Ecological assessment of five coffee farms in north-central Nicaragua

Finca Las Lajas, Jinotega

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Overleaf: Leopard frog (adj. to Finca Los Altos); Mantled howler monkey (Finca El Quetzal); Collared Aracari (Selva Negra); Unk. orchid (Finca El Quetzal); Unk. butterfly (Finca Las Lajas)

Executive Summary

Five large coffee farms in the Atlantic foothills of northern Nicaragua were surveyed for birds and other wildlife by Cooper Ecological Monitoring, Inc. between 13 and 24 March, 2007. These farms were selected because they have supplied coffee to Rogers Family Company for several years, and because they all have a high potential to effect forest conservation in the region. Each farm has reserved a significant amount of their property (at least 25%) as protected forest, much of which has been designated national forest reserves by the Nicaraguan government. It is imperative that these farms continue to provide protection to these forest ecosystems and the irreplaceable wildlife of this region.

More than 200 species of birds were detected during the March surveys, which represents nearly a third of all species known from Nicaragua. Many species observed on these farms are of global or national concern due to their risk of extinction, including the Highland Guan and the Three-wattled Bellbird. Though forest habitat is generally very well-managed on these properties, several opportunities for improvement were identified, including the eradication of non-native and invasive plant species, better management of cattle grazing, installation of ecological signage, and the expansion and connecting of forested corridors through production areas.

One site in particular, Finca Hammonia/Selva Negra, is singled out for a proposed ecotourism effort aimed at strengthening the link between sustainable coffee production and forest/wildlife protection. Selva Negra is one of the most-visited sites in Nicaragua, attracting tourists from all over the world, and presents an unparalleled opportunity to reach an international audience. Suggested programs include an overhaul of the trail system and printed materials, and a nature guide program similar to those at such famous rain forest sites as the Monteverde Cloud Forest Reserve in Costa Rica.

I. Introduction - "Beyond Shade Grown"

Coffee farms are special places. They are at once human communities, agricultural production areas, and nature reserves. In Nicaragua, their ouput represents a vital component in the national economy. Their schools and clinics provide education and health care to a rural, underserved population. Their non-cultivated lands are essentially - and in some cases literally - forest reserves of national-park quality, protecting streams from pollution, hillsides from erosion, and supporting hundreds if not thousands of plant and animal species, a few of which are threatened with extinction.

With tourism gaining momentum in Nicaragua, and given the location of these farms near two major towns (Jinotega and Matagalpa), they - including the farm owners and staff alike - have a rare opportunity to "tell the story" of coffee and conservation before an international audience. One farm in particular, Finca Hammonia, includes a rustic lodge ("Selva Negra") which is one of the most popular tourist destinations in the country.

What are the major messages of this story of coffee and conservation? One could start with the forest, a place of profound natural beauty which helps us recharge and reconnect with the world. Nicaragua's rain forest and its wildlife, the bellbirds, howler monkeys and orchids, are a shared global heritage, an irreplaceable resource with intrinsic value that deserves protection.

We can also start with the farm. Coffee *fincas* are basically self-contained communities (people+place), and these communities are what protects the forests. These farms are unique places where people and nature must co-exist to benefit both. Without the farms' limiting human access to the forests, and without the understanding and cooperation of the people living there, the forests would be quickly lost to wood-cutting, grazing and settlement.

We could also address the consumer. Thousands of miles away, the simple act of choosing to buy a particular coffee can have a profound effect on this system. These communities depend on a market for their coffee in order to stay afloat. Our shared challenge is to draw the connection between the activities of the farms themselves - the choice to maintain the forest, to not hunt animals, to plant shade trees, to allow habitat corridors along streams - and the consumer who chooses to support the values evinced by these farms.

This is a big idea, and not something that can be summarized by a certification or a slogan. It requires a full understanding of the natural resources of each of these farms, a committment by the farm owners to continue to protect these

resources, and a willingness on the part of the buyer to support good conservation practices. In March 2007, I was hired by Rogers Family Companies to conduct an "eco-audit" of a group of coffee farms in northern Nicaragua, simliar to a previous study I designed in November 2006 in the Soconusco region of southern Chiapas, Mexico (Cooper 2006). Here again, my task was to examine the actual and potential contribution each farm was making to forest and wildlife conservation in the region, and to provide Rogers Family with recommendations and management goals for each property.

II. Methods

This study employed rapid-assessment techniques to evaluate the ecological integrity of five large coffee farms in north-central Nicaragua (described in Cooper 2006). Each site was sampled for two or three days, depending on extend of habitat and access, between 13 and 24 March 2007, and all individuals of all bird species were tallied. Birds were used as the main focus of the study since they are readily observed, present in high numbers at every site, and are a very well-known group. I supplemented bird counts with observations of diurnal mammals (squirrels, large rodents), amphibians and general forest habitat attributes, and photo-documented the forest habitat and *cafetal* at each site. As with the previous study, I used the presence of "indicator species" as a metric of comparison among farms; though all individual birds were tallied, I used the presence of 32 forest-dependent bird species considered by conservationists to be most at risk of extinction (Gillespie 2001, IUCN 2006, Rich et al. 2004) to rank each property in terms of its contribution to supporting sensitive species. These species and their representation on the farms surveyed are presented in Table 1.

Table 1. Sensitive species of Nicaragua used in these surveys

		SELVA NEGRA	SAN LUIS	EL QUETZAL & vic.	LAS LAJAS	SANTA MAURA	Conservation Score[a]
Latin name	**English name**						
Penelopina nigra	Highland Guan	2	5	6	1	1	*0.253*
Odontophorus melanotis	Black-eared Wood-Quail				2	4+	*0.021*
Elanoides forficatus	Swallow-tailed Kite	1		1	7	2	*W*
Buteo swainsoni	Swainson's Hawk	1[b]				2	*W*
Spizaetus tyrannus	Black Hawk-Eagle			1		1	*0.183*
Micrastur ruficollis	Barred Forest-Falcon	4	1?				*0.294*
Geotrygon albifacies	White-faced Quail-Dove	1[b]		3		6	*0.39*
Pionopsitta haematotis	Brown-hooded Parrot	2		2?			*0.092*
Pionus senilis	White-crowned Parrot	3			4?		*0.02*
Amazona albifrons	White-fronted Parrot				4	30	*0.022*
Lampornis sybillae	Green-br. Mountain-gem	5	4	1	2	3	*E*
Ramphastos swainsonii	Ch.-mandibled Toucan				1		*0.163*
Dendrocincla fuliginosa	Plain-brown Woodcreeper					1	*0.021*
Formicarius analis	Black-faced Antthrush					11	*0.22*
Mionectes oleagineus	Ochre-bellied Flycatcher	4		1	3	5	*0.073*
Contopus cooperi	Olive-sided Flycatcher			1	1		*W*
Empidonax traillii	Willow Flycatcher	2					*W*
Procnias tricarunculatus	Three-wattled Bellbird	10+		4	1	4	*0.097*
Cyanocorax melanocyaneus	Bushy-crested Jay	20		12	5		*E*
Microcerculus philomela	Nightingale Wren	2	1	1	1	4	*0.021*
Myadestes unicolor	Slate-colored Solitaire	20	20	8	4	7	*0.08*
Hylocichla mustelina	Wood Thrush	34	6	5		5	*W*
Vermivora chrysoptera	Golden-winged Warbler	4	1	3	1	2	*W*
Protonotaria citrea	Prothonotary Warbler	2			1		*W*
Helmitheros vermivorum	Worm-eating Warbler	5				2	*W*
Oporornis formosus	Kentucky Warbler	2	2			1	*W*
Wilsonia canadensis	Canada Warbler	1[b]					*W*
Habia rubica	Red-crowned Ant-Tanager	10+	2	3	4	13	*0.23*
Melozone leucotis	White-eared Gr.-Sparrow	2	2	2			*0.023*
Passerina ciris	Painted Bunting		1				*W*
Euphonia gouldi	Olive-backed Euphonia	2			1	6	*0.148*
Chlorophonia occipitalis	Blue-crowned Chlorophonia	8					*0.149*
TOTAL		21	10	15	16	20	

[a] Based on Gillespie 2001; higher score indicates greater risk of extinction. Species not scored are included either because they are endemic to northern Central America ("E"; Stattersfield et al. 1998) or are considered as declining, "WatchList" migrant species ("W"; Rich et al. 2004).
[b] Observed during a brief visit after completion of study, so not included in total.

The focus on forest, as opposed to another habitat type, was a function of the conservation priorities of this particular region. Much of the original forest has been logged in Nicaragua (as is the case throughout Central America and Mexico), and large coffee properties either protect significant forest themselves, or provide an opportunity to restore forest-like features to agricultural landscapes. In the case of these Nicaragua properties, four of the five sites actually included official (state-recognized) forest reserves within their boundaries.

As in the Soconusco study, I would typically arrive at each *finca* in late afternoon, and would scout the forest on the site accompanied by a staff member or the owner. I would begin surveys each day at dawn and would finish in the late afternoon, attempting to visit each major forest area of the property at least once during my stay. This was accompished for each site with the exception of the main forest reserve of Finca San Luis, which was visited on just one morning (16 March). As in the Chiapas study, I employed a walking transect method for surveys, in which I walked along a linear track (dirt road or trail) through the finca, identifying every individual bird to species by sight or voice. All forest surveyed was humid foothill rain forest, though two sites, Finca Hammonia and Finca Santa Maura, supported additional deciduous formations at lower elevations that were only visited briefly. Pastureland habitat, present at most *fincas*, was also lightly-surveyed in an effort to focus on the more senstive and species-rich rain forest habitat. A list of sites and dates is below.

Table 2. Survey dates for each farm.

Farm	**Department**	**Survey dates (2007)**
Finca Hammonia/Selva Negra	Matagalpa	13 - 15 Mar.
Finca San Luis	Matagalpa	16 - 17 Mar.
Finca El Quetzal/Los Altos	Matagalpa	18 - 20 Mar.
Finca Las Lajas	Jinotega	21 - 22 Mar.
Finca Santa Maura	Jinotega	22 - 24 Mar.

III. Study Area

This study took place within the Caribbean foothills of northern Nicaragua, near the southern terminus of the highlands that extend south from Chiapas, Mexico through Guatemala and Honduras. The farms ranged in size from just over 150 hectares to 700 hectares, and all were located in northern Matagalpa

and adjacent southwestern Jinotega Departments, accessible by dirt roads east of the main highway that connects the towns of Matagalpa and Jinotega. Most wildlife observations from the farms were from a narrow elevational band between 1300 and 1500 meters, which facilitated comparisons among sites.

Land use in this area is mainly agricultural below c. 1300 m (coffee, some cattle and horticultural crops), with large blocks of forest along the upper slopes above this elevation. One of the farms, Finca Hammonia, includes a tourist lodge, "Selva Negra", with cabins for rent, a full restaurant, a trail network, a small museum, and guided tours of the unique coffee operations, which are described below. The other farms are more typical coffee estates with limited public access, though Finca Santa Maura includes a field branch of University of Central America with facilities for visiting students.

Nicaragua, like Costa Rica to the south, features a chain-like network of forest reserves which not only serve to preserve the water supply and protect towns at lower elevations from erosion and landslides, but since the 1980s were established explicitly to protect and promote biodiversity. To date, the Nicaraguan government has recognized 20 forest reserves in the northern highlands alone, some thousands of hectares in extent. The five fincas in the study are situated among and adjacent to two of these reserves, La Reserva Natural Cerro Arenal and La Reserva Cerro Datanli-El Diablo, both of which were very recently established. These reserves are not like national parks or national forests in the U.S., with clearly-defined borders and limited private in-holdings; they are more like large, goverment-administered conservation easements, with private landowners holding title to the land with an agreement to manage the resources for conservation and to not expand the agricultural activity present when the reserve was designated. So, in the case of these coffee farms, owners may replant existing cleared areas for coffee, but cannot clear land for new plantings within the boundaries of these reserves.

La Reserva Natural Cerro Arenal, which includes the forest of the upper portions of Selva Negra and Finca San Luis, covers nearly 1,500 hectares and includes 36 land owners (MARENA 2003, Fig. 1). It is situated between the towns of Jinotega and Matagalpa, and includes the southernmost populations of many cloud forest species in the country, notably the Resplendant Quetzal *Pharomachrus mocinno*, which is apparently a scarce resident. The second reserve, La Reserve Natural Cerro Datanli-El Diablo covers nearly 6,000 hectares, lies to the northeast of the Cerro Arenal reserve (east of the town of Jinotega), and includes most of the forested portions of Finca Las Lajas and Santa Maura, which are situated along its eastern and northern border, respectively (MARENA 2002, Fig. 2).

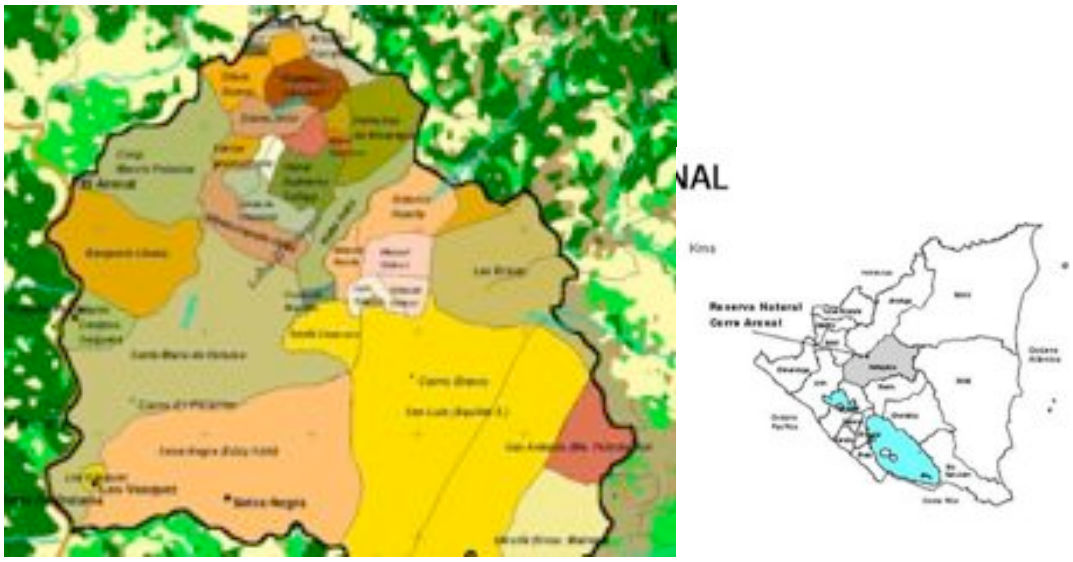

Figure 1. Location and ownership, La Reserva Natural Cerro Arenal. Finca Hammonia/Selva Negra is the large pink property in the lower left; Finca San Luis is the large yellow property in the lower right (from MARENA 2003).

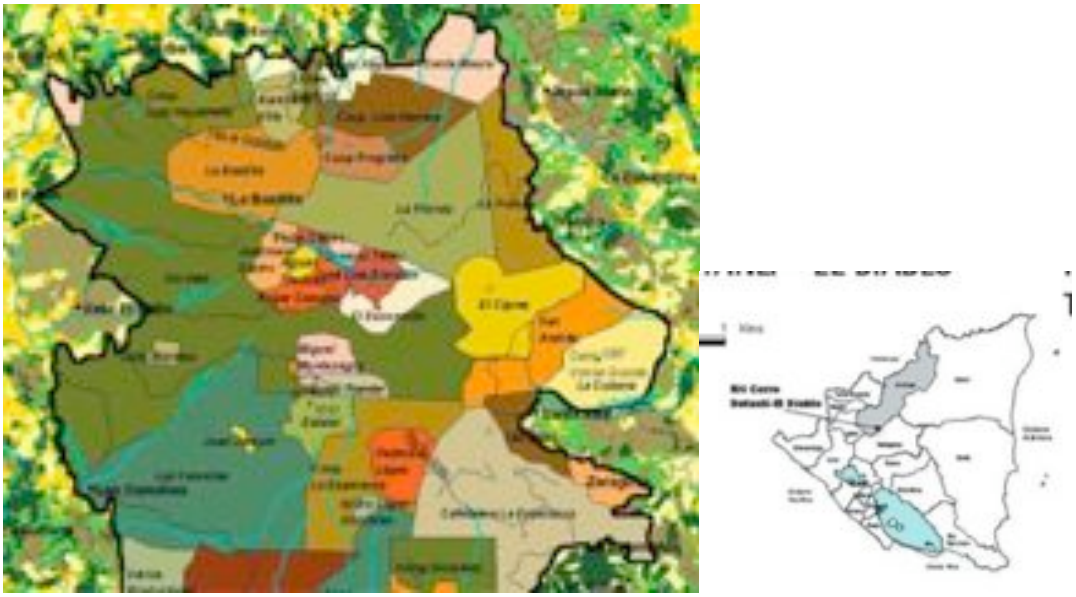

Figure 2. Location and ownership, La Reserva Natural Cerro Datanli-El Diablo. Finca Las Lajas is in brown at lower right; Finca Santa Maura is in pink at top right (from MARENA 2002).

Both reserves were designated by presidential degree in 1991, are part of SINAP (the national system of protected areas in Nicaragua), and serve to

conserve natural ecosystems and to provide goods and services for the benefit of the surrounding human population. According to recently-produced management plans, these reserves provide and protect water resources for their respective regions (Matagalpa, just downstream of Cerro Arenal, is the second-largest city in Nicaragua). Both were officially recognized for their dense forests that support a varied flora and fauna, as well as for the importance of the local production of coffee, flowers, ferns and agricultural products (MARENA 2002, 2003). The forest in and adjacent to Finca El Quetzal (incl. Fincas Los Altos, El Paraisito, and several parcels under consideration for purchase by the owner of El Quetzal), are situated between the above protected areas, but support similar flora and fauna which are basically indistinguishable from the forest habitats of the protected areas.

Ecologically, the forest of this region is structurally diverse and varies depending on both elevation and proximity to moisture-laden winds off the Atlantic. The eastern sites are typically wetter than those near the continental divide, which is essentially traced by the highway connecting the towns of Jinotega and Matagalpa. Central America receives most of its rainfall from the east, leaving the Pacfic slope drier (yet still very warm and humid). Also, forests on exposed ridges here are not dry and windswept as might be expected in North America, but super-wet, with all surfaces cloaked with a thick layer of moss, and large tree-ferns throughout the understory. Patches of forest that are blocked from easterly winds by high ridges, such as the forest along the western side of Finca El Quetzal, were noticeably drier than formations that received direct coastal airflow, such as the rain forest on the slopes that extend above Finca Las Lajas, which directly face the Caribbean lowlands with no intervening ridges.

At the highest elevations, the ridgetops in the region, such as that at Selva Negra (c. 1500 m) which extends east to Finca San Luis, support a cloud forest known as **Lower Montane Rain Forest** (*per* Taylor 1963). This forest type strongly features two high-elevation plant families, Ericaceae (which includes small-leaved, blueberry-like shrubs such as *Vaccinium*) and Melastomataceae (incl. *Miconia*). The tree canopy of the lower montane zone is only moderately high (20 m tall or less), and lianas become rare with increased elevation. This is the spongy, mossy forest that is commonly termed "cloud forest;" each night brings a dense cloud cover that supports a luxurient growth of epiphytic plants. Characteristic birds of this zone in the study area include Highland Guan *Penelopina nigra*, Spot-crowned Woodcreeper *Lepidocolaptes affinis*, Mountain Elaenia *Elaenia frantzii*, Gray-breasted Wood-Wren *Henicorhina leucophrys*, Ruddy-capped Nightingale-Thrush *Catharus frantzii* and Common Bush-Tanager *Cholospingus ophtalmicus*.

An interesting subset of this super-lush forest community known as "elfin forest" was present at just one of the sites, Finca San Luis, on the extreme eastern edge of the farm. This dense, low-growing forest is maintained by near-constant wind, and is best-developed on steep slopes and ridges, where poor soils help discourage tall, straight trees. Essentially impenetrable by people due to the dense, gnarled shrubs and bamboo that form its understory, elfin forest features stunted versions of the some of the same forest trees present on slopes more protected by the elements. Though the bird community is typically only a subset of that of lower montane forest, there are several unique species of plants that are endemic to this habitat (i.e., found nowhere else).

Most of the forest in the study area was found to be tall, dense rain forest just below the zone of the cloud forest, and best fits the description of **Premontane Rain Forest** (*per* Holdridge 1971, *in* Hartshorn 1983). This type dominates the lower slopes of the Cerro Arenal reserve at Selva Negra, as well as the forest patches of Fincas El Quetzal/Los Altos, the steep slopes of the Datanli-Cerro El Diablo reserve forest above Finca Las Lajas, and the "La Pila" area of Finca Santa Maura. It features a high evergreen canopy (30-40 m tall), a dense subcanopy (making it very difficult to see much), and a thick cover of ferns and herbs on the forest floor. Epiphytes, including orchids and bromeliads, are abundant on the older trees, but don't coat every surface as in classic cloud forest. Characteristic birds of this highly diverse premontane zone in Nicaragua include Stripe-tailed Hummingbird *Eupherusa eximia*, Spotted Woodcreeper *Xiphorhynchus erythropygius*, Slaty Antwren *Myrmotherula schisticolor*, Three-wattled Bellbird *Procnias tricarunculatus*, Tawny-crowned Greenlet *Hylophilus ochraceiceps*, White-breasted Wood-Wren *Henicorhina leucosticta*, Golden-crowned Warbler *Basileuterus culicivorus*, Red-crowned Ant-Tanager *Habia rubica*, and Chestnut-capped Brush-Finch *Buarremon brunneinucha*.

A slightly drier foothill forest appears along the western side of Finca El Quetzal and dominates most of Finca Santa Maura. This may be classified as **Premontane Wet Forest** (*per* Holdridge 1971, *in* Hartshorn 1983 as described from Costa Rica) in that it is semi-evergreen (includes deciduous oaks) and multi-leveled, with few tree ferns or epiphytes, and has abundant climbing herbaceous vines. The bird community here includes certain species typical of semi-deciduous ("moist") forests of the Pacific slope in Central America (see Stiles and Skutch 1989), including Long-tailed Manakin *Chiroxiphia linearis*, Chestnut-capped Warbler *Basileuterus rufifrons*, and Gray-headed Tanager *Eucometis penicilata*.

[A final forest habitat that was not well surveyed during this study, found over a large area of Finca Santa Maura called "Los Planes", appeared to support **Premontane Moist Forest** (Hartshorn 1983), a.k.a. "Seasonal Evergreen Forest" (*per* Taylor 1963). This features sprawling, broad-canopied, deciduous trees with tiny compound leaves, few epipytes, and abundant woody-stemmed vines. Los Planes was visited only briefly, but was found to support a distinctive bird community that deserves further investigation (incl. Plain Xenops *Xenops minutus* and Tropical Gnatcatcher *Polioptila plumbea*).]

Generally speaking, the forests of the study area are decidedly more Caribbean than Pacific in the birds they support. However, because the mountains of northern Nicaragua are neither as high nor as linear as those of neighboring countries (most ridgelines reach just 1500-1600 m), the species mix represents a blend of east and west, as well as north and south, with numerous Pacific forest species on the Atlantic slope, and vice-versa. In addition, this region supports many northern plant and animal species at the southern end of their range, many of which join species of the low humid tropics within the same patch of woods. Interestingly, while many of the more common species here are found throughout the humid Neotropics (from eastern Mexico into South America) due to the geographical position of these foothills in Central America, several Caribbean-slope species common in Costa Rica and Panama occur here near the northern end of their ranges. A final additional dimension to the bird community of this region is the annual presence of large numbers of Neotropical migrants, species that nest in North America during the summer and that spend the majority of the year at tropical latitudes, particularly in the foothills. This region appears to be very important for these migrants, including some of the ones most in need of conservation action, such as Wood Thrush *Hylocichla mustelina*, Golden-winged Warbler *Vermiovra chrysoptera* and Worm-eating Warbler *Helmitheros vermivorum*.

IV. Findings

A total of 206 bird species were recorded during the study, which is c. 50 more than were recorded during the Soconusco study. This higher count is due to the wider species diversity as one moves south into Central America, and also reflects the more extensive forest present on the properties in Nicaragua, which support many localized forest-dependent species. Few amphibians or mammals were detected during this study, which therefore focuses on birds.

Gillespie (2001) presented an analysis of threatened and/or declining bird species for Nicaragua, which I use to compare across sites. These are birds that are narrowly restricted to forest habitat, and have small geographical and/or

elevational ranges. They also possess physical attributes known to increase extinction risk, such as high body weight (many endangered birds are large and sedentary; a "classic" extinction-prone species in this study would be Highland Guan *Penelopina nigra*, a turkey-like bird confined to a band of foothill rain forest from southern Mexico to northern Nicaragua). Other sensitive species like macaws, quetzal and Three-wattled Bellbird *Procnias tricarunculata* (locally known as "*pajaro rancho*") were treated by Gillespie. Migratory species that winter in these forests and return to North America to breed were not, and for these, we use conservation scores developed by the international consotrium Partners in Flight (PIF; Rich et al. 2004), which evaluated the global extinction threat to all North American species and identify a group of "WatchList" species with especially acute risks (Table 1).

Two additional species detected during the study are not currently rare, but have very small global ranges and are therefore important to consider for developing conservation priorities. These include the striking forest hummingbird Green-breasted Mountain-Gem *Lampornis sybillae* and the charismatic Bushy-crested Jay *Cyanocorax melanocyaneus*, which was loud and conspicuous around the cabins at Selva Negra. These two (along with the Slate-colored Solitaire *Myadestes unicolor*) were the only representatives of the North Central American highlands Endemic Bird Area (EBA 18; see Stattersfield et al. 1998), which extends just into the study area from the north.

Gillespie (*Ibid*) identified 18 bird species as extinction-prone at a global level, and an additional 53 birds as similarly threatened at the national level. He further divided these species by degree of threat (Critical, Endangered and Vulnerable) based on how the probability-of-extinction score. Just over one quarter (27%) of these threatened species were detected on the five properties during the study, which alone should illustrate their importance. Species identified by Gillespie as Critical/Endangered at the global level include the Highland Guan, Three-wattled Bellbird, and the Slate-colored Solitaire, whose rich, thrush-like song echoed through the forest at every site. More widespread species felt to be threatened at the national level include the Barred Forest-Falcon *Micrastur ruficollis*, Chestnut-mandibled Toucan *Ramphastos swainsonii*, and two colorful forest songbirds, Olive-backed Euphonia *Euphonia gouldii*, and Blue-crowned Chlorophonia *Chlorophonia occipitalis*. Finally, I detected eleven North American-migrant WatchList species on the five fincas, including two that were singled-out for "immediate conservation action" by PIF, the spectacular Swallow-tailed Kite *Elanoides forficatus* (locally known as "tijerata") and the Golden-winged Warbler *Vermivora chrysoptera*, one of the most imperiled songbirds in North America.

Total species counts of the five sites ranged from a high of 131 species (Selva Negra) to a low of 77 (Finca San Luis), with Finca Santa Maura near the top (127) and Fincas El Quetzal and Las Lajas in between with 97 and 91, respectively. Not surprisingly, Selva Negra and Finca Santa Maura were found to support a similarly high proportion of the 32 sensitive bird species (21 and 20, respectively, over 60% of the combined total at all five fincas). Las Lajas and El Quetzal/Los Altos had 16 and 15 sensitive species, respectively, and Finca San Luis had just 10. However, access to the forest habitat may have influenced how many species I could detect; Fincas San Luis and Las Lajas had but a single narrow trail through the main forest habitat, while the others had numerous paths through various blocks of forest.

Of course, it is impossible to say how many additional sensitive species would have been found if the study had been extended a few more days or if it had been conducted during another season. However, the bird checklist of Selva Negra (the only site of the five that had ever been previously surveyed for birds) lists just *two* additonal sensitive bird species not observed during the study (i.e., in addition to the 32 I found), which suggests that the methods used were adequate to detect the majority of the sensitive species present. Both of these two known-but-undetected birds, Great Currasow *Crax rubra* and Resplendant Quetzal, are extremely shy and localized in the region, and it is not surprising that I missed them.

Several notable concentrations of sensitive species were detected at the *fincas*, encouraging for local conservation efforts. The Three-wattled Bellbird ("Vulnerable", *per* IUCN 2006) is a distinctive tropical species that is confined to southern Central America, with two discrete populations in northern Nicaragua/adjacent Honduras and Costa Rica/western Panama. This plump, brown and white cotinga adorns the engraved wooden signs at the entrance to the forest at Selva Negra, and has long been one of the target species for birders visiting the famous nature reserves of Costa Rica (e.g., Monteverde Cloud Forest Reserve). Bellbirds were found to be numerous along the lower portion of the forest trails at Selva Negra (10+/day), their impossibly loud, car-alarm-like calls audible constantly. Bellbirds were even heard calling from isolated remnant forest trees amid the *cafetal* well over a hundred meters from the forest edge (Selva Negra only). Smaller numbers were heard at the other *fincas* save San Luis, which has essentially no Premontane Rain Forest left, apparently the preferred habitat of this species in the region. Bellbirds were also absent in the Moist Forest/"Los Planes" area at the foot of Finca Santa Maura. As a side note, the nest of the Three-wattled Bellbird is unknown to science, presenting an opportunity for a major discovery in the study area.

The scarce Highland Guan ("Near-Threatened", *per* IUCN 2006) was represented by multiple birds at every site, the males' siren-like, ascending whistles heard daily. This bird is heavily persecuted by hunters throughout its range (Howell and Webb 1995), and the fact that it is persisting on these *fincas* is very good news. By contrast, the Soconusco study (Cooper 2006), which focused on a region with much less remaining forest than the Nicaragua area, found this guan at just one of the seven sites visited.

Two other sensitive forest species that deserves mention due to their global extinction vulnerability (*per* Gillespie 2001) are the Slate-colored Solitaire and the Nightngale Wren *Microcerculus philomela*, the latter with an amazing, unforgetable songs. Like the bellbird, the solitaire proved exceptionally common at Selva Negra and along the adjacent cloud forest of Finca San Luis (up to 20/day), and were also numerous in the mossy, epiphyte-rich forest patches along the eastern edge of El Quetzal/Los Altos. The Nightingale Wren, numerically less common, was still found at each site, with up to four birds per day at the super-humid forests on the slopes above Finca Las Lajas.

The Green-breasted Mountain-Gem, not considered sensitive but restricted to the mountains of Honduras and northern Nicaragua, was detected at all five farms, sometimes in (presumably-breeding) pairs. With such a limited range, this hummingbird is highly sought-after by birdwatchers, but is so poorly-known that even at Selva Negra where fairly common (up to 5/day, including birds feeding at flowers around cabins) it does not appear on the existing bird checklists (Kuhl 2007). The large, blue and black Bushy-crested Jay, which has almost as small a range as the hummingbird (northern Central America only), was very common at Selva Negra, which may be among the easiest places to see either of these distinctive species on earth - something to consider when augmenting the eco-tourism/birding offerings of the region.

Neotropical migrants were found to be common at each site; the foothills of Nicaragua are located in the "sweet spot" for wintering North American songbirds (humid foothills), and one of these, the Wood Thrush *Hylocichla mustelina*, is a familiar but declining songbird throughout the eastern U.S. that proved to be among the most common birds in the forest at Selva Negra, where 30+/day were encountered. These large thrushes seem to require intact forest with an ample cover of leaf-litter, where they forage for invertebrates. A much more imperiled migrant, the Golden-winged Warbler, was detected in small numbers (up to 4/day) in forest at every site, and because its main winter range is limited to a narrow band within the foothills of Central America and adjacent South America (Confer 1992), these and additional recent observations from

the highlands of northern Nicaragua (Kjeldsen 2005) suggest that these forests may represent an important wintering area for this species.

A. Finca Hammonia/Selva Negra

Finca Hammonia is unique among the five sites in that it includes a full-service lodge, "Selva Negra" with an extensive network of hiking trail through its forest (other *fincas* have informal, short trails through forest, mostly used as footpaths/shortcuts by workers and residents). About a third of the 450 hectares of Selva Negra is a dedicated forest reserve (part of Reserva Natural Cerro Arenal). The remainder of the property is split evenly between coffee cultivation and a wide variety of enterprises, including a slaughterhouse, a cheese factory, a machine shop, and several large ponds. The worker's area features a school, a health clinic, kitchen, housing, and a laundry/bathing complex. Selva Negra prides itself on nearly two decades of working tirelessly toward sustainability, and now produces most of its own food (including meat, milk and produce) and tries to recycle as much waste into energy as possible, adding new innovations every year.

The *cafetal* at Selva Negra is mainly Commercial Polyculture *per* Moguel and Toledo 1999), well-shaded with a multi-level canopy. The forest at Selva Negra, including that within the Cerro Arenal reserve, was among the most diverse visited, with a wide belt of Premontane Rain Forest along the base of the ridge behind the restaurant/lodge area (Fig. A1) grading into Lower Montane Rain Forest along the 1500-meter-high ridge through the northern half of the property (Fig. A2). The lower slopes of the property below the headquarters (e.g., the "Puma area") near the sports field supported patches of slightly drier Premontane Wet Forest as well as open scrubland and pasture habitat. Very large forest trees dot the *cafetal*, and corridors of young forest with emergent trees extend along stream courses through the entire property.

Based on the bird surveys, Selva Negra supported more species (131) and more sensitive species (21) than any other *finca* visited, including large and significant populations of Three-wattled Bellbird ("*pajaro rancho*"), Slate-colored Solitaire and Bushy-crested Jay. The mammals of Selva Negra were also notable among the *fincas*, in that the cat-sized rodent, the Central American Agouti *Dasyprocta punctata*, is abundant here, both within and away from the forest. This was the only site where agouti was observed in such numbers; it is hunted widely throughout its range in Latin America, including in Nicaragua. Other interesting mammals include numbers of Mantled Howler Monkey *Alouatta palliata* and recent reports of a family group of Central American Spider Monkey *Ateles geoffroyi* (M. Kuhl, *pers. comm.*). The forest reserve and patches at

Selva Negra supported the small Deppe's Squirrel *Sciurus deppei*, as well as a small, orange-bellied forest squirrel that was undoubtedly Richmond's Squirrel *Sciurus richmondi*, a poorly-known species confined on earth to the Altantic slope of Nicaragua, one of the smallest ranges of any mammal in North or Central America. Neither of these squirrels is found away from mature, intact forest, so their presence here is a good indicator of the health of the ecosystem.

In short, Selva Negra may support as complete a representation of the local fauna as possible, and in many ways, serves as the model of best forest practices. For example, fallen logs are left to decompose back into the soil (Fig. A1) rather than being sawn for lumber and removed (discussed later). Streams through the coffee are left to develop thick growth of trees and shrubs, rather than being sprayed with herbicide or hand-cleared (Fig. A3). The *cafetal* itself features a diverse tree canopy with individuals of various ages at different levels (Fig. A4).

Figure A1. Fallen log along Canal Trail through main forest reserve, Selva Negra.

Figure A2. Lower Montane Rain Forest (aka "cloud forest") along high ridge, Selva Negra. Note profusion of epiphyes and thick mosses coating trunk, and thick, dense ground cover.

Figure A3. Typical corridor of native forest trees through cafetal, Selva Negra.

A4. Typical shade coffee at Selva Negra, with multi-leveled canopy and grassy understory.

Rather than make recommendations for the maintenance of the forest reserve or the habitat within the *cafetal*, I would instead focus on maximizing the visitor experience of Selva Negra, as it is currently operating far below its potential as an ecotourism destination. After spending several days here and talking with the staff and various foreign guests (and having stayed at many eco-lodges throughout Latin America during the past 10 years, often as a tour guide), I can offer the following thoughts:

Visitors to Selva Negra - aside from those who come for organized events such as weddings - are of two types, local and foreign. Rather than promoting stereotypes, understanding the distinctions between the two is important to characterize the "audience" for Selva Negra, and must guide the development of public offerings and communication materials. The typical local visitor arrives for the day from Managua or Matagalpa, in a private vehicle with his/her extended family (kids, grandparents) as a day trip, often to escape the heat of the lowlands (Selva Negra is known country-wide for its cool climate and mountain setting). The family may take a tour of the property with Mausi Kuhl (the owner/manager of the property), but more likely has a meal (typically lunch) and spends time enjoying the view of the lake and the lower trails closest to the lodge. These families are neither agricultural workers nor adventure tourists, but are middle-class Nicaraguans; either way, they do not arrive dressed for hiking, and are not expecting a wilderness experience. They may pick up some cheese or sausage from the hotel store to take home. The family may stay the night, but often returns to town in the afternoon.

The typical foreign visitor is either from Europe or the U.S., and commonly speaks no Spanish (but is often conversant in English), and is either part of an organized tour or is backpacking around Central America, often following a trip to Costa Rica. They arrive in a rental car, have traveled previously in Central America and elsewhere in the world, and are visiting Selva Negra because it's one of the only places in Nicaragua where one can experience the cloud forest and hope to see wildlife. The foreign visitor may be traveling with a friend about the same age and background, and he/she will typically take a guided tour of the farm operations, but then will quickly pack a water bottle and binoculars and hike the trails for several hours. The foreign guest will often spend one or two nights, and will enjoy several meals in the restaurant.

Though the coffee operations and the history of the site are fascinating, the forest reserve at Selva may be as much of an attraction - if not a greater draw - for the foreign visitor. The forest is the thing that takes people away from their daily routine and helps them reconnect with something larger - nature. They want to use their ears and eyes in ways different from when they are sitting at their computer or driving in their car. And at Selva Negra, they have a chance - and for the foreign visitor, it is a rare and treasured chance - to hear the roar of a howler monkey, to spot an owl roosting in a tangle of strangler figs, or to watch in disbelief as a river of leaf-cutter ants transforms a sapling into yard waste, piece by piece. Though these things may seem mundane to residents of tropical countries who spend time in the rain forest, they are truly unique and magical to the majority of Selva Negra's guests, who do not.

Regardless of background, all visitors to the forest at Selva Negra must have their interest sparked, and their curiosity about nature satisfied. By staying in a place as distinctive and remote as Selva Negra, they are not just interested in how the farm is living sustainably - they are also hoping for a bit of the "rain forest experience" that this site can uniquely offer. After all, there are many sustainable farms throughout Europe and the U.S., and there are even many coffee farms elsewhere - even in Nicaragua - that offer tours of their operations. However, the forest along the trails of Selva Negra is unlike any other that a visitor is likely to see during a trip to Nicaragua. Recommendations for Selva Negra, and for the other *fincas*, are discussed in the next section.

B. Finca San Luis

San Luis is located adjacet to Selva Negra to the east, and its forest area, also within the Cerro Arenal reserve, is even more extensive than that of Selva Negra's. The *cafetal* of Finca San Luis is mainly Shaded Monoculture with smaller areas of Unshaded Monoculture (a.k.a. "sun coffee"), *per* Moguel and

Toledo (1999), with no areas of multi-level shade coffee that typifies adjacent Selva Negra. A very large property, San Luis may be divided into several habitat areas. Its northern half is a vast expanse of Lower Montane Rain Forest, a super-wet, mossy habitat accessible by a single footpath that follows a small mountain creek on the western slope of Cerro Bravo, a local peak. This forest is essentially identical to the ridge forest on Selva Negra, and doubtless supports a full compliment of the region's (lower-) montane species.

The eastern portion of San Luis is very steep, its slopes cloaked with a stunted elfin forest, maintained by near-constant cloud cover and moisture-laden breezes off the Caribbean Sea (Fig. B1). This forest is apparently contiguous with the main reserve just off the property boundary to the north, but in an area that is virtually inaccessible on foot. Small areas along creeks through the *cafetal* on the property have been left as native forest (or allowed to regrow as such), including one posted as "*Reserva de Granadillo*" (Fig. B2). A small area of drier forest occurs along a creek in the lowermost portion of the property, similar to that below Selva Negra (Fig. B3), and large areas of pastureland on the eastern portion of the property and along the *cafetal*/forest boundary provide a fourth habitat type (Fig. B4).

The shade over the *cafetal* of San Luis is very open, and does not feature the multi-leveled shade of Selva Negra or other *fincas*. However, the owners have left many of the roadsides "messy" for purposes of supporting orchids and helping control erosion (J. Solorzano, pers. *comm.*).

Figure B1. Elfin forest adjacent to cattle pasture (left) and the interior of the same forest (right), Finca San Luis. Dense stunted trees form a totally impenetrable, moss-covered understory, almost a "cloud forest chaparral."

Figure B2. Small forested drainage within *cafetal*, Finca San Luis. These habitats are critical for bird and wildlife movement through the finca, and were found to support several species of forest birds otherwise absent from the production areas (incl. Emerald Toucanet *Aulacorhynchus prasinus* and Common Bush-Tanager).

Figure B3. Seasonal Evergreen Rain Forest fragment along stream, lower Finca San Luis. This habitat was too limited to have been surveyed well.

Figure B4. Pastureland at Finca San Luis. Tall grass (partially grazed in photo) is invasive Elephant Grass *Pennisetum purpureum* planted for forage and windbreaks and locally called "Taiwan grass." Established over a large area of the property, this has now invaded large areas of forest here, and has proven extremely difficult, if not impossible, to eradicate.

Finca San Luis supported both the lowest number of total bird species (77) and sensitive bird species (10) found during the study. This is probably because the forest it protects is mainly high-elevation cloud forest and wind-swept elfin forest; the structurally taller and more species-rich Premontane Rain/Wet Forest found at lower elevations on the other *fincas* (including over most of Selva Negra) was apparently removed from the site long ago. Thus, the "classic" premontane rain forest species such as the Three-wattled Bellbird, Golden-crowned Warbler, and Red-crowned Ant-Tanager were all found to be absent or rare.

Still, San Luis holds very important habitat areas, and has tremendous potential to contribute substantially to biodiversity conservation in the region. The main forest area that is part of Cerro Arenal was found to support numbers of several sensitive species, including Slate-colored Solitaire (at least 20 singing birds); Highland Guan (flock of five roosting in treetops on 16 Mar., and two more in elfin forest the next day); and several individuals of the endemic Green-breasted Mountain-Gem hummingbird. The only Painted Bunting *Passerina ciris* seen during the study was at Finca San Luis - this species is considered globally Near-Threatened (IUCN 2006), and probably winters here in small numbers. Other localized species detected here include the giant Strong-billed Woodcreeper *Xiphocolaptes promeropirhynchus* (pair seen in cloud forest high on ridge) and White-eared Ground-Sparrow *Melozone leucotis*. As for mammals, no howler monkeys were heard, though the forest here may be above the typical elevation for this species; however, a single Richmond's

Squirrel was observed in the forest on 16 Mar., and Deppe's Squirrel probably also occurs.

Ecologically, the major threats to the biodiversity at the site involve the extent to which cattle are permitted to graze the forest fragments, particularly along the eastern portion of the property. Grazing removes the understory of the forest, encourages invasions by non-native species, and inhibits regeneration by saplings. It can also have deleterious effects on water resources, particularly if cattle are allowed to wade into streams to defectate/urinate when drinking (Figure B5). Isolated forest trees in this area are heavily laden with epiphytes, including orchids, and are especially prone to wind damage. These could be preserved by fencing in corridors through the pasture to connect larger trees, thus allowing native forest to regenerate inside the fenced area. The high rainfall and extensive forest adjacent to these pastures should assist in regeneration if grazing were contained better.

Figure B5. Results of cattle grazing in cloud forest fragment (left) and streambed (right), both Finca San Luis.

C. Finca El Quetzal and vicinity

Finca El Quetzal provided a base for surveys of several adjacent parcels, including Finca Los Altos, Finca El Paraisito, and several contiguous properties that included forest fragments. These habitats were found to support above-average numbers of species and sensitive species compared to other sites, but were notable for several reasons. The forest fragments here appear to be little-disturbed by the local residents; a few supported Highland Guan (up to six per day, the highest of any site surveyed), a species that would have been hunted out in more populous regions. In addition to the guan, all of the most

extinction-prone species identified by Gillespie (2001) and recorded on the five *fincas* were still present at El Quetzal, including the White-faced Quail-Dove *Geotrygon albifacies* (three in the western forest block, across the river from the main house), Three-wattled Bellbird (up to four/day in forest patches), Nightingale Wren *Microcerculus philomela* (one in the western forest block, probably more elsewhere), Slate-colored Solitaire (common; nest with eggs discovered on 18 Mar., Fig. C1), and White-eared Ground-Sparrow (pair at house).

The *cafetal* at El Quetzal/Los Altos is a mix of Unshaded Monoculture (a.k.a. "sun coffee") and smaller areas of Shaded Monoculture (*per* Moguel and Toledo 1999), with eucalyptus the dominant shade tree (in contrast to the *Inga* spp. used on other farms). The forest in the region is of two types, a lush, epiphyte-heavy Premontane Rain Forest that dominates in the region (Fig. C2); and a large block of essentially primary rain forest along western forest area that is blocked from prevailing northeasterly winds by a high ridge and is noticeably drier and more deciduous (Fig. C3). This forest block - Premontane Wet Forest - was found to have a slightly different bird community than the cloud forest patches elsewhere on El Quetzal/Los Altos.

This diversity of habitats helps explain the relatively high total number of bird species detected (97), which includes 15 of the 32 sensitive bird species encountered during the study. Only a few species were found here that were not encountered elsewhere, with the notable exception of Acorn Woodpecker *Melanerpes formicivorus* (the same species that occurs in California), which maintains a small colony in the oak-dominated forests. A pair of the forest-dependent Ruddy Foliage-Gleaner *Automolus rubiginosus* was observed in one of the patches between Los Altos and El Quetzal at a lush, plant-covered roadcut, where it was possibly nesting. At least one Black Hawk-Eagle *Spizaetus tyrannus*, a rare raptor of the rugged foothills, was observed; this species (as is the case with most hawks) is often shot by rural residents who feel it eats their chickens. Howler monkey seemed especially numerous here (heard along west side of El Quetzal only), and a small troop allowed me to photograph it as it gorged on the young leaves of a massive oak at the edge of the coffee. Finally, a few forest-dependent Deppe's Squirrels were encountered, including in the smallest forest patches, suggesting these fragments are still retaining some of their ecological functionality.

Figure C1. Nest (left) of the Slate-colored Solitaire (right, ph. Oliver Komar), a characteristic songbird resident found in humid foothill and montane forests of northern Central America. The nest, a cup of mosses and rootlets, was found affixed to a vine-covered fallen log within *cafetal* at the forest edge, near "El Paraisito" parcel.

Figure C2. Typical forest patch adjacent to Finca El Quetzal. Though not part of a formal reserve, these habitats supported an intact forest bird/wildlife community similar to that of the Cerro Arenal reserve that includes Selva Negra.

Figure C3. Interior view of 40-ha western forest block at Finca El Quetzal. Note lack of vines/lianas and mossy branches, the latter due to a drier microclimate.

Like the other *fincas* surveyed, El Quetzal and the surrounding properties provide several opportunities for improvement. For one, most of the *cafetal* at El Quetzal is shaded with eucalyptus trees, some planted years or even decades ago (Fig. C4) when eucalyptus was still regarded as appropriate for re-forestation projects in the Americas. However, areas of the property are still apparently being planted with eucalyptus, including a field adjacent to one of the most significant habitat blocks encountered on any *finca*, the 40-hectare block of Premontane Wet Forest northwest of the main house (Figure C5). Birds and native wildlife were especially scarce in these areas planted with eucalyptus, probably for several reasons. First, the leaves of the eucalyptus produce oils that discourage grasses and herbs from establishing in the understory. The trees themselves hold little appeal to birds, particularly residents which need a ready supply of fruit, flowers, and/or insects (eucalyptus bark resists insects). When flowering, eucalyptus can support nectar-feeding birds, providing some ecological value, but this is offset by the negative impact that eucalyptus groves have on the landscape overall.

Ideally, all eucalyptus would be removed from the properties; since this may be unrealistic at least in the short term, eradication efforts could focus on eliminating trees from stream zones and other sensitive habitat areas. Wildlife response would be most dramatic along streams, which are currently severely impacted, as the streams themselves act as conduits to transport and plant the

eucalyptus seeds elsewhere in the region. Those trees around houses/buildings and in solid production areas would be a lower priority for removal.

Figure C4. Typical eucalyptus shade of Finca El Quetzal. Eucalyptus is native to Australia, and is no longer considered appropriate for use as a shade tree in Latin America. Note lack of vegetation under eucalyptus (except for coffee plants).

Figure C5. New plantation of eucalyptus for shade (red arrow points to young trees) adjacent to large block of high-quality Premontane Wet Forest, Finca El Quetzal.

Another area for improvement in and around Finca El Quetzal involved the logging of fallen logs. According to various locals I spoke with, windstorms regularly knock down large trees, which are gradually sawn into boards and hauled off (Figure C6). While this may not seem like a major impact, fallen logs are critical to maintain biodiversity in tropical forests, as they support native amphibians and provide nesting sites for birds and small mammals. Not coincidentally, salvage logging is typically banned from forest reserves worldwide, and while El Quetzal/Los Altos is not part of a formal nature reserve, their wildlife communities are essentially national reserve-quality, and should ideally be managed with the same care. Though signage will not entirely eliminate this problem, it might be a good first step. The signs at Finca Santa Maura (discussed below) provide a good example in the region.

Figure C6. Informal salvage logging, Finca El Quetzal. This was a frequent sight in the area's forest patches, which are not protected as a formal reserve as is forest on other *fincas* in the study.

Ecological improvements at El Quetzal/Los Altos will involve a re-thinking of the entire landscape: the *cafetal*, the rivers, and the forest parcels that support the exceptional wildlife resources of the region. Obviously, continuing to plant of native shade trees is key to this (Fig. C7), but it may take many years for planted trees to resemble the shade coffee present at sites such as Selva Negra. More important would be working to maintain and expand the areas of young

forest and scrub that already connect the individual habitat patches, such as wooded corridors along streams, windbreaks, ridges and roadsides (i.e., areas that are not cultivated for coffee). Identifying selected areas that could support "demonstation areas" of regeneration of actual forest, would be a good first step, such as along the numerous windbreaks that criss-cross the landscape (Fig. C8), or, particularly, along streams (Fig. C9).

Figure C7. Reforestation plantings with the fruiting tropical hardwood "*Granadillo*" (species unknown, possibly *Platymiscium pinnatum*), Finca El Quetzal. These forest trees should enable native wildlife, especially birds, to move through the property.

Figure C8. Typical view of *cafetal* at Finca El Quetzal, showing windbreaks (red arrows) that could be used as forest regeneration corridors.

Figure C9. Typical stream through *cafetal* at Finca El Quetzal, showing canopy of eucalyptus and little understory vegetation. These barren zones are especially prone to erosion and facilitate transport of invasive weeds, but have high potential for supporting native wildlife if restored.

D. Finca Las Lajas

Finca Las Lajas was the most easterly property surveyed, located near the headwaters of a drainage that flows directly to the Caribbean. It is nestled against the steep, forested slopes along the eastern edge of the Cerro Datanli-El Diablo natural reserve, and its forest is part of that reserve. The forest at Las Lajas may be divided into two areas, the large expanse of foothill forest that extends west into the interior of the reserve, and a narrow strip of young rain forest along the major stream through the middle of the *finca*. The bird community has a distinct Caribbean feel, with several species not observed at the Matagalpa sites that are characteristic of the Atlantic lowlands of Central America, particularly the striking Scarlet-rumped Tanager *Ramphocelus passerinii*. Las Lajas was found to have an average number of total bird species (91) and sensitive species (16) during the surveys, though given the poor access

of the main habitat here (only a single footpath provided access to the reserve, and it follows a loud, rushing stream), more species were undoubtedly present but not detected.

The *cafetal* at Las Lajas is primarily Shaded Monoculture grading into a more multi-leveled, diverse Commercial Polyculture (*per* Moguel and Toledo 1999) near the forest edge and along roadsides (Fig. D1). The coffee lanes have a lush layer of grasses and herbs in most areas. Perhaps not coicidentally, several pairs of the tiny Ferruginous Pygmy-Owl *Glaucidium brasilianum* were found (absent elsewhere) within the *cafetal* - a good sign that it supports a food base for these birds. Also, several mixed species flocks were found in the coffee far from the forest, a situation also noted at Selva Negra but not at San Luis or El Quetzal, possibly because of an intensive weeding and spraying regime of these farms.

The forest of Finca Las Lajas is mainly Premontane Rain Forest, sharing features of higher-elevation Lower Montane Rain Forest on ridges and within the canyon bottom, similar to the habitats at Selva Negra (Fig. D2). Though the forested corridor through the property included some mature trees and a rocky stream (called the *bosquecito*, "little forest," by the staff; Fig. D3) it was apparently too narrow to support many of the 32 extinction-prone species (only two, Golden-winged Warbler and Prothonotary Warbler *Protonotaria citrea*, neither of them residents, were found in the *bosquecito*); most of the sensitive species at Las Lajas were restricted to the foothill forest above the *cafetal*, including that on the adjacent property to the north, which was visited briefly.

Figure D1. Typical Commercial Polyculture, Finca Las Lajas.

Figure D2. View of forest interior within the Cerro Datanli-El Diablo reserve, Finca Las Lajas.

Figure D3. Interior of *bosquecito*, a narrow, forested corridor through the center of Finca Las Lajas.

Finca Las Lajas, like Selva Negra, presents a good model of the coexistence of habitat preservation and coffee production, and I have few recommendations at this time except perhaps the installation of ecological signage (no hunting, no wood-cutting, etc.) similar to those at Finca Santa Maura, described below. As a side note, the grassy horse pasture just downhill of the buildings was found to support at least one localized species, the White-throated Crake *Laterallus albigularis* (called "*gallito de agua*" by locals), which occurs in wet meadow habitat on the Atlantic slope of Central America. This habitat, along with other grassy and brushy areas, should be preserved on the farm if possible, and not mowed/burned (though light grazing as occurs now would be fine).

E. Finca Santa Maura

Finca Santa Maura is a sprawling, 700-hectare property located north of Finca Las Lajas on the northern edge of the Cerro Datanli-El Diablo reserve. Nearly 300 hectares of the property is dedicated as forest, and about the same amount is cultivated in coffee. Santa Maura joined Selva Negra in supporting very high species diversity (127 species identified in two days). Of these species, 20 were sensitive, either extinction-prone or endemic to the region; again, nearly identical to Selva Negra. The *cafetal* presents a variety of cultivation styles, including a mix of Commercial Monoculture and Commercial Polyculture, with large swaths dedicated to a Traditional Polyculture, which features an almost forest-like, highly diverse shade cover of trees of various species and ages. All roadsides and most lanes through the coffee were left to develop a thick herb and grass layer, similar to Selva Negra and Las Lajas, which was probably accounted for the abundance and diversity of birds in the *cafetal* itself, including forest-dependent taxa (Figure E1).

Figure E1. Typical roadside through *cafetal* at Finca Santa Maura, showing grassy roadsides, dense shade cover, and forest patch in background.

The habitat on the *finca* may be divided into several distinct zones, each with its own forest type. The top of the farm, an area known as "*La Pila*" after the spring-fed water tank that provides water for the farm, is a large block of Premontane Rain Forest which is part of the main Datanli-El Diablo reserve. A level footpath follows a large stream through the forest reserve. Montane bird species such as Highland Guan and Slate-colored Solitaire were found here, along with some of the most forest-dependent birds in the region, including Black-eared Wood-Quail *Odontophorus melanotis*, Black-faced Antpitta *Formicarius analis* (10+/day) and Nightingale Wren (4/day) among the most threatened. The viney thickets along the river itself were exceptionally productive for birds, and presumably for other wildlife as well - both Deppe's and Richmond's squirrels were here, and a set of large tracks in the mud were likely those of Mountain Lion *Felis concolor* (Fig. E2).

Figure E2. Possible Mountain Lion *Felis concolor* track, Finca Santa Maura.

Santa Maura was essentially unique in supporting large patches of intact forest integrated within the farm. These patches were somewhat drier than the *La Pila* canyon area, with a rather open understory. Unlike the other sites surveyed, where narrow corridors of forest followed streams or clung to steep slopes, the forest patches at Santa Maura were totally integrated throughout the property, such that farm roads constantly passed in and out of high-quality forest patches (Fig. E3); each area of coffee seemed "balanced" by a similarly-sized area of forest. Perhaps unsurprisingly, some of the most sensitive bird species in the area were found not in remote forest reserves, but within the *cafetal* itself, including the White-faced Quail-Dove *Geotrygon albifacies* (up to 6/day) and the highly-localized Buffy-crowned Wood-Partridge *Dendrortyx leucophrys*, both of which are hunted throughout their ranges. A large area of mainly deciduous forest at lower elevations on the property ("*Los Planes*") provided a third distinct forest type, Premontane Moist Forest, with its own distinctive bird community (Fig. E4).

Finca Santa Maura is also notable for what can be described as a "culture of conservation". Clear signage posted property-wide indicates the importance of conserving the forest and the wildlife, and conversations with the staff indicate a high awareness of these resources (Fig. E5).

Figure E3. Typical forest patch within *cafetal*, Finca Santa Maura. These patches of mature Premontane Wet Forest were integrated throughout the property, and contributed to the high forest bird species diversity at the site.

Figure E4. View of Premontane Moist Forest in the lower portion of Finca Santa Maura. This semi-deciduous woodland was unique among the five sites, and has been widely cleared for cattle, logging and agriculture in Central America.

Because of a long commitment to forest protection and the high quality of habitat at Santa Maura, it is also difficult to suggest ways to improve conditions for wildlife on the farm. However, some changes that would be appropriate include the management of the main stream through the farm headquarters; as was the case on many farms, the stream is used as a laundry area (Fig. E6) as well as a casual rubbish dump by certain residents - a totally normal situation in the region, but one that could be having deleterious effects on water quality here and downstream.

Though this study did not address chemical usage at these farms, I was surprised to see farm employees spraying fungicide in sandals and tank-tops, their heavy plastic protective gear laying unused on the side of the road. All workers (on all farms!) should all have access to appropriate hot-weather protective gear when spraying (ultra light-weight DuPont coveralls are available for around $5.00 each; see www.northernsafety.com).

Figure E5. Typical ecological signage at edge of forest patch, Finca Santa Maura. This reads "We are part of the reserve. Protect it." This signage included distinctive and large lettering, and was posted high on trees, and thus less vulnerable to vandals.

Figure E6. Washing clothes in stream, Finca Santa Maura. This practice, as well as bathing with soap/shampoo, is widespread at coffee *fincas* throughout the region.

V. Summary of Recommendations

Selva Negra/Finca Hammonia

- Overhaul trail map and signage. Trail map must be clear and legible, with an accurate depiction of current trails. Signage in the forest should also be clear and consistent, legible *from both directions*, and should enable the disoriented visitor to find his/her way back to the lodge in the most direct way. Large wooden "Reserva Cerro Arenal" signs were laying on the ground during my visit; these should be properly installed.
- Consider ways to produce a trail map/guide that includes photographs of distinctive species the visitor is likely to see while at Selva Negra (e.g., Agouti, Bushy-crested Jay, Emerald Toucanet, orchids, etc.).
- Develop English translation of Selva Negra brochure (current brochure is in Spanish and therefore inaccessible to nearly all foreign guests), and use brochure to convey "the message" about how the coffee supports the *finca*, which in turn protects the forest; without the *finca* and the reserve (Cerro Arenal), the forest would likely be cut down, as it has been in the surrounding area.
- Consider establishing a "micro-nature-center", possibly using the building that currently houses the craft store. This can serve as a centralized location for visitors who intend to hike the trails and

experience the forest. The visitor can purchase laminated trail guides and wildlife guides (similar to the "Wildlife of Costa Rica" guide I left), or can rent binoculars (donated by Birder's Exchange or similar group). He/she can also hire a trail guide from the local community, ideally a young man or woman that has received some training in English and nature interpretation (see next item).

- Consider establishing a short (1- or 2-week) summer internship program for nature guides, similar to the weeklong program that was building the children's library during my visit. This program could host guides from sites in Costa Rica (e.g., Monteverde Cloud Forest Reserve) to train local students, and could be co-directed by college students from the U.S. Graduates of this program could then become nature/farm guides at Selva Negra (delivering the farm tour that Mausi currently conducts up twice a day!), and could help run the nature center.
- Carefully consider opening new areas to cattle grazing, particularly in areas of the property that currently support regenerating forest along streams. These forested corridors are vital for movement of species from highland cloud forest into the lower-elevation habitats during storms and following breeding, and must be protected from grazing. Concerns such as providing shade and water to cattle can often be met by using tent-like shelters and water troughs, rather than by allowing cattle to enter and foul streambeds.

Finca San Luis

- Work toward eradicating Taiwan grass/Elephant grass from the site, beginning with areas of high-quality, intact forest where grass is invading.
- Expand *Reserva de Granadillo* and other forest corridors along streams to better connect to larger forest patches, particularly those that link with Reserva Cerro Arenal, possibly by using fencing.
- Protect isolated forest patches within pasture areas from grazing using fencing, especially those that are contiguous with Reserva Cerro Arenal.
- Identify potential chemical-free zones within the farms, possibly along streams or near forest edges, and post signs indicating what these are.

Finca El Quetzal/Los Altos and vicinity

- Post signage around individual forest patches clarifying that the trees and wildlife are to be protected, and that logging, hunting, etc. are not tolerated (similar to those of Finca Santa Maura).

- Work toward reducing the amount of eucalyptus throughout the farm, beginning by removing those trees along streams and adjacent to intact forest patches (and possibly re-planting native species to replace them).
- Identify potential ecological corridors between existing forest patches, and establish demonstration areas that allow forest understory to regenerate along these corridors to connect patches of forest.
- Identify potential chemical-free zones within the farms, possibly along streams or near forest edges, and post signs indicating what these are.

Finca Las Lajas

- Install ecological signage around forest patches, stream crossings, etc., similar to those of Finca Santa Maura (no hunting, no logging, etc.).
- Identify potential chemical-free zones within the farms, possibly along streams or near forest edges, and post signs indicating what these are.

Finca Santa Maura

- Encourage use of dedicated laundry/bathing areas, rather than allowing residents to use the stream for these activities, which leave behind pollutants (detergent, bleach, etc.)
- Identify potential chemical-free zones within the farms, possibly along streams or near forest edges, and post signs indicating what these are.
- Obtain and provide appropriate hot-weather chemical protection gear for staff.

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