

BEETLES AS INDICATORS FOR FOREST CONSERVATION IN CENTRAL AMERICA

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Summary

Accelerated rates of deforestation, species loss and global threat to biodiversity make imperative increasing conservation efforts such as establishment of biological reserves, based on studies of biodiversity indicators. However, in developing regions such as Central America, the time, economic resources and taxonomic expertise are scarce. Therefore, the use of bioindicator groups such as passalid beetles (Coleoptera: Passalidae) dung beetles (Coleoptera: Scarabaeidae: Scarabaeinae) and leaf litter-inhabiting weevils (Coleoptera: Curculionidae) and rove beetles (Coleoptera: Staphylinidae) can be cost-effective, rapid, contrasting, and strong tools to produce objective and confident criteria to prioritize the establishment and evaluation of protected areas. It has been possible to use these groups because they are well studied in the region, are speciose, highly endemic (especially in mountains) and are easily collected and identified. Three cases (in Honduras, Guatemala and Costa Rica) are summarized which demonstrate that beetles can readily identify regions for conservation, maximizing diversity in minimal area for each region.

1. Introduction

Central America (Figure 1) is a tropical region formed by seven countries (Guatemala, Belize, El Salvador, Honduras, Nicaragua, Costa Rica and Panama), with a territory of near 523 000 km² and a population of near 39 million. Geologically, Central America can be divided in three regions. The northern region from Guatemala (including Chiapas in México) to mid Nicaragua, consists of two terranes, the Chortis Block (southern Chiapas, southern Guatemala, El Salvador, Honduras and northern Nicaragua), and the Mayan Block (Yucatan Peninsula, northern Chiapas, northern Guatemala, and Belize). These two blocks collided near the end of Cretaceous. The southern region of Central

America (southern Nicaragua, Costa Rica and Panama) is a more recent territory that, at first, consisted of oceanic volcanic islands which coalesced in the Pliocene (3 million years ago) to form the Panama isthmus, permitting the great biotic interchange of megafauna between North and South America.



Figure 1. Central American countries and geomorphology. Courtesy of NASA.

Landscape topography is dominated by a Pacific volcanic chain extending from Tacaná volcano on the Guatemalan-Mexican border to west of the Sierra de Talamanca of Costa Rica and Panama. A series of almost continuous mountainous regions is present in southern Belize (Mayan mountains), Guatemala, Honduras, northern El Salvador and northwestern Nicaragua (see Figure 1). Lowlands are present in the Caribbean and Pacific versants of the region. Relevant inter-montane valleys and other dry areas (generally considered biogeographic barriers for wet montane species) include the dry Motagua valley in Guatemala, the valleys of San Pedro Sula and Yoro in Honduras, the area around Lake Guija in Guatemala and El Salvador, northeast Golfo de Fonseca, the areas west of Lake Nicaragua, Guanacaste and Peninsula de Nicoya in Costa Rica and east of Peninsula de Azuero in Panama.

Vegetation (Figure 2) includes coniferous forests dominated by pines in the mountainous areas in Guatemala, Honduras, El Salvador and northern Nicaragua (forests of *Pinus caribaea* occurs in lowlands of Belize, Guatemala, Honduras and Nicaragua); pine-oak montane forests; cloud forests; lowland rain forests; dry forests; mangrove forests and a type of paramo in Cerro de la Muerte highlands of Costa Rica. The Holdridge Life Zone system maps (Figure 3) are widely used to designate vegetation types in Central America. Central America includes at least 50 tropical and subtropical life zones. Life zones are delimited on basis of mean annual bio-temperature (temperature favorable to living plants, 0-30°C), potential evapotranspiration, annual precipitation, latitude and altitude.

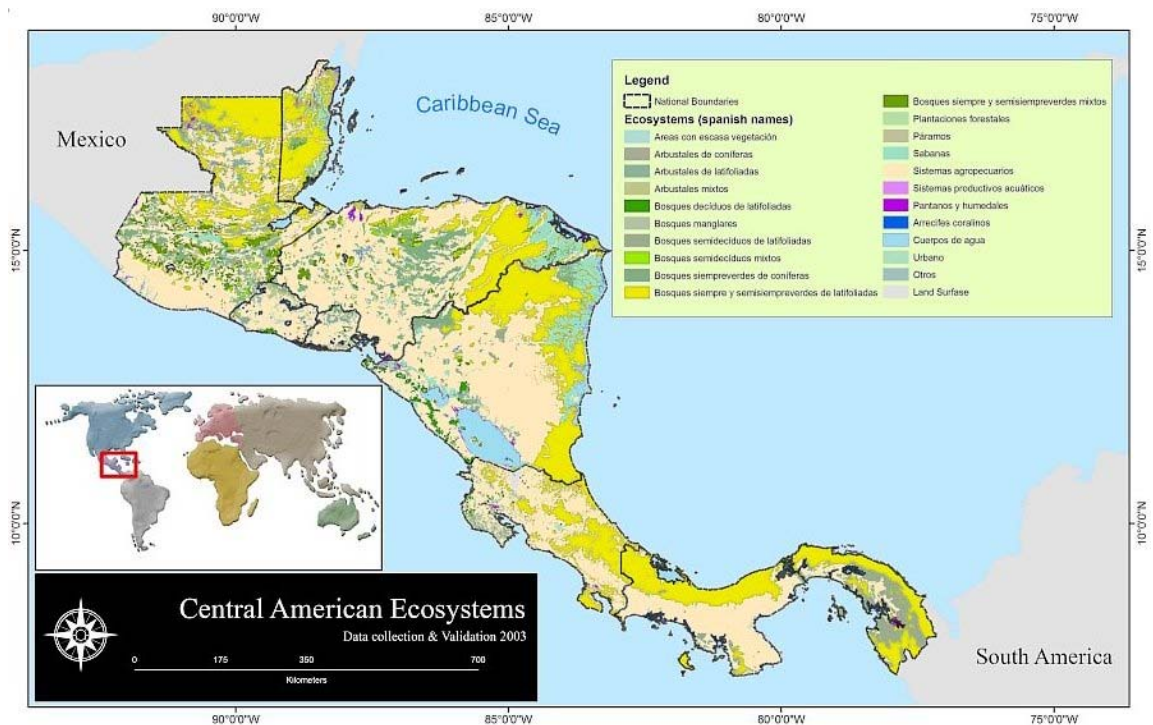


Figure 2. Ecosystems of Central America. Data courtesy of Comisión Centroamericana de Ambiente y Desarrollo (CCAD).

The region has a highly concentrated diversity, although estimates of species richness and endemism are certainly biased by differences in intensity of study and exploration among the countries. Floral diversity has been estimated at approximately 18 000 species of vascular plants (21% endemics). Also, animal diversity is high, especially amphibians, reptiles, freshwater fishes, small mammals, and some groups of well studied arthropods. Interestingly, data from different taxa demonstrate that Central America possesses at least two centers of diversification: The Costa Rica and Panamá cluster and the northern Central America cluster (Guatemala, El Salvador, Honduras, northern Nicaragua and adjacent Chiapas). For example Guatemala share with Costa Rica only 11% of june beetle species (*Phyllophaga*) and 2% of species of jewel beetles genus *Chrysina*.

Several countries in Central America have been through turbulent political periods and were politically unstable as recently as 1996. As a consequence, high levels of poverty

and direct dependence of agriculture and renewable resources have produced or sustained the major threats to region's biodiversity: slash and burn agriculture, cattle ranching, illegal logging, invasions of protected areas, narcotraffic, large-scale use of pesticides, water pollution, environmentally aggressive industrial development, and petroleum exploitation. Increasing conservation efforts are thus crucial to preserve Central America's wealth of ecosystems. In 1992 produced what was probably the most important set of international agreements to date on the preservation, investigation, and sustainable use of biodiversity – the Rio Convention on Biological Diversity (CBD). Article 7 (identification and monitoring) of the CBD to which the Central American countries are signatories, states that “each contracting party shall, as far as possible and as appropriate, identify components of biological diversity important for its conservation and sustainable use”. Among the recommended categories of such listed components (Annex I, CBD), are “ecosystems and habitats containing high diversity and large numbers of endemic or threatened species” and those with importance for research into the conservation and sustainable use of biodiversity, as indicator species.

2. Forest Conservation in Central America

Although establishment of municipal forest reserves date from 1870 in Guatemala, biological conservation in Central America begin in 1923 when the Barro Colorado Island in the Panama Canal was declared natural monument. In 1928 the British administration of Belize declared Half Moon Cay as a Crown Reserve (now, National Monument), the oldest reserve in Belize. In 1952 Honduras declared San Juancito in Tegucigalpa as a Forest Reserve, which in 1980 became to be “La Tigra” National Park. In 1955 the volcanic craters in Costa Rica were declared National Parks. Between 1955 and 1956 Guatemala declared 38 protected areas, including the first National Park, Tikal. Panama declared the Altos de Campana National Park in 1966.

The decades of 1970s and 1980s were significant for the conservation in Central America (see Figure 4). In Nicaragua, the first National Park, Volcán Masaya, was declared in 1979 and the Ministry of Environment and Natural Resources was created in 1994, based on the Constitution of 1987. Costa Rica proclaimed in 1983 the Law of Conservation of Wild Fauna, when wild fauna refuges were created and, in 1997, its Law of Creation of the National Parks Service. In 1981 Belize passed its Laws of Protected Areas (The Wildlife Protection Act 1981 (No. 4) and National Parks Systems Act 1981 (No. 5)). El Salvador declared its three legally protected areas in 1987 (Montecristo National Park), 1989 (El Imposible National Park) and 1996 (El Jocotal Lagoon); the Law of Wildlife Conservation was passed in 1994, although the Law of Protected Natural Areas was approved in 2005. Guatemala proclaimed its Law of Protected Areas in 1989. By the parliamentary act No. 87 of 1987, Honduras declared 37 protected areas mostly of cloud forest. Panama, between 1980 and 1988, declared protected 14 of the 20 more important areas of the country, corresponding to 95% of protected land, and in 1992 created the National System of Protected Areas (Ugalde and Godoy 1992).

During this time most reserves were established based on opportunity (most were national lands), and a few were designed based on biological criteria (particularly endangered and charismatic species). Protected areas have incremented in numbers but not much in area since 1990s (Figure 4).

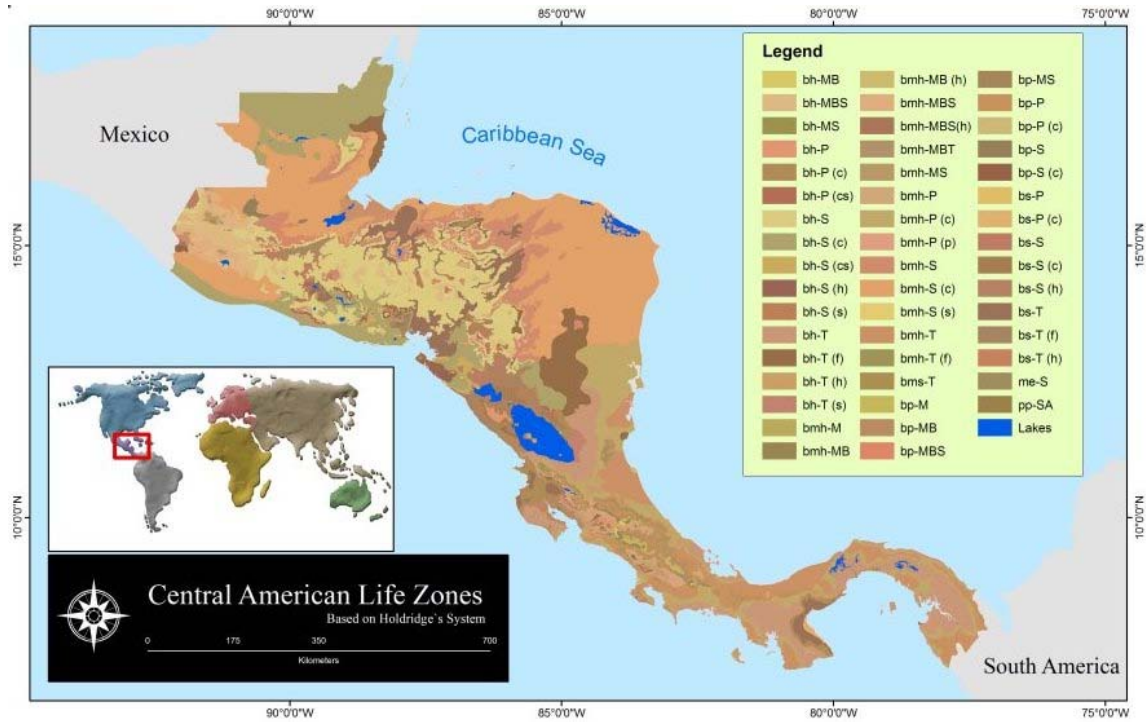


Figure 3. Life zones of Central America. Data courtesy of Comisión Centroamericana de Ambiente y Desarrollo (CCAD).

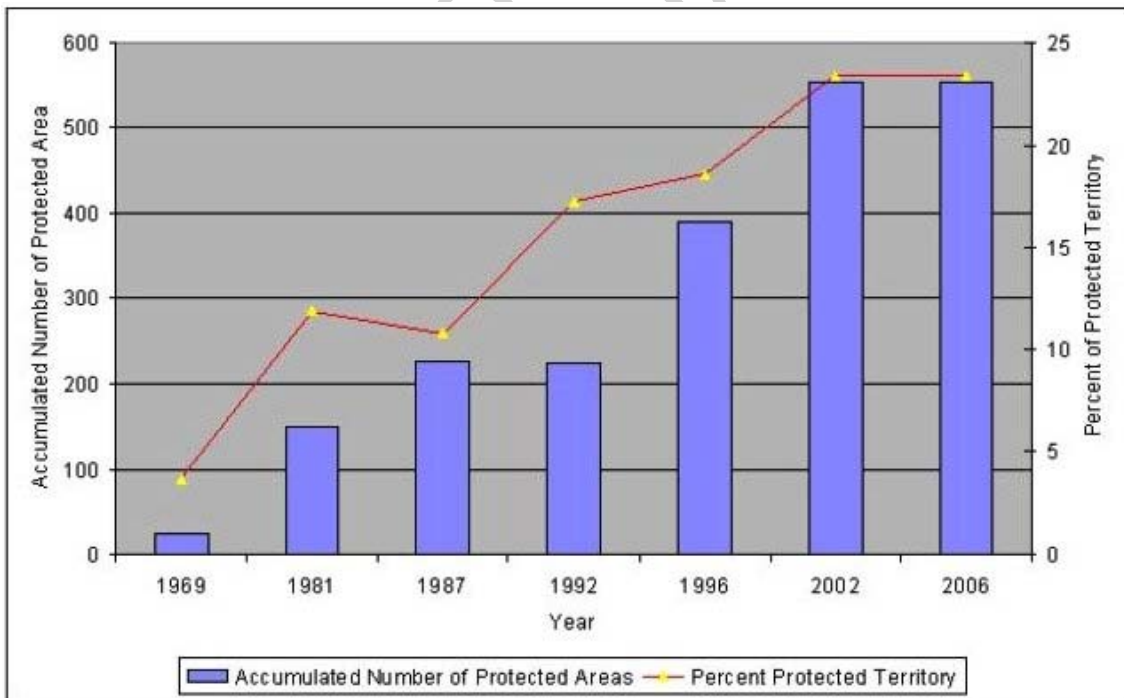


Figure 4. Accumulated number and area of biological reserves in Central America. Numbers may be different according to published data or different criteria applied by national authorities. Some areas are still not clearly delimited and others are “virtual reserves”.

	Guatemala	Belize	El Salvador	Honduras	Nicaragua	Costa Rica	Panama	Central America
Territory (sq.km)	108,889	22,966	21,040	112,492	130,682	51,100	75,517	522,68
Population (thousand)	12,000	266.4	6,500	6,900	5,484	4,262	3,253	38,665.40
Forest cover	37.2%	79%	9.6%	48%	24.5%	46%	45%	39.06%
Number of protected areas	123	74	3	64	76	155	50	545
Protected territory	29.40%	47.20%	0.33%	21.70%	17%	25.20%	26%	23.35%

Table 1. Relevant data of Central American countries.

Actually in Central America it has been legally declared that more than 545 protected areas, occupying approximately 23.35% of the terrestrial surface of the region (see Table 1 and Figure 5). Guatemala, Nicaragua, Costa Rica and Panama protect almost 29.40%, 17%, 25.20% and 26% of their territory, respectively. Astonishingly Belize protects the 47.20% of its territory, whereas El Salvador with only 9.6% of its natural forest remaining protects only 0.33% of its territory in just three legally declared protected areas.

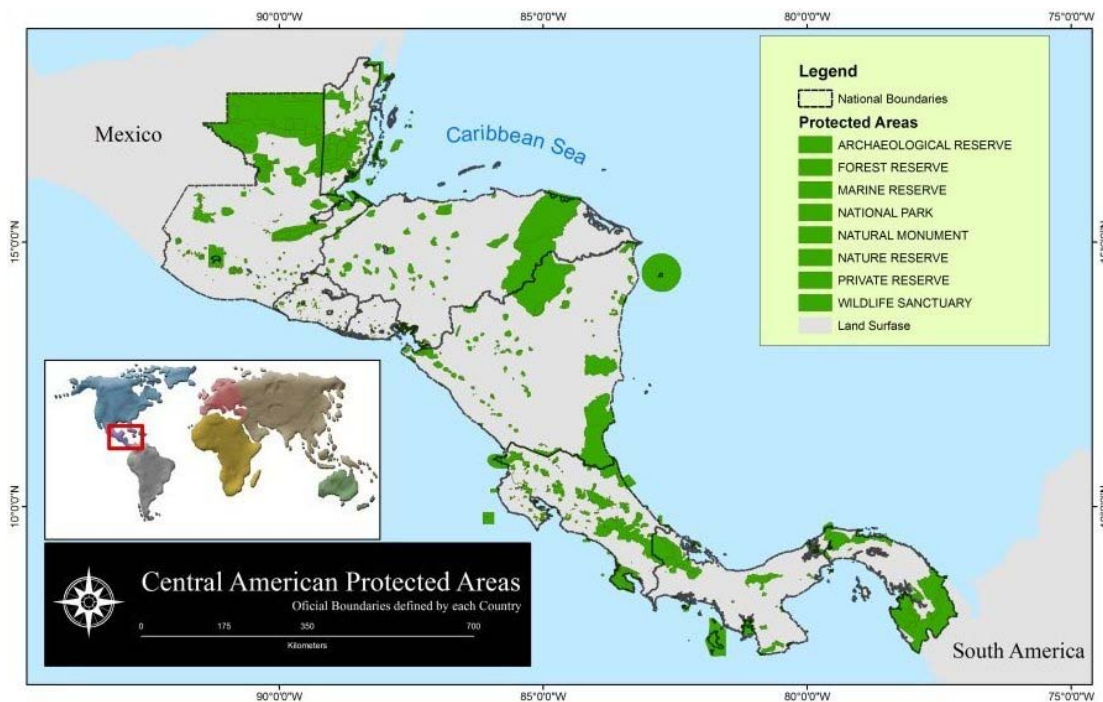


Figure 5. Protected areas of Central America. Data courtesy of CCAD.

3. The Knowledge of Entomological Diversity in Central America

The first modern contribution to the knowledge of the Central American entomological diversity was the 67-volume *Biologia Centrali-Americana* (<http://www.sil.si.edu/digitalcollections/bca/>) published over several decades, beginning in 1879, as a result of the British expeditions of Frederick Ducane Godman and Osbert Salvin. Insects were collected by Salvin and Godman or by contacted collectors in Central America (particularly, A. Salle, M. Boucard, J.J. Rodriguez, L. Conradt and F. Sarg (Guatemala), F. Blancaneaux (Belize), T. Belt, E.M. Janson and W.B. Richardson (Nicaragua), H. Rogers, P. Biolley, Van Patten, C.F. Underwood and H. Lankester (Costa Rica), E. Trötsch, H. Ribbe and A. Boucard (Panama)), but most of the collecting work was due to George C. Champion who spent four years (from March 16, 1879 to May 23, 1883) collecting in Guatemala and Panama (Godman 1915, Champion 1907). Forty-three volumes deal with insects, arachnids, and myriapods, 38 of which are dedicated solely to insects, covering 30,802 species. Most groups of organisms, and certainly insects, have received little or no attention since then and the “*Biologia*” continue to be used by young taxonomists.

At present, we recognize the development of moderate-sized insect collections in Guatemala (Universidad del Valle de Guatemala), El Salvador (Museo de Historia Natural de El Salvador), Honduras (Escuela Agrícola Panamericana El Zamorano), Nicaragua (Museo Entomológico de Leon), Costa Rica (CATIE and the University of Costa Rica) and Panama (Museo de Invertebrados G.B. Fairchild de la Universidad de Panama). However, the more than 3 million of insect specimens collected and stored by the Instituto Nacional de Biodiversidad de Costa Rica (INBio) represent the most coordinated and efficient effort toward the knowledge of entomological biodiversity in any country of Central America in the last 20 years.

As a result of contributions from all countries, several publications dealing with insects of Central America have been realized. Of particular interest are regional taxonomic guide-style publications such as “The dynastine scarab beetles of Costa Rica and Panama” (Ratcliffe 2003), “The dynastine scarab beetles of Honduras, Nicaragua and El Salvador” (Ratcliffe and Cave 2006), “Insects of Panama and Mesoamerica” (edited by Quintero and Aiello in 1992), “Orchid bees of tropical America: Biology and field guide” (Roubik and Hanson 2004), “Dragonflies and damselflies of Middle America and the Caribbean” (Esquivel 2006), and “Treehoppers of tropical America” (Godoy et al. 2006), as examples.

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Biographical Sketches

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Jack C. Schuster is head of the Systematic Entomology Laboratory and Director of the Ecotourism department at UVG. Interests include biogeography, systematics and behavior of passalid beetles as applied to forest conservation. He is also a rock and folk musician since his time at University of Michigan (B.S and M.S. biology) and University of Florida (Ph.D. entomology). Tours of his rock band "Alux Nahual" have resulted in the discovery of new species of passalid beetles.