EFFECTS OF HURRICANES IRMA AND MARIA ON BIRDS IN THE FAJARDO CHRISTMAS BIRD COUNT IN NORTHEASTERN PUERTO RICO: A PRELIMINARY ASSESSMENT

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Abstract

This report describes the effects of Hurricanes Irma (6 Sept.) and Maria (20 Sept.) in 2017 on bird populations in northeastern Puerto Rico by comparing the Fajardo Christmas Bird Count (FCBC) post-hurricane results (17 Dec. 2017) with pre-hurricane results (18 Dec. 2016). Although the search effort, measured as party hours, was less after the hurricane (45 vs. 54), both FCBCs used similar procedures and relied on volunteers who counted birds in a circular area prescribed by a diameter of 15 miles. Total numbers of individual birds decreased after the hurricanes compared to the 2016 pre-hurricane FCBC (1,934 birds vs. 2,579 birds) as did total species (82 species vs. 97 species). When corrected for search effort the number of species per party hour (ph) was identical in pre- and post-FCBCs (1.8), but the number of individuals per ph decreased by 10.2% from 2016 (47.8) to 2017 (42.9). Most aquatic species (tijeretas, pelicanos, patos, gaviotas), shorebirds (playeros, chorlos) and waders (garzas) declined as expected for species exposed to the direct effects of storm winds and rain. Indirect effects likely caused most declines of nectarivores (-310%, hummingbirds [zumbadores] and Bananaquits [Reinita Común]) as expected for species that lost their food sources (flowers). Fruits and seeds also appeared to have declined and some fruit/seedeaters correspondingly declined as expected (White-crowned Pigeon [Paloma Cabeciblanca] -82%; Puerto Rican Bullfinch [Come ñame]) -70%), perhaps due to mortality or they moved to other sites. In contrast, other fruit/seed-eaters increased (Scaly-naped Pigeon [Paloma Turca] +82%; Red-legged Thrush [Zorzal de Patas Colorados] +100%; Pearly-eyed Thrasher [Zorzal Pardo] +124%; Puerto Rican Oriole [Calandria] +140%), likely due to increased detectability as they wandered more widely than normal in search of food. Counts of insectivores increased substantially afterwards (+1862%), probably due in part to increased detectability, because some vocalized more frequently than normal and were easier to detect (Puerto Rican Woodpecker [Carpentaro] +57%) and some species normally hidden high in the canopy were easier to see once they foraged at ground level in the fallen canopy (Puerto Rican Tody [San Pedrito] +92%). The 2017 FCBC occurred when most birds were wandering widely in search of resources lost in the storm. The proportion of the declines attributable to mortality versus post-storm emigration out of the count circle is unknown. Thus the FCBC occurred during a difficult period to assess population status, which will require future FCBCs after most species have returned to a more sedentary existence.

Key words Caribbean, citizen science, cyclonic storm effects, bird populations, habitat disturbance.

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Hurricanes can directly or indirectly influence bird populations and, in turn, affect some of the characteristics of island avifaunas (reviewed in Waide 1991, Wiley and Wunderle 1994, Wunderle and Wiley 1996). Direct effects of hurricanes on bird populations include mortality due to exposure to high winds, rains, and storm surges. Aquatic species, seabirds, shorebirds, and others with limited shelter options are most vulnerable to these direct effects, although landbirds, as with all birds, can be killed when blown into objects or when trees or debris fall on them. Dead birds found in the immediate aftermath of storms provide evidence of these direct effects. However, finding storm-killed birds can be difficult as carcasses may be covered in debris, washed away, or removed by scavengers. Indirect effects may be detected shortly after a storm's passage, but usually have the longest lasting influence on bird populations. These indirect effects include loss of food resources or foraging substrates, increased risk of predation, loss of nests and nest or roost sites, and microclimate changes. The short-term responses of birds to hurricane damage, at least for terrestrial species, include shifts in diet, habitats, and foraging locations. Terrestrial birds most vulnerable to hurricanes have a diet of nectar, fruit or seeds; roost or forage on large old trees; require closed forest canopy; have special microclimate requirements and/or live in a habitat in which vegetation recovers slowly. These vulnerability traits are exacerbated in small populations isolated in habitat fragments, where the risk of local extinction may be high (e.g. Puerto Rican Bullfinch [Come ñame de Puerto Rico] in St.Kitts - Wunderle et al. 1992).

In the immediate storm aftermath, avian reproduction may be curtailed or nest success decline and reproductive success may change due to mortality of breeders, which shifts population age structure. As vegetation recovers, however, terrestrial birds may respond to outbreaks of herbivorous insects as defoliated plants leaf-out (Torres 1992) and as production of flowers, seeds, and fruits increases (Wunderle 1999). These food resource blooms, before or coinciding with the second post-hurricane breeding season, can increase avian reproductive success because of plentiful food resources enabling breeding pairs to produce multiple clutches extending the normal breeding period (Arendt 2006).

To assess the effects of hurricanes on bird populations and follow their response requires long-term monitoring of populations, both before and after the storm. Unfortunately, long-term monitoring of bird populations is rarely conducted in the Caribbean, although Puerto Rico has some of the longest-running population monitoring efforts in the region. For example, the endangered Puerto Rican Parrot (*Amazona vittata*) population in the Luquillo Mountains, has been monitored by U.S. Fish and Wildlife Service yearly since 1973 (Snyder et al. 1987) including before and after Hurricanes Hugo and Georges (e.g., Beissinger et al. 2008, White et al. 2014) and continues in the aftermath of Hurricanes Irma and Maria in 2017 (Thomas White, pers. com). In contrast to monitoring a single species population, the forest bird community including permanent and winter residents species have been monitored with mist nets and banding in the Guánica Commonwealth Forest on the island's south coast. This ongoing effort was initiated in 1972 and has been conducted for three consecutive days every January (except in 1977 and 1979) for over 45 years and has documented the effect of Hurricane Georges on the dry forest bird community (Faaborg et al. 2013).

Another form of bird population monitoring in Puerto Rico and its satellite islands are the Annual Christmas bird counts (CBC) each of which involve only a day of counting birds per year in a specified area, but after several years counting

at a site CBCs can detect some population trends. Although the regularity with which they have been conducted has varied, CBCs have been conducted in Arecibo, Cabo Rojo, Carite, San Juan, Fajardo, Vieques, and Culebra. As is standard for Christmas Bird Counts, all birds are counted during a day within a circle of 15 miles diameter. As the name suggests, the counts are limited to the holiday season between 14 December and 5 January. CBCs conducted annually for several years, such as Cabo Rojo (27 years) and Fajardo (24 years), provide baseline data to enable before and after comparisons of the avifauna following habitat changes or perturbations. The results from each CBC are archived online and are accessable at: http://www.audubon.org/content/american-birds-annual-summary-christmas-bird-count.

Figure 1. Location of the Fajardo Christmas Bird Count in northeastern Puerto Rico. The count established in 18 December 1994, has been conducted annually with volunteers every December since in a circle of 15 mile diameter as per the count guidelines established by the National Audubon Society.

CBCs were initiated in 1900 when ornithologist, Frank M. Chapman and others concerned about declining bird populations, conducted bird counts on the same day in 25 locations throughout North America. Chapman initiated the bird counts during the holiday period as a conservation alternative to the traditional side hunts in which hunters shot as many wild animals as they could find. Thus began the National Audubon Society's Christmas Bird Counts, which as of the 117th count (2016-17) have included over 2,500 counts with 73,153 observers throughout North America, Latin America, and the Caribbean. Results from the CBCs contribute to a long-term database on bird populations, which has been used by various state and federal agencies and non-government organizations as an important basis for making decisions about birds. Moreover, CBC results have provided the data for over 200 peer-reviewed scientific publications on birds.

The Fajardo Christmas Bird Count (henceforth FCBC) occurs in a 15 mi diameter circle (center at 18° 18' N 65° 42' W), which was established in northeastern Puerto Rico as a site for an annual bird population monitoring program, which includes a diversity of habitats and the major protected areas of the region (Figure 1). Protected areas within the 15 mi diameter circle include a portion El Yunque National Forest (also known as the Luquillo Experimental Forest), Northeast Ecological Corridor, Las Cabezas de San Juan Natural Reserve, Ceiba Commonwealth Forest, and portions of the former naval base at Roosevelt Roads. The first FCBC was conducted on 18 December 1994, and has occurred annually since with assistance of several organizations and numerous volunteers or citizen scientists (see acknowledgements). The FCBC was initiated to monitor bird

populations annually over many years with citizen scientist participation to determine the status of various bird species and to provide baseline for comparisons of population changes after future habitat changes and perturbations, such as hurricanes and droughts. Therefore the FCBC was well positioned with baseline of pre-hurricane bird abundance data to document the effects of two hurricanes in 2017. The count area was first affected by Hurricane Irma, which brushed the northeast coast of Puerto Rico on 6 September 2017, followed two weeks later on 20 September by Hurricane Maria, which crossed the island from southeast to northwest as a class 4 hurricane. Thus this paper describes the effects of Hurricanes Irma and Maria in 2017 on bird populations in northeastern Puerto Rico by comparing results of the 2017 FCBC obtained ~3 months after Hurricane Maria with the results of the 2016 FCBC. The objective of this report is to describe the changes in bird populations shortly after two hurricanes affected northeastern Puerto Rico. This report should be viewed as preliminary because it is based on only one pre-hurricane FCBC (2016) as baseline and does not include the other available years, which will be included in future analyses.

The 24th Fajardo Christmas Bird Count was conducted on 17 December 2017, after substantial storm damage and lingering shock and disruptions from Hurricanes Irma (6 Sept.) and Maria (20 Sept.). Despite extensive defoliation (estimated 50-100%), and loss of tree branches with some trees felled or snapped, vegetation recovery by count day was well underway, at least for re-growth of leaves and some vines in the lowlands. In the lower elevations, most trees had re-sprouted new leaves in contrast to the higher elevations in El Yunque, where leaf sprouting was rare in most species (except tree ferns [Helecho de árbol] and *Cercropia peltata* [Yagrumo hembra]).

METHODS

The FCBC follows the methods specified by the National Audubon Society at: http://www.audubon.org/christmas-bird-count-compiler-resources. Although, only 43 people participated in the 2017 count (compared to 70 people in 2016), all but one of the experienced guides/leaders from previous FCBCs surveyed their traditional sites or routes in the count circle. These leaders and their assistants surveyed 15 sites in 2017, only one less than in the previous 2016 count, which included an additional site in Roosevelt Roads. In both 2016 and 2017, an owl (Múcaro) census was conducted from 5:30-6:30 am and the separate groups began their counts between 6:00 – 7:00 am. All morning groups ended their counts between 11:00 am – 12:00 pm and only one group searched for birds in the afternoon until 5:00 pm in both years. Overall, the search effort for the 2017 count was only 45 party hours (i.e., total time spent in the field by each of the separate groups or parties), which was below the 54 party hours of effort in 2016 (Tables 1 and 2 summarize the party hours, sites, and group leaders for 2016 and 2017 respectively).

RESULTS AND DISCUSSION

Overall, we tallied 1,934 birds of 82 species, both of which were low counts for past FCBCs (e.g., 2016 FCBC had 2,579 birds, 97 species). When corrected for search effort in the field, we found 1.8 species per party hour (ph), a value not much lower than the mean for counts of the previous 10 years and within the range of earlier counts (1.8-2.2 species per ph). In marked contrast to species per ph, however, we had only 43 individual birds per ph, which was well below the 10-year mean of 59.6 individuals per ph and outside the 10-year range of previous counts (47.7-68.2 individuals per ph). Thus, post-hurricane field groups (or parties)

Table 1. Summary of places, leaders, group sizes, time on foot, distance (miles) on foot, time in car, distance (miles) in car for the 23rd Fajardo Christmas Bird Count on 18 December 2016.

Place	Group Leader(s)	Group size	Foot time	Foot distance	Car time	Car Distance	Party No.
Owling Party-EYNF/LEF	Joe Wunderle	12	1	0.2	0	0	Owls
Morning Parties							
El Faro I –Las Cabezas de San Juan	Eduardo Esquilin Solís	7	3	3	0	0	1
El Faro II –Las Cabezas de San Juan	Antonia Bulnes Galán	9	1.5	3	0	0	2
El Faro III –Las Cabezas de San Juan	Leonor Alicea Rodríguz	7	3	2	0	0	3
Colinas del Yunque	Jean Lodge	3	0.5	0.1	2	4.3	4
Rio Mar Resort	Jean Lodge	3	0	0	2.7	8.1	4
El Portal/Catalina, EYNF/LEF	Edgar Vázquez	2	2.8	2.5	0	0	5
Bisley, EYNF/LEF	Victor Cuevas & José R. Burset	4	5.25	2	0.5	2.5	6
Icacos Valley, EYNF/LEF	Joe Wunderle	3	1.5	1	0	0	7
Yokahú Tower & Rte 191	Joe Wunderle	3	0.55	0.05	0.1	3	7
Roosevelt Roads 1 (Machos wetland)	Emilio Font	5	0.25	1	4.75	12	8
Roosevelt Roads 2	Noel Rivera Gomez	17	1.5	1.1	2	6.2	9
Bosque de Ceiba-Cayo Largo	Sharon Cantrell & Carlos Laboy	2	6.25	3	0.5	1	10
San Miguel –NE Ecological Corridor	Laura Fidalgo & Luis Villaneuva	4	5.75	3.5	0	0	11
Finca Las Paulinas –NE Ecological Cor.	Omar Monzón-Carmona	2	2.51	2.4	0	0	12
Big Tree Trail, EYNF/LEF	Felipe Cano	5	3.25	3	0	0	13
Afternoon Party							
Governor's Beach & Laguna de Aguas Prietas	Joe Wunderle & Emilio Font	6	2.5	0.75	0.25	1	14
TOTALS (Excludes Owling)			40.11	28.4	12.8	38.1	
Total Party Hours	53.91						
Total Party Miles	66.5						
Total Participants	70						

encountered new species for their lists at a rate only slightly lower than in previous counts, but encounters of new individual birds were markedly lower than previously. Thus, not surprisingly after two hurricanes, the number of individual birds counted was much reduced, although there was considerable variation among species in changes in counts of individuals (Appendices 1 and 2 summarize counts of all species in 2016 and 2017 FCBCs respectively).

To compare potential hurricane effects on individual species and groups of species I corrected all counts for effort (i.e., divided by party hours, ph) and compared the post-hurricane 2017 results with last year's 2016 FCBC. Given this correction for effort the number of species per party hour was identical in 2016 (1.79) and 2017 (1.80), but the number of individuals per ph decreased by 10.2% from 2016 (47.84) and 2017 (42.9).

I expected that aquatic species (pelicanos, patos, gaviotas), shorebirds (playeros, chorlos), and waders (garzas) would show some of the most severe post-hurricane declines given their exposure risk in open habitats with limited cover. Indeed this was the case for marine species all of which showed severe post-hurricane declines (Magnificent Frigatebird [Tijereta], -81.5%; Brown Pelican [Pelicano] -42.4%; Clapper Rail [Pollo de Mangle], -93.6%; Royal Tern [Gaviota Real], -82.9%). Although some aquatic species that swim on the water surface increased (Common Gallinule [Gallareta común] +27.9%), probably because they were easier to detect, others such as White-checked Pintails [Pato Quijada Colorado] declined (11 before to 0 after). Eighty percent of 15 shorebird species (playeros, chorlos) declined after the hurricane. However, the migrant Lesser Yellowlegs [Playero Guineilla Pequeña] increased from 0.17 individu-

Table 2. Summary of count places, leaders, group sizes, time on foot, distance (miles) on foot, time in car, distance (miles) in car for the 24th Fajardo Christmas Bird Count on 17 December 2017.

Place	Group Leader(s)	Group size	Foot time	Foot distance	Car time	Car Distance	Party No.
Owling Party-EYNF/LEF	Joe Wunderle	8	1	0.2	0	0	Owls
Morning Parties							
El Faro I –Las Cabezas de San Juan	Eduardo Esquilin Solís	2	2	3	0	0	1
El Faro II –Las Cabezas de San Juan	Eduardo Esquilin Solís	2	1	3	0	0	1
El Faro III –Las Cabezas de San Juan	Eduardo Esquilin Solís	2	0.5	2	0	0	1
Colinas del Yunque Urb.	Jean Lodge	2	0.5	0.13	2.5	4.3	2
Rio Mar Resort	Jean Lodge	2	0.5	0.13	1.5	8.1	2
El Portal/Catalina, EYNF/LEF	Edgar Vázquez	7	2	2.5	0	0	3
Bisley, EYNF/LEF	Victor Cuevas & José R. Burset	2	3	2	0	0	4
Rte 988 & 983	Victor Cuevas & José R. Burset	2	0	0	3	3	4
Icacos Valley, EYNF/LEF	Joe Wunderle	3	2	1	0	0	5
Yokahú Tower & Rte 191	Joe Wunderle	3	0.4	0.05	0.1	3	5
Roosevelt Roads 1 (Machos wetland)	Emilio Font	6	0.25	1.5	3.75	10.8	6
Bosque de Ceiba-Cayo Largo	Sharon Cantrell & Carlos Laboy	3	6.25	5.5	0.5	1	7
San Miguel –NE Ecological Corridor	Laura Fidalgo & Luis Villaneuva	8	4.75	4.7	0	0	8
Finca Las Paulinas –NE Ecological Cor.	José Salguero & Omar Monzón	8	4	1.5	0	0	9
Big Tree Trail, EYNF/LEF	Felipe Cano & Jessica Ilse	2	3.81	2.71	0	0	10
Afternoon Party							
Governor's Beach & Laguna de Aguas Prietas	Joe Wunderle & Emilio Font	6	2.5	0.75	0.25	1	11
TOTALS (Excludes Owling)			33.46	30.47	11.6	31.2	
Total Party Hours	45.06						
Total Party Miles	61.67						
Total Participants	43						

als per ph (9 birds) to 2.38 individuals (107 birds) after the hurricanes possibly because of increased detectability and the likelihood that this migrant species arrived on the island after the hurricanes.

The counts of herons and egrets (garzas) per party hour actually increased after the storms, but this was attributable to a colony of 53 Snowy Egrets (Garza Blanca), which surprisingly, were breeding as evidenced by courtship displays, copulations and 3 egrets [garzas] incubating/brooding on nests) on the Rio Mar Resort property. Removal of the Snowy Egret (Garza Blanca) colony tally from the analysis indicated that herons/egrets numbers declined by 173% after the storms.

Native or permanent resident raptors (hawks and falcons; guaraguaos y falcónes) declined by an average of only 8.1%, despite the 92% increase in Red-tailed Hawks in this year's count (likely due to increased detectability). American Kestrels (Falcón Común), a resident species, declined by -71.2%, which pulled the average down for the resident raptors.

As found in many post-hurricane studies, nectarivores (hummingbirds [zumbadores] and Bananaquits [Reinita Común) showed the greatest decrease (-310%) of any group of birds, but not too surprising given the disappearance of their flowers. Frugivore/seedeaters, however, showed an increase of 632% from the 2016 counts per ph, which was unexpected given marked declines in fruits and seeds. Many frugivore/seedeaters were likely actively searching for food, and hence much easier to detect (Monk Parakeets [Periquito Monje] +619%; Scaly-naped Pigeon [Paloma Turca] +82%; Red-legged Thrush [Zorzal de Patas Colorados] +100%; Pearly-eyed Thrasher [Zorzal Pardo] +124%; Puerto Rican Oriole [Calandria] +140%), but other frugivore/seedeaters showed decreases possibly due to mor-

tality or movement to other sites (White-crowned Pigeon [Paloma Cabeciblanca] -82%; Ruddy Quail-Dove [Paloma Perdiz Rjoza] -100%; Puerto Rican Bullfinch [Come name] -70%). Although native seed-eating finches showed increased numbers (Yellow-faced Grassquit [Gorrión Barba Amarilla] +20%; Black-faced Grassquit [Gorríon Negro] +34%) all the non-native finches declined (Bronze Mannikin [Diablito] -79%) and most other formerly common non-native species were absent showing declines of 100% (Nutmeg Mannikin [Gorrión Canela], Orange-cheeked Waxbill [Veterano Mejillianarajado], Pin-tailed Whydah [Viuda Colicinta]). Whether these differences in detections represent response differences to hurricanes by the native and non-native finches needs further study.

Counts of insectivorous species increased substantially after the storms (+1862%), likely due in part to increased detectability, because some vocalized more frequently than normal and were easier to see (Puerto Rican Tody [San Pedrito] +92%; Puerto Rican Woodpecker [Carpentaro] +57%; Logger-head Kingbird [Clérigo] +1098%). But other normally vocal insectivores were unusually quiet (Adelaide's Warbler [Mariposera] -4%) as was the omnivorous Puerto Rican Tanager ([Llorosa] +60%). A species of conservation concern, the insectivorous endemic Elfin-woods Warbler [Reinita de Bosque Enano] was found on the Big Tree Trail in El Yunque N.F., but not in the Icacos valley (where previously found) possibly due to the extensive defoliation there. Counts of migrant insectivores were on average higher after the hurricane (+559%) than before probably also likely due to increased detectability (Northern Parula [Reinita Pechidorado] +350%; Black-throated Blue Warbler [Reinita Azul] +259%, Prairie Warbler [Reinta Galana] +200%). Nonetheless, some migrant species did show declines in counts, such as Northern Waterthrush (Pizpita de Mangle, -48%) and Louisiana Waterthrush (Pizpita de Rio, -100%) both possibly due to loss of canopy cover over their ground foraging sites.

How do we interpret all of these seemingly inconsistent post-hurricane changes in bird numbers (i.e., both increases in some species and decreases in others) after the 2017 hurricanes? The Fajardo bird count occurred almost three months after the passage of Maria, during a post-hurricane period when birds are wandering widely in search of critical resources lost in the storm (food, foraging substrates, cover, nesting and roosting sites, etc.). Similar post-hurricane wandering was found for several months after Hurricane Hugo in mist net captures, which were unusually high (above baseline levels), especially for canopy dwelling species (Wunderle 1995). Increases in counts of some species such as frugivores are also consistent with previous observations of frugivores concentrating in fruit-rich sites. Such food patches may exist because of sheltered locations or rapid recovery of certain fruiting plants (Wunderle et al. 1992, Wunderle 1995). Palms, especially Royal Palms (*Roystonea* sp.) are known to be especially attractive to birds when fruiting after hurricanes (Wiley and Wunderle 1994, Wunderle and Wiley 1996).

In summary, some post-hurricane increases may result from birds concentrating in some of the few food-rich patches, while decreases occurred in sites where food or other resources have disappeared. Increased post-hurricane detectability also plays a large role especially for displaced canopy dwellers foraging at ground level where they are easier to observe (e.g., Puerto Rican Tody, San Pedrito), or simply because the absence of leaves makes some species easier to observe (e.g., some insectivorous birds). The FCBC coincided with the post-hurricane period when many birds were still wandering in search of resources eliminated or damaged by the hurricanes. Therefore, the FCBC occurred during a difficult period to evaluate population status, which will require future FCBCs to determine the

status of the island's species in response to the 2017 hurricanes. Although there are likely to be substantial differences among bird species in their rates of recovery to pre-hurricane abundance I am optimistic that most bird populations will recover as they have from past hurricanes, assuming that their habitat is not lost to development.

Acknowledgements

The success of the Fajardo Christmas Bird Count is due to the enthusiastic contribution of participants, especially in the challenging year after the devastating hurricanes, leaving some participants without electricity, water, and reliable communications at the time of the count. Their commitment to the FCBC is very much appreciated. Also appreciated are the various organizations that contributed to the event including the Puerto Rican Ornithological Society Inc. (SOPI), Para la Naturaleza, Coalition for Defense of the Northeastern Ecological Corridor, and the USDA Forest Service (International Institute of Tropical Forestry & El Yunque National Forest). To organize and lead the many participants requires experienced observers who led groups in different areas and kept records of the birds observed as well as notes on search efforts. The group and co-group leaders represent the backbone of the Fajardo count and their regular participation contributes greatly to the consistency of the count, facilitating analyses of long-term trends. Thanks to those who led or co-led groups including: José Burset, Sharon Cantrell, Sergio Colón, Victor Cuevas, Felipe Cano, Carlos Laboy, Eduardo Esquilín, Laura Fidalgo, Emilio Font, Jessica Ilse, Jean Lodge, Edgar Vázquez, and Luis Villaneuva. Edwardo Esquilín facilitated the use of Las Cabezas de San Juan Reserve as a mid-day meeting site. Emilio Font obtained permission to census birds at Roosevelt Roads and coordinated count efforts there, as well as obtaining permission to census the Governor's Beach, and Laguna de Aguas Prietas. I thank Olga Ramos for preparation of Figure 1. This study was conducted in cooperation with the University of Puerto Rico.

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Appendix 1. Results of the 23rd Fajardo Christmas Bird Count conducted on 18 December 2016 in the year before Hurricanes Irma and Maria, in northeastern Puerto Rico summarizing tallies per site for each species. The number at the head of each column refers to the site or route surveyed for birds in the count circle. The key to the numbered sites is found at the bottom of the table along with the leaders responsible for the counts at each specified site. The total number of observations for each species is designated by the column labeled "Tot" and Tot/Ph refers to the total number of individuals of the species divided by the total party hours (53.9 party hours).

Species	Sites by number (See key at end)																	Tot
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Tot	/Ph
Pied-billed Grebe			1		1							2					4	0.07
(Zaramago)																		
Mag. Frigatebird	21									2	1			1		1	26	0.48
(Tijereta)																		
Brown Pelican	8		2		2					21	5	7		4		3	52	0.96
(Pelicano pardo)																		
White-cheeked Pintail										11							11	0.20
(Pato quijada colorado)																		
Tricolored Heron	1		1							2							4	0.07
(Garza pechiblanca)																		
Little Blue Heron	9									10	2						21	0.39
(Garza azul)																		
Snowy Egret					12					2			2			1	17	0.32
(Garza blanca)																		
Great Blue Heron	2	1															3	0.06
(Garzón azulado)																		
Great Egret	1		2		4		1			9	7	8		4			36	0.67
(Garza real)																		
Cattle Egret				1	12						9	3					25	0.46
(Garza de ganado)																		
Green Heron	2	1					1				1	4					9	0.17
(Martinete)																		
Yellow-cr. Night-Heron	3																3	0.06
(Yaboa común)																		
Least Bittern																	0	
(Martinetito)																		
Osprey					1					4							5	0.09
(Aguila pescadora)																		
Red-tailed Hawk				1		1	3	1	4		3	2	2	5	2	1	25	0.46
(Guaraguao colirrojo)																		
Broad-winged Hawk							1										1	0.02
(Guaraguao de bosque)																		
American Kestrel					2					7	1	2		1		4	17	0.32
(Falcón común)																		
Merlin																	0	
(Esmerejón)																		
Peregrine Falcon							1						1				2	0.04
(Falcón peregrino)																		
Clapper Rail	9	2									8						19	0.35
(Pollo de mangle)																		
Common Moorhen					9					1		4		3			17	0.32
(Gallareta común)																		
Caribbean Coot																	0	
(Gallinazo antillano)																		
Solitary Sandpiper	1		1														2	0.04
Playero solitario																		
Greater Yellowlegs										2							2	0.04
(Playero guineilla grande)																		
Lesser Yellowlegs	2									5	2						9	0.17
(Playero guineilla pequeña)																		
Spotted Sandpiper	2									2	1			6			11	0.20
(Playero coleador)																		
Ruddy Turnstone										5							5	0.09
(Playero turco)																		
Least Sandpiper	11										1						12	0.22
(Playero menudo)																		
Semipalmated Sandpiper										3	8						11	0.20
(Playerito gracioso)																		

Species	Sites by number (See key at end)																	Tot
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Tot	/Ph
Stilt Sandpiper			4								22	1					27	0.50
(Playero patilargo)																		
Short-billed Dowitcher											30						30	0.56
(Chorlo pico corto)																		
Black-necked Stilt											22	1					23	0.43
(Viuda)																		
Black-bellied Plover											13						13	0.24
(Playero cabezón)																		
Semipalmated Plover															23		5	28	0.52
(Playero acollarado)																		
Killdeer																	0	
(Playero sabanero)																		
Wilson's Plover			1														1	0.02
(Playero marítimo)																		
Laughing Gull											2						2	0.04
(Gaviota gallega)																		
Royal Tern			1								6						7	0.13
(Gaviota real)																		
Rock Pigeon						2								12		25	39	0.72
(Paloma caseral)																		
White-crowned Pigeon			14	4							1	1					20	0.37
(Paloma cabeciblanca)																		
Scaley-naped Pigeon			1	4		2		22	22	1	1	1	3	4	3	2	66	1.22
(Paloma turca)																		
Zenaida Dove			14	7		13	7	12	3		5	1	30		2		8	102	1.89
(Tórtola cardosantera)																		
White-winged Dove			4	8		46	11	10	1		3	1	4	8	1		1	98	1.82
(Tórtola aliblanca)																		
Mourning Dove													7					7	0.13
(Tórtola plañidera)																		
Common Ground Dove			2	2	2	7					6	1	3	12	23		3	61	1.13
(Rolita)																		
Ruddy Quail-Dove								2					4	3		1	1	11	0.20
(Paloma perdiz rojiza)																		
Monk Parakeet							2										2	0.04
(Periquito monje)																		
Orange-fronted Parakeet						6		2	2								10	0.19
(Periquito frentianaranjado)																		
White-winged Parakeet (Canary-wing)						12											12	0.22
(Periquito aliblanco)																		
Mangrove Cuckoo				1				1	5			2	3		2		14	0.26
(Pájaro bobo menor)																		
PR Lizard Cuckoo						2		1	6							2	11	0.20
(Pájaro bobo mayor)																		
Smooth-billed Ani						1					5		21		5		32	0.59
(Judío)																		
PR Screech Owl										14						1	15	0.28
(Múcaro de Puerto Rico)																		
Antillean Mango											1				1		2	0.04
(Zumbador dorado)																		
Green Mango													2		1		3	0.06
(Zumbador verde)																		
Antillean Cr. Hummingbird			1	6							1			6	3		17	0.32
(Zumbadorcito crestado)																		
Puerto Rican Emerald				1					1				3			2	7	0.13
(Zumbadorcito de PR)																		
Belted Kingfisher											1						1	0.02
(Martín pescador)																		
Puerto Rican Tody						1		3	16	2		4		4	1	1	1	33	0.61
(San pedrito)																		
Puerto Rican Woodpecker				1		8		5	1			1	2	3	2	3		26	0.48
(Carpintero de PR)																		
Caribbean Elaenia				5								18	4					27	0.50
(Juí blanco)																		

Species	Sites by number (See key at end)																	Tot
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Tot	/Ph
Puerto Rican Flycatcher								1			1			1	1	1	1	6	0.11
(Juí de Puerto Rico)																			
Gray Kingbird			12	8	8	35	14	6	7		27	19	40	8	18		10	212	3.93
(Pitirre)																			
Loggerhead Kingbird								1										1	0.02
(Clérigo)																			
Cave Swallow																		0	
(Golandrina de cuevas)																			
Red-legged Thrush						5		8	3				2					18	0.33
(Zorzal de patas coloradas)																			
N. Mockingbird						19					6	1	15	3	2			46	0.85
(Ruiseñor)																			
Pearly-eyed Thrasher						4	6	5			3		1	2	2			23	0.43
(Zorzal pardo)																			
PR Vireo												1						1	0.02
(Bien-te-veo)																			
Black-whiskered Vireo								7	5							1		13	0.24
(Julián Chiví)																			
Red-eyed Vireo																1		1	0.02
(Julián Chiví ojirrojo)																			
Black-and-white Warbler											1	1						2	0.04
(Reinita trepadora)																			
Prothonotary Warbler																		0	
(Reinita anaranjada)																			
Northern Parula				3							3	1		1				8	0.15
(Reinita pechídorado)																			
Yellow Warbler			1								2							3	0.06
(Canario de mangle)																			
Black-thr. Blue Warbler								1										1	0.02
(Reinita azul)																			
Adelaide's Warbler			7	18	11						6		20	9	11		4	86	1.60
(Reinita mariposera)																			
Blackpoll Warbler																		0	
(Reinita rayada)																			
Prairie Warbler				1													1	2	0.04
(Reinita galana)																			
Elfin Woods Warbler																		0	
(Reinita de bosque enano)																			
Ovenbird														5				5	0.09
(Pizpita dorado)																			
Northern Waterthrush			5	2		1					48	9	5		1		1	72	1.34
(Pízpita de mangle)																			
Louisiana Waterthrush								5								2		7	0.13
(Pízpita de río)																			
Common Yellowthroat													3					3	0.06
(Reinita pica tierra)																			
Hooded Warbler											1							1	0.02
(Reinita capucha)																			
American Redstart								1			7						1	9	0.17
(Candelíta)																			
Bananaquit			7	16	3	55	4	28	35	1	2	21	2	40	23	50	49	15	351	6.51
(Reinita común)																			
P. R. Stripe-headed Tanager										2		1		1		3	2		9	0.17
(Reina mora)																			
Puerto Rican Tanager								2	1	3	2						1		9	0.17
(Llorosa)																			
PR Bullfinch								7	5	3	1								16	0.30
(Come ñame de PR)																			
Yellow-faced Grassquit													4						4	0.07
(Gorrión barba amarilla)																			
Black-faced Grassquit						1			1			16	2	20	7	6			53	0.98
(Gorrión negro)																			
Shiny cowbird			6			6													12	0.22
(Tordo lustroso)																			

Species	Sites by number (See key at end)																Tot	Tot
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Tot	/Ph
Greater Antillean Grackle			9	2		113	32				16	9	4	18	2		205	3.80
(Chango)																		
Puerto Rican Oriole			3				1	3	2						2		11	0.20
(Calandria capuchinegra)																		
House Sparrow						2								3			5	0.09
(Gorrión inglés)																		
Pin-tailed Whydah						2							80				82	1.52
Viuda colicinta																		
Orange-cheeked Waxbill													7	5	5		17	0.32
Veterano mejillianaranjado																		
Bronze Mannikin						14	55						2	2			73	1.35
(Diablito)																		
Nutmeg Mannikin						35	9						3		4		51	0.95
(Gorrión canela)																		
Muscovy Duck							9										9	0.17
(Pato criollo)																		
Western Sandpiper			15														15	0.28
(Playerito occidentalis)																		
Worm-eating Warbler											1						1	0.02
(Reinita gusanera)																		
Chuck-wills-widow													1				1	0.02
(Guabairo mayor)																		
Lesser Scaup																10	10	0.19
(Pato pechiblanco menor)																		
Unidentified Duck species																	5	0.09
(Pato especies)																		
Unidentified Warbler sp.								3			1						4	0.07
(Reinita spp.)																		
Unidentified Hummingbird sp.			1	2	2						1	1					7	0.13
(Zumbador spp.)																		
Unidentified finch					8												8	0.15
(Gorrión spp)																		
Unidentified Vireo								3			1						4	0.07
Unidentifie d Dove												1					1	0.02
(Tortola sp.)																		

Total Individuals = 2579
Total Species = 97

Code	Locations	Leader
1	El Farro I	Eduardo Esquilín Solís
2	El Farro II	Antonio Bulnes Galán
3	El Farro III	Leonor Alicea Rodríguez
4	Colinas del Yunque	Jean Lodge
5	Rio Mar	Jean Lodge
6	El Portal - Catalina, EYNF	Edgar Vázquez
7	Bisley Watersheds, rte 988, EYNF	Victor Cuevas & José R. Burset
8	Icacos Valley, EYNF	Joe Wunderle
9	Yokahu Tower Rte. 191, EYNF	Joe Wunderle
10	Roosevelt Roads I (Machos wetland & p7.4)	Emilio Font
11	Roosevelt Roads II	Noel Rivera Gómez & Jean C. Díaz
12	Bosque de Ceiba (includes Cayo Largo)	Sharon Cantrell & Carlos Laboy
13	Finca Las Paulinas, El Convento-NE Ecological Corr.	Omar Monzón-Carmona
14	San Miguel - NE Ecological Corridor	Laura Fidalgo & Luis Villaneuva
15	Big Tree Trail, EYNF	Felipe Cano
16	Governor's Beach & La Laguna de Aguas Prietas	Joe Wunderle & Emilio Font

Appendix 2. Results of the 24th Fajardo Christmas Bird Count conducted on 17 December 2017 after Hurricanes Irma and Maria, in northeastern Puerto Rico summarizing tallies per site for each species. The number at the head of each column refers to the site or route surveyed for birds in the count circle. The key to the numbered sites is found at the bottom of the table along with the leaders responsible for the counts at each specified site. The total number of observations for each species is designated by the column labeled "Tot" and Tot/Ph refers to the total number of individuals of the species divided by the total party hours (45 party hours).

Species	Sites by number (See key at end)																Tot
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Tot	/Ph
Pied-billed Grebe					1						1					2	0.04
(Zaramago)																	
Mag. Frigatebird	1									1	2					4	0.09
(Tijereta)																	
Brown Pelican	3	2								8	11				1	25	0.56
(Pelicano pardo)																	
White-cheeked Pintail																0	0.00
(Pato quijada colorado)																	
Tricolored Heron																0	
(Garza pechiblanca)																	
Little Blue Heron										5						5	0.11
(Garza azul)																	
Snowy Egret					53								1			54	1.20
(Garza blanca)																	
Great Blue Heron											2					2	0.04
(Garzón azulado)																	
Great Egret		5			2		1			3	5					16	0.36
(Garza real)																	
Cattle Egret				3	22		1				2	1				29	0.64
(Garza de ganado)																	
Green Heron	2			1							5		2			10	0.22
(Martinete)																	
Yellow-cr. Night-Heron	1										1					2	0.04
(Yaboa común)																	
Least Bittern											1					1	0.02
(Martinetito)																	
Osprey										1					1	2	0.04
(Aguila pescadora)																	
Red-tailed Hawk				2		2	7	3	8	1	2	2	2	8	2	39	0.87
(Guaraguao colirrojo)																	
Broad-winged Hawk																0	0.00
(Guaraguao de bosque)																	
American Kestrel										2		1			1	4	0.09
(Falcón común)																	
Merlin											1				1	2	0.04
(Esmerejón)																	
Peregrine Falcon											1	1				2	0.04
(Falcón peregrino)																	
Clapper Rail	1															1	0.02
(Pollo de mangle)																	
Common Moorhen					10					3	4		1			18	0.40
(Gallareta común)																	
Caribbean Coot					2											2	0.04
(Gallinazo antillano)																	
Solitary Sandpiper																0	
Playero solitario																	
Greater Yellowlegs																0	
(Playero guineilla grande)																	
Lesser Yellowlegs	1									106						107	2.38
(Playero guineilla pequeña)																	
Spotted Sandpiper											1		11			12	0.27
(Playero coleador)																	
Ruddy Turnstone										2						2	0.04
(Playero turco)																	
Least Sandpiper																0	
(Playero menudo)																	
Semipalmated Sandpiper																0	
(Playerito gracioso)																	

Species	Sites by number (See key at end)																Tot
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Tot	/Ph
Stilt Sandpiper																0	
(Playero patilargo)																	
Short-billed Dowitcher																0	
(Chorlo pico corto)																	
Wilson's Snipe																0	
(Becasina de Wilson)																	
Black-necked Stilt	2															2	0.04
(Viuda)																	
American Oystercatcher																0	
(Ostero o Caracolero)																	
Black-bellied Plover										8						8	0.18
(Playero cabezón)																	
Semipalmated Plover													19			19	0.42
(Playero acollarado)																	
Killdeer											1					1	0.02
(Playero sabanero)																	
Wilson's Plover																0	
(Playero marítimo)																	
Laughing Gull																0	
(Gaviota gallega)																	
Royal Tern											1					1	0.02
(Gaviota real)																	
Rock Pigeon							4					45				49	1.09
(Paloma caseral)																	
White-crowned Pigeon		3														3	0.07
(Paloma cabeciblanca)																	
Scaley-naped Pigeon	1	3	1	12		8	6	7	1	3	14	8	14	20	3	101	2.24
(Paloma turca)																	
Zenaida Dove		2		16	22	9	9			10	3		6		2	79	1.76
(Tórtola cardosantera)																	
White-winged Dove				27		6				1		34	1			69	1.53
(Tórtola aliblanca)																	
Mourning Dove											6	1				7	0.16
(Tórtola plañidera)																	
Common Ground Dove	3			6						7	25	13	6		3	63	1.40
(Rolita)																	
Ruddy Quail-Dove																0	
(Paloma perdiz rojiza)																	
Monk Parakeet				4							3		5			12	0.27
(Periquito monje)																	
Orange-fronted Parakeet				4			1						3			8	0.18
(Periquito frentianaranjado)																	
White-winged Parakeet (Canary-wing)																0	
(Periquito aliblanco)																	
Mangrove Cuckoo				1							1		1		1	4	0.09
(Pájaro bobo menor)																	
PR Lizard Cuckoo				2		1	4					1				8	0.18
(Pájaro bobo mayor)																	
Smooth-billed Ani	5		1	10								1				17	0.38
(Judío)																	
PR Screech Owl						4										4	0.09
(Múcaro de Puerto Rico)																	
Antillean Mango				1												1	0.02
(Zumbador dorado)																	
Green Mango																0	
(Zumbador verde)																	
Antillean Cr. Hummingbird												1				1	0.02
(Zumbadorcito crestado)																	
Puerto Rican Emerald				3												3	0.07
(Zumbadorcito de PR)																	
Belted Kingfisher	1									4	1					6	0.13
(Martín pescador)																	
Puerto Rican Tody				5		4	23	2		5	4	3		7		53	1.18
(San pedrito)																	

Species	Sites by number (See key at end)															Tot	Tot
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Tot	/Ph
Puerto Rican Woodpecker				12		1	10	1		1	2	4	1	2		34	0.76
(Carpintero de PR)																	
Caribbean Elaenia		1								1	1	1				4	0.09
(Juí blanco)																	
Puerto Rican Flycatcher				4			1				1		1			7	0.16
(Juí de Puerto Rico)																	
Gray Kingbird	11			55	11	1	4			9	37	25	13		5	171	3.80
(Pitirre)																	
Loggerhead Kingbird				9		1										10	0.22
(Clérigo)																	
Cave Swallow				4								4				8	0.18
(Golandrina de cuevas)																	
Red-legged Thrush				11		6	11				1	1				30	0.67
(Zorzal de patas coloradas)																	
N. Mockingbird				4	1		1			10	8	2			2	28	0.62
(Ruiseñor)																	
Pearly-eyed Thrasher	2			9	1		1	7		4	4	8	3	1	3	43	0.96
(Zorzal pardo)																	
PR Vireo							1									1	0.02
(Bien-te-veo)																	
Black-whiskered Vireo				2		1	2							1		6	0.13
(Julián Chiví)																	
White-eyed Vireo																0	
(Vireo ojiblanca)																	
Red-eyed Vireo																0	
(Julián Chiví ojirrojo)																	
Black-and-white Warbler											3					3	0.07
(Reinita trepadora)																	
Prothonotary Warbler																0	
(Reinita anaranjada)																	
Northern Parula				8	3	1	7			1	10					30	0.67
(Reinita pechídorado)																	
Yellow Warbler												1			1	2	0.04
(Canario de mangle)																	
Black-thr. Blue Warbler							2		1							3	0.07
(Reinita azul)																	
Adelaide's Warbler	7	5	3							8	14	17	12		3	69	1.53
(Reinita mariposera)																	
Blackpoll Warbler				1												1	0.02
(Reinita rayada)																	
Prairie Warbler												5				5	0.11
(Reinita galana)																	
Elfin Woods Warbler														1		1	0.02
(Reinita de bosque enano)																	
Ovenbird											1	2				3	0.07
(Pizpita dorado)																	
Northern Waterthrush	2	2			1					20	3		2		1	31	0.69
(Pízpita de mangle)																	
Louisiana Waterthrush																0	
(Pízpita de río)																	
Common Yellowthroat																0	
(Reinita pica tierra)																	
Hooded Warbler												1				1	0.02
(Reinita capucha)																	
American Redstart							2	3		2	1	1		4		13	0.29
(Candelíta)																	
Bananaquit		6	3	57	1	19	19	6	1	17		13	34	26	8	210	4.67
(Reinita común)																	
P. R. Spindalis					2	1	1					1		2		7	0.16
(Reina mora)																	
Puerto Rican Tanager							3	4						5		12	0.27
(Llorosa)																	
PR Bullfinch					1		1	2								4	0.09
(Come ñame de PR)																	

Species	Sites by number (See key at end)															Tot	Tot
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Tot	/Ph
Yellow-faced Grassquit												4				4	0.09
(Gorrión barba amarilla)																	
Black-faced Grassquit	5	4	1	7						8	7	9	17		1	59	1.31
(Gorrión negro)																	
Shiny cowbird				4								14				18	0.40
(Tordo lustroso)																	
Greater Antillean Grackle	5			67	55		11				17	26			3	184	4.09
(Chango)																	
Puerto Rican Oriole					15	2	2				1		2			22	0.49
(Calandria capuchinegra)																	
House Sparrow					3							10				13	0.29
(Gorrión inglés)																	
Pin-tailed Whydah																0	
Viuda colicinta																	
Orange-cheeked Waxbill																0	
(Veterano mejillianaranjado)																	
Bronze Mannikin					13											13	0.29
(Diablito)																	
Nutmeg Mannikin																0	
(Gorrión canela)																	
Jungle Fowl							3									3	0.29
(Gallo)																	
Muscovy Duck					16											16	0.36
(Pato criollo)																	
Eurasian Collared-Dove												1				1	0.02
(Paloma collarina)																	
Unidentified Hummingbird sp.											1		1			2	0.04
(Zumbador spp.)																	
Unidentified Pigeon															2	2	0.04
(Paloma spp)																	

Total Individuals = 1,934
Total Species = 82 species

Code	Locations or routes	Leader
1	El Faro I – Las Cabezas Reserva Natural	Eduardo Esquilín Solís
2	El Faro II - Las Cabezas Reserva Natural	Eduardo Esquilín Solís
3	El Faro III - Las Cabezas Reserva Natural	Eduardo Esquilín Solís
4	Colinas del Yunque Urbanization	Jean Lodge & Hilda Morales
5	Rio Mar Resort	Jean Lodge & Hilda Morales
6	El Portal - Catalina, EYNF/LEF	Edgar Vázquez
7	Bisley, & Rte 988 & 983	Victor Cuevas & José Burset
8	Icacos Valley – Route 191 – EYNF	Joe Wunderle
9	Yokahú Tower (around the tower; tower not open) –EYNF/LEF	Joe Wunderle
10	Roosevelt Roads	Emilio Font
11	Bosque de Ceiba & Cayo Largo	Sharon Cantrell & Carlos Laboy
12	Finca Las Paulinas, El Convento - NE Ecological Corridor	José Salguero
13	San Miguel - NE Ecological Corridor	Luis Villaneuva & Laura Fidalgo
14	Big Tree Trail – EYNF/LEF	Felipe Cano & Jessica Ilse
15	Governor's Beach & La Laguna de Aguas Prietas	Joe Wunderle & Emilio Font