An Overview of a Landbird Monitoring Program at Tortuguero, on the Caribbean Coast of Costa Rica[1]

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Abstract

Since 1994, the Tortuguero Integrated Bird Monitoring Program has been monitoring birds in a coastal lowland rain forest of northeast Costa Rica. The Program has combined the use of area searches, constant-effort mist netting, and migration counts into a long-term landbird monitoring and training program following the recommendations of the Partners In Flight – Aves de las Américas monitoring guidelines. We briefly summarize the methods and results from our monitoring, including the numbers of bird species captured, censuses from 1994 through 2002, and age ratios for five species of migrant landbirds. Additionally, we describe our accomplishments in methods training and information exchange within the Americas.

Key words: area search census, Costa Rica, landbird, migration count, mist netting, monitoring, neotropics.

Introduction

In light of growing concerns about the status of the birds of the rain forests in Mesoamerica, both tropical residents and migrants, we have established long-term monitoring stations in the area of Tortuguero, in northeast Costa Rica, in a program called the Tortuguero Integrated Bird Monitoring Program. To our knowledge, this is the longest constant-effort monitoring program of the landbirds of Costa Rica. The program has established the following broad objectives:

- Maintain a long-term monitoring program for the study of nearctic-neotropical migrants and the relatively little-known tropical resident landbirds, and
- Provide training opportunities and exchange information with Latin Mesoamerican and Caribbean students and biologists.

More than 100 biologists, students, scientists, and interns have contributed to the monitoring as well as methods training and information exchange in continuing the monitoring program. Here, we present a preliminary description of our results and discuss the importance of monitoring migrating birds en route to their wintering sites.

Study Area

The monitoring stations are all within 6 km of the village of Tortuguero on the northeast coast of Costa Rica, Limón Province (Latitude 10°32' N.; Longitude 83°30' W.). This region is dominated by the Holdridge (1987) forest type of Lowland, Very Wet Broadleaf Tropical Forest, laced with rivers and canals and, increasingly, areas altered for agriculture and other human use. The region has a mean annual temperature of 29.9°C and receives a mean annual rainfall of >500 cm, making it the wettest region of the country. The area's importance as a nesting habitat for sea turtles has led to the protection of the surrounding lands and a growing ecotourism culture in Tortuguero. The majority of forested lands surrounding the village are protected within the 19,211-ha Tortuguero National Park and the nearby Barra del Colorado National Wildlife Refuge. Our monitoring stations are located in both primary and secondary forest types within 1 km of the Caribbean Sea, some with a narrow scrub zone between the forest and sand beach, and others bordered by either river or canal.

Methods

The Program uses the standardized methods of mist-net arrays, migration counts, and area search censuses described by Ralph et al. (1993) and recommended by the

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Partners In Flight – Aves de las Américas – Monitoring Working Group (Hussell and Ralph 1998). In August 1995, after an initial testing period in fall 1994, we began constant-effort operations at five primary stations and two satellite stations, covering about 9 to 10 months each year. Most of the analyses in this paper are based on the data recorded between August 1995 and December 2002. The dates of operation were primarily from August to December and mid-January to May annually. Each station is composed of 10 to 15 12-m mist net locations, a diurnal migration count location, and two area search routes. The primary stations were usually operated once every 7 days, and the satellite stations once a month, with some stations operated up to three times every 7 days during migration. The season referred to as "fall" in this paper refers to the postbreeding period of the migrants from the temperate region of the Americas. Mist nets were operated for 6 hours, beginning at sunrise. Captured birds were banded and biometric information recorded as outlined by Ralph et al. (1993), including weight, body fat class, molt status, age, and sex. We defined age ratio as the percentage of young of all birds captured each year, without adjustment for effort between years. Tropical resident species were photographed to document their plumage and molt. The migration counts were a 10-minute unaided scan of the sky facing the direction of the oncoming migration in which only the migrating birds were recorded. The counts were conducted opportunistically throughout the day, usually at 2-hour intervals, and at a prescribed location at each station. Thus, counts were usually conducted 50-60 minutes in a day, weather and schedule permitting. The area searches lasted 20 minutes, and a minimum of two searches were conducted within the netting station for each netting effort, during which all birds detected were recorded.

Results and Discussion

Resident and Migrant Species Captured

Between 1994 and 2002, we operated mist nets for almost 93,000 net-hours and captured more than 27,000 birds of 182 species, of which approximately one-third were migratory species and two-thirds were tropical resident species (*Appendix A*). Forty resident and migrant species have each been represented by more than 100 captures.

The White-collared Manakin (scientific names are given in *Appendix A*) was the most frequently captured resident species during all years of the study, comprising about 25 percent of all resident captures (*Appendix A*). Three of the next most frequently captured resident species were hummingbirds: Bronzy Hermit, Long-billed Hermit, and Rufous-tailed Hummingbird. The Variable Seedeater was also very common. These five species made up almost 75 percent of the resident species that were captured and were among the 10 most commonly netted residents during each year of our study.

The five most common migrant species captured were "Traill's" (the essentially inseparable Alder and Willow complex) Flycatcher, Swainson's Thrush, Prothonotary Warbler, Northern Waterthrush, and Veery, and they accounted for more than one-half of the migrants captured.

We have had one banded bird recovered in North America, a Gray-cheeked Thrush near Toronto, Ontario, Canada, 18 months following its original capture at Tortuguero in October 1996.

Age Ratios of Migrants

We examined the age ratios for the five most common migrant species between August and December for 1995-2002 (*figs. 1-5*) for their magnitude and between-year consistency. All the species had, in most years, more young birds than adults. The Prothonotary Warbler had more than about 75 percent young (Hatch Year) each year, whereas the other species had lower percentages of young, and the percentages varied more between years.

The numbers of all species were rather variable between years, and these differences may reflect reproductive success. In the Traill's Flycatcher, the 2 years with relatively few young were also the 2 years with the lowest number of total captures, perhaps indicating poor years for breeding. This coincidence was not seen in other species, so occasional low percentages of young may be indicative of other causes.

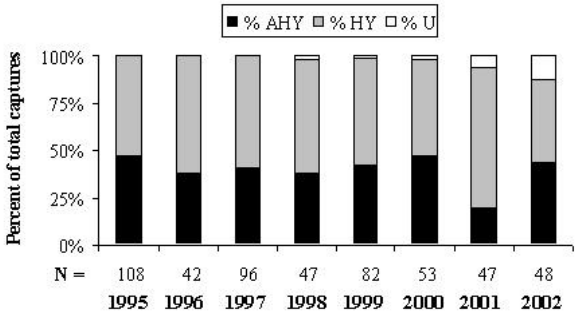

Figure 1— Age classes for the Northern Waterthrush, with the percent of total captures (N) of After Hatch Year (AHY), Hatch Year (HY), and Unknown (U), captured from August to December, 1995–2002.

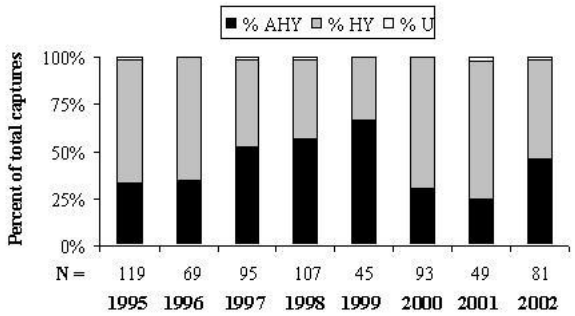

Figure 2— Age classes for the Veery, with the percent of total captures (N) of After Hatch Year (AHY), Hatch Year (HY), and Unknown (U), captured from August to December, 1995–2002.

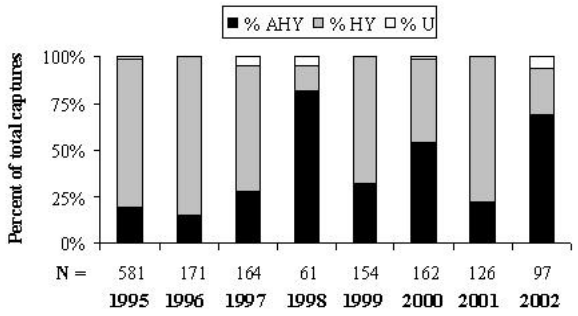

Figure 3— Age classes for the "Traill's" Flycatcher, with the percent of total captures (N) of After Hatch Year (AHY), Hatch Year (HY), and Unknown (U), captured from August to December, 1995–2002.

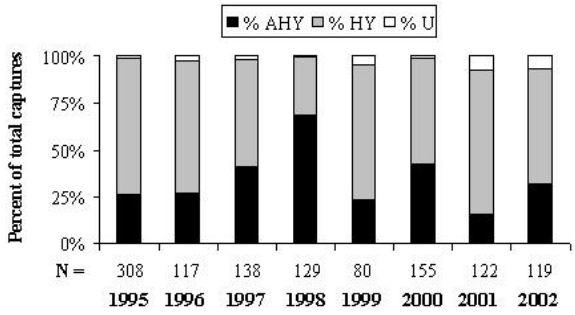

Figure 4— Age classes for the Swainson's Thrush, with the percent of total captures (N) of After Hatch Year (AHY), Hatch Year (HY) and Unknown (U), captured from August to December, 1995–2002.

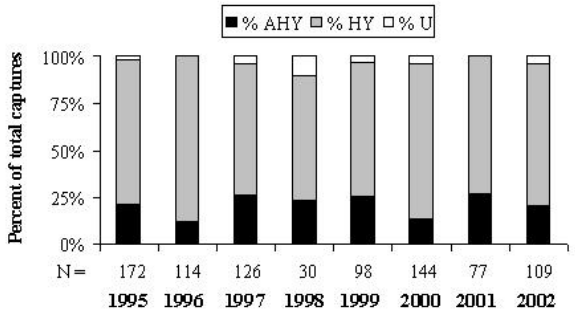

Figure 5— Age classes for the Prothonotary Warbler, with the percent of total captures (N) of After Hatch Year (AHY), Hatch Year (HY), and Unknown (U), captured from August to December, 1995–2002.

By monitoring the age classes of migrants, population-limiting factors may be better understood as well as productivity changes between years. The factors that limit the populations of a species during the migratory period are poorly understood (Sherry and Holmes 1993). We strongly urge increased efforts, during migration, to investigate the factors influencing the routes taken, stopover habitats used, timing of passage, and demographic fluctuations.

For example, in North America, age ratios have been used to suggest routes of migration (Ralph 1978). At North American coastal stations, young birds often make up more than 95 percent of captured migrants in the fall, probably indicating that the young have become disoriented (Ralph 1978), with the main route inland. The occurrence of a lower proportion of young birds, in at least some species at this coastal location, suggests that age classes have largely integrated as the birds moved farther south.

Diurnal Migration Counts

We conducted 4,928 migration counts at our stations from fall 1995 through 2002. The species we detected most often, excluding the unidentified swallow and hawk species, were the Barn Swallow, Cliff Swallow, Eastern Kingbird, Broad-winged Hawk, and Chimney Swift (*table 1*). Migration counts have been used extensively elsewhere to census diurnal migrants (Moore et al. 1995) and have the advantage of sampling birds that are not routinely captured by mist nets. Researchers have usually focused on raptor migration counts and worked in areas where specific topographic features funnel the raptors through a survey area.

The most notable overall result was the marked differences between years in some species. The total numbers of individuals of the two swallow species were fairly consistent between years, with differences of less than one order of magnitude (*table 1*), even if the counts were corrected for effort. By contrast, the numbers of hawk, kingbird, and swift can vary more than three orders of magnitude. This annual variation is possibly due to differences in migration routes between years, with birds at times moving more inland, closer to the mountains, about 100 km away. The variation between years could also reflect that we only sample, rather than make a continuous count, as is typical of other studies. During the intervals between counts, substantial numbers of birds could move through, as evidenced by the passage in 1999 of an estimated

Table 1— *Total number of birds observed and number of counts (N) per year for the five most abundant migrant species detected during 10-minute migration counts in Tortuguero, Costa Rica, 1995–2002.*

Species	1995	1996	1997	1998	1999	2000	2001	2002	Total
N =	283	713	1033	331	316	736	701	815	4,928
Barn Swallow	12,912	12,179	11,962	2,704	5,475	8,691	8,278	8,912	71,113
Cliff Swallow	16,853	6,777	6,079	1,753	11,137	10,168	3,590	12,521	68,878
Eastern Kingbird	9,119	7,221	7,622	50	21	8,620	1,859	14,125	48,637
Broad-winged Hawk	16,366	2,120	25	3	10,000	297	5	8	28,824
Chimney Swift	3,913	3,602	12,920	39	1,167	1,417	114	5,102	28,274

10,000 Broad-winged Hawks in one 10-minute period, the only observation of that species in that year.

Seasonal patterns differed considerably between the five species we examined, when all years and stations were pooled, and counts were corrected for effort. Barn Swallows (*fig. 6*) were recorded in the spring between mid-March and mid-May. During the fall, they were much more abundant, with a protracted migration from the end of August over a 3-month period, peaking through mid-October (with a maximum of 16,000 individuals recorded in one 10-minute count). The Cliff Swallow migration (*fig. 7*) occurred mostly in the fall and was much briefer, occurring over a month in September and October (with peak counts of nearly 10,000). Eastern Kingbirds (*fig. 8*) were similar, migrating at the same time as the Cliff Swallows, primarily in the fall, with a maximum count of 6,000. Broad-winged Hawks (*fig. 9*) moved through quickly, almost entirely in October (with a peak of 10,000 on one 10-minute count). Only the Chimney Swift (*fig. 10*) was detected in any numbers during the spring migration, peaking in mid-March (with a 5,000 maximum in a 10-minute count). In the fall, fewer swifts were counted, and they peaked in October, later than the swallows and kingbirds.

We examined the annual variation in timing and migration rates for the Cliff and Barn swallows during the fall migration period, from August 1 to November 30. Cliff Swallows exhibited some similarity in timing between years (*fig. 11*), moving through each year in a single pulse. Following their first movements in late August and early September, the number of Cliff Swallows typically increased for a period of 10 to 20 days, reaching peak migration rates most commonly in late September. This species deviated from this pattern only in 2001, when peak passage rates occurred largely in early September. Although the timing of movement was usually similar between years, relative abundance varied to a greater extent. During the peak of migration in 1997, a mean of 49 birds were observed during each 10-minute count. In 2002, however, a mean of 350 Cliff Swallows were recorded on the counts during the peak of migration.

The Barn Swallow had greater variability between years in its passage, in both timing of peak abundance and in its amplitude (*fig. 12*). As was the case when all years were combined, we found that its passage was similarly protracted in each year when each year was considered separately. We also found that the timing of the peak of the passage was quite variable between years, contributing to the protracted nature of the Barn Swallow's passage.

Area Search Censuses

An integral component of our monitoring program is conducting time- and area-constrained area searches at each of our stations. By incorporating this method into our demographic station protocol, we were able to monitor several species that are rarely captured in nets. Nearly 200 species have been recorded on our area search censuses, including 46 North American migratory species described as declining by DeGraaf and Rappole (1995) and six listed by Partners In Flight and the National Audubon Society as WatchList Priority Species (Rich et al. 2004). From these results and other sources, we have compiled an annotated checklist of 285 species that have been seen in the area, with common names in both Spanish and English, and notes on status, habitat, and abundance (Widdowson and Widdowson 2002). Our checklist has been a conservation tool for Tortuguero National Park, local ecotourism, and the public. Using area search data, we have also begun to estimate population trends for the 10 most common species observed. We also have been developing techniques to compare the estimates from census and capture data in order to compare the different methods in their ability to estimate the population size and trends of both resident and migrant species.

Research and Monitoring Outlook

Within the broad research and monitoring mandate of the Program, we are recording many data to answer many important questions about the migrants and residents. Primary among the questions are those involving the descriptive life histories of the many little-studied species of resident birds as well as the

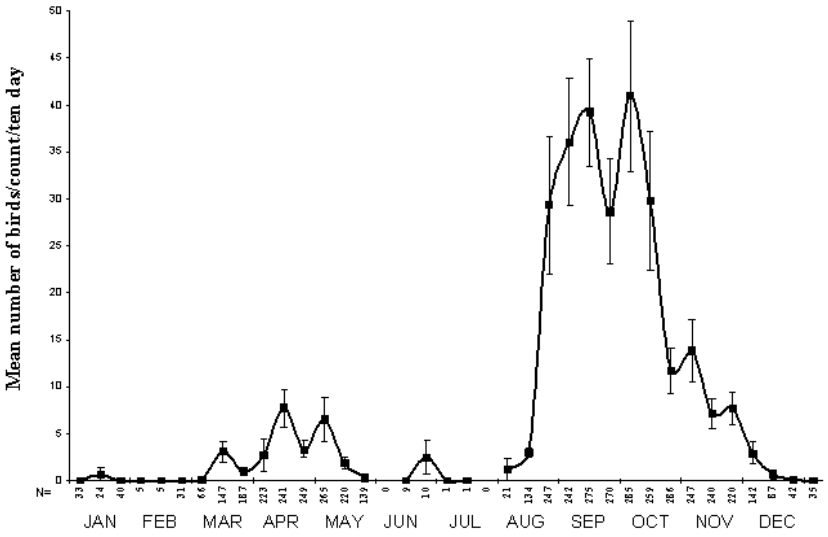

Figure 6— Mean number (±standard error) of Barn Swallows observed per 10-day period during 10-minute migration count surveys at all stations and times combined in Tortuguero, Costa Rica, 1995–2002. N = number of surveys per 10-day period.

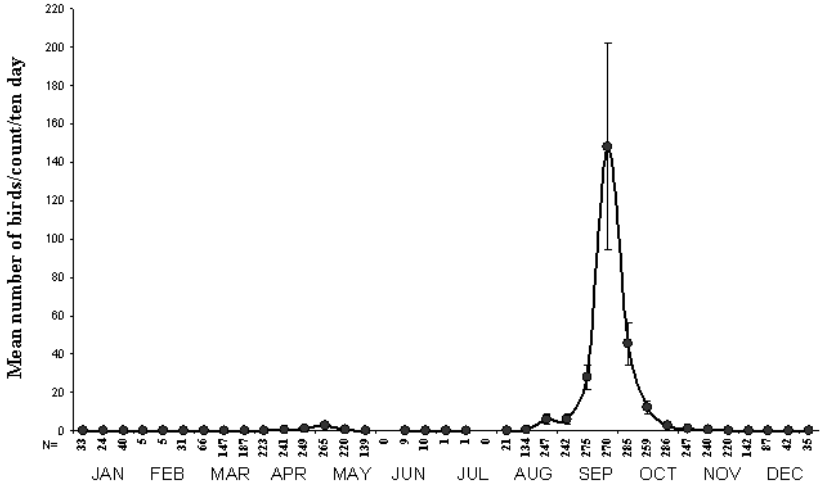

Figure 7— Mean number (±standard error) of Cliff Swallows observed per 10-day period during 10-minute migration count surveys at all stations and times combined in Tortuguero, Costa Rica, 1995–2002. N = number of surveys per 10-day period.

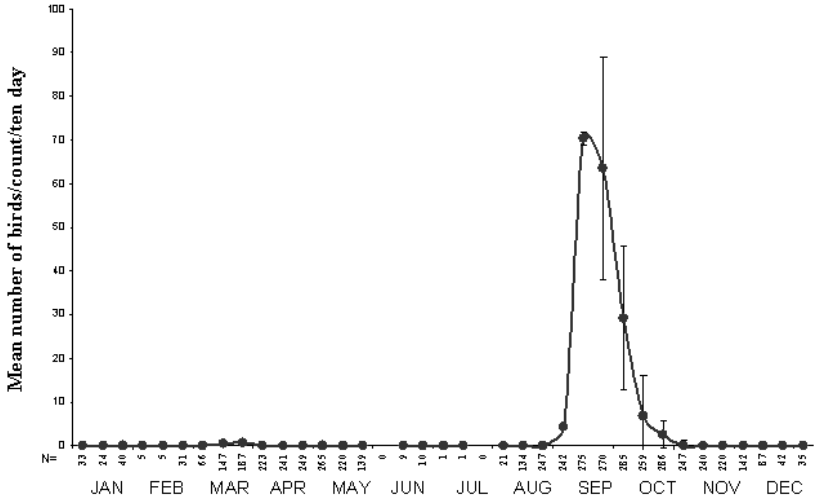

Figure 8— Mean number (±standard error) of Eastern Kingbirds observed per 10-day period during 10-minute migration count surveys at all stations and times combined in Tortuguero, Costa Rica, 1995–2002. N = number of surveys per 10-day period.

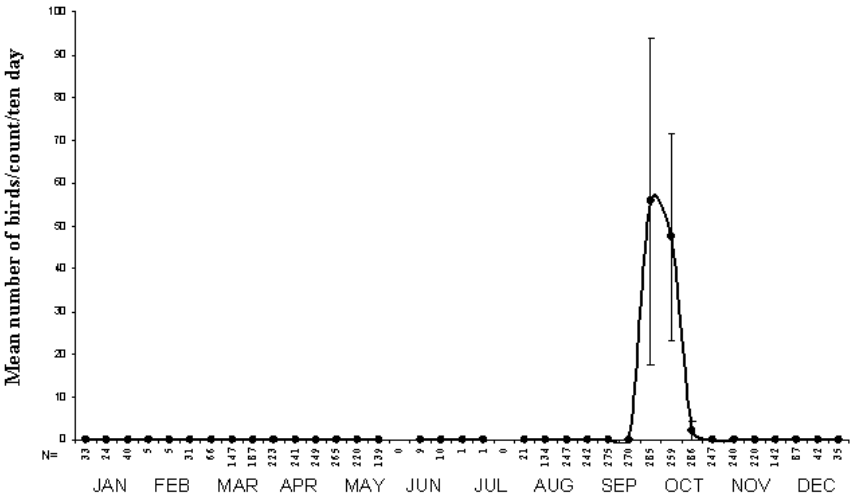

Figure 9— Mean number (±standard error) of Broad-winged Hawks observed per 10-day period during 10-minute migration count surveys at all stations and times combined in Tortuguero, Costa Rica, 1995–2002. N = number of surveys per 10-day period.

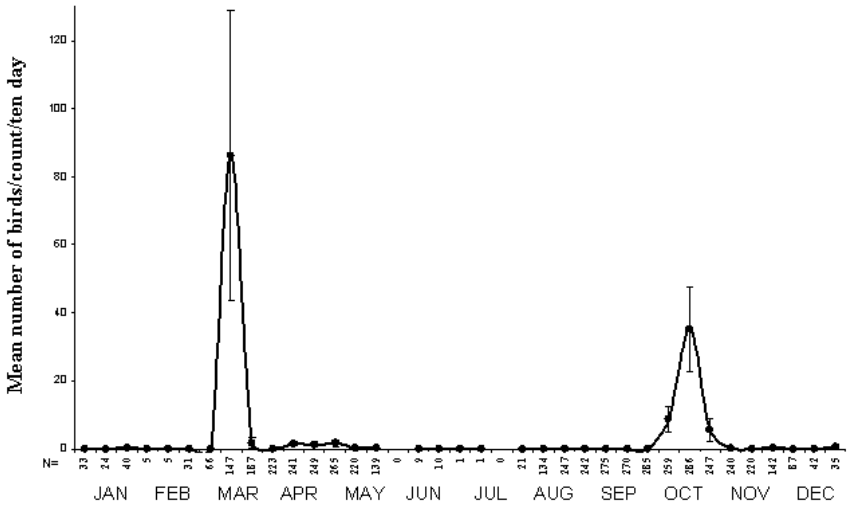

Figure 10— Mean number (±standard error) of Chimney Swifts observed per 10-day period during 10-minute migration count surveys at all stations and times combined in Tortuguero, Costa Rica, 1995–2002. N = number of surveys per 10-day period.

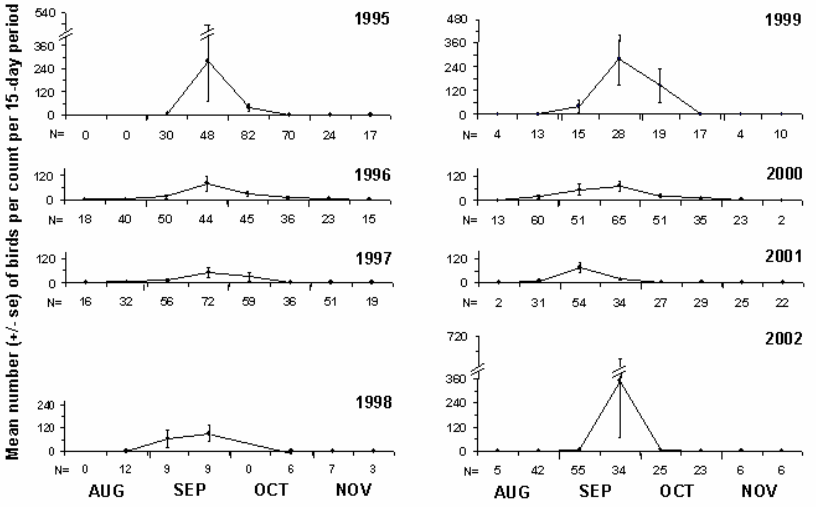

Figure 11— Mean number (±standard error) of Cliff Swallows observed per 15-day period during 10-minute migration count surveys at all stations and times combined in Tortuguero, Costa Rica, 1995–2002. N = number of surveys per 15-day period.

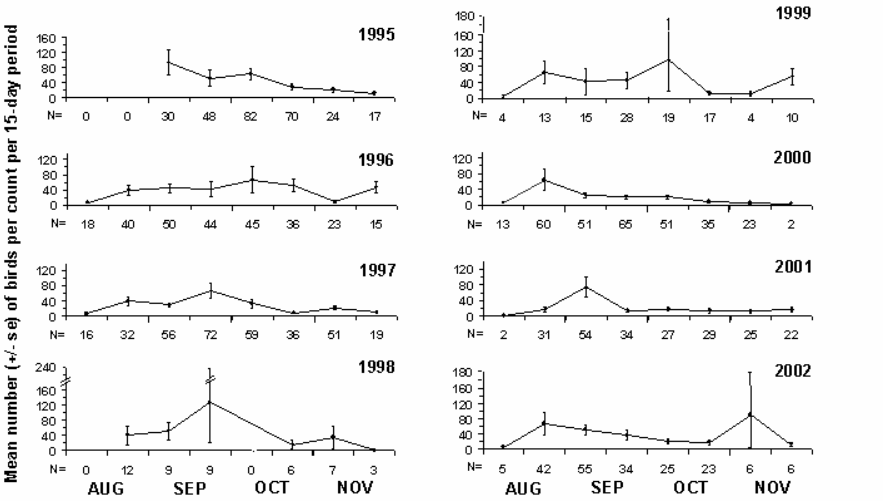

Figure 12— Mean number (±standard error) of Barn Swallows observed per 15-day period during 10-minute migration count surveys at all stations and times combined in Tortuguero, Costa Rica, 1995–2002. N = number of surveys per 15-day period.

overwintering migrants from North America. The long-term nature of the monitoring has laid the foundation for comparing the between-year timing of movements, the productivity, and the survivorship of various resident and migratory species. This baseline database of resident individuals, whose ages are known, and the documentation of plumages and molt of individual birds of various species through photographs are a unique resource in the neotropics.

Training and Information Exchange

The Tortuguero Integrated Bird Monitoring Program's internships and training workshops contribute to the international cooperative effort to implement Partners in Flight – Aves de las Américas monitoring and conservation goals in the neotropics.

Our long-term objective has been to establish a network of monitoring stations in Mesoamerica and the Caribbean to better understand the status and distribution of nearctic-neotropical migrants, as well as neotropical resident birds (Ralph and Milá 1994). We have identified skill sets (for example, monitoring methods, field techniques, ageing and sexing criteria, data management, data analyses, statistical methods, geographical information systems, and technical writing) that will effectively address training needs, provide training and mentorship, and facilitate the establishment of demographic monitoring projects in Mesoamerica and the Caribbean. To achieve this, our objective is to increase the capacity of biologists in Mesoamerica and the Caribbean area to create effective habitat management and long-term monitoring programs by providing training in internationally recognized bird-monitoring techniques. Training in their own region will enable biologists to focus on their own local conservation priorities and increase the likelihood of successful bird conservation through a grassroots approach to the establishment of a Landbird Monitoring Network of the neotropics.

Since 1995, we have presented eight training workshops on landbird monitoring methods at Tortuguero and hosted more than 100 interns from Mesoamerica and the Caribbean. This has led directly to the establishment of more than 20 independent monitoring projects throughout the region. Most recently, in 2003, the program presented a 5-day training workshop on bird-monitoring methods at Tortuguero, in partnership with Point Reyes Bird Observatory Conservation Science, and the University of Costa Rica. The workshop participants were primarily students from the University of Costa Rica, and biologists from Costa Rica, El Salvador, Guatemala, Nicaragua, and Panama. All interns and workshop participants were given intensive instruction on landbird-monitoring methods and provided with English- or Spanish-language handbooks of field methods for monitoring landbirds.

Our information-exchange efforts within the Americas have included the completion of refined ageing and sexing criteria, descriptive studies for many tropical resident species, and the distribution of a landbird monitoring methods handbook in both English and Spanish (Ralph et al. 1993, 1996). We assisted in the production of a guide to molt, age, and sex in selected Costa Rican landbirds (Pyle 2001). A description of the plumages and molt patterns of the Variable Seedeater, based on banding and photographic records collected at Tortuguero, has been completed and is being prepared for publication (Frey 2004, pers. comm.). These descriptive studies will greatly enhance the ability of Mesoamerica and Caribbean biologists to accurately determine age and sex classes of many little-understood resident species of the neotropics.

Acknowledgments

The Program has been successful through our partnership with the Caribbean Conservation Corporation, the Humboldt Bay Bird Observatory, and the Point Reyes Bird Observatory. Critical to our success has been the active collaboration of Costa Rica National University, University of Costa Rica, Costa Rica National Park Service, Canadian Organisation for Tropical Education and Rainforest Conservation, and Costa Rica Expeditions. We thank David Godfrey, Daniel Evans, Roxana Silman, and the staff of the Estación Biología at Tortuguero of the Caribbean Conservation Corporation for their tireless support. William Widdowson provided excellent project coordination, Jim Zook gave us continuous technical help on identification and plumages, and Jim Lewis provided logistical help along the way. Thanks also go to Geoff Geupel, Steve Latta, and the Point Reyes Bird Observatory for financial support and assistance with training during the monitoring workshops. Most of all, many thanks go to all the volunteers, student interns, and biologists who have conducted the field work and training for the program. We thank John Alexander, Geoff Geupel, Sherri Miller, Carol Pearson Ralph, and William Widdowson for helpful comments on the manuscript. We will always be grateful to the late Daniel Hernandez for his inspiration and leadership in the early years of this project.

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