ORNITOLOGIA NEOTROPICAL 16: – , 2005


# STRATEGIES FOR THE CONSERVATION MONITORING OF RESIDENT LANDBIRDS AND WINTERING NEOTROPICAL MIGRANTS IN THE AMERICAS

**Steven C. Latta[1,3], C. John Ralph[2], & Geoffrey R. Geupel[1]**

[1]PRBO Conservation Science, 4990 Shoreline Highway 1, Stinson Beach, California 94970, USA.

[2]U.S. Forest Service Redwood Sciences Laboratory, 1700 Bayview Dr., Arcata, California 95521, USA.

**Resumen. – Estrategias para el monitoreo y conservación de aves terrestres residentes y migratorias neotropicales en las Américas. –** Muchas organizaciones a nivel internacional, regional y local, han concordado con la necesidad de establecer programas de monitoreo de aves a largo plazo en las Américas. Sin embargo, el reto de desarrollar programas de monitoreo nacional e internacional es difícil, debido a la falta de biólogos capacitados u otros recursos en las regiones claves. Más aún, aquellas organizaciones locales que cuentan con personal y recursos para desarrollar un programa de monitoreo, usualmente tienen sus propias metas y objetivos de monitoreo definidos a nivel local. Estos objetivos pueden variar entre regiones y países, pero deben apoyarse durante el diseño y financiamiento de programas de monitoreo a gran escala. Presentamos una estrategia de monitoreo que permite a las organizaciones locales generar resultados de importancia para sus esfuerzos de gestión local, y que al mismo tiempo les permite participar en esfuerzos de monitoreo más amplios, a nivel regional e internacional. Bajo esta estrategia, los resultados de esfuerzos conjuntos sirven a su vez para determinar las tendencias poblacionales y las relaciones de hábitat de las aves migratorias y residentes, a una escala mucho mayor que la que puede ser alcanzada por un esfuerzo de monitoreo aislado. Igualmente, esta estrategia nos permite enfocarnos en resolver preguntas básicas sobre la ecología y la historia natural de las especies de aves migratorias y residentes. A través de un esfuerzo cooperativo como el presentado aquí, y mediante el uso de protocolos que incorporan métodos de monitoreo estandarizados, podemos evaluar la eficacia de las acciones de conservación y manejo a lo largo de las Américas, y al mismo tiempo cumplir con los objetivos de conservación y monitoreo definidos a nivel local.

**Abstract. –** Many international, regional, and local partner organizations have agreed in the need to establish long-term bird monitoring and research programs in the Americas. However, the challenge of developing national or international monitoring programs is difficult often because of the lack of qualified biologists or other resources in key regions. More fundamentally, locally-based organizations that may have personnel and resources that could be involved in monitoring programs often have their own goals and locally defined monitoring objectives. These objectives may vary among regions and countries, but must be supported when designing and funding monitoring programs. Here we present a monitoring strategy that allows locally-based organizations to generate results that will have relevance to their local management efforts, while enabling them to participate in wider, regional and international monitoring efforts that will

[3]*Corresponding author e-mail:* slatta@prbo.org

help to determine population trends and habitat relationships of both migratory and permanent resident birds, at a scale far greater than any single monitoring effort. It also allows to address basic research questions of the ecology and natural history of migratory and resident bird species. Through a cooperative effort such as outlined here, and with the use of protocols that incorporate standardized monitoring methods, we can evaluate the efficacy of conservation and management actions throughout the Americas, while also fulfilling locally-defined conservation and monitoring objectives. *Accepted 3 March 2005.*

**Key words:** Monitoring, Latin America, Neotropical migratory birds, avian ecology, avian conservation.

## INTRODUCTION

The conservation and management of terrestrial landbirds requires the collection of habitat-specific data on population parameters because a vast majority of conservation and management activities are related to the population size of a species (Faaborg 2000). For example, population dynamics of game species must be understood well enough to allow continued harvest activities without negative impacts on future reproduction and population levels. With threatened and endangered species, we must know the distribution of species, the population size, population trend, and primary population parameters in order to develop and evaluate effective conservation plans. For species that are neither harvested, threatened, or endangered, monitoring activities must be adequate to detect population trends so that declining species can be recognized while they are still relatively abundant. Linking bird population data to specific habitat types, land-use practices, or landscapes is perhaps the most effective way to allow managers to use the information effectively in setting conservation priorities and assessing the effect of management actions (Martin 1995, Hutto & Young 2002).

Many international, regional, and local conservation organizations have agreed to the need to establish long-term avian monitoring and research programs in the Americas. Much discussion over the past decade about the establishment of bird monitoring programs throughout the Americas has established the need for the use of standardized methods in monitoring bird populations (e.g., Ralph & Milá 1994, Geupel & Warkentin 1995, Latta *et al.* 2003). Data on population parameters must be quantifiable and collected in a similar manner on a regular basis so that comparisons can be made across space and time (e.g., Koskimies & Vaisanen 1991). Standardized monitoring methods for landbirds have been presented in Ralph *et al.* (1993, 1996) and are in general use, but challenges remain in developing national or international monitoring programs. These challenges include the potential lack of qualified biologists, methods of integrated data management and dissemination, and (perhaps more often) the lack of key resources such as funding. More fundamentally, locally-based organizations that may have personnel and resources for monitoring programs often have their own goals and locally-defined monitoring objectives. These objectives may vary among regions and countries, but must be supported when designing and funding monitoring programs.

Here we present a monitoring strategy that allows locally-based organizations to generate objectives and results that will have relevance to their locally-defined management efforts, while enabling their participation in wider regional and international monitoring efforts that will help determine population trends and habitat relationships of migratory and permanent residents birds at a scale far greater than any single monitoring effort. It also allows us to address important (and often

TABLE 1. A strategy for the conservation monitoring of landbirds in the Americas based on six levels of monitoring. Increasing the level of monitoring (from level A through level F) increases complexity and cost, but builds the level of knowledge needed for effective conservation. The key questions and techniques from lower levels of monitoring which may still be addressed are included in higher levels also.

| Basic questions | Monitoring objectives | Basid technique(s) |
|---|---|---|
| CENSUS METHODS | | |
| | Level A: Species presence/absence | |
| What species are present? | | Observations |
| | Level B: Population size | |
| How large is the population? | | Single set of counts |
| Where are the birds (and why)? | | Habitat measurements |
| What species are present? | | Observations |
| | Level C: Population trends | |
| What is the population trend? | | Repeated sets of counts |
| How large is the population? | | Habitat measurements |
| Where are the birds (and why)? | | Observations |
| What species are present? | | |
| | Level D: Ecology/natural history | |
| What are birds doing (and when)? | | Constant-effort mistnetting |
| What is the population trend? | | Repeated sets of counts |
| Where are the birds (and why)? | | Habitat measurements |
| What species are present? | | Observations |
| DEMOGRAPHIC METHODS | | |
| | Level E: Reproductive success | |
| What are the causes of population changes | | Monitoring of nests |
| What is the reproductive rate? | | Habitat measurements |
| What is the population trend? | | Observations |
| What are the birds doing (and when)? | | |
| Where are the birds (and why)? | | |
| What species are present? | | |
| | Level F: Survival and productivity | |
| What are the causes of population change? | | Constant-effort mistnetting |
| What are the rates of productivity and survival? | | Color-band resighting |
| What is the population trend? | | Repeated sets of counts |
| What are the birds doing (and when)? | | Habitat measurements |
| Where are the birds (and why)? | | Observations |
| What species are present? | | |

novel) basic research questions of the ecology and natural history of migratory and resident bird species. Through a cooperative effort such as outlined here, and with the use of protocols that incorporate standardized monitoring methods, we can evaluate the efficacy of conservation and management actions throughout the Americas, while also fulfilling locally-defined conservation and monitoring objectives.

In building a candidate monitoring scheme, we suggest six conditions to strive for achieving. First, the proposed monitoring strategy should focus on methods that are intended to apply over a relatively small spatial scale, such as a refuge, national park, or forest preserve of perhaps 10,000 $km^2$ or less, where management actions need to be based on information from the local area. Within each area, one or more monitoring sites could be established incorporating the methods described here. Second, we propose that all methods should be, to the greatest extent possible, mutually compatible, so that existing programs at a station can, with minimal perturbation, be integrated with other existing or proposed programs at other stations. Third, monitoring efforts should seek to understand factors that involve both Neotropical migratory birds and permanent resident species. To implement this condition, one would conduct surveys both during the northern winter when Neotropical migrants are present, and during the season when most permanent resident species are breeding. Fourth, we emphasize the need for basic research into the ecology and natural history of both resident and migratory birds. As the Partners in Flight Research Working Group (2002) has pointed out, monitoring, research, and management are closely interrelated, and much research depends on well-coordinated monitoring efforts; clearly the mechanisms of population change can best be understood through continued and expanded population monitoring. Fifth, monitoring efforts should strive to seek to understand both primary and secondary population parameters whenever possible, as it is important that we identify not only negative population trends, but also the demographic factors that might be associated with population declines. And finally, the data at any monitoring station should be able to be upwardly integrated. No matter what the resources of the operator at a station, the data are much more valuable if they contribute to larger programs. Specifically, an operator can contribute to one or more monitoring objectives for a single site, and further, those data can also be aggregated to answer larger, regional questions.

## A MONITORING STRATEGY IN SIX LEVELS

We suggest that the general goals of any bird monitoring program can usually be placed among six objectives and their concomitant methods, and these can be arranged semi-linearly in an interactive structure from ëLevel A monitoringí to ëLevel F monitoringí such that each can form the foundation for the next level (Table 1). As we envision this sequence of objectives, as one moves from level A through level F, one gains additional knowledge concerning avian populations and ecology, the complexity of monitoring methods increases, and costs and personnel needs for the monitoring program increase.

At its simplest, avian monitoring consists of an inventory, that is, the determination of presence or absence of various species (Level A). Building on this foundation, we can construct successively more complex objectives, including: defining population size, and determining habitat relationships based on a broad-scale set of point counts (Level B); estimation of long-term population trends with censuses based on repeated counts (Level C); determining the population ecology and life history of species through constant mist-netting effort or observations (Level D); the determination of reproductive success and reproductive rate through nest monitoring (Level E); and, the estimation of population composition and limitations through demographic parameters, such as survivorship and site fidelity, with a comprehensive program of mist netting and/or color-band resighting (Level F). With each new level, methods are added, or their intensity is increased, and at the same time understanding and perspective are increased. Below we define more clearly these monitoring levels.

*Level A monitoring: Species presence or absence through observation.* This level of monitoring is an inventory, and is the basic level of monitoring. Techniques include various counting methods, area searches, targeted searching, and the compilation of data from historic records, birdwatchers, and others familiar with the area. This would result in a checklist of birds over time, such as many protected areas and parks have already accomplished. Checklists are usually augmented by subjective estimates of relative abundance of species, habitat associations, and seasonal changes in presence and abundance.

*Level B monitoring: Estimating population size through a single set of counts.* Monitoring at this level involves the possibility of evaluation of many habitats and many species. Estimations of population size with variable-distance counts, habitat relationships, and habitat requirements can be generated with this monitoring method (e.g., Hutto *et al.* 1986, Lynch 1989). Point counts are usually considered as the best option during the breeding season, when species are actively singing, but they have also been used at all times of the year. Area search counts (usually 20 min in duration) are also considered a good option during all times of the year, and are especially useful for flocking species.

This monitoring method reflects guidelines presented in Ralph *et al.* (1993, 1995) and Faaborg (2000), in which a route of many point counts, or a series of area searches is recommended. For point counts, we suggest a minimum of 25 census stations/habitat. Routes are preferentially located on tertiary roads, then secondary roads, and then off-road trails. Primary roads should be avoided to reduce edge effects. Using either a 5-min or 10-min, unlimited-radius point count, we recommend that all birds seen and heard at a station be tallied, both inside and outside a given distance (for example 25 or 50 m). The distance to each individual bird can also be recorded so that detection probabilities and density of birds can be determined rather than relying on the index of number of birds per station (Ralph & Scott 1981, Burnham & Anderson 1984). For area searches, all birds seen within and outside the observerís walking circle are tallied. We suggest specific seasons for surveys; for example, wintering Neotropical migrants could be censused annually during January, or several times during the northern winter, while breeding birds could be censused at a locally-determined date.

The advantages of a census are its ability to detect many species simultaneously, as well as population-level responses to habitats, and the relatively easy logistics of implementation. Its main disadvantages are that roadside habitats will be different in some degree from a random sample of an area, and observer variability may be somewhat higher than in the demographic methods described below. This variability results from the difficulty of learning to identify a large number of species, especially in the diverse tropical forests, and the seasonality of detection rates. Some of these disadvantages can be ameliorated by recording the distance to each individual bird as noted above. Alternatively, it can be advantageous to select a subset of focal species and/or easily recognized species to count (Geupel & Warkentin 1995, Chase & Geupel in press).

In addition to counts, we recommend that vegetation measurements be made at each census station to provide on-the-ground information on habitat characteristics for developing land management guidelines and habitat requirements of the species. At a minimum, such data should allow comparison with remote sensing data or aerial photography. At the ultimate level, it can give fine-scale resolution of habitat preferences. There are many suggestions on how to complete vegetation measurements, but the most likely to prove useful is one that is rapidly taken and gives an overview of the vegetation, without great detail. Such a method, the relevé (Ralph *et al.* 1993), involves estimating the height of layers in the vegetation, identifying principal tree and shrub species or species groups, and determination of percent cover of each species in each vegetation layer. Most birds respond to habitat on this fairly large structural and spatial scale (Verner *et al.* 1986), rather than on the presence or absence of, for instance, the small plants in the herb layer.

*Level C monitoring: Estimating population trends with repeated counts.* This level of monitoring is an elaboration of level B monitoring, and consists of a system of counts repeated at least annually. While level B monitoring calls only for a single visit to each counting station, if such censuses are repeated annually, they can provide information on population trends (Nur *et al.* 1999). This monitoring protocol (when using 3-min point counts repeated annually) is similar to that of the North American Breeding Bird Survey (Robbins *et al.* 1986). The intent of the breeding bird survey is the detection of large-scale trends in population sizes, so that possible causes of population changes can be investigated with further monitoring, research, or management actions. The breeding bird survey is thus designed to give us a first warning of population changes across a broad region. When counts are repeated at more frequent intervals, such as monthly, bi-monthly, or quarterly, and of longer duration (5 or 10 min or greater), counts can also contribute to the knowledge of ecology and seasonal movements of birds. When vegetation and habitat measures are taken at regular intervals (approximately every 5 years) at each station, as in level B monitoring, it can also potentially provide on-the-ground information on habitat characteristics for developing land management guidelines and habitat requirements of the species.

*Level D monitoring: Ecology and life history through constant-effort mist netting.* This is a fundamental monitoring method used to determine the presence of rare and secretive species, breeding and migration phenology, age structure of the population, and ecology and life history of species. Constant-effort mist netting may be used to determine population trends if repeated annually (e.g., Faaborg *et al.* 1984, Dugger *et al.* 2001), and it can also provide the foundation for a much fuller understanding of the demographic changes within populations, as well as the potential causes of trends revealed by, for example, census-monitoring methods (e.g., Lynch & Whigam 1995). While constant-effort mist netting is sometimes undertaken once a year, monitoring can be more productive when nets are operated at more regular intervals, such as daily, weekly, monthly, or quarterly, in order to give a fuller picture of bird activity around the year.

Constant-effort mist netting conducted throughout the year or in the season of interest can greatly enhance our knowledge of the population ecology and life history strategies of species. When coupled with behavioral observations, repeated counts, or nest monitoring, mist netting can be a valuable, proactive tool in understanding changes in bird populations (Nur & Geupel 1993, Silkey *et al.* 1999), and detailing vital aspects of the ecology and life history of birds. This can include molt patterns, prevalence and diversity of parasites, food habits (through analysis of droppings), and temporal changes in body condition. In addition, level D monitoring can be used to determine migration movements and dispersal patterns of Neotropical migrants (e.g., Ralph & Hollinger 2003), as well as seasonal movements of tropical resident birds. Migration monitoring through constant-effort mist netting can assess migratory patterns, flock composition, and population trends of species during the annual spring and fall migrations. This might be particularly important in coastal areas and areas known as migration stopover sites where birds rest and refuel before continuing on migration.

Mist nets in level D monitoring are set in fixed locations that form a circle, a grid pattern, or a single long line. Depending on bird activity, one might use 10, 24, or even more nets (usually 12 m x 2.5 m, 30 or 36 mm mesh) per site. However, it is important that net numbers and locations at each site are fixed within a site so that timing and location are consistent among years and sites. A given monitoring station may set their own mist-netting schedule with the understanding that capture rates decline precipitously as nets are operated continuously over a few days, and most operations do not generally exceed three consecutive days in a single site except during migration when newly-arriving birds are still prone to net capture. Migration monitoring stations generally set mist nets in fixed positions that are opened every 1–3 days throughout the migratory period. While longer periods between net operations can result in missing major movements (Ralph *et al.*, 2004a), or obscuring trends (Thomas *et al.*, 2004), this might be ameliorated by combining data from a network of stations (Hussell & Ralph in press, Ralph *et al.* 2004b). All birds netted should be banded with a uniquely numbered aluminum band. In most countries, the capture and marking of migratory birds listed under the Migratory Bird Treaty Act requires a permit from the host country. As in other monitoring methods, vegetation and habitat measures should be taken at regular intervals (approximately every 5 years) at each station.

*Level E monitoring: Reproductive success through nest monitoring.* The monitoring of birds during the breeding season has as its goal the determination of local reproductive success and estimation of survival rates of resident species (Nur *et al.* 2000). A common and straight-forward method of monitoring reproductive success is through nest searching and nest monitoring. The nest-searching protocol is based on the Breeding Biology Research and Monitoring Database (BBIRD) program described in Martin & Geupel (1993), Ralph *et al.* (1993, 1996), and Martin *et al.* (1997). Plots for nest searching may be variable in size, and can be in any habitat of interest. The plots are systematically searched for nests, and each nest is checked every 3–4 days to determine if it is still active (with eggs or young) or if it has failed. Vegetation measurements are used to provide information on microhabitat choices made by nesting birds and for developing some aspects of land management guidelines, with vegetation assessed at the plant containing the nest, and in the area surrounding the nest site. By directly monitoring nest success on plots, we can also examine rates and consequences of nest parasitism (e.g., by cowbirds), provide badly needed data on life history traits, clutch size, and other demographic features of species, and provide direct information on nesting habitat conditions associated with high success (Martin & Geupel 1993).

*Level F monitoring: Survival and productivity through mist netting.* Level F monitoring is an elaboration of levels B and D monitoring and seeks to determine the demographic parameters of populations and habitat-specific measures of site fidelity and survival. This local, intensive monitoring complements broad-scale, rapid monitoring (levels B and C) by helping to explain population trends that the more rapid monitoring protocols find. In level F monitoring, constant-effort mist netting provides an index of annual productivity and information on annual survival. By addition of recapture of banded birds, or the resighting of color-marked birds, one can determine site fidelity and site persistence as an index of survival among or between seasons.

Level F monitoring is based on work on wintering migrant site fidelity by Holmes *et al.* (1989), Wunderle & Latta (2000), and Latta & Faaborg (2001, 2002), but can be applied to both resident species and wintering migratory birds. Since the documentation of continent-wide declines in some migratory species (Robbins *et al.* 1989), a growing number of studies focused on the need for habitat specific, demographic and site fidelity data in assessing habitat preferences of wintering migratory birds (e.g., Holmes *et al.* 1989). 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 (Van Horne 1983). Furthermore, abundance cannot be equated with survival, so data on site fidelity, including overwintering site persistence and annual return rate, would be required to assess habitat quality. Thus, recent studies focused on habitat-specific demographies and site fidelity of wintering migrants (Holmes *et al.* 1989, Wunderle 1995, Wunderle & Latta 2000, Marra & Holmes 2001; Latta & Faaborg 2001, 2002), and these studies have set the standard for studies of overwintering ecology of migrants.

In level F monitoring, constant-effort mist netting, color-banding, and resighting of color-banded birds through area searches is best repeated at intervals throughout the year or season of interest. Intervals between capture sessions are generally quarterly or bimonthly, with the more frequent option chosen for seasonal studies. After each capture session, resighting of color-banded birds can be accomplished by systematically searching the study site and the immediate area for individual birds, mapping the location of birds on prepared site maps, and following birds to help determine their territories or home ranges. Resighting should continue until observers are confident that no more color-banded birds remain unidentified on the plot.

The protocol presented here is similar in some aspects to the ëMoSI Programí (Monitoreo de Sobrevivencia Invernal) which seeks "to determine for each species the habitat characteristics that provide for adequate overwintering survival and good physical condition at the end of the winter season" (DeSante *et al.* 2003). But MoSI largely attempts to assess habitat-specific overwintering survival of migratory landbirds using mist netting and capture-recapture models alone. Color-banding and resighting individual birds is encouraged as "an excellent means for improving the precision of survival-rate estimates because, with sufficient effort, resighting probabilities can be substantially higher than recapture probabilities." However, participants may be discouraged by the perception that resighting is more "labor intensive", and by the lack of access to color bands. But recapture probabilities of wintering migrants are often very low, and if the number of mist netting sessions is several per season, then the labor can approach being as intensive as one requiring resighting of color-banded birds. In addition, a protocol involving resighting color-marked birds has the advantage that both migrants and permanent residents can be simultaneously studied, data analyses are straightforward, and perhaps most importantly, data need not be pooled among many unrelated sites, but rather, data can be analyzed from a small number of sites (for example, a single reserve) because the inclusion of resighted color-banded birds allows investigators to increase greatly the ability to track more individuals birds in the population.

Constant-effort mist netting can also be used as an alternative method of monitoring reproductive success through constant-effort mist netting (DeSante *et al.* 2001), thus building on monitoring levels D and E. Constant-effort mist netting can provide data on reproductive success by determining the number of young birds relative to the number of adult birds that are captured. Promoted as the Monitoring Avian Productivity and Survivorship (MAPS) program (http://www.birdpop.org/), the method depends on a network of banding stations collaborating across the breeding range of the same species, and has been used to explain very broad-scale patterns of bird productivity (Nott *et al.* 2002), but has not been used to determine trends at the level of a reserve, state, or similar-sized region.

## CONCLUSIONS

Prior to initiating any of these monitoring programs, important decisions must be made concerning 1) the objective(s) of the monitoring program, 2) the scale of the monitoring that is possible given likely available resources, including funding and personnel, 3) the time of year that monitoring is of interest, and 4) the frequency of the monitoring. In the case of monitoring Neotropical migratory birds on their wintering grounds, the season is well-defined and reasonably consistent. Monitoring of permanent resident species is less circumscribed because breeding of any given species may occur at any time of the year depending upon latitude, altitude, and climate, and in some species, may even occur more than once per year.

Once implemented, the methods outlined here will produce much-needed information on relative abundance, demographics, and bird-habitat interactions that can be compared among sites and years. Some of these monitoring methods (e.g., counts and mist netting) are much less time-consuming than biologists and managers sometimes think. A very worthwhile monitoring program could involve as few as 10 person-days per year by implementing road-based point counts, area searches, or a single mist netting session annually. A complete monitoring program for a reserve could involve as little as 30–40 person-days per year. The implementation of a long-term landbird monitoring station is therefore quite affordable. We particularly advocate the inclusion where possible of demographic methods (monitoring levels E and F) which seek to understand both primary and secondary population parameters so that we can identify not only negative population trends, but also the problems associated with population declines (Pienkowski 1991).

Finally, a long-term monitoring program can also serve as a basis for the development of a much larger and more comprehensive avian conservation program. We have seen many cases where the initiation of a monitoring program based on constant-effort mist netting, censusing, and/or nest searching, can serve as a facility to train new biologists and volunteers, develop a community-based environmental education program, serve as a basis for the development of research projects and theses for students and other investigators, and catalyze other local and regional conservation initiatives. Monitoring programs that incorporate mist netting can also be used as a public education tool, teaching schoolchildren and adults the beauty of birds and the importance of healthy ecosystems.

As is often the case, training is vital to any avian monitoring effort, and toward this end, joint efforts of various organizations and individuals are underway to offer training in monitoring methods. Such programs are offered by PRBO Conservation Science (formerly Point Reyes Bird Observatory; http://www.prbo.org), Klamath Bird Observatory (http://www.klamathbird.org), and the U.S. Forest Serviceís Redwood Science Laboratory (http://www.fs.fed.us/psw/rsl/), among others. Monitoring workshops enable individuals and local conservation organizations to provide biologists, land managers, and naturalists with the skills necessary to conduct standardized avian monitoring, as well as the analytical skills necessary to manage and interpret their data (e.g., Nur *et al.* 1999). Course participants are introduced to basic concepts in avian ecology and conservation biology, as well as bird identification, census methodologies, monitoring techniques, and environmental sampling, all adapted to their specific locales. These monitoring courses increase the exchange of information among biologists and monitoring stations throughout the Americas. The contacts and partnerships generated through the training courses, and the establishment of the additional monitoring programs, greatly enhances communication among biologists, fosters cooperation, and increases the effectiveness of larger-scale monitoring efforts advocated here.

## ACKNOWLEDGMENTS

We thank participants of the U.S. National Park Serviceís and American Airlineís International Workshop for Park Flight Grantees held in Pico Bonito National Park, Honduras in November 2002, and the VI Congreso Para el Estudio y Conservación de las Aves de México (CECAM) meeting in Culiacán, Sinaloa, México in March 2004, for their interest and comments on presentations of earlier versions of this monitoring scheme. We also acknowledge the generous support of the Goldman Foundation and an anonymous donor for their support of PRBO Conservation Scienceís Latin America program. Raymond McNeil and two anonymous referees helped to improve the manuscript. This is Contribution Number 1189 of PRBO Conservation Science.

## REFERENCES

Burnham, K. P., & D. R. Anderson. 1984. On the need for distance data in line transect counts. J. Wildl. Manage. 48: 1248–1254.

Chase, M. K., & G. R. Geupel. In press. The use of avian focal species for conservation planning in California. *In* Ralph, C. J., & T. D. Rich (eds.). Proceedings of the third international Partners in Flight conference. U.S.D.A. Forest Service, Albany, California.

DeSante, D. F., Nott, M. P., & O'Grady, D. R. 2001. Identifying the proximate demographic cause(s) of population change by modelling spatial variation in productivity, survivorship, and population trends. Ardea 89: 185–207.

DeSante, D. F., T. S. Sillett, R. B. Siegel, J. F. Saracco, C. Alvarez, S. Morales, A. Cerezo, D. R. Kaschube, & B. Milá. 2003. MoSI (Monitoreo de Sobrevivencia Invernal): assessing habitat-specific overwintering survival of Neotropical migratory landbirds. Unpublished protocols available at http://www.birdpop.org.

Dugger, K. M., J. Faaborg, & W. J. Arendt. 2001. Rainfall correlates of bird populations and survival rates in a Puerto Rican dry forest. Bird Populations 5: 11–27.

Faaborg, J. 2000. Avian monitoring systems. Pp. 89–98 *in* Latta, S. C., & R. Lorenzo (eds.). Results of the national planning workshop for avian conservation in the Dominican Republic. Dirección Nacional de Parques, Santo Domingo, Dominican Republic.

Faaborg, J., W. J. Arendt, & M. S. Kaiser. 1984. Rainfall correlates of bird population fluctuations in a Puerto Rican dry forest: a nine-year study. Wilson Bull. 96: 575–593.

Geupel, G. R., & I. G. Warkentin. 1995. Field methods for monitoring population parameters of landbirds in Mexico. Pp. 242–248 *in* Wilson, M. H., & S. A. Sader (eds.). Conservation of Neotropical migratory birds in Mexico. Misc. Publ. 727, Maine Agricultural Forest Experiment Station, Orono, Maine.

Holmes, R. T., T. W. Sherry, & L. Reitsma. 1989. Population structure, territoriality and overwinter survival of two migrant warbler species in Jamaica. Condor 91: 545–561.

Hussell, D. J. T., & C. J. Ralph. In press. Recommended methods for monitoring change in bird populations by counting and capture of migrants. N. Am. Bird Bander.

Hutto, R. L., & J. S. Young. 2002. Regional landbird monitoring: perspectives from the northern Rocky Mountains. Wildl. Soc. Bull. 30: 738–750.

Hutto, R. L., S. M. Pletschet, & P. Hendricks. 1986. A fixed-radius point count method for nonbreeding and breeding season use. Auk 103: 593–602.

Koskimies, P., & R. A. Vaisanen. 1991. Monitoring bird populations. Finnish Museum of Natural History, University of Helsinki, Helsinki, Finland.

Latta, S. C., & J. Faaborg. 2001. Winter site fidelity of Prairie Warblers in the Dominican Republic. Condor 103: 455–468.

Latta, S. C., & J. Faaborg. 2002. Demographic and population responses of Cape May Warblers wintering in multiple habitats. Ecology 83: 2502–2515.

Latta, S. C., A. Tossas, A. Sutton, H. Gonzalez, P. B. Hamel, & D. DeSante. 2003. 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. J. Carib. Ornithol. 16: 1–19.

Lynch, J. F. 1989. Distribution of overwintering Nearctic migrants in the Yucatan Peninsula, I: general patterns of occurrence. Condor 91: 515–544.

Lynch, J. F., & D. F. Whigam. 1995. The role of disturbance in the ecology of overwintering migratory birds in the Yucatan Penisula. Pp. 199–214 *in* Wilson, M. H., & S. A. Sader (eds.). Conservation of Neotropical migratory birds in Mexico. Misc. Publ. 727, Maine Agricultural Forest Experiment Station, Orono, Maine.

Marra, P. P., & R. T. Holmes. 2001. Consequences of dominance-mediated habitat segregation in a migrant passerine bird during the non-breeding season. Auk 118: 92–104.

Martin, T. E. 1995. Avian life history evolution in relation to nest sites, nest predation and food. Ecol. Monogr. 65: 101–127.

Martin, T. E., & G. R. Geupel. 1993. Nest-monitoring plots: methods for locating nests and monitoring success. J. Field Ornithol. 64: 507–519.

Martin, T. E., C. Paine, C. J. Conway, W. Holachka, P. Allen, & W. Jenkins. 1997. BBIRD field protocol. Available from T. E. Martin, Montana Cooperative Wildlife Research Unit, University of Montana, Missoula, Montana 59812.

Nott, M. P., DeSante, D. F., Siegel, R. B., & P. Pyle. 2002. Influences of the El Niño/Southern Oscillation and the North Atlantic Oscillation on avian productivity in forests of the Pacific Northwest of North America. Global Ecol. Biogeogr. 11: 333–342.

Nur, N., & G. R. Geupel. 1993. Evaluations of nest monitoring, mist-netting, and other methods for monitoring demographic processes in landbird populations. Pp. 237–244 *in* Finch, D. M., & P. W. Stangel (eds.). Status and management of Neotropical migratory birds. Publication GTR RM-229, U.S.D.A Forest Service, Fort Collins, Colorado.

Nur N., S. Jones, & G. R. Geupel. 1999. A statistical guide to data analysis of avian monitoring programs. Biological Technical Publication BTP-R6001-1999, U.S.D.I. Fish and Wildlife Service, Washington, D.C.

Nur N., G. R. Geupel, & G. Ballard. 2000. The use of constant-effort mist-netting to monitor demographic processes in passerines: Annual variation in survival, productivity, and floaters. Pp. 185–194 *in* Boney, R., D. Pashley, R. J. Cooper, & L. Niles (eds). Strategies for bird conservation: The Partners in Flight planning process; Proceedings of 3rd Partners in Flight workshop, Proceedings RMRS-P-16, USDA Forest Service, Ogden, Utah.

Partners in Flight Research Working Group. 2002. Priority research needs for the conservation of

Neotropical migrant landbirds. J. Field Ornithol. 73: 329–339.
Pienkowski, M. W. 1991. Using long-term ornithological studies in setting targets for conservation in Britain. Ibis 133 (Suppl.): 62–75.
Ralph, C. J., & K. Hollinger. 2003. The status of the Willow and Pacific-Slope flycatchers in northwestern California and southern Oregon. Stud. Avian Biol. 26: 104–117.
Ralph, C. J., & B. Milá. 1994. Towards an integrated and standardized monitoring program for landbirds in Latin America. Pp. 676–678 *in* Bissonette, J. A., & P. R. Krausman (eds.). Integrating people and wildlife for a sustainable future. Proceedings of the First International Wildlife Management Congress, San José, Costa Rica, The Wildlife Society, Bethesda, Maryland.
Ralph, C. J., & J. M. Scott. 1981. Estimating numbers of terrestrial birds. Stud. Avian Biol. 6: 1–630.
Ralph, C. J., G. R. Geupel, P. Pyle, T. E. Martin, & D. F. DeSante. 1993. Handbook of field methods for monitoring landbirds. General Technical Report PSW-GTR-144, U.S.D.A. Forest Service, Albany, California.
Ralph, C. J., S. Droege, & J. R. Sauer. 1995. Managing and monitoring birds using point counts: standards and applications. Pp. 161–169 *in* Ralph, C. J., J. R. Sauer, & S. Droege (eds.). Monitoring bird populations by point counts. U.S.D.A. Forest Service General Technical Report PSW-GTR-149, Albany, California.
Ralph, C. J., G. R. Geupel, P. Pyle, T. E. Martin, D. F. DeSante, & B. Milá. 1996. Manual de metodos de campo para el monitoreo de aves terrestres. General Technical Report PSW-GTR-159, U.S.D.A. Forest Service, Albany, California.
Ralph, C. J., E. H. Dunn, W. J. Peach, & C. M. Handel. 2004a. Recommendations for the use of mist nets for inventory and monitoring of bird populations. Stud. Avian Biol. 26: 187–196.
Ralph, C. J., S. L. Miller, & K. Hollinger. 2004b. Monitoring productivity with multiple mist-net stations. Stud. Avian Biol. 26: 12–20.
Robbins, C. S., D. Bystrak, & P. H. Geissler. 1986. The breeding bird survey: its first fifteen years, 1965–1979. U.S. Fish and Wildlife Service Resource Publication 157, Laurel, Maryland.
Robbins, C. S., J. R. Sauer, R. S. Greenberg, & S. Droege. 1989. Population declines in North American birds that migrate to the Neotropics. Proc. Natl. Acad. Sci. USA 86: 7658–7662.
Silkey M., N. Nur, & G. R. Geupel. 1999. The use of mist net capture rates to monitor annual variation in abundance: a validation study. Condor 101: 288–299.
Thomas, L., G. R. Geupel, N. Nur, & G. Ballard.2004. Optimizing the allocation of count
days in migration monitoring programs. Stud. Avian Biol. 26: 97–111.
Van Horne, B. 1983. Density as a misleading indicator of habitat quality. J. Wildl. Manage. 47: 893–901
Verner, J., M. L. Morrison, & C. J. Ralph (eds.). 1986. Wildlife 2000: modeling habitat relationships of terrestrial vertebrates. University of Wisconsin Press, Madison, Wisconsin.
Wunderle, J. M., Jr. 1995. Population characteristics of Black-throated Blue Warblers wintering in three sites on Puerto Rico. Auk 112: 931–946.
Wunderle, J. M., Jr., & S. C. Latta. 2000. Winter site fidelity of Nearctic migrant birds in isolated shade coffee plantations of different sizes in the Dominican Republic. Auk 117: 596–614.