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Composition and vulnerability of mixed bird flocks in tropical biodiversity hotspots

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ABSTRACT

The extinction of ecological interactions represents the most dramatic scenario resulting from the massive loss of species. Essentially, mixed-species flocks constitute critical mutualistic relationships for the structure, cohesion, and diversity in bird communities, yet they are strongly threatened by the extensive destruction of primary forests. In tropical regions and their biodiversity hotspots, there appears to be no integrated assessment of mixed-species flocks in terms of composition, vulnerability, or habitat use. Thus, a systematic review was conducted based on 269 studies on mixed-species flocks, including 55 conducted in the tropics from 1963 to 2022. We highlight 367 bird species most frequently found in mixed-species flocks, among which 13 are threatened and 14 are near-threatened. According to global assessments, the Tropical Andes harbor the highest number of threatened species, followed by the Coastal Forest of East Africa, Western Ghats and Sri Lanka, and at a third level, the Himalayas. The Atlantic Forest did not present any threatened species, although it constitutes the focus of discussions concerning mixed-species flocks in tropical regions. Additionally, member species are more vulnerable compared to nuclear species, and overall, forests, savannas, and shrubland formations are the most critical habitats for the conservation of mixed-species flocks in these territories. Therefore, we emphasize that the birds evaluated herein should be at the forefront of global actions aimed at restoring ecosystems, preventing functional extinction, expanding the extent of protected areas, and mitigating the effects of climate change.

Keywords: Birds; Heterospecific Interactions; Mixed-species Flocks; Tropical Hotspots.

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SIGNIFICANCE STATEMENT

Here we present a global overview of the composition and vulnerability of mixed-species flocks of birds in tropical regions and their hotspots based on a systematic review. We demonstrate the focal points of discussion, identify key habitats for the conservation of mixed-species flocks as well as those harboring greater diversity of nuclear species and member species. We also emphasize the role of non-threatened species in the conservation of mixed-species flocks. Finally, we suggest that the species evaluated herein be at the forefront of global discussions focusing on the conservation of ecological interactions, prioritization of areas, and ecological restoration in the tropics and their hotspots.

INTRODUCTION

Mutualistic interactions are essential ecological processes in determining patterns in biological communities, particularly in terms of composition, foraging dynamics, fitness, and distribution (Chomicki et al., 2020; Connor, 1995; Fowler et al., 2023; Swynnerton, 1915). From this perspective, mutualistic dependence predicts that organisms living in isolation have lower adaptive success in the face of biotic and abiotic selective pressures. In this sense, species become, at different levels, dependent on these interactions to persist in ecosystems (Chomicki et al., 2020). This theoretical framework is especially relevant when we seek to understand mutualistic interactions as vulnerable as mixed-species bird flocks, which, not coincidentally, have been studied for over a century (Moynihan, 1962; Powell, 1989, 1985; Swynnerton, 1915).

Mixed-species flocks consist of mutualistic associations in which two or more species forage and move synchronously along the same feeding route (Greenberg, 2000; Moynihan, 1962; Powell, 1989). Unlike fortuitous groupings that form around temporary food sources (e.g., fruit-bearing trees), mixed-species flocks are cohesive and mutually dependent interspecific associations (Greenberg, 2000; Machado, 1999, 1997; Moynihan, 1962; Sridhar et al., 2009). In more detail, the formation, structure, and cohesion of mixed-species flocks in terms of composition depend on stimuli and behavioral responses from their members, especially nuclear species (Moynihan, 1963; Powell, 1989).

Essentially, nuclear species are gregarious, as they attract multiple birds to their vicinity (Moynihan, 1962; Powell, 1989). High movement frequency and vocalizations are also key characteristics of these species, which, in turn, exhibit their typical sentinel behavior in mixed-species flocks (Amaral and Ragusa-Netto, 2008; Bell, 1986; McClure, 1967; Moynihan, 1963; Powell, 1989). In particular, presence in mixed-species flocks results in higher chances of survival and reproduction for birds, as species optimize their foraging and reduce predation risk (Bohórquez, 2003; Greenberg, 2000; Jullien and Clobert, 2000; Machado, 1997; Moynihan, 1963; Sridhar et al., 2009).

Mixed-species bird flocks have been the focus of studies in ecology and conservation in the tropics, especially due to their vulnerability and dependence on primary forests (Bohórquez, 2003; Buskirk et al., 1972b; Cordeiro et al., 2015; Van Houtan et al., 2006; Mokross et al., 2013; Zou et al., 2018). However, the synergistic impact of native vegetation suppression, expansion of pastures and monocultures, as well as natural and anthropogenic fires, has strongly threatened these regions (Giam, 2017; Hansen et al., 2020; Van Houtan et al., 2006; Symes et al., 2018). This critical scenario justifies the fact that tropical forests are among the most threatened ecosystems on the planet (Symes et al., 2018). Additionally, these impacts may have more devastating consequences in biodiversity hotspots, especially due to the high degree of vulnerability and irreparability of these territories (Brooks et al., 2006; Fischer et al., 2021; Laurance et al., 2000; Myers et al., 2000, 2004).

Specifically, advancing discussions with an emphasis on mixed-species bird flocks reinforces the need to prioritize ecological interactions and, consequently, multispecies in decision-making processes (Ceballos et al., 2020; Cordeiro et al., 2015; Muñoz and Jankowski, 2022; Sainz-Borgo et al., 2018; Valiente-Banuet et al., 2014; Zuluaga et al., 2015). Currently, this scenario assumes an urgent character considering that birds have been assessed as the vertebrates most impacted by anthropogenic actions, constituting 65% of species on the brink of extinction (Ceballos et al., 2020).

Birds are associated with multiple ecosystem services including pollination, seed and fruit dispersal, and pest control (Mariyappan et al., 2023; Sekercioglu et al., 2004; Whelan et al., 2008, 2015). However, these and numerous ecological interactions dependent on multitaxa may be extinct due to the massive population decline of species (Valiente-Banuet et al., 2014; Zhou et al., 2019). From this perspective and the current scenario of mass extinction (Ceballos et al., 2020), species would be living in such low densities as to become functionally extinct (Valiente-Banuet et al., 2014).

In extensively fragmented landscapes, for example, it has been demonstrated that the functional extinction of birds directly impacts seed dispersal (Galett and Guevara, 2013), besides reducing the potential resilience of tropical forests

(Hatfield et al., 2023). Specifically, mixed-species flocks are fundamental for maintaining birds in ecosystems, enabling greater taxon diversity and structuring multiple interaction networks (Goodale et al., 2020; Powell, 1989). In this sense, the destruction of megadiverse ecosystems such as tropical forests represents the imminent decline of multispecies associated with mixed-species flocks and, consequently, the extinction of these interactions (Valiente-Banuet et al., 2014). Additionally, this impact may be greater on birds that frequent mixed-species flocks during periods of food scarcity and, in turn, depend on this interaction to resist numerous selective pressures (da Luz et al., 2022; Maldonado-Coelho and Marini, 2004, 2000, 2003; Mokross et al., 2013; Rutt et al., 2020).

Although representing less than 10% of the Earth's surface, tropical regions harbor two-thirds of all species on the planet, constituting one of the most biodiverse territories globally (DeFries et al., 2007; Giam, 2017; Hansen et al., 2020; Saatchi et al., 2021). However, the historical scenario of primary forest suppression in the tropics has increasingly demanded urgency in decision-making processes (Edwards et al., 2019). This includes careful land use planning (Hansen et al., 2020), combined efforts in restoration (Brancalion et al., 2019; Strassburg et al., 2020), sustainable action direction, and expansion of protected area coverage (Cazalis et al., 2020; Hansen et al., 2020; Vidal et al., 2016). This integrated effort has already proven effective in reducing deforestation in forest ecosystems as well as in the conservation of birds in at least eight of the planet's most threatened hotspots (Brooks, 2010; Cazalis et al., 2020; Giam, 2017; Mittermeier et al., 2011; Myers et al., 2004). Mixed-species bird flocks have been the subject of numerous discussions in tropical regions and their hotspots (Bohórquez, 2003; Buskirk et al., 1972a; Goodale and Kotagama, 2005; Machado, C.G. & Rodrigues, 2000; Machado, 2002; Martínez and Gomez, 2013; Richard, 1994; Swynnerton, 1915; Tien et al., 2005; Zuluaga et al., 2015), but apparently there has not yet been an integrated assessment in terms of composition, vulnerability, or habitat use of these birds.

Here, we analyze the composition and vulnerability of mixed-species flocks in the tropics and their biodiversity hotspots based on a systematic review. Thus, we present a list of the most frequent birds in mixed-species flocks in studies conducted in the tropics and indicate which hotspots are the focus of these discussions. Additionally, we emphasize the standout regions in terms of threatened birds in mixed-species flocks and, particularly, nuclear species. Finally, we demonstrate, from a general ecological perspective, the priority habitats in terms of restoration and, therefore, conservation of mixed-species flocks.

MATERIAL AND METHODS

Literature research

The data were collected from technical publications, primarily focusing on articles, and also including monographs, master's theses, or doctoral dissertations on mixed-species bird flocks in the tropics. To avoid duplication of information, we assessed whether these recent studies had been published subsequently. In such cases, only the publications were considered. The studies were obtained from the following sources: Web of Science, Scopus, Academia.edu, ResearchGate, Google Scholar, and Mendeley. Generally, we searched for studies in English, French, Spanish, and Portuguese using the following keywords: mixed-species bird flocks, interspecific bird behavior, and heterospecific bird flocks.

Criteria for Inclusion or Exclusion of Studies

Only studies conducted in tropical regions were included. Specifically, the following countries and territories were included: Argentina, Bolivia, Brazil, Colombia, Colombia, Costa Rica, Cuba, Ecuador, French Guiana, Vietnam, India, Mexico, Panama, Republic of the Congo, Sri Lanka, Tanzania, Venezuela, India, and the island of Madagascar. Additionally, we did not set an initial period for the searches, and thus included both historical studies (from the second half of the 19th century) and those completed/published up to December 2022. Conversely, we excluded reviews and studies conducted in predominantly anthropized ecosystems, such as monocultures or pastures. The included studies included different types of documents: articles based on field studies, literature reviews, master's theses and doctoral dissertations, which in turn were our main source of data for the construction of statistical analyses and maps.

Representation of Studies and Key Species of Mixed-species Flocks in the Tropics

We analyzed the studies for two sets of information. First, in the "Materials and Methods" section, we consulted the locations and respective exact or approximate geographical coordinates provided by the authors. When not available, we obtained general coordinates from the described locations. Thus, we analyzed whether the studies were primarily conducted in the tropics, and when applicable, in biodiversity hotspots. Next, we extracted from the “Results” and “Discussion” sections the most frequent birds in mixed-species flocks. This was possible because we noticed that authors generally use expressions such as “target species” and “species most frequently recorded” to emphasize patterns in flock composition. Additionally, according to authors’ classifications, we defined the birds as either member species (i.e., members of mixed-species flocks) or nuclear species.

Based on this information, we constructed maps demonstrating the distribution of historical studies and nuclear species in tropical biodiversity hotspots. We also assessed the representativeness of these regions focusing on nuclear species, particularly, as well as threatened mixed-species flock birds, in general. The maps were produced using the trial version of the ArcGIS software (Esri, 2023). All the functionalities available in the version used (e.g. definition of colour gradients and layer clipping) fully met the requirements for the construction, layout definition and finalisation of the maps.

Definition of Target Group

After assessing the threat category of species based on criteria from the International Union for Conservation of Nature (IUCN, 2024), we defined a target group for the analyses. In detail, the group consisted of species with two ecological profiles: 1) threatened, not at risk, or near threatened member species, and 2) nuclear species (under some degree of threat or not at risk). Predominantly, threatened species are targeted for monitoring, management, and conservation programs, being crucial in decision-making worldwide (Howard et al., 2020; Strassburg et al., 2020). Near threatened species, in turn, become similarly relevant due to the potential decline in their populations and reduction in their distribution in the face of extensive ecosystem destruction (Margules and Pressey, 2000; Zhou et al., 2019).

Particularly, nuclear species directly influence the formation and cohesion of mixed-species flocks as well as the recruitment of individuals, even if member species are declining (Goodale and Beauchamp, 2010; Powell, 1989; Zou et al., 2018). Species assessed as not at risk, on the other hand, are crucial for maintaining ecosystem services and resilience, especially as they are typically the most abundant (Baker et al., 2019).

As a result of this assessment, the target group was composed of birds included in the following categories: Least Concern (LC), Near Threatened (NT), Vulnerable (VU), Endangered (EN), and Critically Endangered (CR). Based on these categories, we established a vulnerability ranking ranging from one to five. Lower values represented a lower degree of vulnerability, while higher values represented a higher degree of vulnerability (IUCN, 2024).

Additionally, we sought information about the most common habitats for the presence of these species and constructed a general ecological profile for the target group (IUCN, 2023). As a result of this analysis, we evaluated the following habitats: Forests, Savannas, Shrublands, and Wetlands (IUCN, 2023). Lastly, we sought to identify the main impacts on threatened species in order to build a general vulnerability profile for these birds and their hotspots (IUCN, 2023). We used the IUCN’s taxonomic classification system as a criterion to compile the final list of birds, as well as to update nomenclature that has changed over the years.

Statistical Analyses

We conducted three statistical tests to assess the vulnerability and ecological preference of the target group. To analyze the level of vulnerability, we performed a non-parametric Mann-Whitney test (Nachar, 2008), comparing the values established in the ranking between nuclear species and member species ($p < 0.05$). Seeking to demonstrate a general pattern of habitat use based on a global assessment (IUCN, 2023), we performed two ordinations via NMDS - non-metric multidimensional scaling (Agarwal et al., 2007), with a stress value defined between 0.1 and 0.3. In the first analysis, we considered only nuclear species, and in the second, all species in the target group were included. We used presence and absence matrices to assess these general ecological patterns in the ordinations. The matrices were constructed from categorical data, taking into account the habitat type mentioned on the IUCN platform. Thus, we assigned a value of ‘1’ to indicate the occurrence of species in phytophysiognomic formations (habitats) such as forest formations, savannas, shrub formations or wetlands, and ‘0’ to indicate no correspondence to such habitats. From this point we constructed the ordinations and calculated the diversity indices.

Additionally, we calculated the Shannon-Wiener diversity index (H) for each habitat considering the usage profile of these formations by the target group. Then, we compared the diversity between habitats using a 95% confidence interval estimated via bootstrapping with 9999 randomizations (Johnson, 2001). The analyses and graphs were conducted using the software Past (v. 4.03) (Hammer et al., 2001) and the trial version of Statistica (v.10) (Icn, 2011). Conventionally, some information contained in the figures and graphs is presented in English.

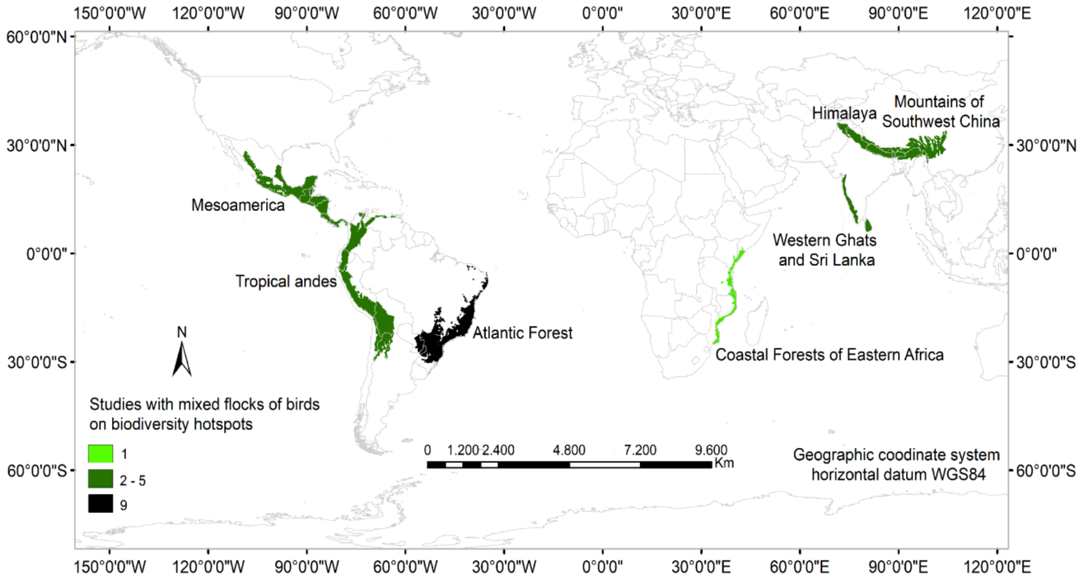
RESULTS

We identified 269 studies focusing on mixed-species flocks, of which 55 were conducted in tropical regions from 1963 to 2022 (Additional File 1), during which 367 species were the most frequently studied (Additional File 2). The evaluated studies consisted of 50 articles, two monographs, one master's thesis, and two doctoral dissertations. Specifically, the highest number of studies conducted in the Atlantic Forest makes this hotspot the center of historical discussions focusing on mixed-species flocks of birds in the tropics. Following this, the Tropical Andes, Mesoamerica, the Himalayas, the Southwest China Mountains, the Western Ghats, Sri Lanka, and lastly, the Eastern African Coastal Forest are highlighted (Figure 1). Nuclear species, on the other hand, exhibit a more pronounced concentration in the Tropical Andes, followed by the Atlantic Forest, Mesoamerica, the Himalayas, the Southwest China Mountains, the Western Ghats, Sri Lanka, and lastly, the Eastern African Coastal Forest (Figure 2).

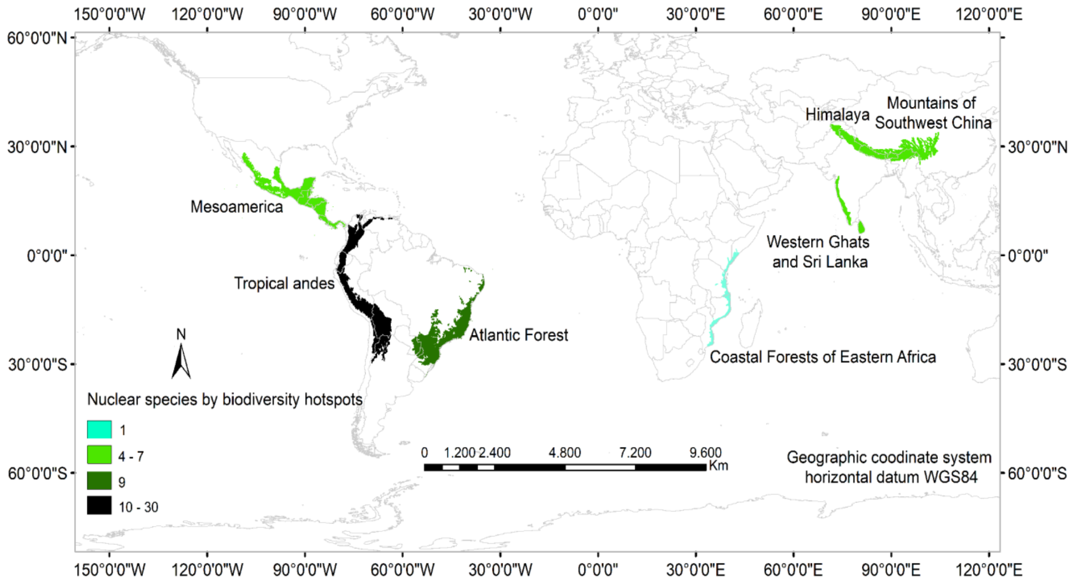
According to recent literature records and global assessments (IUCN 2024), five tropical hotspots harbor threatened birds of mixed-species flocks. Particularly, the Tropical Andes harbor the highest number of threatened species, followed by the Eastern African Coastal Forest, the Western Ghats, Sri Lanka, and on a third level, the Himalayas (Table 1). In relation to the total number of mixed-species flock species recorded in the studies, 92.6% are classified as Least Concern (LC), among which 15.2% are nuclear species. Additionally, we noted similar sets of impacts on threatened species and their respective hotspots. Logging, large-scale development, road construction, establishment of pastures, and wildfires constitute the main anthropogenic threats to these territories (IUCN, 2024).

Based on the target group (Table 2), we demonstrate that nuclear species and member species differ significantly in terms of vulnerability (via ranking). From this general perspective, we noticed that member species are more vulnerable (Figure 3) compared to nuclear species. Additionally, we observed that nuclear species are more associated with forests, savannas, and shrubland formations (Figure 4, a). We also noted that forests and shrublands represent the most critical habitats for the conservation of the target group overall (Figure 4, b).

The reflection of habitat association patterns was reinforced by diversity indices. Specifically, forests harbor the highest species diversity, followed by savannas and shrubland formations (Figure 5). Wetlands are at the lowest level, which, based on the literature reviewed here, featured a species classified as Near Threatened according to global criteria (Figure 5).



Hình 1. Number of studies on mixed flocks of birds in tropical hotspots. The light and dark shades represent an ascending order from the lowest to the highest values.



Hình 2. Number of nuclear species of mixed flocks in tropical hotspots.

Bảng 1. ?

Species	**Hotspots**	**General scenario (IUCN, 2024).**
Basileuterus griseiceps Sclater & Salvin, 1869 (EN) *Diglossa venezuelensis* Chapman, 1925 (EN) *Premnoplex tatei* Chapman, 1925 (EN)	Tropical Andes	No research or monitoring actions, but sites identified for conservation and occurrence in protected áreas (PAs).
Bangsia melanochlamys (Hellmayr, 1910), (VU) *Hypopyrrhus pyrohypogaster* (de Tarragon, 1847), (VU)	Tropical Andes	(Idem).
Argya cinereifrons (Blyth, 1851), (VU)	Western Ghates and Sri Lanka	(Idem).
Urocissa ornata (Wagler, 1829), (VU) *Sturnornis albofrontatus* (Layard, 1854), (VU)	Sri Lanka	(Idem).
Sitta formosa Blyth, 1843 (VU) *Phaenicophaeus pyrrhocephalus* (Pennant, 1769), (VU)	Himalaya	(Idem).
Anthreptes rubritorques Reichenow, 1905 (VU)	Coastal Forest of Eastern Africa	(Idem).
Artisornis moreaui (W.L. Sclater, 1931), (CR) *Hedydipna pallidigaster* (Sclater & Moreau, 1935), (EN)	Coastal Forest of Eastern Africa	Actions directed at systematic monitoring, sites identified for conservation and occurrence in PAs.

Bång 2. ?

Species	English Name	IUCN	Habitat
Artisornis moreaui (W.L. Sclater, 1931)	Long-billed Forest-warbler	CR	a, c
Hedydipna pallidigaster (Sclater & Moreau, 1935)	Amani Sunbird	EN	a, b
Basileuterus griseiceps Sclater & Salvin, 1869	Grey-headed Warbler	EN	a
Diglossa venezuelensis Chapman, 1925	Venezuelan Flowerpiercer	EN	a, c
Premnoplex tatei Chapman, 1925	White-throated Barbtail	EN	a
Argya cinereifrons (Blyth, 1851)	Ashy-fronted Babbler	VU	a
Anthreptes rubritorques Reichenow, 1905	Banded Sunbird	VU	a, b
Bangsia melanochlamys (Hellmayr, 1910)	Black-and-gold Tanager	VU	a
Hypopyrrhus pyrohypogaster (de Tarragon, 1847)	Red-bellied Grackle	VU	a
Sitta formosa Blyth, 1843	Beautiful Nuthatch	VU	a
Sturnornis albofrontatus (Layard, 1854)	White-faced Starling	VU	a
Urocissa ornata (Wagler, 1829)	Sri Lanka Blue Magpie	VU	a
Xiphorhynchus pardalotus (Vieillot, 1818)	Chestnut-rumped Woodcreeper	NT	a, b
Vermivora chrysoptera (Linnaeus, 1766)	Golden-winged Warbler	NT	a, c, d
Amazona leucocephala (Linnaeus, 1758)	Cuban Amazon	NT	a, b
Arizelocichla milanjensis (Shelley, 1894)	Stripe-cheeked Bulbul	NT	a, c
Myiothlypis cinereicollis Sclater, 1865	Grey-throated Warbler	NT	a
Iridosornis porphyrocephalus (Sclater, 1856)	Purplish-mantled Tanager	NT	a
Leptasthenura setaria (Temminck, 1824)	Araucaria Tit-spinetail	NT	a
Melopyrrha nigra (Linnaeus, 1758)	Cuban Bullfinch	NT	a, c
Myrmotherula unicolor (Ménétries, 1835)	Unicolored Antwren	LC	a, b
Conirostrum binghami (Chapman, 1919)	Giant Conebill	NT	a
Patagioenas leucocephala Linnaeus, 1758	White-crowned Pigeon	NT	a
Setophaga cerulea (Wilson, 1810)	Cerulean Warbler	NT	a
Tauraco fischeri (Reichenow, 1878)	Fischer's Turaco	NT	a, c
Tangara cyanoptera (Vieillot, 1817)	Azure-shouldered Tanager	NT	a
Vireo atricapilla Woodhouse, 1852	Black-capped Vireo	NT	a, c
*Phaenicophaeus pyrrhocephalus** (Pennant, 1769)	Red-faced Malkoha	VU	a
Epinecrophylla gutturalis (Sclater & Salvin, 1881)	Brown-bellied Antwren	LC	a
*Thamnomanes ardesiacus** (Sclater & Salvin, 1868)	Dusky-throated Antshrike	LC	a
*Basileuterus culicivorus** (Deppe, 1830)	Stripe-crowned Warbler	LC	a
*Myiothlypis flaveola** (Baird, 1865)	Flavescent Warbler	LC	a
*Basileuterus melanogenys** Baird, 1865	Black-cheeked Warbler	LC	a
*Arremon torquatus** (d'Orbigny & Lafresnaye, 1837)	White-browed Brush-finch	LC	a
Chlorospingus canigularis* (Lafresnaye, 1848)	Ashy-throated Bush-tanager	LC	a
*Myrmotherula menetriesii** (d'Orbigny, 1837)	Grey Antwren	LC	a, b

to be continued...

Species	English Name	IUCN	Habitat
*Myrmotherula axillaris** (Vieillot, 1817)	White-flanked Antwren	LC	a, d
*Thamnomanes caesius** (Temminck, 1820)	Cinereous Antshrike	LC	a
*Trichothraupis melanops** (Vieillot, 1818)	Black-goggled Tanager	LC	a
*Myiothlypis bivittata** (d'Orbigny & Lafresnaye, 1837)	Two-banded Warbler	LC	a
*Tangara inornata** (Gould, 1855)	Plain-colored Tanager	LC	a
*Sittasomus griseicapillus** (Vieillot, 1818)	Eastern Olivaceous Woodcreeper	LC	a, b, c
*Habia rubica** (Vieillot, 1817)	Red-crowned Ant-tanager	LC	a
*Tangara labradorides** (Boissonneau, 1840)	Metallic-green Tanager	LC	a
*Lepidocolaptes falcinellus** (Cabanis & Heine, 1859)	Scalloped Woodcreeper	LC	a
*Myioborus melanocephalus** (Tschudi, 1844)	Spectacled Whitestart	LC	a, c
*Setophaga pitiayumi** (Vieillot, 1817)	Tropical Parula	LC	a, b
*Dendroma rufa** (Vieillot, 1818)	Buff-fronted Foliage-gleaner	LC	a, d
*Syndactyla rufosuperciliata** (Lafresnaye, 1832)	Buff-browed Foliage-gleaner	LC	a
*Pachysylvia semibrunnea** (Lafresnaye, 1845)	Rufous-naped Greenlet	LC	a
*Hemithraupis ruficapilla** (Vieillot, 1818)	Rufous-headed Tanager	LC	a
*Hylophilus amaurocephalus** (Nordmann, 1835)	Grey-eyed Greenlet	LC	a, b, c
*Mecocerculus leucophrys** (d'Orbigny & Lafresnaye, 1837)	White-throated Tyrannulet	LC	a, c
*Leiothlypis ruficapilla** (Wilson, 1811)	Nashville Warbler	LC	a
*Myioborus brunniceps** (d'Orbigny & Lafresnaye, 1837)	Brown-capped Whitestart	LC	a
*Myioborus miniatus** (Swainson, 1827)	Slate-throated Whitestart	LC	a
*Phylloscartes oustaleti** (Sclater, 1887)	Oustalet's Tyrannulet	LC	a
*Thamnomanes schistogynus** Hellmayr, 1911	Bluish-slate Antshrike	LC	a
*Argya rufescens** (Blyth, 1847)	Orange-billed Babbler	LC	a, c
*Anisognathus igniventri** (d'Orbigny & Lafresnaye, 1837)	Fire-bellied Mountain-tanager	LC	a, c
*Anisognathus somptuosus** (Lesson, 1831)	Blue-winged Mountain-tanager	LC	a
*Basileuterus hypoleucus** Bonaparte, 1850	White-bellied Warbler	LC	a
*Buthraupis montana** (d'Orbigny & Lafresnaye, 1837)	Hooded Mountain-tanager	LC	a
*Chlorornis riefferii** (Boissonneau, 1840)	Grass-green Tanager	LC	a
*Chlorospingus flavigularis** (Sclater, 1852)	Yellow-throated Bush-tanager	LC	a, c, d
*Chlorospingus flavopectus** (Lafresnaye, 1840)	Common Bush-tanager	LC	a, c
*Diglossa cyanea** (Lafresnaye, 1840)	Masked Flowerpiercer	LC	a, c
*Hemithraupis guira** (Linnaeus, 1766)	Guira Tanager	LC	a, b
*Hylophilus poicilotis** Temminck, 1822	Rufous-crowned Greenlet	LC	a
*Iridosornis jelskii** (Cabanis, 1873)	Golden-collared Tanager	LC	a
*Lanio fulvus** (Boddaert, 1783)	Fulvous Shrike-tanager	LC	a
*Lanio versicolor** (d'Orbigny & Lafresnaye, 1837)	White-winged Shrike-tanager	LC	a
*Microrhopias quixensis** (Cornalia, 1849)	Dot-winged Antwren	LC	a
*Orthogonys chloricterus** (Vieillot, 1819)	Olive-green Tanager	LC	a

to be continued...

Species	**English Name**	**IUCN**	**Habitat**
*Phylloscartes ventralis** (Temminck, 1824)	Mottle-cheeked Tyrannulet	LC	a
*Polioptila caerulea** (Linnaeus, 1766)	Blue-grey Gnatcatcher	LC	a, b, c
*Polioptila plumbea** (Gmelin, 1788)	Tropical Gnatcatcher	LC	a, b, c
*Islerothraupis rufiventer** (Spix, 1825)	Yellow-crested Tanager	LC	a
*Tangara arthus** Lesson, 1832	Chestnut-breasted Tanager	LC	a
*Tangara chilensis** (Vigors, 1832)	Paradise Tanager	LC	a
*Tangara aurulenta** Lafresnaye, 1843	Golden Tanager	LC	a
*Sporathraupis cyanocephala** (d'Orbigny & Lafresnaye, 1837)	Blue-capped Tanager	LC	a, c
*Veniliornis spilogaster** (Wagler, 1827)	White-spotted Woodpecker	LC	a, b
*Vireo olivaceus** (Linnaeus, 1766)	Red-eyed Vireo	LC	a
*Xiphorhynchus pardalotus** (Vieillot, 1818)	Chestnut-rumped Woodcreeper	LC	a,b

DISCUSSION

In this study, we provide a comprehensive overview of the composition and vulnerability of mixed-species flocks in tropical regions and their biodiversity hotspots (1), identify their general ecological preferences in terms of habitat use (2), and propose targets for restoration and conservation efforts (3). From this perspective, we proceed to illustrate the observed scenarios and emphasize the urgent need for national restoration policies, expansion of protected areas, and maintenance of connectivity in tropical regions and their hotspots. Specifically, forests, savannas, and shrubland habitats should be the primary targets for restoration and, consequently, conservation of mixed-species flocks. Therefore, these integrated actions assume urgency in light of the need to mitigate anthropogenic impacts and their effects on the tropics and on a global scale.

Vulnerability and Conservation Opportunities in Tropical Regions and their Hotspots

In a first scenario, we observed a low number of threatened or near-threatened nuclear species according to global criteria (IUCN, 2024). This outlook is particularly positive when considering the history of fragmentation and threat to primary forests in the Tropical Andes (Comer et al., 2022) and the Atlantic Forest (Willrich et al., 2019). This is because we demonstrated that these hotspots harbor the highest number of nuclear species recorded in the literature. Alternatively, this may reflect the persistence that birds exhibit in fragmented regions and their forest remnants (Pizo and Tonetti, 2020). In this sense, we assume that this may be the general scenario in both hotspots, as this persistence may be associated with the maintenance of original conditions of environmental heterogeneity in post-deforestation landscapes (Willrich et al., 2019).

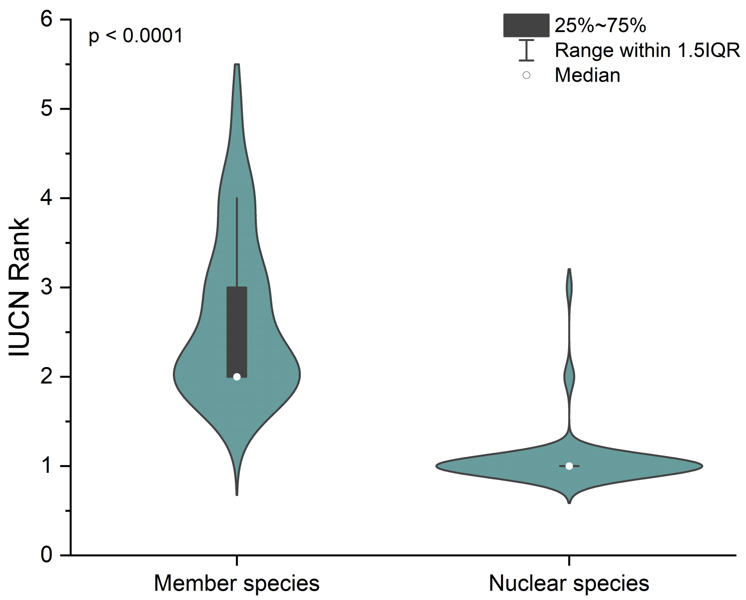
Additionally, we emphasize that national-level actions can have a broad scope of effectiveness in conserving mixed-species flocks, whose benefits may extend beyond political borders (Mason et al., 2020; Wilson, 2021). In this regard, maintaining functional and structural connectivity between ecosystems (Beier and Noss, 1998; Belote and Wilson, 2020) seems to be the most promising approach in terms of conservation planning for the Tropical Andes, Atlantic Forest, and other tropical hotspots highlighted here (Wilson, 2021).

From this perspective, we highlight the establishment of minimum dynamic areas with a particular focus on adjacent ecosystems as a key action for the conservation of these regions (Belote and Wilson, 2020; Blanco et al., 2020; Riva and Fahrig, 2022). This scenario of opportunity and urgency also includes alternatives for the conservation of multiple habitat interfaces and their transitions (Belote and Wilson, 2020; Blanco et al., 2020; Riva and Fahrig, 2022). Riparian corridors in fragmented landscapes, for example, have already proven to be effective for the movement of forest birds (Lees and Peres, 2007; Mendes, 2016; Sekercioglu, 2009), an ecological profile that predominates in species of mixed-species flocks in tropical regions (Bohórquez, 2003; Thiollay, 1999). Moreover, riparian forests integrate multiple mosaics, connecting habitats structurally and functionally, and are therefore essential for the conservation of mixed-species flocks (Lees and Peres, 2007; Mendes, 2016; Ribeiro and Walter, 2008; Sekercioglu, 2009).

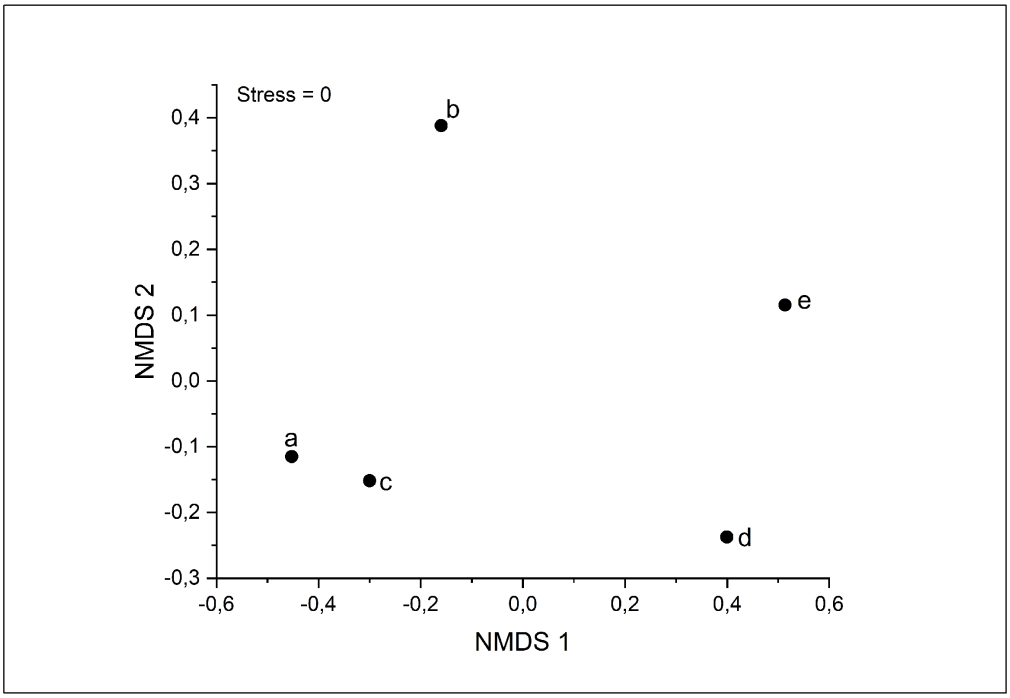
We also demonstrate that mixed-species flocks recorded in literature harbor threatened birds in five tropical hotspots (IUCN, 2024). In this regard, the Tropical Andes constitute the region with the highest number of threatened species, for which there are no specific conservation or research actions (IUCN, 2024). Specifically, the impact of native vegetation loss has increasingly demanded urgency in expanding networks of protected areas in the Tropical Andes (Bax and Francesconi, 2019; Hrdina and Romportl, 2017). This is because in this hotspot, only 10% of all threatened species are effectively covered by protected areas, and moreover, 90% of endemics are unprotected and therefore imminently threatened (Bax and Francesconi, 2019; Comer et al., 2022). From a broader perspective, assessments of the International Vegetation Classification (IVC) emphasize that the Tropical Andes have already lost between 50% to 70% of their forest cover, including up to 54% of shrub formations (Comer et al., 2022). In this sense, we highlight that mixed-species flocks may be under imminent threat in the Tropical Andes, as forests and shrub formations are among the critical habitats for these interactions.

Surprisingly, despite extensive loss of primary formations and low coverage of protected areas, the Tropical Andes are among the global hotspots with the lowest restoration requirements (Brancalion et al., 2019). On the other hand, this may represent a scenario of opportunities not only in the Tropical Andes but also in the other tropical hotspots evaluated here (Hrdina and Romportl, 2017; Ripple et al., 2020; Tonetti et al., 2022). As recently emphasized, natural ecosystem regeneration in tropical hotspots is crucial for preventing the extinction of numerous taxa and maintaining ecosystem services at different scales (Hrdina and Romportl, 2017; Ripple et al., 2020; Tonetti et al., 2022).

According to the studies evaluated here, none of the species in mixed-species flocks from the Atlantic

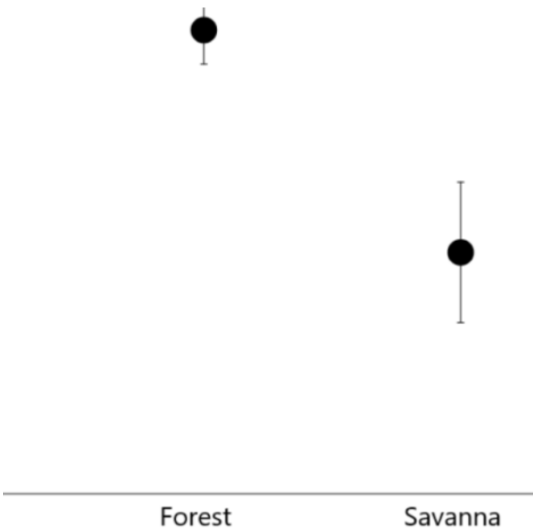


Hình 3. Mann-Whitney test comparing vulnerability levels between member species and nuclear species.



Hình 4. Ordinations evaluating the nuclear species (A) and the entire target group (B) showing their associations with the different habitats. a = Forest; b = Savannah; c = Shrub formations; d = Wetlands.

Forest are globally threatened (IUCN, 2024). However, we emphasize that from a local perspective, this scenario is critical in terms of habitat availability and connectivity between forest remnants. This is because the Atlantic Forest has already lost 70% of its original coverage due to extensive fragmentation (Pizo and Tonetti, 2020; Rezende et al., 2018). Particularly, landscape homogenization (Jongman, 2002), reduction in home range size (Mortelliti and Lindenmayer, 2015), and increased isolation among fragments (Blanco et



Hình 5. Comparison of diversity between habitats based on the target group.

al., 2020; Turvey et al., 2015) are imminent threats to mixed-species flocks in this territory.

Even in the face of these multiple impacts, it has been reported that the persistence of birds in landscapes as drastically fragmented as the Atlantic Forest depends directly on landscape characteristics (Matos et al., 2018; Pizo and Tonetti, 2020; Tonetti et al., 2022). Among these, habitat heterogeneity, connectivity dynamics, edge extent, and potential for natural regeneration are critical for bird persistence in the Atlantic Forest and other similarly threatened tropical hotspots (Pizo and Tonetti, 2020; Riva and Fahrig, 2022; Tonetti et al., 2022). A highlight of this scenario is that mixed-species flocks are predominantly composed of insectivorous birds, which, however, represent the least abundant species in fragmented landscapes (Pizo and Tonetti, 2020). This reinforces the indispensable need for terrestrial ecosystem restoration (Abhilash, 2021; Ma et al., 2023) and the establishment of ecological corridors in tropical regions and their hotspots (Abhilash, 2021; Ma et al., 2023; Rutt et al., 2020).

This panorama justifies the fact that the Atlantic Forest has recently been identified as one of the global targets for restoration and, therefore, serves as a model for similarly threatened tropical hotspots due to fragmentation (Brancalion et al., 2019). In a broader context, the restoration and conservation of tropical forests are directly associated, for example, with mitigating the effects of climate change (Edwards et al., 2019; Franchito et al., 2012; Nelson and Chomitz, 2009; Sales et al., 2020). This is because the restoration of these ecosystems is one of the fastest and most promising ways to remove CO2 from the atmosphere, representing an essential solution against the accumulation of this greenhouse gas (Edwards et al., 2019; Franchito et al., 2012; Koch and Kaplan, 2022; Tonetti et al., 2022). In this sense, given the current perspective of climate emergency (Ripple et al., 2020), the Tropical Andes and the Atlantic Forest stand out as regions of global opportunities in forest restoration (Abhilash, 2021), conservation of mixed-species flocks, and carbon capture post-extensive restoration (Koch and Kaplan, 2022).

Despite these positive perspectives, we emphasize that the current scenario is concerning, especially because after extensive periods of deforestation, tropical forests become significant emitters of CO2 into the atmosphere (Mills et al., 2023). In this sense, directing restoration and conservation programs in tropical regions and their hotspots is currently critical (Abhilash, 2021; Pizo and Tonetti, 2020). In general terms, this would represent the maintenance of viable minimum populations, conservation of ecological interactions and ecosystem services, as well as mitigation of climate change. This restoration perspective is especially relevant in the Tropical Andes, Western Ghats, Sri Lanka, Himalayas, and the Coastal Forest of Africa, which harbor threatened mixed-species flocks. Additionally, we highlight the Atlantic Forest as a hotspot with the highest number of nuclear species.

In tropical forests, approximately 130 million forest fragments were recorded by 2018 (Taubert et al., 2018), and recent projections demonstrate that the loss of forest cover in these systems can reduce extensive native forests to small fragments (Edwards et al., 2019; Ma et al., 2023). Included in this list of challenges is the urgent task of maintaining heterogeneity in ecosystems, especially in landscapes increasingly homogeneous in terms of composition and community structure (Edwards et al., 2019; Ma et al., 2023). As we have demonstrated here, since mixed-species flocks are associated with and exhibit greater diversity in forests, savannas, and shrubland formations, we suggest that these habitats be prioritized for restoration (Abhilash, 2021; Brancalion et al., 2019; IUCN, 2024; Leberger et al., 2020; Marzluff and Ewing, 2001). This is essentially relevant as threatened mixed-species flocks in the Western Ghats, Sri Lanka, Coastal Forest of Africa, Tropical Andes, and the Himalayas are facing similar impacts (IUCN, 2023). In detail, logging, expansion of pastures, and monocultures threaten multiple habitats, their transitions (Kark, 2013), and consequently, mixed-species flocks in these territories.

The tolerance potential expressed by birds in the face of the expansion of rural and urban areas has been particularly evaluated in open tropical ecosystems, including savannas and shrubland formations (Mikula et al., 2023). Essentially, the significant growth of the human population, from 6.4 to 7.7 billion inhabitants in just 17 years, has substantially contributed to the increased pressure on these ecosystems (Potapov et al., 2022; Tollefson, 2019; United Nations, 2019). Specifically, shrubland formations have been intensely impacted by the expansion of monocultures, with estimated losses of nearly 50 thousand hectares in just five years, representing a direct threat to mixed-species flocks (Pool et al., 2014). Even in the face of such impacts, savannas and shrubland formations constitute key habitats for biodiversity and species conservation and, therefore, deserve special attention in terms of restoration and spatial prioritization (Mikula et al., 2023).

Imminent functional extinction and future perspectives for conservation

The functional extinction of ecological interactions such as mixed-species bird flocks is ultimately one of the most concerning consequences, particularly in biodiversity hotspots (Valiente-Banuet et al., 2014). In general terms, the reduction in species population density can directly influence the functioning of ecological interactions (Valiente-Banuet et al., 2014). In this sense, functional extinction can occur even before the disappearance of species (Valiente-Banuet et al., 2014). This is because the massive decline in populations directly impacts ecosystems and their respective services at a faster rate than the actual extinction of species (Valiente-Banuet et al., 2014). Thus, prioritizing the conservation of mixed-species flocks and their distribution areas in the tropics, particularly in hotspots, is an important step in preventing functional extinction through the conservation of multispecies and their interaction networks (Root et al., 2003; Valiente-Banuet et al., 2014).

This context of ecological interaction extinction applies directly to bird communities since the decline in species results in the loss of functional diversity (Ali et al., 2023). In the Atlantic Forest, for example, insectivorous birds are highly sensitive to the loss of functional diversity (Mariano-Neto and Santos, 2023). However, from an optimistic perspective, the high number of insectivorous species and their ecological redundancy result in better adaptive capacity in response to anthropogenic impacts (Luck et al., 2013). Obviously, this scenario includes species whose populations are more abundant, generally crucial for the maintenance of ecological processes (Baker et al., 2019; Julliard et al., 2006).

In addition to the target group that was the subject of our evaluation, it is crucial to highlight the potential role of the other 282 species classified as of least concern (LC) in terms of mixed-species flock conservation in the tropics and their hotspots. These species can play a critical role in the resilience of mixed-species flocks in the face of habitat fragmentation and loss, mainly due to their greater abundance in ecosystems (Baker et al., 2019). Furthermore, mixed-species flocks rely on populations in constant interaction, making least concern species crucial in terms of structure, species recruitment, and conservation, even in fragmented landscapes (Bates, 1863; Goodale and Beauchamp, 2010; Machado, 2002; Maldonado-Coelho and Marini, 2003; Powell, 1989).

From a vulnerability standpoint, even small declines in population size result in massive individual losses, yet these species may not be included in any IUCN threat category (Baker et al., 2019). The ecological role of least concern species becomes even more relevant considering the vulnerability of threatened species in response to stochastic fluctuations in demographic or environmental factors, even in protected areas (Baker et al., 2019; Evans et al., 2022). Thus, we emphasize the essential role that least concern mixed-species flock birds can play in species recruitment and the maintenance of mixed-species flocks in vulnerable regions such as the tropics and their hotspots.

Looking ahead, we stress the need for a deeper understanding of the intrinsic ecological mechanisms of mixed-species flocks. This includes their stability, habitat selection, and dispersion across different feeding sites in fragmented landscapes (Batista et al., 2013; Develey et al., 2001; Martínez and Gomez, 2013). We also underscore the importance of analyzing functional connectivity between fragment networks through ecological corridors, using mixed-species flocks as a model. Additionally, niche modeling focusing on nuclear species represents a key alternative in this process. The benefits of such theoretical predictions include filling gaps in the distribution and availability of habitat, as well as the vulnerability of mixed-species flocks to climate change (Beier and Noss, 1998; Borges et al., 2019; Borges and Loyola, 2020; Correa Ayram et al., 2016; Sekercioglu et al., 2004).

Finally, we emphasize that mixed-species flock birds in tropical regions and their hotspots should be at the forefront of global efforts aimed at restoring ecosystems, preventing functional extinction, expanding protected area coverage, and mitigating the effects of climate change.

DATA AVAILABILITY

The data used to support the findings of this study are available from the corresponding author upon reasonable request.

CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

CONTRIBUTION STATEMENT

Conceived of the presented idea: ESF, AS, CGM.
Carried out the experiment: ESF, AS.
Carried out the data analysis: ESF, CGM, AS.
Wrote the first draft of the manuscript: ESF.
Review and final write of the manuscript: ESF, CGM, AS.

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Additional Files

Add File 1. General list of studies

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Add File 2. List of the most frequently recorded species in studies of mixed flocks in tropical regions. * =nuclear species; a= Forest; b= Savanna; c= Shrubland; d= Wetlands; LC= Least Concern; NT= Near Threatened; VU= Vulnerable; EN= Ameaçada; CR= Critically Endangered; (Complementary study list) - 1 = Jullien and Thiollay (1998); Jullien (2000); Houtan et al (2006); 2 = Jullien and Thiollay (1998); Jullien (2000); Houtan et al (2006); Markoss et al (2018); 3 = Maldonado-Coelho and Marini (2004); Ghizoni-Jr and Azevedo (2006); Cestari (2007); 4 = Ghizoni-Jr and Azevedo (2006, 2009); 5 = Jullien and Thiollay (1998); Jullien (2000); Houtan et al (2006); Makross et al (2013); Markoss et al (2018); 6 = Jullien and Thiollay (1998); Jullien (2000); Houtan et al (2006); Buitrón-Jurado (2007); Munoz (2011); Martinez et al (2018); Rodriguez (2019); 7 = Anjos et al (2015); Mangini (2017); Fanjul et al (2021); Jullien and Thiollay (1998); Houtan et al (2006); Munoz (2011); Martinez et al (2018); Markoss et al (2018); 8 = Jullien (2000); Houtan et al (2006); Munoz (2011); Makross et al (2013).

Species	English Name	IUCN	Habitat	Works
Artisornis moreaui	Long-billed Forest-warbler	CR	a, c	Cordeiro et al (2015).
Hedydipna pallidigaster	Amani Sunbird	EN	a, b	Cordeiro et al (2015).
Basileuterus griseiceps	Grey-headed Warbler	EN	a	Zuluaga e Rodeward (2015).
Diglossa venezuelensis	Venezuelan Flowerpiercer	EN	a, c	Zuluaga e Rodeward (2015).
Premnoplex tatei	White-throated Barbtail	EN	a	Zuluaga e Rodeward (2015).
Argya cinereifrons	Ashy-fronted Babbler	VU	a	Goodale e Kotagama (2005); Mammides et al (2015).
Anthreptes rubritorques	Banded Sunbird	VU	a, b	Cordeiro et al (2015).
Bangsia melanochlamys	Black-and-gold Tanager	VU	a	Zuluaga e Rodeward (2015).
Hypopyrrhus pyrohypogaster	Red-bellied Grackle	VU	a	Zuluaga e Rodeward (2015).
*Phaenicophaeus pyrrhocephalus**	Red-faced Malkoha	VU	a	Goodale e Kotagama (2005).
Sitta formosa	Beautiful Nuthatch	VU	a	Srinivasan et al (2012).
Sturnus albofrontatus	White-faced Starling	VU	a	Mammides et al (2015).
Urocissa ornata	Sri Lanka Blue Magpie	VU	a	Goodale e Kotagama (2006).
Epinecrophylla gutturalis	Brown-bellied Antwren	NT	a	Powell (1979); Stouffer e Bierregaard (1995).1
Xiphorhynchus pardalotus	Chestnut-rumped Woodcreeper	NT	a, b	Powell (1979); Stouffer e Bierregaard (1995).2
Vermivora chrysoptera	Golden-winged Warbler	NT	a, c, d, f	Buskirk et al (1972); Zuluaga e Rodeward (2015).
Amazona leucocephala	Cuban Amazon	NT	a, b	Hamel e Kinkkconnell (2005).
Arizelocichla milanjensis	Stripe-cheeked Bulbul	NT	a, c	Cordeiro et al (2015).
Myiothlypis cinereicollis	Grey-throated Warbler	NT	a	Zuluaga e Rodeward (2015).
Iridosornis porphyrocephalus	Purplish-mantled Tanager	NT	a	Zuluaga e Rodeward (2015).
Leptasthenura setaria	Araucaria Tit-spinetail	NT	a	Anjos et al (2015).
Melopyrrha nigra	Cuban Bullfinch	NT	a, c	Hamel e Kinkkconnell (2005).
Myrmotherula unicolor	Unicolored Antwren	NT	a, b	Ghizoni-Jr e Azevedo (2006); Cestari (2007).
Conirostrum binghami	Giant Conebill	NT	a	Mathysen (2008).
Patagioenas leucocephala	White-crowned Pigeon	NT	a	Hamel e Kinkkconnell (2005).

to be continued...

Species	English Name	IUCN	Habitat	Works
Setophaga cerulea	Cerulean Warbler	NT	a	Zuluaga e Rodeward (2015).
Tauraco fischeri	Fischer's Turaco	NT	a, c	Cordeiro et al (2014).
Tangara cyanoptera	Azure-shouldered Tanager	NT	a	Machado e Rodrigues (2000).
*Vireo atricapillus**	Black-capped Vireo	NT	a, c	Hutto (1994)
*Anisognathus igniventris**	Fire-bellied Mountain-tanager	LC	a, c	Chaparro (2012)
*Anisognathus somptuosus**	Blue-winged Mountain-tanager	LC	a	Jones e Robinson (2020)
*Basileuterus culicivorus**	Stripe-crowned Warbler	LC	a	Godoy (2011); Da Luz et al., (2022)
*Myiothlypis flaveola**	Flavescent Warbler	LC	a	Batista et al (2013)
*Basileuterus hypoleucus**	White-bellied Warbler	LC	a	Maldonado-Coelho e Marini (2000)
*Basileuterus melanogenys**	Black-cheeked Warbler	LC	a	Moynihan (1963)
*Arremon torquatus**	White-browed Brush-finch	LC	a	Mangini e Fanjul (2013)
*Buthraupis montana**	Hooded Mountain-tanager	LC	a	Chaparro (2012)
*Chlorornis riefferii**	Grass-green Tanager	LC	a	Chaparro (2012)
*Chlorospingus canigularis**	Ashy-throated Bush-tanager	LC	a	Jones e Robinson (2020)
*Chlorospingus flavigularis**	Yellow-throated Bush-tanager	LC	a, c, d	Munoz (2011)
*Chlorospingus flavopectus**	Common Bush-tanager	LC	a, c	Moynihan (1963); Buskirk et al (1972).
*Diglossa cyanea**	Masked Flowerpiercer	LC	a, c	Chaparro (2012).
*Habia rubica**	Red-crowned Ant-tanager	LC	a	Develey e Peres (2000); Maldonado-Coelho e Marini (2003).3
*Hemithraupis guira**	Guira Tanager	LC	a, b	Ghizoni-Jr (2009).
*Hemithraupis ruficapilla**	Rufous-headed Tanager	LC	a	Maldonado-Coelho e Marini (2000); Maldonado-Coelho e Marini (2003).
*Hylophilus amaurocephalus**	Grey-eyed Greenlet	LC	a, b, c	Maldonado-Coelho e Marini (2003); Batista et al (2013).
*Hylophilus poicilotis**	Rufous-crowned Greenlet	LC	a	Machado (1999); Machado (2002).
*Iridosornis jelskii**	Golden-collared Tanager	LC	a	Chaparro (2012).
*Lanio fulvus**	Fulvous Shrike-tanager	LC	a	Jullien e Thiollay (1998).
*Lanio versicolor**	White-winged Shrike-tanager	LC	a	Munoz (2011).
*Lepidocolaptes falcinellus**	Scalloped Woodcreeper	LC	a	Ghizoni-Jr e Azevedo (2006); Ghizoni-Jr (2009); Anjos et al (2015).
*Mecocerculus leucophrys**	White-throated Tyrannulet	LC	a, c	Mathysen (2008); Mangini e Fanjul (2013); Fanjul et al (2021).
*Microrhopias quixensis**	Dot-winged Antwren	LC	a	Munoz (2011).

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Species	English Name	IUCN	Habitat	Works
*Vireo olivaceus**	Red-eyed Vireo	LC	a	Machado (1999); Mangini (2017).
*Leiothlypis ruficapilla**	Nashville Warbler	LC	a	Hutto (1994).
*Veniliornis spilogaster**	White-spotted Woodpecker	LC	a, b	Ghizoni-Jr (2009).
*Argya rufescens**	Orange-billed Babbler	LC	a, c	Goodale e Kotagama (2006); Mammides et al (2015).
*Trichothraupis melanops**	Black-goggled Tanager	LC	a	Rodrigues et al (1994); Maldonado-Coelho e Marini (2000; 2003).4
*Sporathraupis cyanocephala**	Blue-capped Tanager	LC	a, c	Chaparro (2012).
*Thamnomanes schistogynus**	Bluish-slate Antshrike	LC	a	Munoz (2011).
*Thamnomanes caesius**	Cinereous Antshrike	LC	a	Powell (1979); Stouffer e Bierregaard (1995). 5
*Thamnomanes ardesiacus**	Dusky-throated Antshrike	LC	a	Powell (1979); Stouffer e Bierregaard (1995). 6
*Tangara labradorides**	Metallic-green Tanager	LC	a	Jones e Robinson (2020).
*Tangara inornata**	Plain-colored Tanager	LC	a	Moynihan (1963).
*Tangara arthus**	Chestnut-breasted Tanager	LC	a	Munoz (2011).
*Tangara chilensis**	Paradise Tanager	LC	a	Munoz (2011).
*Tangara aurulenta**	Golden Tanager	LC	a	Jones e Robinson (2020).
*Islerothraupis rufiventer**	Yellow-crested Tanager	LC	a	Munoz (2011)
*Syndactyla rufosuperciliata**	Buff-browed Foliage-gleaner	LC	a	Anjos et al (2015); Mangini e Fanjul (2013); Fanjul et al (2021).
*Sittasomus griseicapillus**	Eastern Olivaceous Woodcreeper	LC	a, b, c	Machado (1999); Ghizoni-Jr (2009).7
*Polioptila plumbea**	Tropical Gnatcatcher	LC	a, b, c	Batista et al (2013).
*Polioptila caerulea**	Blue-grey Gnatcatcher	LC	a, b, c	Hutto (1994); Hamel e Kinkkconnell (2005).
*Phylloscartes ventralis**	Mottle-cheeked Tyrannulet	LC	a	Mangini e Fanjul (2013); Fanjul et al (2021).
*Phylloscartes oustaleti**	Oustalet's Tyrannulet	NT	a	Machado (1999); Machado e Rodrigues (2000); Machado (2002).
*Philydor rufum**	Buff-fronted Foliage-gleaner	LC	a, d	Machado (1999); Machado (2002); Maldonado-Coelho e Marini (2000).
*Setophaga pitiayumi**	Tropical Parula	LC	a, b	Ghizoni-Jr e Azevedo (2006); Brandt et al (2009); Ghizoni-Jr (2009).
*Pachysylvia semibrunnea**	Rufous-naped Greenlet	LC	a	Jones e Robinson (2020).

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Species	English Name	IUCN	Habitat	Works
*Orthogonys chloricterus**	Olive-green Tanager	LC	a	Machado (1999); Machado (2002).
*Myrmotherula menetriesii**	Grey Antwren	LC	a, b	Powell (1979); Stouffer e Bierregaard (1995).8
*Myrmotherula axillaris**	White-flanked Antwren	LC	a, d	Stouffer e Bierregaard (1995); Jullien e Thiollay (1998).9
*Myiothlypis bivittata**	Two-banded Warbler	LC	a	Mangini e Fanjul (2013).
*Myioborus miniatus**	Slate-throated Whitestart	LC	a	Buskirk et al (1972); Munoz (2011); Jones e Robinson (2020).
*Myioborus melanocephalus**	Spectacled Whitestart	LC	a, c	Munoz (2011); Chaparro (2012); Ávila (2019).
*Myioborus brunniceps**	Brown-capped Whitestart	LC	a	Mathysen (2008); Mangini e Fanjul (2013); Fanjul et al (2021).
*Alcippe poioicephala**	Brown-cheeked Fulvetta	LC	a,c	Sridhar and Sankar (2008).
*Deleornis axillaris**	Grey-headed Sunbird	LC	a	Perón and Crochet (2009).
*Dicrurus ludwigii**	Square-tailed Drongo	LC	a,b	Cordeiro et al (2015).
*Phyllastrephus icterinus**	Icterine Greenbul	LC	a,b	Perón and Crochet (2009).
*Teretistris fernandinae**	Yellow-headed Warbler	LC	a,c	Hamel and Kirkconnell (2005).
*Teretistris fornsi**	Oriente Warbler	LC	a,c	Hamel and Kirkconnell (2005).
Myrmotherula longipennis	Long-winged Antwren	LC	-	-
Philydor erythrocercum	Rufous-rumped Foliage-gleaner	LC	-	-
Automolus infuscatus	Olive-backed Foliage-gleaner	LC	-	-
Conirostrum speciosum	Chestnut-vented Conebill	LC	-	-
Tunchiornis ochraceiceps	Tawny-crowned Greenlet	LC	-	-
Hypothymis azurea	Black-naped Monarch	LC	-	-
Acritillas indica	Yellow-browed Bulbul	LC	-	-
Leptopogon amaurocephalus	Sepia-capped Flycatcher	LC	-	-
Mniotilta varia	Black-and-white Warbler	LC	-	-
Xenops minutus	White-throated Xenops	LC	-	-
Xiphorhynchus fuscus	Lesser Woodcreeper	LC	-	-
Arremon dorbignii	Stripe-crowned Sparrow	LC	-	-
Automolus leucophthalmus	White-eyed Foliage-gleaner	LC	-	-
Ceuthmochares aereus	Chattering Yellowbill	LC	-	-
Chiroxiphia caudata	Blue Manakin	LC	-	-
Culicicapa ceylonensis	Grey-headed Canary-flycatcher	LC	-	-

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Species	English Name	IUCN	Habitat	Works
Certhiasomus stictolaemus	Spot-throated Woodcreeper	LC	-	-
Setophaga fusca	Blackburnian Warbler	LC	-	-
Setophaga virens	Black-throated Green Warbler	LC	-	-
Dicrurus remifer	Lesser Racquet-tailed Drongo	LC	-	-
Dysithamnus mentalis	Plain Antvireo	LC	-	-
Glyphorynchus spirurus	Wedge-billed Woodcreeper	LC	-	-
Harpactes fasciatus	Malabar Trogon	LC	-	-
Myiarchus swainsoni	Swainson's Flycatcher	LC	-	-
Myiobius barbatus	Whiskered Flycatcher	LC	-	-
Pachyramphus polychopterus	White-winged Becard	LC	-	-
Pycnonotus barbatus	Common Bulbul	LC	-	-
Tangara cyanocephala	Red-necked Tanager	LC	-	-
Terpsiphone paradisi	Indian Paradise-flycatcher	LC	-	-
Tangara sayaca	Sayaca Tanager	LC	-	-
Tolmomyias sulphurescens	Yellow-olive Flatbill	LC	-	-
Turdus rufiventris	Rufous-bellied Thrush	LC	-	-
Cardellina pusilla	Wilson's Warbler	LC	-	-
Xiphocolaptes albicollis	White-throated Woodcreeper	LC	-	-
Abroscopus albogularis	Rufous-faced Warbler	LC	-	-
Agelaius humeralis	Tawny-shouldered Blackbird	LC	-	-
Schoeniparus castaneceps	Rufous-winged Fulvetta	LC	-	-
Alcippe nipalensis	Nepal Fulvetta	LC	-	-
Chamaetylas fuelleborni	White-chested Alethe	LC	-	-
Alophoixus flaveolus	White-throated Bulbul	LC	-	-
Anabazenops dorsalis	Dusky-cheeked Foliage-gleaner	LC	-	-
Anabazenops fuscus	White-collared Foliage-gleaner	LC	-	-
Anairetes flavirostris	Yellow-billed Tit-tyrant	LC	-	-
Anairetes parulus	Tufted Tit-tyrant	LC	-	-
Stelgidillas gracilirostris	Slender-billed Greenbul	LC	-	-
Eurillas gracilis	Grey Greenbul	LC	-	-
Andropadus masukuensis	Shelley's Greenbul	LC	-	-
Eurillas virens	Little Greenbul	LC	-	-
Hedydipna collaris	Collared Sunbird	LC	-	-
Anthreptes neglectus	Uluguru Violet-backed Sunbird	LC	-	-
Apalis melanocephala	Black-headed Apalis	LC	-	-
Apaloderma vittatum	Bar-tailed Trogon	LC	-	-
Asthenes dorbignyi	Creamy-breasted Canastero	LC	-	-
Asthenes modesta	Cordilleran Canastero	LC	-	-

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Species	English Name	IUCN	Habitat	Works
Atlapetes citrinellus	Yellow-striped Brush-finch	LC	-	-
Atlapetes melanolaemus	Black-faced Brush-finch	LC	-	-
Attila spadiceus	Bright-rumped Attila	LC	-	-
Automolus ochrolaemus	Buff-throated Foliage-gleaner	LC	-	-
Batara cinerea	Giant Antshrike	LC	-	-
Batis mixta	Forest Batis	LC	-	-
Bleda syndactylus	Red-tailed Bristlebill	LC	-	-
Bradypterus lopezi	Evergreen-forest Warbler	LC	-	-
Cryptolybia olivacea	Green Barbet	LC	-	-
Camaroptera brachyura	Bleating Camaroptera	LC	-	-
Campephilus guatemalensi	Pale-billed Woodpecker	LC	-	-
Campethera mombassica	Mombasa Woodpecker	LC	-	-
Pardipicus nivosus	Buff-spotted Woodpecker	LC	-	-
Campylorhamphus falcularius	Black-billed Scythebill	LC	-	-
Chamaeza campanisona	Short-tailed Antthrush	LC	-	-
Chamaeza ruficauda	Rufous-tailed Antthrush	LC	-	-
Chlorochrysa calliparaea	Orange-eared Tanager	LC	-	-
Riccordia ricordii	Cuban Emerald	LC	-	-
Habia carmioli	Carmiol's Tanager	LC	-	-
Cissa chinensis	Common Green Magpie	LC	-	-
Cnemoscopus rubrirostris	Grey-hooded Tanager	LC	-	-
Colaptes auratus	Yellow-shafted Flicker	LC	-	-
Colaptes melanochloros	Green-barred Woodpecker	LC	-	-
Columbina passerina	Common Ground-dove	LC	-	-
Conopophaga lineata	Rufous Gnateater	LC	-	-
Contopus caribaeus	Cuban Pewee	LC	-	-
Coracina azurea	Blue Cuckooshrike	LC	-	-
Ceblepyris caesius	Grey Cuckooshrike	LC	-	-
Coracina melaschistos	Black-winged Cuckooshrike	LC	-	-
Cranioleuca erythrops	Red-faced Spinetail	LC	-	-
Criniger calurus	Red-tailed Greenbul	LC	-	-
Cryptospiza reichenovii	Red-faced Crimsonwing	LC	-	-
Cyanerpes cyaneus	Red-legged Honeycreeper	LC	-	-
Cyanocorax chrysops	Plush-crested Jay	LC	-	-
Dacnis cayana	Blue Dacnis	LC	-	-
Deconychura longicauda	Northern Long-tailed Woodcreeper	LC	-	-
Dendrocincla fuliginosa	Plain-brown Woodcreeper	LC	-	-
Dendrocincla merula	White-chinned Woodcreeper	LC	-	-

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Species	English Name	IUCN	Habitat	Works
Dendrocincla turdina	Plain-winged Woodcreeper	LC	-	-
Dendrocolaptes certhia	Amazonian Barred Woodcreeper	LC	-	-
Dendrocolaptes picumnus	Black-banded Woodcreeper	LC	-	-
Dendrocolaptes platyrostris	Planalto Woodcreeper	LC	-	-
Setophaga caerulescens	Black-throated Blue Warbler	LC	-	-
Setophaga discolor	Prairie Warbler	LC	-	-
Setophaga dominica	Yellow-throated Warbler	LC	-	-
Setophaga magnolia	Magnolia Warbler	LC	-	-
Setophaga palmarum	Palm Warbler	LC	-	-
Setophaga pityophila	Olive-capped Warbler	LC	-	-
Setophaga tigrina	Cape May Warbler	LC	-	-
Dendropicos fuscescens	Cardinal Woodpecker	LC	-	-
Dendroplex picus	Straight-billed Woodcreeper	LC	-	-
Dicrurus aeneus	Bronzed Drongo	LC	-	-
Dicrurus atripennis	Shining Drongo	LC	-	-
Dicrurus paradiseus	Greater Racquet-tailed Drongo	LC	-	-
Drymophila malura	Dusky-tailed Antbird	LC	-	-
Dryoscopus cubla	Black-backed Puffback	LC	-	-
Dumetella carolinensis	Grey Catbird	LC	-	-
Elaenia pallatangae	Sierran Elaenia	LC	-	-
Eleoscytalopus indigoticus	White-breasted Tapaculo	LC	-	-
Elminia albonotata	White-tailed Crested-flycatcher	LC	-	-
Empidonax minimus	Least Flycatcher	LC	-	-
Epinecrophylla erythrura	Rufous-tailed Antwren	LC	-	-
Epinecrophylla leucophthalma	White-eyed Antwren	LC	-	-
Erpornis zantholeuca	White-bellied Erpornis	LC	-	-
Erythrocercus mccallii	Chestnut-capped Flycatcher	LC	-	-
Eubucco bourcierii	Red-headed Barbet	LC	-	-
Euphonia pectoralis	Chestnut-bellied Euphonia	LC	-	-
Euphonia violacea	Violaceous Euphonia	LC	-	-
Falco sparverius	American Kestrel	LC	-	-
Formicivora grisea	Southern White-fringed Antwren	LC	-	-
Geothlypis trichas	Common Yellowthroat	LC	-	-
Glaucidium siju	Cuban Pygmy-owl	LC	-	-
Glyphorynchus spirurus	Wedge-billed Woodcreeper	LC	-	-
Grallaria varia	Variegated Antpitta	LC	-	-
Gymnopithys rufigula	Rufous-throated Antbird	LC	-	-
Harpactes erythrocephalus	Red-headed Trogon	LC	-	-

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Species	English Name	IUCN	Habitat	Works
Heliobletus contaminatus	Sharp-billed Treehunter	LC	-	-
Helmitheros vermivorum	Worm-eating Warbler	LC	-	-
Hemipus picatus	Bar-winged Flycatcher-shrike	LC	-	-
Kleinothraupis atropileus	Black-capped Hemispingus	LC	-	-
Thlypopsis superciliaris	Eyebrowed Hemispingus	LC	-	-
Hemitriccus margaritaceiventer	Pearly-vented Tody-tyrant	LC	-	-
Leioptila annectens	Rufous-backed Sibia	LC	-	-
Hylexetastes perrotii	Red-billed Woodcreeper	LC	-	-
Hylopezus nattereri	Speckle-breasted Antpitta	LC	-	-
Tunchiornis ochraceiceps	Tawny-crowned Greenlet	LC	-	-
Willisornis poecilinotus	Common Scale-backed Antbird	LC	-	-
Hypsipetes leucocephalus	Black Bulbul	LC	-	-
Icterus dominicensis	Cuban Oriole	LC	-	-
Icterus pyrrhopterus	Variable Oriole	LC	-	-
Illadopsis rufipennis	Pale-breasted Illadopsis	LC	-	-
Indicator variegatus	Scaly-throated Honeyguide	LC	-	-
Irena puella	Asian Fairy-bluebird	LC	-	-
Xiphorhynchus fuscus	Lesser Woodcreeper	LC	-	-
Lepidocolaptes squamatus	Scaled Woodcreeper	LC	-	-
Lepidocolaptes affinis	Northern Spot-crowned Woodcreeper	LC	-	-
Leptasthenura fuliginiceps	Brown-capped Tit-spinetail	LC	-	-
Sylviorthorhynchus yanacensis	Tawny Tit-spinetail	LC	-	-
Leptopogon superciliaris	Slaty-capped Flycatcher	LC	-	-
Limnothlypis swainsonii	Swainson's Warbler	LC	-	-
Lochmias nematura	Streamcreeper	LC	-	-
Chlorophoneus multicolor	Many-coloured Bush-shrike	LC	-	-
Malimbus nitens	Blue-billed Malimbe	LC	-	-
Mecocerculus stictopterus	White-banded Tyrannulet	LC	-	-
Megalaima viridis	White-cheeked Barbet	LC	-	-
Melanochlora sultanea	Sultan Tit	LC	-	-
Pericrocotus flammeus	Scarlet Minivet	LC	-	-
Dendropicos griseocephalus	Olive Woodpecker	LC	-	-
Microbates collaris	Collared Gnatwren	LC	-	-
Microspingus erythrophrys	Rusty-browed Warbling-finch	LC	-	-
Mimus polyglottos	Northern Mockingbird	LC	-	-
Mionectes rufiventris	Grey-hooded Flycatcher	LC	-	-
Muscicapa adusta	African Dusky Flycatcher	LC	-	-
Myiarchus sagrae	La Sagra's Flycatcher	LC	-	-

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Species	English Name	IUCN	Habitat	Works
Myiarchus tyrannulus	Brown-crested Flycatcher	LC	-	-
Myiopagis viridicata	Greenish Elaenia	LC	-	-
Myrmornis torquata	Southern Wing-banded Antbird	LC	-	-
Isleria guttata	Rufous-bellied Antwren	LC	-	-
Myrmotherula longipennis	Long-winged Antwren	LC	-	-
Cyanomitra olivacea	Olive Sunbird	LC	-	-
Neocossyphus rufus	Red-tailed Ant-thrush	LC	-	-
Nicator gularis	Eastern Nicator	LC	-	-
Ochthoeca leucophrys	White-browed Chat-tyrant	LC	-	-
Ochthoeca oenanthoides	D'Orbigny's Chat-tyrant	LC	-	-
Onychorhynchus coronatus	Amazonian Royal Flycatcher	LC	-	-
Oriolus chlorocephalus	Green-headed Oriole	LC	-	-
Pachyramphus castaneus	Chestnut-crowned Becard	LC	-	-
Pachyramphus validus	Crested Becard	LC	-	-
Pachyramphus versicolor	Barred Becard	LC	-	-
Pachyramphus viridis	Green-backed Becard	LC	-	-
Setophaga americana	Northern Parula	LC	-	-
Machlolophus xanthogenys	Black-lored Tit	LC	-	-
Percnostola rufifrons	Black-headed Antbird	LC	-	-
Pericrocotus flammeus	Scarlet Minivet	LC	-	-
Pheucticus aureoventris	Black-backed Grosbeak	LC	-	-
Philydor atricapillus	Black-capped Foliage-gleaner	LC	-	-
Anabacerthia lichtensteini	Ochre-breasted Foliage-gleaner	LC	-	-
Phyllastrephus cabanisi	Cabanis's Greenbul	LC	-	-
Phyllastrephus debilis	Lowland Tiny Greenbul	LC	-	-
Phyllastrephus flavostriatus	Yellow-streaked Greenbul	LC	-	-
Phyllastrephus xavieri	Xavier's Greenbul	LC	-	-
Phylloscopus occipitalis	Western Crowned Leaf-warbler	LC	-	-
Phylloscopus reguloides	Blyth's Leaf-warbler	LC	-	-
Phylloscopus ruficapilla	Yellow-throated Woodland-warbler	LC	-	-
Phylloscopus trochiloides	Greenish Warbler	LC	-	-
Piaya cayana	Common Squirrel-cuckoo	LC	-	-
Picumnus cirratus	White-barred Piculet	LC	-	-
Picumnus pygmaeus	Spotted Piculet	LC	-	-
Picumnus temminckii	Ochre-collared Piculet	LC	-	-
Piranga flava	Red Tanager	LC	-	-
Pithys albifrons	White-plumed Antbird	LC	-	-
Ploceus bicolor	Dark-backed Weaver	LC	-	-

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Species	English Name	IUCN	Habitat	Works
Pogoniulus leucomystax	Moustached Green Tinkerbird	LC	-	-
Pogonocichla stellata	White-starred Robin	LC	-	-
Polioptila lembeyei	Cuban Gnatcatcher	LC	-	-
Pomatorhinus horsfieldii	Indian Scimitar-babbler	LC	-	-
Priotelus temnurus	Cuban Trogon	LC	-	-
Pselliophorus tibialis	Yellow-thighed Finch	LC	-	-
Pyriglena leucoptera	White-shouldered Fire-eye	LC	-	-
Quiscalus niger	Greater Antillean Grackle	LC	-	-
Rhipidura albicollis	White-throated Fantail	LC	-	-
Dumetia atriceps	Dark-fronted Babbler	LC	-	-
Rhynchocyclus olivaceus	Eastern Olivaceous Flatbill	LC	-	-
Coccyzus merlini	Cuban Lizard-cuckoo	LC	-	-
Sclerurus scansor	Rufous-breasted Leaftosser	LC	-	-
Scytalopus speluncae	Mouse-colored Tapaculo	LC	-	-
Schoeniparus castaneceps	Rufous-winged Fulvetta	LC	-	-
Seiurus aurocapillus	Ovenbird	LC	-	-
Parkesia motacilla	Louisiana Waterthrush	LC	-	-
Parkesia noveboracensis	Northern Waterthrush	LC	-	-
Setophaga ruticilla	American Redstart	LC	-	-
Sheppardia sharpei	Sharpe's Akalat	LC	-	-
Sitta castanea	Indian Nuthatch	LC	-	-
Sitta frontalis	Velvet-fronted Nuthatch	LC	-	-
Sphyrapicus varius	Yellow-bellied Sapsucker	LC	-	-
Spindalis zena	Western Spindalis	LC	-	-
Spinus magellanicus	Hooded Siskin	LC	-	-
Stactolaema leucotis	White-eared Barbet	LC	-	-
Synallaxis azarae	Azara's Spinetail	LC	-	-
Synallaxis cinerascens	Grey-bellied Spinetail	LC	-	-
Synallaxis ruficapilla	Rufous-capped Spinetail	LC	-	-
Tachyphonus coronatus	Ruby-crowned Tanager	LC	-	-
Tangara cyanoventris	Gilt-edged Tanager	LC	-	-
Tangara icterocephala	Silver-throated Tanager	LC	-	-
Tangara schrankii	Green-and-gold Tanager	LC	-	-
Tangara seledon	Green-headed Tanager	LC	-	-
Tchagra australis	Brown-crowned Tchagra	LC	-	-
Terenotriccus erythrurus	Ruddy-tailed Flycatcher	LC	-	-
Terpsiphone batesi	Bates's Paradise-flycatcher	LC	-	-
Terpsiphone rufiventer	Red-bellied Paradise-flycatcher	LC	-	-

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Species	English Name	IUCN	Habitat	Works
Terpsiphone viridis	African Paradise-flycatcher	LC	-	-
Thalurania glaucopis	Violet-capped Woodnymph	LC	-	-
Thamnophilus ambiguus	Sooretama Slaty Antshrike	LC	-	-
Thamnophilus caerulescens	Variable Antshrike	LC	-	-
Thamnophilus murinus	Mouse-colored Antshrike	LC	-	-
Thraupis cyanocephala	Blue-capped Tanager	LC	-	-
Tangara episcopus	Blue-grey Tanager	LC	-	-
Tiaris olivacea	Yellow-faced Grassquit	LC	-	-
Tiryra seminasciata	Masked Tityra	LC	-	-
Lophoceros camurus	Dwarf Hornbill	LC	-	-
Todus multicolor	Cuban Tody	LC	-	-
Troglodytes aedon	House Wren	LC	-	-
Trogon surrucura	Southern Surucua Trogon	LC	-	-
Trogon viridis	Green-backed Trogon	LC	-	-
Turdus abyssinicus	Abyssinian Thrush	LC	-	-
Turdus nigriceps	Andean Slaty Thrush	LC	-	-
Turdus plumbeus	Northern Red-legged Thrush	LC	-	-
Tyrannus caudifasciatus	Loggerhead Kingbird	LC	-	-
Tyrannus crassirostris	Thick-billed Kingbird	LC	-	-
Ochetorhynchus andaecola	Rock Earthcreeper	LC	-	-
Vermivora cyanoptera	Blue-winged Warbler	LC	-	-
Vireo altiloquus	Black-whiskered Vireo	LC	-	-
Vireo flavifrons	Yellow-throated Vireo	LC	-	-
Vireo griseus	White-eyed Vireo	LC	-	-
Vireo gundlachii	Cuban Vireo	LC	-	-
Vireo leucophrys	Brown-capped Vireo	LC	-	-
Vireo philadelphicus	Philadelphia Vireo	LC	-	-
Setophaga citrina	Hooded Warbler	LC	-	-
Xiphidiopicus percussus	Cuban Green Woodpecker	LC	-	-
Xiphocolaptes major	Great Rufous Woodcreeper	LC	-	-
Xiphorhynchus elegans	Elegant Woodcreeper	LC	-	-
Xiphorhynchus guttatus	Buff-throated Woodcreeper	LC	-	-
Xiphorhynchus obsoletus	Striped Woodcreeper	LC	-	-
Xiphorhynchus ocellatus	Ocellated Woodcreeper	LC	-	-
Xiphorhynchus spixii	Spix's Woodcreeper	LC	-	-
Xiphorhynchus pardalotus	Chestnut-rumped Woodcreeper	LC	-	-
Zenaida asiatica	White-winged Dove	LC	-	-
Zosterops ceylonensis	Sri Lanka White-eye	LC	-	-

to be continued...

Species	English Name	IUCN	Habitat	Works
Zosterops palpebrosus	Indian White-eye	LC	-	-
Zosterops senegalensis	African Yellow White-eye	LC	-	-