



Multi-taxonomic survey in the Sierra del Abra Tanchipa Biosphere Reserve

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SAHAGÚN-SÁNCHEZ, F.J., DE-NOVA, J.A. Multi-taxonomic survey in the Sierra del Abra Tanchipa Biosphere Reserve. *Biota Neotropica* 21(1): e20201050. <https://doi.org/10.1590/1676-0611-BN-2020-1050>

Abstract: Studies on biological diversity are essential to generate baseline information in natural protected areas. In the present study, we developed a multi-taxonomic inventory in the Sierra del Abra Tanchipa Biosphere Reserve, located northeast of San Luis Potosí, Mexico. Systematic samplings were performed between January 2017 to May 2018, for the taxonomic groups of flora, amphibians, reptiles, birds, and mammals. A total of 3 730 records of 683 species were obtained, corresponding to 427 species of flora, 10 of amphibians, 20 of reptiles, 192 of birds, and 34 of mammals, from which 47 species are threatened. The results obtained represent the critical biodiversity that can be found in this natural protected area. The information will be useful for decision-making on the management and conservation of biodiversity in the Sierra Madre Oriental's ecological corridor.

Keywords: *Biodiversity; Conservation; Ecological corridor; Natural protected area; Seasonally dry tropical forest; San Luis Potosí.*

Estudio multitaxonómico en la Reserva de la Biosfera Sierra del Abra Tanchipa

Resumo: Los estudios sobre biodiversidad son fundamentales para generar información de línea base para las áreas naturales protegidas. En el presente estudio se desarrolló un inventario multitaxonómico de la Reserva de la Biosfera Sierra del Abra Tanchipa, ubicada al noreste del estado de San Luis Potosí, México. Se realizaron muestreos sistemáticos para los grupos taxonómicos de flora, anfibios, reptiles, aves y mamíferos y se construyó una base de datos donde se incluyeron todos los registros por grupo taxonómico. Se obtuvieron un total de 3 730 registros de 683 especies, que corresponden a 427 especies de flora, 10 especies de anfibios, 20 especies de reptiles, 192 especies de aves y 34 especies de mamíferos; de las que 47 especies se encuentran en alguna categoría de riesgo. Los resultados obtenidos son una muestra representativa de la importante biodiversidad que es posible encontrar en esta Área Natural Protegida. La información será útil para la toma de decisiones sobre las acciones de manejo y conservación de la biodiversidad en el Corredor Ecológico de la Sierra Madre Oriental.

Palavras-chave: *Biodiversidad; Conservación; Corredor ecológico; Área natural protegida; Bosque tropical estacionalmente seco; San Luis Potosí.*

Introduction

There is great concern over the conservation of global biodiversity due to factors such as climate change, habitat loss, and degradation, as well as the overexploitation of resources (List et al. 2017, O'Connor et al. 2020). Additionally, the processes of compiling biodiversity inventories of high diversity regions such as the Neotropical realm are incomplete, and it is necessary to complete baseline information to improve the conservation efforts (Martínez-Morales et al. 2013, Martínez-Meyer et al. 2014, Almazán-Nuñez et al. 2018).

Mexico is considered one of the hotspots for global biodiversity due to its species richness and high level of endemism but experiencing exceptional loss of habitat (Myers et al. 2000, Llorente-Bousquets & Ocegueda 2008, Mittermeier et al. 2011, Sosa & De-Nova 2012, Sosa et al. 2018). This great biodiversity results from the combination of its orographic and geographic characteristics, which have molded its evolution and ecological relationships over millions of years, forming the diverse ecosystems found in Mexico today (Plascencia-Vázquez et al. 2014, Almazán-Nuñez et al. 2018, Sosa et al. 2018). However, there are some regions in the country where detailed biodiversity inventories are still lacking, so its conservation and adequate management are at risk (Martínez-Meyer et al. 2014, Villaseñor 2016).

Increasing knowledge on biodiversity across the national territory is needed as an initial action for setting out appropriate strategies for ensuring its conservation, particularly in ecological corridors as priority conservation regions in Mexico (Ortiz-Pulido et al. 2010, Larios-Lozano et al. 2017). The Sierra Madre Oriental is a physiographic province that includes threatened ecosystems that are a priority for conservation, like cloud forest and seasonally dry tropical forest (Luna et al. 2004). Since 2010, the National Commission for Natural Protected Areas (CONANP), the German Corporation for International Cooperation GmbH (GIZ), and several institutions and universities have worked together with local communities to establish a regional strategy via the Program for Adaptation to Climate Change for the Sierra Madre Oriental Ecological Corridor, published in 2013 (CONANP-GIZ 2013). This regional strategy has focused on the generation of knowledge on the specific conditions in priority conservation areas in the Sierra Madre Oriental and, particularly, in the State of San Luis Potosí since gaps and omissions in the state's system of biosphere reserves have been identified in recent years (Chapa-Vargas & Monzalvo-Santos 2012). These omissions represent vulnerability and risk for the integrity of regional ecosystems and biodiversity. In this context, efforts that obtain up-to-date information on the components of the region's biological diversity and ecosystem services are urgent since the absence of necessary information on its biotic communities and natural protected areas (NPA) (Martínez-Morales et al. 2013).

The Sierra del Abra Tanchipa Biosphere Reserve (SATBR) in the state of San Luis Potosí, Mexico, is an NPA that constitutes one of the northernmost regions for Northeast Mexico where the seasonally dry tropical forest is found. Moreover, several studies describe its great importance as a corridor for the jaguar populations (*Panthera onca*) (Ortega-Huerta & Peterson 2004, Dueñas-López et al. 2015) and habitat for plant species such as the elephant's foot (*Beaucarnea inermis*), cycads (*Zamia fischeri* and *Dioon edule*), orchids and others (Rubio-Méndez et al. 2018, De-Nova et al. 2019b). Although there are gaps in information on regional biological diversity, this NPA has been recognized for its high levels of biodiversity as a Priority Terrestrial Region, under the reference RTP-96 (Arriaga et al. 2009), and an Important Bird Area,

under the reference AICA C-54 (Arizmendi & Márquez 2000). Given its location, the reserve functions as a connectivity link for threatened and endangered species in the Sierra Madre Oriental Ecological Corridor (CESMO 2018) and is a significant provider of ecosystem services in the region (Lott et al. 1987, Mandujano & Gallina 1996, Navarro et al. 2004, García & Cabrera-Reyes 2008, Mballa et al. 2011, Martínez 2013, De-Nova et al. 2019b).

Therefore, this study aims to generate information on the richness and taxonomic diversity of five different ecological groups (plants, amphibians, reptiles, birds, and mammals) in the Sierra del Abra Tanchipa Biosphere Reserve (SATBR), using rapid biological inventories. The results will be useful for increasing baseline information and strengthening efforts to conserve biodiversity at a local, regional, and national level.

Materials and Methods

1. Study area

The SATBR is located northeast of San Luis Potosí, Mexico (Figure 1), with a surface area of 21 464 ha, of which 16 758 ha constitute its nucleus, 4 223 are for sustainable use, and 482 are for traditional uses, according to the reserves' management program (SEMARNAT-CONANP 2014). The SATBR area of influence includes the municipalities of Ciudad Valles and Tamuín. There is an altitudinal range that goes from 300 m to 850 m asl 3 to 10.5 km in length from west to east, and then descend abruptly to 100 m asl to the east. The soils are of the regosol, vertisol, lithosol, and rendzina types, and sedimentary limestone rocks predominate facilitating infiltration and allowing the recharge of water bodies (INEGI 2011). This region has a warm subtropical climate and rains in the summer (Aw1 and Aw0), with an average annual temperature of 24.5°C and average annual precipitation of 1 095 mm. Simultaneously, its vegetation mainly comprises seasonally dry tropical forests, with a limited presence of palm groves, tropical oak forest, and secondary vegetation outside the core area of the NPA (Durán 2018). These tropical ecosystems are under threat from human activities that cause deforestation and fragmentation, especially in the cultural region of San Luis Potosí known as the Huasteca (Reyes-Hernández et al. 2006).

2. Field sampling

Nine systematized field trips with an average duration of three days were conducted in the SATBR from January 2017 to May 2018, collecting the curatorial, taxonomic, and geographical information from the recorded species (Figure 1). We sampled amphibians and reptiles in three of the field trips, mammals in five, and plants and birds in all of them. We collect records in 10 sites for amphibians, 13 for reptiles, 40 for mammals, 235 for plants, and 438 for birds. For the field sampling, three to six people participated per taxonomic group, including at least one local guide. Plant voucher specimens were collected according to the agreement CONABIO-CONANP FB1829/PJ029/17, in the other cases, we release all the individuals collected. The risk categories were established based on Official Mexican Standard NOM-059-ECOL-2010 (SEMARNAT 2010), the Red List of the International Union for the Conservation of Nature (IUCN 2018), and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES 2018).

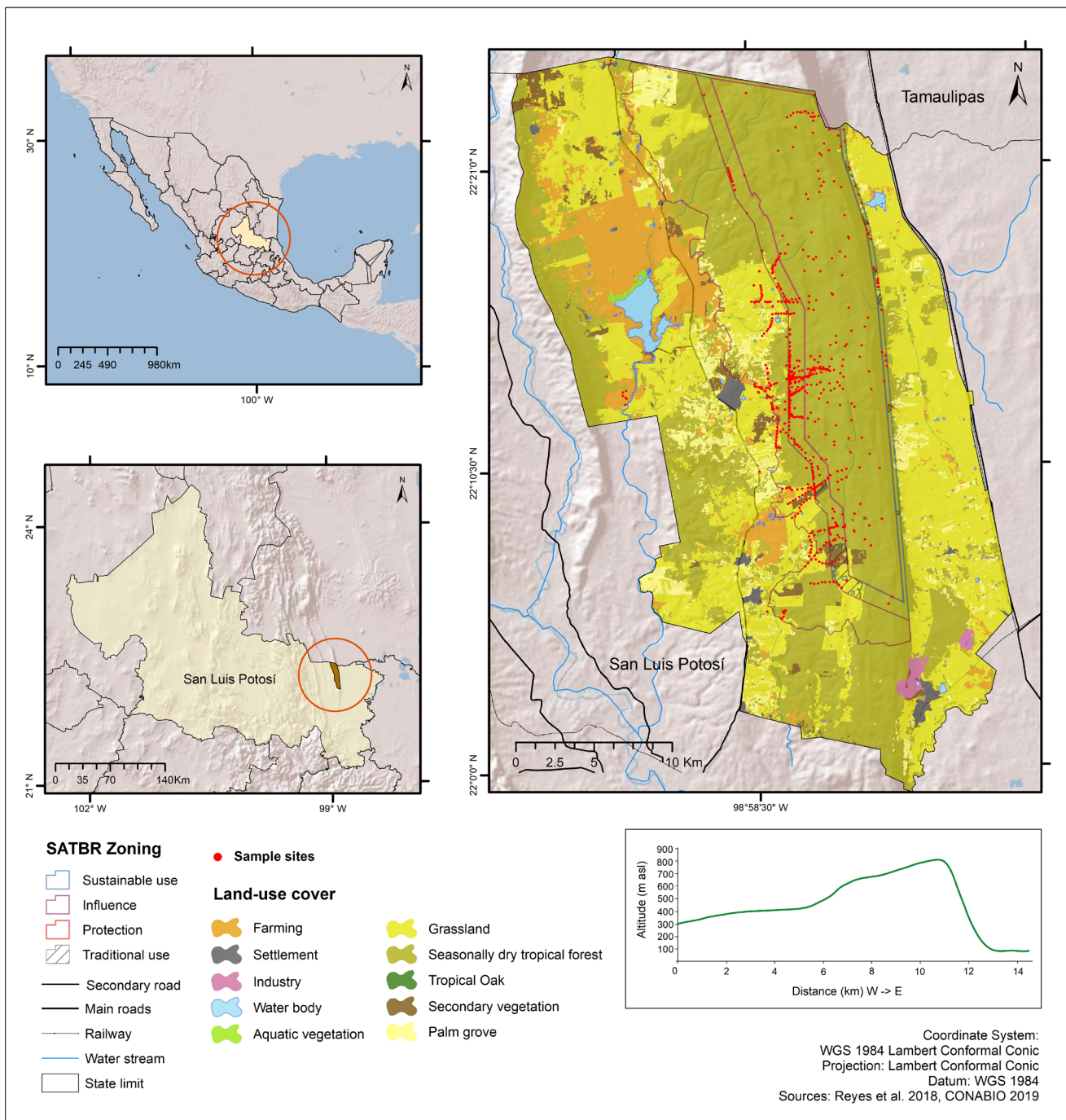


Figure 1. Geographic location and land-use cover of Sierra del Abra Tanchipa Biosphere Reserve in San Luis Potosi, Mexico.

2.1. Flora

The floristic inventory was conducted using standardized methods and sampling by vegetation variants. Sampling was carried out along transects from 4 km to 9 km in length, west to east (De-Nova et al. 2019a, b). For each species, its growth form was assigned according to the concepts of Font Quer (1953). The first duplicate for each voucher was deposited at the Isidro Palacios Herbarium (SLPM) for the processing and identification. The rest of the identified duplicates were distributed in regional herbaria (HGOM, IBUG, QMEX, and UAT). The collections at SLPM and UAT herbariums were also consulted for

historical vouchers from the region. The nomenclature was standardized using the Taxonstand v.2.1 software package (Cayuela et al. 2017) for R (R Core Development Team 2019), which is based on The Plant List (TPL 2010). The angiosperms were classified using the APG IV (2016) system, while the ferns and allies, as well as gymnosperms were classified using the systems proposed by Christenhusz et al. (2011a, b).

2.2. Amphibians and reptiles

In order to register the amphibians and reptiles, intensive direct searches were carried out at each site during the field visits, in the

morning for four hours around noon and at night for three hours, mainly in bodies of water, under rocks, in caves and burrows, in the vicinity of human constructions, and under tree trunks. All the animals captured were released. Some individuals were collected live, placed in muslin bags, and transported to the laboratory for correct identification and subsequent release. The individuals were identified based on the work of Casas-Andreu & McCoy (1987), Duellman (1970), Flores-Villela et al. (1995), Frost et al. (2006), Lemos-Espinal & Dixon (2013), Rovito et al. (2015), Smith & Taylor (1945), Wiens et al. (2007), and Wilson et al. (2013). The present study followed the taxonomy proposed by Liner (2007), while the names of the amphibians and reptiles were updated based on the work of Flores-Villela & Canseco-Márquez (2004), Lemos et al. (2015), Lemos & Dixon (2016), and Ramírez-Bautista et al. (2014).

2.3. Birds

The bird species were recorded via a combination of field methods to maximize the successful detection of species. Line transects with approximately 3 km in length were applied in thirteen sites (Ralph et al. 1996, Blendinger et al. 2004, Travaini et al. 2004). We visited sampling sites in the morning between 6:30 and 10:30 a.m. and the afternoon between 5:00 and 7:00 p.m. as this is the period during which the highest level of bird activity occurs and increases the possibility of obtaining visual and auditory records of species (Salinas-Melgoza & Renton 2005, De Labra et al. 2010, Forshaw 2010). The time of record, the number of individuals, the detection method (vocalization, visualization, or photographic), and the activity presented (roosting, foraging, vocalizing, and in-flight) were recorded for each individual, as were the type of habitat and vegetation in which the individual was observed and all other data required by the project public database. In the other hand, mist nets were installed at each site for two days, for an average of ten hours per day, and reviewed every 30 minutes, in order to capture and identify inconspicuous species in the undergrowth, an approach which increased the number of species registered, with all individuals captured then released. The identification of the species in the field was carried out using the guides produced by Howell & Webb (1995), Kaufman (2005), Peterson & Chalif (1989), and Van Perlo (2006), as well as the applications (apps) produced from guides by the IBird PRO, Sibley, and Audubon Bird PRO. Finally, information related to the birds' seasonality was determined based on that proposed by Howell & Webb (1995) and Berlanga et al. (2015). The taxonomic arrangement used supplements up to number 60 (Chesser et al. 2019), proposed by the American Ornithologists Society (AOS 2019).

2.4. Mammals

For small mammals sampling, 150 Sherman traps were set in line transects per night during field trips inside the reserve, baited with a mix of oats, cracked corn, sorghum, and vanilla. The small mammals captured were identified and recorded, then were released at the site of their capture. Mist nets were installed for the registration of Chiroptera, while an ultrasonic detector was used to record the insectivorous bats, with the recordings donated to the project Sonozotz National Bat-Sound Library project (AMMAC-CONABIO). The bats were identified in the field and released at their capture site (Medellín & Sánchez 2008). Owl pellets were collected to find skulls they could contain; they were cleaned according to Cruzado et al. (2018). Medium- and large-sized mammals were registered using 38 camera traps for 54 days located

around water bodies, and sites known for local guides as wildlife crossing sites in the area. The cameras were installed in November 2017 and were removed in January 2018. The species was classified following the taxonomy proposed by Ramírez-Pulido et al. (2014) and Wilson & Reeder (2005).

3. Data analysis

Potential species richness for each taxonomic group was estimated using accumulation curves, where new species registered per sampling unit (days) were graphically represented (Villareal et al. 2006). The curves were calculated with the function *specaccum* in the *vegan* software package (Oksanen et al. 2019) in R.3.3.3 (R Development Core Team 2019), using 10 000 random replicates via the first order Jackknife nonparametric estimator (Jack 1). Jack 1 is a function of the number of species present in one single sampling unit, and it is a good estimator in terms of global precision (95%), even with a low number of samples (González-Oreja 2010, Gotelli & Colwell 2011). Since the number of taxa is logarithmic dependent of the size area, we compare the species richness for each taxonomic group in the NPA with other sites with similar ecosystems, using the taxonomic biodiversity index according to Squeo et al. (1998): $TBI = S/\ln A$, where S is the total of recorded species and $\ln A$ is the natural logarithm of the size of the study area.

Results

The total species richness, for the five taxonomic groups studied, includes 683 species (256 for fauna and 427 for flora) from 497 genera, 166 families, and 66 orders (Table 1). The information is supported with specimens in biological collections, photographs, and registers in open databases and forms part of the resources available in the National System of Information on Biodiversity (SNIB) of National Commission for the Knowledge and Use of Biodiversity (CONABIO) in México. The online database can be consulted at the link: <http://www.conabio.gob.mx/institucion/cgi-bin/datos.cgi?Letras=PJ&Numero=29>.

Table 1. Species richness for taxonomic groups in the Sierra del Abra Tanchipa Biosphere Reserve, San Luis Potosi, Mexico.

Taxonomic group	Order	Family	Genus	Species	Endemic	Threatened
Plants	35	89	305	427	46	9
Birds	22	44	134	192	19	26
Mammalia	6	14	30	34	8	5
Amphibia	1	7	10	10	0	2
Reptilia	2	12	18	20	6	5
Total	66	166	497	683	79	47

1. Flora

A total of 707 botanical specimens were collected over 61 days, representing 427 species of vascular plant, from 305 genera and 89 families (Appendix 1, Table 1). The richness estimator predicted the presence of 456.13 ± 36.21 species (Figure 2a), and the TBI was 87.91 sp/ $\ln A$. The eudicots are the best represented taxonomic group, with 308 species (72.13%), followed by the monocots, with 98 species (22.95%),

while the remainder is divided among magnoliids, with 13 species, gymnosperms, with two species, and ferns and allies, with 11 species respectively. The most diverse families were Fabaceae (28 genera, 40 species), Orchidaceae (23 genera, 28 species), Poaceae (15 genera, 21 species), Asteraceae (18 genera, 20 species), and Euphorbiaceae (nine genera, 20 species). The most diverse genera were *Ipomea*, *Peperomia*, and *Tillandsia*, with seven species each, followed by *Euphorbia* and *Solanum*, with six species each. There were 206 herbs, 81 trees, 64 shrubs, 47 climbings, and 29 epiphytes concerning the growth type. From all species, 409 are supported with herbarium specimens, and 18 are photographic records included in the project 2301 of portal Naturalista (CONABIO 2019) (Figure 3). According to the NOM-SEMARNAT-059-2010, the area includes two endangered species (P), four threatened species (A), and one subject to special protection. Additionally, 40 species are listed in Appendix II of CITES. For the IUCN, two species are endangered (EN), three are near threatened (NT), 85 in the least concern (LC), and seven with data deficient (DD).

2. Amphibians

A total of 10 species for amphibians were recorded, including seven families and ten genera (Appendix 2, Table 1, Figure 4). The species accumulation curve for this group predicting the possible presence of 10.47 ± 1.12 species (Figure 2b). The TBI was 1.86 sp/lnA. Only *Rhinophrynus dorsalis* and *Lithobates berlandieri* are categorized as species subject to special protection, according to NOM-SEMARNAT-059-2010. There are no species listed as threatened in the Red List of IUCN.

3. Reptiles

Two reptile orders were recorded in the area (Sauria and Testudines), comprising 71 individuals corresponding to 20 species from 18 genera, 12 families, and two orders (Appendix 3, Table 1, Figure 4). The species accumulation curve estimates the presence of 21.23 ± 2.66 species (Figure 2c), and the TBI was 3.72 sp/lnA. Six species are endemic to Mexico (Appendix 3), and according to the NOM-SEMARNAT-059-2010, there are four cataloged species under threat (*Terrapene carolina mexicana*, *Lepidophyma micropholi*, *Scincella silvicoland*, and *Leptophis mexicanus*). For the IUCN, three are considered vulnerable species (*Terrapene carolina mexicana*, *Trachemys venusta*, and *Lepidophyma micropholis*).

4. Birds

In total, 192 bird species were recorded from 22 orders, 44 families, and 134 genera (Appendix 4, Table 1, Figure 5). The accumulation curve indicates that the sampling is representative, with the estimator predicting the possible presence of 206.11 ± 6.68 species (Figure 2d), and the TBI was 42.28 sp/lnA. The order Passeriformes is the best represented, with 17 families, of which, Parulidae and Tyrannidae include the highest number of species, followed by the families Cardinalidae, Accipitridae, and Icteridae. In terms of the migratory status of the species, 75% were found to be permanent residents and 17% winter residents, and the remainders are 4% summer residents and 4% passing migrants. 23 species have a category of endemism, being remarkable the Tamaulipas crow (*Corvus imparatus*), the red-crowned amazon (*Amazona viridigenalis*), and the crimson-collared

grosbeak (*Rhodothraupis celaeno*). Two species (*Glaucidium sanchezi* and *Dendrotyx barbatus*) endemic to the Sierra Madre Oriental were registered. Twenty-six species are in a risk category, eight species in danger of extinction, five under threat, and 13 are subject to special protection according to the classification set out in NOM-059-SEMARNAT-2010 (Appendix 4). In terms of the IUCN categories, three species were cataloged as Endangered (EN) (*Amazona oratrix*, *Amazona viridigenalis*, and *Setophaga chrysoparia*) and three as Vulnerable (VU) (*Ara militaris*, *Crax rubra*, and *Dendrotyx barbatus*). Three species (*Amazona oratrix*, *Amazona viridigenalis*, and *Ara militaris*) were classified under the CITES Appendix I criteria, and 26 species under Appendix II criteria with a significant number of species from the families Accipitridae and Trochilidae.

5. Mammals

A total of 381 records for 34 mammal species from 30 genus were obtained (Appendix 5, Table 1, Figure 4). The richness estimator predicted the potential presence of 37.21 ± 4.38 species (Figure 2e), and the TBI was 6.51 sp/lnA. Among six orders, were registered, with the best-represented orders being Chiroptera and Rodentia. Fourteen families were registered, of which, the rodent family Cricetidae and the bat family Mormoopidae presented the highest numbers. The record of a new species for San Luis Potosí (*Perimyotis subflavus*) should also be noted. Five species are under conservation concern by the NOM-059-SEMARNAT-2010 (*Perimyotis subflavus veraecrucis*, *Panthera onca veraecrucis*, *Herpailurus yagouaroundi cacomitli*, *Leopardus pardalis pardalis*, and *Leopardus wiedii oaxacensis*), and for the IUCN, *Perimyotis subflavus veraecrucis* is considered vulnerable, and two species are near threatened (*Panthera onca veraecrucis*, *Leopardus wiedii oaxacensis*).

Discussion

The extent of the Sierra del Abra Tanchipa Biosphere Reserve (SATBR) represents only 0.35% of the state of San Luis Potosí, making its species richness more significant. In terms of the biodiversity of the state, the SATBR contains 7.88% of its vascular plants (Villaseñor 2016), 23.25% of its amphibians (Quintero-Díaz et al. 2019a), 14.49% of its reptiles (Quintero-Díaz et al. 2019b), 35.87% of its birds (García-Trejo et al. 2019), and 20.98% of its mammals (Martínez de la Vega et al. 2019), reaffirming it as a priority conservation region. At a national level, the best-represented group in the SATBR, is the birds with 16.79% of the country (Navarro et al. 2014). Additionally, the presence of emblematic species, such as the military macaw (*Ara militaris*), the yellow-headed amazon (*Amazona oratrix*), and the ornate hawk-eagle (*Spizaetus ornatus*), supports the AICA classification for the SATBR. On the other hand, amphibians represent 2.64%, reptiles 2.31%, and mammals 6.35% of Mexico's fauna. The vascular plants in the reserve represent up to 13.24% of the richness described for seasonally dry tropical forests in Mexico and, as in other sites with this vegetation, the most species-rich families are Apocynaceae, Asteraceae, Convolvulaceae, Euphorbiaceae, Fabaceae, Malvaceae, Orchidaceae, and Poaceae (De-Nova et al. 2019b), with emblematic species such as the "chamal" cycad (*Dioon edule*) and the elephant's foot palm (*Beaucarnea inermis*).

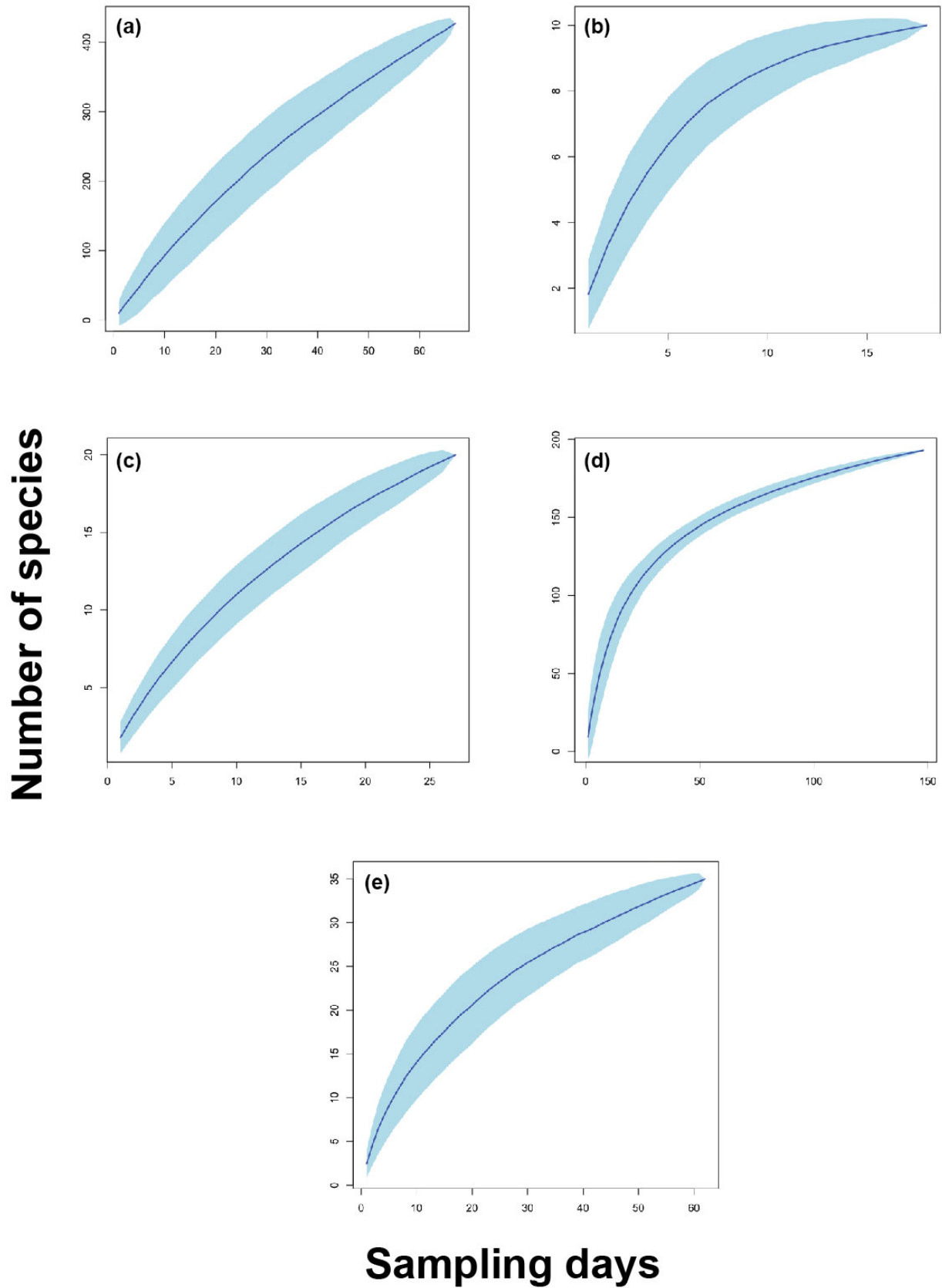


Figure 2. Species accumulation curves for a) Plants (Tracheophyta), b) Amphibia, c) Reptilia, d) Birds and e) Mammalia, in the Sierra del Abra Tanchipa Biosphere Reserve, San Luis Potosi, Mexico. The line highlights the cumulative increase of species, and the shaded area exposes the 95% confidence intervals.

Multi-taxonomic survey in Abra Tanchipa

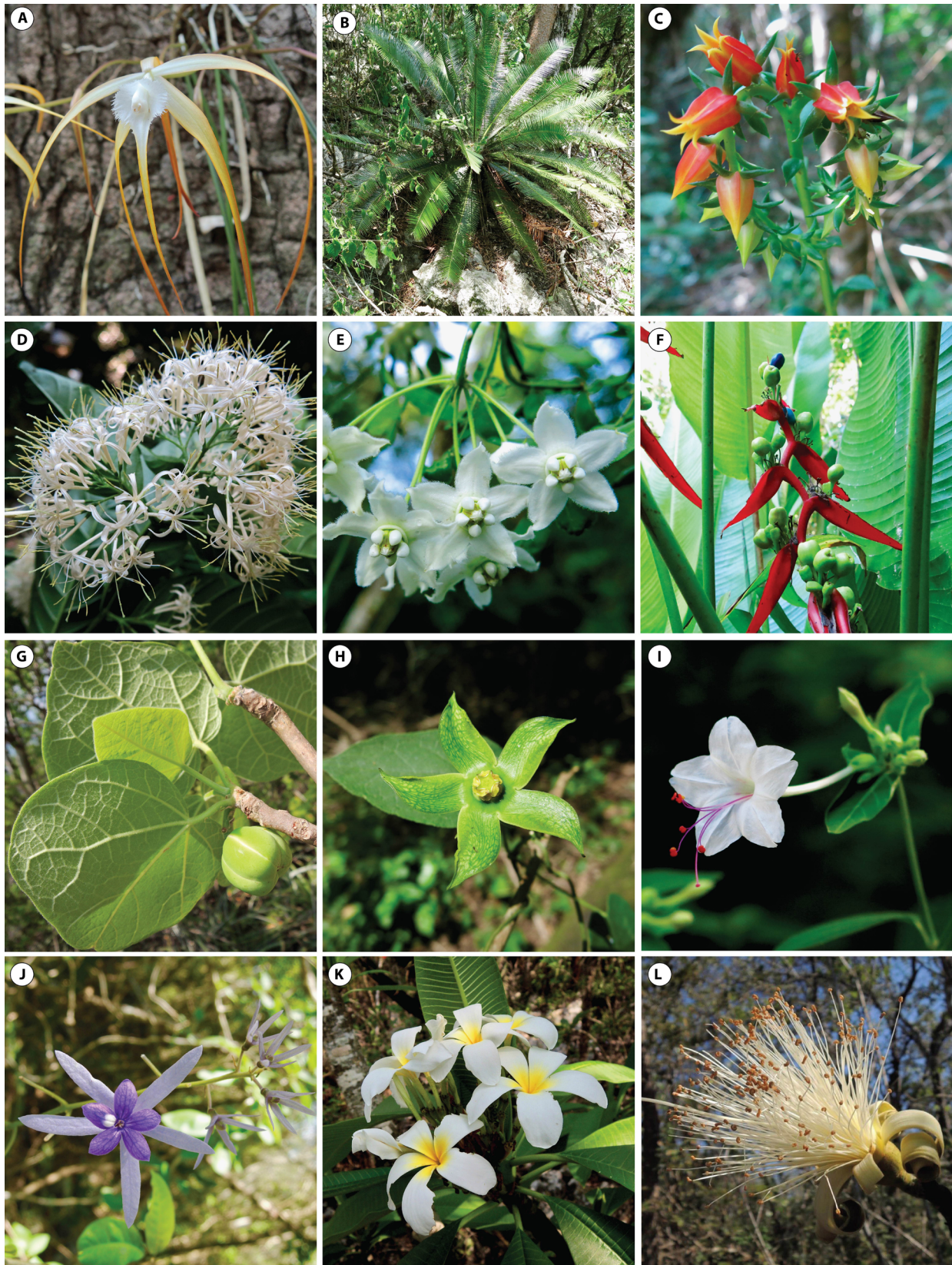


Figure 3. Some vascular plant species in the Sierra del Abra Tanchipa Biosphere Reserve, San Luis Potosi, Mexico. A) *Brassavola cucullata*; B) *Dioon edule*; C) *Echeveria tamaulipana*; D) *Exostema caribaeum*; E) *Funastrum pannosum*; F) *Heliconia schiedeana*; G) *Jatropha sotoi-numyezii*; H) *Matelea suberifera*; I) *Mirabilis longiflora*; J) *Petrea volubilis*; K) *Plumeria rubra*; L) *Pseudobombax ellipticum*. Photographs by J.A. de Nova.



Figure 4. Some amphibian, reptile, and mammal species in the Sierra del Abra Tanchipa Biosphere Reserve, San Luis Potosi, Mexico. A) *Hypopachus variolosus*; B) *Rhinophrynus dorsalis*; C) *Trachycephalus typhonius*; D) *Ficimia olivacea*; E) *Gerrhonotus ophiurus*; F) *Leptophis mexicanus*; G) *Micrurus tener*; H) *Sceloporus variabilis*; I) *Terrapene carolina mexicana*; J) *Dermanura azteca azteca*; K) *Lasiurus cinereus cinereus*; L) *Puma concolor cougar*. Photographs A, B, C, D, E, F, G, H, and J, by J. Cruzado and L by H. Barcenas.

Multi-taxonomic survey in Abra Tanchipa

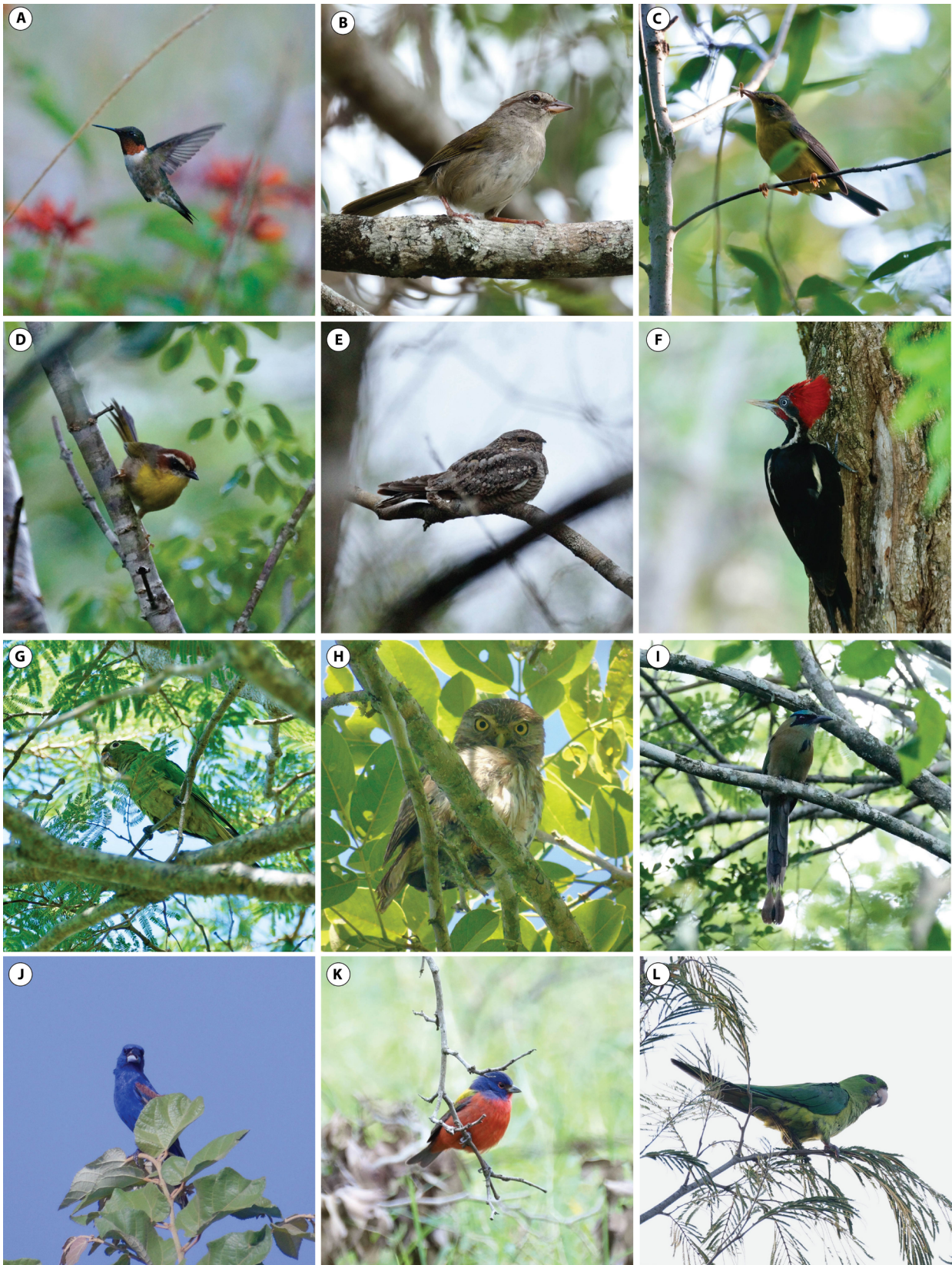


Figure 5. Some bird species in the Sierra del Abra Tanchipa Biosphere Reserve, San Luis Potosi, Mexico. A) *Archilochus colubris*; B) *Arremonops rufivirgatus*; C) *Basileuterus culicivorus*; D) *Basileuterus rufifrons*; E) *Chordeiles acutipennis*; F) *Dryocopus lineatus*; G) *Eupsittula nana*; H) *Glaucidium brasilianum*; I) *Momotus coeruleiceps*; J) *Passerina caerulea*; K) *Passerina ciris*; L) *Psittacara holochlorus*. Photographs by Luis E. Martínez.

The species richness registered in the SATBR could result from its good state of conservation and the continuous cover of its natural vegetation, which enables organism mobility and, thus, maintains the genetic flow of populations, among other processes. As described above, the SATBR is located in the eastern-central biogeographical region of the Sierra Madre Oriental and forms part of an NPA network distributed along the length of the Sierra Madre Oriental Ecological Corridor (CESMO 2018). The species richness registered in the SATBR corresponds to 23.84% of vascular plants, 14.49% of amphibians and reptiles, 36.27% of birds, and 17% of mammals registered for the entire Sierra Madre Oriental, despite to comprise solely 0.47% of this physiographic province (Luna et al. 2004).

Comparing the species richness of the groups in the SATBR with other NPAs in the region, reveals a similar floristic richness of El Cielo Biosphere Reserve in Tamaulipas (581 spp) which also includes a significant surface covered by seasonally dry tropical forest (Hernández et al. 2005). However, there exists a substantial difference in the number of species recorded for amphibians and reptiles (15 spp, 57 spp, respectively, Lavin et al. 2005), birds (179 spp, Gram et al. 2005), and mammals (64 Spp, Sosa et al. 2005). This differences could be related to the higher surface of the El Cielo Biosphere Reserve since the number of taxa is logarithmic dependent of the size area (Squeo 1998) and the existence of different types of vegetation that includes, cloud forest, oak forest, and coniferous forests (Luna et al. 2004), and mainly to the fact that a sampling effort has been made in the field for several years (Sánchez-Ramos et al. 2005).

The TBI calculated for the groups studied in the SATBR in the present research is comparable to that obtained for the El Cielo Biosphere Reserve (2.06 (sp/ln area) for amphibians, 7.83 (sp/ln area) for reptiles, 24.60 (sp/ln area) for birds, and 8.80 (sp/ln area) for mammals), although this NPA has a considerably larger surface area (144 530 ha) than the SATBR (21 464 ha). Comparing the SATBR TBI with data for groups in other regions of the country revealed that it is considerably higher than that calculated. For example, for the bird species of the municipality of Tomatlán, Jalisco, a region of western Mexico predominated by seasonally dry tropical forest (Ramírez-Albores 2007), 214 bird species were registered and a TBI of 26.70 (sp/ln area), despite its surface area (302 359 ha) is greater than the SATBR (21 464 ha).

Only 4.5 % of seasonally dry tropical forest extent is legally preserved in the neotropics (Portillo-Quintero et al. 2015), and it has been documented that there is a high degree of endemism, diversity of plant life forms and ecophysiological types that have been used as indicators to promote their conservation in the region (Ceballos & Garcia, 1995; Portillo-Quintero et al. 2015). The SATBR contains endemic species, which are priorities for conservation, like reptile species such as *Lepidophyma micropholis*, *Leptophis mexicanus*, and *Scincella silvicola*; bird species such as *Dendrortyx barbatus* and *Glaucidium sanchezi*; mammal species such as *Sigmodon toltecus*, *Pteronotus parnellii mexicanus*, *Artibeus jamaicensis yucatanicus* and, plant species such as *Aristolochia rhizantha*, *Agave univittata*, *Beaucarnea inermis*, *Dioon edule*, *Funastrum pannosum*, *Jatropha sotoi-nunyezii*, *Laelia anceps*, *Mammillaria magnimamma*, *Pilosocereus cometes*, and *Tillandsia utriculata* subsp. *pringlei*. Sierras, such as the SATBR, represent islands of conservation among the areas dedicated to agriculture and livestock, however, the land-use changes in the Sierra

Madre Oriental in recent years, have affected the natural plant cover and biodiversity (Sahagún-Sánchez et al. 2011).

Unfortunately, seasonally dry tropical forest is one of the most threatened ecosystems in the neotropics due to the processes of land-use change, deforestation, and degradation caused by unsustainable agricultural and livestock activities (Pennington et al. 2000, Brooks et al. 2004, Dick & Wright 2005), increasing the importance of inventory studies (Ramírez-Albores 2007, Vergara-Paternima et al. 2017). Reyes-Hernández et al. (2006) found that in 1973, the seasonally dry tropical forest comprised a surface area of approximately 98 270 hectares, which had been reduced to 10 216 hectares in 2000, corresponding to an annual deforestation rate of 11%. This situation reinforces the need to carry out concerted actions to increase knowledge about the area's biodiversity.

The continued compilation of inventories is a response to the results obtained by different studies, which identify these and other NPA as areas with gaps in the information on their biological richness and diversity (Chapa-Vargas & Monzalvo-Santos 2012). An example of the situation mentioned above, in particular for the SATBR, is that until five years ago, there were no registers for the interior of the reserve in databases of scientific collections and on community science websites (e.g., eBird or Naturalista), a situation addressed via projects of community science involving local inhabitants.

Initiatives, such as the Sierra Madre Oriental Ecological Corridor, which aims to increase landscape connectivity among other NPA of the region, such as the El Cielo Biosphere Reserve, the Xilitla Priority Conservation Region, and the Sierra Gorda Biosphere Reserve, may be useful for conserving the regions' habitats and biodiversity. As described by Halfiter (2011), management and conservation actions in NPA must address the sustainable use of resources, be respectful of traditional uses, and be oriented to contributing to the wellbeing and progress of the communities that have, for generations, inhabited the territories occupied by the reserves and beyond.

The present study sets out the most up-to-date information about SATBR. Rapid inventories contribute significantly to the extant body of knowledge on the region and provide elements that enable evaluating the state of conservation of both endemic species and those in a risk category. The information generated by the present research will be incorporated into the reserves' management program, which was reviewed and updated in 2019. It must, eventually, be analyzed and considered by the actors involved in the management of the NPA, to improve the design of management and conservation strategies for mitigating the impact and negative externalities produced by the agricultural, livestock, and other activities undertaken to exploit the resources of this NPA area of influence.

Supplementary Material

The following online material is available for this article:

Appendix 1 - Checklist of the vascular plants in the Sierra del Abra Tanchipa Biosphere Reserve, San Luis Potosí, México. Species endemic to Mexico (E). Growth form: tree (T); shrub (Sh); epiphytes (Ep); herb (He); climbing (Cl). Risk categories (NOM-059-SMARNAT-2010): endangered of extinction (P); threatened (A); subject to special protection (Pr). CITES: Appendix II. IUCN risk categories: endangered (EN); near threatened (NT); least concern (LC); data deficient (DD).

Appendix 2 - Checklist of amphibians in the Sierra del Abra Tanchipa Biosphere Reserve, San Luis Potosi, Mexico. Risk categories (NOM-059-SMARNAT-2010): endangered of extinction (P); threatened (A); subject to special protection (Pr). IUCN risk categories: endangered (EN); near threatened (NT); least concern (LC).

Appendix 3 - Checklist of reptiles in the Sierra del Abra Tanchipa Biosphere Reserve, San Luis Potosi, Mexico. Species endemic to Mexico (E). Risk categories (NOM-059-SMARNAT-2010): endangered of extinction (P); threatened (A); subject to special protection (Pr). IUCN risk categories: endangered (EN); near threatened (NT); least concern (LC).

Appendix 4 - Checklist of birds in the Sierra del Abra Tanchipa Biosphere Reserve, San Luis Potosi, Mexico. Species endemic to Mexico (E), quasi endemic (Q), semi endemic (S), endemic to SMOs (EM). Risk categories (NOM-059-SMARNAT-2010): endangered of extinction (P); threatened (A); subject to special protection (Pr). CITES: Appendix I, II and III. IUCN risk categories: endangered (EN); near threatened (NT); least concern (LC). Residence status: permanent resident (R), winter resident (MI), summer resident (MV), spring or fall transient (T).

Appendix 5 - Checklist of mammals in the Sierra del Abra Tanchipa Biosphere Reserve, San Luis Potosi, Mexico. Species endemic to Mexico (E). Risk categories (NOM-059-SMARNAT-2010): endangered of extinction (P); threatened (A); subject to special protection (Pr). IUCN risk categories: endangered (EN); near threatened (NT); least concern (LC).

Acknowledgments

This research was funded by grant CONABIO FB1829/PJ029/17, and partially by the National Commission of Protected Natural Areas (CONANP), CONACYT (CB-2014/243454), and SEP-PRODEP (103.5/13/6575). The authors are grateful to Juan Cruzado for the work done in the data record for amphibians, reptiles, and mammals. To Pedro Castillo Lara, Javier Fortanelli Martínez, Ricardo González Trujillo, Ana Kareem Gudiño Cano, Flor Isabel Díaz Parra, Luis Enrique Martínez Hernández, María Magdalena Salinas Rodríguez, for their support in the field, the registration, organization, and generation of information in the databases. To José García Pérez and the SLPM Herbarium. To Alejandra Galindo Cruz for the revision on the faunistic lists. To Alejandro Durán Fernández, director of RBSAT, for all the facilities and support during the investigations carried out in the NPA. We especially appreciate the support in the field of Don Hermelindo Guzmán Antonia. The authors are also grateful to the authorities of Ejidos Laguna del Mante, Los Sabinos, and Gustavo Garmendia.

Author Contributions

Francisco Javier Sahagún-Sánchez: concept and design; data collection, data analysis and interpretation, manuscript preparation, and critical revision, adding intellectual content.

José Arturo De-Nova: concept and design; data collection, data analysis and interpretation, manuscript preparation, and critical revision, adding intellectual content.

Conflicts of Interest

The authors declare that they have no conflict of interest related to the publication of this manuscript.

Data availability

The project database was migrated to the National Biodiversity Information System (SNIB) data model of the National Commission for the Knowledge and Use of Biodiversity in Mexico, in Microsoft Office Access format and is also available in the Darwin Core (DwC) VR 1.4 standard in Excel 97-2000 files, a table in Access 2000 and comma-delimited text. All the information can be access in the following website: <http://www.conabio.gob.mx/institucion/cgi-bin/datos.cgi?Letras=PJ&Numero=29>

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Received: 05/06/2020

Revised: 21/10/2020

Accepted: 26/10/2020

Published online: 21/12/2020