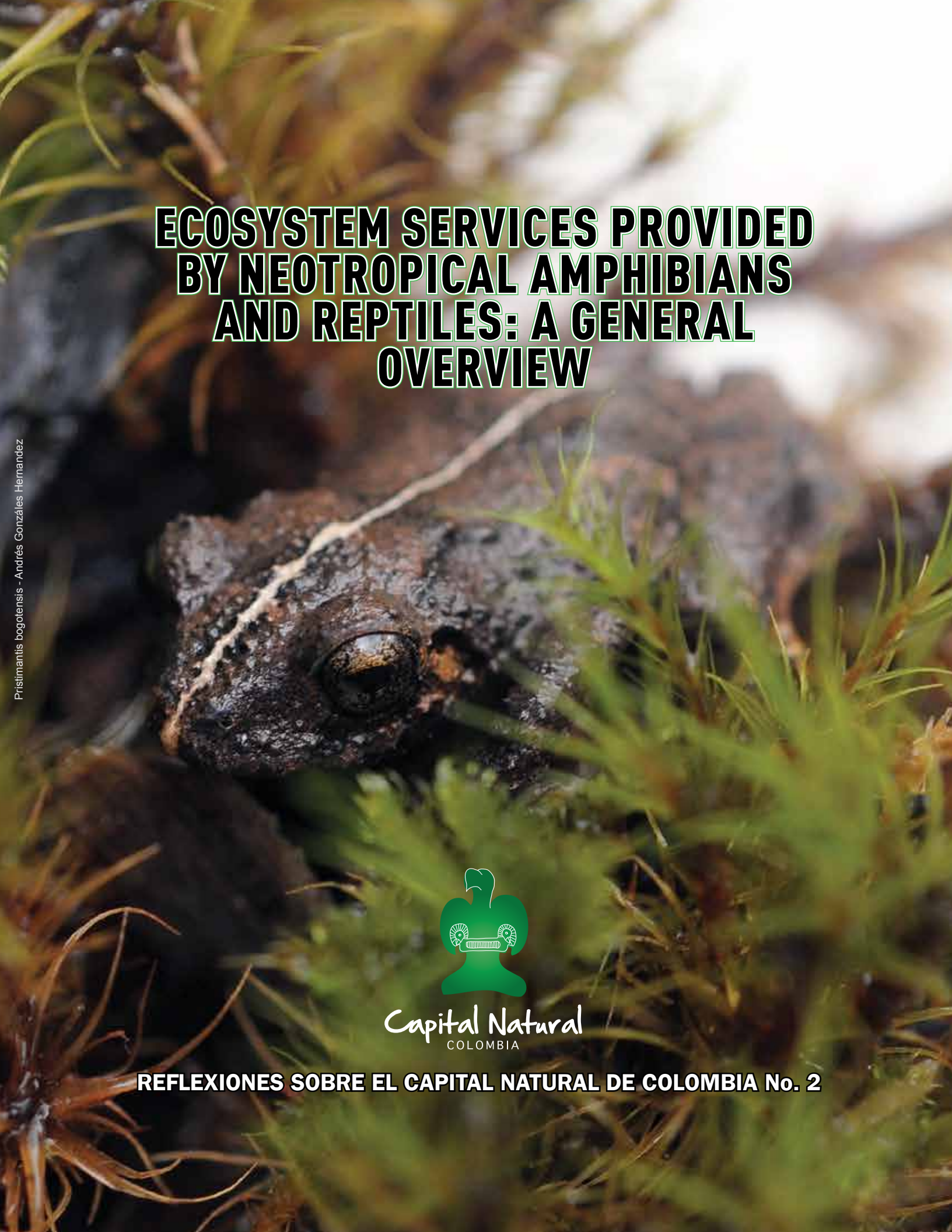
ECOSYSTEM SERVICES PROVIDED BY NEOTROPICAL AMPHIBIANS AND REPTILES: A GENERAL OVERVIEW



Pristimantis bogotensis - Andrés Gonzáles Hernandez

Capital Natural
COLOMBIA

REFLEXIONES SOBRE EL CAPITAL NATURAL DE COLOMBIA No. 2

Playas-Lepidochelys olivacea hatchling (copyright Rod)

REFLEXIONES SOBRE EL CAPITAL NATURAL DE COLOMBIA 2:

Ecosystem services provided by neotropical amphibians and reptiles: A general overview.

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Selva choco - Marco Rada

Summary

The benefits provided by the ecosystems that are used by humans for their survival and to fulfil their basic needs are called ecosystem services. Based on literature available regarding the role of amphibians and reptiles in the neotropical ecosystems, it was found that these animals play an important role in such processes as energy flow, nutrient cycling, dispersion, pollination and pathogen regulation. However, there has not been an adequate analysis of how the interactions and functions of these organisms contribute, directly or indirectly, to the ecosystem services that are important for human societies. In this regard, the environmental services in neotropical ecosystems have been identified and described, outlining their biological functions to provide a general overview on their importance not only for the functioning of ecosystems but also for human wellbeing.

Keywords: amphibians, reptiles, environmental services, human wellbeing, function

Dendrosophu labialis - Andrés Gozáles H

Introduction

The strategy of "Colombia's Natural Capital" ("Capital Natural de Colombia"), https://sites.google.com/site/capitalnaturalcolombia/iniciativa-capital-natural-colombia, was initiated in 2010 by the International Colombian Conservation Organisation and the Colombian government. This strategy has two main objectives: 1) to gain knowledge of and to understand the importance of ecosystems at a social, economic and environmental level, to generate mechanisms that allow decision makers to integrate the value of Colombia's natural capital with the different social and economic actions that can be taken to develop the country and the wellbeing of Colombians, and 2) to preserve the natural capital and to acknowledge the importance of ecosystem services in all economic and social services.

Within the development framework of this strategy, a series of studies have been initiated to gain knowledge of this natural capital. In 2012, part of this exercise focused on understanding the role of certain elements of biodiversity and their direct benefits to human wellbeing.

Ecosystems provide societies with a significant amount of goods and services through regulation processes (insect suppression, pollination, seed dispersal, climate regulation, soil stabilisation), supply of products and services (food, fibres, medicines), support systems (nutrient cycling, soil formation, primary production) and cultural benefits (aesthetic, educational, spiritual, and recreational) that improve human wellbeing (MEA, 2005; Díaz et al., 2006; Wenny et al., 2011). The basis of these ecosystem services is natural capital, which is generated by the different ecosystem components and the processes and interactions between them (Gualdrón-Duarte et al., in press). Due to the evident dependence of human societies on ecosystems for these "services", during the last several decades, there has been an increase in efforts to preserve them on a global scale. It is estimated that 60% of these ecosystems are currently being degraded or exploited in a non-sustainable way (MEA, 2005; Wenny et al., 2011).

Ecosystem components, such as biodiversity, regulate a significant number of ecosystem maintenance processes, and they often affect and sustain human life (Nelson and Daily, 2010). It is important to understand how and to what extent different aspects of biodiversity are sufficiently important to affect a particular service because the services are essential for human societies (de Groot et al., 2002; TEEB, 2010; Díaz et al., 2011) given that the organisms, as components of the ecosystems, contribute directly or indirectly to their proper functioning. The organisms and other ecosystem components not only provide numerous ecosystem services to humankind but also maintain the integrity and functionality of the natural capital (Costanza and Daly, 1992; Collins and Crump, 2009).

Modern amphibians and reptiles are the result of independent lineages that have been separated for the last 300 million years (Pough et al., 1998). Evolution has produced a great diversity of amphibians (6,771 species; Frost, 2011) and reptiles (9,596 species; Uetz, 2012). Both classes occupy a great variety of habitats: lagoons, creeks, rivers, canyons, undergrowth and tall tree habitats in forests and different jungles, as well as deserts. Some species are strictly aquatic; some specialise in terrestrial life or inhabit trees (Schlaepfer et al., 2005; Wells, 2007). Due to their biological (size, biomass) and ecological characteristics (population density), amphibians and reptiles play a key role in energy flow and nutrient cycling in both terrestrial and aquatic ecosystems (Beard et al., 2002; 2003; Wells, 2007). Because they may be herbivores or carnivores, these organisms can regulate the dynamics

of aquatic ecosystems by reducing natural eutrophication or by increasing certain insect populations in the terrestrial habitats. Certain of these insects are hosts for human pathogens; others may affect crops of economic importance (Spielman and Sullivan, 1974; Caldwell and Carmozina, 1998; Flecker et al., 1999; Lajmanovich et al., 2003; Peltzer et al., 2002; 2005; 2010; Solomon et al., 2004; Ranvestal et al., 2004; Attademo et al., 2005; Attademo et al., 2007a, 2007b; Conelly et al., 2008; Collins and Crump, 2009; Colon-Gaud et al., 2009; Conelly et al., 2011). Similarly, amphibians and reptiles can potentially play a role in seed dispersal (Iverson, 1985; Da Silva and Britto-Pereira, 2006; Fialho, 1990; Traveset, 1990; Cortes-Figueira et al., 1994; Moll and Jansen, 1995; Wilson et al., 1996; Varela and Bucher, 2002; Benítez-Malvido et al., 2003; Strong and Fragoso, 2006; Jerozolimski et al., 2009) or pollination of certain plant species (Sazima et al., 2005).

As mentioned earlier, the roles played by different species within ecosystems can directly or indirectly influence the function of ecosystems, and a portion of these functions translate into services that are used or enjoyed by society (Martín-López et al., 2007). For this reason, it is important to evaluate the various roles of neotropical amphibians and reptiles to establish how exactly their role can be considered a “service”, as has been performed for such groups as insects (Losey and Vaughan, 2006; Nichols et al., 2008), fishes (Holmlund and Hammer, 1999), birds (Whelan et al., 2008; Wenny et al., 2011) and mammals (Kunz et al., 2011). This report is focused on the identification and brief description of the ecosystem services that amphibians and reptiles provide to human communities in neotropical ecosystems with the objective of establishing a framework or general overview of their importance for both the ecosystem and our own wellbeing.

Literature review

All of the information used in this review was collected from four sources: **a)** databases, such as ISI, JSTOR, SCOPUS and, in certain cases, Google Scholar; from which we used scientific papers from such journals as Acta biológica venezuelica, Agriculture, Ecosystems and Environment, Australian Journal of Botany, Biodiversity and Conservation, Biological Conservation, Biotropica, Brasil Forestal, Bulletin of the Herpetological Society of France, Ecología en Bolivia, Conservation Biology, Copeia, Environmental Monitoring and Assessment, Froglog, Insugeo Miscelánea, Journal of Biogeography, Journal of Ethnobiology, Journal of Ethnobiology and Ethnomedicine, Journal of Ethnopharmacology, Journal of Food Composition and Analysis, Journal of Zoology, Manejo de fauna silvestre en Amazonía y Latinoamérica, Oecologia, Revista boliviana de ecología y conservación ambiental, Revista Colombiana de Ciencia Animal, Revista de Estudios Sociales, Revista institucional Universidad Tecnológica del Chocó: Investigación, Biodiversidad y Desarrollo, Revista de geografía agrícola, local agricultural studies, Russian Journal of Herpetology, The Journal of Wildlife Management; **b)** Chapters from the following books: Diversidad, amenazas y áreas prioritarias para la conservación de las selvas secas del Pacífico de México (Diversity threats and core areas for conservation of drywoods in the Mexican Pacific), La Biodiversidad en Chiapas (Biodiversity in Chiapas), Estudio de Estado (Study of State), Hunting for sustainability in tropical forests, Manejo y conservación de fauna silvestre en América Latina (Management and preservation of wildlife in Latin America), Neotropical Wildlife Use and Conservation; **c)** Information supplied by national and international researchers, and **d)** the platform Celsius, a bibliographic collection of the Universidad del Valle, which provided references. The search for information was restricted through the use of such keywords as the following: ecosystem services, amphibians, reptiles, tadpole,

frog, toad, caecilian, salamander, lizard, snake, caiman, turtle, tortoise, hunting, meat, trade, feeding, consumption, biological control, mosquito control, diet, predation, food habit, seed dispersal, seed ingestion, dispersers, frugivory, pollination, foraging and flower.

Gathering of Information

An exhaustive information search was performed during a two-month period (June-July 2012) with close attention to publications of the last four decades (1970-2012). The information obtained was summarised in a data matrix in which each article was classified according to the following features: a) group studied (amphibians or reptiles), b) geographical subdivision (Caribbean, Central and South America), c) country, d) geographical region, e) study area, f) name of the article, g) publication year h) author/authors, i) type of service provided, j) species used, k) uses and l) source.

The role of amphibians and reptiles in providing ecosystem services

Worldwide, different amphibian and reptile species have been used by human communities for centuries for survival (Gerdes et al., 1985; Klemens and Thorbjarnarson, 1995; Hirth et al., 1999; Hoffman et al., 2000; Hoffman, 2008). Many of these organisms have a direct economic value to the societies that rely on them for food, medicine, clothing materials, crafts and construction, as well as for aesthetic, cultural and scientific purposes (Mittermeier et al., 1992; Collins and Crump, 2009). Certain ecosystem processes, including those of diverse species (plants and animals), provide benefits through indirect interactions (MEA, 2005). It has been documented that a portion of amphibian and reptile species participate in such ecological processes as nutrient cycling (biotransformation), pollination, seed dispersal and pathogen regulation (table 1), which are of great importance for the ecosystem function and human wellbeing (Gómez-Baggethun and de Groot, 2007). For example, in processes of nutrient cycling and energy flow, which contribute to ecosystem stability and resiliency, it has been shown that the frog *Eleutherodactylus coqui* increases the availability of essential nutrients for plants and helps to develop foliage and improve primary productivity and speeding decomposition (Beard et al., 2002; 2003). In a similar manner, other species in this group help the flow of energy through the production of biomass, which is used by other organisms (Sazima and Strüssmann, 1990; Mora, 1999).

Crocodylus acutus - JVRued

Table 1. Ecosystem services provided by certain species of amphibians and reptiles in neotropical regions.

Ecological process	Ecosystem service	Type of service	Group involved	Importance for human wellbeing	Sources
Animal biomass accumulation	Provision	Food	Reptiles	Basic supply of food	Wetterberg et al., 1976; Norman, 1987; Bolkovic, 1999; Ortega et al., 1999; Cuellar, 2000; Hill and Padwe, 2000; Remor et al., 2000; Arispe and Rumiz, 2002; Naranjo et al., 2004; Peres and Nascimento, 2006; Cuesta-Ríos et al., 2007; Racero-Casarrubia et al., 2008; Naranjo and Cuarón, 2010; De la Ossa et al., 2011; Naranjo, 2012
		Raw material		Economic resources	Norman, 1987; Fizgerald et al., 1991; Fitzgerald et al., 1994;Klemens and Thorbjarnarson, 1995; Bolkovic and Ramadori, 2006; Loa et al., 1998; Collins and Crump, 2009; Naranjo and Cuarón, 2010; Naranjo, 2012
Alkaloid accumulation		Medicinal resources	Amphibians and reptiles	Chemical compounds with medical applications	Elguero et al., 1996; Tyler et al., 2007; Ciscotto et al., 2009; De Azevedo et al., 2011
Nutrient cycling	Support	Nutrient cycling	Amphibians and reptiles	Maintenance of the health of the ecosystem	Fittkau, 1970; Flecker, 1999; Arias et al., 2002; Beard et al., 2002; 2003; Ravestel et al., 2004; Connelly et al., 2008; Colón-Gaud et al., 2009; Connelly et al., 2011
Pollen and seed transport by animals	Regulation	Pollination and seed dispersal	Amphibians and reptiles	Dispersion of economically and ecologically important plants among ecosystems.	Iverson, 1985; da Silva et al., 1989; Fialho, 1990; Traveset, 1990; Cortes et al., 1994; Moll and Jansen, 1995; Willson et al., 1996; Varela and Bucher, 2002; Castro and Galetti, 2004; Sazima et al., 2005; Guzmán and Stevenson, 2008; Strong and Fragoso, 2006; Jerozolimski et al., 2009; Sadeghayobi et al., 2011; Blake et al., 2012
Predation and interaction in trophic levels		Pest and disease control	Amphibians	Biological control of organisms detrimental to human health and crops	Spielman and Sullivan, 1974; Peltzer et al., 2002; 2005; Lajmanovich et al., 2003; Attademo et al., 2005; 2007a; 2007b

These ecosystem services or values are used by people according to their preferences and needs. In this instance, the ecosystems and their services have a value for human societies because a person can obtain direct or indirect benefits from them (MEA, 2005). Thus, provision value or *direct use value* refers to those values that are consumed directly by people, and *indirect use values* are those derived from goods and services provided by an ecosystem that are used indirectly (TEEB, 2010). According to this classification, provision services for food, use of raw materials and medicines fall in the first category, while nutrient cycling, pollination, seed dispersal and pest control are in the second category.

Nacimiento de Caiman - Giovanni Ulloa

Provision services: Amphibian and reptile species used for food.

Humans obtain safe and nutritive food from ecosystems and ecosystem components to fulfil their nutritional needs (Laterra et al., 2011). In this way, wildlife has been a natural resource for societies for a long time, and even today, numerous species of mammals, birds and reptiles are considered important food sources, particularly as sources of protein (Naranjo et al., 2004; Aquino et al., 2007; Naranjo and Cuaron, 2010). The life histories of amphibians and reptiles make them adequate food sources in lowland tropical areas (Mittermeier et al., 1992).

The use of turtles, snakes, lizards and crocodiles as human food varies considerably among communities. Although many reptile species are consumed by people, only certain groups such as turtles (marine, aquatic and terrestrial) and certain lizards are extensively consumed, usually in accordance with medicinal or cultural beliefs (Klemens and Thorbjarnarson, 1995). For example, in such countries as Argentina, Bolivia, Brazil, Colombia, Mexico, Paraguay and Venezuela, the consumption of "wildlife meat" is a common practice in rural areas, comprising up to 70% of the protein consumed by a family (Norman, 1987). In this sense, turtles serve as an important protein source for rural and urban areas, particularly in developing countries. Given the generalised consumption of oil, meat and eggs of turtle such species as *Dermatemys mawii, Chelonoidis carbonaria, C. chilensis, C. denticulata, Chelonoidis* spp, *Chelus fimbriatus, Chelydra serpentina, Kinosternon scorpioides, K. spurelli, Podocnemis expansa, P. lewyana, P. unifilis, Rhinoclemmys melanosterna, R. nasuta, R. punctularia, Trachemys callirostris,* and *T. scripta*, their capture has caused a substantial decrease in their population numbers, placing them in some degree of endangerment (according to IUCN, 2012). This phenomenon is threatening the survival of these species (Wetterberg et al., 1976; Milton et al., 1991; Klemens and Thorbjamarson, 1995; Peres, 2000; Remor et al., 2000; Naranjo et al., 2004; Peres and Nascimento, 2006; Tejada et al., 2006; Cuesta-Ríos et al., 2007; Racero-Casarrubia et al., 2008; Naranjo and Cuarón, 2010; De la Ossa et al., 2011; Naranjo, 2012). Like turtles, crocodiles (figure 1) have been extensively used as a protein source, and even though their consumption has not been as intensive compared to turtles, the meat and eggs of the species *Caiman crocodilus, C. latirostris, C. yacare, Crocodylus acutus, C. moreletii, Melanosuchus niger,* and *Paleosuchus trigonatus* are consumed with few effects on the wild populations (Klemens and Thorbjamarson, 1995; Ortega et al., 1999; Hill and Padwe, 2000; Arispe and Rumiz, 2002; Cuesta-Ríos et al., 2007; Racero-Casarrubia et al., 2008; Naranjo and Cuarón, 2010; Naranjo, 2012).

Figure 1. *Caiman crocodiles,* specie used as a protein source by many rural communities in Neotropics. Photograph: Diego Villaquirán

Other wild animal products are extensively used for medicinal purposes by the indigenous tribes and in rural areas, where people possess deep knowledge of the local fauna (Alves et al., 2009). Among these fauna, reptiles are one of the groups most often used in popular medicine, and their roles in medicinal practices have been registered in different social and cultural contexts all over the world (Alves et al., 2008). For example, numerous rural communities in the neotropics (Figure 2) use such body parts as the fat, bile, meat, rattles (from snakes) and feet, among others, from such lizard species as *Basiliscus basiliscus, B. galeritus, Ctenosaura similis, Ctenosaura* sp. and *Iguana iguana* and such snake species as *Boa constrictor, Bothrops* spp, *Corallus annulatus, Crotalus durissus, Eunectes murinus,* and *Lachesis muta* for medicinal purposes to cure or treat such diseases as asthma, whooping cough, spasms, backaches, wounds, infections, rabies, AIDS, malaria, tuberculosis, cancer and snake bite (Amaya, 1984; Norman, 1987; Loa et al., 1998; Bolkovic, 1999; Ortega et al., 1999; Cuellar, 2000; Hill and Padwe, 2000; Naranjo et al., 2004; Tejada et al., 2006; Vázquez et al., 2006; Cuesta-Ríos et al., 2007; Racero-Casarrubia et al., 2008; Naranjo and Cuarón, 2010; Naranjo, 2012). The meats of such species as *Tupinambis rufescens* and *T. teguixin* are of culinary interest, due to their high quality and taste (Caldironi and Manes, 2006).

Figure 1. A. Survey of inhabitants of Putumayo to evaluate the use of herpetofauna in the region. B. *Boa constrictor,* snake used to treat many diseases. Photograph: Sebastián Orjuela S.Photograph: Anyelet Valencia.

Provision services: Leather and animals commerce

Leather, wool and hair from several species of birds, mammals and reptiles are sold in the international market to make clothes and accessories, such as shoes, shawls and purses, as well as decorations and furniture, such as rugs, amulets and trophies (MEA, 2005). For example, the countries in the neotropical region have a great diversity of amphibians and reptiles, and such species as frogs, salamanders, lizards, snakes, turtles and crocodiles are sold for their skin and meat, and others are sold live as a pet and research purposes (Klemens and Thorbjarnarson, 1995; Collins and Crump, 2009).

A number of reptile species have been hunted by rural communities for centuries for survival. The kills are used for human consumption (meat), and the skins and other parts are used for different purposes. For example, in certain rural districts of Argentina and Paraguay, 91% of the inhabitants that hunt lizards (*Tupinambis*) sell their skins as an important source of income. However, this practice not only provides income to these people but is also considered an important activity for the economy of these countries, being valued in millions of dollars per year in exports to the United States, Canada, Mexico, Hong Kong, Japan and certain European countries (Norman, 1987; Fizgerald et al., 1991; Fitzgerald et al., 1994; Bolkovic and Ramadori, 2006). The exploitation of some species of *Tupinambis* has caused major international concern, leading to the inclusion of these species in Appendix II of the Convention on International Trade in Endangered Species (CITES). However, even though

the quota for export has been restricted, it is still considerably high, with numbers of close to a million skins being collected from 1997-2003 (Basso et al., 2005 cited by Caldironi and Manes, 2006). Similarly, in other countries, such as Bolivia, Colombia and Mexico, many hunters sell live animals, particularly turtles (*C. serpentina, K. scorpioides, T. callirostris* and *R. nasuta*), as pets to meet their basic needs (Cuesta-Ríos et al., 2007; De la Ossa et al., 2011), other hunters export crocodile skins or sell live toads, iguanas, rattlesnakes, turtles and caimans. (Loa et al., 1998; Naranjo and Cuarón, 2010; Naranjo, 2012).

Regulation services: Pollination and seed dispersal by amphibians and reptiles

The supply of certain ecosystem services is related to direct interactions between plants and animals, such as herbivory, pollination and seed dispersal. These interactions can directly or indirectly influence the maintenance or functioning of the ecosystems that, in turn, provide services to societies (MEA, 2005). These environmental regulation services, called *indirect use values* (TEEB, 2010) are more often provided by reptiles than by amphibians in neotropical ecosystems. These organisms facilitate pollination and seed dispersal in tropical and subtropical habitats. Several studies have documented the role of reptiles as pollination agents, mainly in insular systems. Reptiles come into contact with many flowers; they transfer pollen and foster genetic diversity in plants (Pérez-Mellado and Casas, 1997; Traveset and Sáez, 1997; Olsson et al., 2000; Pérez-Mellado et al., 2000; Nyhagen et al., 2001; Hansen et al., 2007; Olesen et al., 2012). Specifically in neotropical terrestrial ecosystems, the Brazilian lizard *Trachylepis atlantica* forages in *Erythrina velutina* trees, coming in contact with the flower's anthers when feeding on the nectar accumulated at the base of the flowers. This species transports grains of pollen among flowers of *E. velutina* and acts as a pollinator of the plant (Sazima et al., 2005). Evaluating the roles of other species in plants pollination would not only increase the understanding of the ecological relationship between plants and animals but would also help with conservation efforts.

Birds and mammals, are considered major dispersal agents among vertebrates, and seed dispersal is considered one of the most important ecosistem services provided by those groups (Lawton and Putz, 1988, Whelan et al., 2008; Kunz et al., 2011). Birds are the main dispersal agent for several species of tropical plants and by dispersing seeds they influence their distribution patterns (Lawton and Putz, 1988). Similarly, bats consume and disperse the seeds of approximately 120 plant families in neotropical habitats (Whelan et al., 2008; Kunz et al., 2011). In amphibians and reptiles, frugivory has been documented for certain species, but the importance of such frugivory in seed dispersal has been underestimated (Valido and Nogales, 1994; Olesen and Valido, 2003). However, in recent decades, numerous researchers have evaluated the role of this group in seed dispersal in terrestrial neotropical ecosystems, identifying approximately 14 species of amphibians (a frog) and reptiles (lizards and turtles, figure 3) responsible for the dispersal of seeds of at least 56 species of plants (Iverson, 1985; Da Silva et al., 1989; Fialho, 1990; Traveset, 1990; Cortes-Figueira et al., 1994; Moll and Jansen, 1995; Wilson et al., 1996; Varela and Bucher, 2002; Benítez-Malvido et al., 2003; Castro and Galetti, 2004; Strong and Fragoso, 2006; Guzmán and Stevenson, 2008; Jerozolimski et al., 2009). The plants dispersed by these animals include *Momordica charantia* (bitter squash), *Passiflora edulis* (Maracuya) and *Psidium guajava* (guava), all of which are of economic importance to humans.

Figure 3. *Chelonoidis carbonaria,* dispersal agent of numerous seeds in different terrestrial neotropical ecosystems. Photograph: Angela M. Cortés-Gómez.

Regulation services: Consumption of herbivore insects and disease vectors

Pest management in crops and disease vectors continues to be one of the great problems facing humankind. Annually, these organisms (primarily insects) cause great losses to agriculture and cause public health problems, increasing costs and threatening human wellbeing (Schwartz and Klassen, 1980; Duran and Hopkins, 2008). There have been many efforts to control the populations of these pests using traditional methods and technologies, but these practices are not selective and cause, in certain cases, greater problems for other species, for the ecosystem and for humans (Williamson, 1998). Because of this effect, in recent decades, there has been an interest in implementing handling methods or integral management for pest control with the aim of reducing the damage caused by various components in the habitats where they are applied. For this reason, the understanding of the interactions between pest species and their natural enemies would promote an understanding of how the latter could be used for biological control. Such biological control could help reduce the economic and environmental costs of pest species (Bellows, 2001; Blaustein and Chase, 2007). In this sense, the role of generalist predators, such as the amphibians, for biological control has become important in the past several years (Attademo et al., 2007a; 2007b). Studies on the feeding habits of *Osteopilus septentrionalis* and *Lysapsus*

limellum found that these species consume larvae of *Culex pipiens quinquefasciatus,* flies (of the family Ephydridae) and dragonflies (associated to stagnant water), respectively, which are vectors for human diseases. When the interactions between frogs, toads and these insects were studied, a decrease in the vectors (hosts of pathogenic microorganisms) was observed, suggesting that certain amphibian species exert effective control on insects that are potentially harmful to human health (Spielman and Sullivan, 1974; Peltzer and Lajmanovich 2002).

Similarly, studies intended to evaluate the relationship between herbivorous insects and the ecology of wild amphibians have found that both frogs and toads act as biological controls for economically important crops. For example, the transgenic Argentinean soybean, of which 30 million tons are produced annually, is affected by a number of insects that attack the plant at different growth stages and cause multiple types of damage (Hartmann et al., 1999, cited by Attademo et al., 2007b). Various species of the families Bufonidae (*Rhinella arenarum , Rhinella fernandezae*), Cycloramphidae (*Odontophrynus americanus*), Leiuperidae (*Physalaemus albonotatus*, *Physalaemus biligonigerus*) and Leptodactylidae (*Leptodactylus chaquensis, Leptodactylus latinasus*) actively feed on arthropods, such as the larvae of lepidopterans (*Spilosoma virginica, Anticarsia gemmatalis, Peridroma saucia, Rachiplusia un, Spodoptera* sp.), homopterans (immature *Scapteris borrelli*), species of *Armadillum vulgare, Agriotes* sp., *Anomala* sp., *Diloboderus* sp., *Diabotrica speciosa, Lagria villosa, Anurogryllus muticus, Gryllus argentinus, Scapteriscus borelli, Schistocerca* sp., *Empoasca fabae, Edessa meditabunda, Nezara viridula, Delphacodes kuscheli* and leaf-cutting ants (*Acromyrmex* spp, *Atta* sp., *Eciton preadator*), which are harmful for the crops and are known to decrease the height of soybean plants. It is thus possible to consider these populations of anurans as potential natural enemies of many pests; these species could therefore be used as effective biological controls to reduce damage to the soybean plant (Lajmanovich et al., 2003; Peltzer et al., 2005; Attademo et al., 2005; Attademo et al., 2007a; 2007b; Peltzer et al., 2010).

Conclusions

There is no doubt that biodiversity provides human societies a great variety of goods and services, which can be used to improve the quality of life. As mentioned before, amphibians and reptiles provide direct ecosystem services and benefits (food, medicines, commercial goods) and indirect benefits (pollination, seed dispersal and control of pests and disease vectors). The roles of these organisms in such processes as nutrient cycling and energy flow could be helping to maintain the structure and function of the ecosystems that they inhabit. These organisms may also influence the stability of different ecosystems and thereby benefit human societies.

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