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AUTUMN MONITORING OF RESIDENT AVIFAUNA ON GUANA ISLAND, BRITISH VIRGIN ISLANDS

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Resumen. – Monitoreo de otoño de la avifauna residente in Isla Guana, Islas Virgenes Británicas. – Aunque la región Caribe es considerada un centro de biodiversidad y de gran prioridad en los esfuerzos de conservación ecológica, existe poca información sobre las tendencias poblacionales de aves terrestres en las Indias Occidentales. En este estudio combinamos datos de tres estudios previos cubriendo un periodo de 16 años en una pequeña isla, con minima presencia humana en las Islas Virgenes Británicas. Tomando en conjunto, los estudios presentan patrones temporales de abundancia de aves y como las condiciones ambientales influyen en su detectabilidad. Nuestros datos indican una composición estable de la avifauna. Aunque las abundancias variaron entre los estudios, las mismas especies fueron detectadas con solo raras excepciones. A pesar de la estabilidad en la composición de especies, las aves residentes fueron variables en sus detectabilidades individuales. Las detecciones reflejaron relativamente las tasas de captura para algunas especies, pero fueron muy dife-rentes para otras especies. Sospechamos que esto es debido a diferencias en detectabilidad por comportamiento especifico de cada especie, mediada por condiciones medioambientales tales como la lluvia un mes o varios meses previos a nuestros estudios. Es difícil evaluar la influencia de la sincronización o la cantidad de precipitación sobre las tasas de detección en nuestros estudios, debido en parte a la carencia de una consistente recolección de datos climáticos locales en las Islas Virgenes Británicas. Nuestros estudios sugieren realizar esfuerzos de monitoreo de aves en conjunto con recolección de datos climáticos específicos para cada sitio, lo cual facilitara una mejor interpretación de los datos de estos estudios, y un mejor entendimiento de la respuesta de las aves a los cambios climáticos.

Abstract. – Although the Caribbean region is considered a biodiversity hotspot and a priority for ecological conservation efforts, little information exists on population trends of West Indian landbirds. We combined avian survey data collected from three studies spanning a 16-year period on a small island with a minimal human presence in the British Virgin Islands. Although abundances varied among surveys, the same species were detected with rare exceptions. Despite stability in species composition, the resident landbirds were variable in their individual detectabilities. Survey detections relatively mirrored net captures for some species, but are quite different for others. We suspect that this is likely due to differences in detectability due to species-specific behaviors mediated by environmental conditions, such as rainfall, during the month or months prior to our surveys. It is difficult to assess the influence of timing or amount of precipitation on bird detections rates among our surveys due to a lack of consistent collection of location-specific weather data in the British Virgin Islands. Our study suggests monitoring efforts conducted in concert with collection of site-specific climate data would facilitate improved interpretation of survey data and a better understanding of avian species response to climate mediated changes. *Accepted 11 November 2013.*

Key words: Bananaquit, *Coereba flaveola*, Pearly-eyed Thrasher, *Margarops fuscatus*, avifaunal richness, monitoring, species composition, surveys, British Virgin Islands, Guana Island.

INTRODUCTION

The Puerto Rican Bank, consisting of Puerto Rico, the US Virgin Islands, and the British Virgin Islands, is one of ten Endemic Bird Areas of the Caribbean (BirdLife International 2010). Within the Puerto Rican Bank, substantial research and monitoring attention have been directed at resident bird communities (Dugger *et al.* 2000, Faaborg & Arendt 1992, Faaborg *et al.* 1997) and the Nearctic/Neotropical migrant landbirds wintering in dry forest within the Guánica Biosphere Reserve, Puerto Rico (Dugger *et al.* 2004, Faaborg *et al.* 2007). In contrast, there is a paucity of data for the British Virgin Islands (Mayer & Chipley 1992, Boal *et al.* 2006, McGowan *et al.* 2007). Indeed, there is a well-recognized need for avian monitoring programs among the Caribbean islands in general (Latta 2005, Haynes-Sutton and Wood 2008). Monitoring of avifaunal communities is important to identify the impact of environmental changes, and to facilitate assessments of the loss, habituation, recovery, or expansion of highly vulnerable, often endemic species (Arendt *et al.* 1997, Hilton *et al.* 2003, Dalsgaard *et al.* 2007). Monitoring may be especially important given likely environmental changes that are anticipated to occur in association with changing climate. For example, hurricanes are known to have negative influences on migrant and resident landbirds (Wiley & Wunderle 1993, Wunderle 2005). Hurricane events have increased over the last century (Martin & Weech 2001) and the prognosis is for an increased frequency and intensity of hurricanes due to warmer sea surface temperatures associated with climate change (Emanuel 2005).

Most islands in the Caribbean have experienced various extents of human presence and the influences of anthropogenic activities (e.g., landscape conversion, introduction of non-native species) on avifaunal trends are important factors. However, islands with little human disturbance would allow assessment of environmental influences while keeping the confounding factors of local anthropogenic activities to a minimum. Under this guiding concept, we combined data collected from three different studies spanning a 16-year period on a small Caribbean island with a minimal human presence. The studies were conducted at different times by different researchers so there are slight inconsistencies in methodological approaches. Taken together, however, the studies present a view of temporal patterns in avifaunal abundances and, perhaps more importantly, how environmental conditions may influence detectability.

METHODS

We conducted bird surveys on Guana Island (18°30'N, 64°30'W), a small (3.1 km^2) island approximately 0.5 km immediately north of Tortola, British Virgin Islands (BVI). The BVI are located approximately 150 km east of Puerto Rico. Temperature in the BVI normally ranges from 28–33 °C, with relative humidity fairly constant at about 78% (Lazell 2005). Annual mean rainfall for Guana Island is estimated at 92 cm, but data are limited and the long-term average may be lower (Lazell 2005).

Guana Island is topographically rugged with elevations ranging from sea level to 246m. It is privately owned and has undergone little development or habitat fragmentation. A small resort area occupies approximately 3% of the island; the remainder of the island is a *de facto* nature preserve covered by subtropical vegetation, the majority of which is subtropical dry forest (90%) and mesic ghaut (i.e., drainage) forest (5%) (Lazell 2005). The primary native vegetation on Guana Island is *Tabebuia heterophylla* (Bignoniaceae), *Bursera simaruba* (Burseraceae), *Pisonia subcordata* (Nyctaginaceae), *Conocarpus erectus* (Combretaceae), *Plumeria alba* (Apocynaceae), *Acacia muricata* (Fabaceae), and *Coccoloba uvifera* (Polygonaceae) (Lazell 2005).

We used fixed-radius points (Hutto *et al.* 1986) to survey landbirds on Guana Island during the month of October in 1994 (Arendt 1995), 2001 (Wunderle 2001), and 2007–2009 (Boal 2010). Surveyors recorded all birds detected by sight and or sound and classified distance as less than or greater than 25-m from the survey point. Birds in flight were not included in the analyses. Surveys were conducted for 10 min at each point during the 1994 and 2001 surveys, and for 7 min during the 2007–2009 surveys.

We used a hip-chain and biodegradable string to locate survey points at 100-m intervals along parallel transects placed 100 m apart across the entire island in 1994. In 2001 and 2007–2009, we took advantage of a network of trails across Guana Island. The trail system allowed access to all vegetation communities and areas on the island and made surveys more logistically feasible and repeatable given the rugged topography and thick vegetation. A hip-chain was also used in 2001 to locate survey points at 100-m intervals along the trails. In 2007, survey points were paced at 150 pace intervals which, based on GPS coordinates, resulted in survey points located approximately 120 m apart. Survey-point coordinates were recorded with a hand-held GPS unit in 2007 and used to survey the same points in 2008 and 2009. Ultimately, the same sections of trail and, hence, the same areas, were sampled in all surveys, which facilitates comparison of data among survey years.

Caribbean birds can be counted during any season, but surveys should be conducted at the same time annually using the same protocol to monitor population changes (Wunderle 1994, Faaborg *et al.* 2000). Surveys of bird populations also need to take into account species-specific detection rates. Distance sampling (Buckland *et al.* 2001) has become a method of choice for estimating avian abundance, density, and population size in context of different detectabilities. However, meeting assumptions for distance sampling can be challenging. A minimum of 75–100 detections per species within a cover type is necessary for estimation of valid detection functions when using point counts (Buckland *et al.* 2001). Furthermore, a critical component of distance sampling is accurate estimation of distance (Buckland *et al.* 2001). Auditory detections can comprise over 80% of songbird detections in tropical forests (Scott *et al.* 1981). Based on trials with song simulation, Alldredge *et al.* (2007a) estimated observers detected only 19–65% of the true bird population, and suggested a lack of control under normal field survey conditions likely makes estimates even more variable. Furthermore, trials have revealed substantial uncertainty in distance estimation based on aural detections and that point count estimates based on distance methods are likely biased (Alldredge *et al.* 2007b).

Failure to meet criteria of distance sampling methodology, such as adequate sample size, and suspicion of bias due to the majority of detections of forest birds being derived from aural cues, compromise use of the method under some conditions and in certain habitat types. Project constraints that limit the number of species whose numbers can be reliably estimated by detectability methods dictate that indices be used as an alternative (Thompson *et al.* 1998). Therefore, we present our data as an index of relative abundance, not actual density. Indices do not allow for precise estimates of population densities, but they do allow for comparisons between years within the same study area (Hutto & Young 2002).

Based on our survey data, we calculated mean number of detections within 25-m fixed-radius points. We used Kruskal-Wallis tests to compare median number of detections within 25 m among years. We conducted these analyses for two variables, the number of individuals and number of species detected, for resident landbird species only. We used multiple comparisons of mean rank to examine differences among years (Siegel & Castellan 1988). We then examined species-specific patterns of detection for those species that were detected ≥ 50 times.

During each October of 2007–2009, CWB operated a banding station on Guana Island. This provided us the opportunity to compare survey detection rates to capture rates. Nets were placed in the same locations along a northeast–southwest ridge on the west side of the island at ca. 70 m elevation each year. All nets were placed in subtropical dry forest and in human-altered areas of the island hotel. As many as 12, 32-mm mesh nets were opened for an average of 422 (± 57 SE) h each year (Boal 2010). The banding station occupied only a small area of the island, whereas surveys were island-wide. However, net captures provide a measure of relative abundance independent of surveys based on aural/visual detections (Faaborg *et al.* 2004). Therefore, for the 2007–2009 data, we compared survey data to net capture rates to assess common patterns in numerical trends. We ranked the relative abundance of each species captured or detected, depending on method, over the three study periods in 2007–2009 to examine similarities or differences between net captures and surveys. This resulted in a ranking of 1–15 (3 years x 5 species) for each method. We then took the absolute values of the difference of the ranks of the two methods for each species within a given year and calculated the 95% Confidence Interval on these numbers. If the two methods are equivalent, the interval would be expected to include zero. Failure of inclusion of zero may indicate detection probabilities varied between methods, among years and species, the methods are equivalent but sampled different populations due to restricted area sampled by the mist-netting, or a combination of these factors.

RESULTS

We analyzed October avian survey data collected at 60 points in 1994, 65 points in 2001, and at 58, 53, and 57 points in 2007–2009, respectively (Table 1). The surveys in 2007–2009 were at the same points each year, but differed in number due to weather or other factors preventing complete surveys of all 58 points.

We detected a total of 17 species across all survey periods (Table 1). There was a significant difference among surveys in terms of total individuals of resident species detected ($H_{4, 293}$ = 101.87, P < 0.0001) and number of resident species detected ($H_{4, 293}$ = 89.97, P < 0.0001). Pairwise comparisons of total detections indicated significant differences (P < 0.05) between 1994 and all other years, and between 2001 and 2007, 2007 and 2009, and 2008 and 2009. A pairwise comparison of species detected indicated significant differences (P < 0.05) between 1994 and 2007, 2008, and 2009; detections in 2001, 2007, and 2008 were all significantly different from those in 2009. Essentially, 2009 was consistently lower in detections of both total individuals and total resident species compared to all other survey years (Table 2).

Because we restricted our species-specific analysis to only those species for which we had at least 50 detections, our analysis included Bananaquit (*Coereba flaveola*; n = 307), Pearly-eyed Thrasher (*Margarops fuscatus*; n = 306), Caribbean Elaenia (*Elaenia martinica*; n = 70), Zenaida Dove (*Zenaida aurita*; n = 70), and Black-faced Grassquit (*Tiaris bicolor*; n = 54); no other resident landbird was detected 50 or more times.

Detections of the Bananaquit varied among the survey periods ($H_{4, 293}$ = 23.36, P =

TABLE 1. Proportion of 25-m radius survey points in which a species was represented by at least one individual during October surveys on Guana Island, British Virgin Islands, 1994, 2001, and 2007–2009. Number of survey points: 1994 - n = 60; 2001- n = 65; 2007 - n = 58; 2008 - n = 53; 2009 - n = 57.

Species	1994	2001	2007	2008	2009
American Kestrel	0	0	0.03	0	0
Mangrove Cuckoo	0.12	0	0.02	0	0
Smooth-billed Ani	0.02	0	0	0	0.02
Scaly-naped Pigeon	0.08	0.11	0.09	0.08	0.04
Zenaida Dove	0.43	0.17	0.12	0.09	0.05
Common Ground-dove	0.15	0	0	0.04	0
Bridled Quail-dove	0.03	0.11	0.05	0.04	0
Green-throated Carib	0.22	0.23	0.03	0.06	0.05
Antillean Crested Hummingbird	0.17	0.05	0.1	0.09	0
Antillean Mango	0.02	0	0	0	0
Gray Kingbird	0.13	0.08	0.03	0.08	0.02
Caribbean Elaenia	0.3	0.18	0.22	0.15	0.11
Pearly-eyed Thrasher	0.87	0.85	0.47	0.38	0.16
Northern Mockingbird	0	0	0	0	0
Bananaquit	0.75	0.57	0.74	0.64	0.46
Yellow Warbler	0	0	0	0	0.02
Black-faced Grassquit	0.12	0.15	0.17	0.19	0.02

0.0001) with differences between 1994 and 2009 (P = 0.001) and 2007 and 2009 (P = 0.0015). Mean detections of the Bananaquit were similar and highest in 1994 (mean = 1.38 ± 0.13) and 2007 (mean = 1.34 ± 0.14) but lowest in 2009 (mean = 0.56 ± 0.14) (Table 2). Differences among years were more pronounced for the Pearly-eyed Thrasher ($H_{4, 293}$ = 102.39, P < 0.0001). The only survey periods between which differences (P < 0.05) were not detected among thrashers were those of 1994 and 2001, and 2008 and 2009. In general, detections of the Pearly-eyed Thrasher were highest in 1994 (mean = 1.97 ± 0.12) and progressively decreased to the lowest detection rate in 2009 (mean = 0.16 ± 0.12) (Table 2).

There were no statistical differences among years in detections of Caribbean Elaenia ($H_{4, 293}$ = 8.97, P = 0.062), Zenaida Dove ($H_{4, 293}$ = 8.17, P = 0.080), or Black-faced Grassquit ($H_{4, 293}$ = 9.19, P = 0.056). Detections for the Black-faced Grassquit in 2009 was only 34% of that in 2007 and 32% of that in 2008 (Table 2). Similarly, detections for the Zenaida Dove in 2009 were only 33% of that in 2007 and 26% of that in 2008 (Table 2). Differences among years for elaenias were not as dramatic, but did suggest a consistent decline in detections from 1994 to 2009 (Table 2).

Mist net captures were not consistent among years for most resident species. The Bananaquit was the most frequently captured resident species in all years, with 19.8/100 net-h in 2007, a dip to 13.7/100 net-h in 2008, then up to 16.3/100 net-h in 2009. The Pearly-eyed Thrasher, the second most frequently captured resident species, demonstrated a similar pattern with 11.5 captures/100 net-h in 2007, a drop to only 4.1/100 net-h in 2008, then 9.5/100 net-h in 2009. Captures of the Black-faced Grassquit were similar in 2007 and 2009 (2.9 and 3.4/100 net-h), but almost double in 2008, with 6.3 birds per 100 net-h. The Caribbean Elaenia was the

TABLE 2. Average detection numbers/registrations (± SE) of common resident landbirds within 25-m radius plots during October surveys on Guana Island, British Virgin Islands, in 1994, 2001, and 2007–2009.

Year/species	Bananaquit	Black-faced Grassquit	Caribbean Elaenia	Pearly-eyed Thrasher	Zenaida Dove
1994	1.38 ± 0.13	0.13 ± 0.07	0.43 ± 0.07	1.97 ± 0.12	0.55 ± 0.07
2001	0.81 ± 0.13	0.17 ± 0.07	0.23 ± 0.07	1.53 ± 0.12	0.23 ± 0.07
2007	1.34 ± 0.14	0.26 ± 0.07	0.26 ± 0.07	0.83 ± 0.12	0.15 ± 0.07
2008	1.15 ± 0.14	0.28 ± 0.08	0.15 ± 0.07	0.58 ± 0.13	0.19 ± 0.07
2009	0.56 ± 0.14	0.09 ± 0.07	0.10 ± 0.07	0.16 ± 0.12	0.05 ± 0.07

only resident species that demonstrated a consistent decrease in captures, with 2.2, 0.9, and 0.6/100 net-h, in 2007, 2008, and 2009, respectively. Due to the small mesh size of the nets and the large body size of Zenaida Doves which reduced probability of capture, we did not include the species in analysis of mist net captures. In general, Bananaquit and Pearly-eyed Thrasher were captured in greater numbers in 2007 and 2009, with lows in 2008. In contrast, the Black-faced Grassquit was captured in similar numbers in 2007 and 2009, but in higher numbers in 2008.

We found evidence that the methods of surveys and net captures are not equitable in assessing avian abundance. The mean rank was 2.27 (± 1.89) with a 95% Confidence Interval (1.22, 3.31) that did not include zero.

DISCUSSION

Our combined survey data indicate that Guana Island appears to be stable in terms of avifaunal composition. Although abundance varied among surveys (Tables 1, 2), the same species were detected with rare exceptions. Typically, these discrepancies were of species that normally occur at low density, such as American Kestrel (*Falco sparverius*) and Red-tailed Hawk (*Buteo jamaicensis*). However, Arendt (1995) observed an Antillean Mango (*Anthracothorax dominicus*), which has not been detected during surveys since, and Boal (2010) detected the resident Caribbean form of the Yellow Warbler (*Setophaga petechia cruziana*; verified by subsequent capture).

Despite stability in species composition, Caribbean resident landbirds are variable in their individual detectabilities. For example, the Mangrove Cuckoo (*Coccyzus minor*), known for being secretive, had high detectability ratios in 1994 due to calling associate with breeding (Arendt 1995). In contrast, Wunderle (2001) did not detect the species on surveys, and Boal (2010) detected very few, and in only two of three years. T. S. Estabrook (pers. com.) considered the species abundant on Guana Island, however, based on responses to call-playback surveys (which elicit territorial responses) conducted during the same 3-yr period. As Wunderle (2001) suggested, some of these differences may be associated with differences in rainfall prior to the surveys or seasonal hurricane events. The 1994 survey was conducted at the end of a wet period that, presumably, resulted in more species breeding during the survey period (Arendt 1995, Wunderle 2001). The high detection rates Arendt (1995) found for Zenaida Dove and Common Ground-Dove, due largely to their calling associated with breeding, have not been approached in systematic surveys since. When making qualitative comparisons between surveys and net captures in 2007–2009, the trend in survey detections relatively mirrored net captures for

Caribbean Elaenia and Black-faced Grassquit. However, survey data for Bananaquit and Pearly-eyed Thrasher are quite different from net capture data. We suspect that this is likely due to species-specific differences in detectability, possibly as a result of behaviors mediated by, as yet uncertain, environmental conditions.

It is difficult to assess the influence of timing or amount of precipitation on bird detection rates among our surveys due to a lack of consistent collection of location-specific weather data in the British Virgin Islands. The closest weather station to Guana Island at the time of our surveys was 40 km to the southeast at Charlotte Amalie on Saint Thomas. Thus, rainfall conditions on Guana Island are derived more from onsite assessments by the researchers during October than by actual measures. The survey in 1994 was conducted during what was considered a wet year, whereas the 2001 survey was conducted at the end of a long dry period (Wunderle 2001). Surveys in 2007, 2008, and 2009 were considered, respectively, normal, wet, and dry.

The Caribbean region has experienced an increase in average annual temperatures over the last century, and is anticipated to experience a further increase of over 2°C this century (U.S. Department of Interior 2010). In addition to increased temperature, a decades-old drying trend is also expected to continue in the Caribbean, resulting in less summer precipitation (Neelin *et al.* 2006, U.S. Department of Interior 2010). Added to this is the expected increase in frequency and severity of tropical storm events due to warming sea waters. These environmental changes may have consequences for birds resident to the Caribbean islands. Even though monitoring is primarily a passive means of identifying population change, and often fails to provide insight as to causes of those changes, it is an important tool for initiating and evaluating conservation plans. As Latta (2005) and Haynes-Sutton & Wood (2008) have stated, monitoring of Caribbean avifauna is sorely lacking. Because environmental conditions are likely to have a substantial influence on both detection and population size of resident landbirds, survey methods need to be suitable for addressing these issues. Our study suggests monitoring efforts conducted in concert with collection of site-specific climate data would facilitate improved interpretation of survey data and a better understanding of avian species response to environmental and climate mediated changes. This would enable robust modeling of time-specific influences of climate conditions on behavior and, therefore, detectability of resident bird species. Such modeling efforts would allow more confidence in interpretation of monitoring data and identification of factors driving population trends.

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