



*Oxyrhopus petolarius*, Yotoco, Reserva forestal, 2012, Fdo Castro.



## Conservation status of the herpetofauna, protected areas, and current problems in Valle del Cauca, Colombia

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**Abstract.**—In this study, we present an analysis of the conservation status of amphibian and reptile species by associating the natural protected areas and municipalities with the distribution of richness in Valle del Cauca. We establish the percentage of species of amphibians and reptiles in each of the IUCN (International Union for Conservation of Nature) threat categories and assign local conservation categories to all species, construct distribution maps for the records of species in relation to their threat status, and analyze the endemic and total number of species in each of the protected areas. We found that nearly 50% of the species in the Valle del Cauca are under some degree of risk or threat, that the largest percentage are in the Vulnerable (VU) category, whereas 37% of the fauna is not threatened (Least Concern [LC] and Near Threatened [NT]), and 13% is categorized as Data Deficient (DD). Although the distribution of species is scattered throughout the territory, patterns are maintained within the various regions, with areas of greater richness found in the Pacific region and the cordilleras; the municipalities with the largest number of species under some level of threat are Buenaventura, Darién, El Cairo, Dagua, Cali, La Cumbre, and Yotoco. The types of protected areas with the largest number of species are the Reservas Forestales Protectoras Nacionales (RFPN) 37%, followed by the Parques Nacionales Naturales (PNN) 18%, the Reservas Forestales Protectoras Regionales (RFPR) 10%, and the Parques Nacionales Regionales (PNR) 7.5%; 17% (~ 57 spp.) of the species in the Valle del Cauca have not been recorded in any of the protected areas, and more than 65% of these are under some type of threat. We consider this study a starting point for evaluating conservation priorities for the herpetofauna of Valle del Cauca.

**Key words.** Amphibians, reptiles, distribution, IUCN, population declines, threats

**Resumen.**—En este trabajo presentamos un análisis del estado de conservación de las especies de anfibios y reptiles relacionando las áreas naturales protegidas y los municipios con la distribución de riqueza en Valle del Cauca. Establecemos los porcentajes de especies de anfibios y reptiles en cada categoría de amenaza establecida por UICN (Unión Internacional para la Conservación de la Naturaleza) y asignamos categorías de conservación local a todas las especies, se realizó mapas de distribución de los registros de las especies en relación a los estados de amenaza, y analizamos el número de especies totales y endémicas en cada área protegida. Encontramos que cerca del 50% de las especies en el Valle del Cauca presentan algún grado de riesgo o amenaza, que la mayor proporción se encuentra en la categoría vulnerable (VU), mientras que el 37% de la herpetofauna no se encuentra en riesgo (preocupación menor [LC] y casi amenazado [NT]) y el 13% está categorizada en datos deficientes (DD). Aunque la distribución es diferencial a lo largo del territorio, se conservan patrones a lo largo de las regiones, con sitios de mayor riqueza en la región pacífica y las cordilleras; y los municipios con mayor número de especies con algún grado de amenaza son Buenaventura, Darién, El Cairo, Dagua, Cali, La Cumbre y Yotoco. Los tipos de áreas protegidas con mayor número de especies son las Reservas Forestales Protectoras Nacionales (RFPN) 37%, seguidas por los Parques Nacionales Naturales (PNN) 18%, Reservas Forestales Protectoras Regionales (RFPR) 10%, y los Parques Nacionales Regionales (PNR) 7.5%; el 17% (~

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**57 spp.) de las especies del Valle del Cauca no se han registrado en ningún tipo de área protegida y más del 65% de ellas presenta algún tipo de amenaza. Consideramos este trabajo un punto de partida para evaluar prioridades en la conservación de la herpetofauna vallecaucana.**

**Palabras claves.** Anfibios, reptiles, distribución, UICN, declive poblacional, amenazas

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## Introduction

Many populations of amphibians and reptiles are in decline (Mendelson et al. 2006; Böhm et al. 2013), primarily as a result of habitat loss, climate change, introduced species, diseases, and illegal trafficking (Young et al. 2001; Stuart et al. 2004; Mendelson et al. 2006; Wake 2007; Rovito et al. 2009; Böhm et al. 2013). Estimates indicate that 15–36% of the world's species of reptiles are threatened (Böhm et al. 2013), and according to Stuart et al. (2004) 22.5% of the species evaluated by IUCN lacked sufficient information to evaluate their status. Although the IUCN standardized the use of categories that can be applied to any taxon and has attempted to catalogue the majority of species (IUCN 2012), many species still have not been evaluated or lack the necessary information for conducting an assessment; in the case of reptiles, 59% of the species have not been assessed.

In Colombia, in addition to the above mentioned factors that threaten populations of amphibians and reptiles (Rueda 1999; Ruiz and Rueda-A 2008; Velásquez et al. 2008; Isaacs and Urbina 2011; Urbina 2011; Urbina et al. 2011; Vargas and Amezcua 2013), the social problem associated with the planting and eradication of illicit crops threatens the fauna because of the destruction of primary forests and the use of pesticides such as Glifosato (Arroyo and Lynch 2009; Brain and Solomon 2009). A mining crisis also has developed in the country, where mining permits are granted to people for economic purposes while the long-term impact on the environment caused by these activities is ignored (Mancera and Alvarés 2006; UPME 2007; Hernández et al. 2013).

In response to these problems, early in the 1930s “áreas naturales protegidas” (= natural protected areas) were designated in the country, which led to the formation of “zonas forestales protectoras” (= protected forest areas) in the department (dpto= a territorial division in Colombia that has autonomy in the administration of regional issues, planning, and the promotion of economic and social development within its territory under the terms established by the Constitution) of Valle del Cauca (decree 1393/40). Regulations for determining the exact management categories that competent authorities at dif-

ferent levels can assign to protected areas, however, still have not been implemented in the country (Vásquez and Serrano 2009). Currently, 197 reserves of all types exist in the Valle del Cauca; three natural national parks are the most important because of their large size and location in areas of high herpetofaunal diversity, in the dpto and in the country—the “Cordillera Occidental” (= the Western Cordillera) and the “Región Pacífica” (= Pacific Region) (Cardona et al. 2013); environmental problems, however, are present in these areas, as their biological patrimony has not been fully elucidated (Patiño 2010).

Valle del Cauca is one of the dptos with the greatest amount of herpetofaunal species richness (333 species), which represents 24% of the amphibian and 25% of the reptile species recorded from the country (Cardona et al. 2013). We are unaware, however, of the number of threatened species in the dptos, or plans for their conservation. In a red book of amphibians, Castro-H and Bolívar-G (2010) included 68 species under some type of threat, and along with an action plan for the conservation of amphibians in Valle de Cauca provided by Corredor et al. (2010); these publications are considered pioneer efforts in conservation; in general, research programs usually are developed separately and independently.

The objective of this paper is to present an analysis of the conservation status of the species of amphibians and reptiles by associating the natural protected areas and municipalities with the distribution of richness in Valle del Cauca, as a starting point for evaluating conservation priorities for the herpetofauna of this region.

## Materials and Methods

### Study area

Valle del Cauca is a dpto in southwestern Colombia that consists of 42 municipalities (Fig. 1) with a total surface area of 22,142 km<sup>2</sup>; it contains a diversity of landscapes, including very humid tropical forests, premontane pluvial forests in warm transition, dry and very dry tropical forests, and lowland montane to pluvial montane forests that range in elevation from sea level to 4,000 m. This

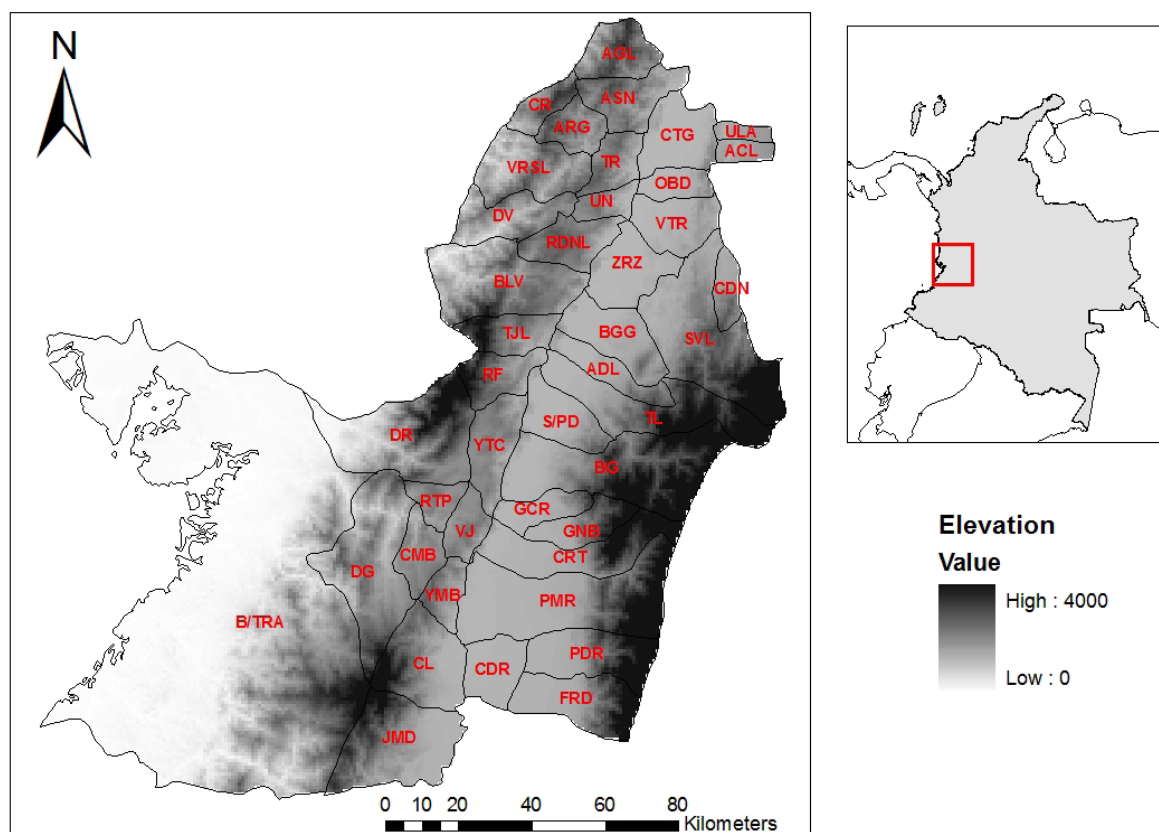
dpto has allocated 233,889 ha for parks and natural reserves, which because of their ecological importance and abundance of natural resources have been established in various strategic ecosystems and protected areas (Gómez et al. 2007).

### Sources of information

In updating their list on the herpetofauna of Valle del Cauca, Cardona et al. (2013) considered the following:

- Geographic data: Obtained from bibliographic sources, field notes, and biological collections of amphibians and reptiles at the Universidad del Valle (UV-C), and online databases from the Instituto de Ciencias Naturales (ICN), and the National Museum of Natural History at the Smithsonian Institution (USNM).
- Threat category (species recorded from the dpto were catalogued using the following criteria): trafficking in species, deaths caused by vehicular traffic or by humans, distribution within the dpto (eco-regions, localities, life zones), occurrence in disturbed habitats, frequency of observation, number of citations in publications, and the presence of species in protected

areas. All these criteria were scored from 0 to 4, where 0 means no risk in the particular criteria, 3 high risk, and 4 is unknown (see supplemental material at [amphibian-reptile-conservation.org](http://amphibian-reptile-conservation.org) for the definition of the score in each criteria). Based on the data obtained for each species, it calculated the weighted average for the different natural groups (amphibians, lizards, and snakes), and assigned a percentage in the final score to each criteria according to the natural group, because the same criteria does not affect each natural group in the same way (see supplemental material for the percentage assigned in each criteria). With the weighted average of each species, these were assigned to some of the categories proposed by the IUCN, as follows: LC 0–1.4, NT 1.5–2.0, VU 2.1–2.6, EN 2.7–3.0, CR 3.1–3.3, DD 3.4–4.0. Each category was justified according to the appendix of the IUCN (2012), especially considering the threats to each species. Additionally, the threat status for each species reported from the dpto was examined by searching through the IUCN Red List of Threatened Species (<http://www.iucnredlist.org/>), the red books of amphibians and reptiles in Colombia (Castaño-M 2002; Rueda-A et al. 2004), and the red book of amphibians from Valle del Cauca (Castro-H and Bolívar-G 2010).



**Fig. 1.** Political map of Valle del Cauca (Colombia). North: El Águila (AGL), El Cairo (CR), Ansermanuevo (ASN), Argelia (ARG), Cartago (CTG), Ulloa (ULA), Alcalá (ACL), Toro (TR), Versailles (VRSL), Obando (OBD), La Unión (UN), El Dovio (DV), Roldanillo (RDNL), La Victoria (VTR), Zarzal (ZRZ), Bolívar (BLV); East: Sevilla (SVL), Caicedonia (CDN); Middle: Bugalagrande (BGG), Trujillo (TJL), Andalucía (ADL), Rio Frio (RF), Tuluá (TL), San Pedro (S/PD), Yotoco (YTC), Darién (DR), Buga (BG), Guacarí (GCR), Ginebra (GNB), Vijes (VJ), Restrepo (RTP), Cumbre (CMB), El Cerrito (CRT); South: Palmira (PMR), Yumbo (YMB), Cali (CL), Candelaria (CDR), Pradera (PDR), Florida (FRD), Jamundí (JMD); West: Buenaventura (B/tura), Dagua (DG).

- Protected areas: Each species was recorded according to geographic location and the use of bibliographic resources on protected areas within the dpto, considering the important areas with a wide extension and with the ability to hold a great diversity of herpetofauna. The definition of protected areas were defined based on the Decree-Law 622 of 1977 and 2372 of 2010 of the National Government (in parentheses the areas that were chosen in this work):
  - Parques Nacionales Naturales (PNN) is an area of great extent permitted ecological autoregulation and whose ecosystems in general have not been substantially altered by human exploitation or occupation, where plant and animal species, geomorphological resorts, historical or cultural events have scientific, educational, aesthetic and recreational value and their perpetuation is subjected to an appropriate management regime (Farallones de Cali, Las Hermosas, Uramba-Bahía Málaga, Tatamá).
  - Santuario de Flora y Fauna (SFF) is dedicated to preserving wildlife species or plant communities to preserve genetic resources of native flora and fauna (Decreto 622 de 1977), (Isla Malpelo).
  - Parque Natural Regional (PNR) is a regional geographic area where landscapes and strategic ecosystems, maintain their structure, composition and function. The natural and cultural values are associated with human disposition for preservation, restoration, knowledge, and enjoyment (La Sierpe and Páramo del Duende).
  - Reservas Forestales Protectoras (RFP) is a geographical area where forest ecosystems maintain their function, although their structure and composition have been modified and associated natural values are accessible to the human population to who allocated their preservation, sustainable use, restoration, knowledge, and enjoyment. In this type of protected area are the forests, national (RFPN) (Amalme, Anchicayá, San Cipriano and Escalerete rivers, Bosque de Yotoco, Dagua, Cali, Tuluá, Sonso-Guabas, Cerro Dapa-Carisucio) and regional (RFPR) (Bitaco and Frayle-Desbaratado) protection.
  - Reserva Natural (RN) is an area in which undisturbed conditions exist or have undergone minimal human disturbance of flora, fauna, and soil, and it is intended for conservation, research, and study of its natural wealth (Laguna de Sonso).
- Distrito de Manejo Integrado (DMI) is a geographical space where landscapes and ecosystems retain their composition and function, although their structure have been modified and whose natural and cultural associated values are set to reach the human population who allocated their sustainable use, preservation, restoration, knowledge, and enjoyment (La Plata and Enclave Subxerofítico Atuncela).
- Municipalities: Each species was recorded based on its documented geographic location within the municipalities of the dpto.

### Analysis of the Data

The species distribution model for each threat category was performed using all the records collected from the different museums and georeferenced using Google Earth 7.1.2.2014; these models were constructed in MaxEnt Version 3.3.3a. The software generated models using the theory of maximum entropy only when presence data were available (Phillips et al. 2006). For this work, we used the 19 climate layers of the WorldClim project ([www.worldclim.org](http://www.worldclim.org), spatial resolution of 30 arc second or ~ 1 km<sup>2</sup>). To evaluate the predictive ability of the models generated, the Area Under the Curve (AUC) score was taken into account. The AUC is a ranked approach for assessing model fit, which determines the probability that a presence location will be ranked higher than a random background location (Phillips et al. 2006). The prediction models generated by MAXENT were mapped in ArcGIS 10.1 (ESRI 2013), with only the detection probabilities above 0.5 taken into account.

The percentages of amphibian and reptile species for each threat status was determined, and through histograms indicate the endemic number of species and total number of species in each of the protected areas.

### Results

#### Status of threats to the herpetofauna

Approximately 51% of the species in the dpto showed some degree of risk or threat. The majority of amphibians (60%) are in one of the threat categories, with the Vulnerable (VU) containing the most species (59), followed by the Critically Endangered (CR) and Endangered (EN), each with 29, and 27 in the Near Threatened (NT) (Fig. 2A) categories. Conversely, more than one-third of the reptile species show some degree of risk, with those in the NT and VU containing the largest number of species (38 in each), followed by the EN (14), and a few (six) in the CR (Fig. 2B) categories. Of the remaining herpetofaunal species in the dpto, 17% show no risk (LC), and 14% are Data Deficient (DD; see supplemental material).

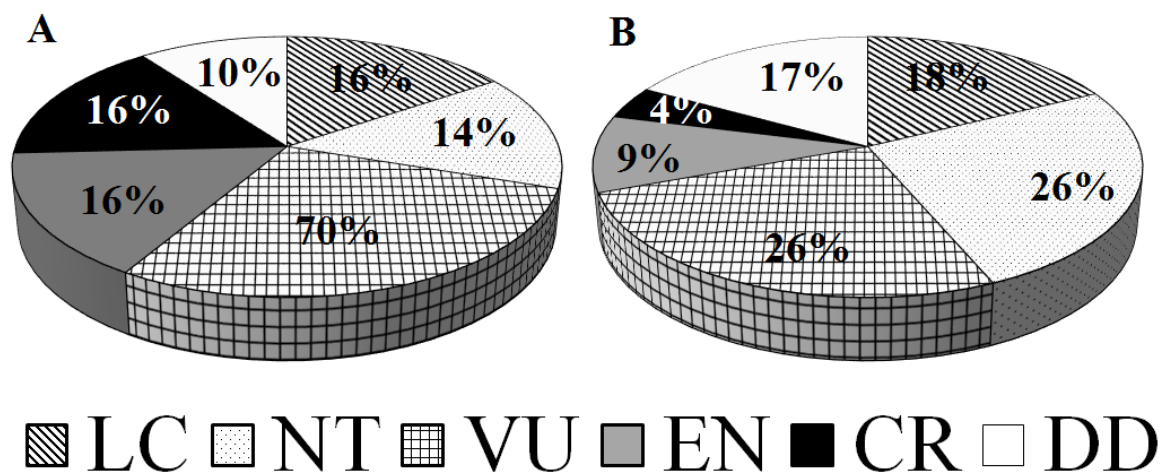


Fig. 2. Threat status of the percentage of herpetofaunal species in Valle de Cauca: (A) = Amphibians, (B) = Reptiles.

Eighty percent of the amphibian families contain species under some level of threat, with 40% of the species in the family Craugastoridae in one of the threat categories. In general, the NT species are represented mostly in the families Craugastoridae, Centrolenidae, Hylidae, Dendrobatidae, and Leptodactylidae. In addition, more than one-half of the VU species are in the family Craugastoridae; in particular, the VU and EN species follow the same pattern and include the families Craugastoridae, Centrolenidae, Dendrobatidae, and Hylidae. Significantly, 70% of the CR species are grouped in the Craugastoridae, Bufonidae, and Centrolenidae, families with the greatest risk of losing species, along with representatives of the family Hemiphractidae, which are restricted to the EN and CR. As with the amphibians, most families of reptiles (84%) contain species under some level of threat. In particular, most of the threatened species are in the families Colubridae, Dactyloidae, Dipsadidae, and Gymnophthalmidae, with most in the NT and VU categories. Over 30% of the NT species are in the family Colubridae, followed by the Dipsadidae and Dactyloidae, whereas the VU species are mostly in the Dactyloidae and Dipsadidae. The majority of EN species are in the families Colubridae, Dipsadidae, and Gymnophthalmidae. Furthermore, the CR species are represented by one species in each family, except for the Dactyloidae.

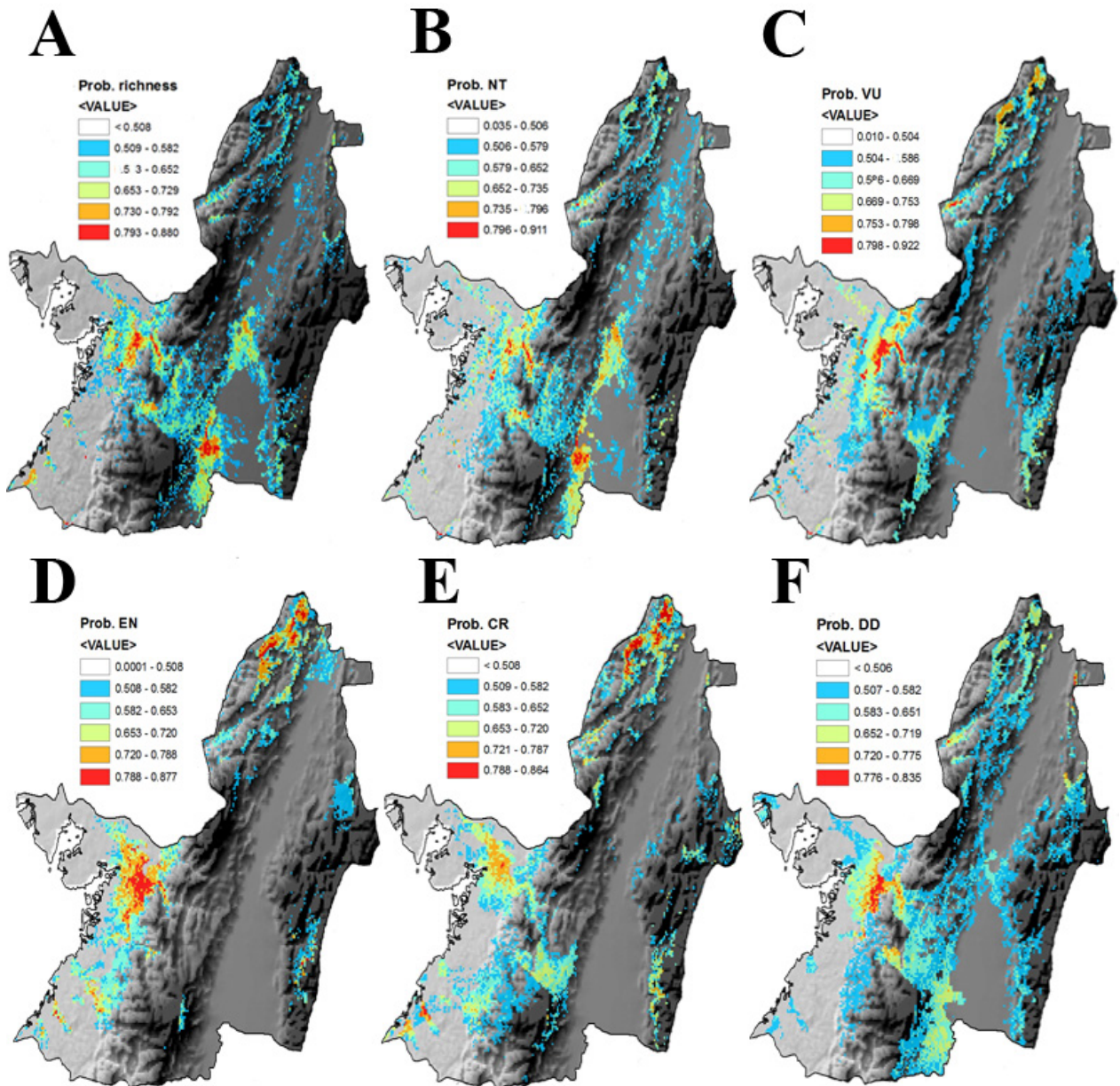
The modeling of the maps present an AUC of 0.754–0.83, indicating a better performance than the random models (Manel et al. 2001). Herpetofaunal richness is scattered throughout Valle del Cauca, but the areas (see Cardona-B. et al. [2013] to define ecoregions in the Valle del Cauca) with the greatest amount of richness are the Pacific region and the Cordilleras (Fig. 3A). The NT species show a wide distribution along the western Cordillera (specifically in the northern and central area), and cover a large area along the Interandean Valley and the Pacific (Fig. 3B). The VU species are found along the foothills and northern and central portions of the western Cordillera, but are less represented in the central Cor-

dillera and in the Interandean Valley (Fig. 3C). The EN species are found in two important areas, the Pacific region and the western Cordillera in the northern part of the dpto; in the central Cordillera, a few representatives are found in the high elevation areas of Sevilla, Tuluá, and Buga, to the north, and Palmira, Pradera, and Florida, to the south (Fig. 3D). The distribution of the CR species is important, based on the presence of *Atelopus* in the central and western Cordilleras and groups of *Pristimantis* in highland areas of the western and central Cordilleras; in addition, the centrolenids and dendrobatids are found in the western Cordillera and the Pacific region (Fig. 3E). Significantly, the DD species are distributed all along the dpto, but show similar patterns to species in the threat categories (Fig. 3F).

In particular, 90% of the municipalities in Valle del Cauca contain one species in at least one of the threat categories, whereas 62% of the municipalities contain more than two species. The municipalities of Buenaventura (82 species), Darién (61), El Cairo (51), Dagua (45), Cali (42), La Cumbre (19), and Yotoco (11) contain the greatest number of species under some level of threat (Fig. 4). A similar pattern was found in these municipalities, where the majority of species fall into the VU category, followed by the EN, and last by the CR, with the only exceptions in the municipalities of Cali and La Cumbre. The municipalities of Buenaventura (six amphibians, five reptiles), El Cairo (10, zero), and Darién (eight, one) contain the largest number of CR species.

### The herpetofauna and protected areas

Protected areas in Valle del Cauca with the greatest number of species are the RFNP (228 species), followed by the PNN (120), RFPR (60), PNR (45), DMI (34), and RN (21), and the area with the least number is the SSF (three species of reptiles). The majority of the species in the RFNP and the PNN are in the VU, and in the remaining areas most of the species are in LC, except for the



**Fig. 3.** Distribution maps for the richness of herpetofauna in the most documented areas in Valle del Cauca. (A) richness, (B) NT species, (C) VU species, (D) EN species, (E) CR species, and (F) DD species.

SFF (Fig. 5). The areas that protect the largest number of species in a threat category are the RFPN (162 species), the PNN (84), the RFPR (37), and the PNR (25), and the areas that protect the least numbers are the DMI, RN, and SFF (13, four, and three, respectively). Throughout the dpto, 17% (~ 57 spp.) of the species are not found in a protected area, and more than 65% of those fall into one of the threat categories (NT = four, VU = 10, EN = seven, and CR = 15). In addition, information is not available for 31% of these species (DD). The protected area with the largest number of species is the RFN de Anchicayá (183 species), followed by the PNN Farallones de Cali (90), the RFPN of the rivers San Cipriano and Escalerete (84), and the RFPR de Bitaco (49).

### Endemic species

Nineteen endemic species are found in the dpto, which represents only 6% of the species diversity. Amphibians represent the largest number of species (13), with 75% in one of the threat categories: CR (six species), EN (three), and VU (two); the remaining 15% are categorized as DD. With regard to the threat categories for reptiles, three species are in the CR, and the other three are DD because they lacked sufficient information for an assessment (Fig. 6). The endemic species are distributed in four types of protected areas, the PNN and the RFPN, which contain a high number of species, and it is worth noting that the PNR el Páramo del Duende and the SFF Isla

Conservation status of the herpetofauna in Colombia

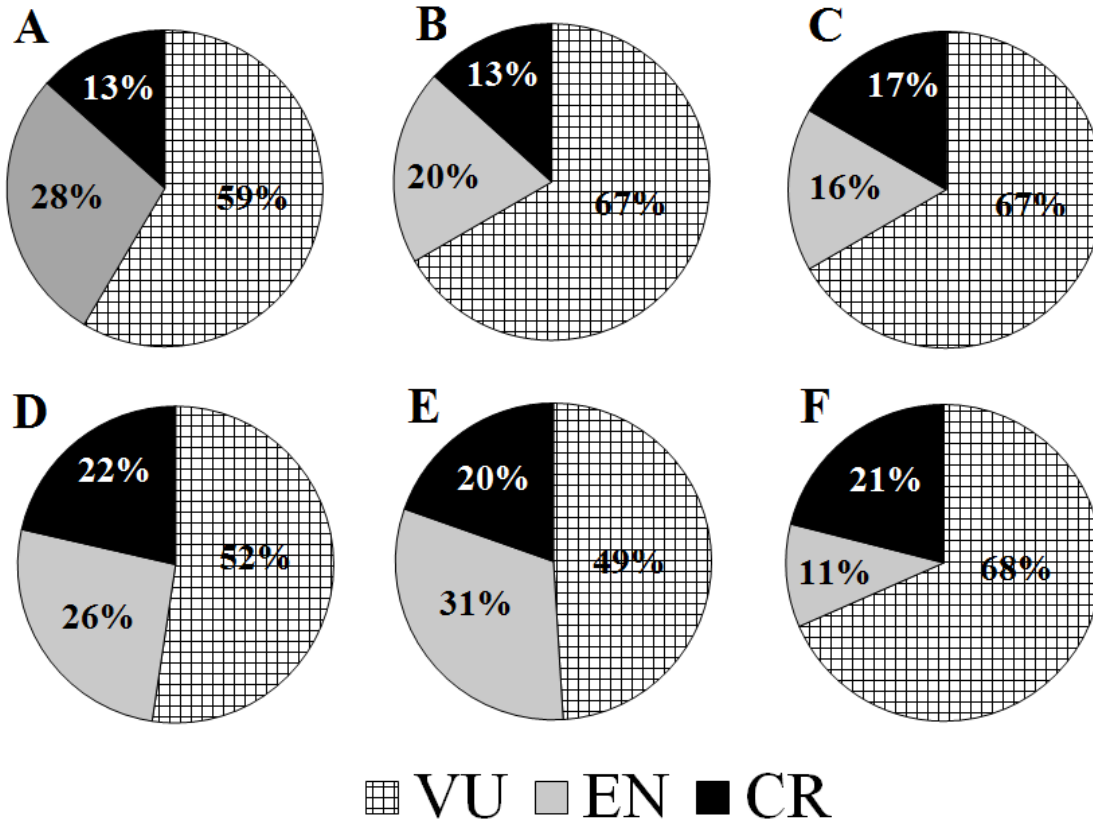


Fig. 4. Municipalities in Valle del Cauca with the greatest number of species in the threat categories: (A) Buenaventura, (B) Dagua, (C) Cali, (D) Darién, (E) El Cairo, and (F) La Cumbre.

de Malpelo are the types of areas with the greatest number of endemic species. Only four species (*Pristimantis diaphonus*, *Anomaloglossus atopoglossus*, *Nymphargus armatus*, and *Geophis betaniensis*) are not found in any of these areas.

**Discussion**

**Conservation status of amphibians and reptiles**

The need to recognize the status of a species in a specific area should be considered baseline information for developing studies and management plans for its conservation. The IUCN categorizations are generally applied globally for each taxon to determine the status of a species at the local or regional levels, and are considered advanced studies (Castro-H. and Bolívar-G. 2010); information on certain species (e.g., population status, natural history) is necessary to elicit an approximate categorization. Records for the DD species (13% of the species in this study) are not well represented in herpetological collections (some are only known from their original descriptions), and thus it is not possible to determine their status.

The dpto contains a high proportion of amphibian species (60%) in one of the threat categories, which represents nearly one-half of the total herpetofauna of the dpto, and the majority of these species show a moderate risk of extinction or population decline over the medium term (VU). In comparison with the results of Castro-H

and Bolívar-G (2010), we show a significant increase in the number of species in the CR (11), EN (10), VU (12), and NT (one) categories, indicating that the risk of disappearance has increased in certain species, which is troublesome.

The lack of a threat status among the reptiles results from insufficient basic ecological information and the actual distribution of their populations (Urbina-Cardona 2008), for which an evaluation of the threat status has focused on specific species or groups (e.g., the red book of reptiles in Colombia), and thus has become a problem for planning conservation strategies. For this reason, the status of populations of reptile species in a given area has been proposed as a mechanism to change attitudes and generate interest in preserving these organisms (Dodd 2001), the protection and restoration of large areas these organism inhabit (Roe et al. 2004; França and Araújo 2006), species-specific information, field studies, demographics, natural history, and possible threats (Cagle 2008; Elfes et al. 2013). Significantly, this study is a local proposal that easily addresses the status of reptile species in Valle del Cauca, so that more effective strategies can be accomplished. This study is the first to assess many species of reptiles, and in spite of their low density threats might make them vulnerable and affect their abundance in the dpto; in many cases, characteristics of their natural history allow them to avoid these conditions.

The conservation of snakes remains subjective, because the current status of many species remains un-



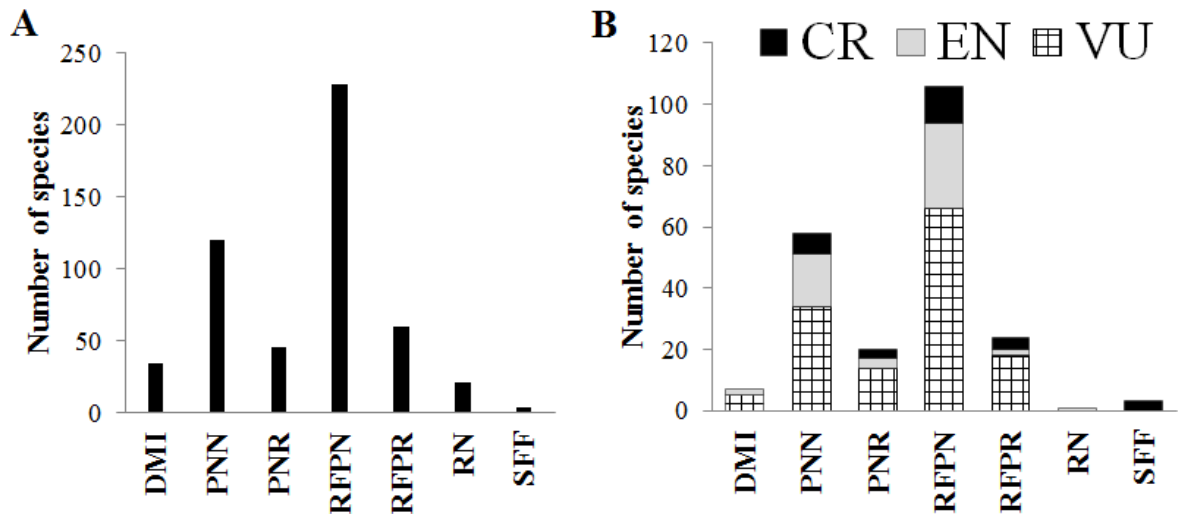


Fig. 5. The herpetofauna of Valle del Cauca according to (A) the type of protected area, and (B) species with some degree of threat in each type of protected area.

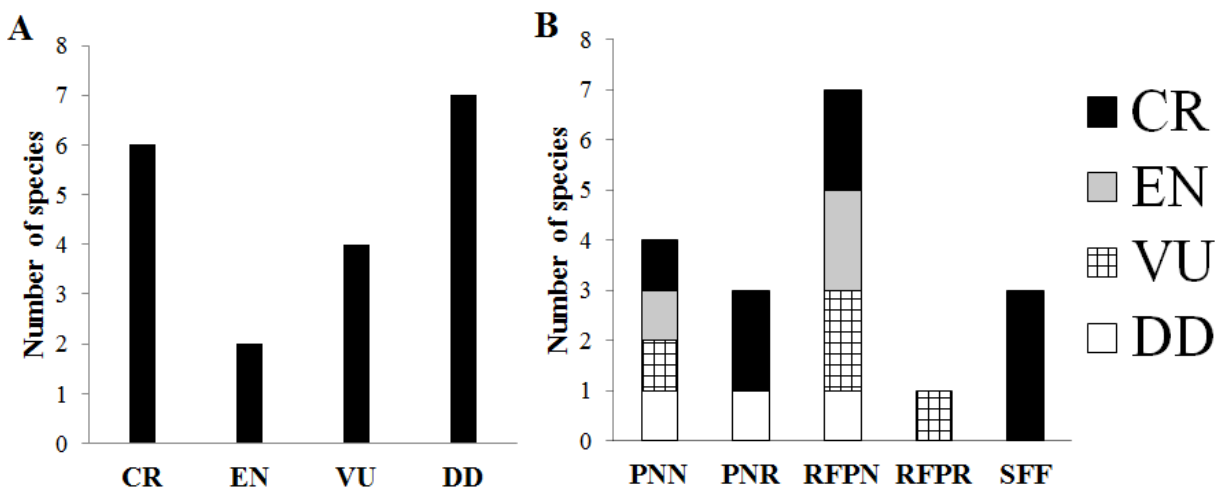


Fig. 6. Endemic species listed according to (A) threat category, and (B) by protected areas in Valle del Cauca.

known. According to Lynch (2012), these animals are some of the most threatened because their deaths are provoked by people living in rural areas, vehicles traveling on highways, the loss of habitat, climate change, and illegal trafficking. Vargas et al. (2011) showed that even in a protected area such as the RFPN Bosque de Yotoco (Valle del Cauca), some snakes are vulnerable to the effects of roads on account of the prolonged amount of time that deaths by vehicles have been caused, considering the low density of populations and small size of the reserve.

### Threatened species in the municipalities and protected areas

Because of their considerable size and strategic location in high diversity life zones, municipalities such as Buenaventura, El Cairo, and Dagua contain a large number of threatened species of both groups (Cardona et al. 2013); however, these areas are the focal point of

anthropogenic pressures, and thus certain species have been affected. Moreover, municipalities such as El Águila, Ulloa, El Dovio, Versalles, Ansermanuevo, Florida, Pradera, Palmira, El Cerrito, Buga, Tuluá, and Sevilla, among others, lack adequate sampling and are under-represented in collections, and the few data available from these municipalities correspond to widely distributed generalist species, such as colubrid and dipsadid snakes that because of their high dispersal abilities can easily adapt to anthropogenic environments, and thus are categorized as LC (Adams 1994). Conservation efforts, therefore, should be focused in habitats influenced by the western versant of the central Cordillera, important areas for species in the different threat categories.

The distribution of the threat categories in the dpto reflects the pressures on the categorized species; for example, a large number of CR species are in the genus *Atelopus* and most of these are distributed in the two Cordilleras, and like their congener species possibly have been seriously affected by chytridiomycosis (Bonaccorso



*Hypsiboas picturatus*, Buenaventura, San Cipriano, 2003, Fdo Castro.

and Guayasamin 2003; Sanchez et al. 2008; Coloma et al. 2010). In addition, the fragmentation and loss of habitat due to human activities have affected certain sensitive species (like the centrolenids and dendrobatids) principally distributed in the Andean Cordilleras (Hutter et al. 2013) and in the Pacific region (Castro-H and Bolívar 2010). Besides these pressures, several species have experienced a population decline as a result of illegal trafficking and collection for scientific studies (Castro-H and Bolívar-G 2010; Corredor et al. 2010).

Additionally, in evaluating natural groups the “Sistemas Municipales de Áreas Protegidas” (Municipal System of Protected Areas; SIMAP) and the “Sistemas Nacionales de Áreas Protegidas” (National System of Protected areas; SINAP) have centered in municipalities such as Buenaventura, Cali, Dagua, La Cumbre, El Cairo, Darién, and Yotoco in an effort to better understand the conservation status of species in these areas, and to promote the monitoring of populations of these organisms. Furthermore, a network of community reserves is present in the municipality of El Cairo, in the Serranía de los Paraguas (which were not included in our analysis), and we suggest studying and monitoring the natural populations of many threatened and endemic species in this area in order to promote their conservation.

A greater number of species are found in RFPN than in the PNN because of three factors: (1) an extensive area of the RFPN (ca. 154,091 ha) lies in Valle del Cauca, (CVC 2012); although is not larger than that of the PNN,

compared to other types of areas it represents a substantial part of the territory; (2) several reserves in the dpto are located in areas of great richness, such as the RFPN of Anchicayá, and of the San Cipriano and Escalereite rivers in the Pacific Region (Cardona et al. 2013); and (3) extensive research projects have been conducted in several of these areas, for which many bibliographic references are available and a large number of specimens are present in collections, such as in the RFN del Bosque de Yotoco, in which the research group from the Laboratorio de Herpetología de la Universidad del Valle has been conducting inventories from 1978 until the present and recorded a large list of species, of which some are no longer being reported from the area (Castro et al. 2007).

In spite that one of the most effective methods for preserving natural spaces is the use of specific forms of protection and legal regulation that limit or prohibit the development of productive or extractive activities (Vásquez and Serrano 2009), state policies are necessary to guarantee the conservation of important ecological areas (Castro-H and Bolívar-G. 2010) by means of the environmental authority granted to autonomous corporations. In Valle del Cauca, several CR species undergoing population pressures were found in the PNN and the RFPN, such as *Oophaga lehmani*, in which the principal causes for decline in protected areas are the loss of habitat and illegal trafficking (Avila 2007), a clear example of not applying the articles of the *Código de Recursos Naturales Renovables y Protección del Medio Ambiente*



*Bolitoglossa medemi*, Buenaventura, Bendiciones, 2011.



*Oophaga histrionica*, Buenaventura, Anchicaya, 2000.



*Strobomantis ruizi*, Trujillo, Andinapolis, 2010.



*Agalychnis spurelli*, Buenaventura, san Cipriano, 2003.



*Andinobates bombetes*, Darien, Lago Calima, 2005.



*Diasporus gularis*, Buenaventura, Bazan, 2010.



*Gastrotheca antomia*, Dagua, Alto Queremal, 1993, Extinct.



*Pristimantis achatinus*, Buenaventura, Bazan, 2010.

(Code of Renewable Natural Resources and Environmental Protection; CRN). A similar situation exists with other species of amphibians and reptiles that are under great pressure in protected areas of Valle del Cauca, such as the ones mentioned previously and including mining, death caused by humans, and pesticide contamination from the fumigation of illicit crops, which illustrates a lack of control in these protected areas. In addition, the current laws in these areas and the reasons for proposing them are not clear, such as for preservation, conservation, and ecotourism, and in some areas they could supersede their carrying capacity.

Castro-H and Bolívar-G (2010) indicated that within the great variety of habitats found in the dpto those with specific characteristics became inclusive centers of speciation, and that these unique areas are of great importance because they contain endemic species. The endemic species in these areas could easily disappear on account of an environmental threat, because of their specialized requirements and limited distribution. The size of their distributional range is indispensable for their conservation, and these species should be included in at least one state protected area where conditions are stable, so there is less potential for risks and their populations can continue to develop (Rueda-A. et al. 2004). These requirements are necessary for their preservation, but it is worth noting that four endemic species (*Nymphargus armatus* and *Anomaloglossus atopoglossus* [CR], *Pristimantis diaphonus* [EN]; and the snake *Geophis betaniensis* [DD]) are not found in any of protected areas designated by the government and/or autonomous regional corporations (CAR = Institutions that are responsible for implementing the policies, plans, programs, and projects on environment and renewable natural resources. Also, they give a full and application to current legal provisions, under the regulations, standards, and guidelines issued by the ministry of environment), which makes them even more susceptible to threats.

### Global categorization vs local situations

Many species of continental turtles and crocodilians are sacrificed for consumption of their meat and eggs, and commercialization of their skins. In addition, pet commercialization, global warming, and developmental activities such as hydroelectric plants also have had a negative impact on their populations (Rueda-A. et al. 2007; Páez et al. 2012). For these reasons, these charismatic species are used to promote studies (biological and economic) and the categorization of these organisms (Castaño-M. 2002; Páez et al. 2012). Various local pressures, however, lead to an analysis of the situation or threat status of these species; for example, *Kinosternon leucostomum* (NT in this study) is a broadly-distributed species for which we have wide information on its ecology and reproductive biology (Giraldo et al. 2012), but it has been affected by habitat deterioration and is con-

sidered the most trafficked pet trade vertebrate species in southwestern Colombia (Galvis-R. and Corredor-L. 2005), which threatens the natural populations.

Although the loss of biological diversity in Colombia has been studied for several years, and plans for the management of threatened species that include a prioritized list of amphibians (Castro-H and Bolívar 2010) have been implemented at the regional and national levels, additional actions and research are still required. Some species in Valle del Cauca that appear in the IUCN category of LC, such as *Gastrotheca argenteovirens* (Ramírez-P. et al. 2004) and *Anolis fraseri* (Castañeda et al. 2011), are at risk and others listed as VU, such as *Centrolene geckoiideum* (Bolívar et al. 2004) and *Gastrotheca antomia* (Castro and Lynch 2004), have not been reported from the dpto in recent years, which suggests a subjectivity in analyzing the threat category in these species, especially on a regional basis. Also, the fossorial habits and difficulty in locating organisms such as caecilians must be considered, and thus their threat status is difficult to determine. According to the IUCN, most species of caecilians are categorized as LC and two species (*Caecilia guntheri* and *Osaecilia polizona*) as DD; however, on a local scale and considering the lack of information for these organisms, not enough data is available to establish a category in the dpto, as reflected in the family Caeciliidae. Similarly, other species might appear stable, but with additional data and the implementation of management plans their threat status might be updated so that protected areas will be able to comply with their function and agreements, in addition to the implementation of management plans for the short, medium, and long terms that are in place but have not been assumed by the environmental authority (CAR del Valle del Cauca, CVC), where all the stakeholders are included.

### Conclusions

One-half of the herpetofauna of Valle del Cauca is under some degree of threat, which is important for the conservation of this fauna, mainly in two areas in the western Pacific region (municipality of Buenaventura) and north on western Cordillera (municipality of Cairo). These hotspots are locations where extensive sampling of the herpetofauna has been conducted, and where species under some degree of threat occur differentially along the dpto.

Additional information on the distribution of amphibians and reptiles, the current status of populations, and the natural history of species in Valle del Cauca are necessary to develop an initiative for a conservation program with specific short-term objectives, so that decisions can help mitigate negative effects in the populations. Furthermore, the protected areas and municipalities in the dpto must develop monitoring plans in their areas that contain detailed information on the presence or absence



*Hypsiboas rubracila*, Buenaventura, Bazan, 2014.



*Pristimantis juanchoi*, La Cumbre, Chicoral, 2010.



*Centrolene gekkoideum*, La Cumbre, Chicoral, 1988, Extinct.



*Anolis lyra*, Buenaventura, Bazan, 2010.



*Kinosternon Leucostomum*, Buenaventura, Zaragoza, 2013.



*Thecadactylus rapicaudus*, Buenaventura, Zaragoza, 2009.



*Basiliscus galeritus*, Buenaventura, Zaragoza, 2013.



*Diploglossus monotropis*, Buenaventura, Bahia Malaga, 2013.

of species, so that along with other organizations they can negotiate the protection and conservation of ecosystems essential for the herpetofauna. In particular, we ask the CAR to ensure compliance with the development of these initiatives.

The conservation of endemic species of amphibians and reptiles should be clear and we must recognize that this requires special management, but the current regulations are not clear enough to define the measures that actually will allow the implementation of specific conservation plans for these species; in many places, the type of area will not allow the sustainability of these species, which are an emblem for the dpto.

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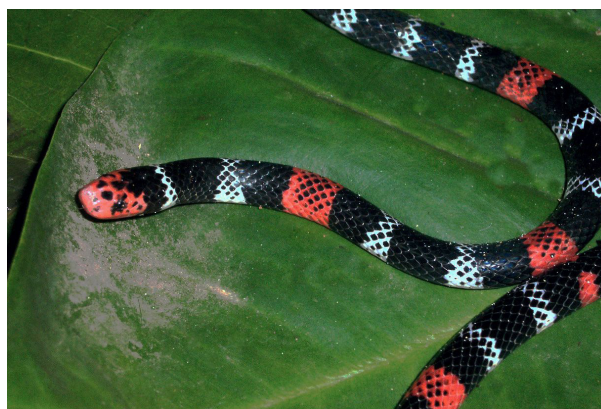
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## Conservation status of the herpetofauna in Colombia



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