



## The Mammal Fauna

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La Selva has been a field station of the Organization for Tropical Studies (OTS) more than a quarter-century. Habitat and wildlife have been protected or managed since the mid-1950s when Leslie R. Holdridge created Finca La Selva. In this chapter I explore the nature and diversity of the mammalian fauna of La Selva by integrating what is known about this fauna from the published literature in the context of my own impressions and experience. I present a complete list of the mammals that are known to occur at La Selva with estimates of their abundance in appendix 8 and discuss here the distributional patterns of these species. I also discuss research published on mammals at La Selva and briefly review some of the more significant research findings. I compare this fauna briefly with other tropical faunas, discuss the impact of human activities on mammalian distributions and abundance in this region, and note some of the major gaps in knowledge as suggestions for future research.

### THE MAMMALIAN FAUNA OF COSTA RICA AND LA SELVA

Costa Rica is one of the few countries in the Western Hemisphere in which the entire mammalian fauna that was present at the time of European settlement is still largely extant. Good populations of most species can be found within the country; populations of a few species, however, have been reduced to sizes that can no longer be considered healthy and viable. Of the approximately 116 species of mammals originally found at La Selva (app. 8), perhaps only two species, the giant anteater and the white-lipped peccary, have been locally extirpated. Both species may have disappeared from La Selva since the 1970s (Timm et al. 1989). Although occasionally present, jaguars are now only rarely observed at La Selva and do not have a viable breeding population there. Thus, La Selva retains more than 98% of its component species.

The mammalian fauna of La Selva historically included 5 marsupials, 65+ bats, 3 (possibly 4) primates, 7 edentates, 1 rabbit, 3 squirrels, at least 9 long-tailed rats and mice (families Heteromyidae, Muridae, and Echimyidae), 1 pocket gopher, 1 porcupine, 1 paca, 1 agouti, 5 mustelids, 4 procyonids, 5 cats, 2 peccaries, 2 deer, and 1 tapir (app. 8). These 116 species represent 57% of the species of mammals found in the country (app. 8). This list cannot be considered a complete enumeration of all mammal species that have occurred or currently do occur at La Selva, however. Two species of bats, *Pteronotus*

*davyi* and *Chrotopterus auritus*, recently were added to the faunal list and, undoubtedly, additional species of bats and rodents will be found there (Timm et al. 1989). With the exception of these orders it is likely that the list of La Selva's mammals is complete.

This list of La Selva mammals differs from that of Wilson (1983) and unpublished lists that have been circulated over the years in that some species have been added and several species now suspected not to occur there have been deleted. Identifications of specimens in collections have been verified or corrected, and all published literature records have been evaluated. No species are included as "expected to occur in the area," a category that created an artificially high species count. I base estimates of relative abundance of species on my observations and those of other experienced individuals and on the logbook of mammal sightings kept at La Selva since 1979, which I critically evaluated. The 116 documented species are 21 fewer than Wilson's (1983) listing of 137 species known or expected to occur at La Selva; it is unlikely that these "expected" additional species occur in the Puerto Viejo region.

The majority of mammals found at La Selva are widespread species, typical of neo-tropical rain forests (app. 8). Most have a broad distribution throughout the tropical lowlands of Central America. Many species are even more widely distributed, including some with broad elevational ranges in Costa Rica (and elsewhere in Central America) and/or wide geographic distributions throughout the lowlands of Central and South America. Of the 116 species of mammals that occurred at La Selva, 58 (49%) are broadly distributed in the Neotropics, often occurring as far north as Mexico and ranging south through Central America and much of tropical South America; 35 (30%) occur in the northern tropics, generally being found from tropical Mexico through Central America and northern South America; 15 (13%) are restricted to Central America; 7 (6%) are very wide ranging, found from the United States through Central America and across most of South America; and 1 (1%) is widely distributed in North America, occurring as far south as central Panama (app. 8). Interestingly, the bat fauna of La Selva consists overwhelmingly of species that are either widely distributed in the tropics or are of northern Neotropical distribution (60 of 65 species, or 92%). La Selva's primates are all of northern Neotropical distribution. The edentates are all of either wide distribution in the tropics or of northern Neotropical distribution. The single species of rabbit found at La Selva has a wide-ranging distri-

bution in the lowland tropics of Central and South America. The rodent fauna varies; some members are widespread in the tropics, whereas others are of northern Neotropical or Mesoamerican distribution. All of the smaller rodents, including the squirrels, pocket gopher, long-tailed rats and mice, and the porcupine, are either of northern tropical or Mesoamerican distribution, whereas agoutis and pacas are widely distributed in the tropics. The carnivore fauna is represented by many species whose ranges include much of the tropics but also includes species with more extensive nontropical distributions (7 of 15 species, or 47%).

In general, species that are common at La Selva are common throughout their ranges, and species that are rare at La Selva also are rare throughout their ranges. Notable exceptions in the bat fauna are Caribbean white bats, which are more abundant at La Selva than at any other site from which they are known and disk-winged bats, which are abundant at Tortuguero and elsewhere in the Caribbean lowlands but are rare at La Selva. Although this rarity is unexplained, it is not because of the absence of suitable roosting sites in the Puerto Viejo region. These tiny insectivorous bats roost only in the immature, rolled leaves of *Heliconia*, which are abundant at La Selva, and in which the bats are easily located if present.

Relatively few species of mammals are endemic to Costa Rica: six rodents, one carnivore, and, perhaps, two or three shrews. Most of these are species of mid- to high elevations and occur in restricted habitats. Of these endemics, only the pocket gopher, *Orthogeomys cherriei*, occurs at La Selva. *Orthogeomys cherriei* is found in a broad elevational band north and east of the Cordillera Central and north and west of the Cordillera de Tilarán in northern Costa Rica (Hafner and Hafner 1987). The Caribbean white bat is the only other mammal species at La Selva that has an extremely limited distribution. White bats are restricted to the Caribbean lowlands of Honduras, Nicaragua, Costa Rica, and extreme northwestern Panama (Timm 1982).

Three groups of mammals found elsewhere in the Neotropics are absent from the fauna of the La Selva region: shrews (Soricidae), coyotes and foxes (Canidae), and bears (Ursidae). A single genus of shrew, *Cryptotis*, is found in the Neotropics, and at least five species occur in Costa Rica, but all are restricted to the highlands (Woodman 1992). Canids do not occur in the Caribbean lowlands of Costa Rica although the family is widely distributed worldwide and occurs throughout North, Central, and South America. The bush dog, *Speothos venaticus*, does (did) occur in eastern Panama, including the Caribbean lowlands. Coyotes, *Canis latrans*, continue to expand their range in Costa Rica (Vaughan 1983; Monge-N. and Morera 1987) but have yet to reach the Caribbean lowlands. Bears have a disjunct distribution in the New World, being widely distributed in North America, absent in Central America, and with a single species, the spectacled bear (*Tremarctos ornatus*), occurring in the Andes of northern South America.

Historical biogeography of the Central and South American mammal faunas was reviewed by Hershkovitz (1972), Savage (1974, 1982), Marshall et al. (1982), and Rich and Rich (1983) and of Costa Rican rodents by McPherson (1985, 1986). An interesting review of mammalian ecology in Costa Rica is provided by Janzen and Wilson (1983); it includes in-

sightful discussions of the relatively low species diversity of terrestrial mammals, seasonal environmental stress, the largely frugivorous diet of many tropical "carnivores," and an overview of tropical bat radiation. They pointed out that the high species diversity of mammals seen per unit area in Costa Rica and elsewhere in Central America is the result of a dramatic increase in the number of bat species. Species richness of terrestrial mammals per unit area in tropical Central America is similar to that of temperate North America. Excellent summaries of the biology of many of the common mammals at La Selva and in Costa Rica may be found in *Costa Rican Natural History* (Janzen 1983b). Two extremely useful and nicely illustrated guides to Neotropical mammals, many of which occur at La Selva, were published. Eisenberg (1989) treats distribution and identification of the mammals of the northern Neotropics (defined as Panama, Colombia, Venezuela, and the Guyanas). Emmons and Feer (1990) is a field guide to Neotropical rain forest mammals and covers species occurring primarily below 1,000 m in elevation.

### RESEARCH ON MAMMALS AT LA SELVA

Until the 1980s the northern Caribbean lowlands and midelevational slopes of Costa Rica received little attention from naturalists, particularly mammalogists. Goodwin (1946) discussed the distribution and natural history of the approximately 125 species of mammals then known or thought to occur in the country in his *Mammals of Costa Rica*, but he made little mention of the northeastern lowlands and cited no specimens from the region. Even today very few specimens of mammals from this region reside in scientific collections, which hinders efforts to better understand the fauna.

It was not until the 1960s that studies on mammals began at La Selva. The first published mention of mammals there and in the surrounding region was by Paul Slud (1960, 76) in his classic study of the avifauna. In the 1960s a few papers were published on rare species of mammals found at La Selva. As OTS developed La Selva into a working biological station, its popularity with researchers grew. In the 1970s and 1980s numerous publications on a wide array of subjects appeared on mammals at La Selva. These studies can be broadly categorized into four main areas: distribution and systematics, ecology and natural history, community structure, and mammal-plant and mammal-insect interactions.

Papers focusing on geographic distributions and systematics often include morphometric data, taxonomic notes, and valuable natural history information, especially on reproduction. Several distributional papers deal exclusively with bats (Casebeer et al. 1963; Starrett and Casebeer 1968; Gardner et al. 1970; LaVal 1977), and one deals with the possible occurrence at La Selva of night monkeys of the genus *Aotus* (Timm 1988). Wilson's (1983) checklist of mammals at the OTS field sites was the first modern assessment of mammalian distributions in Costa Rica, and as such gives researchers an important baseline. Two recent reports review the fauna of this region (Timm et al. 1989; Wilson 1990).

Timm et al. (1989) conducted a faunal survey of the elevational transect from 35 m to 2,600 m that encompasses La Selva and Parque Nacional Braulio Carrillo to Volcán Barva. We documented that at least 141 species of mammals occur in

the region, including several species new to the area's fauna. Additionally, we review the systematics, distribution, and natural history of these species and provide new biological information on each. This is the first in-depth study of an elevational transect in the Neotropics, and the first comprehensive review of the mammalian fauna for any region of Costa Rica since Goodwin's (1946) *Mammals of Costa Rica*.

Publications from La Selva in the category of ecology and natural history of mammals include studies on natural history, behavior, general ecology, and evolutionary ecology. Emphasized here are specific ecological problems as well as in-depth autecological studies. Interestingly, most of the twenty-odd published studies in this category have been on bats. In addition, Fleming has published several reports of his studies on rodents; Greene (1989) provides interesting observations of aggressive interactions between male three-toed sloths; and Fishkind and Sussman (1987) provide a preliminary survey of primate densities at La Selva and the adjacent zona protectora (now Parque Nacional Braulio Carrillo), suggesting that six to ten groups of howler monkeys, two to four groups of spider monkeys, and two to three groups of white-faced capuchins are in the La Selva reserve. Two important studies, both on primates, are underway at La Selva in 1992. Amy Fishkind Campbell is studying white-faced capuchins, and Kathryn Stoner is working on howler monkeys. These studies represent the first modern autecological work to be undertaken on primates in the Caribbean wet forests of Costa Rica and as such will provide refined estimates of densities and valuable comparative data.

Several species of bats, including some of the most poorly known and those considered to be extremely rare, have been studied at La Selva. Until it was rediscovered at La Selva in 1961, *Ectophylla alba* (fig. 18.1) was among the least known of all mammals: only two poorly preserved specimens existed, one collected in the late 1880s and from Honduras and one in the early 1890s from Nicaragua (see Timm et al. 1989), with no associated biological data (Casebeer et al. 1963; Timm 1982). Several aspects of its biology have been investigated at La Selva, including its construction of roost "tents" by modifying leaves (Greenbaum et al. 1975; Timm and Mortimer 1976; LaVal and Fitch 1977; Timm 1982; Timm and Kermott 1982; Brooke 1987a, 1989). White bats create tents by severing the lateral veins and interconnected tissues on both *Heliconia* and *Calathea* leaves from near the base to the tip of the leaf, causing the sides of the leaf to droop down. The roosting bats hang from the midribs of the leaves and are protected from both predators and the elements by their tents (fig. 18.1). White bats roost only under these altered leaves, using them as diurnal roosts, maternity roosts, and night-feeding roosts. *Ectophylla alba* is now known from thirteen localities, but only at La Selva and in the adjoining Parque Nacional Braulio Carrillo is there assurance that it and its habitat will be protected. Other studies on specific aspects of the ecology of bats at La Selva focus on social organization and foraging in emballonurid bats (Bradbury and Vehrencamp 1976b), tent construction and social organization in *Vampyressa nymphaea* (Brooke 1987b), prey selection and foliage gleaning by *Micronycteris megalotis* (LaVal and LaVal 1980), reproduction during the dry season (Mares and Wilson 1971), the influence of human-made trails on foraging by frugivorous bats (Pal-



Fig. 18.1. Photograph of a colony of four white bats, *Ectophylla alba*, roosting in a tent cut from a *Heliconia* leaf. The bats typically hang curled in tight clusters from the midrib. Details of the cut side veins and interconnected tissues may be seen along the midrib of the leaf. The holes in the leaf were made by the bats' claws. Tents such as this one may be used for several weeks. *Ectophylla* roosts only under leaves that it modifies as tents.

meirim and Etheridge 1985), the influence of body size on diet and habitat in *Carollia* (Fleming 1991), ecology and systematics of tent-making bats (Timm 1984, 1985, 1987; Timm and Clauson 1990), foraging of vampire bats (Young 1971a), and ecology of *Saccopteryx bilineata* (Young 1972c; but see 1975).

In the early 1970s Theodore H. Fleming began a series of classic studies on the population ecology of Desmarest's spiny pocket mouse, *Heteromys desmarestianus* (see Fleming 1973, 1983; Fleming and Brown 1975; and additional references cited). He investigated population dynamics (Fleming 1974a), social organization (Fleming 1974b), growth and development (Fleming 1977a), and experimental responses of animals to manipulated food and water availability (Fleming 1977b). These studies were among the first in-depth on any species of small tropical rodent. As such, they provide an important basis for comparisons with temperate rodents and some of the first baseline data on tropical species. Fleming's work is especially important in elucidating the ecology of and roles played by both *H. desmarestianus* and *Liomys salvini* as "key industry" species in tropical forests. As these heteromyids are often the most abundant small mammals in the community, they serve as both major seed predators and seed dispersers and are important prey items for a wide variety of carnivores.

At La Selva Fleming found *Heteromys* to be the most abundant small terrestrial mammal present. Densities ranged from nine to eighteen per hectare and the population was stable over the two-year study. Both males and females bred throughout the year although reproductive activity declined markedly during May and June. Litter size averaged 3.1 young, and females produced up to five litters per year. *Heteromys* is perhaps the dominant granivorous vertebrate of the forest floor. Fleming found spiny pocket mice to feed extensively on seeds of the palms *Socratea durissima* and *Welfia georgii*, and we observed them to feed on the palms *Euterpe macrospadix*, *Geonoma* sp., and *Iriartea gigantea* and on *Meliosma* sp. (Sabiaceae) (Timm et al. 1989). Based on extensive

trapping, Fleming suggested that *Heteromys* does not have mutually exclusive home ranges or territories. My live trapping of this species at Monteverde certainly supports that conclusion. There are, however, tremendous population fluctuations of spiny pocket mice at Monteverde (pers. observation).

Publications that focus on mammalian community structure at La Selva are exclusively concerned with bats (Findley 1976; Findley and Wilson 1983; LaVal and Fitch 1977). One of the first comparative studies of tropical bats was by LaVal and Fitch (1977), who compared the structure, movements and reproduction of the complex bat communities at La Selva, La Pacifica (tropical dry forest), and Monteverde (premontane moist and premontane wet forests). They found the highest species diversity of bats at La Selva; much of this diversity was due to insectivorous bats, both foliage-gleaning and aerial feeders. The three sites were similar in species diversity of nectar- and pollen-feeding bats. Most tropical bats reproduce seasonally. Bats at La Pacifica, with its sharply delineated wet and dry season, have the shortest and most sharply delineated reproductive seasons. A longer reproductive season was typical of bats at La Selva, and Monteverde was intermediate between the two (LaVal and Fitch 1977).

It is often assumed that the extreme species richness observed in a large, complex fauna like that of tropical bats can occur only if species are restricted to narrow and mutually exclusive feeding niches. Findley (1976), however, compared the bat fauna of La Selva to those at other tropical and temperate sites and demonstrated that although temperate faunas do exhibit greater rarity or even absence of ecologically distinctive taxa compared to tropical faunas, tropical and temperate faunas do not differ significantly in species packing or degree of niche overlap among component species.

Findley and Wilson (1983) demonstrate that species density of New World frugivorous bats is significantly greater than tropical African frugivorous bats. Capture rates with standard mist nets showed that the absolute numbers of species captured, as well as the numbers of individuals within species, are higher in the Neotropics. They did, however, observe a compensatory trend in biomass: the larger frugivorous pteropid bats of Africa (mean body mass of 52 grams) occurred in roughly the same total biomass density as the more numerous but smaller New World frugivorous phyllostomids at La Selva (mean body mass of 18 grams). It should be noted that the difference in size between pteropid bats and microchiropterans is also a phylogenetic one.

One of the advantages of a heavily used biological station such as La Selva is that biologists with diverse interests and skills are able to exchange ideas and expertise. Such a stimulating atmosphere encourages cross-disciplinary collaboration, such as the very fruitful research on mammal-plant interactions, including studies on seed dispersal by mammals (Vandermeer et al. 1979), seed hoarding (an extremely uncommon behavior among Neotropical mammals) by spiny pocket mice (Vandermeer 1979), the effect of predation on seeds and seedlings by mammals (Denslow and Moermond 1982; McHargue and Hartshorn 1983), bat pollination of flowers (Voss et al. 1980), the role of bats in dispersing *Piper* (O'Donnell 1989), and the alteration of leaf shape by bats to produce diurnal roosting structures (Foster and Timm 1976; Brooke 1987a, 1987b; Timm 1987).

Two important studies of mammal-insect interactions have been completed at La Selva. An apparently phoretic relationship between *Heteromys desmarestianus* and a newly discovered species of tineid moth (*Amydria selvini*) has been reported (Davis et al. 1986). Females of this moth were found only on spiny pocket mice; the male of the species is unknown. *Amydria selvini* has been found only at La Selva although I have searched unsuccessfully for it elsewhere in Costa Rica at higher elevations. The tight association between female moths and *Heteromys* suggests that the life cycle of the moth is associated with the nesting biology of the rodents, but this has yet to be demonstrated. A parallel association is found between three-toed sloths and sloth moths. The sloths at La Selva have large populations of these phoretic/ectoparasitic moths, but they have not been studied there. A review of the complex parasite fauna of sloths and its interesting biological relationships, based primarily on research conducted in Panama and Brazil, is provided by Waage and Best (1985). Three species of batflies of the family Streblidae that are host-specific, blood-feeding ectoparasites on *Carollia perspicillata* were investigated at La Selva by Fritz (1983). He found that the life cycles of the batflies are tightly synchronized with the life cycles of their hosts.

#### HISTORY OF KNOWLEDGE OF LA SELVA MAMMALS

Biologists in a wide array of fields have long been aware of the tremendous diversity of organisms found in the tropics. With the recent awareness of the plight of tropical rain forests, there has been a parallel scientific awakening and interest in this diversity. To understand the structure and nature of tropical rain forests biologists have attempted to characterize, compare, and contrast the diversity of particular organisms at and between sites.

Critical to these types of studies is the historical component of time and how one's knowledge of the biota at a particular site increases with time. The time component is quite complex and includes two aspects: the percentage of the total fauna available for sampling at the time of the study and the percentage of the total fauna known to the investigator(s). Incomplete tabulations might result from local extinctions before investigation, from species that are rare or difficult to capture or observe, or simply from lack of resources for adequate sampling.

Because such an excellent record of the mammalian fauna at La Selva now exists, it is useful to examine the rate of increase in knowledge of what species of mammals occur at La Selva—a species discovery curve of the fauna.

The question I address here is How long did it take to reach the current level of knowledge? and the database I use is the published literature. A review of the literature on research at La Selva contains more than forty-five primary references covering the thirty-one-year period from 1960 to 1990.

The mammalian fauna of La Selva, as recently as the 1960s, consisted of at least 116 species (app. 8). The discovery curve illustrates the considerable time it took to acquire this knowledge as measured by published reports in the literature (fig. 18.2). Only 16% of the fauna had been identified by 1970; 84% was identified by 1980. It was as late as 1986, how-

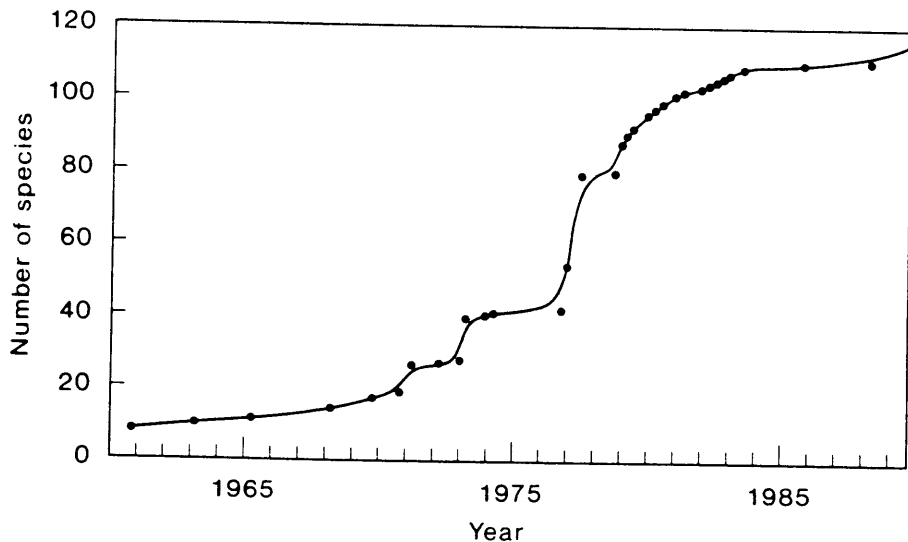


Fig. 18.2. Cumulative species discovery curve for mammal species known from the La Selva Biological Station. Data points are plotted cumulatively by year and represent the number of species added to the fauna based upon the published literature. The X axis is the date of publication of the primary reference to the nearest quarter year.

ever, before 95% of the species known to be present were documented there. Thus, a full twenty-six years elapsed between the first reports and documentation of 95% of the mammalian biodiversity.

This time lapse at such a well-studied site makes it clear that investigators need to exercise extreme caution in making comparisons between sites, especially in the tropics. Without a sufficient database and historical perspective, the comparisons made could be more misleading than insightful. For instance, sites such as La Selva and BCI both approach having 100% of the mammalian diversity identified. Most other Neotropical sites have been studied much less intensively and for a much shorter time and a much lower percentage of their faunas is likely known. Direct comparisons between La Selva or BCI and these other sites could, thus, produce spurious or misleading results.

### LA SELVA AND OTHER TROPICAL SITES

With the previous caveats in mind comparisons between the mammalian fauna at La Selva and other tropical sites can be useful in understanding the structure and complexity of tropical ecosystems on a broad level. Published faunal lists of mammals at Neotropical sites are few, and attempts to make intersite comparisons of tropical mammal faunas have been hampered by lack of data on presence and abundance of species (see Eisenberg and Thorington 1973; Emmons 1984; Bourlière 1989).

Barro Colorado Island (BCI) in central Panama is the only Neotropical site that has been studied intensively for a longer period than La Selva; the first mammalogists visited the area in the late 1910s. La Selva and BCI are in close geographical proximity and have considerable faunal overlap. Barro Colorado Island was isolated as an island when the Río Chagres was dammed to form the central waterway of Panama Canal in 1914. Naturalists first visited BCI in 1916, and it was declared a reserve and tropical field station in 1923. Although there are numerous differences between La Selva and BCI in climate, geology, and the resulting forest, one significant difference now affecting the mammals of these two lowland tropical sites is the fact that BCI has been an island for seven

decades, whereas La Selva lies on the mainland. Additionally, BCI has no streams that flow year-round.

BCI has been the site of excellent long-term studies on several species of mammals, including white-faced capuchins, howler monkeys, sloths, red-tailed squirrels (*Sciurus granatensis*), agoutis, and coatis (see Leigh et al. 1982, and references therein). No studies, however, have been published about the La Selva and BCI mammal faunas that are directly parallel, making ecological comparisons between the two difficult. As with La Selva, several species of mammals have benefited from the reduction and/or elimination of predators by humans. The larger cats and raptors, especially harpy eagles, are absent or rare on BCI.

A comparison of the numbers of species represented in each order of mammals in all of Costa Rica, at La Selva, and at BCI shows that the La Selva and BCI faunas are extremely similar (table 18.1). La Selva and BCI have about the same number of marsupials (five and six, respectively), neither has any insectivores, and La Selva has more species of bats than BCI (sixty-six compared with fifty-six species). BCI may have only one additional species of primate (crested bare-faced tamarins, *Saguinus oedipus*); the two sites have the same number of edentates, rabbits, artiodactyls, and perissodactyls; La Selva, however, appears to have twice as many carnivores (fourteen compared to seven) and 60% more rodents (sixteen compared to ten). As with the La Selva fauna, much of the BCI fauna has a widespread distribution in the tropics, which accounts for the fact that the two sites share many species.

Just how representative the fauna and densities of mammals currently occurring on BCI is of what one would expect for a pristine lowland forest in central Panama has been the subject of much debate. Glanz (1982, 1990) documented both the historical and recent changes in abundance of terrestrial mammals on BCI, including the extinction of pumas (*Felis concolor*) and white-lipped peccaries, and the apparent tenfold increase of agoutis and squirrels, among others. He did, however, suggest that many species might just appear to be more abundant because they are less wary now as a result of protection from hunting.

The fauna of La Selva is much more terrestrial than the faunas found in the greater Amazon Basin. Faunas of season-

**Table 18.1** Comparison of mammalian faunal diversity at the ordinal level between Costa Rica in total, La Selva, and Barro Colorado Island

Order	Costa Rica	La Selva	BCI
Marsupialia	8	5	6
Insectivora	5	0	0
Chiroptera	105	65	56*
Primates	5	3	5
Edentata	7	7	7
Lagomorpha	3	1	1
Rodentia	45	16	10
Carnivora	22	14	7
Artiodactyla	4	4	4
Perissodactyla	1	1	1
TOTALS	205	116	97

\*Handley et al. 1991.

ally flooded forests such as those of Manaus are typically composed of a greater proportion of arboreal species. Although arboreal marsupials, primates, rodents, and carnivores are present at La Selva, the number of arboreal species in each group is considerably fewer than seen at Amazonian sites. The paucity of arboreal species is not a reflection of the forest but of geography; most of the truly arboreal species are of southern origin.

Terborgh (1988, 1990b) provided thought-provoking, controversial essays on the importance of large carnivores in maintaining biological diversity of both plants and animals in the Neotropics. He noted that BCI, an island with few of its larger predators left, has populations of agoutis, pacas, and coatis that are ten times higher than those observed at Cocha Cashú (with its predator populations intact) in Amazonian Peru and that populations of smaller prey species, such as cottontail rabbits, armadillos, and opossums, are from two to ten times greater on BCI. He suggests that at such high densities, these species act as significant seed predators and that the artificially elevated abundances of these mammals that occur on BCI may have had a major impact upon the structure of the forest. Although interesting, these sorts of comparisons between sites are largely untestable given the multitude of factors involved. Forest type differs from site to site, and the history of land use for each of the sites is quite different. For example, Manaus (Brazil) has notoriously poor soils and a strong dry season, both of which may contribute to the depauperate mammal fauna and low numbers of individuals there (Malcolm 1990). Manu (Peru) has thirteen species of primates, many of which occupy a squirrel-like niche, perhaps contributing to its paucity of squirrels. There is little acceptance among wildlife managers of the notion that a single predator species can actually control or regulate a prey species' population. Elimination of many or all predator species coupled with major habitat changes, however, may impact prey species' populations.

#### IMPACT OF HUMAN ACTIVITIES

Several species of mammals at La Selva undoubtedly have increased in abundance as human activities adjacent to the reserve opened the forest and as the reserve expanded to include

secondary forest and other disturbed areas. Conversely, hunting pressure and forest destruction have a direct negative impact upon the number of species and, often, densities of mammals.

Subsistence farming, especially when based on small family garden plots surrounded by forest, has a positive effect on species diversity and abundance of certain marsupials, bats, and small to medium-sized rodents. Crops and their associated insect pests provide a dense and readily available source of food for animals. Additionally, opening up of the forest increases the edge effect, or ecotone habitat, creating a rich habitat for many species. Species that have undoubtedly increased in abundance because of human activity in the region include *Didelphis marsupialis*, *Glossophaga soricina*, *Carollia perspicillata*, *Artibeus jamaicensis*, *Dasyprocta punctata*, and, possibly, *Sylvilagus brasiliensis*. All are generalists within their particular feeding niches and are typically forest-edge species. For example, although *Glossophaga soricina* is a nectarivorous bat, it uses a broader range of plant species than do other nectar-feeding bats.

Agoutis and squirrels are considerably more abundant at La Selva than in large tracts of lowland rain forest in the Amazon Basin (pers. observation). Agoutis and, probably, other small to medium-sized rodents may have also benefited from the systematic killing of predators by humans. An interesting discussion of predators in tropical ecosystems, with special reference to La Selva, is presented by Greene (1988). He identifies one hundred species of vertebrates as predators at La Selva and independently concurs in attributing the high population densities of many rodents currently observed at La Selva and BCI to removal or reduction of predator populations by humans.

The three common species of primates at La Selva, *Ateles geoffroyi*, *Alouatta palliata*, and *Cebus capucinus*, all appear to be more abundant now than they were in the 1960s and early 1970s. Primate populations throughout much of the Caribbean lowlands of Central America were decimated by an epidemic of mosquito-borne yellow fever during the early 1950s (see Fishkind and Sussman 1987, and references therein). Although data are not available for the La Selva region, one assumes that this epidemic reduced primate populations in the reserve. Far fewer primates were observed at La Selva between the late 1960s and early 1980s than in similar tracts of primary forest elsewhere in the Neotropics (pers. observation). Although Milton (1982) suggests that the howler monkey population on BCI had rebounded from the yellow fever epidemic by 1970, that recovery was apparently not as rapid in the Sarapiquí region, perhaps because of other factors, including hunting. Primate populations at La Selva, however, have certainly rebounded during the late 1980s. Capuchin, howler, and spider monkeys can now be seen almost daily and often in large groups. K. Stoner (pers. comm.) estimated in 1990 that seven to twelve groups of howler monkeys, three to six groups of spider monkeys, and four to seven groups of white-faced capuchins were on the greater La Selva property. Howler monkeys are the most abundant. These results agree with a preliminary 10-day survey conducted at La Selva in 1986 by Fishkind and Sussman (1987) although Stoner's numbers for 1990 are higher.

This increase in primate abundance may also be owed, in

part, to a decrease in the abundance of natural predators, especially harpy eagles (*Harpia harpyja*). Cebid monkeys of the genera *Alouatta*, *Ateles*, and *Cebus* constituted more than one-third of the prey consumed by a pair of harpy eagles in Guyana; two- and three-toed sloths, opossums, and agoutis also were important prey items (Izor 1985). Harpy eagles were rare in the Puerto Viejo region as early as the late 1950s (Slud 1960) and are now absent.

Primates, as well as many other species, undoubtedly benefit from complete protection from hunting at La Selva. We are, perhaps, witnessing a period of fluctuation in numbers of many predatory and prey species because of the changing degrees of hunting pressure by humans. Because human populations increased in the Puerto Viejo region in the 1940s and 1950s before the establishment of La Selva as a reserve, one would assume that hunting pressure increased dramatically. Now that La Selva is well protected, hunting pressure has been effectively eliminated from the reserve although poaching continues in Braulio Carrillo as at La Selva into the early 1980s. It will be interesting to observe the population responses of predators and the larger prey species. Complicating the ability to detect such changes is the fact that individuals of many species become less wary when not hunted and, thus, are more easily observed, which gives the false impression of higher abundance even though numbers may not have changed.

Historically, families in the Sarapiquí region relied heavily upon local wildlife as a source of protein. Tapirs, white-lipped and collared peccaries, and pacas are highly prized meats and are among the largest mammals of the region. Medium-sized mammals such as agoutis, monkeys, and squirrels (*Sciurus* spp.) were hunted to a lesser extent. Tapirs and pacas are now uncommon at La Selva and in the general vicinity even where adequate habitat remains. White-lipped peccaries are extirpated from La Selva; no sightings have been confirmed on the property for several years although Slud (1960) found them to be common there in the late 1950s. In the past few years, however, the population of collared peccaries has increased dramatically.

The recent extirpation of white-lipped peccaries from La Selva may be affecting the nature of the forest there. Peccaries are both major seed dispersers and seed predators, and the activities of large herds could greatly affect the forest plants. Herd sizes of fifty or more individuals are commonly reported for white-lipped peccaries where they are not heavily hunted, and they tend to concentrate their activities in areas of favorite food resources.

Large- and medium-sized mammalian predators, including jaguars, ocelots, tayras, and coatis, have been persecuted by humans in the Puerto Viejo region as they have been throughout the human-inhabited tropical lowlands. These animals were killed to protect livestock and crops as well as for their pelts. Other predators whose populations have been reduced in the Puerto Viejo region, as well as throughout their ranges, include bushmasters (*Lachesis muta*) and hawks and eagles that prey on medium-sized rodents and primates. It is likely that the other three species of cats and the one river otter have also been affected by hunting and habitat destruction. Since Costa Rica's 1975 ratification of the Convention on International Trade in Endangered Species (CITES), the Costa Rican

government has effectively controlled illegal trade in wildlife. Previously, cat skins were openly sold in markets. Cat populations continue to be seriously threatened by both habitat destruction and hunting. The other species of carnivores are, perhaps, nearly as abundant now as in the past where suitable habitat exists, but systematic studies are lacking.

Giant anteaters probably are extirpated in this region and throughout most of the country. Originally, giant anteaters were found from Belize and Guatemala throughout the lowlands of Central America and tropical South America. Little is known about their original distribution and abundance in Costa Rica. In the late 1870s Alston (1879–82) reported that giant anteaters were rare in Costa Rica and confined to the low, hot forest lands near the coast. There have been no reports of *Myrmecophaga* from this region in recent years, and one presumes that they are now only found in the most remote regions of the country (Timm et al. 1989).

La Selva, even with its connection, Parque Nacional Braulio Carrillo, may be only minimally large enough to support populations of predatory bats of the subfamily Phyllostominae. The eighteen species of the phyllostomines that I report here for La Selva probably represent all the species expected to occur there. Some of these large predatory species are encountered in much higher densities elsewhere, in larger tracts of pristine forest than currently exist at La Selva (pers. observation). Large populations of predaceous bats were reported from La Selva by LaVal and Fitch (1977). Although all of these species are still present in the reserve, most are not now encountered as frequently as in the past (pers. observation). Apparently, this decline is the result of the destruction of much of the forest that surrounded La Selva and provided more extensive habitat for these bats. As with the large predatory cats, these bats may be good "indicator" species in that they may be among the first components to disappear as a result of human disturbance (fig. 18.3). Thus, the connection of La Selva to the recently expanded Parque Nacional Braulio Carrillo and the continued effort to expand Braulio Carrillo are vitally important to the maintenance of populations of these highly vagile, predatory bats, as well as other mammals.

Human impact in this region undoubtedly has altered the abundance of many species of mammals; some have increased in abundance, whereas many have decreased in abundance. With the exception of giant anteaters and white-lipped peccaries, all species of mammals present at La Selva before the arrival and colonization of the region by Europeans have survived there. La Selva and the adjoining Parque Nacional Braulio Carrillo are large enough to provide suitable habitat for most species of mammals but probably not for larger, highly vagile species such as giant anteaters and white-lipped peccaries. Every effort should be made to preserve as much of the forest surrounding La Selva and Braulio Carrillo as possible.

## SUGGESTIONS FOR FUTURE RESEARCH

A review of the literature on mammals at the La Selva Biological Station includes more than forty-five original published contributions. Most deal with ecology and natural history and interactions between mammals and other biotic components of the environment. Although more has been published about mammals at La Selva than at other Neotropical sites, except



Fig. 18.3. The carnivorous bat *Vampyrum spectrum* has a large body and is found only in low numbers. They are monogamous and have only a single young per year with extended parental care. Like the terrestrial predators, it is among the first mammal species to disappear with fragmentation of rain forests.

BCI much remains to be learned about this complex fauna and its component species. When reviewing these research reports, it is ironic that one must conclude that more questions have been posed than answered. Interestingly, much more is known about the larger mammals on BCI and even at Manu in Peru than at La Selva.

Nonmammalogists might wonder why bats have been studied so much at La Selva (and elsewhere in the Neotropics) and rodents or other groups have been studied so little, in contrast to the voluminous literature on temperate rodents. Perhaps, part of the answer lies in the relative abundance of bats in the tropics and their relative ease of capture with mist nets. Most mammal species are nocturnal, wary of humans, and have excellent hearing and vision. Many of them (especially marsupials, primates, edentates, rodents, and carnivores) are partially or wholly arboreal in the tropics, adding to the difficulty of capture and study. The environment at La Selva has a three-dimensional complexity much greater than that of temperate sites or even other tropical sites. These difficulties, along with frequent heavy rainfall, render direct observation, radiotelemetry, and most of the standard mark-recapture techniques employed by temperate mammalogists difficult. Although most of the mammal research at La Selva has centered on bats, at-

tempts have been made to study other mammals. Some of these were unsuccessful, perhaps for some of the reasons mentioned above.

A spectacular tropical forest such as that found at La Selva presents unlimited opportunities for future study. This work needs to be undertaken at several different levels, as outlined next.

#### **Faunal Surveys Coupled with Systematic Studies of the Mammal Species**

Species of mammals undoubtedly occur at La Selva that have not yet been recorded. These previously undetected species probably include more than one species of bat and one or more species of long-tailed rodents. This lack of the most basic knowledge of what species are present is also true for all other Neotropical sites. Researchers quite literally do not have a complete listing of the mammal fauna of any New World tropical site. In addition, knowledge of many of the small mammals is so rudimentary that undoubtedly more than one good biological species may be included under a single name. This confusion is almost certainly true for *Oryzomys (Oligoryzomys) fulvescens*. Additionally, even though Costa Rica is one of the most intensively studied countries in the Neotropics, species of mammals new to science continue to be discovered there. Understanding of tropical forest ecosystems and the ability to make meaningful comparisons between La Selva and other sites are hampered by incomplete knowledge of the fauna.

#### **Habitat Requirements, Life History Strategies, and Reproductive Modes**

Essentially nothing is known about the habitat (and other) requirements of most species of mammals in the Neotropics, especially the small and medium-sized species that make up most of the fauna. Given the now widespread attention to the biodiversity crisis in the tropics, it is critical that biologists have a better understanding of the ecology of tropical mammals. Detailed knowledge of this sort will be critical for the proper management of species and wildlife reserves in the future. One of the most basic questions is How large an area does a given species need to maintain a viable population? The answer has direct implications for the size and shapes of reserves.

#### **Population Biology and Community Ecology of Neotropical Mammals**

Knowledge of the structure and dynamics of populations will be critical to understanding how communities are organized and how tropical systems differ from temperate systems and to understand all aspects of evolutionary biology theory. Studies on rates of reproduction, litter sizes, survival rates, and longevity are all feasible and will provide considerable insights.

Research on mammals in the tropics is entering an exciting phase. Investigators are now perfecting the techniques needed to work with these animals. La Selva's diverse fauna provides biologists with numerous opportunities to explore ecological and evolutionary questions. The field facilities at La Selva are superb, encouraging interactions among scientists and providing excellent access to a rich fauna.



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## APPENDIX 8

### Mammals

Robert M. Timm

Scientific Name	Common Name*	Abundance <sup>b</sup>	Distribution <sup>c</sup>
Marsupialia	Marsupials		
Didelphidae	American Opossums		
<i>Caluromys derbianus</i>	Woolly opossum	uncommon	2
	Zorro de balsa		
<i>Chironectes minimus</i>	Water opossum	uncommon	1
	Zorro de agua		
<i>Didelphis marsupialis</i>	Southern opossum	abundant	1
	Zorro pelón or Zarigüeya		
<i>Marmosa mexicana</i>	Mexican mouse-opossum	uncommon	3
	Zorra or Zorricí		
<i>Philander opossum</i>	Gray four-eyed opossum	uncommon	1
	Zorro de cuatro ojos		
Chiroptera	Bats		
Emballonuridae	Sac-winged Bats		
<i>Centronycteris maximiliani</i>	Thomas' bat	rare	1
<i>Cormura brevirostris</i>	Wagner's sac-winged bat	rare	1
<i>Cyttarops alecto</i>	Short-eared bat	rare	2
<i>Diclidurus albus</i>	Ghost bat	rare	1
<i>Peropteryx kappleri</i>	Greater doglike bat	uncommon	1
<i>Rhynchonycteris naso</i>	Brazilian long-nosed bat	abundant	1
<i>Saccopteryx bilineata</i>	Greater white-lined bat	abundant	1
<i>Saccopteryx leptura</i>	Lesser white-lined bat	common	1
Noctilionidae	Fishing and Bulldog Bats		
<i>Noctilio albiventris</i>	Lesser bulldog bat	common	1
<i>Noctilio leporinus</i>	Greater bulldog bat	common	1
Mormoopidae	Mustached Bats		
<i>Pteronotus davyi</i>	Davy's naked-backed bat	rare	2
<i>Pteronotus parnellii</i>	Parnell's mustached bat	common	1
Phyllostomidae	Leaf-nosed Bats		
Phyllostominae	Carnivorous Bats		
<i>Chrotopterus auritus</i>	Peter's false vampire bat	rare	1
<i>Macrophyllum</i>	Long-legged bat	rare	1
	<i>macrophyllum</i>		
<i>Micronycteris brachyotis</i>	Dobson's large-eared bat	rare	2
<i>Micronycteris daviesi</i>	Davies' large-eared bat	rare	2
<i>Micronycteris hirsuta</i>	Hairy large-eared bat	rare	2
<i>Micronycteris megalotis</i>	Brazilian large-eared bat	common	1
<i>Micronycteris minuta</i>	Gervais' large-eared bat	rare	1
<i>Micronycteris nicefori</i>	Niceforo's large-eared bat	uncommon	2
<i>Micronycteris</i>	Schmidt's large-eared bat	rare	2
	<i>schmidtorum</i>		
<i>Mimon cozumelae</i>	Cozumel spear-nosed bat	uncommon	1
<i>Mimon crenulatum</i>	Striped spear-nosed bat	uncommon	1

## Appendix 8 (continued)

Scientific Name	Common Name <sup>a</sup>	Abundance <sup>b</sup>	Distribution <sup>c</sup>
<i>Phyloderma stenops</i>	Northern spear-nosed bat	rare	1
<i>Phyllostomus discolor</i>	Pale spear-nosed bat	rare	1
<i>Phyllostomus hastatus</i>	Spear-nosed bat	rare	1
<i>Tonatia bidens</i>	Spix's round-eared bat	uncommon	1
<i>Tonatia brasiliense</i>	Pygmy round-eared bat	uncommon	1
<i>Tonatia silvicola</i>	D'Orbigny's round-eared bat	rare	1
<i>Trachops cirrhosus</i>	Fringe-lipped bat	common	1
<i>Vampyrum spectrum</i>	False vampire bat	rare	2
Glossophaginae	Nectar-feeding Bats		
<i>Choeronycteris godmani</i>	Godman's bat	rare	2
<i>Glossophaga commissarisi</i>	Commissaris' long-tongued bat	common	3
<i>Glossophaga soricina</i>	Pallas' long-tongued bat	common	1
<i>Hylonycteris underwoodi</i>	Underwood's long-tongued bat	common	3
<i>Lichonycteris obscura</i>	Brown long-nosed bat	rare	2
<i>Lonchophylla robusta</i>	Panama long-tongued bat	uncommon	2
Carollinae	Short-tailed Bats		
<i>Carollia brevicauda</i>	Silky short-tailed bat	abundant	1
<i>Carollia castanea</i>	Allen's short-tailed bat	abundant	2
<i>Carollia perspicillata</i>	Seba's short-tailed bat	abundant	1
Stenoderminae	Fruit-eating Bats		
<i>Artibeus jamaicensis</i>	Jamaican fruit-eating bat	abundant	2
<i>Artibeus lituratus</i>	Big fruit-eating bat	common	1
<i>Artibeus phaeotis</i>	Pygmy fruit-eating bat	common	2
<i>Artibeus watsoni</i>	Thomas' fruit-eating bat	abundant	3
<i>Chiroderma villosum</i>	Shaggy-haired bat	rare	1
<i>Ectophylla alba</i>	Caribbean white bat	common	3
<i>Sturnira lilium</i>	Yellow-shouldered bat	rare	1
<i>Sturnira ludovici</i>	Anthony's bat	rare	2
<i>Uroderma bilobatum</i>	Tent-making bat	common	1
<i>Vampyressa nymphaea</i>	Big yellow-eared bat	uncommon	2
<i>Vampyressa pusilla</i>	Little yellow-eared bat	common	1
<i>Vampyrodes caraccioli</i>	San Pablo bat	rare	1
<i>Vampyrops helleri</i>	Heller's broad-nosed bat	common	1
Desmodontinae	Vampire Bats		
<i>Desmodus rotundus</i>	Vampire bat	common	1
	Vampiro		
Furipteridae	Smoky Bats		
<i>Furipterus horrens</i>	Smoky bat	uncommon	1
Thyropteridae	Disk-winged Bats		
<i>Thyroptera tricolor</i>	Spix's disk-winged bat	rare	1
Vespertilionidae	Vespertilionid Bats		
<i>Eptesicus brasiliensis</i>	Brasilian brown bat	rare	1
<i>Eptesicus furinalis</i>	Argentine brown bat	rare	1
<i>Myotis albescens</i>	Silver-tipped myotis	uncommon	1
<i>Myotis elegans</i>	Elegant myotis	uncommon	3
<i>Myotis nigricans</i>	Black myotis	uncommon	1
<i>Myotis riparius</i>	Riparian myotis	common	1
<i>Rhogeessa tumida</i>	Central American yellow bat	rare	1
Molossidae	Free-tailed Bats		
<i>Molossus bondae</i>	Bond's mastiff bat	uncommon	2
<i>Molossus sinaloae</i>	Allen's mastiff bat	common	2
Primates	Primates		
Cebidae	New World Monkeys		
<i>Alouatta palliata</i>	Mantled howler monkey	abundant	2
	Mono congo or Mono aullador		
<i>Aotus lemurinus</i>	Night monkey	rare?	2
	Mono nocturno		
<i>Ateles geoffroyi</i>	Geoffroy's spider monkey	common	2
	Mono colorado or Mono araña		
<i>Cebus capucinus</i>	White-faced capuchin	abundant	2
	Mono cara blanca		

## Appendix 8 (continued)

Scientific Name	Common Name <sup>a</sup>	Abundance <sup>b</sup>	Distribution <sup>c</sup>
Edentata	Edentates		
Bradypodidae	Three-toed Sloths		
<i>Bradypus variegatus</i>	Three-toed sloth	common	1
	Perezoso de tres dedos		
Choloepidae	Two-toed Sloths		
<i>Choloepus hoffmanni</i>	Two-toed sloth	uncommon	2
	Perezoso		
Dasypodidae	Armadillos		
<i>Cabassous centralis</i>	Five-toed armadillo	rare	2
	Armadillo zopilote		
<i>Dasybus novemcinctus</i>	Nine-banded armadillo	uncommon	1
	Cusuco		
Myrmecophagidae	Anteaters		
<i>Cyclopes didactylus</i>	Silky anteater	uncommon	1
	Serafín de platanar or Tapacara		
<i>Myrmecophaga tridactyla</i>	Giant anteater	extirpated	1
	Oso caballo or Hormiguero		
<i>Tamandua mexicana</i>	Northern tamandua	common	2
	Oso hormiguero		
Lagomorpha	Rabbits, Hares, and Pikas		
Leporidae	Rabbits		
<i>Sylvilagus brasiliensis</i>	Forest rabbit	uncommon	1
	Conejo		
Rodentia	Rodents		
Sciuridae	Squirrels		
<i>Microsciurus alfari</i>	Alfaro's pygmy squirrel	uncommon	3
	Ardilla or Chiza		
<i>Sciurus granatensis</i>	Red-tailed squirrel	common	2
	Ardilla or Chiza		
<i>Sciurus variegatoides</i>	Variiegated squirrel	uncommon	3
	Ardilla or Chiza		
Geomyidae	Pocket Gophers		
<i>Orthogeomys cherriei</i>	Cherrie's pocket gopher	uncommon	3
	Taltusa		
Heteromyidae	Pocket Mice		
<i>Heteromys desmarestianus</i>	Desmarest's spiny pocket mouse	abundant	2
	Ratón semiespinosa		
Muridae	Long-tailed Rats and Mice		
<i>Nyctomys sumichrasti</i>	Sumichrast's vesper rat	rare	3
	Ratón		
<i>Oryzomys alfari</i>	Alfaro's rice rat	rare	3
	Ratón arrozera		
<i>Oryzomys bombycinus</i>	Long-wiskered rice rat	rare	2
	Ratón		
<i>Oryzomys caliginosus</i>	Dusky rice rat	common	2
	Ratón arrozera		
<i>Oryzomys fulvescens</i>	Pygmy rice rat	rare	2
	Ratón		
<i>Tylomys watsoni</i>	Watson's climbing rat	rare	3
	Rata azul		
Erethizontidae	Porcupines		
<i>Coendou mexicanus</i>	Prehensile-tailed porcupine	rare	3
	Puercoespín		
Agoutidae	Pacas		
<i>Agouti paca</i>	Paca	uncommon	1
	Tepezcuintle		
Dasyproctidae	Agoutis		
<i>Dasyprocta punctata</i>	Agouti	abundant	1
	Guatusa		
Echimyidae	Spiny Rats		

## Appendix 8 (continued)

Scientific Name	Common Name <sup>a</sup>	Abundance <sup>b</sup>	Distribution <sup>c</sup>
<i>Hoplomys gymnurus</i>	Armored rat Ratón	uncommon	2
<i>Proechimys semispinosus</i>	Tomes' spiny rat Ratón	common	2
Carnivora	Carnivores		
Mustelidae	Skunks, Weasels, and Otters		
<i>Conepatus semistriatus</i>	Striped hog-nosed skunk Zorro hediondo	common	3
<i>Eira barbara</i>	Tayra Gato de monte	common	1
<i>Galictis vittata</i>	Grison Grisón or Tejón	rare	1
<i>Lutra longicaudis</i>	Southern river otter Perro de agua or Nutria	common	1
<i>Mustela frenata</i>	Long-tailed weasel Comadreja	rare	4
Procyonidae	Raccoons		
<i>Bassaricyon gabbii</i>	Olingo Martilla	rare	2
<i>Nasua narica</i>	White-nosed coati Pizote	common	3
<i>Potos flavus</i>	Kinkajou Mico de noche	common	1
<i>Procyon lotor</i>	Raccoon Mapachín	rare	5
Felidae	Cats		
<i>Felis concolor</i>	Puma Puma or León de montaña	rare	4
<i>Felis onca</i>	Jaguar Tigre	uncommon	4
<i>Felis pardalis</i>	Ocelot Manigordo or Ocelote	rare	4
<i>Felis wiedii</i>	Margay Caucél	rare	4
<i>Felis yagouaroundi</i>	Jaguarundi León breñero or Gatillo de monte	uncommon	4
Artiodactyla	Deer and Peccaries		
Tayassuidae	Peccaries		
<i>Tayassu pecari</i>	White-lipped peccary Chancho de monte	extirpated	1
<i>Tayassu tajacu</i>	Collared peccary Saino	common	1
Cervidae	Deer		
<i>Mazama americana</i>	Red brocket deer Cabro de monte	uncommon	1
<i>Odocoileus virginianus</i>	White-tailed deer Venado cola blanca	uncommon	4
Perissodactyla	Tapirs and Horses		
Tapiridae	Tapirs		
<i>Tapirus bairdii</i>	Baird's tapir Danta	uncommon	2

*Note:* Night monkeys are added to this list as likely to occur there (see Timm 1988). The smaller species of *Artibeus* and *Vampyressa* are difficult to identify in the field and are often misidentified. I caution investigators to review prepared study specimens carefully before making identifications in the field and to save vouchers whenever possible.

<sup>a</sup>The common name(s) for each species is listed in English and in Spanish immediately below. Spanish names listed herein are those used in this region of Costa Rica. Because nonmammalogists do not distinguish most of the many species of bats, there are few local common names in Spanish for bat species other than direct translations of the published common names.

<sup>b</sup>Abundance: abundant = often observed and/or captured in the appropriate habitats; common = frequently observed in the appropriate habitats; uncommon = only occasionally observed in the appropriate habitats; rare = very few records for La Selva; extirpated = previously known from the area but no longer occurs in the region owing to overhunting and habitat destruction.

**Appendix 8** (*continued*)

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†Distribution: 1 = tropical, found throughout the New World tropics often being found as far north as Mexico, through Central America and much of tropical South America; 2 = northern Neotropics, generally found from tropical Mexico through Central America and northern South America; 3 = mesoamerica, found in the Central American countries but not as far south as Colombia; 4 = wide-ranging, found from the United States (and, in some cases, southern Canada) through Mexico, Central America, and most of South America to Argentina; 5 = North American, widely distributed in North America from southern Canada across most of the United States, Mexico, and Central America to Panama.