Migrant Songbirds, Habitat Change, and Conservation Prospects in Northern Petén, Guatemala: Some Initial Results

David F. Whitacre[1], Julio Madrid M.[2], Ciriaco Marroquín[3], Mark Schulze[4], Laurin Jones[5], Jason Sutter[5], and Aaron J. Baker[4]

Abstract — A recently-created complex of reserves spanning the Guatemala, México, Belize borders in the southern Yucatán Peninsula constitutes 5.5 million acres of contiguous, protected lowland forest. Information is needed on compatibility of various land-uses and biodiversity protection in multiple-use zones of these reserves. To address these and other needs related to conservation of migrant songbirds, Peregrine Fund collaborators (6 Guatemalans and 5 North Americans) in 1992 began studies of songbirds wintering in and near the Guatemalan portion of the Maya/Calakmul/Rio Bravo reserve complex. Research consists of two parts. The "intensive" portion involves detailed study on 25-ha plots; goals are to produce long-term monitoring of migrant populations and new information on their winter ecology. The goal of the "extensive" portion is to generate relative abundance indices for migrant species in a variety of pristine and human-altered habitats. Results are presented from a 7680 mist net-hour comparison of 10 sites in slash-and-burn regeneration (3 to 16 years of age) and 10 sites in primary forest of two types. Wood Thrushes were far more common in primary forest than in second-growth. Yellow-breasted Chats, Gray Catbirds, and Ovenbirds were all more abundant in second-growth than in primary forest, and in low, dense-understoried "bajo" forest than in tall, closed-canopy upland forest. Among second-growth sites, capture rates of Kentucky Warblers and Ovenbirds showed significant positive correlations with age of second growth; they appeared to prefer more mature sites. A hypothesis is presented concerning the structural similarity of some types of naturally-occurring "bajo" forest and successional forest, and bird use of the same. Land use patterns in northern Petén are briefly described, with emphasis on conservation challenges and opportunities.

[1]*The Peregrine Fund, Inc., 5666 West Flying Hawk Lane, Boise, Idaho 83709.*

[2]*Centro de Estudios Conservacionistas, Universidad de San Carlos de Guatemala, Parque Nacional tikal, Petén, Guatemala.*

[3]*The Peregrine Fund, Inc., Parque Nacional tikal, Petén, Guatemala.*

[4]*The Evergreen State College, Olympia, Washington 98505.*

[5]*22582 Veronica Dr., Salinas, California 93908.*

INTRODUCTION

Recent establishment of the Maya/Calakmul/Rio Bravo reserve complex spanning the Guatemala, Mexico, Belize borders has created the largest enclave of protected lowland forest in Central America and Mexico. The Guatemalan portion, Maya Biosphere Reserve, includes large multiple-use areas. Management plans for these areas are still being developed. To aid in decisions about permissible uses of these areas, managers require information concerning compatibility of various land uses with conservation of biological diversity, including populations of migrant and resident songbirds. Migrant songbird research begun in winter 1992 as part of The Peregrine Fund's long-term "Maya Project" helps meet these needs, and complements a program of ecological monitoring of these forest ecosystems developed over the past five years. All aspects of the project provide training and experience in conservation field research for Latin American personnel, who conduct a great deal of the field work. Some results of the first year of migrant songbird research are presented here.

DESCRIPTION AND CONSERVATION OPPORTUNITIES OF NORTHERN PETEN

Project Area Description

The 3.45 million acre Maya Biosphere Reserve was created in January 1990 by Guatemalan law. The 1.8 million acre Calakmul Biosphere Reserve in Campeche, Mexico was created in 1989, and Rio Bravo Resource Management and Conservation Area (202,000 acres) in adjacent Belize was created in 1988. Taken together, this reserve complex encompasses 5.5 million acres, and is the largest contiguous area of legally protected lowland forest in Central America and Mexico.

The Petén Department, 35,800 square km in area, constitutes slightly more than a third of Guatemala's surface, and 60 per cent of the country's forest cover (Heinzman and Reining 1990). The Petén forms the basal part of the Yucatán Peninsula, abutting in the south the mountain ranges that form the backbone of Central America. Elevation of the Petén is mostly 100 to 300 m amsl; the climate is lowland tropical, with mean annual temperature of 26.6 degrees C. A marked precipitation gradient exists over the Yucatán Peninsula, from 3000 mm annual rainfall along the mountains in the south, to 1000 mm and less in the northwest corner of the peninsula near Merida, Yucatán; yearly rainfall in most of the Petén is between 1500 mm (northern Petén) and 2000 mm (southern Petén) (Secretaria de Programación y Presupuesto 1981). A pronounced dry season is typical, from January or February through May.

The forest types represented in the area are classified by Pennington and Sarukhan (1968) as selva alta-mediana subperennifolia (tall to mid-height subperennial forest) and selva baja subperennifolia (low subperennial forest). The nature of undisturbed forest in northern Petén is strongly determined by a topographic and soil type gradient, probably mainly through their effects on soil moisture. Though relief is often no more than tens of meters, the effect on vegetation and soil is marked. Hill tops and slopes have shallow, well-drained, rocky, sandy-loamy soils with relatively low clay content (and presumably limited water-holding capacity, due in part to limestone bedrock a few tens of cm below surface). In contrast, low-lying areas have deep soils (often > 140 cm) with very high clay content; these areas are often seasonally inundated.

Along this topographic/soil gradient is a largely predictable continuum in forest "types". Schulze and Whitacre (in prep.) recognize the following series of forest types: Upland Forest, Upland Dry Forest, Hill-base Forest, Sabal Forest, Transitional Forest, and Bajo Forest (including "Tintal"). Vegetation of upland areas is normally tall, closed-canopy forest with high tree species diversity, complex subcanopy foliage structure, open to moderately open shrub/sapling layer, and sparse ground cover. Forests in low-lying ("bajo") areas are highly variable. In the extreme case, they are "tintales", of very low (3-6 m) stature, and dominated by Tinto (*Haematoxylum campechianum*) and a few other tree species, but more often they have greater tree species diversity, moderately low stature (5-15 m), open canopy structure, very dense shrub/sapling layer, and ground cover which may be sparse or heavy (Schulze and Whitacre, in prep.). While some tree species occur over a wide range of the community continuum described above, their abundances typically vary with position on this gradient. Several tree species are restricted to one or a few of the forest types listed above.

Conservation Needs and Opportunities in the Area

Traditional forest-based industries which thrive in the northern Petén make this area especially interesting due to the potential confluence of sustainable development and conservation goals. Reserves may provide for both biotic conservation and human livelihoods much as rubber-based extractive reserves in Amazonia (Gradwohl and Greenberg 1988). Products extracted from the Petén's forests in potentially sustainable fashion produce a few to several million dollars annually as exports. Currently the economically dominant product is foliage of the Xate (pronounced *shah-tay*) palms (*Chamaedorea* spp.), used in floral arrangements in the U.S. and Europe. This industry employs some 7000 individuals; the value of 1987 exports was nearly $2 million (Heinzman and Reining 1990).

Chicle, the sap of the chicozapote (*Manilkara zapota*) has been harvested from intact Petén forests at least since the 1880's and has been a dominant influence in the areas social and economic evolution (Schwartz 1990). Peak production of ca 2.2 million kg/yr was reached during the 1920's to 1940's. During the 1980's, production ranged from 136,000 to 273,000 kg/year (Heinzman and Reining 1990), with a price on the order of $4.15 per kg. At least 900 people are employed in the chicle industry, with this figure rising as high as two or three thousand during years of high demand, when production may reach .9 to 1.4 million kg/yr (Heinzman and Reining 1990).

Another forest product of the Petén is allspice--the fruit of pimienta gorda (*Pimenta dioica*). Fruit-laden limbs of this common understory species are lopped off during July through

September. In 1986, Guatemalan exports amounted to 394,000 kg valued at $230,000 (Heinzman and Reining 1990). Other forest products exploited in smaller quantities include Bayal (*Desmoncus ferox*), a climbing palm which yields rattan-like fiber used in basketry and furniture, and a yam, *Dioscorea* sp. which provides steroid building blocks for birth control pills (Heinzman and Reining 1990).

Commercial logging of Mahogany and Cedro in the Petén can be traced back to the 1820's, and reached much greater importance beginning in the 1860's and 1870's (Schwartz 1990). Commercial logging is monetarily the dominant extractive industry in the Petén, employing thousands of seasonal loggers and about 1,200 sawmill workers. Contrary to what might be assumed, logging as practiced in this area does not lead to the immediate and outright elimination of forest, though its impact on forest biodiversity is largely unstudied. Logging in this region has traditionally been selective, mainly for two species--Mahogany or "Caoba" (*Swietenia macrophylla*) and Cedro (the "cigar box tree")(*Cedrela odorata*), though perhaps a dozen additional species are also taken at times (S. Gretsinger, pers. comm.).

Southern Petén is more heavily deforested than is northern Petén (pers. obs.). The "agricultural frontier", where slash-and-burn farmers and cattle-ranchers make inroads into fringes of remaining large blocks of forest, runs east-west across the Petén at roughly the latitude of the southern boundary of Tikal National Park and the Maya Biosphere Reserve. However, where a few major roads penetrate farther north, significant deforestation has in some cases occurred along these roads within the Biosphere Reserve; further immigration along these roads, should it continue, represents a significant threat to the integrity of the reserve.

Based on casual observations, primary proximate mechanism of deforestation in this area is slash-and-burn ("milpa") agriculture. Commercial logging, while not destroying the forest outright, tends to facilitate expansion of the agricultural frontier by creating roads into hitherto roadless areas. Cultural heritage also plays a role in deforestation dynamics; while long-time residents of northern Petén tend to be firmly enmeshed in a "forest culture" based on extraction of chicle, xate, etc., recent immigrants from other parts of Guatemala are much more prone to engage mainly in slash-and-burn farming, for it is the livelihood with which they are experienced (K. Kline, pers. comm., Schwartz 1990).

Cattle ranching claimed much land once forest in southern Petén, and this process, often following on the heels of slash-and-burn farming, also exists along the southern boundary of the Maya Biosphere Reserve. Some rough figures on the rate of expansion of cattle ranching in the Department of Petén are: 1957-1964--6,000 head; 1977--21,000 head; 1979--75,000 head; 1980--150,000 head (Schwartz 1990). Cattle-ranching appears to be one of the predominant threats to remaining forests of the Petén.

Human-induced changes in the Petén have been primarily recent and accelerating. While as recently as 1941, the Petén boasted 5 automobiles and about 11,000 people (Schwartz 1990: pp. 11, 333), the decades since the late 1960's have witnessed a rapid increase in milpa agriculture, cattle ranching, and logging (Schwartz 1990). As late as 1964 the population of Petén was but 25,000 (Schwartz 1990: p. 10); by 1986 it had reached an estimated 300,000 (Schwartz 1990: p. 11). A primary ultimate factor leading to high rates of forest conversion in Petén is a high rate of immigration, primarily from more heavily populated portions of Guatemala's south and east; immigration rates are believed to be on the order of 250 people per day (Heinzman and Reining 1990).

Rather than painting the situation as desperate, we prefer to point out the potential for meeting both conservation goals and human needs by accentuating sustainable forest products industries now thriving in the area. To do so, however, will require limiting the roles of cattle-ranching, slash-and-burn farming, and human immigration.

The Need for Migrant Songbird Research in Northern Petén

The northern Petén supports large numbers of neotropical migrant songbird species and individuals. While the Maya/Calakmul/Rio Bravo reserve complex is large, neither this protected area, nor the sum of all protected areas in the region, can house the majority of the wintering populations of migrant songbirds that utilize the area. Unlike Monarch Butterflies (*Danaus plexippus*), of which the entire eastern U.S./Canada population can be protected in winter by preserving a few key forested mountainsides in central Mexico, wintering songbird populations cannot be adequately protected in biotic reserves as currently construed. Extant reserves do not encompass enough area to achieve this, and it is most unlikely that reserve systems will grow sufficiently to do so.

By their nature, songbird populations are relatively thinly spread over large areas, including much area already used or destined to be used by humans for agriculture, lumbering, and other purposes. Hence, fate of neotropical migrant populations wintering in this region is inextricably linked to patterns of land use outside of reserves. For this reason, it is important to learn how useful many types of human-altered landscapes in this region are to migrant songbirds (and other biota). This is a primary goal of research described here.

PEREGRINE FUND RESEARCH ON NEOTROPICAL MIGRANT LANDBIRDS IN NORTHERN PETEN

Our efforts with migrant songbirds in Guatemala began during winter of 1990/91, with exploratory mist netting and observations. This developed in January 1992 into the research described here, which continues to date. Research goals are: (1) create training opportunities for Latin American personnel, (2) document impact of various land-use practices on migrant songbirds, (3) put in place a program for long-term monitoring of migrant populations wintering in the area, and (4) contribute to knowledge of the winter ecology of neotropical migrants.

Research consists of two parallel programs. An "extensive" component conducts standardized sampling of a number of sites relatively rapidly. The goal of this component is to generate information on relative abundance of migrant species in the predominant natural and human-altered habitats of the area. The "intensive" component studies a few permanent 25 hectare study plots in depth, using color-banding, spot-mapping and ancillary techniques to monitor population density, survival, fat levels, body weight, and to collect other ecological information. Here we report results of "extensive" investigations during late winter/early spring 1992.

Habitats Studied

We compared 10 primary forest sites to 10 slash-and-burn regeneration sites. Five primary forest sites represented predominantly "upland" forest, while five represented "bajo" forest. These forest types are described in more detail above; briefly, upland forest is tall, closed-canopy forest with well-developed subcanopy layers but relatively sparse ground cover and shrub layer, while bajo forest is low in stature, open of canopy, with extremely dense shrub-sapling layer. Time elapsed since last cultivation of the slash-and-burn sites is given in Table 1.

Table 1. — Time since prior cultivation, and overall farming history of 10 slash-and-burn study sites. (All sites are within a radius of ca. 15 km, between Tikal National Park and Ixlu, Petén.)

Site	*Time since farmed*	*Prior history*
La Placa (Don Adolfo)	3 years	First cleared from primary forest 6 years ago.
Don Antonio	5 years	Was primary forest 5 years ago.
Don Margarito	6 years	Was first cleared from primary forest 18 years ago; recent farming was second cycle.
Don Francisco	7 years	First cleared from primary forest 9 years ago.
Don Peto (Porvenir Plan B)	7-8 years	Was already second growth when land purchased in 1982.
Don Leno	8 years	Evidently was burned 50-100 years prior; first cultivated 9 or 10 years ago.
Don Emilio (Plan B)	8 years	Tall forest initially felled ca. 15 years ago, farmed once then, and then farmed again recently, to be abandoned 8 years ago. In spring 1992, it was felled and burned in preparation for farming during summer 1992.
Cahui Administración	12 years	Was already second growth 57 years ago; has been farmed off and on since then.
Cahui Barba	12 years	Same as Cahui Administración.
Ixlu (Pedro Castellano)	16 years	First cleared from primary forest 17 years ago.

The accuracy of site histories given in Table 1 depends on that of the memories of individuals (normally land owners) providing information. Ages since cultivation are probably accurate within a couple years. It is important to note the rate and nature of vegetation succession following slash-and-burn farming varied a great deal between sites; some sites appeared more recovered than did sites which had lain fallow for longer periods. This was probably due in large part to local differences in drainage, soil type, surrounding vegetation (and hence seed sources) and to the total history of farming and soil exhaustion on each site.

Birds using a given site may be influenced by the nature of the surrounding habitat matrix. Primary forest sites were all within Tikal National Park, a 576 square km area of primary and lightly-altered forest; all sites were well within park boundaries. Second-growth sites were in an agricultural mosaic typical of that existing along the "agricultural frontier" throughout Latin America. Over many square km, the habitat is a patchwork of mostly 5-7 ha units, comprised of actively farmed milpas, fallow fields mostly 0 to 7 years of age, and small remnants of mature forest. Remaining chunks of mature forest are mostly 1 to 100 ha in area, and are often degraded by periodic passage of fire, and by extraction of guano palm, fire wood, and lumber for local construction.

Methods

At each site, sixteen 36 mm mesh mist nets were operated for eight hours on each of three consecutive days. Nets (ATX, obtained from Association of Field Ornithologists) were 12 m in length and 2.6 m tall, and spaced 12 m apart. In all cases but two, nets were in a single linear array. In two cases nets were placed in two parallel arrays of eight nets each, with 60-100 m between arrays; this was done because these habitat blocks were too small to accommodate a single 484 m array (sixteen nets with 50 m of habitat extending beyond ends of the array).

Nets were opened at sunrise time as determined by the current Nautical Almanac (Secretary of the Navy 1989) and closed eight hours later. All captured birds were banded--North American breeders with U.S. Fish and Wildlife Service bands and others with commercially obtained numbered metal bands--and standard data were taken. Each 3-day netting stint comprised 384 net-hours of sample effort. Because sample effort was equal for all comparison units, data used for analyses were number of distinct individuals captured per 3-day sample.

Use of capture rates as an index of abundance can be problematic for comparisons between habitats if birds show behavioral differences correlated with habitat. For example, birds using mainly canopy are far above nets when in tall forest, but may commonly enter nets in second-growth where canopy dips near ground level. For this reason, we restricted comparisons to species largely active within 2.5 m of the forest floor (see below). We felt the vertical pattern of activity of these species was sufficiently similar in habitats compared here to allow comparison of capture rates between habitats without risk of serious artifacts. While recognizing that abundance and vertical distribution of activity are not the only factors affecting mist net results, we assume that capture rates do in large part reflect relative abundance.

Age of second-growth was determined by questioning local people, primarily farmers who had worked parcels in question. In addition, one author (M. Schulze), a plant ecologist experienced in this region, ranked the degree of plot recuperation. Because factors such as farming history and proximity of seed source affects recuperation rates, age of successional stands does not necessarily indicate degree of recuperation from the standpoint of usefulness to birds. Though rankings were similar, that for age as reported by farmers gave higher correlations with bird results overall, and is used here. Significance of Spearman Rank Correlations were determined after Siegel (1956). For all comparisons of capture rates between habitats, the Mann-Whitney U Test was used.

RESULTS

Results are presented here for eight species whose abundance we felt was reliably revealed by mist netting: Wood Thrush (*Hylocichla mustelina*), Kentucky Warbler (*Oporornis formosus*), Hooded Warbler (*Wilsonia citrina*), Worm-eating Warbler (*Helmitheros vermivorus*), Northern Waterthrush (*Seiurus noveboracensis*), Yellow-breasted Chat (*Icteria virens*), Gray Catbird (*Dumetella carolinensis*), and Ovenbird (*Seiurus aurocapillus*). Results are given in Table 2. Four species had significantly different capture rates (Mann-Whitney U test) in primary forest versus successional vegetation 3 to 16 years in age. Wood Thrushes were far more common in primary forest than in second growth ($p = .02$). Species that were more abundant in successional than in primary forest were Yellow-breasted Chat ($p < .01$), Gray Catbird ($p < .01$), and Ovenbird ($p < .002$). Kentucky, Worm-eating and Hooded

Table 2. — Distinct individuals of eight focal species captured per 1,000 net hours in two types of primary forest and slash-and-burn successional vegetation.

	Primary Upland Forest	Primary Bajo Forest	Slash-and-burn Regeneration
Wood Thrush	10.94[1]*	11.98[1]*	3.65[2]
Kentucky Warbler	8.85	9.38	6.51
Worm-eating Warbler	5.21	3.65	3.39
Northern Waterthrush	0	6.77	0.26
Hooded Warbler	4.17	6.77	7.55
Yellow-breasted Chat	0	2.08	6.77**
Gray Catbird	1.04	7.29	15.36**
Ovenbird	0.52	5.73***	16.93**

[1] For total captures in primary upland and bajo forest, multiply numbers given here by 1.92.
[2] For total captures in slash-and-burn regeneration, multiply numbers given here by 3.84.
* Significantly more common in primary forest (upland plus bajo) than in second growth.
** Significantly more common in second growth than in primary forest (upland plus bajo).
*** Significantly more common in primary bajo forest than in primary upland forest.

Warblers showed nonsignificant trends, and Northern Waterthrush results appeared strongly affected by distribution of standing water; all captured individuals were at inundated sites (Table 2).

As discussed above, naturally-occurring "bajo" forest often structurally resembles successional forest in some respects. Due to this similarity, we felt it possible that some species perceive and utilize bajo and successional forest similarly. Hence we tested whether capture rates differed between bajo and high-ground forest. Of three species which were more common in successional than primary forest, the Ovenbird also was more common in bajo than in high-ground forest ($p < .05$), while Gray Catbird ($p < .10$) and Yellow-breasted Chat, ($p = .20$) did not differ significantly in these two habitats in this small sample (5 sites of each type). Results are equivocal due to small sample size, but suggest the value of further attention to this topic.

To investigate whether species occurred more commonly in younger or older second-growth, we calculated Spearman Rank Correlation Coefficients between age rank of slash-and-burn sites and the number of captures per site. This was done for seven species, the Northern Waterthrush omitted because its results appeared dominated by the effect of standing water. Three of seven species showed significant correlations. Kentucky Warblers were caught in greater numbers in older than younger second growth (corrected Rho = .649, one-tailed p .05)(Fig. 1) and the same was true for Ovenbirds (corrected Rho = .732, one-tailed $p < .05$)(Fig. 1). Gray Catbirds showed the opposite result, with more captures in younger second-growth (corrected Rho = -.566, one-tailed $p < .05$) (Fig. 1)

DISCUSSION

Our most robust result was that certain species had higher capture rates (and presumably were more abundant) in primary forest than in successional forest, and other species showed the reverse pattern. The identity of species more abundant in primary forest (Wood Thrush significantly, Kentucky Warbler and Worm-eating Warbler non-significantly) is not a surprise, nor for the most part is that of species occurring more commonly in successional forest (Yellow-breasted Chat, Gray Catbird, and Ovenbird significantly, Hooded Warbler nonsignificantly).

The great excess of Ovenbirds captured in successional habitats may come as somewhat of a surprise. Other workers have often found Ovenbirds occupy a variety of agricultural and successional habitats (Waide 1980, Lynch 1989, Robbins et. al. 1990, Petit et al. 1990, Lynch 1990), and Lynch (1989) characterized this species as lying about halfway between extreme reliance on mature forest and completely general use of mature forest, second-growth forest, and agricultural fields, and as using moist tall, moist medium-height, and dry, medium-height forest with equal facility. We are not aware of any other workers having reported such a preponderance of Ovenbird occurrence in relatively young successional vegetation as that shown in Table 2. However, the fact that Ovenbirds were

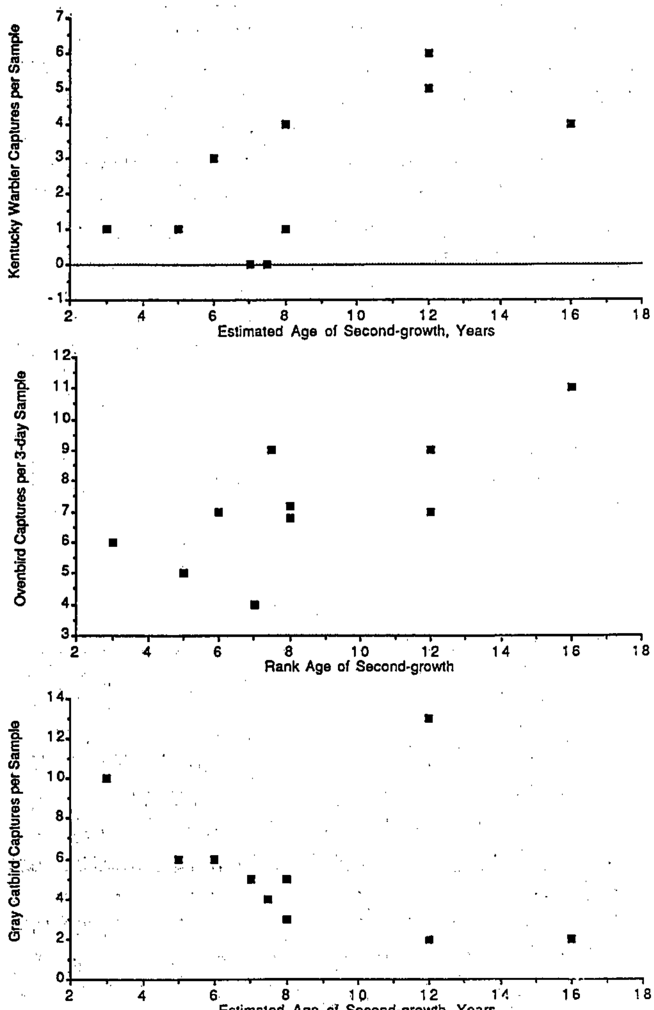

Figure 1. — Scatterplots of capture rates versus age of second-growth vegetation for three species having significant Spearman Rank Correlations among the same.

caught significantly more often in older than in young second growth cautions against the interpretation that the species does quite well in young second growth, and a similar comment may be made about the Kentucky Warbler.

Our results, though admittedly preliminary, lend support to the idea that some bird species perceive some types of "bajo" forest and successional forest in a similar fashion. Bajo forest occupies very extensive portions of the Yucatán Peninsula, and is hence an important forest type for migrant songbirds. It seems likely that some species of migrants are adapted in part to wintering in dense natural vegetation types such as bajo forest. Such species may be preadapted to use of second-growth habitats stemming from slash-and-burn farming, and thus may be relatively immune to effects of milpa agriculture, as compared to species which typically make heavier use of upland forest. If this hypothesized similarity of bajo and second-growth habitats is true, this implies the proliferation of slash-and-burn farming over the past several thousand years in the region may have had less impact on bajo-dwelling species than might otherwise be supposed.

In contrast, the structural difference between upland forest and young second-growth is vast to a human observer. For this reason, any species which typically occur much more commonly in upland than in bajo forest may have a more difficult time making use of second-growth habitats. Interestingly, in our limited sample, none of the eight focal species appeared markedly more common in upland than in bajo forest. The Wood Thrush, for example, was equally abundant in both types of primary forest, and far less common in second growth.

Conservation Prospects

It seems clear that if present rates of human immigration into the region are not reduced, it will be difficult for the conservation potential of this reserve complex to be realized. Direct impacts of non-lumber forest extractive industries (chicle, xate, allspice, guano thatch) on migrant and resident songbirds are likely to be negligible. Of these, only removal of guano thatch and allspice produces noticeable changes in forest structure. These potentially sustainable industries are the most ecologically appropriate extractive industries currently practiced in the area.

While slash-and-burn farming has reportedly declined over the past decade in nearby Quintana Roo (Lynch 1990), this is not the case in the Petén. We cannot give quantitative data, but it is clear that forest destruction by milpa agricultors continues at a fast pace in some parts of the northern Petén and, along with cattle-ranching, has already converted much of the southern Petén into a patchwork of mature forest remnant, successional vegetation, pastures and crops. It is our impression that slash-and-burn agriculture and cattle ranching are the two most potent threats to forest in and near the Maya Biosphere Reserve. While cattle ranching has more devastating impacts on forest biota (pers. obs.), milpa farming seems to be at least as important a source of deforestation at this time in the northern Petén. The two seemed to be linked, moreover, with cattle-ranching often following slash-and burn cultivation (pers. obs., Schwartz 1990).

For species that thrive in successional vegetation, slash-and-burn farming may not present a problem, while for species mostly using mature forest, slash-and-burn appears to be a serious threat in northern Petén. Under pre-Columbian population densities, milpa agriculture may often have maximized regional biodiversity by providing a mosaic of successional stages, with long rotation schedules presumably allowing forest to recuperate mature characteristics. Thus, milpa agriculture in and of itself is probably not inherently "bad" for biological diversity (see also Lynch 1990:192). Rather, the problem is that rotation schedules today are typically so brief, due to human population pressure, that forest rarely if ever is allowed to reach even a moderately mature stage before being felled once more. In our study area, a given patch of ground is farmed 2 years out every 6 to 9 (Heinzman and Conrad 1990, Schwartz 1990). A plot, usually of 5-6 ha, is normally farmed for two years, after which it is fallowed for 4 to 7 years before again being farmed; demographic and economic pressure often leads to fallow periods being further reduced (Schwartz 1990, pp. 269, 274, 276, 286). Hence, the bulk of milpa second-growth is from 0 to 7 years of age. It is difficult to envision, under current human population pressures, how the length of the slash-and-burn rotation may be increased to allow forest to recover more fully. Research on alternatives to slash-and-burn farming, and on ways to increase ability of the slash-and-burn landscape to sustain migrant songbirds and other fauna should be a high priority.

A final thought takes the form of a caution. It is currently popular among international development aid personnel working in the Petén to promote harvesting of more tree species than the two--mahogany (*Swietenia macrophylla*) and Cedro (*Cedrela odorata*)-- traditionally taken. While imparting greater value to the forest is widely recognized as desirable, there is a danger in multi-species harvest, if it is executed without sufficient control. Casual observation suggests the traditional two-species logging practiced today may not necessarily be disastrous for migrant songbirds and other forest biota. The extent of logging damage to the forest appears to vary a great deal, depending on density of the two primary target species as well as other factors (pers. obs., S. Gretsinger, pers. comm.), but in some cases damage appears modest. Our fear is that without controls ensuring a truly long cutting cycle, logging of multiple tree species could lead to a scale and intensity of harvest much worse for migrant birds and other biota, than is the traditional two-species logging practiced today. Promotion of taking more tree species should be contingent upon infrastructure development ensuring the ability to control logging rates over time horizons longer than a human life span.

SUGGESTIONS FOR FUTURE RESEARCH

The success of our inter-habitat comparisons after a single season of study, with limited samples, hinges on strict standardization of methodology which we achieved. If the various researchers conducting similar work in northern Latin America and the Caribbean were to converge on a common methodology, comparisons across a much broader suite of habitats and geographical regions would be facilitated. Such standardization should be a priority in the near future.

ACKNOWLEDGEMENTS

Funding for this research was provided by the National Fish and Wildlife Foundation and Kennetech/U.S. Windpower. We are grateful to the individuals named in Table 1, who allowed us to work on their property. We are thankful to the following government officials who have facilitated our work in Guatemala in many ways: Arq. Claudio Olivares, Lic. L. Leopoldo Colom Molina, and Rogel Chi Ochaeta of the Instituto de Antropología e Historia de Guatemala; Lic. Billy Alquijay Cruz, Lic. Milton Cabrera, and Lic. Ismael Ponciano of (or formerly of) the Centro de Estudios Conservacionistas de la Universidad de San Carlos de Guatemala, and Ing. Milton Sarabia, Lic. Arturo Duarte Ortíz, and Arq. Andreas Lehnhoff, of (or formerly of) the Consejo Nacional de Areas Protegidas.

LITERATURE CITED

Gradwohl, J. and R. Greenberg. 1988. Saving the tropical forests. Island Press, Washington, D. C. 214 pp.

Heinzman, R. and C. Reining. 1990. Sustained rural development: extractive forest reserves in the northern Petén of Guatemala. Tropical Resources Institute Working Paper # 37, Yale University School of Forestry and Environmental Studies, Yale University, New Haven, CT., 104 PP.

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. 1990. Distribution of overwintering Nearctic migrants in the Yucatan Peninsula, II: Use of native and human-modified vegetation. Pp. 178-196 *in* Ecology and conservation of neotropical migrant landbirds. J. M. Hagan III and D. W. Johnston, eds. Smithsonian Institution Press, Washington, D. C.

Pennington, T. D. and J. Sarukhan. 1968. Arboles tropicales de México. México, D. F., México, Instituto Nacional de Investigaciones Forestales.

Petit, D. R., L. J. Petit, and K. G. Smith. 1990. Habitat associations of migratory birds overwintering in Belize, Central America. Pp. 247-256 *in* Ecology and conservation of neotropical migrant landbirds. J. M. Hagan III and D. W. Johnston, eds. Smithsonian Institution Press, Washington, D.C.

Robbins, C. S., B. A. Dowell, D.K. Dawson, J. A. Colón, R. Estrada, A. Sutton, R. Sutton, and D. Weyer. 1990. Comparison of Neotropical migrant landbird populations wintering in tropical forest, isolated fragments, and agricultural habitats. Pp. 207-210 *in* Ecology and conservation of neotropical migrant landbirds. J. M. Hagan III and D. W. Johnston, eds. Smithsonian Institution Press, Washington, D.C.

Schwartz, N. 1990. Forest society: a social history of Petén, Guatemala. University of Pennsylvania Press, Philadelphia. 367 pp.

Secretaria de Programación y Presupuesto. 1981. Carta de climas 1:1,000,000, Merida. Direccion General de Geografia del Territorio Nacional. Mexico, Mexico.

Secretary of the Navy. 1989. The Nautical Almanac for the year 1991. U. S. Gov't. Printing Office, Washington, D.C.

Siegel, S. 1956. Nonparametric statistics for the behavioral sciences. McGraw-Hill, New York. 312 pp.

Waide, R. 1980. Resource partitioning between migrant and resident birds: the use of irregular resources. Pp. 337-352 *in* Migrant birds in the neotropics: ecology, behavior, distribution, and conservation. A. Keast and E. S. Morton, eds. Smithsonian Institution Press, Washington, D. C.