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RESEARCH, MONITORING, AND CONSERVATION OF NEOTROPICAL MIGRATORY LAND BIRDS IN THE WEST INDIES:

A REPORT TO THE SOCIETY FOR THE CONSERVATION AND STUDY OF CARIBBEAN BIRDS (SCSCB) BY THE NEOTROPICAL MIGRATORY BIRD WORKING GROUP OF THE SCSCB

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Abstract.—In a Caribbean-wide effort to compile and exchange among islands information about Neotropical migratory birds that spend the non-breeding season in the Caribbean Basin, we collected summaries of research projects undertaken on each island which had as their focus the ecology of Neotropical migratory birds, current research and conservation projects in each country, and a bibliography of publications based on local research. We then used these data to generate a comprehensive list of research priorities concerning migrants in the non-breeding season, and finally, recommend uniform methodologies for the monitoring of migratory land birds on the islands.

Resumen.—INVESTIGACION, MONITOREO Y MONSERVACIÓN DE AVES MIGRATORIAS NEOTROPICALES EN LAS INDIAS OCCIDENTALES: UN REPORTE AL SOCIEDAD PARA LA CONSERVACIÓN Y ESTUDIA DE AVES CARIBEÑAS (SCSCB) POR EL GRUPO DE TRABAJO PARA AVES MIGRATORIAS NEOTROPICALES DE SCSCB. En un esfuerzo para compilar y intercambiar entre los ornitólogos y conservacionistas de las islas caribeñas información sobre aves migratorias que pasan la temporada no-reproductiva en el Caribe, aquí presentamos un resumen de investigaciones concluidos sobre la ecología de las aves migratorias, investigaciones y proyectos de conservación que están en marcha, y una bibliografía de publicaciones sobre aves migratorias en el Caribe. Usamos estos datos para producir una lista amplia de los prioridades de investigación sobre aves migratorias, y finalmente, unas recomendaciones para métodos uniformes para el monitoreo de aves migratorias en las islas.

Résumé.—ETUDE, SUIVI ET CONSERVATION DES OISEAUX MIGRATEURS TERRESTRES DANS LES ANTILLES : RAPPORT À LA SOCIÉTÉ POUR L'ETUDE ET LA CONSERVATION DES OISEAUX DE LA CARAÏBE (SCSCB) DU GROUPE DE TRAVAIL SUR LES OISEAUX MIGRATEURS NÉOTROPICAUX. Dans le cadre d'un effort de compilation et d'échange d'informations entre les îles de la Caraïbe sur les oiseaux migrateurs néotropicaux qui y séjournent en dehors de la période de nidification, nous avons réunis des résumés des projets de recherches entrepris sur chaque île. Ces projets concernaient l'écologie des oiseaux migrateurs néotropicaux, les recherches et les actions de conservation en cours ainsi que l'établissement d'une bibliographie des publications basées sur des recherches locales. Ces données ont ensuite permis de définir une liste exhaustive des priorités de recherche sur les migrants hors saisons de nidification et, en conclusion, de recommander des méthodes homogènes de suivi de ces espèces dans les îles.

Key words: *conservation*, *monitoring*, *Neotropical migrant birds*, *research*, *West Indies*

INTRODUCTION

AT THE 13TH MEETING of the Society of Caribbean Ornithology (now the Society for the Conservation and Study of Caribbean Birds [SCSCB]) held in Topes de Collante, Cuba, 15–22 July, 2001, a special symposium was conducted on Neotropical migratory birds in the Caribbean. The symposium consisted of a series of presentations of original research and island reports, including summaries of previous research projects undertaken in each country, current research and conservation projects in each country, research needs, and a bibliography of publications based on local research. There followed a presentation and discussion of various research and monitoring protocols that may be applicable to Neotropical migrants in the West Indies. Following this symposium, a formal Working Group on Neotropical Migratory Birds was formed with the following objectives: (1) to compile and exchange among islands information about Neotropical migratory birds in the Caribbean Basin; (2) to recommend uniform methodologies for the research and monitoring of migratory birds in the islands; and (3) to sponsor training programs for Caribbean biologists interested in applying recommended research and monitoring techniques. The Working Group also supported assembling and publishing a summary report of these discussions and the recommendations that the symposium engendered.

HISTORY OF RESEARCH OF NEOTROPICAL MIGRATORY BIRDS IN THE CARIBBEAN

With few exceptions, the history of research and monitoring of Neotropical migratory birds in the Caribbean Basin has followed a similar pattern among the various islands. Early work was limited to species lists and observations made by visiting or resident ornithologists and naturalists. These observations are mostly scattered in the literature as notes, included in check-lists, or perhaps summarized in bird guides and special publications (i.e., Barbour 1923, Wetmore and Swales 1931, Bond 1960, Biaggi 1970, Woods 1975, Dod 1978). Since the mid-1970s, when the first symposium on Neotropical migratory birds was held (Keast and Morton 1980), through the 1980s (Rappole *et al*. 1983, Arendt 1986), and especially subsequent to the 1989 publication of Chandler Robbins' documentation of continent-wide declines in some migratory species (Robbins *et al*. 1989), the ecology of Neotropical migrants has attracted increased attention. Whereas most of this attention has been directed toward breeding-ground events in North America, a few early studies of migrants during the non-breeding season focused primarily on the distribution, abundance, and foraging behavior of species in Mesoamerica and the Caribbean (i.e., Terborgh and Faaborg 1980; Arendt 1992; Finch and Stangel 1993; Wunderle and Waide 1993, 1994), and often concluded that species were generalists because they were found in geographically widespread areas and a variety of habitats. But beginning with Faaborg and Arendt's research in Puerto Rico (Faaborg and Arendt 1984), and later Holmes and Sherry's work in Jamaica (Holmes *et al*. 1989), studies began to focus on the need for habitat-specific, demographic, and site-fidelity data in assessing habitat preferences of migratory birds during the non-breeding season. Because some species were shown to segregate by sex and age class, abundance data alone could be a misleading indicator of population size and habitat preference. Moreover, abundance cannot be equated with survival, so data on site fidelity, including site persistence and annual return rate, may be required to assess habitat quality. Thus, across the Caribbean, several recent studies have focused on habitat-specific demographies and site fidelity of warblers during the non-breeding season (Woods 1975; Holmes *et al*. 1989; Wunderle 1995; Marra *et al*. 1998; Wunderle and Latta 2000; Marra and Holmes 2001; Sillett *et al*. 2000; Latta and Faaborg 2001, 2002), and these studies have set the standard by which studies of the ecology of migrants are measured. Below we briefly summarize previous research and monitoring efforts on each of the islands or island systems where substantial numbers of Neotropical migrants are known to spend the non-breeding season.

Cuba.—A tremendous amount of work on Neotropical migratory birds has come out of Cuba. Because of its geographical position and large size, a considerable number of migrants is found in Cuba during migration and throughout the Nearctic winter. With these large numbers of birds and the reported general declines in migrant populations, Cuban ornithologists have developed research programs to determine the state of migrant populations and factors that affect these populations, and collected data needed to implement management plans for the conservation of the habitats that these migrants use. Unique to the Caribbean Basin, research in Cuba has focused on the following objectives: (1) determine the influence of various forest-types and regions of the island on the distribution, community composition, and abundance of migratory and resident birds throughout the year; (2) delineate possible migration corridors; (3) determine the distribution and state of communities of resident and migratory birds in the different regions of Cuba; and (4) make management recommendations to managers of protected areas concerning birds and their habitats.

With these objectives, from 1988 to 1999 Cuban biologists using linear transects, point counts, and mist-nets have worked in 34 localities in 10 regions of Cuba (Guanahacabibes, Mil Cumbres, la Guira, Peninsula de Hicacos, Ciénaga de Zapata, Cayo Coco, Cayo Santa María, Gibara, Altiplanicie de Nipe, and Parque Alejandro de Humbolt) to evaluate communities of terrestrial birds. Vegetation composition and structure have also been measured in circular plots at each site. This work adds to the growing body of evidence from several countries showing the importance of combining circular point counts and mist-net captures to efficiently sample avian communities (Ralph and Scott 1981, Ralph *et al*. 1993). Differences in species richness and abundance among study sites owe principally to the distribution of migratory birds. In addition, biologists have found differences in sex ratios of migrants among regions of Cuba. Characteristics of the vegetation structure that have most influenced the composition and abundance of bird communities are canopy cover, ground cover, and the volume of foliage at 0–1 m. Areas most important for Neotropical migratory birds include Guanahacabibes, Peninsula de Hicacos, Cayo Coco, Cayo Santa Maria, and Gibara. With relation to migratory birds banded in the non-breeding season and later recaptured, 49.5% of 111 birds were recaptured in the same mist-net where they were previously banded, whereas an additional 31.5% were recaptured within 100 m of the mist-net where they were banded, thereby demonstrating strong site fidelity to territories, and corroborating not only that birds return to the same region or area, but that they occupy the same microhabitat each year. Additional work has been done on migratory populations of shorebirds and waterbirds. Work on migratory birds has been summarized in some 37 articles published in journals in Cuba, United States, Mexico, Canada, and Spain. Two doctoral dissertations have been successfully defended (González 1996, Rodríguez 2000a), as well as two theses (Pérez 1996, Ayón 1998). Financial support for the work has been provided by Canadian Wildlife Service, World Wildlife Fund of Canada, International Council for Bird Preservation (now BirdLife International), Tennessee Department of Conservation, and the Institute of Ecology and Systematics of the Ministry of Science, Technology, and Environment of Cuba.

Jamaica.—Jamaica has seen intensive surveys by local biologists for many decades for both Neotropical migrants and residents, and has been the site of important, sustained research on the ecology of Neotropical migrants during the non-breeding season. Since the 1970s important counts and surveys have been conducted in Jamaica by Lack (1976), Ann and Robert Sutton, Wunderle and Waide (1993), Chandler Robbins (Robbins *et al*. 1987, 1992), and many others. Beginning in 1986, Richard Holmes (Dartmouth College) and Tom Sherry (Tulane University), followed by students Peter Marra, Allan Strong, Matthew Johnson, and Scott Sillett, conducted some of the first studies of demographic differences in habitat use and site fidelity of migratory birds during the non-breeding season, with much of their work focused on the American Redstart (*Setophaga ruticilla*), Black-throated Blue Warbler (*Dendroica caerulescens*), and Ovenbird (*Seiurus auricapillus*) across an array of habitat types that exhibit different degrees of stress as the dry season progresses. Results from redstarts have shown that patterns of habitat occupancy such as sexual habitat segregation are caused by behavioral dominance of older males (Marra 2000). Sexual habitat segregation is important to the population dynamics of these species, with individual birds in less suitable habitats having lower annual survival and poorer physiological condition (Marra and Holmes 2001). Using stable-carbon isotopes, Marra *et al*. (1998) showed that redstarts in high-quality habitats in Jamaica arrived on breeding grounds earlier and in better physical condition, both of which are positively correlated with reproductive success on the breeding grounds. Poor body condition during the non-breeding season was linked to food availability for the Ovenbird by Allan Strong (Strong and Sherry 2000). Research on another ground-forager, Swainson's Warbler (*Limnothlypis swainsonii*), suggests that for this guild, differences in foraging strategy and the location of available prey will dictate a species' ability to maintain body mass in Jamaica (Strong 2000, Strong and Sherry 2001). Recently, Leo Douglas has built on some of this work to look at migrant behavior in anthropogenic habitats (Douglas 2001). Work has also shown that Jamaican shade-coffee plantations provide relatively high quality habitat for redstarts, and the types of shade trees used to shelter the coffee affects the birds via their influence on food availability (Johnson 2000b). Finally, climate cycles, such as the El Niño Southern Oscillation have been shown to influence survival of the Black-throated

Blue Warbler in Jamaica, which in turn affects recruitment rates in the subsequent breeding season (Sillett *et al*. 2000).

Hispaniola.—Hispaniola was probably less intensively surveyed for Neotropical migratory birds than were some of the other Caribbean islands, although Chandler Robbins (Robbins *et al*. 1987, 1992), and later Wunderle and Waide (1993) included the Dominican Republic in their Caribbean-wide surveys. In addition, early surveys of migrant abundance and habitat use were made by Terborgh and Faaborg (1980) and Arendt (1992, Table 4). Whereas political instability has prevented work in Haiti (but see Woods and Ottenwalder 1983, 1986), the Dominican Republic has seen numerous studies of the ecology of Neotropical migratory birds since the early 1990s. These studies were first led by Joseph Wunderle (U.S. Forest Service), and later by Steven Latta (University of Missouri) and Chris Rimmer (Vermont Institute of Natural Science). Work over the past decade has focused on several species of migratory birds which spend the non-breeding season in large numbers on the island. Significant progress has been made in understanding habitat needs of such species as the Black-throated Blue Warbler, Cape May Warbler (*Dendroica tigrina*), Prairie Warbler (*Dendroica discolor*), Palm Warbler (*Dendroica palmarum*), American Redstart, and Ovenbird. Studies completed by Joseph Wunderle and Steven Latta focused on migrant use of shade coffee plantations (Wunderle and Latta 1994; 1996; 1998a,b; 2000), with the plantations serving as a model for fragmented forest habitat. Results indicated that site fidelity to small shade coffee plantations was comparable to that found in some native tropical forests, and that size of the plantation had little effect on site fidelity. This work also provided some of the early scientific basis needed to promote "bird friendly coffee." Subsequent studies of migrants by Latta focused on natural habitats in the Sierra de Bahoruco where some of the most significant parcels of native habitat remain. In the Bahorucos, Latta established nine long-term study sites, each with color-banded populations of birds, and focused research on habitat-specific demographics and site fidelity, and factors responsible for variation in site fidelity among habitats. Among other results, Latta has shown the importance of late dry-season events and habitat heterogeneity in the non-breeding season ecology of the Prairie Warbler (Latta and Faaborg 2001), linked both population responses and individual condition of nonbreeding Cape May Warblers to prevailing ecological conditions across habitats (Latta and Faaborg 2002), and demonstrated that an ectoparasite can have a dramatic impact on Palm Warblers (Arendt 1992, p. 164; Latta and O'Connor 2001; Latta, in press), thus suggesting the potential importance of parasites to limitation of avian populations during the non-breeding season.

Hispaniola is also the principal non-breeding grounds of the globally threatened Bicknell's Thrush (*Catharus bicknelli*) that has been intensively studied in the Dominican Republic by Chris Rimmer and collaborators. Research has focused on distribution, habitat use, site fidelity, and survival of these birds in high elevation, moist broadleaf sites (Rimmer and McFarland 2001). Current research is investigating apparent sexual segregation in this species and the possible impact of this on population dynamics.

Finally, the Dominican Republic is unique in the Caribbean in that in 1998 a national avian conservation workshop was held which sought, among other things, to prioritize avian research needs and to promote the concept of long-term avian monitoring (Latta and Lorenzo 2000, Latta 2000). This led to a national monitoring plan which includes methods for the monitoring of birds during both the breeding and non-breeding seasons. Portions of that plan have been implemented (see Monitoring below).

Puerto Rico.—As has occurred in other islands, early work in Puerto Rico was limited to observations of species occurrence by visiting and resident ornithologists and naturalists. These observations are scattered in the literature as notes or included in check-lists and supplements, and have since been summarized in bird guides and special publications (Biaggi 1970, Raffaele 1989). Since the 1970s, several more rigorous studies of Neotropical migrants have been conducted in Puerto Rico. Two of the principal researchers working with migratory landbirds in the island are John Faaborg (University of Missouri – Columbia) and Wayne J. Arendt (U. S. Forest Service, International Institute of Tropical Forestry, Río Piedras, PR). They have been studying residents and migratory birds in the subtropical dry forest of Guánica in southwestern Puerto Rico since 1972 with the primary purpose of monitoring long-term population fluctuations. This is indeed the longest-running monitoring program in the region and has yielded a wealth of data on population trends and the response of warbler populations to habitat change and climate fluctuations (Faaborg 1982; Faaborg and Arendt 1984, 1989, 1990 1992a, b, 1995). Numerous other completed research projects have focused on Neotropical migrants in

Puerto Rico during shorter-term periods including three doctoral dissertations (Richardson 1974, Faaborg 1975, Baltz 2000). General research topics have included migrant community structure (Faaborg 1975, Wunderle and Waide 1993), migration ecology (Richardson 1974, 1976), habitat use by focal species (Baltz 2000; Wunderle 1992, 1995), social behavior (Staicer 1992), and conservation (Wunderle and Waide 1994).

Bahamas.—Beyond general surveys (Wunderle and Waide 1993), occasional mist-netting, and intensive searching for Kirtland's Warbler (*Dendroica kirtlandii*), little work has been conducted in the Bahama Islands. John Emlen (1977) completed a monograph on land-bird communities of Grand Bahama Island which included data on residents during the non-breeding season, whereas more recently Michael Murphy and co-authors (2001) studied population structure and habitat use by Neotropical migrants on San Salvador Island. Joseph Wunderle is overseeing the only active project studying habitat use by the endangered Kirtland's Warbler on Eleuthera Island, with additional work on the demographics and site fidelity of the suite of Neotropical migratory birds inhabiting low scrub vegetation. This work is undertaken with the participation of Bahamas National Trust, Bahamas Department of Agriculture, The Nature Conservancy, and the U. S. Forest Service.

Virgin Islands.—Beyond survey work and avian monitoring completed by David Ewert and Robert Askins (see below), little work has taken place in the Virgin Islands with regard to migrants. Work by Askins *et al*. (1992) pointed to the abundance of migrants in unfragmented moist forests of St. John Island compared to the fragmented forests of St. Thomas. There are no active projects beyond a recently initiated monitoring project at a single site on St. Croix (see below).

RESEARCH NEEDS

1. **Habitat associations**
   a. Habitat-specific survival data by sex and age class are unavailable for most species and most habitats.
   b. Although almost all major natural habitat types have received some attention, a few habitat types are almost completely unstudied.
   c. With the exception of shade coffee, few studies of site fidelity have used anthropogenic habitats, whereas managers may be most interested in what levels of disturbance migratory birds will tolerate. What is the relationship between habitat use and anthropogenic changes to habitats? What value does early successional habitat have for migrants? Bamboo? Acacia woodlands? What are the possibilities of managing selected crops as habitat (especially pasture, citrus, cacao, and other agricultural crops)?
2. **Social behavior of species on their non-breeding grounds**
   a. How prevalent are mixed-species flocks in the Caribbean and what species participate in flocks?
   b. Similarly, which species are territorial on their non-breeding grounds?
   c. What drives the movements of "floaters" or "wanderers" and how does wandering influence survival probabilities?
3. **Limiting factors**
   a. What are the limiting factors for each species on their non-breeding grounds (e.g., climate, food, habitat, predators, disease)?
   b. How do weather patterns (especially rainfall) affect site fidelity, and can these data be related to climate change (i.e., global warming) and global climate patterns such as the El Niño Southern Oscillation (ENSO)?
   c. How general is the model of non-breeding season ecology and population dynamics as presented for the American Redstart?
   d. Do events that occur in the nonbreeding period play a critical role in population dynamics of these species in the annual cycle?
4. **Conservation concerns**
   a. What are the effects of habitat fragmentation on migrants on their non-breeding grounds? Do effects vary among habitats? Can we develop standard techniques of rapidly assessing habitat quality?
   b. In addition to coffee plantation research, are there any other examples of cost-effective attempts to improve quality and quantity of migrant-bird habitats?
   c. Can we prioritize the conservation importance of species within and across political units (island/country)?
5. **General concerns**
   a. Few studies cover the entire migratory or non-breeding season. We need a better understanding of arrival and territory establishment periods, and spring fattening periods. We need an understanding of how birds prepare for spring

migration, both behaviorally and physiologically, and whether territorial individuals use different habitats just before migration.

b. Are there competitive relationships among permanent-resident and non-breeding season-resident migratory species and how are these relationships affected by habitat alteration?

c. How comparable are data when collected using different methodologies? Can we standardize methods of data collection and data analyses?

RECOMMENDED METHODOLOGIES

Our focus is on monitoring seasonal resident Neotropical migratory birds on their non-breeding grounds, and monitoring methods that can be combined with research protocols to determine site fidelity and survival of migrants of both sexes and all age classes in diverse habitats. We recognize that some organizations may want to monitor fall and spring migration, but those methods are not addressed here. Most organizations will also be interested in monitoring permanent-resident bird species. Although this is not directly addressed here either, many of the methods presented do lend themselves to the monitoring of permanent-resident species as well. For reviews of other monitoring methods, see some of the numerous published reviews of monitoring methods (Martin and Geupel 1993; Ralph *et al*. 1993, 1995; Geupel and Warkentin 1995).

Herein, we present a standard avian monitoring plan that can be implemented at one or more of several different levels. Because of their relatively small size, we believe that most Caribbean countries can develop and initiate an avian monitoring program which combines an extensive (country-wide) and quick monitoring system of point counts, and a local and more intensive monitoring method at a limited number of sites at protected areas around the country. Depending on resources, a local, intensive monitoring program could be expanded to a "Level 2" plan which is specifically designed to allow researchers to collect habitat specific, demographic, and site fidelity data to assess habitat preferences of migratory birds during the non-breeding season and factors affecting site fidelity. In selecting a monitoring protocol it must be stressed that these are protocols for long-term monitoring that requires dedicated funding over many years, and dedicated personnel who are committed to the long-term collection of data. Protocols presented here are based on a variety of sources, including Martin and Geupel (1993), Ralph *et al*. (1993, 1995), and especially Faaborg (2000) and Latta and Lorenzo (2000).

Extensive and Quick Monitoring Protocol

This protocol reflects the guidelines set forth by Ralph *et al*. (1993, 1995) and Faaborg (2000), and is based on the North American Breeding Bird Survey (BBS) for broad-scale monitoring of many habitats and many species. This monitoring method consists of a national system of point counts that are conducted once a year by volunteer counters. The intent of the extensive, quick monitoring program is the detection of national trends in population size so that population changes can be addressed with management actions. This survey is designed to give us a first warning of population changes across a broad region.

Specifically:

1. Systematically locate a minimum of 25 census stations across the country, but designate a starting point of each census route at random. This may be accomplished by superimposing 25 or more cells in a grid over a map of the area and then randomly locating a general starting point within each cell. The specific location of each starting point within a cell will then be determined by locating the nearest appropriate road (or trail if no road is available) to the randomly selected starting point. Direction of travel along the selected road or trail should be determined randomly.
2. In all cases try to locate censuses on tertiary roads, then secondary roads, then off-road trails. Primary roads should be avoided. Sampling locations should be checked on the ground before the first count is initiated and their locations mapped, preferably using GIS and GPS methods.
3. Routes should be designed with 25 point-count stations along each route (15 stations for walking routes). Additional routes may be added in the future should funding, trained volunteers, and vehicle accessibility improve.
4. Use 5-min point counts; data should be separated into those individuals seen or heard during the first three minutes and those additional individuals recorded in the remaining two minutes.
5. Points on vehicle routes should be 0.5 mi from one another; points on walking routes should be 250 m apart.
6. Use an unlimited-radius point count, but birds detected within 25 m should be recorded separately. Use of an additional distance band of 25–50 m, or employing distance sampling

techniques (Rosenstock *et al*. 2002, Bart and Earnst 2002), may allow detection probabilities to be factored into results.

7. Point counts should be conducted annually, 1–31 January. Birds should not be surveyed during inclement weather including rain, fog, or high winds.
8. Counters should be trained in binocular use, bird identification by sight, song, and call, and census techniques. Only qualified counters should be used.
9. Use standardized data recording forms in the field. Notations should include species and number; general location and change of location; whether the individual was detected by vocalization, sight, or simultaneous audio-visual detection; whether the detection was a flyover; and incidence of counter-singing, counter-calling, mobbing, or predator-recognition vocalizations.

Local, Intensive Monitoring Protocol

This protocol is based on previous work on migrant site fidelity by Holmes *et al*. (1989), Wunderle and Latta (2000), and Latta and Faaborg (2001, 2002). At its fullest development, this is an intensive effort that involves point counts, constant-effort mist-netting, re-sighting of color-marked birds, and vegetation sampling to determine local site fidelity, and to estimate survival rates of migratory (and resident) bird species at each site and in each habitat. Local, intensive monitoring complements broad, quick monitoring by helping to explain national population trends that the broad, quick monitoring reveals. Point counts and constant-effort mist-netting provide an index of annual productivity and information on annual survival. Re-sighting of color-marked birds is used to determine site persistence or survival over the nonbreeding season. Intensive monitoring will also provide urgently needed data on life-history traits and demography of species, and provide direct information on habitat conditions necessary for survival through the non-breeding season. Together, these data are required to assess the non-breeding ecology of Neotropical migratory birds and habitat conditions for land and species management.

Local, intensive monitoring may be completed as either Level 1 or Level 2 depending on the resources available to the organizers of the monitoring effort, and the type of questions that need to be addressed in the monitoring effort. "Level 1 Local, intensive monitoring" includes a single mid-winter (1 January–15 February) session of point counts and constant-effort mist-netting, with vegetation sampling completed every five years. "Level 2 Local, intensive monitoring" is more labor intensive and includes early-winter (28 October–14 December) and late-winter (1 February–March 20) sessions of point counts and constant-effort mist-netting, with each mist-netting session followed by intensive efforts to re-sight color-banded birds. Vegetation sampling is also completed every five years. The MOSI program (see below) is essentially a Level 2 Local, intensive monitoring program but does not (generally) include the re-sighting effort.

For either Level 1 or Level 2 local, intensive monitoring, study sites of 12–20 ha each should be established. Study sites may be in either native or anthropogenic habitats, altered or pristine states, depending on the monitoring or research questions. Study sites within a habitat will likely need to be replicated. At each site the following should be completed:

Point counts (For both Level 1 and Level 2, Local, intensive monitoring).—Ten-min, unlimited-radius point counts (with data recorded separately for each 5-min interval and for birds seen within 25 m and 50 m) are conducted at each site. Six point counts are established per site and points are counted preceding mist-netting efforts. Points are arranged in either a 3 x 2 grid or a line, depending on mist-net arrangement, and points are a minimum of 150 m apart.

Mist-netting (For both Level 1 and Level 2, Local, intensive monitoring).—Mist-nets are set in fixed lines that form either a grid pattern or a single long line. Depending on bird activity, as many as 24–42 nets (12 m x 2.5m, 30-mm mesh) may be used per site. However, it is important that net numbers at each site and net locations are *fixed* within a site so that there are consistent net hours and net times among years. A given monitoring effort may set its own mist-netting schedule with the understanding that capture rates decline precipitously over time. During monitoring efforts on Hispaniola, we generally open nets from before sunrise to sundown on Day 1, sunrise to 12:00 and 15:30 to sundown on Day 2, and sunrise to 10:30 on Day 3. On Puerto Rico, monitoring efforts extend to three full days of netting. All birds mist-netted (except hummingbirds) should be banded with numbered aluminum bands. All migratory species and some permanent-resident species should be uniquely color-banded if re-sighting is done as prescribed in Level 2, Local intensive monitoring.

Re-sighting (For Level 2, Local, intensive monitoring only).—Following banding efforts, each plot is searched systematically for color-banded individuals. Plots may be searched systematically, with color-banded, territorial birds located on plot maps. Additional effort may be extended to locate previously unrecorded individuals, but re-sighting may take 3–5 days or more by several individuals. Re-sighting should continue until observers are confident that no more color-banded birds remain unidentified on the plot. Search areas may extend approximately 100 m beyond the net lines or plot boundaries.

Vegetation sampling.—Vegetation measurements provide information on habitat characteristics at each site, and can be used for developing land management guidelines. These measurements should be made in the first year of operation of nets and at every five-year interval. At a minimum of nine randomly selected locations across each study site, sample vegetation in a 11.3-m radius circle (James and Shugart 1970). In each circle record:

1. Number of stems of all saplings and shrubs <3 cm DBH along each of the cardinal axes in 2-m wide transects. This is recorded by walking with arms outstretched along each axis and counting the number of "touches" by sapling or shrub branches on the arms.
2. Number of live trees in each DBH size class by species or type, with size classes being 3–7.9 cm, 8–14.9 cm, 15–22.9 cm, 23–38 cm, and >38-cm DBH.
3. At five evenly-spaced points along each of the cardinal axes, record presence or absence (touches on an extended pole) of broadleaf trees, grasses or other ground cover, pine, cactus, or other relevant vegetation type, at each of the following height intervals: 0–0.4 m, 0.5–0.9 m, 1–1.4 m, 1.5–1.9 m, 2–2.4 m, 2.5–2.9 m, 3–3.9 m, 4–5.9 m, 6–7.9 m, 8–9.9 m, 10–11.9 m, 12–14.9 m, 15–19.9 m, 20–25 m, >25 m.
4. The height of the 10 tallest trees in the circle; calculate mean and maximum canopy height.
5. The percent canopy cover using a densiometer.
6. The number of all snags >15 cm DBH.
7. An ocular estimate of percent of the ground covered by green vegetation, grasses or sedges, shrubs, forbs, and ferns.
8. An ocular estimate of percent of ground covered by leaf litter.
9. An ocular estimate of percent of ground covered by downed logs.
10. An ocular estimate of percent of ground that is bare.
11. Plot elevation.
12. Plot aspect and slope.

THE MOSI (MONITOREO DE SOBREVIVENCIA INVERNAL) PROGRAM

The Monitoreo de Sobrevivencia Invernal (MOSI) program uses constant-effort mist-netting and banding during the non-breeding season to monitor survival rates of Nearctic-Neotropical migratory birds and Neotropical resident landbirds. MOSI builds on the Monitoring Avian Productivity and Survivorship (MAPS) program, which suggested that low survival may be a factor in the population decline of several Nearctic-Neotropical migratory landbird species. Although it is not clear where or when in the life cycle of these species the mortality rate is greatest, conventional wisdom suggests that high mortality may well occur during the non-breeding months when environmental conditions are harsh, food resources are relatively scarce, and both intra- and inter-specific competition may be high. Migration to tropical latitudes tends to reduce harsh environmental conditions and increase food resources, but it may also increase the intensity of the competitive regime for both migratory and tropical resident species. When habitat loss and degradation combine with an increased competitive environment during the non-breeding season, dramatically lowered survival rates may result.

Survey work in the Neotropics has provided information on the habitat requirements of many species of migratory and resident landbirds. Such work suggests that many species, even those that are thought to prefer relatively mature and undisturbed primary forest, can also be found in substantial numbers in secondary forest, forest edge, and other disturbed habitats. What remains unknown, however, is how well they survive in such habitats. A concerted effort to determine habitat-specific survival rates throughout the non-breeding season is thus a critical need. Another critical need is to determine age-specific survival rates; that is, survival rates for young (first-year) and adult individuals. This may be a key factor in the population declines of migratory and resident Neotropical birds, particularly if young and adults have differing habitat requirements, or if older birds actively exclude younger birds from possibly optimal habitats or likely critical food or other resources. Similar considerations may apply to sex-related differences in habitat preferences, dominance behavior, and survival through the non-breeding season.

MOSI proposes to apply state-of-the-art mark-recapture models to standardized bird-banding data obtained from a network of mist-netting stations operated throughout the non-breeding season ranges of Nearctic-Neotropical migratory bird species. The establishment of the MOSI program, designed as a cooperative effort among agencies, organizations, and individual bird-banders in Mexico, Central America, and the Caribbean, will facilitate the determination of survival rates for about 20 target migratory landbird species (and many resident species) in a wide range of tropical habitats. A proposed pilot MOSI protocol includes: (1) one session of mist-netting during the early part of the non-breeding season, from 28 October to 14 December, consisting of the operation of at least 16 12-m nets for two or (preferably) three consecutive days on half of a 40-ha study area, followed immediately by two or (preferably) three days of operation of at least 16 nets on the other half of the study area; and (2) one session of mist-netting during the latter part of the non-breeding season, from 1 February to 20 March, which replicates the same protocol at the same net locations on the same study area. All birds captured are to be identified to species, age, and (if possible) sex, and marked with uniquely numbered leg bands; if possible, individuals of one or two focal species should also be individually color-banded to provide mark-resighting data. A four-year pilot project to evaluate and enhance the operation of this network of MOSI stations has been proposed for commencement in 2002–2003. Parties interested in establishing one or more MOSI stations in the Caribbean should contact David F. DeSante (ddesante@birdpop.org,) at The Institute for Bird Populations (IBP), P.O. Box 1346, Point Reyes Station, CA 94956–1346, USA. More information about the MOSI Program can be found at the IBP's website, www.birdpop.org.

CITIZEN SCIENCE AND MONITORING MIGRATORY BIRDS IN THE CARIBBEAN

Citizen Science is a term used for the use of non-professional volunteers in the coordinated gathering of important scientific data. The quality of the scientific knowledge base for conservation of migratory birds in the Caribbean involves both breadth of coverage and depth of detail. The breadth of coverage involves the gathering of information of low level of detail about the broad course of bird movements or bird residence throughout the islands. The depth of detail involves more precise information about the demographic consequences of variation in the nature and features of particular habitats in which a species resides. Between these extremes lies a spectrum of activities of different intensities. Citizen Science has its major application to the broad scale. The activities involved at this broad scale require small investments of time and energy by large numbers of birdwatchers. The required data resulting from birdwatching activities include lists of species, numbers of individuals, dates, and places. Because these data are too numerous, diffuse, and expensive to be gathered in a single effort, they are ideally gathered by a variety of observers who are loosely coordinated. Individually, such data are of modest scientific value, but the collection of such data from many sources is potentially a priceless source of otherwise unavailable information. Maps of occurrence can be drawn from these data, and from these maps more precise hypotheses can be made and then tested with more detailed and specific work.

Citizen Science is relevant to conservation activities to manage or protect habitats used by migratory birds because sufficient information required to conserve these birds during the migratory period is not yet available. Development of the requisite information will occur in a series of steps, each important to the development of a base of knowledge on which conservation action will proceed. These steps each involve different sets of skills, observers, locations, techniques, and costs. Subsequent to the development of the knowledge base, the implementation of conservation action, in which knowledge is applied to influence the future course of land use or management, is a distinct activity requiring a separate treatment. It is important to note that the quality of conservation action is limited by the quality of the knowledge on which conservation action is based, and the quality of the knowledge may depend on Citizen Science.

The development of the knowledge base for conservation of birds during the migratory or non-breeding period has four phases: (1) identification of the avifauna present, their locations, and the timing of their movements; (2) determination of differential movements of sex and age classes of each species, their survival rates, and the relative importance of different locations and habitats for each sex and age class; (3) comparison of the importance of areas for migratory and resident birds, including island endemics; and, (4) evaluation of localities based on habitat contents, geographical context, and relative importance of the migratory species occurring in each locality.

Conduct of this Citizen Science requires individuals with sufficient skill and ambition to record bird presence, as well as access particular sites. Also required is a coordinating body and mechanisms to compile the data and to share the observations with others in a timely way. The Gulf Coast Bird Observatory (GCBO; http://www.gcbo.org) provides an example of how such data can be managed and utilized. The migration monitoring database currently maintained by the GCBO allows straightforward data entry and editing, and compiled data can be downloaded and summarized by any interested person. This process is being made even more user-friendly by the translation of the data entry and retrieval instructions into several languages by members of the SCSCB.

CURRENT NEOTROPICAL MIGRATORY BIRD MONITORING PROJECTS IN THE WEST INDIES

Cuba

None known.

Jamaica

1. Constant-effort Bird-Monitoring Project in Mid-level Forests
   Purpose: Collect long-term information on status and relative abundance of bird populations.
   Methods: Mist-netting and point counts completed once per month, year round.
   Duration: Sporadic before 1990; regular since then. Will continue indefinitely.
   Principal investigator: Ann Sutton

Hispaniola

1. Avian Monitoring in the Sierra de Bahoruco
   Purpose: Monitoring of non-breeding season (migratory) and permanent-resident birds in three habitats (desert thorn scrub, dry forest, pine forest) along an altitudinal gradient.
   Methods: Constant-effort mist-netting; 10 min point counts on 25-m fixed-radius circles (January of each year).
   Duration: Continuous since 1996.
   Principal Investigator: Steven Latta.
2. Avian Monitoring in Montane Wet Forest
   Purpose: Monitoring of non-breeding season (migratory) and permanent-resident birds in montane wet forest of the Sierra de Bahoruco.
   Methods: Constant-effort mist-netting; 10 min point counts on 50-m fixed-radius circles (January of each year).
   Duration: Continuous since 1995.
   Principal Investigator: Christopher Rimmer
3. Fundación Moscoso Puello Monitoring
   Purpose: Monitoring of migrants and permanent residents in three National Parks: Parque del Este, Parque Jaragua, and Valle Nuevo.
   Methods: Constant-effort mist-netting and 10 min point counts on 25-m fixed-radius circles.
   Duration: Initiated in 2002.
   Principal Investigator: Fundación Moscoso Puello

Puerto Rico

1. Guánica Forest
   Purpose: Monitoring of non-breeding season (migratory) and permanent-resident birds in the subtropical dry forest of Guánica.
   Methods: Constant effort mist-netting (January of each year).
   Duration: Continuous since 1972.
   Principal Investigators: John Faaborg and Wayne Arendt.
2. USFWS Sites
   Purpose: To establish long-term monitoring stations in different habitats at Ciales and Cabo Rojo, Puerto Rico, and at Culebra Island.
   Methods: Constant-effort mist-netting.
   Duration: Initiated in 2001
   Principal Investigators: Leopoldo Miranda-Castro and Steve Earsome

Bahamas

None known.

Virgin Islands

1. USFWS Site, St. Croix
   Purpose: To establish long-term monitoring stations at St. Croix, U. S. Virgin Islands.
   Methods: Constant-effort mist-netting.
   Duration: Initiated in 2001
   Principal Investigators: Leopoldo Miranda-Castro and Steve Earsome
2. Virgin Islands National Park, St. John
   Purpose: Monitoring of non-breeding season (migratory) songbirds in Virgin Islands National Park, St John.
   Methods: 10-min point counts on 25-m radius circles at 68 permanently-marked survey points.
   Duration: Completed in seven years from 1987 to 1997. Hope to continue in the future.
   Principal Investigators: Robert Askins and David Ewert.

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