Using Forest Service Multiple Species Inventory and Monitoring Protocols To Count Birds at Forest Inventory and Analysis Plots on the Caribbean Landscape: Results, Observations, and Challenges From Year 1 of a 2-Year Study

Sonja N. Oswalt[1], Thomas J. Brandeis[2], David W. Steadman[3], and Scott K. Robinson[4]

Abstract.—We conducted double-observer point counts of birds from December 3 to December 31, 2005, on preestablished permanent Forest Inventory and Analysis (FIA) plots and National Park Service System trails within the Virgin Islands National Park, St. John, U.S. Virgin Islands. We had three objectives: (1) to collect abundance and distribution data for wintering land birds, particularly neotropical migrants, in the subtropical dry and moist forests of St. John; (2) to test for differences between data collected on the FIA systematic grid and data collected using point counts established along randomly selected National Park System trails and; (3) to evaluate the effectiveness of Multiple Species Inventory and Monitoring (MSIM) protocols in the tropics. We recorded all species of birds (resident and migrant) observed or heard, and the distance from observers to each individual. Broad habitat descriptions were made for trails where habitat data were not already available. In year 1, we identified 47 indigenous species of birds, including 17 species of neotropical migrants. The most frequently recorded species was the resident songbird Caribbean Elaenia, with 517 registrations. The most frequently recorded migrant songbird was the American redstart (98 registrations). We present an overview of the Forest Service, U.S. Department of Agriculture FIA and MSIM protocols as well as results, observations, and challenges from year-1 sampling efforts on St. John.

Introduction

Monitoring plant and animal species at landscape levels can be cost and time intensive to public agencies and, ultimately, taxpayers. Although various intra- and interagency missions differ in the Federal government, there exists a degree of overlap among many, particularly in the natural resources community, where baseline assessments and continued monitoring are necessary and expected goals. The Forest Service Forest Inventory and Analysis (FIA) program is a nationally consistent inventory and monitoring program designed to assess the extent and condition of public and private forest lands in the United States, including outlying islands and U.S. territories. The FIA program collects a wealth of environmental data on an unbiased, systematic sample grid. Much of the data collected by FIA for assessing forest health and condition are very useful to wildlife biologists for assessing habitat extent and condition.

National Forest System and other public lands (e.g., National Park Service, U.S. Fish & Wildlife Service) stand to benefit from FIA monitoring when efforts to sample terrestrial vertebrate and invertebrate species are structured to coincide with FIA plots so that cooperative sampling can occur within or between agency staff. Resulting research may then benefit all

[1] Forester, U.S. Department of Agriculture (USDA) Forest Service, Southern Research Station, Forest Inventory and Analysis, 4700 Old Kingston Pike, Knoxville, TN 37919. E-mail: soswalt@fs.fed.us.

[2] Research Forester, USDA Forest Service, Southern Research Station, Forest Inventory and Analysis, 4700 Old Kingston Pike, Knoxville, TN 37919. E-mail: tbrandeis@fs.fed.us.

[3] Curator of Ornithology, University of Florida Museum of Natural History, Dickinson Hall, Gainesville, FL 32611. E-mail: dws@flmnh.ufl.edu.

[4] Katharine Ordway Professor of Ecosystem Conservation, University of Florida Museum of Natural History, Dickinson Hall, Gainesville, FL 32611. E-mail: srobinson@flmnh.ufl.edu.

involved agencies and thus help to lower the overall cost to any one entity, thereby lowering overall costs to taxpayers. In addition, colocating wildlife sampling with a nationally developed forest inventory permits standardization over large geographic extents, allowing for cross-regional modeling and comparisons.

Building on that concept, the Forest Service developed a Multiple Species Inventory and Monitoring (MSIM) protocol designed to yield a "consistent and efficient method for obtaining basic presence/absence data and associated habitat condition data for a large number of individual species at sites that represent a probabilistic sample" (Manley *et al.* 2006). The MSIM protocol layers common presence/absence species survey methodologies over the established FIA systematic grid to colocate sample points, thus taking advantage of data already collected by FIA. Protocols from both survey programs allow for intensification, both increasing the statistical accuracy of FIA data and increasing the usefulness of MSIM data where funding is available.

Methodologies contained in the MSIM program were developed and compiled by a team of biologists across the continental United States using well-known and tested protocols. The MSIM program, in conjunction with FIA, has received limited implementation, however, resulting in a paucity of information about the ability to perform the suggested protocols across a variety of landforms and habitat types. To date, MSIM, in conjunction with FIA sampling, has been tested and used primarily on national forest land in the Pacific Southwest, which is not representative of all United States landscapes, particularly insular landscapes occurring at subtropical and tropical latitudes.

An FIA sample plot framework was established on St. John, U.S. Virgin Islands, in the summer of 2004 to record forest resources and health. The Caribbean West Indies, including the island of St. John, are home to not only resident land birds year-round but also a host of neotropical migratory songbirds each winter. This last group of species requires an intercontinental effort for conservation goals to succeed. The Caribbean islands are the "most important (and sometimes exclusive) wintering ground" for many declining species of warblers, including the Cape May warbler, black-throated blue warbler, and prairie warbler (BirdLife International 2004). These species face continuing pressures on their wintering grounds. Habitat destruction, fragmentation, and invasive species are primary threats to avian diversity of the Caribbean. Arendt (1992) stressed the need for more long-term monitoring of birds on islands throughout the West Indies, particularly areas in which forested habitat persists.

Previous avian studies on St. John (Askins and Ewert 1999, Askins *et al.* 1992) have been conducted primarily along established trail systems and roadways, which may result in forest-edge, forest-type, or landform-related biases. Given the need for up-to-date information regarding migratory and resident land birds on St. John, combined with the need to test MSIM protocols on FIA plots in tropical regions, we initiated a 2-year avian study designed to accomplish three goals: (1) collect abundance and distribution data for wintering land birds, particularly neotropical migrants, in subtropical dry and moist forests; (2) test for differences between data collected on the FIA systematic grid and data collected using point counts established along randomly selected National Park System trails and; (3) evaluate the effectiveness of MSIM protocols in the tropics. Here, we discuss the results and challenges from the first year of avian sampling.

Methodology

Vegetation Sampling

Habitat data were collected on the island of St. John, U.S. Virgin Islands, in June through July of 2004 using the Forest Service FIA sample design (USDA Forest Service 2002). Twenty plots were arranged on an unbiased, systematic hexagonal sample grid across the island. Hexagons covered about 200 ha each, with one sample plot located within each hexagon. Plots were located and mapped using Global Positioning System equipment to ensure a high degree of accuracy. Plots were installed and measured in locations where at least 10-percent tree canopy coverage and a minimum forested area of 0.4 ha around each plot center was present, as designated by Forest Service FIA sample design guidelines. Plots consisted of a cluster of four subplots, each with a 7.3-m radius. Each subplot was 167 m^2, for a total sampled area of 670 m^2 (0.017 ha) in a fully forested plot. Plots were assigned to life zones sensu Holdridge (1967).

Field crews collected forest inventory, understory structure and composition, and physiographic data on each subplot. Diameter at breast height (d.b.h.) (taken at 1.37 m), total height, crown ratio, crown width, and other parameters were measured on all trees with d.b.h. greater than or equal to 12.5 cm within the subplots; d.b.h. and total height were measured on saplings with d.b.h. greater than or equal to 2.5 cm within a 2.1-m radius microplot nested in each subplot (Bechtold and Scott 2005, USDA Forest Service 2002).

Avian Sampling

A team of six qualified observers from the University of Florida conducted double-observer, unlimited-radius circular plot point counts from December 3 to December 31, 2005. A total of 64 point-count stations were associated with FIA plots. At each FIA plot, two to five stations were arrayed around a central location slightly offset from the FIA plot center, as recommended by MSIM protocols. Each point-count station was located at least 200 m apart, and all points associated with one FIA plot were sampled on the same day using 10-minute point counts made during times of little or no rain, little or no wind, and within 4 hours of daybreak. Ninety-three additional points were established at 200-m intervals along randomly selected, maintained National Park Service trails systems to augment the FIA sample, for a total of 157 point-count stations. All species of birds detected during point counts were recorded by detection method (sight or sound) and by distance. Birds observed flying over count stations were recorded separately.

Statistical Methods

Absolute abundances of species at each point-count station were used to populate a species-by-station matrix (Wunderle and Waide 1993). The abundance matrix was then subject to Indicator Species Analysis in the statistical software PC-ORD, using two groups: (1) FIA (point-count stations colocated with FIA plots), and (2) non-FIA (point-count stations independent of FIA plots) (McCune and Mefford 1999). Indicator species were selected based on species importance values in the predefined groups, determined as a combination of relative abundance and relative frequency of species. Monte Carlo statistics were used to test the significance of species as indicators of a given group. Species with Monte Carlo significance at $P \leq 0.05$ in a given group were considered "more likely" to be encountered in that particular group than in the opposing group, even if the species was present to some degree in both groups.

Analysis of variance was used to evaluate if raw species counts differed between FIA and non-FIA groups. Multiresponse permutation procedures with Euclidean distance measures were used to test for differences in species composition between groups. A chi square was used to evaluate whether bias existed in the representation of life zones on FIA compared with non-FIA groups.

Results

Observers detected 2,317 individuals of 47 species on St. John (including flyovers), or an average of 14.8 individual birds per station. Seventeen of the species detected were neotropical migrants (table 1). The resident songbird Caribbean Elaenia *(Elaenia martinica)* was the most frequently recorded species, with 519 registrations. Detected at 85 percent of point-count stations, an average of 3.8 Caribbean Elaenias were observed at each station where the species was recorded. Although the Caribbean Elaenia was common in both life zones, it was observed more frequently in the subtropical dry forest ($P = 0.007$).

The most frequently observed neotropical migrant was the American redstart (*Setophaga ruticilla*; table 1). American redstarts were recorded a total of 98 times on 34 percent of point-count stations, with an average of 1.8 individuals observed at stations where the species was detected. American redstarts were most frequently observed in subtropical moist forests ($P = 0.001$).

The total number of species detected did not differ between FIA and non-FIA groups ($P = 0.26$). Point-count stations in the FIA group averaged 13.9 (± 0.65) individuals per point whereas stations in the non-FIA group averaged 15.1 (± 0.81) individuals per point. Species composition differed between groups ($T = -10$; $P < 0.0001$) but within-group heterogeneity was very high ($A = 0.04$), a phenomenon that was not surprising given that

Table 1.—*Number of year-1 observations of avian species at point-count stations, December 2005, St. John, U.S. Virgin Islands.*

Species	Number of observations	Species	Number of observations
Neotropical migrants		Bridled quail dove (*Geotrygon mystacea*)	47
American redstart (*Setophaga ruticilla*)	98	Green-throated carib (*Eulampis holosericeus*)	31
Yellow warbler (*Dendroica petechia*)	61	Zenaida dove (*Zenaida aurita*)	27
Northern parula (*Parula americana*)	51	Mangrove cuckoo (*Coccyzus minor*)	17
Black-and-white warbler (*Mniotilta varia*)	48	Smooth-billed ani (*Crotophaga ani*)	8
Ovenbird (*Seiurus aurocapillus*)	47	Common ground dove (*Columbina passerina*)	7
Prairie warbler (*Dendroica discolor*)	44	Scaly naped pigeon (*Columba squamosa*)	5
Northern waterthrush (*Seiurus noveboracensis*)	35	American kestrel (*Falco sparverius*)	3
Hooded warbler (*Wilsonia citrina*)	10	Red-tailed hawk (*Buteo jamaicensis*)	3
Worm-eating warbler (*Helmitheros vermivorus*)	10	Black-whiskered vireo (*Vireo altiloquus*)	2
Unknown warbler	5	Northern mockingbird (*Mimus polyglottos*)	2
Yellow-rumped warbler (*Dendroica coronata*)	4	Hummingbird sp.	2
Barn swallow (*Hirundo rustica*)	4	Puerto Rican flycatcher (*Myiarchus antillarum*)	1
Blackpoll warbler (*Dendroica striata*)	3	Puerto Rican flycatcher (Myiarchus antillarum)	1
Magnolia warbler (*Dendroica magnolia*)	2		
Black-throated blue warbler (*Dendroica caerulescens*)	1	**Others—data not analyzed**	
		Black-necked stilt (*Himantopus mexicanus*)	9
Black-throated green warbler (*Dendroica virens*)	1	Common moorhen (*Gallinula chloropus*)	6
Cape May warbler (*Dendroica tigrina*)	1	Unknown bird	4
Rose-breasted grosbeak (*Pheucticus ludovicianus*)	1	Belted kingfisher (*Ceryle alcyon*)	4
Rose-breasted grosbeak (Pheucticus ludovicianus)	1	Brown pelican (*Pelecanus occidentalis*)	3
		Spotted sandpiper (*Actitis macularia*)	2
Resident songbirds		Domestic chicken (*Gallus gallus*)	1
Caribbean Elaenia (*Elaenia martinica*)	519	Falcon sp.	1
Pearly eyed thrasher (*Margarops fuscatus*)	403	American coot (*Fulica americana*)	1
Bananaquit (*Coereba flaveola*)	368	Great blue heron (*Ardea herodias*)	1
Lesser Antillean bullfinch (*Loxigilla noctis*)	151	Great egret (*Casmerodius albus*)	1
Gray kingbird (*Tyrannus dominicensis*)	135	Green heron (*Butorides striatus*)	1
Antillean crested hummingbird (*Orthorhyncus cristatus*)	74	Magnificent frigatebird (*Fregata magnificens*)	1
Black-faced grassquit (*Tiaris bicolor*)	49	Sora (*Porzana carolina*)	1

groups were predetermined based on a nonbiological criterion rather than by environmental factors. Significant indicator species on FIA plots included the American kestrel, bananaquit, gray kingbird, lesser Antillean bullfinch, and yellow warbler. Significant indicator species on non-FIA plots included the American redstart, bridled quail dove, northern parula, and pearly eyed thrasher. Eleven species (20 individuals) were detected only at FIA related stations, whereas 9 species (18 individuals) were detected only at non-FIA related stations.

The distribution of FIA compared with non-FIA point-count stations differed by Holdridge life zone ($X^2 = 13.6$; $P < 0.001$). Sixty-two percent of FIA associated stations fell in the dry forest life zone, while 68 percent of non-FIA associated stations fell into the subtropical moist forest life zone. When FIA and non-FIA stations were considered together, distribution was relatively even between life zones, with 56 percent of stations in subtropical moist forest and 44 percent in dry forest.

Discussion and Conclusions

The results of this study suggest that neither the FIA sample grid nor the non-FIA–related trail systems adequately sample both life zones by themselves. Wintering neotropical migrants recorded during 1 year of study on St. John appear to prefer the subtropical moist forest life zone, while resident species generally appear to be more abundant in subtropical dry forests. Therefore, if only one method is used to sample songbirds (FIA or established park trails), the sample may need to be augmented to include additional points in underrepresented forest types.

Although methodologies differ slightly, our first year of sampling effort performed well when compared to other bird surveys on St. John and elsewhere in the Caribbean. Wunderle and Waide (1993) counted 28 species (12 migrants) at 60 point-count locations (generally along trails or roads) on St. John in 1993. Our study included 97 more stations, and we detected nearly twice the number of total species and nearly 1.5 times the number of migrant species.

The 20 FIA plots appear to undersample the subtropical moist forests, which, on St. John, occur on mountain tops at higher elevations and along gullies, ravines, and streams. Although the FIA grid is intensified on St. John, the sampling scale is still such that a systematic grid is less likely to capture rare or linear events on the landscape than would a stratified sample. Non-FIA sample points, in contrast, tend to be concentrated in this forest type because the same landscape features that can cause undersampling may influence the design of the park's trail systems and roadways. For example, ephemeral streams and moist forests are aesthetically pleasing and provide protective shade to adventurous tourists. Streams and trails follow similar "pathways of least resistance" up and down mountainous terrain. Also, the northern aspects where moist forests are prevalent provide more photoready viewing opportunities of sandy white beaches than are found on the drier, south sides of the island's mountains, which may affect road placement. In contrast, the FIA grid system results in a sample less affected by potential edge-effect biases associated with roads and trails. In addition, detailed quantitative vegetation information is available for FIA associated stations, whereas non-FIA station vegetation descriptions are vague and qualitative (although that could be remedied given additional time and money and using protocols similar to FIA for measuring vegetation information).

Although FIA-related point counts of birds have less bias and have the additional advantage of detailed habitat information, they also presented challenges to which non-FIA trail stations were not subjected. Terrain on St. John is steep and, in some areas, treacherous. A year-round growing season results in thick vegetation, including cacti and *Agave* species that make cross-country travel difficult. When conducting point counts of birds, researchers are generally restricted to a sampling period from dawn to 10 a.m., when birds are most active. On St. John, merely hiking to a given plot may take as much as 3 to 4 hours. In addition, thick vegetation and rapidly changing forest types restrict the number of point-count stations that may be associated with any given FIA point. In contrast to the Pacific Southwest, where MSIM was initially developed, our team was only able to establish, on average, two to three stations per FIA plot, as opposed to the suggested five to seven stations. Often, our team was only able to implement one station in the dawn-to-10 a.m. sampling window due to the time required to access the site. These complications suggest that sampling avian species on FIA plots, in difficult to access, rapidly changing terrain and vegetation types, may require modifications to the existing MSIM protocol. Nevertheless, the amount of information acquired by including FIA related stations serves as adequate justification for considering MSIM on FIA points in addition to traditional trail counts when developing avian monitoring plans.

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