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Global Ecology and Conservation

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Review paper

Endemism of woody flora and tetrapod fauna, and conservation status of the inter-Andean Seasonally Dry Tropical Forests of the Marañón valley

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ARTICLE INFO

Keywords:

Marañón river
Endemism
Distribution patterns
Threats
Dam
Conservation

ABSTRACT

Based on a review of literature related to the biological diversity of the inter-Andean Seasonally Dry Tropical Forests of the Marañón valley (ISDTFM), located in the regions of Cajamarca, Amazonas, Piura, La Libertad, Ancash, and Huánuco (Perú), this study highlights the richness of endemic species of woody flora and tetrapod fauna, as well as addressing their threats and state of conservation. We report 143 woody flora endemics, with *Coursetia cajamarcana*, *Parkinsonia peruviana*, and *Pradosia argentea*, among the most important due to their Critically Endangered (CR) condition, according to the International Union for Conservation of Nature and Natural Resources. The endemic fauna is represented by four amphibians, 28 of reptiles, 13 birds, and five mammals; outstanding among them *Synallaxis maranonica* due to its CR. We have identified three distribution patterns (A, B, and C) for the endemic fauna. In some cases, there is altitudinal and latitudinal replacement between patterns A and B. This forest is severely impacted and fragmented by the constant expansion of agriculture and new access routes. This situation could become even worse if planned energy and extractive activities take place. On the other hand, only 1.97% of this forest is under some Natural Protected Area scheme. Therefore, it is essential to have this information to prioritize both their conservation and protection of the ISDTFM.

1. Introduction

The seasonal dry tropical forests (SDTF) of the Neotropics cover separate areas of variable size, lying from northwestern Mexico to northern Argentina and southwestern Brazil (DRYFLOR et al., 2016; Linares-Palomino et al., 2011; Pennington et al., 2000), and constitute 66.7% of the global area of seasonally dry forests (Aguirre et al., 2006). Two hypotheses about SDTF biogeography are currently recognized. The Pleistocene Arc hypothesis states that the current SDTF in eastern South America from the Caatingas of Brazil to Paraguay and Argentina would have been a continuous formation of plants during the Pleistocene period, which is supported

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<https://doi.org/10.1016/j.gecco.2021.e01639>

Received 5 December 2020; Received in revised form 29 April 2021; Accepted 15 May 2021

Available online 21 May 2021

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by studies of floristic similarity. (Linares-Palomino et al., 2011). On the other hand, The Long-Distance Dispersal hypothesis is also plausible since the SDTF flora specialists could have spread in response to suitable climatic and edaphic conditions for their development (Caetano and Naciri, 2011; Moggi et al., 2015). The seasonal dry forest is an ecosystem typically dominated by deciduous trees (> 50%) in frost-free areas, with an annual mean temperature >25 °C, total annual precipitation of 700–2000 mm, and at least three or more dry months with rainfall < 100 mm per year (Prieto-Torres et al., 2020). This type of forest develops on fertile soils, and the dominant plant families are Leguminosae and Bignoniaceae. However, there is a sparse herbaceous stratum, in contrast to similar seasonally dry ecosystems, such as savannas, characterized by acidic and dystrophic soils with fire-tolerant xeromorphic grass stratum (Pennington et al., 2000). These forests are home to high levels of species richness and endemism of wild flora and fauna (DRYFLOR et al., 2016; Pennington et al., 2009; Prieto-Torres et al., 2019). However, they rank among the most threatened terrestrial ecosystems in the world due to human disturbance (Mesa-Sierra et al., 2020; Miles et al., 2006; Portillo-Quintero and Sánchez-Azofeifa, 2010). Besides that, these ecosystems are relatively poorly studied and protected concerning other systems (Dimson and Gillespie, 2020).

In Perú, seasonally dry tropical forests (SDTF) are on the north coast, the inter-Andean valleys, and east of the Andes (Linares-Palomino and Pennington, 2007). Linares-Palomino (2004) based on a multivariate analysis of its floristic components, divides SDTF into; 1) Equatorial SDTF (ESDTF), 2) inter-Andean SDTF (ISDTF) and 3) eastern SDTF (ESDTF). Linares-Palomino and Pennington (2007) adopt a broader concept of SDTF, with six well-represented ecological regions; A1) seasonally dry mountain forests on the north coast, A2) seasonally dry lowland forests on the north coast, B) dry forests of the Marañón valley system, C) Mantaro dry valley system, D) dry forests of the Apurimac dry valley system and E) Tarapoto seasonally dry forests. From which, the system of the inter-Andean SDTF of the Marañón valley (ISDTFM) is located between 6° and 6° 30' latitude sur, covering several basins along the Marañón, Chamaya, Utcubamba, Llaucan and Chocano rivers in the departments of Cajamarca, Amazonas, Piura and La Libertad, with notable populations in Ancash and Huánuco (Fig. 1) (Linares-Palomino, 2004; Reynel et al., 2013). These forests present a high degree of diversity and endemism of species and genera of flora and fauna, which not only have evolved under strong geographic isolation but have also adapted to extreme climatic variation (Marcelo-Peña et al., 2016; Pennington et al., 2010; Särkinen et al., 2011). Therefore, preserving these forests is a priority to avoid the loss of this unique ecosystem, which is considered a world biodiversity epicenter

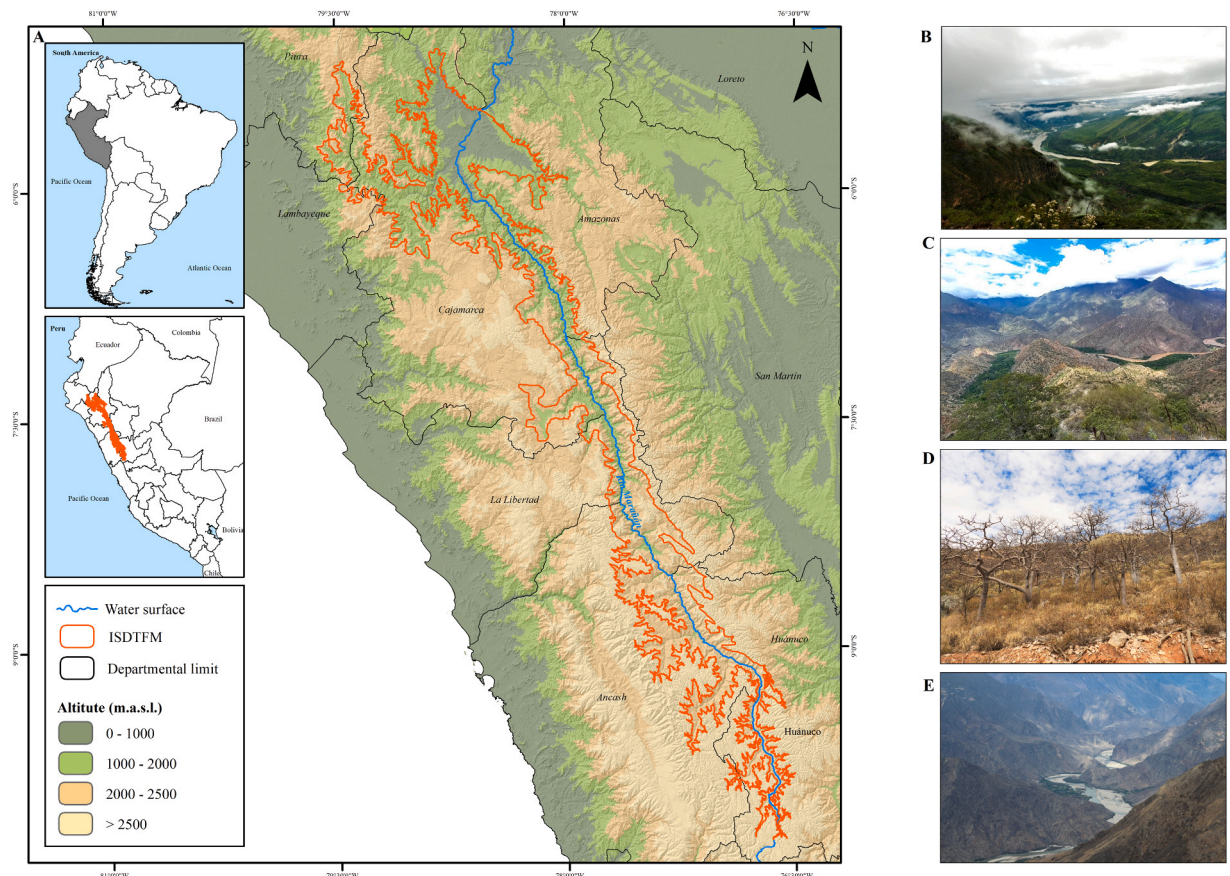


Fig. 1. Inter-Andean seasonally dry tropical forests of the Marañón valley. A: Geographical location of the study area. B: Characteristic vegetation in the wet season in the province of Cutervo (Cajamarca) and Utcubamba (Amazonas). C: Dry season vegetation in the province of Celendín (Cajamarca) and Chachapoyas (Amazonas). D: Dry season vegetation in the province of San Marcos (Cajamarca). E: Vegetation in the province of Cajabamba (Cajamarca). Note that the landscape of the valley varies according to the course of the Marañón river.

because they are part of the Tropical Andes Biodiversity Hotspot (Llosa, 2001).

The ISDTFM are surrounded by Andean shrubs, humid mountain forests, and paramos at the highest altitudes (Figueroa et al., 2016). The climatic conditions form islands of xeric ecosystems (Brack, 1986; Brack and Mendiola, 2010; Killeen et al., 2007), which favor their high degree of endemism, as they contribute to the evolution of numerous endemic species. Furthermore, these forests are part of the biological corridor to conserve a key species, the Andean bear (*Tremarctos ornatus* F. G. Cuvier) (Figueroa et al., 2013). Part of this ecoregion is considered to be one of the Endemic Bird Area (EBA), specifically EBA-048 (EBA Marañón valley), where it shares species with the EBA-045 (Tumbesian region) and with the EBA-051 (Peruvian high Andes) (Stattersfield et al., 1998). This diversity and endemism are also represented for other taxonomic groups such as flora, amphibians, and reptiles (Marcelo-Peña et al., 2019).

Paradoxically, despite their high richness of endemic species of wild flora and fauna, there are currently only seven Natural Protected Areas (NPA), which protect 1.97%; despite the fact that these forests are considered a priority site for the conservation of biological diversity in the Master Plan for Protected Natural Areas (MINAM, 2009). In addition, these forests are rapidly being affected and fragmented by various human activities such as agriculture, livestock, and road construction, leading to deforestation and loss of 48.4% of their original coverage in the regions of Amazonas and Cajamarca (Figueroa et al., 2016). This situation is aggravated by latent threats such as the potential construction of hydroelectric dams along the Marañón River. A clear example of this is that in 2011 the Peruvian government declared the construction of 20 hydroelectric plants in the Marañón river basin to be of "national and social interest", through the Supreme Decree 020–2011-EM (MINEM, 2011). But fortunately, at the national level, there are institutions that have been researching and working for the conservation and protection of these forests, such as the Universidad Nacional Agraria La Molina (UNALM), Universidad Nacional Mayor de San Marcos (UNMSM), Universidad Nacional de Cajamarca (UNC), Universidad Nacional de Jaén (UNJ) and Universidad Nacional Toribio Rodríguez de Mendoza de Amazonas (UNTRM) in collaboration with international universities; as well as the National Service of Protected Natural Areas (SERNANP), the National Forest and Wildlife Service (SERFOR) and the Regional Governments of Amazonas and Cajamarca, and Non-Governmental Organizations (NGOs) such as Nature and Culture International (NCI), el Centro de Ornitología y Biodiversidad (CORBIDI), la Sociedad Peruana de Derecho Ambiental (SPDA) and the Marañón Waterkeeper (Waterkeeper Alliance Member).

This document provides information on the endemism of woody flora and tetrapod fauna and their distribution, threats, and conservation status of these forests. To do this, it presents (i) a description of the endemic species of woody flora and fauna in the inter-Andean SDTF in the Marañón valley and their threat categories according to the International Union for the Conservation of Nature and Natural Resources (IUCN), (ii) a description of the distribution of these species and (iii) a description of the threats faced by these forests and their conservation status based on NPA.

2. Materials y methods

2.1. Study Area

The ISDTFM are located in the Central Andes, bordered by the Western Cordillera and the Central Cordillera to the east. They extend from the Huancabamba depression in northern Peru with the lowest elevation of 2145 m at Abra de Porculla (Duellman and Pramuk, 1999; Koch et al., 2018) along the flanks of the rivers Chinchipe, Chamaya, Huancabamba, and Utucubamba and their tributaries (departments of Piura, Cajamarca, Amazonas) to the south along the deep, narrow valleys of the river Marañón and its tributaries in the department of La Libertad (Särkinen et al., 2011). Its climate differs widely; in the lower part, it is warm and dry due to the Shadow Rain effect caused by the Central Mountain Range of the Northern Andes, while on the hillsides, it is temperate and humid. The temperature is generally constant with an average of 25.9 °C, with four months of higher rainfall (February - May) and an average annual rainfall of 758.55 mm (García-Bravo, 2011). Its extension covers approximately 2'293,199.61 ha (CDC-UNALM, 2006; MINAM, 2009).

2.2. Methodology

Based on the search of various databases and through personal communications, we obtained a total of 165 documents, which were reviewed and filtered by the topics set out in the objective. Thus, getting a total of 99 valuable documents distributed in 65 scientific articles, 17 books (including book sections), five theses between undergraduate and postgraduate, 12 technical documents (reports, decrees, files, and technical cards of NPA).

In addition to the databases mentioned above, we considered six Rapid Biological Inventories (RBI) from the following NPA: Private Conservation Area (PCA) Gotas de Agua I and II, Communal Cujillo PCA, Regional Conservation Area (RCA) Seasonally Dry Tropical Forests of the Marañón, San Pedro de Chuquibamba PCA and the Dry Forests of the Marañón RCA (Appendix A and B); which, of course, report endemic species richness, threats and conservation status of the woody flora and tetrapod fauna (amphibians, reptiles, birds and mammals) in the inter-Andean SDTF in the Marañón valley.

In order to consolidate the list of endemic species, the taxonomic classification of each taxonomic group was updated. The taxonomic classification of woody plants was verified in "The Plant List" (2013) (<http://www.theplantlist.org/>) and Tropicos (<https://www.tropicos.org/home>) (Missouri Botanical Garden, 2021); as for the tetrapod fauna, the list of amphibian species follows the taxonomic order of Frost and American Museum of Natural History (2020) (<https://amphibiansoftheworld.amnh.org/>), the reptile species follows Uetz and Hošek, (2020) (<http://www.reptile-database.org>), the bird species follows the taxonomic order and residence status code: X (Residents), NB (Non-breeders), V (Vagrants), IN (Introduced), H (Hypothetical) and X(e) (Endemic) of South American Classification Committee (SACC) (Remsen et al., 2021) Version Version [01 March 2021] (<http://www.museum.lsu.edu/~Remsen/>

SACCBaseline.htm), species belonging to some EBA, according to Stattersfield et al. (1998) and subspecies according to Plenge (2021). Finally, the list of mammals follows the taxonomic order according to Pacheco et al. (2009) and Peruvian endemism.

To identify the distribution of endemic species of woody flora and tetrapod fauna in the inter-Andean SDTF in the Marañón valley, we used location coordinates available in published documents, technical files of the NPAs, and digital platforms. Coordinates for woody flora were obtained from published documents and NPA technical files. In the case of amphibians and reptiles, we used the coordinates published by Koch et al., 2018. Concerning birds, we requested the corresponding data from the electronic platform eBird (<https://ebird.org/>). Finally, we used the Global Biodiversity Information Facility platform for mammals (<https://www.gbif.org/>) (GBIF.org, 2021a, 2021b, 2021c, 2021d, 2021e) and the RBI of NPA. In this instance, all coordinates were filtered in the area of interest, and duplicated data was removed. To determine the species threats category for each taxonomic group, we used the IUCN Red List of Threatened Species version 2021–1 (IUCN, 2021), considering the following threat categories, Vulnerable (VU), Endangered (EN), and Critically Endangered (CR) and its criteria according to version 3.1 (IUCN, 2012).

3. Results

By reviewing the 99 documents mentioned above, we report that the inter-Andean SDTF in the Marañón valley harbors 441 species of woody flora, of which 143 are endemic to the Marañón valley, and ten are threatened (Table 1 and Appendix A). Regarding the tetrapod fauna, of the 315 species, 50 are endemic to this area, and 19 are threatened (Table 2 and Appendix B: B1, B2, B3).

3.1. Woody flora

An inventory of 440 species of woody plants has been compiled for the inter-Andean SDTF in the Marañón valley (Marcelo-Peña et al., 2016), based on 32 rapid botanical inventories, 92 plots, and a study at the level of local and international herbaria. The species on this list are distributed in 221 genera and 61 families, of which 241 are shrubs, 177 trees, and 22 lianas or scandent shrubs. The most diverse family in terms of species (78) and genera (32) is Leguminosae, and the least diverse is Urticaceae (five species). In terms of genera, the most diverse is *Croton* (12 species), and in contrast, the least diverse is *Zanthoxylum* (four species). The most frequent species in the valley are *Acacia aroma* Gillies ex Hook. & Arn. and *Eriotheca discolor* (Kunth) A. Robyns followed by *Browningia pilleifera* (F. Ritter) Hutchison, *Cynophalla flexuosa* (L.) J. Presl, *Armatocereus rauhii* Backeb., *Sideroxylon obtusifolium* (Humb. ex Roem. & Schult.) T.D. Penn., *Jacquinia mucronata* Roem. & Schult., *Parkinsonia praecox* (Ruiz & Pav.) Hawkins, *Ruprechtia aperta* Pendry and *Browningia altissima* (F. Ritter) Buxb. Additionally, *Lourteilla resinosa* S.A. Graham, Baas & Tobe is included in this inventory, which was reported by

Table 1
Summary of the species endemics and threatened species of the woody flora of the ISDTFM.

Family	Endemic species	Endangered species
	143	10
Acanthaceae	1	
Amaranthaceae	1	
Apocynaceae	4	
Bignoniaceae	1	
Boraginaceae	3	
Cactaceae	29	2
Capparaceae	1	
Caricaceae	1	
Celastraceae	1	
Clusiaceae	2	
Compositae	27	1
Ericaceae	1	
Erythroxylaceae	2	
Euphorbiaceae	16	
Leguminosae	16	4
Loasaceae	1	
Malpighiaceae	7	
Malvaceae	10	2
Meliaceae	2	
Myrtaceae	1	
Nyctaginaceae	1	
Oleaceae	1	
Polygonaceae	2	
Primulaceae	1	
Rhamnaceae	1	
Rubiaceae	1	
Rutaceae	1	
Sapindaceae	1	
Sapotaceae	1	1
Solanaceae	4	
Verbenaceae	2	

Table 2

Summary of the total species, endemics species and threatened species of the tetrapod fauna of the ISDTFM.

Taxonomic group	Total species	Endemic species	Endangered species
Amphibians	14	4	2
Bufo	4	1	
Centrolenidae	2		
Dendrobatidae	3	2	2
Craugastoridae	3	1	
Leptodactylidae	2		
Reptiles	57	28	4
Phyllodactylidae	9	6	3
Sphaerodactylidae	2	2	
Dactyloidae	1		
Polychrotidae	2	1	1
Tropiduridae	3	3	
Teiidae	5	3	
Scincidae	1		
Gymnophthalmidae	2	2	
Amphisbaenidae	1	1	
Boidae	1	1	
Elapidae	1		
Viperidae	1	1	
Colubridae	12	1	
Dipsadidae	9	3	
Anomalepididae	1	1	
Leptotyphlopidae	6	3	
Birds	193	13	10
Tinamidae	2		
Anatidae	1		
Cracidae	1		
Columbidae	10	1	1
Cuculidae	6		
Caprimulgidae	3		
Apodidae	2		
Trochilidae	13	3	3
Rallidae	6		
Charadriidae	3		
Scolopacidae	2		
Ciconiidae	1		
Ardeidae	5		
Cathartidae	2		
Pandionidae	1		
Accipitridae	11		
Tytonidae	1		
Strigidae	7		
Alcedinidae	3		
Picidae	6	1	
Falconidae	4		
Psittacidae	5	1	2
Thamnophilidae	5		
Melanopareiidae	1		
Furnariidae	7	3	2
Tityridae	4		1
Tyrannidae	22		1
Vireonidae	2		
Corvidae	1		
Hirundinidae	4		
Troglodytidae	3		
Poliotilidae	1		
Donacobiidae	1		
Turdidae	2		
Mimidae	1		
Passeridae	1		
Fringillidae	4		
Passerellidae	3		
Icteridae	5		
Parulidae	5		
Cardinalidae	4		
Thraupidae	22	4	
Mammals	51	5	3
Phyllostomidae	19		

(continued on next page)

Table 2 (continued)

Taxonomic group	Total species	Endemic species	Endangered species
Molossidae	1		
Vespertilionidae	3		
Didelphidae	2		
Myrmecophagidae	1		
Cebidae	2	1	1
Cricetidae	7	4	
Erethizontidae	1		
Dasyproctidae	2		
Cuniculidae	2		
Leporidae	1		1
Felidae	2		
Canidae	2		
Mustelidae	2		
Mephitidae	2		
Ursidae	1		1
Cervidae	1		

Goicochea (2019) in El Hualango dry forest, located in the district of Sitacocha, province of Cajabamba in Cajamarca department; making a total of 441 species reported for the ISDTFM.

Some of these species have been reported in the RBI for the establishment and recognition of NPA (I. Mejía, personal communication, June 20, 2020; E. Allauja, personal communication, June 16, 2020).

3.1.1. Endemism and threat categories

The endemism of the Marañón valley can be divided into two floristic subunits (north and south), each of which is characterized by its own species. This endemism represents 33% of the total species recorded (Fig. 2-a; Appendix A) in an altitudinal range that varies from 300 to 2300 m. Compositae (27 species) and Cactaceae (29 species), are the families with the highest level of endemism. The genera with the highest number of endemic species are *Verbesina* (ten species), *Espositoa* (eight species), *Mimosa* (seven species), *Pappobolus* (six species) and *Armatocereus*, *Cnidoscolus* and *Ferreyranthus* (four species) (Marcelo-Peña et al., 2016). Ten species are threatened: *B. altissima* (VU), *Calliandra mollissima* (Willd.) Benth. (VU), *Piptadenia weberbaueri* Harms (VU), *Eriotheca peruviana* A. Robyns (VU), *Loxanthocereus sulcifer* Rauh & Backeb. (EN), *Monactis rhombifolia* Sagást. & Dillon (EN), *Gossypium raimondii* Ulbr. (EN), *Coursetia cajamarcana* Lavin (CR), *Parkinsonia peruviana* C.E.Hughes, Daza & Hawkins (CR) and *Pradosia argentea* (Kunth) T.D.Penn. (CR). Likewise, using the IUCN red list category criteria for assessing whether a species belongs to a threat category, we found that species such as *Mimosa lamolina* C.E. Hughes & G.P. Lewis, *Mimosa jaenensis* Särkinen, Marcelo-Peña & C.E. Hughes, *Caesalpinia celendiniana* G.P. Lewis & C.E. Hughes, would be categorized as CR, under criteria b1 and *Cedrela molinensis* T.D. Penn. & Reynel and *Cedrela kuelapensis* T.D. Penn. & Daza, would be categorized as C, under criteria A2c (Allauja-Salazar et al., 2020; Lewis et al., 2010; Pennington and Muellner, 2010; Särkinen et al., 2011). In recent years, new flora species have been reported and described in the ISDTFM including *Clusia rigida* M.Gustaffson, *C. celendiniana*, *Caesalpinia pluviosa* var. *maraniona* G.P. Lewis & C.E. Hughes, *M. lamolina*, *C. molinensis*, *C. kuelapensis*, *M. jaenensis*, *Erythroxylum dillonii* Plowman ex Jara and *Heteropterys tiinae* W.R. Anderson.

Furthermore, the endemic species with high local abundance are *B. pilleifera*, *A. rauhii*, *R. aperta*, *Tetrasida chachapoyensis* (Baker f.) Fryxell & Fuertes, *Praecereus euchlorus jaenensis* (Rauh ex Backeb.) Ostolaza and *Rauhocereus riosaniensis jaenensis*. Conversely, the endemic species that show the opposite pattern of low local abundance include *Tetramerium peruvianum* (Lindau) T.F.Daniel, *Gochnatia vernonioides* Kunth, *Cnidoscolus hypoleucus* (Pax) Pax, *M. jaenensis* and *Solanum hutchisonii* (J.F. Macbr.) Bohs. Finally, endemic species that have only been known for some of their reported subpopulations are *P. peruviana*, *C. cajamarcana*, *M. lamolina*, *M. jaenensis*, *P. argentea*, *Eugenia curvipilosa* McVaugh, *C. celendiniana*, *H. tiinae*, *Mimosa ctenodes* Barneby, and *Schrebera americana* (Zahlbr.) Gilg (Marcelo-Peña, 2017; Marcelo-Peña et al., 2016).

3.2. Tetrapod fauna

3.2.1. Amphibians and reptiles

Koch et al. (2018), through an evaluation during 2005 and 2014, in 35 localities located in the regions of Amazonas, Cajamarca and La Libertad, at altitudes between 384 and 2092 m., reported 68 species of amphibians and reptiles, to which should be added *Imantodes cenchoa* (Linnaeus, 1758) and *Dicrodon guttulatum* Duméril y Bibron, 1839 (A. García-Bravo, personal communication, September 25, 2020) and *Stenocercus philmayi* Venegas, García-Ayachi, Chávez-Arribasplata, Chávez, Wong & García-Bravo, 2020 (Venegas et al., 2020), this brought the total number of amphibians and reptiles to 71 species (Appendix B.1). Some of these species have been reported in the RBI (I. Mejía, personal communication, June 20, 2020; E. Allauja, personal communication, June 16, 2020).

The most recently described species (15) are: *Hyloxalus insulatus* (Duellman, 2004) (Duellman, 2004), *Phylllopezus marañonensis* Koch et al., 2006 (Koch et al., 2006), *Varzea altamazonica* (Miralles et al., 2006) (Miralles et al., 2006), *Rulyrana mcdiarmidi* (Cisneros-Heredia et al., 2008) (Cisneros-Heredia et al., 2008), *Phyllodactylus delsolari* Venegas et al., 2008 and *Phyllodactylus thompsoni*

Venegas et al., 2008 (Venegas et al., 2008), *Polychrus jacquelineae* Koch et al., 2011 (Koch et al., 2011), *Ameiva aggerescans* Koch, Venegas, Rödder & Böhme, 2013 and *Ameiva nodam* Koch, Venegas, Rödder & Böhme, 2013 (Koch et al., 2013), *Epictia septemlineata* Koch et al., 2015, *Epictia vanwallachi* Koch et al., 2015 and *Epictia antoniogarciai* Koch et al., 2015 (Koch et al., 2015), *Phyllodactylus pachamama* Koch et al., 2016 (Koch et al., 2016), *Tantilla tjiasmantoi* Koch and Venegas, 2016 (Koch and Venegas, 2016) and *S. philmayi* (Venegas et al., 2020).

3.2.2. Endemism and threat categories

Of the total species reported by Koch et al. (2018), there are four species of amphibians endemic to Perú, two of which are threatened, *Excidobates mysteriosus* (Myers, 1982) (EN), *H. insulatus* (VU), *Pristimantis percnopterus* (Duellman and Pramuk, 1999) and *Rhinella* sp. Regarding reptile diversity, 57 species have been registered, of which 28 species are reported to be endemic to Peru, with exclusive distribution to the ISDTFM (Fig. 2-b). These include; *P. delsolari* (EN), *Phyllodactylus interandinus* (Duellman and Pramuk, 1999), *Phyllodactylus johnwrighti* Dixon & Huey, 1970 (EN), *P. pachamama*, *P. thompsoni* (EN), *P. marañonensis*, *Gonatodes atricucularis* Noble, 1921, *Pseudogonatodes barbouri* (Noble, 1921), *P. jacquelineae*, *Microlophus stolzmanni* (Steindachner, 1891), *Stenocercus huancabambae* Cadle, 1991, *S. philmayi*, *A. aggerescans*, *Ameiva concolor* Ruthven, 1924, *A. nodam*, *Bachia barbourin* Burt & Burt, 1931, *Bachia intermedia* Noble, 1921, *Amphisbaena pericensis* Noble, 1921, *Boa constrictor ortonii* Cope, 1878, *Bothrops* sp., *T. tjiasmantoi*, *Leptodeira septentrionalis larcorum* Schmidt & Walker, 1943, *Sibynomorphus oneilli* Rossman & Thomas, 1979, *Sibynomorphus vagrans* (Dunn, 1923), *Anomalepis aspinosus* Taylor, 1939, *E. antoniogarciai*, *E. septemlineata* and *E. vanwallachi*.

3.2.3. Birds

Based on bibliographic information (Angulo et al., 2008; Begazo et al., 2001, 2003; Chávez et al., 2021; García-Bravo, 2011, 2014; García-Bravo et al., 2015; Guevara, 2017) and unpublished data resulting from the aforementioned RBI (I. Mejía, personal communication, 20 June 2020; E. Allauja, personal communication, 16 June 2020), plus specialized websites (BirdLife International, 2021; eBird Perú, 2021) and observations made by Antonio García-Bravo in a Florida Museum of Natural History and CORBIDI expedition (Balsas, Amazonas, November 6–14, 2009), a total of 193 species are reported for the ISDTFM (Appendix B.2). Some species, such as *Patagioenas oenops* (Salvin), 1895, *Thaumasius taczanowskii* P. L. Sclater, 1879, and *Turdus maranonicus* Taczanowski, 1880, are distributed throughout the ISDTFM. However, there are some species that have a limited distribution to the north (*Incaspiza watkinsi* Chapman, 1925), and south (*Incaspiza laeta* (Salvin), 1895) of the ISDTFM. Most interestingly, there are cases of species of the same genus being replaced in both the northern and southern latitudes and altitudes of the inter-Andean SDTF in the Marañón valley.

3.2.3.1. Endemism and threat category. Out of the total number of registered birds, 22 have a restricted distribution to EBA 048 (EBA Marañón Valley), of which 13 are endemic to Peru. Ten species are threatened: *P. oenops* (VU), *Taphrolesia griseiventris* (Taczanowski), 1883 (EN), *Aglaeactis aliciae* Salvin, 1896 (VU), *Chaetocercus bombus* Gould, 1871 (VU), *Forpus xanthops* (Salvin), 1895 (VU), *Ara militaris* (Linnaeus, 1766) (VU), *Synallaxis maranonica* Taczanowski, 1879 (CR), *Synallaxis hypochondriaca* (Salvin), 1895 (VU), *Pachyramphus spodiurus* P. L. Sclater, 1860 (VU) and *Lathrotriccus griseipectus* (Lawrence), 1869 (VU).

3.2.4. Mammals

Little is known about the mammals of the dry inter-Andean valleys (Ceballos and Simonetti, 2002; Pacheco, 2002). We have been able to compile records of a total of 51 species (Appendix B.3) from reports of various biodiversity assessments. Few scientific studies are available on mammals in the area (Ceballos and Simonetti, 2002; Figueroa et al., 2013; Koopman, 1978; Musser and Carleton, 2005; Osgood, 1923; Pacheco, 2002; Pacheco et al., 2015, 2009; Patton et al., 2015; Prado and Percequillo, 2013; Ruelas et al., 2016; Shanee et al., 2013; Shanee and Shanee, 2018; Uturnunco, 2015; Uturnunco and Pacheco, 2016). We are also considering information derived from rapid biological inventories carried out in the RCA del Marañón Seasonally Dry Tropical Forest (I. Mejía, personal communication, June 20, 2020; Gobierno Regional Amazonas and Naturaleza y Cultura Internacional, 2017). Moreover, studies consider the dry Marañón valley as a potential habitat for certain species such as *Platylina genovensium* Thomas, 1928 (Ruelas and Pacheco, 2018), *Lonchophylla hesperia* G. M. Allen, 1908 (Tirira et al., 2011), *Artibeus fraterculus* Anthony, 1924 (Pinto et al., 2013) and *T. ornatus* (Figueroa et al., 2016; Meza et al., 2020).

3.2.4.1. Endemism and threat category. Of the total number of species recorded in these forests, five species are endemic to Peru that inhabit ISDTFM; the gray rice rat or Marañón *Oryzomys Eremoryzomys polius* (Osgood, 1913), *Eremoryzomys mesocaudis* sp. nov., Cajamarca Oldfield Mouse *Thomasomys praetor* (Thomas, 1900), Friendly Leaf-eared Mouse *Phyllotis amicus* (Thomas, 1900) and Peruvian Night Monkey *Aotus miconax* Thomas, 1927 (EN) (Fig. 2-d).

Besides *Sylvilagus brasiliensis* (Linnaeus, 1758), which is not an endemic species but is endangered (EN), the presence of *T. ornatus* should be mentioned, a key species for the conservation of these forests, due to its ecological role as an important seed disperser and therefore as a regenerator of the forest (Figueroa et al., 2013). This important species is categorized as Vulnerable (VU).

3.3. Distribution of species endemic of woody flora and tetrapod fauna in the ISDTFM

Among the 143 species of woody flora, only 51 species are found within NPA under regional and private administration (Appendix A). Within these species, we can mention *Tecoma rosifolia* Kunth, *Espositoa blossfeldiorum* (Werderm.) Buxb., *Maranionia lavinii* C.E. Hughes, G.P. Lewis, Daza & Reynel, *Mimosa pectinatipinna* Burkart, *Pseudobombax cajamarcanus* Fern. Alonso, *B. altissima*,

B. pilleifera, *Ditaxis dioica* Kunth, have been widely distributed (north and south) throughout the ISDTFM. On the other hand, *T. peruvianum*, *Marsdenia oligantha* K.Schum., *Armatocereus rauhii* subsp. *rauhii*, *Pereskia horrida* (Kunth) DC., *Croton adipatus* Kunth, *C. mollissima*, *Coursetia maraniona* Lavin, *Esenbeckia cornuta* Engl., are found in NPA located in the northern zone. Similarly, in the NPA of the southern zone, we can find species like, *C. rigida*, *Arnaldoa weberbaueri* (Muschl.) Ferreyra, *Verbesina andina* Sagást., *C. celendiniana*, *P. peruviana* and *Jatropha weberbaueri* Pax & K.Hoffm.

We classified the inter-Andean SDTF in the Marañón valley endemic amphibians, reptiles, and birds in three patterns. These patterns are based on the coordinates of amphibian and reptile species recorded by Koch et al. (2018) and the potential bird distribution ranges elaborated by Angulo et al. (2008). Here we provide some examples of the endemic species of these three taxonomic groups, associated with each pattern: **pattern A**: species with distribution extending from 06° 06' 00.7" S 078° 29' 52.5" W northward, represented by the amphibian *E. mysteriosus* (EN); reptiles, *A. pericensis*, *P. barbouri*, *G. atricucularis* and *P. johnwrighti* (EN); and the birds, *I. watkinsi*, *Synallaxis chinchipensis* Chapman, 1925 and *S. maranonica*; **pattern B**: species with distribution going from 06° 06' 00.7" S 078° 29' 52.5" W southwards, represented by the reptiles, *P. jacquelineae* (DD), *P. delsolari* (EN) and *P. maranonensis* and the birds, *F. xanthops*, *A. aliciae*, *S. hypochondriaca*, *Phacelodomus dorsalis* Salvin, 1895 and *I. laeta* y **pattern C**: species with distribution throughout EBA-048 (pattern A and B), represented by the amphibian *H. insulates* (VU), the reptile *M. stolzmanni*, and the birds *P. oenops*, *T. maranicus*, *Melanopareia maranonica* Chapman, 1924 and *Thlypopsis inornata* (Taczanowski), 1879. In some cases, there is an altitudinal and latitudinal replacement of species of the same genus between patterns A and B (*P. johnwrighti*/*P. delsolari*, *I. watkinsi*/*I. laeta*, *S. chinchipensis*/*S. hypochondriaca*).

3.4. Threats and state of conservation of the ISDTFM

3.4.1. Threats

This document shows that these forests are home to a large variety of biodiversity and high levels of woody flora and tetrapod fauna are endemic to this area. However, all this species richness is constantly threatened by natural and anthropogenic factors (Toby Pennington et al., 2006). In particular, climate change could lead to changes in species distribution and populations due to alterations in temperature and rainfall patterns by natural factors (Enquist, 2002; Mason-Romo et al., 2018; Prieto-Torres et al., 2018). As far as anthropogenic factors are concerned, the primary threat comes from expanding the agricultural frontier for farming and livestock purposes and the construction of roads, which is reflected in the environmental degradation and fragmentation of these forests (Marcelo-Peña, 2017). From the 221 political districts covered by the inter-Andean SDTF in the Marañón valley, 48 districts are in the range of 60–100% monetary poverty (Geo Perú, 2021; INEI, 2020). Such poverty rates could be related to the pressure on these forests since their main economic activity is agriculture and livestock farming. However, there is no socioeconomic data that would allow us to affirm this hypothesis. On top of this, there are also potential threats, such as the construction of dams along the Marañón river (Arana, 2012), most notably Chadín 2 and Veracruz projects, which have definitive concessions (Grandez et al., 2020), and the Oil Lot 145. The construction of these dams would affect the biological diversity of these forests and change the hydrological regime and impact on the hydrobiological resources. Likewise in socioeconomic terms, flooding part of the areas destined to agriculture and fishing could cause economic losses in settlements situated along the Marañón river (Rubio et al., 2017).

In opposition to the potential construction of dams along the Marañón river, Koch et al. (2013) named two species of lizards: *Ameiva aggerrecusans* "The specific epithet is an agglutination of the Latin nomen "agger" which means dam and the verb "recusare" which means reject. As in *Ameiva nodam* sp. nov. this name was chosen to further emphasize our protest against the possible dam constructions along the Marañón river".

3.4.2. State of conservation

Currently, there are seven established and recognized NPA (Table 3; Fig. 3), covering 1.97% of these forests. However, the Peruvian government considers that the protection of these forests is well represented by the NPA that forms part of the National System of Natural Protected Areas (SINANPE) and the areas complementing this system (RCA). Under this point of view, only 1.60% would be protected. There is also an Ecological Reserve known as Huacaybamba Cerro Cedropata, which covers an area of 8600 ha (Roncal et al., 2013); as well as the Environmental Conservation Area "Bosque Seco Chinchipe Marañón" with an area of 48,883.28 ha (Municipalidad distrital de Bellavista, 2016) and the Environmental Conservation Area Bosques Secos del Crisnejas - Marañón (Municipalidad Provincial de Cajabamba, 2018) with an area of 5046.34 ha; located in the Cajamarca region. However, these have not been included in our analysis because it is not an NPA.

4. Discussion

The inter-Andean SDTF in the Marañón valley are characterized by a plant formation of seasonally dry ecosystems. Which are surrounded by mountain forests, this has allowed a high rate of endemism of species of flora and fauna (Brack and Mendiola, 2010; Figueroa et al., 2013). This is evidenced by the 143 (33%) endemic species of woody flora with a distribution restricted to the Marañón valley out of 441 reported until now (Bridgewater et al., 2003; Hughes et al., 2003; Lewis et al., 2010; Linares-Palomino, 2006, 2004; Linares-Palomino et al., 2003; Linares-Palomino and Pennington, 2007; Marcelo-Peña et al., 2007, 2019, 2016, 2010; Rodríguez et al., 2015, 2016; Särkinen et al., 2011). The ISDTFM hosts 78 of the 166 species of the Leguminosae family reported in the SDTF of Peru, as well as 39 of the 63 species of the Euphorbiaceae family, 35 of the 44 species of the Compositae family, 34 of the 68 species of the Cactaceae family, 21 of the 45 species of the Malvaceae family. In the same sense, it hosts all the species described for the genera *Caesalpinia*, *Espostoa*, *Verbesina*, *Pappobolus*, *Acalypha*, *Buddleja*, and *Ferreyranthus*. Likewise, 12 species of the 23 reported species of

Table 3
Natural Protected Areas in the ISDTFM.

Natural Protected Areas	Political Location	Total extension (ha)	ISDTFM Coverage (ha)	ISDTFM coverage (%)	ISDTFM total extension (ha)
Private Conservation Area Gotas of Agua I ^b	Cajamarca	3.00	3.00	0.0001%	2'293,199.61
Private Conservation Area Gotas of Agua II ^b	Cajamarca	7.50	7.50	0.0003%	
Private Conservation Area Comunal Cujillo ^b	Cajamarca	3740.28	3740.28	0.1631%	
Regional Conservation Area Seasonally Dry Tropical Forest of the Marañón ^b	Amazonas	13,929.12	12,705.25	0.5540%	
Private Conservation Area San Pedro of Chuquibamba ^b	Amazonas	19,560.00	4674.54	0.2038%	
Regional Conservation Area Dry Forests of the Marañón ^b	Cajamarca	21,794.71	21,794.71	0.9504%	
National Park Huascarán ^a	Ancash	340,000.00	2191.02	0.0955%	
Total		399,034.61	45,116.30	1.9672%	

^a This NPA is part of SINANPE.

^b These NPA are complementary to SINANPE.

the genus *Croton*, 11 of the 14 species of the genera *Senna*, 10 of the 14 species of the genera *Mimosa*. This data indicate that the ISDTFM constitutes a significant representative of the SDTF of Peru, with an extension of only 3750 km² (Marcelo-Peña et al., 2016). Furthermore, from a woody flora endemism point of view in a neotropical context, these forests rank third, after the Mexican SDTF, which harbor 60 % of endemic species, and the Brazilian SDTF with 34 % of endemic species; the latter SDTFs are characterized by being large forests (Giulietti et al., 2004; Rzedowski, 1991). However, the richness of endemic species of flora of the ISDTFM may increase since these forests have cryptic species, besides having gaps in botanical prospection and collection, reasons for which the diversity and endemism of these forests may be underestimated (Gagnon et al., 2015; Reynel et al., 2013; Särkinen et al., 2011). On top of this, the distribution of these endemic species remains unknown throughout the valley (Allauja-Salazar et al., 2020), and this information is critical to understand the complexity of these forests and establish criteria for their conservation. Moreover, from the 143 species of endemic woody flora, only 51 species are found within regionally and privately administered NPA (*M. lamolina* and *C. celendiniana*), and endemic tetrapod fauna (*E. septemlineata* and *E. vanwallachi*) are only known from their type locality so that these areas inhabited by these scarce species are specifically protected to prevent their extinction.

Regarding the tetrapod fauna, four endemic species of amphibians, 28 reptiles, 13 birds, and five mammals are reported, highlighting the importance of the ISDTFM in terms of their level of endemism of wild flora and fauna. For birds, there are proportionally more endemic species in EBA-048 of the ISDTFM (0.20 species x km²) than in EBA-045 of the ESDTF (0.04 x km²). EBA-048 contains other threatened species. Ten species in different threat categories that represent 41%, including one species in CR (*S. maranonica*, based on IUCN A3c criterion, which means that this species is facing an extremely high risk of extinction as a wildlife species), one (EN) and eight (VU). Compared to 18 threatened species representing 32% in EBA-045, of which six are in the EN category and 12 in the VU category (BirdLife International, 2021; eBird Perú, 2021; IUCN, 2021; Plenge, 2021; Remsen et al., 2021; Stattersfield et al., 1998; UICN, 2012). Birds shared with the Tumbesian region are all species from the northern lower Marañón, and those shared with the Peruvian high Andes are all from the southern upper Marañón. In this sense, we consider the ISDTFM to be of greater importance for conservation and research purposes. In this regard, we believe ISDTFM to be of major importance for conservation and research.

Koch et al. (2018), based on other publications, mentions that, in ISDTFM, there are endemic genera of plants that coexist with several groups of animals such as amphibians, reptiles, and birds; which is not the case in ESDTF. Furthermore, it is essential to mention that, in the ISDTFM, from 2005 to 2014, 11 new species of amphibians and reptiles have been described for science (Koch et al., 2018). In 2020, a new reptile species, *S. phillmayi* (Venegas et al., 2020) and the subspecies *Synallaxis stictothorax chinchipensis* Chapman, 1925 has been separated into the species *Synallaxis chinchipensis* (BirdLife International, 2017a; Stopiglia et al., 2020), the latter two species, new to science, are considered endemic to Peru and with distribution restricted to the ISDTFM. The aforementioned demonstrates and highlights the need for research in this ecoregion compared to the ESDTF.

In addition, there is the proposal (898) A. Split the Tawny-crowned Pygmy-Tyrant *Euscarthmus meloryphus* into two species. B. Establish English names for the species of the SACC, by Alvaro Jaramillo, where he recommends separating *Euscarthmus fulviceps* Sclater, 1871 from *Euscarthmus meloryphus* Wied, 1831, based on their voices and plumages (SACC, 2021). However, BirdLife International (2016a, 2016b) already considered the separation of this species. Other cases that should also be considered for the separation of subspecies to species are *Polioptila plumbea maior* Hellmayr, 1900 into *Polioptila maior* (Hellmayr, 1900) (BirdLife International, 2017b; Smith et al., 2018), *Arremon abeillei nigriceps* Taczanowski, 1880 into *Arremon nigriceps* Taczanowski, 1880 (BirdLife International, 2016b) and *Thamnophilus bernardi shumbae* (Carraker), 1934 into *Thamnophilus shumbae* (VU) Carraker, 1934 (BirdLife International, 2020). The official separation of the species *P. maior*, *A. nigriceps* and *T. shumbae* would increase the number of endemic species in the ISDTFM to 15. The aforementioned, demonstrates and highlights the need for research in this ecoregion compared to the ESDTF.

The bird populations are highly dependent on the flora of the ISDTFM, as it is part of their diet (Roncal-Rabanal et al., 2020), which are constantly threatened by forest fragmentation, due to the expansion of the agricultural frontier and access roads (Chávez et al., 2021; Marcelo-Peña, 2017; Marcelo-Peña et al., 2010; Pennington and Muellner, 2010), which also affects the tetrapod fauna populations recorded in these forests. Likewise, these species could become extinct if hydroelectric, mining and oil projects located in the

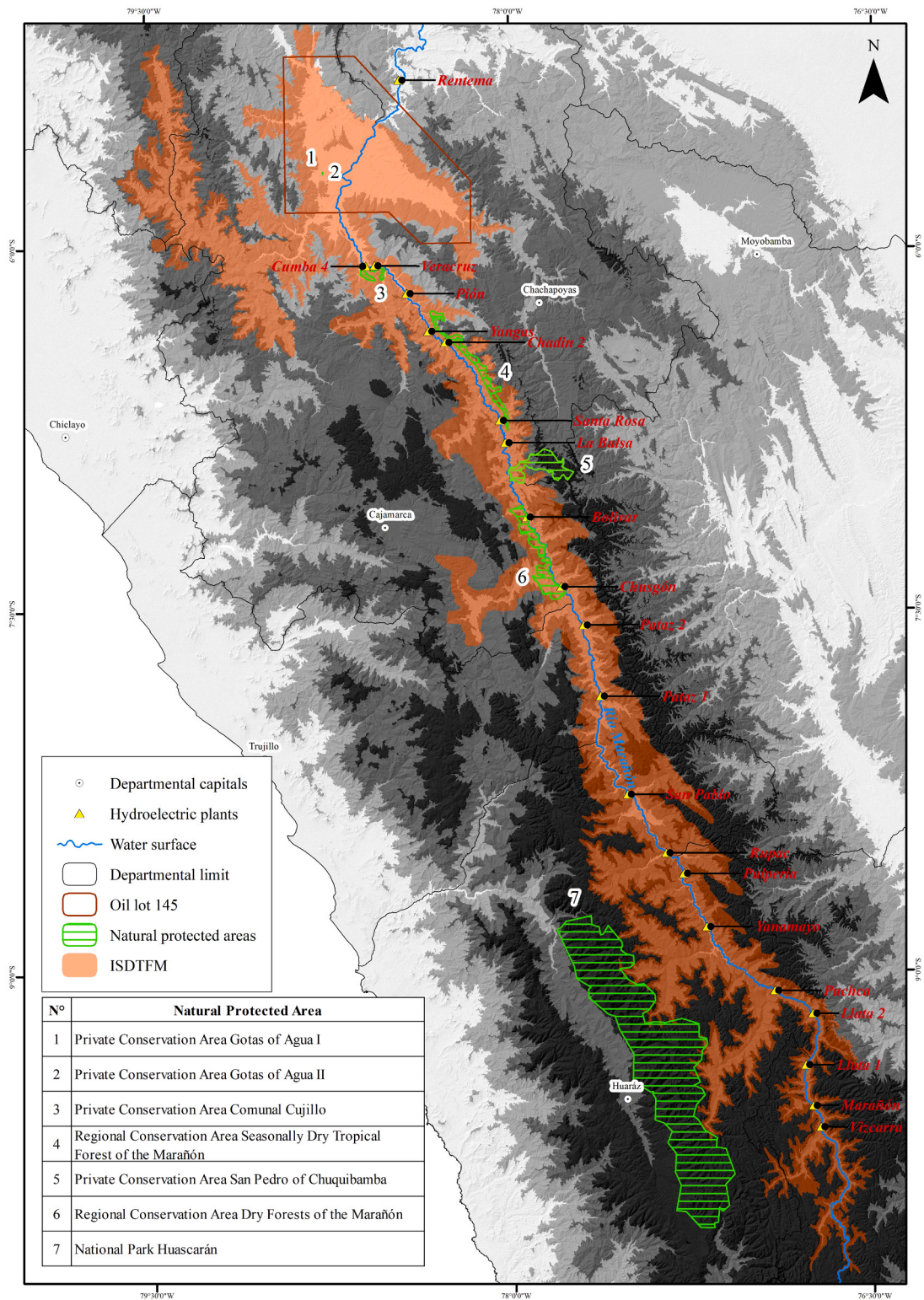


Fig. 3. Threats and state of conservation of ISDTFM.

Marañón valley are implemented (Chávez et al., 2021; García-Bravo, 2011; Grandez et al., 2020).

The inter-Andean SDTF in the Marañón valley have an extension of 2'293,199.61 ha, of which the percentage of protection through NPA has been increasing during the last years; in 2009, the Master Plan of Natural Protected Areas reported 0.10% of protection (MINAM, 2009) which is indeed low compared to other ecoregions of the same biome, such as the dry forests of Piura and Tumbes (5.83%) and the dry forests of the inter-Andean valleys (0.29 %); in 2019, this percentage was raised to 0.60% (SERNANP, 2019) thanks to the establishment of the Marañón Seasonally Dry Tropical Forests RCA in the Amazon department. In 2021 it reached 1.60% with the recent establishment of the RCA Dry Forests of the Marañón in the Cajamarca region (MINAM, 2021). However, in this study, we report 1.97% protection since we include not only the NPA of national and regional administration (RCA), but also those areas of private administration (PCA) that according to the Regulations of the Law of Natural Protected Areas (MINAGRI, 2001; SERNANP, 2014) are complementary NPA to SINANPE. Given these facts, we suggest that NPA and other effective conservation modalities be promoted throughout the valley with the aim of protecting and conserving the unique biological diversity at a neotropical level that these forests contain.

5. Conclusion

From the review above, key findings emerge from several studies of woody flora and tetrapod fauna in the inter-Andean SDTF in the Marañón valley, demonstrating the high richness and endemism of these forests. In recent years, new flora species have been reported and described in the ISDTFM including *C. rigida*, *C. celendiniana*, *Caesalpinia pluviosa* var. *maraniona* G.P. Lewis & C.E. Hughes, *M. lamolina*, *C. molinensis*, *C. kuelapensis*, *M. jaenensis*, *Erythroxylum dillonii* Plowman ex Jara and *H. tiinae*; where some of them, as is the case of *M. lamolina* are only known from their type locality. These species are nationally and globally rare, and therefore a priority for protection and conservation; given this, the creation of new NPA under regional and private administration is recommended in the northern zone, specifically in the provinces of Jaén, Cutervo, and Celendín, in the department of Cajamarca; the provinces of Utcubamba, Balsas, Luya in the department of Amazonas; and the provinces of Bolívar and Pataz in the department of La Libertad. On the other hand, endemism not only occurs on species but also on botanical genera (e.g., *Lasiocereus*, *Maraniona*, *Johnstonia*, and *Calymmanthium*). Furthermore, ISDTFM are characterized by their cryptic species, and it is therefore recommended that detailed studies of the molecular phylogeny of species of the Leguminosae family and the species *E. discolor* (widely distributed in these forests) should be carried out. In addition, it should be mentioned that the lack of botanical prospecting in inaccessible places means that the richness and endemism of these forests are still unknown. Therefore, it is recommended to carry out scientific explorations in areas of difficult access on both sides of the Marañón river and the areas of its tributary rivers, including the Crisnejas, Chinchipe, Chamaya, Miriles, and Utcubamba rivers; this would also allow us to know the distribution of the species within the ISDTFM. In the same sense, from 2005 to 2014, 11 new species of amphibians and reptiles have been described for science. In 2020, a new species of reptile, *S. phillmayi*, has been described. The subspecies *S. stictothorax chinchipensis* has been separated into the species *S. chinchipensis*. The last two species, new for science, are considered endemic to Peru and with a distribution restricted to the ISDTFM. It must be highlighted that there are three distribution patterns (A, B, and C) in the endemic tetrapod fauna and in some cases, there is altitudinal and latitudinal replacement between the A and B patterns. As a matter of fact, all this richness of unique species at a neotropical level and the ecosystem services that these forests provide are constantly threatened and together with poor protection by NPA, we consider an urgent priority for the protection by the competent environmental institutions that, beyond the ecoregion approach, should adopt an approach at a basin level, taking into account that it is part of the Amazon River Basin. Likewise, conservation strategies for endemic species of the ISDTFM should be implemented through management plans with the active participation of local and national strategic stakeholders in order to achieve sustainability.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

The authors would like to thank the support of the SNIP Project N° 316114 "Creation of the Services of a Biodiversity Laboratory and Conservation of Genetic Resources of Wild Species of the Toribio Rodríguez de Mendoza National University, Amazonas." – BIODIVERSIDAD, financed by the National Public Investment System (SNIP) of the Ministry of Economy and Finance (MEF) of Peru. And to Nature and Culture International (NCI) Peru headquarters for allowing us access to the biological baseline information of the NPA that they are helping create and manage in the ISDTFM with support from the Andes Amazon Fund and the Stiefel Behner Charitable Foundation.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at [doi:10.1016/j.gecco.2021.e01639](https://doi.org/10.1016/j.gecco.2021.e01639).

References

- Aguirre, Z., Linares-Palomino, R., Kvist, L.P., 2006. Especies leñosas y formaciones vegetales en los bosques estacionalmente secos de Ecuador y Perú. *Arnaldia* 13, 324–346.
- Allauja-Salazar, E., Dávila-Estela, L., Huamán-Delgado, E., 2020. Nuevos reportes de subpoblaciones de *Cedrela kuelapensis* (Meliaceae) en el valle del río Marañón, Perú. *Rev. For. del Perú* 35, 122–131. <https://doi.org/http://dx.doi.org/10.21704/rfp.v35i2.1580>.
- Angulo, F., Palomino, C., Arnal-Delgado, H., Auca, C., Uchofen, O., 2008. Corredor de Conservación de Aves Marañón - Alto Mayo (CCAMAM): Análisis de Distribución de Aves de Alta Prioridad de Conservación e Identificación de Propuestas de Áreas para su Conservación. Constantino Auca Chutas, Juan Angel Torres Saavedra y Abdiel Bustamante Navarrete, Cusco, Perú.
- Arana C., M., 2012. Proyectos hidroeléctricos en la cuenca del río Marañón, Serie Cuadernos de Integración 3. Lima, Perú.
- Begazo, A.J., Valqui, T., Sokol, M., Longlois, E., 2001. Notes on some birds from central and northern Peru. *Cotinga* 15, 81–87.
- Begazo, A.J., Flanagan, J.N.M., Vellinga, W.-P., 2003. Avifauna y conservación de los bosques secos de la cuenca del río Marañón. In: Begazo, A.J., Flanagan, J.N.M., Vellinga, W.-P. (Eds.), *Primer Congreso Internacional Bosques Secos (6–9 Nov. 2003)*. Universidad de Piura, Piura, Perú, pp. 1–9.
- BirdLife International, 2016a. *Euscarthmus meloryphus*. The IUCN Red List of Threatened Species 2016: e.T103681055A93732060. <https://dx.doi.org/10.2305/IUCN.UK.2016-3.RLTS.T103681055A93732060.en> (Accessed 1 June 2021).
- BirdLife International, 2016b. *Arremon nigriceps*. The IUCN Red List of Threatened Species 2016: e.T103771846A104277763. <https://dx.doi.org/10.2305/IUCN.UK.2016-3.RLTS.T103771846A104277763.en> (Accessed 6 January 2021).
- BirdLife International, 2017a. *Synallaxis chinchipensis* (amended version of 2016 assessment). The IUCN Red List of Threatened Species 2017: e.T103675711A112280517. <https://dx.doi.org/10.2305/IUCN.UK.2017-1.RLTS.T103675711A112280517.en> (Accessed 6 January 2021).
- BirdLife International, 2017b. *Polioptila maior* (amended version of 2016 assessment). The IUCN Red List of Threatened Species 2017: e.T103882394A113229227. <https://dx.doi.org/10.2305/IUCN.UK.2017-1.RLTS.T103882394A113229227.en> (Accessed 1 June 2021).
- BirdLife International, 2020. *Thamnophilus shumbae*. The IUCN Red List of Threatened Species 2020: e.T103658063A179983981. <https://dx.doi.org/10.2305/IUCN.UK.2020-3.RLTS.T103658063A179983981.en> (Accessed 6 January 2021).
- BirdLife International, 2021. BirdLife International. BirdLife Int. Ctry. profile Peru. <http://www.birdlife.org/datazone/country/peru>.
- Brack, A., Mendiola, C., 2010. *Ecología del Perú*. Editorial Bruño, Lima, Perú.
- Brack, A., 1986. Las Ecorregiones del Perú. *Boletín Lima* 44, 57–70.
- Bridgewater, S., Pennington, R.T., Reynel, C.A., Daza, A., Pennington, T.D., 2003. A preliminary floristic and phytogeographic analysis of the woody flora of seasonally dry forests in northern Peru. *Candollea* 58, 129–148.
- Caetano, S., Naciri, Y., 2011. The biogeography of seasonally dry tropical forests in south america. In: Dirzo, R., Young, H., Mooney, H., Ceballos, G. (Eds.), *Seasonally Dry Tropical Forests: Ecology and Conservation*. Island Press, pp. 23–44. https://doi.org/10.5822/978-1-61091-021-7_2.
- CDC-UNALM, 2006. Análisis del Recubrimiento Ecológico del Sistema Nacional de Áreas Naturales Protegidas por el Estado, CDC-UNALM/TNC. Lima, Perú. <https://doi.org/10.1017/CBO9781107415324.004>.
- Ceballos, G., Simonetti, J.A., 2002. Diversidad y conservación de los mamíferos neotropicales, Primera ed. ed. CONABIO-UNAM, D.F., México.
- Chávez, C., Roncal-Rabanal, M., Angulo Pralongo, F., García-Bravo, A., Guevara, J., Barrantes, P., Jondec, V., 2021. Ampliación del rango de distribución del pecho de luna del Marañón (*Melanopareia maranonica*) en la cuenca media del río Marañón, Perú. *Rev. Peru. Biol.* 28 (e18857), 2021. <https://doi.org/10.15381/rpb.v28i1.18857>.
- Cisneros-Heredia, D.F., Venegas, P.J., Rada, M., Schulte, R., 2008. A new species of glassfrog (Anura: Centrolenidae) from the foothill andean forests of Ecuador and Peru. *Herpetología* 64, 341–353. <https://doi.org/10.1655/06-078.1>.
- Dimson, M., Gillespie, T.W., 2020. Trends in active restoration of tropical dry forest: methods, metrics, and outcomes. *For. Ecol. Manag.* 467, 118150 <https://doi.org/10.1016/j.foreco.2020.118150>.
- Dryfor, Banda-R, K., Delgado-Salinas, A., Dexter, K., Linares-Palomino, R., Oliveira-Filho, A., Prado, D., Pullan, M., Quintana, C., Riina, R., Rodríguez, G., Weintritt, J., Acevedo-Rodríguez, P., Aduarve, J., Álvarez, E., Aranguren, A., Camilo-Arteaga, J., Aymard, G., Castaño, A., Ceballos-Mago, N., Cogollo, A., Cuadros, H., Delgado, F., Devia, W., Duénas, H., Fajardo, L., Fernández, A., Ángel-Fernández, M., Franklin, J., Freid, E., Galetti, L., Gontto, R., González-M, R., Graveson, R., Helmer, E., Idárraga, A., López, R., Marcano-Vega, H., Martínez, O., Maturo, H., McDonald, M., McLaren, K., Melo, O., Mijares, F., Mogni, V., Molina, D., Del Pilar Moreno, N., Nassar, J., Neves, D., Oakley, L., Oatham, M., Olvera-Luna, A.R., Pezzini, F., Reyes, O.J., Elvira-Ríos, M., Rivera, O., Rodríguez, N., Rojas, A., Sárikinen, T., Sánchez, R., Smith, M., Vargas, C., Villanueva, B., T.B., P., 2016. Plant diversity patterns in neotropical dry forests and their conservation implications. *Science* 353, 1383–1387. <https://doi.org/10.1126/science.aaf5080>.
- Duellman, W.E., 2004. Frogs of the genus *Colostethus* (Anura: Dendrobatiidae) in the Andes of northern Peru. *Sci. Pap. Nat. Hist. Museum Univ. Kansas* 1–49. <https://doi.org/10.5962/bhl.title.8467>.
- Duellman, W.E., Pramuk, J.B., 1999. Frogs of the Genus *Eleutherodactylus* (Anura: Leptodactylidae) in the Andes of Northern Peru. *Sci. Pap. Nat. Hist. Museum Univ. Kansas* 13, 1–78. <https://doi.org/10.5962/bhl.title.16169>.
- eBird Perú, 2021. eBird Perú. <https://ebird.org/peru/home>.
- Enquist, C.A.F., 2002. Predicted regional impacts of climate change on the geographical distribution and diversity of tropical forests in Costa Rica. *J. Biogeogr.* 29, 519–534. <https://doi.org/10.1046/j.1365-2699.2002.00695.x>.
- Figueroa, J., Stucchi, M., Rojas-Verapinto, R., 2016. Modelación de la distribución del oso andino *Tremarctos ornatus* en el bosque seco del Marañón (Perú). *Rev. Mex. Biodivers.* 87, 230–238. <https://doi.org/10.1016/j.rmb.2016.01.008>.
- Figueroa, J., Stucchi, M., Rojas-Verapinto, R., 2013. Redes de Conectividad: El oso andino como una especie importante en la conservación del bosque seco del Marañón (Cajamarca y Amazonas, Perú). Lima, Perú.
- Frost, D., American Museum of Natural History, 2020. Amphibian Species of the World 6.0, an Online Reference Am. Museum Nat. Hist. <https://amphibiansoftheworld.amnh.org/> (Accessed 8 September 2020).
- Gagnon, E., Hughes, C.E., Lewis, G.P., Bruneau, A., 2015. A new cryptic species in a new cryptic genus in the *Caesalpinia* group (Leguminosae) from the seasonally dry inter-Andean valleys of South America. *Taxon* 64, 468–490. <https://doi.org/10.12705/643.6>.
- García-Bravo, A., 2011. Amenazas y conservación del Gorrión Jaeno (*Incapisiza watkinsi*) en Cajamarca y Amazonas, Perú. *Boletín Inf. UNOP* 6, 8–13.
- García-Bravo, A., 2014. *Fanerógamas y aves del Fundo Gotas de Agua, Sector El Pongo, Jaén - Perú*. Universidad Nacional de Piura, p. 2007.
- García-Bravo, A., Rosario, D., Tiravanti, J., Herrera-Peralta, K., Díaz, R., 2015. Registros de *Donacobius atricapilla* en los Bosques Secos del Marañón, Amazonas y Cajamarca, Perú. *Boletín Inf. UNOP* 10, 6.
- GBIF.org, 2021a. GBIF Occurrence Download: *Anomalepis aspinosus* Taylor, 1939. <https://doi.org/https://doi.org/10.15468/dl.bzfgma>.
- GBIF.org, 2021b. GBIF Occurrence Download: *Aotus miconax* Thomas, 1927. <https://doi.org/https://doi.org/10.15468/dl.2wb9br>.
- GBIF.org, 2021c. GBIF Occurrence Download: *Phyllotis amicus* Thomas, 1900. <https://doi.org/https://doi.org/10.15468/dl.y9w2a9>.
- GBIF.org, 2021d. GBIF Occurrence Download: *Bachia intermedia* Noble, 1921. <https://doi.org/https://doi.org/10.15468/dl.tvutvj>.
- GBIF.org, 2021e. GBIF Occurrence Download: *Thomasomys praetor* (Thomas, 1900). <https://doi.org/https://doi.org/10.15468/dl.34pbnv>.
- Geo Perú, 2021. Plataforma Nacional de Datos Georeferenciados Geo Perú. <https://visor.geoperu.gob.pe/> (Accessed 25 April 2021).
- Giulietti, A.M., du Bocage, A.L., J.F. Castro, A., Gamarra-Rojas, C., Sampaio, E., Fernandes, J., Paganucci, L., Figueiredo, M., Nogueira, M. de J., Vasconcellos, M., Harley, R., 2004. Diagnóstico da vegetação nativa do bioma Caatinga. In: Da Silva, J., Tabarelli, M., Tavares, M., Vanucci, L. (Eds.), *Biodiversidade Da CAATINGA: Áreas e Ações Prioritárias Para a Conservação*. Ministério do Meio Ambiente, Brasília, DF, pp. 47–90.
- Gobierno Regional Amazonas, Naturaleza y Cultura Internacional, 2017. Expediente técnico para la creación del Área de Conservación Regional (ACR) en el ámbito de los Bosques Tropicales Estacionalmente Secos del Marañón (BTESM). Amazonas, Perú.
- Goicochea, L.M., 2019. Caracterización florística y estructural de las plantas leñosas del bosque seco El Hualango, caserío Huacra en Sitacocha, Cajabamba. Universidad Nacional de Cajamarca.

- Grandez, P., Mora, C., Ramírez, P., Palao, L., Monteferrri, B., 2020. Análisis de la situación jurídica ambiental de los proyectos de centrales hidroeléctricas Veracruz y Chadín 2 en el río Marañón. SPDA, Lima.
- Guevara, E., 2017. *Diversidad de Aves del Corredor Ecoturístico Santa Rosa (Celendín)- Balsas (Chachapoyas)*. Universidad Nacional de Cajamarca.
- Hughes, C.E., Yomona, A.D., Hawkins, J.A., 2003. A new Palo Verde (Parkinsonia - Leguminosae: Caesalpinioideae) from Peru. *Kew Bull* 58, 467–472. <https://doi.org/10.2307/4120630>.
- INEI, 2020. In: *Primera (Ed.), Mapa de Pobreza Monetaria Provincial y Distrital 2018*. Instituto Nacional de Estadística e Informática, Lima, Perú.
- IUCN, 2021. The IUCN Red List of Threatened Species. Version 2021–1. Int. Union Conserv. Nat. Nat. Resour. <https://www.iucnredlist.org> (Accessed 27 April 2021).
- Killeen, T.J., Douglas, M., Consiglio, T., Jørgensen, P.M., Mejia, J., 2007. Dry spots and wet spots in the Andean hotspot. *J. Biogeogr.* 34, 1357–1373. <https://doi.org/10.1111/j.1365-2699.2006.01682.x>.
- Koch, C., Venegas, P.J., 2016. A large and unusually colored new snake species of the genus *Tantilla* (Squamata; Colubridae) from the Peruvian Andes. *PeerJ* 4, 2767. <https://doi.org/10.7717/peerj.2767>.
- Koch, C., Venegas, P.J., Böhme, W., 2006. A remarkable discovery: description of a big-growing new gecko (Squamata: Gekkonidae: Phyllopezus) from northwestern Peru. *Salamandra* 42, 145–150.
- Koch, C., Venegas, P.J., Garcia-Bravo, A., Böhme, W., 2011. A new bush anole (Iguanidae, Polychrotinae, Polychrus) from the upper Marañón basin, Peru, with a redescription of *Polychrus peruvianus* (Noble, 1924) and additional information on *P. gutturosus* Berthold, 1845. *Zookeys* 141, 79–107. <https://doi.org/10.3897/zookeys.141.1678>.
- Koch, C., Venegas, P.J., Rödder, D., Flecks, M., Böhme, W., 2013. Two new endemic species of *Ameiva* (Squamata: Teiidae) from the dry forest of northwestern Peru and additional information on *Ameiva concolor* Ruthven, 1924. *Zootaxa* 3745, 263–295. <https://doi.org/10.11646/zootaxa.3745.2.6>.
- Koch, C., Venegas, P.J., Böhme, W., 2015. Three new endemic species of *Epictia* Gray, 1845 (Serpentes: Leptotyphlopidae) from the dry forest of Northwestern Peru. *Zootaxa* 3964, 228–244. <https://doi.org/10.11646/zootaxa.3964.2.4>.
- Koch, C., Flecks, M., Venegas, P.J., Bialke, P., Valverde, S., Rödder, D., 2016. Applying n-dimensional hypervolumes for species delimitation: Unexpected molecular, morphological, and ecological diversity in the Leaf-Toed Gecko *Phyllodactylus reissii* Peters, 1862 (Squamata: Phyllodactylidae) from northern Peru. *Zootaxa* 4161, 41–80. <https://doi.org/10.11646/zootaxa.4161.1.2>.
- Koch, C., Venegas, P.J., Santa-Cruz, R., Böhme, W., 2018. Annotated checklist and key to the species of amphibians and reptiles inhabiting the northern Peruvian dry forest along the Andean valley of the Marañón river and its tributaries. *Zootaxa* 4385, 1–101. <https://doi.org/10.11646/zootaxa.4385.1.1>.
- Koopman, K.F., 1978. Zoogeography of Peruvian Bats With Special Emphasis on the Role of the Andes. *Am. Museum Novit.* 3, 1–33.
- Lewis, G.P., Hughes, C.E., Daza-Yomona, A., Solange-Sotuyo, J., Simon, M.F., 2010. Three new legumes endemic to the Marañón Valley, Perú. *Kew Bull.* 65, 209–220. <https://doi.org/10.1007/s12225-010-9203-6>.
- Linares-Palomino, R., 2004. Los Bosques Tropicales Estacionalmente Secos: II. Fitogeografía y Composición florística. *Arnaldoa* 11, 103–138.
- Linares-Palomino, R., 2006. Phytogeography and Floristics of Seasonally Dry Tropical Forests in Peru, in: *Neotropical Savannas and Seasonally Dry Forests*. pp. 257–279. <https://doi.org/10.1201/9781420004496.ch11>.
- Linares-Palomino, R., Pennington, R.T., 2007. Lista anotada de plantas leñosas en bosques estacionalmente secos del Perú - una nueva herramienta en Internet para estudios taxonómicos, ecológicos y de biodiversidad. *Arnaldoa* 14, 149–152.
- Linares-Palomino, R., Pennington, R.T., Bridgewater, S., 2003. The phytoecology of the seasonally dry tropical forests in Equatorial Pacific South America. *Candollea* 58, 473–499.
- Linares-Palomino, R., Oliveira-Filho, A.T., Pennington, R.T., 2011. Neotropical seasonally dry forests: diversity, endemism, and biogeography of woody plants. In: Dirzo, R., Young, H., Mooney, H., Ceballos, G. (Eds.), *Seasonally Dry Tropical Forests: Ecology and Conservation*. Island Press, pp. 3–21. https://doi.org/10.5822/978-1-61091-021-7_1.
- Llosa, G., 2001. Estrategia Regional de Biodiversidad para los Países del Trópico Andino/Conservación de ecosistemas transfronterizos y especies amenazadas. Lima - Perú.
- Marcelo-Peña, J.L., 2017. *Diversidade florística, dendrologia e dendroecologia em florestas estacionais decíduas do Centro e Norte do Peru*. Universidade de São Paulo.
- Marcelo-Peña, J.L., Reynel-Rodríguez, C., Zevallos-Pollito, P., Bulnes-Soriano, F., Pérez-Ojeda del Arco, A., 2007. Diversidad, composición florística y endemismos en los bosques estacionalmente secos alterados del distrito de Jaén, Perú. *Ecol. Appl.* 6, 9–22. <https://doi.org/10.21704/rea.v6i1-2.336>.
- Marcelo-Peña, J.L., Huamantupa, I., Särkinen, T., Tomazello, M., 2016. Identifying conservation priority areas in the marañón valley (Peru) based on floristic inventories. *Edinburgh J. Bot.* 73, 95–123. <https://doi.org/10.1017/S0960428615000281>.
- Marcelo-Peña, J.L., Santini, L., Tomazello Filho, M., 2019. Wood anatomy and growth rate of seasonally dry tropical forest trees in the Marañón River Valley, northern Peru. *Dendrochronologia* 55, 135–145. <https://doi.org/10.1016/j.dendro.2019.04.008>.
- Marcelo-Peña, J.L., Pennington, R.T., Reynel, C., Zevallos, P., 2010. Guía ilustrada de la flora leñosa de los bosques estacionalmente secos de Jaén, Perú. Lima, Perú.
- Mason-Romo, E.D., Ceballos, G., Lima, M., Martínez-Yrizar, A., Jaramillo, V.J., Maass, M., 2018. Long-term population dynamics of small mammals in tropical dry forests, effects of unusual climate events, and implications for management and conservation. *For. Ecol. Manag.* 426, 123–133. <https://doi.org/10.1016/j.foreco.2018.05.058>.
- Mesa-Sierra, N., Laborde, J., Escobar, F., 2020. Effects of biogenerated ferric hydroxides nanoparticles on truffle mycorrhizal plants. *Mycorrhiza* 30, 211–219. <https://doi.org/10.1016/j.myc.2020.103583>.
- Meza, G., Barboza, E., Torres, C., Cotrina, D., Guzman, B., Oliva, M., Bandopadhyay, S., Salas, R., Rojas, N., 2020. Predictive modelling of current and future potential distribution of the spectacled bear (*Tremarctos ornatus*) in Amazonas, northeast Peru. *Animals* 10, 1–21. <https://doi.org/10.3390/ani10101816>.
- Miles, L., Newton, A.C., DeFries, R.S., Ravilious, C., May, I., Blyth, S., Kapos, V., Gordon, J.E., 2006. A global overview of the conservation status of tropical dry forests. *J. Biogeogr.* 33, 491–505. <https://doi.org/10.1111/j.1365-2699.2005.01424.x>.
- MINAGRI, 2001. D.S. N° 038-2001-AG. Reglamento de la Ley de Áreas Naturales Protegidas. Diario Oficial El Peruano, Perú.
- MINAM, 2009. Decreto Supremo N° 016-2009-MINAM: Actualización del Plan Director de las Áreas Naturales Protegidas. Diario Oficial El Peruano, Perú.
- MINAM, 2021. Decreto Supremo que establece el Área de Conservación Regional Bosques Secos del Marañón. DECRETO SUPREMO N° 007-2021-MINAM. Diario Oficial El Peruano, Perú.
- MINEM, 2011. Decreto Supremo N° 020-2011-EM. Declaran de interés nacional y social la construcción de veinte (20) centrales hidroeléctricas en la Cuenca del Río Marañón. Diario Oficial El Peruano, Perú.
- Miralles, A., Barrio-Amorós, C.L., Rivas, G., Chaparro-Auza, J.C., 2006. Speciation in the “Várzea” flooded forest: a new *Mabuya* (Squamata, Scincidae) from Western Amazonia. *Zootaxa* 1188, 1–22. <https://doi.org/10.11646/zootaxa.1188.1.1>.
- Missouri Botanical Garden, 2021. Tropicos.org. <http://www.tropicos.org> (Accessed 1 April 2021).
- Mogni, V.Y., Oakley, L.J., Maturó, H.M., Galetti, L.A., Prado, D.E., 2015. Biogeografía y Florística de los Bosques Secos Estacionales Neotropicales (BSEN). *OKARA Geogr. Debate* 9, 275–296.
- de Bellavista Municipalidad Distrital, 2016. Ordenanza Municipal N° 017-2016-MDB: Ordenanza que declara Área de Conservación Ambiental Municipal “Bosque Seco Chinchipe Marañón”, distrito de Bellavista - Jaén - Cajamarca. Municipalidad Distrital de Bellavista, Perú.
- Municipalidad Provincial de Cajabamba, 2018. Ordenanza Municipal N° 005-2018-MPC: Ordenanza que reconoce como Área de Conservación Ambiental los “Bosques Secos del Crisnejas - Marañón”, del distrito de Sitacocha, provincia de Cajabamba - Cajamarca, por ser de interés público provincial. Municipalidad Provincial de Cajabamba, Perú.
- Musser, G.G., Carleton, M.D., 2005. Superfamily muroidea. In: Wilsonand, D.E., Reeder, D.M. (Eds.), *Mammal Species of the World*. Johns Hopkins University Press, Baltimore, Maryland, pp. 894–1531.
- Osgood, W.H., 1923. Mammals of an expedition across Northern Perú, in: *Publication of the Field Museum of Natural History, Zoological Series, Vol. X*. Field Museum of Natural History, pp. 143–186.

- Pacheco, V., Cadenillas, R., Salas, E., Tello, C., Zeballos, H., 2009. Diversidad y endemismo de los mamíferos del Perú. *Rev. Peru. Biol.* 16, 5–32. <https://doi.org/10.15381/rpb.v16i1.111>.
- Pacheco, V., 2002. Mamíferos del Perú, in: Ceballos, G., Simonetti, J.A. (Eds.), *Diversidad y Conservación de Los Mamíferos Neotropicales*. CONABIO-UNAM, D.F., México, pp. 503–549.
- Pacheco, V., Zeballos, A., Cervantes, K., Pacheco, J., Salvador, J., 2015. Mamíferos del refugio de vida silvestre Los Pantanos de Villa, Lima-Perú. *Científica* 12, 26–41.
- Patton, J.L., Pardiñas, U.F.J., D'Elia, G., 2015. *Mammals of South America*, Vol. 2. University of Chicago, Chicago and London. <https://doi.org/10.7208/chicago/9780226169606.001.0001> (Library).
- Pennington, R., Lavin, M., Oliveira-Filho, A., 2009. Woody plant diversity, evolution, and ecology in the tropics: perspectives from seasonally dry tropical forests. *Annu. Rev. Ecol. Evol. Syst.* 40, 437–457. <https://doi.org/10.1146/annurev.ecolsys.110308.120327>.
- Pennington, R.T., Prado, D.E.D.E., Prendy, C.A., Toby Pennington, R., Prado, D.E.D.E., Pendry, C.A., 2000. Neotropical seasonally dry forests and Quaternary vegetation changes. *J. Biogeogr.* 27, 261–273. <https://doi.org/10.1046/j.1365-2699.2000.00397.x>.
- Pennington, R.T., Lavin, M., Särkinen, T., Lewis, G.P., Klitgaard, B.B., Hughes, C.E., 2010. Contrasting plant diversification histories within the Andean biodiversity hotspot. *Proc. Natl. Acad. Sci. U.S.A.* 107, 13783–13787. <https://doi.org/10.1073/pnas.1001317107>.
- Pennington, T.D., Muellner, A.N., 2010. A monograph of CEDRELA (Meliaceae), 1st ed. dh books, England.
- Pinto, C.M., Marchán-Rivadeneira, M.R., Tapia, E.E., Carrera, J.P., Baker, R.J., 2013. Distribution, abundance and roosts of the fruit bat *Artibeus fraterculus* (Chiroptera: phyllostomidae). *Acta Chiropterol.* 15, 85–94. <https://doi.org/10.3161/150811013X667885>.
- Plenge, M.A., 2021. List of the birds of Peru / Lista de las aves del Perú. Unión de Ornitólogos del Perú: Version [23 enero 2021]. Unión Ornitólogos del Perú. <https://sites.google.com/site/boletinunop/checklist>.
- Portillo-Quintero, C.A., Sánchez-Azofeifa, G.A., 2010. Extent and conservation of tropical dry forests in the Americas. *Biol. Conserv.* 143, 144–155. <https://doi.org/10.1016/j.biocon.2009.09.020>.
- Prado, J.R., Percequillo, A.R., 2013. Geographic distribution of the genera of the Tribe Oryzomyini (Rodentia: Cricetidae: Sigmodontinae) in South America: patterns of distribution and diversity. *Arq. Zool.* 44, 1–120. <https://doi.org/10.11606/issn.2176-7793.v44i1p1-120>.
- Prieto-Torres, D.A., Rojas-Soto, O.R., Bonaccorso, E., Santiago-Alarcon, D., Navarro-Sigüenza, A.G., 2018. Distributional patterns of Neotropical seasonally dry forest birds: a biogeographical regionalization. *Cladistics* 0, 1–15. <https://doi.org/10.1111/cla.12366>.
- Prieto-Torres, D.A., Rojas-Soto, O.R., Santiago-Alarcon, D., Bonaccorso, E., Navarro-Sigüenza, A.G., 2019. Diversity, endemism, species turnover and relationships among avifauna of Neotropical seasonally dry forests. *Ardeola* 66, 257–277. <https://doi.org/10.13157/arla.66.2.2019.ra1>.
- Prieto-Torres, D.A., Lira-Noriega, A., Navarro-Sigüenza, A.G., 2020. Climate change promotes species loss and uneven modification of richness patterns in the avifauna associated to Neotropical seasonally dry forests. *Perspect. Ecol. Conserv.* 18, 19–30. <https://doi.org/10.1016/j.pecon.2020.01.002>.
- Remsen, J.V., Jr., Areta, J.I., Bonaccorso, E., Claramunt, S., Jaramillo, A., Pacheco, J.F., Ribas, C., Robbins, M.B., Stiles, F.G., Stotz, D.F., Zimmer, K.J., 2021. A classification of the bird species of South America. American Ornithological Society. Version [01 marzo 2021]. A Classif. bird species South Am. Am. Ornithol. Soc. <http://www.museum.lsu.edu/~Remsen/SACCBaseline.htm>.
- Reynel, C., Pennington, R.T., Särkinen, T., 2013. *Cómo se formó la diversidad ecológica del Perú*. Biblioteca Nacional del Perú, Lima, Perú.
- Rodríguez, E., Alvítez, E., Pollack, L., Huamán, E., Sagástegui, A., 2015. Notas sobre Malvaceae subfamilia Bombacoideae en la región La Libertad, Peru. *REBIOL* 35, 90–101.
- Rodríguez, E.F., Ramírez Vargas, R., Rimarachín Cayatopa, V., 2016. Notas sobre *Iresine weberbaueri* (Amaranthaceae), una especie endémica del valle Marañón en el norte del Perú. *Arnaldoa* 23, 135–148.
- Roncal, M., Díaz, D., Roncal, C., Rabanal, W., 2013. Huacaybamba Riqueza biológica del Marañón, Universidad Nacional de Cajamarca. Biblioteca Nacional del Perú, Cajamarca, Perú.
- Roncal-Rabanal, M.R., Chávez Chávez, C.A., Sanchez Tello, S., 2020. Reporte de dieta del Periquito de Cara Amarilla (*Forpus xanthops*) en el Bosque Tropical Estacionalmente Seco del Marañón, Perú. *Rev. Peru Biol.* 27, 237–240. <https://doi.org/10.15381/rpb.v27i2.17880>.
- Rubio, J., Escobedo, A., Vallejos, C., Oyague, E., Vera, A., Estrada, M., 2017. Marañón: Costo social de los impactos acumulativos de cinco proyectos hidroeléctricos. Lima, Perú.
- Ruelas, D., Pacheco, V., 2018. Noteworthy records and distribution of Peruvian long-tongued bat, *Platalina genovensium* Thomas, 1928 (Chiroptera, Phyllostomidae). *Check List* 14, 937–944. <https://doi.org/10.15560/14.5.937>.
- Ruelas, D., Ramos, M., Molina, M., Pacheco, V., 2016. First record of leucism in *Glossophaga soricina valens* (Phyllostomidae: Chiroptera) from Peru. *Therya* 7, 343–352. <https://doi.org/10.12933/therya-16-381>.
- Rzedowski, J., 1991. El Endemismo en la Flora Fanerogámica Mexicana: Una apreciación analítica preliminar. *Acta Bot. Mex.* 15, 47–64.
- SACC, 2021. Proposal (898) to South American Classification Committee. A. Split the Tawny-crowned Pygmy-Tyrant *Euscarthmus meloryphus* into two species. B. Establish English names for the species. <https://www.museum.lsu.edu/~Remsen/SACCprop898.htm> (Accessed 1 June 2021).
- Särkinen, T.E., Marcelo-Peña, J.L., Yomona, A.D., Simon, M.F., Pennington, R.T., Hughes, C.E., 2011. Underestimated endemic species diversity in the dry inter-Andean valley of the Río Marañón, northern Peru: an example from *Mimosa* (Leguminosae, Mimosoideae). *Taxon* 60, 139–150. <https://doi.org/10.1002/tax.601012>.
- SERNANP, 2014. Documento de Trabajo 10: Áreas de Conservación Privada. Lima, Perú.
- SERNANP, 2019. REPORTE TÉCNICO N° 001- 2018-SERNANP-DDE Análisis del estado de conservación de los ecosistemas dentro de las ANP mediante la evaluación de los efectos generados por las actividades antrópicas Tercer Trimestre Julio – Agosto.
- Shanee, S., Shanee, N., 2018. Diversity of large mammals in the Marañón–Huallaga landscape, Peru: with notes on rare species. *Zool. Ecol.* 28, 313–328. <https://doi.org/10.1080/21658005.2018.1516277>.
- Shanee, S., Shanee, N., Allgas-Marchena, N., 2013. Primate surveys in the marañón-huallaga landscape, Northern Peru with notes on conservation. *Primate Conserv.* 27, 3–11. <https://doi.org/10.1896/052.027.0114>.
- Smith, B.T., Bryson, R.W., Mauck, W.M., Chaves, J., Robbins, M.B., Aleixo, A., Klicka, J., 2018. Species delimitation and biogeography of the gnatcatchers and gnatwrens (Aves: Ptiliidae). *Mol. Phylogenet. Evol.* 126, 45–57. <https://doi.org/10.1016/j.ympev.2018.03.012>.
- Stattersfield, A., Crosby, M., Long, A.J., Wege, D.C., 1998. *Endemic Bird Area of the World: Priorities for Biodiversity Conservation*. BirdLife International, Cambridge.
- Stopiglia, R., Bockmann, F.A., De Assis, C.P., Raposo, M.A., 2020. Alpha taxonomy of *Synallaxis stictothorax* group (Aves: Passeriformes: Furnariidae): *synallaxis chinchipensis* Chapman, 1925 as a valid species, with a lectotype designation. *Vertebr. Zool.* 70, 319–331. <https://doi.org/10.26049/VZ70-3-2020-05>.
- The Plant List 2013. <http://www.theplantlist.org/>. (Accessed 15 October 2020).
- Tirira, D.G., Burneo, S.F., Boada, C.E., Lobos, S.E., 2011. Mammalia, Chiroptera, Phyllostomidae, *Lonchophylla hesperia* G. M. Allen, 1908: second record of the Western Nectar Bat in Ecuador after 70 years. *Check List* 7, 315–318. <https://doi.org/10.15560/7.3.315>.
- Toby Pennington, R., Lewis, G., Ratter, J., 2006. An overview of the plant diversity, biogeography and conservation of neotropical savannas and seasonally dry forests. In: Pennington, R.T., Lewis, G.P., Ratter, J.A. (Eds.), *Neotropical Savannas and Seasonally Dry Forests*. CRC Taylor & Francis Group, Boca Raton, pp. 1–29. <https://doi.org/10.1201/9781420004496.ch1>.
- Uetz, P., Hošek, J., 2020. The reptile database. <http://www.reptile-database.org> (Accessed 8 September 2020).
- UICN, 2012. *Categorías y Criterios de la Lista Roja de la UICN: Versión 3.1. Segunda edición*. Gland, Suiza y Cambridge, Reino Unido: UICN. vi + 34pp.
- Uturunco, A.C.J., 2015. Estudio morfológico y morfométrico de *Eremoryzomys polius* (Rodentia: Cricetidae) del valle del alto Marañón -Perú. Universidad Nacional Mayor de San Marcos.

- Uturunco, A.C.J., Pacheco, V.R., 2016. Redescrición de *Eremoryzomys polius* (Rodentia: Cricetidae) y descripcón de una nueva especie del género *Eremoryzomys*. *Mastozool. Neotrop.* 23, 483–503.
- Venegas, P.J., Townsend, J.H., Koch, C. y, Böhme, W., 2008. Two new sympatric species of leaf-toed geckos (Gekkonidae: Phyllodactylus) from the balsas region of the upper Marañon Valley. Peru. *J. Herpetol.* 42, 386–396. <https://doi.org/10.1670/07-1341.1>.
- Venegas, P.J., García-Ayachi, L.A., Chávez-Arribasplata, J.C., Chávez, G., Wong, I., García-Bravo, A., 2020. Four new species of *Stenocercus* Duméril & Bibron, 1837 (Squamata, Iguania) from the Department of Amazonas in northeastern Peru. *Evol. Syst.* 4, 79–108. <https://doi.org/10.3897/evolsyst.4.57578>.