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BIRDS IN THE TROPICAL SAVANNAS

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Summary

The Savanna biome is characterized by landscapes dominated by grasses with scattered trees and shrublands, covering about 20% of the world's surface. Tropical Savannas are located mainly in South America, Africa, Australia and South Asia. In the present chapter, we are combining information from different sources to offer a more complete description of the bird diversity in the tropical savannas. We employed data from BirdLife International, articles, field guides, local journals, newsletters, bird distribution maps, checklists and reports by ornithologists around the globe. For our analysis, we considered all main terrestrial and flooded tropical savannas (those savannas occurring in the tropical region). The results show that 2,951 bird species (25 orders, 152 families and 1,404 genera) are found in the Tropical Savannas. The Cerrado (with 850 species) and African Savannas (794 species) have the greatest bird richness. Tyrannidae family has the most diversity, with 162 species which are exclusively found on the Neotropical savannas. Accipitridae is another prominent bird family with around 142 species. Three bird species are common to all tropical savannas: the Cattle Egret *Bubulcus ibis*, Barn Swallow *Hirundo rustica*, and the Osprey *Pandion haliaetus*. The tropical savannas also share 15 orders, 20 families and 19 genera. Twenty families were exclusive to only one savanna. Northern Australian savannas had the greater number of exclusive families (eight families). The similarity analysis shows the following groupings: African Savannas; Terai-Duar; Northern Australian and Trans-Fly; and Beni, Pantanal,

Cerrado and Llanos. The Neotropical savannas (Llanos, Pantanal, and Cerrado) are those that can be considered in fact similar, because they presented a minimum 0.70 Sorenson's index. There are 2,057 bird species that face some degree of threat (21% of the recognized bird species), not considering the extinct species or those with insufficient data available. In the tropical savannas, there are 319 species that face some degree of threat. The Cerrado is a unique tropical savanna considered a hotspots, with the most threatened bird fauna (58 species), and seven of them are critically endangered.

1. Introduction

There are approximately 9,990 bird species in the Earth, distributed in 29 orders, 195 families, and 2,113 genera. The Order Passeriformes include 58% of all extant bird species and among the non-passerines, the Apodiformes is the most diverse order, totaling roughly 443 species, which is about 4% of the total of world bird species. The most representative passerine family in species numbers is Tyrannidae, with around 410 species known as the tyrant flycatchers. Amongst the non-passerine families, Psittacidae, represented by the macaws, parrots, lorries, and lorikeets, has the greater species number, with around 374 species. The genus *Nectarinia* (some sunbirds) shows the greater bird species richness in the world with 78 species.

Due to their varied anatomical and ecological adaptations, birds have a worldwide distribution. The most distinctive zoological region for the avifauna is the Neotropical region, with around one third of Earth's species, including a great number of endemics species (e.g. toucans, manakins, hummingbirds, rheas, among others). Birds are also diversified and abundant in other tropical areas of Ethiopian, Australian and Oriental Zoological regions. They occupy different biomes, mainly tropical forests and savannas.

The plants and animals that inhabit grasslands, savannas and shrublands are adapted to survive the seasonal extremes and are also more dependent on the impact of fire regimes than on the climate itself, and birds are not an exception. Our current knowledge about tropical savanna birds is very broad, although the majority of the data is diffuse, resulting from isolated works. In the present chapter, we are joining different sources of information to offer a more complete description of the bird diversity in the tropical savannas. We employed data from BirdLife International, articles, field guides, local journals, newsletters, bird distribution maps, checklists and reports by ornithologists around the globe.

2. Global Ecoregions and the Savanna Biome

The concept of Global ecoregions was developed by WWF and is defined as: "*a large unit of land or water containing a geographically distinct assemblage of species, natural communities, and environmental conditions*". In this sense, ecoregions represent ecological and conservation units in which natural communities shares the greater part of their biodiversity, ecological processes and similar environmental conditions, producing critical mechanisms for their long-term persistence. This knowledge provides us with a powerful tool that aids us in the investigation of the biodiversity from all terrestrial and aquatic ecosystems on the Earth. A total of 142 terrestrial, 53 freshwater and 43 marine ecoregions are recognized. This concept is a to the biodiversity conservation at a global scale, since it makes possible to sustain regional conservation policies and development strategies. Those habitats include extensive areas and different environmental conditions, ranging from the wettest of forest types to the driest and hottest deserts, reflecting a broad diversity of species, communities and ecosystems.

The Savanna biome is characterized by landscapes dominated by grasses with scattered trees and shrublands. It is a transition between forests and grasses domains. The primary savannas result from typical climate (climatic savannas), soil (edaphic savannas) or grazing conditions. A secondary type, called derived savanna, is produced by human activities, including burning and deforesting. The distribution of savannas includes extensive areas of America, Africa, Asia and Australia continents (Figure 1).

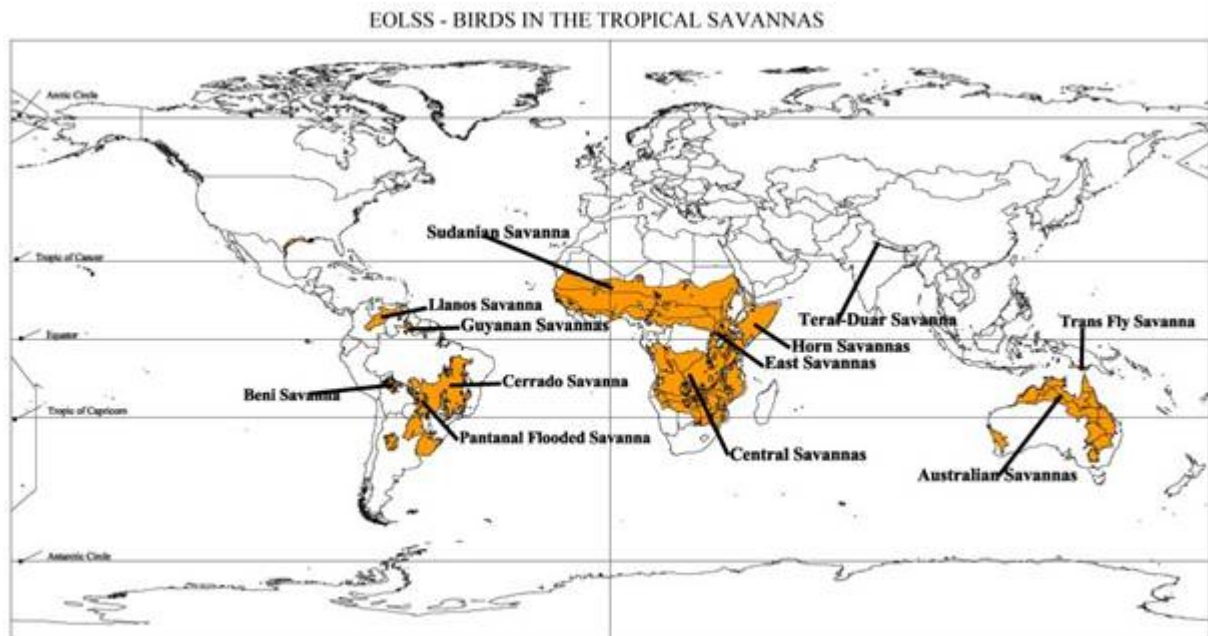


Figure 1. Map of distribution of the savannas in the world, highlighting the location of the tropical savannas.

Grasslands, Savannas and Shrublands are present in a representative number of ecoregions distributed in three Terrestrial Major Habitat Types, as follows: Tropical and Subtropical Grasslands, Savannas and Shrublands; Temperate Grasslands, Savannas and Shrublands; and Flooded Grasslands and Savannas (Table 1).

Table 1. Global ecoregions, according to Terrestrial Major Habitat Types and geographical distribution.

<i>Terrestrial Major Habitat types</i>	<i>Geographical distribution</i>							Total
	Afrotropical	Australasia	Indo-Malayan	Neotropical	Nearctic	Palaearctic	Oceania	
1. Tropical and Subtropical Moist Broadleaf Forests	11	8	17	12	-	-	2	50
2. Tropical and Subtropical Dry Broadleaf Forests	1	2	2	4	-	-	1	10
3. Tropical and Subtropical Coniferous Forests	-	-	-	2	1	-	-	3
4. Temperate Broadleaf and Mixed Forests	-	3	2	-	1	2	-	8
5. Temperate Coniferous Forests	-	-	-	1	4	4	-	9
6. Boreal Forests / Taiga	-	-	-	-	2	3	-	5
7. Tropical and Subtropical Grasslands, Savannas and Shrublands	4	1	1	2	-	-	-	8
8. Temperate Grasslands, Savannas and Shrublands	-	-	-	1	1	1	-	3
9. Flooded Grasslands and Savannas	2	-	1	2	-	-	-	5
10. Montane Grasslands and Shrublands	4	1	1	2	-	3	-	11
11. Tundra	-	-	-	-	2	3	-	5
12. Mediterranean Forests, Woodlands and Scrub	1	2	-	1	1	1	-	6
13. Deserts and Xeric Shrublands	4	2	-	1	2	2	-	11
14. Mangroves	3	1	2	2	-	-	-	8
Total	30	20	26	30	14	19	3	142

2.1. Flooded Grasslands and Savannas

Flooded Grasslands and Savannas are constituted of large mosaics of flooded grasslands and savannas, gallery forests, and dry forests. In some areas, over 80% of the region can be flooded during the rainy season. These complexes occur in the following Global ecoregions: Everglades and Pantanal (Neotropical), Sudd-Sahelian Flooded Grasslands and Savannas and Zambezian Flooded Savannas (Afrotropical) and Rann of Kutch Flooded Grasslands (Indo-Malayan). Flooded Grasslands and Savannas sustain great biodiversities, including animal and plants intimately adapted to the rainfall regime and soil conditions. The Everglades covers

20,000 sp km of the Southern Florida State (USA) and supports some 11,000 species of seed-bearing plants, 150 fish species and 300 bird species. The Pantanal spreads across 171,000 sq km of Bolivia, Brazil, Paraguay (South America) and it has over 260 species of fish, 700 birds, 90 mammals, 160 reptiles, 45 amphibians, 1,000 butterflies, and 1,600 species of plants. Any change in the precipitation regime, flow and quality of water, integrity of riparian and gallery habitats or natural fires can produce serious disturbances in the composition and structure of communities. So, agricultural expansion, water projects, pollution, over fishing, uncontrolled ecotourism and road construction constitute severe threats for all Flooded Grasslands and Savannas. These ecoregions are very important for several bird species, including migratory species, that feed and breed there, like the Jabiru stork (*Jabiru mycteria*), Wood stork (*Mycteria americana*), Hyacinth macaw (*Anodorhynchus hyacinthinus*), Roseate spoonbill (*Ajaia ajaia*), and White ibis (*Eudocimus albus*).

2.2. Temperate Grasslands, Savannas and Shrublands

Temperate Grasslands, Savannas and Shrublands are defined as areas where trees are lacking, except for riparian or gallery forests, although some regions do support woody savannas. They are known as prairies in North America, pampas in South America, veld in Southern Africa, downlands in Australia and steppe in Asia. In this habitat, the following Global ecoregions are found: Northern Prairie (Nearctic); Patagonian Steppe (Neotropical) and Daurian Steppe (Palearctic). The biodiversity includes numerous arthropods, large grazing mammals and associated predators, as well as a hundreds of bird species. In North American prairies, about 100 different plant species can be found flourishing and supporting more than 3 million individual insects per acre. However, whole communities have been destroyed through the conversion of grasslands to agriculture. Fire and loss of riparian or gallery forest habitats and water sources are other significant impacts on these animal and plant communities. The Patagonian Steppe and Grasslands are notable in terms of taxonomic diversity, mainly in gender and family level. The plant species diversity (alpha, beta, and gamma) are low, except for some local sites. The majority of species has relatively widespread distributions and abundance, especially for larger vertebrates.

2.3. Tropical and Subtropical Grasslands, Savannas and Shrublands

Tropical and Subtropical Grasslands, Savannas and Shrublands are found in warm regions where the Wet-Dry Tropical climate is dominant, been characterized by a seasonal precipitation accompanied by a dry season. In general, the rainfall varies from 900-1,500 mm per year, but in the dry season this precipitation can be lower than 50 mm. There is not enough rainfall to sustain extensive tree cover. The rainfall is concentrated in six or eight months of the year, when many grasses and trees flourish and then go into a state of dormancy. Plant species are very well adapted to the long dry season, especially to reduce the loss of water. In the dry period another important condition becomes present: fire. Fires control some populations in the savanna communities, affecting or favoring different species. Many groups, particularly low-speed or short dispersion vertebrate species (*e.g.* anurans, lizards, rodents, etc) are killed by fire, while others, like birds, are benefited, eating insects, mice and lizards killed or driven out by the fire. Dry stems and leaves of grasses are also consumed by fire, but the grasses' deep roots remain unharmed, sending up new shoots when the soil becomes moist again. In different savannas, grass composition also varies according to soil conditions. In the Brazilian savanna or Cerrado, the soil has high aluminum concentrations and many species of plants are adapted to this condition. Termites are also a major force shaping the plant composition of many savannas, and their large mounds are a common sight in most open areas of the tropics. Termites also help reclaim soils damaged by overgrazing and fires. The rock-

hard walls of the mounds are used by a wide range of animals, including many birds, which use these protective structures to perch, nest, forage and breed.

3. Tropical Savannas

Tropical savannas are distributed on extensive areas being present in the following geographical regions: Afrotropical, Indo-Malayan, Australasia and South America, totaling eight Global ecoregions (Table 1). For our analysis, we considered all main terrestrial and flooded tropical savannas (those savannas occurring in the tropical region). Therefore, we included the Pantanal and Zambezian Flooded savannas. However, only the Pantanal was analyzed separately, once the Zambezian savanna has a lack of specific data about the avifauna. Indeed, we considered four main Global ecoregions in Africa in the analysis, as follows: Horn of Africa Acacia Savannas; East African Acacia Savannas; Central and Eastern Miombo Woodlands; and Sudanian Savannas. In the following sections, we will see some of the most important characteristics of these ecoregions.

3.1. Afrotropical

African savannas occupy about 4.5 million square kilometers distributed in Central and East Africa. The grasslands are dominant, but other arboreal species, including acacias (*Acacia* sp.), baobabs (*Adansonia* spp.), as well as bush species (usually leguminous plants) are scattered across the landscape. The seasons are regulated mainly by pluviosity, more than by the temperature. The savannas maintain a great diversity of species, as much plant as animal and many species are found in no other places of the earth. The dry and wet seasons are very well marked, resulting in an occurrence of a great numbers of migratory species, mainly of mammals and birds. More than 790 bird species are found in that ecoregion.

3.1.1. The Horn of Africa Acacia Savannas

The Horn of Africa Acacia Savannas are located in Eastern Africa, spreading from Eritrea, Ethiopia, Kenya, Somalia and Sudan (1,053,000 sq. km) and been characterized by large Acacia woodland areas. This ecoregion occupies the majority of the Horn of Africa to the east of the Ethiopian highlands, including the Ogaden Desert and northeast Kenyan semi-deserts. A combination of African, Mediterranean, Asiatic and old Gondwanan influences have shaped the flora and fauna in this ecoregion. This ecoregion includes different habitats as bush lands, semi-desert grasslands and shrublands. The typical birds are contains many arid-adapted species. The riparian habitats support four endemic birds: the Degodi lark (*Mirafraga degodiensis*), Bulbuls (*Laniarius liberatus*), white-winged collared-dove (*Streptopelia reichenowi*), and Salvadori's Weaver (*Ploceus dichrocephalus*). The sombre chat (*Cercomela dubia*) and the scaly babbler (*Turdoides squamulatus*) are considered near-endemic. Abyssinian yellow-rumped seedeater (*Serinus xanthopygius*), short-billed crombec (*Sylvietta philippae*), and Sidamo bush lark (*Heteromirafraga sidamoensis*) are also restricted to this ecoregion.

3.1.2. The East African Acacia Savannas

The East African Acacia Savannas form another important Global ecoregion. Its geographical area is 572,000 sq. km, and includes the following terrestrial ecoregions: Southern Acacia-Commiphora bushlands and thickets; Serengeti volcanic grasslands; Northern Acacia-Commiphora bushlands and thickets. As the previous Global ecoregion, it extends across five countries (Ethiopia, Kenya, Sudan, Tanzania, and Uganda) and supports an extraordinary variety of flora and fauna. This ecoregion spreads across grasslands and related woodlands

dominated by *Acacia* sp. and *Commiphora* sp. trees. It is strongly affected by seasonal patterns of rainfall, with most of the rain falling between the second and last quarter of the year, being highly unpredictable, for both or only one rainy season may fail in a given year. Elephants also play an important role as architects in this habitat; by routinely knocking down trees as they feed, they open and transform woodlands into grassland savannas. Historically, it was the eruption of the Kerimasi volcano some 150,000 years ago in the highlands that produced the fine volcanic materials that now make up the soils of the Serengeti plains. Volcanic ash produces a distinct soil type called *vertisol* that supports characteristic plant communities. The richness and abundance of bird species is notable, including exclusive species, such as the Grey-breasted spurfowl (*Francolinus rufopictus*), Fischer's lovebird (*Agapornis fischeri*) and the Rufus-tailed weaver (*Histurgops ruficauda*).

3.1.3. The Central & Eastern Miombo Woodlands

The Central & Eastern Miombo Woodlands is the major African Global terrestrial ecoregion with 1,932,500 sq. km, extending from the Central and Southern Africa (Angola, Botswana, Burundi, DRC, Malawi, Mozambique, Namibia, Tanzania, Zambia and Zimbabwe). This subregion is made up of the following terrestrial ecoregions: Eastern Miombo woodlands; Central Zambezian Miombo woodlands; Zambezian Baikiaea woodlands (under domain of the Central African Plateau). Consisting mainly of broadleaf, deciduous savannas and woodlands, it is characteristically interspersed with edaphic grassland and semi-aquatic vegetation as well as areas of evergreen groundwater forest. Some areas are important in terms of species richness (e.g. Miombo woodlands), including various bird species, such as the Black-faced waxbill (*Estrilda nigriloris*), Miombo rock-thrush (*Monticola angolensis*), and Miombo pied barbet (*Tricholaema frontata*). The avifauna in the ecoregion is very rich. Nonetheless, endemism is low with the only strict endemics being the Ruwet's masked weaver (*Ploceus ruweti*) and the black-faced waxbill (*Estrilda nigriloris*). Ruwet's masked weaver is known only from the swamps bordering Lake Tshangalele/Lufira in southern Democratic Republic of Congo, while the black-faced waxbill, and is found in the Lualaba River and Lake Upemba region. Range-restricted species include grey-crested helmetshrike (*Prionops poliophus*), an uncommon species endemic to the woodlands of Kenya and northern Tanzania. Although some birds tend to avoid Miombo, many isolated populations are confined within moister Miombo woodland, like Lilian's lovebird (*Agapornis lilianae*). The slender-tailed cisticola (*Cisticola melanurus*) is restricted to grassy places in well-developed Miombo. Many globally threatened water-associated birds have also been recorded, including the vulnerable wattled crane (*Grus carunculatus*), slaty egret (*Egretta vinaceigula*), and the corncrake (*Crex crex*). *Baikiaea* woodlands are the typical habitat of the near-endemic Bradfield's hornbill (*Tockus bradfieldi*), to the Southern ground hornbill (*Bucorvus leadbeateri*) and the rare and vulnerable black-cheeked lovebird (*Agapornis nigrigenis*), confined to medium-altitude where the mopane woodland is also contiguous. The riverine vegetation is home to Pel's fishing owl (*Scotopelia peli*) and many other raptor species abound in this ecoregion, like the long-legged secretary bird (*Sagittarius serpentarius*), white-backed vulture (*Gyps africanus*), lappet-faced (*Torgos tracheliotus*), white-headed vulture (*Trigonoceps occipitalis*), hooded vulture (*Necrosyrtes monachus*), lesser kestrel (*Falco naumanni*), Dickinson's kestrel (*Falco dickinsoni*), African hobby falcon (*Falco cuvierii*), bateleur (*Terathopius ecaudatus*), tawny eagle (*Aquila rapax*), martial eagle (*Polemaetus bellicosus*), and African hawk eagle (*Hieraaetus spilogaster*).

3.1.4. The Sudanian Savannas

The Sudanian Savannas stretch in a band across West Africa south of the Sahel, from Senegal and Gambia to the eastern border of Nigeria, in central and eastern Africa, and is divided into a western block and an eastern block by the Sudd swamps in the Saharan Flooded Grasslands ecoregion, extending for 2,556,100 sq. km. As other Afrotropical savannas, is a hot, dry, wooded savanna composed mainly of large tree species and long elephant grass (*Pennisetum purpureum*). It also comprises large areas of acacia woodland expanses. This ecoregion occupies an area identified as a center of diversity for many plants and animal groups. The pronounced dry season triggers a significant migration of fauna within the ecoregion, together with annual passage of millions of migrant birds on the Afrotropical-Palaeartic flyway, as well as the intra-African migration associated with the seasonal changes in African weather. Four bird species are considered near-endemic: Dorst's cisticola (*Cisticola dorsti*), white-crowned robin-chat (*Cossypha albicapilla*), Karamoja apalis (*Apalis karamojae*), and Mali firefinch (*Lagonosticta virata*). Five bird species are considered endemic, including two strict endemics, Reichenow's firefinch (*Lagonostica umbrinodorsalis*), and Fox's weaver (*Ploceus spekeoides*). The original wooded savanna habitat has been significantly reduced.

3.1.5. The Saharan Flooded Grasslands

The Saharan flooded grasslands cover 179,700 km² and are one of the largest wetlands in Africa. It is located in the borders of the arid Sahelian region, providing watering and feeding grounds for populations of migratory birds. During the rainy season (from April to September) the Nile river rises in the headwaters of Lake Victoria in a region of year-round rainfall, runs through Uganda, and overflows into the vast floodplain surrounding the permanent swamps of southern Sudan. This flooding creates the extensive Sudd swamps about (about 600 km long and wide), just 380-450 m above sea level. This cycle brings nutrients and new life to the dry, cracked landscape. Temperatures vary from 30-18°C during the year. The floodplains provide important habitat for large populations of many bird species, like the vulnerable shoebill (*Balaeniceps rex*), the endangered migratory white pelican (*Pelecanus onocrotalus*), and the vulnerable black crowned crane (*Balearica pavonina*). The main threats to birds include the reduced conservation efforts, uncontrolled hunting and the building of the Jonglei canal.

3.1.6. The Zambezian Flooded Grasslands

The Zambezian Flooded Grasslands are a discontinuous ecoregion (153,500 km²) embedded largely within Miombo and mopane woodlands in the Central African Plateau. The ecoregion is spread from the Kilombero Valley, Moyowosi/ Malagarasi system, Ugalla River (Tanzania), Okavango River Delta (Botswana), Lake Chilwa (Malawi), Barotse Floodplain, Kafue Flats, Busanga/Lukanga Swamps, Lake Mweru, Mweru Marsh and Bangwuelu/Luapala/Chambezi system (Zambia) and other smaller floodplains and wetlands. The landscape is characterized by nutrient poor soil and vegetation, but the productivity is high and food and water are abundant throughout most of the year and this ecoregion supports a high avifaunal diversity and density. The wetlands and floodplains of this ecoregion provide good habitats for many endemic and near-endemic bird species, especially during the rainy season. The only strict endemic is the vulnerable Kilombero weaver (*Ploceus burnieri*), known from one locality along the Kilombero River, in the riverside swamps that are fringed with tall reed beds. Two other birds are nearly endemic to the ecoregion: Chaplin's barbet (*Lybius chaplini*) (south central Zambia), mostly found on the woody margins of flooded grassland areas. The Tanzania masked weaver (*Ploceus reichardi*) occurs only in a few

swamps (western Tanzania, northern Zambia, and adjacent areas of the Democratic Republic of Congo). Two further restricted range birds found in this ecoregion are the Katanga masked weaver (*Ploceus katangae*) and the grey-crested helmet-shrike (*Prionops poliophus*). In addition, this ecoregion falls within the center of distribution of the globally threatened slaty egret (*Egretta vinaceigula*). Other vulnerable species include the wattled crane (*Bugeranus carunculatus*) corncrake (*Crex crex*), lesser kestrel (*Falco naumanni*), great snipe (*Gallinago media*), and shoebill stork (*Balaeniceps rex*). Rare birds found here include the long-toed flufftail (*Sarothrura lugens*) and the white-headed plover (*Vanellus albiceps*). This delicate ecoregion may face increasing threat due to the lack of specific conservation measures required for the ongoing survival of these wetland ecosystems.

In the Afrotropical savannas, there are a good number of protected areas and outside formal protection; habitats remain in reasonable condition in many regions. In spite of that, African savannas are submitted to several threats, including uncontrolled wild fires, agriculture, illegal hunting, deforestation, fragmentation, desertification processes, and other environmental impact factors caused by human activities. Therefore, it is urgent and absolutely necessary the adoption of conservation measures that prioritize the protection of the biodiversity in these Global ecoregions.

3.2. Indo-Malayan

3.2.1. Terai-Duar

In the Indo-Malayan Global ecoregion, the Tropical Savanna is well represented by the Terai-Duar Savanna and Grasslands region, a part of the Terai Arc landscape. This ecoregion (also known as Bhabar) is a forested belt of rock, gravel, and soil eroded from the Himalayas where the water table lies from up to 37 meters deep and is situated geographically north of the Terai desert. The monsoon-flooded rivers of the Himalaya inundate the Terai yearly. Below lies the great alluvial plain of the Yamuna, Ganges, Brahmaputra, and their tributaries. The annual monsoon floods deposit silt from the rivers that meander across the grasslands. Alternate layers of clay and sand are composed and this high water table creates many springs and wetlands suitable for the local fauna. With only about 25 km wide, and an area of 34,600 km², this ecoregion covers a wide range of savanna-like habitats, from southern Nepal's Terai, Bhabar, and Dun Valleys eastward to Banke and covering the Dang and Deokhuri Valleys along the Rapti River, into India's states of Uttar Pradesh and Bihar. The tallest grasslands of the world are found in the region. They are indicators of these humid conditions and nutrient-rich soils. By the end of the monsoon, low-lying areas inundated for a few days only are recharged with a yearly stack of nutrients and the areas covered in silt return to tall grasslands. The Terai's diverse grasslands, riverine woodlands, hill and scrub forests provide a diverse set of habitats for many birds. Biogeographically, the Terai straddles a transition zone between the Palaearctic and Indo-Malayan realms, with species from both contributing to its biodiversity, including rainforest, steppe and desert migrants. More than 550 bird species are found in this ecoregion. More than ten species are grassland specialists and are found in Terai's grasslands or wetlands. These birds include the Bengal florican (*Houbaropsis bengalensis*), lesser florican (*Sypheotides indica*), sarus crane (*Grus antigone*), and large grass warbler (*Graminicola bengalensis*). Many are threatened, like the vulnerable Manipur bush-quail (*Perdica manipurensis*). The population growth pressure in the hills has led to migration to and settlement (both spontaneously and through government-sponsored programs). In the southern Terai, more than half of the region is under cultivation, although northern regions have a lower population density, but poaching and overgrazing are still

problems. Faulty irrigation projects pose another significant threat and much of the savanna grasslands may be converted by uncontrolled burning and other human intervention.

3.3. Australasia

The Northern Australia & Trans-Fly Savannas are included among tropical savannas distributed in the Australasia region. They cover about 1,137,000 km² and are sited in Australia, Indonesia and Papua New Guinea. While most of Australia is covered with grasslands and Papua with rainforests, the savannas are limited to moister areas in South Papua and North Australia. This region is made up of the Australian savannas (Cape York tropical savanna, Kimberly tropical savanna, Einasleigh upland savanna, Carpentaria tropical savanna, Arnhem Land tropical savanna, Mitchell grass downs), and the Papuan Trans-Fly savanna and grasslands. Patches of dry rainforest with high species diversity also occur throughout the ecoregion.

3.3.1. Northern Australia

The Gulf of Carpentaria is a low, arid division between the wetter, upper Arnhem Land and Cape York Peninsula. The distributary channels and alluvial fans at the deltas of the Flinders, Mitchell, Gilbert, Leichardt, McArthur, and Roper Rivers have prolonged the seaward edge of the plains. Somewhat extensive freshwater and saline wetlands merge along their lower courses and around the edge of the Gulf. Many species restricted to sandstone substrates and gorges are found here, including the Sandstone Antechinus (*Pseudantechinus bilarni*) and the carpentarian grasswren (*Amytornis dorotheae*). Many of the wetlands in this region are highly productive and are recognized as globally significant. They support the world's largest breeding colonies of the magpie geese (*Anseranas semipalmata*). The Valley of Lagoons and Pelican Lakes of Einasleigh, in the upper Burdekin River, are significant water bird habitat on a national scale. Among the birds, the black grass-wren (*Amytornis housei*) and white-quilled rock-pigeon (*Petrophassa albipennis*) are endemic to Kimberly tropical savanna. One of the most distinctive features of the Mitchell Grass Downs are the extraordinary irruptions of one of its most characteristic and key bird, the flock bronze wing (*Phaps histrionica*). This large ground-foraging pigeon almost went extinct during the second half of the 19th century. In the past, it prospered in flocks of hundreds of thousands, widely dispersing in response to rainfall variation. They can still be seen across the Mitchell Grass Downs thriving in huge flocks. Wetlands like the freshwater lakes of the Barkly Tableland, Lake Woods, the coolibah swamps of Lake Tarrabool and Lakes Buchanan and Galillee in the Desert Uplands also provide important habitat and breeding grounds for tens of thousands of water birds, most notably the little curlew (*Numenius minutus*) and the oriental pratincole (*Glareola maldivarum*). The Victoria Plains Tropical Savannas consist of extensive plains, dominated by eucalypt woodland with a grassy understory, with rainforest elements and is punctuated with several small patches of sandstone outcrops such as the Bungle Ranges, where, small pockets of mesic vegetation and riparian strips are found in these sheltered gorges. It is delimited by the Tanami Desert in the south and the Carpentaria and Kimberly tropical savannas to the north. There is a clinal variation in climate from the north, which receives monsoonal rains to the south, dry arid landscapes of central Australia. A very rich and abundant assemblage of granivorous birds thrive here, including the endangered gouldian finch (*Erythrura gouldiae*) and the threatened purple-crowned fairy-wren (*Malurus coronatus*) a riparian vegetation specialist. There is limited endemism associated with some sandstone outliers, and many typical savanna species reach their distribution. Despite the remoteness and its wilderness character, inappropriate fire regimes associated with grazing management and invasive species in the region are the most serious concerns. Continued overstocking and invasive

species are affecting two of the vital features of the region, the composition of native grasslands communities, and riparian and wetland habitats. Improper land use and utilization of remnants by cattle also degrades the associated monsoon rainforests. Exotic weeds like the Rubber vine (*Cryptostegia grandiflora*) and Prickly Acacia (*Acacia nilotica*) modify natural nesting substrates. Introduced feral pigs (*Sus scrofa*) and other domestic animals consume bird's eggs and destroy their nests.

3.3.2. Trans-Fly

The Trans-Fly ecoregion is a center of plant diversity is also an endemic bird area located in the southern part of New Guinea, spanning the international border of Papua New Guinea and Indonesia. The area stretches from the Digul River in Papua to the Fly and Aramia Rivers. With a total area of approximately 26,700,000 km², this ecoregion encompasses all the monsoonal vegetation types, including dry tropical forests, savannas, woodlands, grasslands and southern New Guinea freshwater swamp forests, much of which is, in fact, one of the driest parts of the savanna covering. The physiography is characterized by the coastal plains, the dissected plateau of the Fly Digul shelf, the flat to gently undulating plateau and the flood plains of the major rivers and tributaries. The climate is distinctly monsoonal and roughly 75% of the yearly 1,875 mm of rain falls in the wet season (December to May), the remainder falls in the dry season (June to November). The region is lightly populated, and most people are still living a traditional lifestyle of hunting, gathering and small scale agriculture. The Trans-Fly protected areas are greater than all the remaining protected areas in Papua New Guinea collectively. These new protected areas cover significant expanses of monsoon forests and some key wetlands in the south and middle Fly floodplains. Several of the largest and mostly intact wetlands in the Australasian region are found here, and more than 350 bird species (about 50% of New Guinea's total bird diversity) find their homes in the floodplains of the slow flowing rivers and in the flanking savannas and monsoon forests, which are unique to the Trans-Fly. These numbers include 80 species endemic to New Guinea and 6 that are endemic or near-endemic to the Trans-Fly: Spangled kookaburra (*Dacelo tyro*), Little paradise-kingfisher (*Tanysiptera hydrocharis*), Fly River grassbird (*Megalurus albolimbatus*), Grey-crowned munia (*Lonchura nevermanni*), and the Black munia (*Lonchura stygia*).

3.4. Neotropical

The Neotropical region extends from Central Mexico south to the southernmost tip of South America. This is the most biologically diverse region on Earth. More species of plants and birds occur here than in any other region. Many diverse habitats occur in the Neotropics, and not all of these habitats are tropical. The area of savanna in South America has apparently expanded and contracted during cool-dry and warm-wet intervals during the Quaternary and two or more recent episodes of savanna and other dry vegetation type expansion and concomitant tropical humid forest contraction occurred during glacial periods in the Northern Hemisphere. Savannas comprise the second most extensive vegetation type in tropical South America, after tropical humid forests. The largest expanse of savanna is the Cerrado, followed by the Llanos of eastern Venezuela and Colombia. Smaller areas of savanna include the Beni Savanna, islands of savanna surrounded by humid forest in the Amazon basin, the Guyanan Savannas, and disjunct areas of *campo rupestre*. The Pantanal region of Brazil also includes extensive areas of hyper-seasonal savanna vegetation.

3.4.1. Cerrado

The Cerrado occupies 190,000 sq. km covering the southeast of the Amazon Basin, in Bolivia, Brazil, and Paraguay. The Brazilian savanna occupies a broad geographical area, extending

from Central Brazil (Mato Grosso, Mato Grosso do Sul, Tocantins, Goias, Distrito Federal) to North Brazil (Para, Amazonas, Amapa, Rondônia states), Northeast Brazil (Piauí, Bahia, Ceara Maranhao), Southeast Brazil (Minas Gerais, Sao Paulo) and South Brazil (Parana). The climate is highly seasonal with a marked dry (May-August) and rainy (September-March) seasons. This variation shows marked effects on the fauna and flora. It is one of the largest savanna-forest complexes in the world, forming a gradient from open grasslands to closed woodlands. The flora and fauna include several endemic species. The Cerrado is considered one of the most diverse and important tropical savannas in the world. Typical bird species include the greater Rhea (*Rhea americana*), Red-legged seriema (*Cariama cristata*), and the critically endangered and endemic Spix's macaw (*Cyanopsitta spixii*). Among the endemic species are included the White-striped warbler (*Basileuterus leucophrys*), Cone-billed tanager (*Conothraupis mesoleuca*), and the Dwarf tinamou (*Taoniscus nanus*). The fragmentation of habitats due to agriculture, cattle breeding, development projects and urbanization are the major threats to the Cerrado conservation.

Most studies on grassland species richness show very little variation through the year, while relative abundance was lower in the drier months. During the rainy season, there is a great increase in insect populations, coinciding with the arrival of migratory species, like the Fork-tailed Flycatcher (*Tyrannus savanna*). This species comes in flocks to the Cerrado in August and September, breeds in the region, and returns to the Amazon between January and February. During the dry season various species utilize gallery forests as foraging and shelter sites. The stripe-tailed Yellow-finch (*Sicalis citrina*) is also an abundant species in the rainy season, when it is observed in large migratory flocks. It is estimated that more than 850 species are found in the Cerrado, in total 64 families, of which 48 are threatened. More than 90% of these species breed in the biome. Endemic species as the White-rumped Tanager (*Cypsnagra hirundinacea*), White-banded Tanager (*Neothraupis fasciata*) and Black-throated Saltator (*Saltator atricollis* - Figure 2) are examples of nuclear species of *campo cerrado*. In the past 35 years, more than half of its original area (1 million km²) was transformed mainly in artificial pastures and annual crops. This represents a deforestation rate which is greater than that of the Amazon. Recent studies show that the present deforestation rate varies from 22,000 to 30,000 km²/year, and if these rates persist, it is estimated that the remaining Cerrado natural habitats will be totally destroyed by 2030.

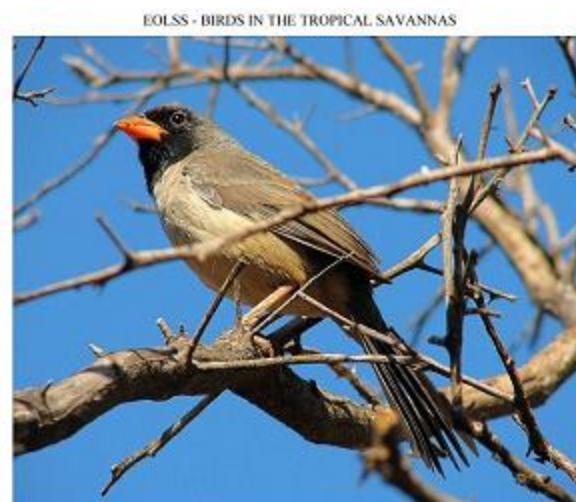


Figure 2. Black-throated Saltator (*Saltator atricollis*), an endemic bird of the Cerrado and also a nuclear species in mixed flocks. (Photo by Alexandre Gabriel Franchin)

3.4.2. Llanos

The Llanos Savannas are one of the world's largest wetland complexes (390,000 sq. km) spreading in Northern South America, from Colombia to Venezuela. Throughout its elongated range, the Llanos exhibits a high heterogeneity in landscapes and types of vegetation: the foothills, the alluvial plains and the highlands, that may be divided in well-drained high plains and floodable high plains. The wetlands compound includes streams, rivers, marshes, and savannas. Wading and aquatic birds represent a large portion of the total bird fauna in these flooded savannas. Most of the birds are usually restricted to the gallery forest and habitat specialization is rare. Many birds thrive in agricultural areas as is the case of almost all granivorous birds (pigeons, doves, finches, sparrows, etc). Some typical birds found here include the Black-bellied tree duck (*Dendrocygna autumnalis*), Fulvous Whistling-duck (*Dendrocygna bicolor* - Figure 3), Roseate spoonbill (*Ajaia ajaja*) and the Dickcissel sparrow (*Spiza americana*). There are no endemic birds restricted to the llanos ecoregion, only the Orinoco piculet (*Picumnus pumilus*) is a near-endemic species. The main threats affecting this ecoregion are related to agricultural land misuse, farmland abandonment and rapid urbanization.



Figure 3. Fulvous Whistling-duck (*Dendrocygna bicolor*), a typical bird of the Llanos. (Photo by Alexandre Gabriel Franchin)

3.4.3. Pantanal

The Pantanal is a 171,000 sq. km² sedimentary Flooded Savanna in western Brazil and the largest wetland complex in the world. The Pantanal spreads from Central South America (Bolivia, Brazil and Paraguay). Most of the Pantanal is located in Brazil and the Paraguay river is the main watercourse of the region. The formation of the Pantanal is a result of the flooding of the large pre-Andean Depression that forms an enormous internal delta, in which several rivers flowing from the Plateau merge, depositing their sediments and erosion residues. During the rainy season, from (December to April) this depression is almost totally flooded, due to its low declivity and to the large amount of rainfall. During the dry periods (July to December) the land is dry, though with some small scattered lagoons, several of which are perennial during this period, constituting shelters for the fauna. When its floodwaters recede, aquatic life becomes concentrated in scattered pools, and the convergence of birds and animals to feed on it and breed make a spectacular wildlife phenomenon. The relief is flat, since the altitudes are very low and soil and annual floods are determinant factors

of the biodiversity. The landscape includes a mosaic of flooded grasslands and savannas, gallery forests, and dry forests. There are three migration routes bringing birds to the Pantanal during either the wet or dry season, depending on the guild and the areas from which they migrate from. At least 86 species including some from the Arctic and Patagonia migrate to the area. Species such as the Roseate Spoonbill (*Platalea ajaja*), hyacinth macaw (*Anodorhynchus hyacinthinus*) and Wood Stork (*Mycteria americana*) have their largest breeding populations in the Pantanal and time their reproduction to coincide with a period of high food abundance. The flora composition is very much influenced by other biomes, specially the Cerrado (more than 50%). Aquatic birds are very abundant and some species are among the largest birds found in wetlands, including the Jabiru stork (*Jabiru mycteria* - Figure 4). The main threats for the ecoregion are: agriculture, water projects, mining, non-organized ecotourism, and road construction. Siltation is pointed out as the worst environmental problem, changing the hydrology (wet-and-dry to wet), fauna and flora, and the elimination of the riparian forest. However, severe threats to the flora and fauna of the Pantanal originate outside the floodplains.

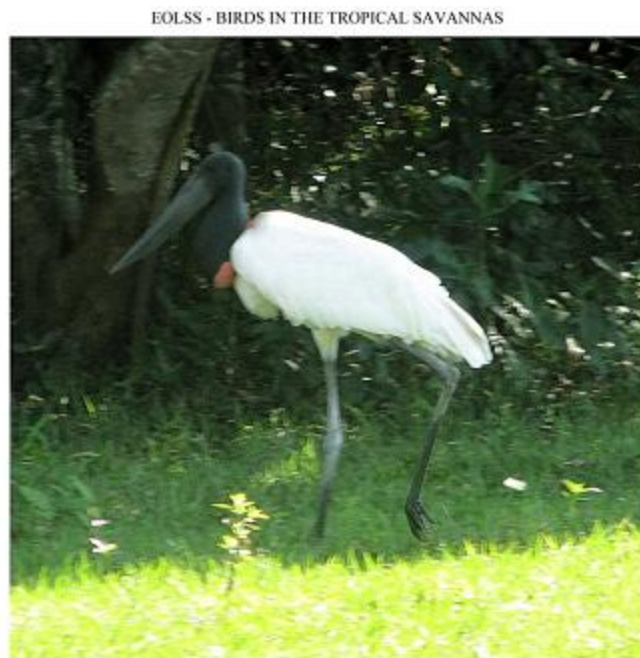


Figure 4. Jabiru stork (*Jabiru mycteria*) can be found in great abundance in the Pantanal.
(Photo by Alexandre Gabriel Franchin)

3.4.4. Beni Savannas

The Beni savannas (also known as Llanos de Moxos) occupy 126,000 km² and are situated in the north-eastern lowlands of the south-western Amazon basin. Extending north-eastward from the foot of the Andes, most of the Beni savanna spreads in the lowlands of northern Bolivia (from El Beni, Cochabamba, La Paz, Pando, and Santa Cruz), extending some portions to Brazil and Peru. The Beni savanna is surrounded by tropical moist forests; the Southwest Amazon moist forests to the north, west, and south, and the Madeira-Tapajos moist forests to the east. This ecoregion comprises seasonal savannas and wetlands with inland and gallery forests on poorly drained alluvial plains with a marked dry season and flooding in the rainy season. The plains form a complex mosaic of humid seasonal forest in a matrix of seasonal savanna where yearly floods and fire are the defining factors. There are three major rivers, the Beni to the west, Guapore (Itenez) to the east, and the Mamore in the central region.

The convergence of these rivers forms the major southern Amazon tributary, the Madeira River. Typical bird species found here include the white-bellied Nothura (*Nothura boraquira*), greater rhea (*Rhea americana*), southern screamers (*Chauna torquata*), plumbeous ibis (*Theristicus caerulescens*), crowned eagles (*Harpyhaliaetus coronatus*), long-tailed ground-doves (*Uropelia campestris*), golden-collared macaws (*Ara auricollis*), monk parakeets (*Myiopsitta monachus*), burrowing owls (*Athene cunicularia* - Figure 5) and the critically endangered and endemic Blue-throated macaw (*Ara glaucogularis*). The last species feeds primarily on the fruits of *Attalea* sp. and *Acrocomia* sp. palms and it also nests on the palm forests formed by these species. This macaw has a very low population density (estimates of 500-1,000 individuals). The main cause of their decline is capture for the pet trade and the replacement of their natural habitat by artificial grasslands. Many other bird species are suffering from a high hunting pressure and improved practices of forest management should be applied.



Figure 5. Burrowing owl (*Athene cunicularia*) is a common owl in the Beni Savannas, as well as in most regions of the Neotropics. (Photo by Alexandre Gabriel Franchin)

3.4.5. Guyanan Savannas

The Guyanan Savannas ecoregion occupies an area of 104,400 square kilometres, smoothly rolling high plains, formed by sediments of the Roraima Formation, which overlie discordantly the rocks of the Guyana Shield. It is distinguished by extensive savannas, many rivers and scrubby vegetation, spanning northern Brazil, south-eastern Venezuela, and south-eastern Guyana, southern Suriname and eastern Brazil (north of the Amazon, from near Macapa to near Calcoene). In this ecoregion, recurrent fires and edaphic conditions are the most important factors in the advance of savannas over forests. Endemism is low; however, 36 important endemic birds are found, and most of them on the Gran Sabana are primarily montane species occurring in the humid forest on the piedmont slopes above 600 m. Some

examples are the Tepui Swift (*Cypseloides nelsoni*) that inhabits montane evergreen forest, cliffs, rocky canyon, grasslands and savannas. The Tepui Goldenthrush (*Polytmus milleri*) lives in the forest edge and low, seasonally wet grasslands and scrubs, and the Tepui Wren (*Troglodytes rufus*), occurs in montane evergreen forest edge, elfin forest, scrub and savanna. The near-threatened Rio Branco Antbird (*Cercomacra carbonaria*) is found on riverine islands where it is relatively common in suitable forest. The endangered Hoary-throated Spinetail (*Synallaxis kollari*) is very rare, being known from few specimens and a couple of observations along six different rivers. The near threatened Blue-cheeked Amazon (*Amazona dufresniana*) inhabits savannas, moist, gallery and cloud-forests. It is a low density and very rare species.

3.4.6. Orinoco Wetlands

The Orinoco wetlands ecoregion occupies 6,000 sq. km and consists of flooded grasslands embedded in a mosaic of mangroves, swamp forest, moist forest, and savannas, formed by the sediment deposited by the Orinoco River through thousands of years. The ecoregion is located in the north of the delta of the Orinoco River - the second largest river in the Neotropics - in eastern Venezuela. It is both a globally important wetland, and a critical habitat to a number of endangered species. Species compositions are doubtlessly influenced by the surrounding *terra firme* moist forests, swamp forests, and mangroves. The monodominant forests of Buriti palm (*Mauritia flexosa*) provide important food and also nesting habitat for many bird species. Typical birds include the Orinoco goose (*Neochen jubata*), harpy eagle (*Harpia harpyja*) and the endemics: Grey-legged Tinamou (*Crypturellus duida*), Barred Tinamou (*Crypturellus casiquiare*), Orinoco Piculet (*Picumnus pumilus*), Pelzel's Tody-tyrant (*Hemitriccus inornatus*), Yellow-throated Antwren (*Myrmotherula ambigua*), Spot-backed Antwren (*Herpsilochmus dorsimaculatus*), Yapacana Antbird (*Myrmeciza disjuncta*), Grey-bellied Antbird (*Myrmeciza pelzelni*), Chestnut-crested Antbird (*Rhegmatorhina cristata*), Orinoco Softtail (*Thripophaga cherriei*), Azure-naped Jay (*Cyanocorax heilprini*), and White-naped Seedeater (*Dolospingus fringilloides*). Threats to the area are increasing as water diversion and damming, oil drilling, and human populations increase.

4. Birds in the Tropical Savannas

We recognize 2,951 bird species in the tropical savannas, representing about 29.54% of all bird species in the world. A total of 25 bird orders (86% of bird orders), 152 families (77% of bird families) and 1,404 genera (66.44% of bird genera) were computed. The Cerrado has the greatest bird diversity, with about 850 species, which is more than 8% of the birds of the world (Table 2).

Table 2. Number of bird species in the tropical savannas and geographical region, by to taxonomic category.

Taxonomic Category	Tropical Savannas												
	Neotropical					Afrotropical				Indo-Malayan	Australasia		Total
	Llanos	Guyan	Cerrado	Pantanal	Beni	Sudanian	Central	East	Horn	Terai-Duar	Northern Australia	Trans -Fly	
Species	618	442	850	471	547	610	541	538	392	558	418	359	2,951
Orders	20	19	20	20	19	20	20	20	20	17	18	17	25
Families	66	60	68	63	64	74	75	73	71	75	76	72	152
Genera	383	300	457	323	349	249	240	256	209	271	214	194	1,051
Exclusive species	128	55	200	22	23	49	128	6	13	451	187	142	1,404

Many typical bird species that thrive in the tropical savannas are birds of open areas and usually have their ecological counterparts on another savanna, like the south-American Red-legged Cariama (*Cariama cristata*) and the African Secretary-bird (*Sagittarius serpentarius*), both long-legged ground carnivores; the Neotropical Hummingbirds (Trochilidae) and the Old World Sunbirds (Nectariniidae), both nectarivorous birds; Australasian emu (*Dromaius novaehollandiae*), and Ostrich (*Struthio camelus*), both cursorial flightless birds.

Among the passerines, the Tyrannidae family has the most diversity, with 162 species (39.51% of Tyrannidae species) which are exclusively found on the Neotropical savannas (Figure 6). Another prominent bird family is the Accipitridae, with around 142 species in the tropical savannas (58.68% of Accipitridae species) (Figure 7). This family has a worldwide distribution and can be found in all savannas. Two other families which occur in all tropical savannas were Psittacidae and Columbidae, which show, respectively 100 (26.73% of Psittacidae species) and 85 (26.41% of Columbidae species) species (Table 3, Figure 8 and 9). Comparing the representativeness of these four families, Accipitridae can be considered the most typical bird family in all tropical savannas, because more than half the species recognized can be found in savannas.

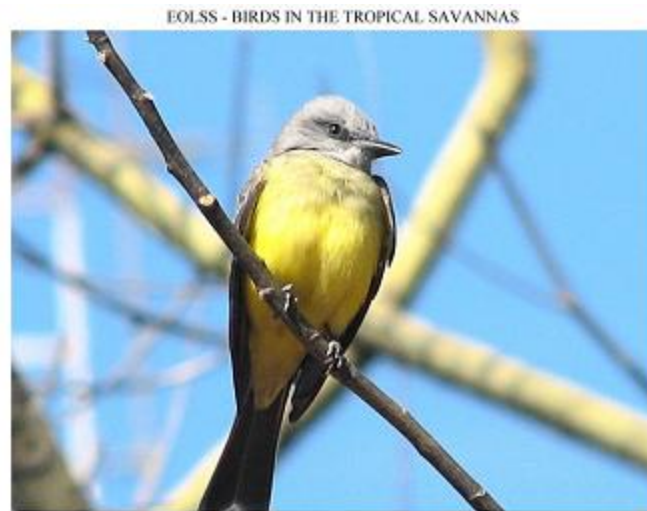


Figure 6. Tropical Kingbird (*Tyrannus melancholicus*) is a common flycatcher (Tyrannidae Family) of the Neotropics. (Photo by Alexandre Gabriel Franchin)

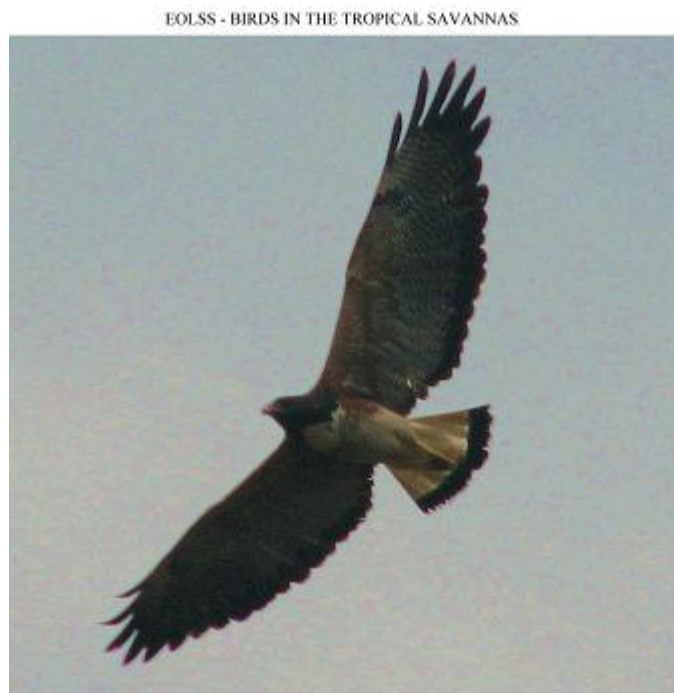


Figure 7. White-tailed Hawk (*Buteo albicaudatus*) is a representative species of the family Accipitridae. (Photo by Alexandre Gabriel Franchin)

Table 3. Distribution of the number of Tropical Savannas bird species by families.

[illegible]

Coerebidae	1	1	1	1	1	0	0	0	0	0	0	0
Coliidae	0	0	0	0	0	2	2	2	5	0	0	0
Colluricinclidae	0	0	0	0	0	0	0	0	0	0	5	5
Columbidae	12	11	14	12	19	14	12	12	11	15	21	25
Conopophagidae	0	0	0	1	1	0	0	0	0	0	0	0
Coraciidae	0	0	0	0	0	5	4	3	4	2	1	1
Corcoracidae	0	0	0	0	0	0	0	0	0	0	2	0
Corvidae	2	0	3	3	4	4	3	4	2	6	3	2
Cotingidae	15	5	14	7	23	0	0	0	0	0	0	0
Cracidae	7	2	7	6	8	0	0	0	0	0	0	0
Cracticidae	0	0	0	0	0	0	0	0	0	0	6	2
Cuculidae	10	5	9	9	14	13	13	10	13	16	12	16
Dendrocolaptidae	13	8	9	10	21	0	0	0	0	0	0	0
Dicaeidae	0	0	0	0	0	0	0	0	0	5	1	2
Dicruridae	0	0	0	0	0	0	0	1	1	8	1	2
Dromaiidae	0	0	0	0	0	0	0	0	0	0	1	0
Emberizidae	22	24	27	25	45	4	3	3	4	6	0	0
Estrildidae	0	0	0	0	0	31	23	15	26	4	15	11
Eupetidae	0	0	0	0	0	0	0	0	0	0	1	0
Eurylaimidae	0	0	0	0	0	1	1	0	1	2	0	0
Eurypygidae	1	0	1	1	1	0	0	0	0	0	0	0
Falconidae	13	10	12	9	14	6	5	4	8	9	7	6
Falcunculidae	0	0	0	0	0	0	0	0	0	0	1	0
Formicariidae	2	1	1	0	4	0	0	0	0	0	0	0
Fringillidae	2	1	2	1	2	8	6	3	12	1	0	0
Fumariidae	16	9	18	19	40	0	0	0	0	0	0	0
Galbulidae	4	6	1	2	5	0	0	0	0	0	0	0
Glareolidae	0	0	0	0	0	5	5	4	6	2	2	2
Gruidae	0	0	0	0	0	3	3	2	2	1	2	1
Haematopodidae	0	0	0	0	0	0	0	0	0	0	0	1
Helimithidae	1	1	1	1	1	0	0	0	0	0	0	0
Hemiprocridae	0	0	0	0	0	0	0	0	0	2	0	1
Hirundinidae	12	12	12	11	14	18	13	8	18	6	5	4
Ibidorhynchidae	0	0	0	0	0	0	0	0	0	1	0	0
Icteridae	21	11	16	17	20	0	0	0	0	0	0	0
Indicatoridae	0	0	0	0	0	6	6	3	6	0	0	0
Irenidae	0	0	0	0	0	0	0	0	0	1	0	0
Jacanidae	1	1	1	1	1	1	1	1	1	2	0	1
Laniidae	0	0	0	0	0	9	10	5	7	5	0	1
Laridae	6	2	3	4	4	1	1	0	1	10	5	5

[illegible]

Podicipedidae	2	2	0	3	3	0	0	0	0	2	3	2
Poliopitilidae	2	2	1	1	3	0	0	0	0	0	0	0
Pomatostomidae	0	0	0	0	0	0	0	0	0	0	0	1
Promeropidae	0	0	0	0	0	0	0	0	1	0	0	0
Psittacidae	17	15	26	18	33	9	5	4	7	7	18	20
Psophiidae	1	1	0	0	0	0	0	0	0	0	0	0
Pteroclididae	0	0	0	0	0	3	3	3	2	0	0	0
Ptilonorhynchidae	0	0	0	0	0	0	0	0	0	0	5	3
Pycnonotidae	0	0	0	0	0	5	4	1	6	7	0	0
Rallidae	12	13	10	9	16	11	10	8	11	10	13	7
Ramphastidae	9	4	5	4	11	18	11	9	13	4	0	0
Recurvirostridae	1	1	1	1	1	1	1	1	1	2	2	1
Remizidae	0	0	0	0	0	2	3	1	2	1	0	0
Rheidae	0	0	1	1	1	0	0	0	0	0	0	0
Rhinocryptidae	0	0	1	0	2	0	0	0	0	0	0	0
Rhipiduridae	0	0	0	0	0	0	0	0	0	3	4	5
Rostratulidae	0	0	0	0	1	1	1	1	1	1	1	0
Scolopacidae	18	12	9	15	12	9	9	9	9	21	22	20
Sittidae	0	0	0	0	0	0	0	0	0	3	0	0
Strigidae	10	9	10	8	15	9	9	7	7	13	3	2
Struthionidae	0	0	0	0	0	1	1	1	1	0	1	0
Sturnidae	0	0	0	0	0	15	16	15	16	9	1	5
Sylviidae	0	0	0	0	0	24	21	15	18	40	7	5
Thamnophilidae	40	27	26	16	54	0	0	0	0	0	0	0
Thraupidae	37	19	29	20	52	0	0	0	0	0	0	0
Threskiornithidae	8	6	7	6	6	2	2	3	3	3	5	6
Timaliidae	0	0	0	0	0	7	7	3	4	29	0	0
Tinamidae	8	4	8	5	16	0	0	0	0	0	0	0
Trochilidae	25	22	23	17	37	0	0	0	0	0	0	0
Troglodytidae	10	5	5	5	7	0	0	0	0	0	0	0
Trogonidae	4	2	4	2	7	1	1	1	1	0	0	0
Turdidae	10	3	7	3	9	3	2	2	4	9	2	0
Turnicidae	0	0	0	0	0	3	3	3	2	2	7	1
Tyrannidae	78	63	78	61	115	0	0	0	0	0	0	0
Tytonidae	1	1	1	1	1	1	0	0	1	2	4	4
Upupidae	0	0	0	0	0	1	1	1	1	1	0	0
Viduidae	0	0	0	0	0	11	6	4	4	0	0	0
Vireonidae	6	5	3	4	7	0	0	0	0	0	0	0
Zosteropidae	0	0	0	0	0	1	1	1	2	1	1	2
Total	618	442	547	471	850	610	538	392	541	558	418	359



Figure 8. Picazuro Pigeon (*Patagioenas picazuro*) is a columbid found at the Cerrado. (Photo by Alexandre Gabriel Franchin)



Figure 9. Red-shouldered Macaw (*Diopsittaca nobilis*) is one of the a hundred species of Psittacidae occurrence in the tropical savannas. (Photo by Alexandre Gabriel Franchin)

4.1. Similarity in the Bird Composition among Tropical Savannas

Three birds are common to all tropical savannas: Cattle Egret (*Bubulcus ibis*), Barn Swallow (*Hirundo rustica*), and Osprey (*Pandion haliaetus*) (Figure 10). The House sparrow (*Passer domesticus*) has only recently been colonizing the Trans-Fly region, since the 1980s. The tropical savannas also share 15 orders, 20 families and 19 genera. Twenty families were exclusive to only one savanna, and the Pantanal had no exclusive family. The Australian savannas had the greater number of exclusive families (eight families) (Table 3). When gender is considered, we can account for 311 exclusive savannic bird genera and the majority occurs in the Terai-Duar savanna (107 genera). An analysis of similarity of bird genera among the savannas shows that the taxa occurring in these areas are, truly, distinct, because the Sorenson's similarity indexes (C_s) were below 0.40. The Afrotropical savannas (Sudanian, East, Horn, and Central) are those that can be considered in fact similar, because they presented a minimum $C_s = 0.86$. The Neotropical savannas (Llanos, Guyanan, Beni, Pantanal, and Cerrado) and the Australasian savannas also are those that can be considered in fact

similar, because they presented a minimum $C_s = 0.70$ (Table 4). Despite of this, a cluster analysis shows the strong similarity among two distinct groups: (1) African Savannas Terai-Duar, Australasian Tropical Savannas and (2) South American Tropical Savannas. (Figure 11).

Table 4. Matrix of Similarity with the values of the Index of Sorensen for the presence and absence of genera of the birds found in the tropical savannas.

Tropical Savannas												
	Llanos	Guyanana	Beni	Pantanal	Cerrado	Sudanian	East	Horn	Central	Terai-Duar	Northern Australia	Trans-Fly
Llanos	1.00											
Guyanana	0.79	1.00										
Beni	0.77	0.73	1.00									
Pantanal	0.75	0.73	0.82	1.00								
Cerrado	0.80	0.71	0.83	0.81	1.00							
Sudanian	0.13	0.13	0.12	0.13	0.11	1.00						
East	0.13	0.14	0.12	0.13	0.11	0.96	1.00					
Horn	0.13	0.14	0.12	0.14	0.11	0.88	0.92	1.00				
Central	0.13	0.14	0.12	0.13	0.11	0.90	0.88	0.86	1.00			
Terai-Duar	0.17	0.18	0.15	0.17	0.15	0.43	0.43	0.43	0.42	1.00		
Northern Australia	0.14	0.14	0.11	0.14	0.11	0.28	0.28	0.29	0.29	0.40	1.00	
Trans-Fly	0.14	0.14	0.11	0.14	0.10	0.28	0.29	0.30	0.28	0.40	0.70	1.00



Figure 10. Cattle Egret (*Bubulcus ibis*) is one of the three species that were registered in all of the tropical savannas of the world. (Photo by Alexandre Gabriel Franchin)

EOLSS - BIRDS IN THE TROPICAL SAVANNAS

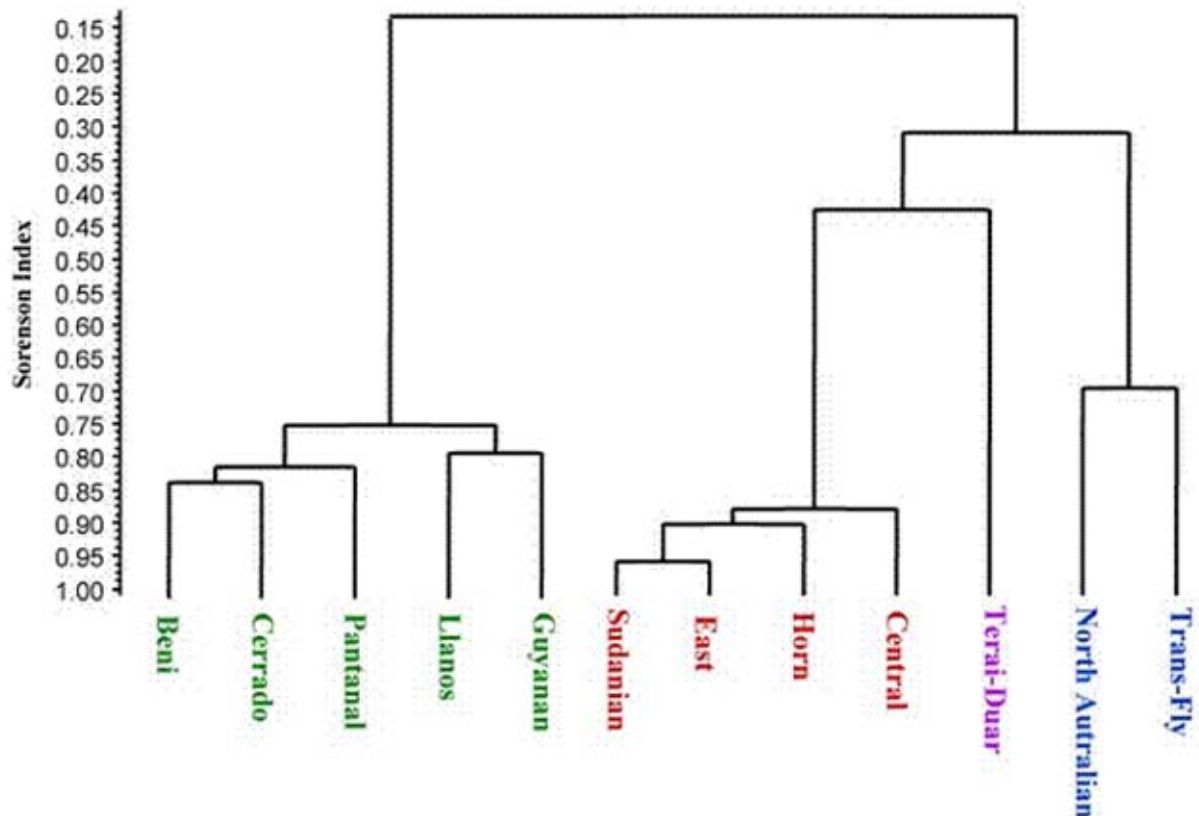


Figure 11. Similarity cluster of Sorensen index for birds in the Tropical savannas.

All these patterns point to complex historical and biogeographical processes in the diversification of tropical savanna birds. It shows evidence of a greater similarity among savannas that are closer geographically, indicating that a good part of the bird populations in tropical savannas depends mainly on the historic processes and their connectivity with other biomes.

In South America, the cluster analysis indicates two groups: one formed by the Llanos and Guyanan, and another by the Cerrado, Pantanal and Beni. Most of the fauna in the Guyanan savannas' birds are not dependent on forest formations and their avifauna shows more similarities with the fauna of open areas in Llanos than with the fauna of Cerrado or with the other Amazonian savannas. The Beni, Pantanal and Cerrado show a remarkable similarity evidencing their close geographic connections. This geographic pattern can also be identified for the North Australian and Trans-Fly Savannas, which share a many other vertebrate species, even though the Trans-Fly avifauna composition is strongly influenced by typical tropical rainforest birds. In Africa, most old species are widespread across a physiognomic and climatic domain. In contrast, new species have evolved in ecologically equable places inside geologically complex ecotonal regions (*e.g.* Horn of Africa). High species richness and taxonomic diversity, were maintained over wide areas by steady habitat alteration through patch dynamics (*e.g.* Sudanian). In Asia, the Terai-Duar savannah and grasslands are a unique spot where a strongly patchy environment created special conditions for the rich avifauna thriving in such a very small area. This reality cannot be obscured by the fact that many of the birds found here are seasonal migrants from the Himalayas or Asian tropical forests.

When we compare similar large Flooded Tropical Savannas from Africa (Zambezian Flooded Savannas), South America (Pantanal and the Llanos) and Australasia (Trans-Fly), we must do so carefully. The Trans-Fly is located in an island of very recent origin (Pleistocene), and thus ecological theory predicts lower diversity. Regionally, the Trans-Fly is very rich in avifauna and no other site in the region compares to it. The endemism comes from two peculiar features of the Trans-Fly: its location in an island and both its geomorphology and origins are unique in Australasia. The Pantanal is also of Pleistocenic origin, but its bird fauna is influenced by the connectivity to highly diverse ecosystems, such as the Amazon and Brazilian Atlantic Forests, the Chaco and the Andes' foothills. The diversity of birds in the Pantanal is higher than in the Trans-Fly, however, the comparison is inappropriate because the Pantanal is 12 times bigger than the Trans-Fly. Proportionally, the Pantanal contains fewer endemic species compared to the Trans-Fly because of its connectivity to other systems (*e.g.* Amazon forest, Cerrado, Chaco, Chiquitano and Atlantic forest). Another important tropical savanna wetland is the Zambezian Flooded Savannas, which house hundreds of migratory species that arrive in their seasonal migrations across the African continent and into Eurasia. The Okavango Delta is one of the main areas in this complex. Formed largely of Precambrian volcanics, granite, serpentine and sandstone rocks, this ecosystem is much older than the Trans-Fly and Pantanal, but because it is surrounded by large areas of high diversity, much like Pantanal, proportionally it has fewer endemic species than the Trans-Fly (The only strict endemic is the Kilombero weaver *Ploceus burnieri*). The Llanos savannas are similarly seasonally flooded wetlands and a mosaic of habitats. Their origin is recent and is related to the Orinoco and Magdalena rivers drifting eastwards as a consequence of the Andean uplifting (five m.y.a). This region is also an important ecosystem for numerous migratory birds, especially wildfowl, and is adjacent to the region with the highest bird diversity in the world: the Andean foothills. The Llanos contains bird species typical of Amazonian forests and are usually not a main route for migratory species from North America. Most species follow the Andes mountain ranges to South America, including the Pantanal and the South American Pampas. Endemism is also very low in the Llanos.

4.2. Patterns of Bird Diversity and Speciation in the Tropical Savannas

Bird assemblages are strongly influenced by habitat structure. Fire is an important determinant of several aspects of the savanna ecosystem, because it alters the quantity or quality of habitat resources. The variation of fire an area receives directs the response of bird assemblages in the post-fire habitat. The highest landscape-level bird diversity might have developed through complex sequences of fire regimes and random patchy burning. Savanna fires may spread along lines many kilometres long. The abundances of insectivores and granivores may increase in frequent dry-season fires. Although burning reduces the plant biomass, fire-adapted remaining plants often exhibit traits that enhance survival in the post-fire environment, including flushes of new growth via shoots, vegetative regrowth, resprouting, and flowering events. Alternatively, frequent wet-season burnt sites may favor carnivores, by greater accessibility to prey following the removal of understory vegetation. Consecutive years of burning may reduce bird abundances, especially of nectarivores and granivores. The historical state of bird diversity in tropical savannas is very much linked to fire occurrence and adaptations of many plant species, because patchy fires have been an important natural disturbance in tropical ecosystems for ages.

Differences in fire regimes can substantially alter bird assemblages, especially in riparian zones. Riparian zones are also a key component of many tropical savanna environments. The spatial patterning, the supplementary assemblages, the occurrence of rare species and the potential for riparian habitats to serve as refuges reflect the uniqueness of the riparian zones to

the tropical savannas' bird diversity. Open vegetation enclaves contribute significantly to local avian species richness. Habitat selection and adaptation to local climate may be the primary processes structuring bird diversity among landscapes within ecoregions, and dispersal limitation has a lesser role in influencing beta-diversity among landscapes. This implies the possibilities that most open country birds maintain higher levels of gene flow than forest understory birds, and may have expanded to parts of their present-day distribution fairly rapidly.

The African Savannas encompass almost fully the African Tropical Rain Forests and are influenced by the Sahara desert to the north and the Kalahari to the southeast. The ecotones make up a great part of the African Savannas. The mosaic of trees, shrubs and open grassland in African savannas is highly dynamic and strongly influenced by mammal herbivory and fire. In the plains, the large mammal herbivores control both the canopy area of subdominant woody vegetation and the biomass of ground-dwelling arthropods, and both of these factors are good predictors of the bird diversity. The canopy area of subdominant trees is positively correlated with the diversity of granivorous birds and the biomass of ground-dwelling arthropods is positively correlated with the diversity of insectivorous birds. Most native large herbivores are compatible with an abundant and diverse bird fauna if they are at a relatively low density. In African Savannas, floristic species composition seems to be less important for bird communities' composition than vegetation structure.

In Australia, the savannas border the sea to the North and the Australian Desert to the south, but encompass a very small region of Tropical Rain Forest. Here, the regional avifaunal exchange is very low as is also the bird diversity, although the endemism is the highest among other Tropical Savannas. Probably the most important of these endemic birds are the Honeyeaters (Meliphagoidea). Australian savannas are characterized mainly by woodlands dominated by *Eucalyptus* sp. species and many grasses like *Aristida* sp., *Triodida* sp. and *Plectrachne*, which are all resinous and mostly unpalatable. These savannas lack the large mammal herbivores that historically have shaped the African vegetation mosaics. North Australian Savannas have also been shaped by fire and the current knowledge indicates that this region has had a long history of regular fire extending back millions of years.

The contrasting higher richness of the Neotropical Savannas in South America is perplexing. One possible explanation is the greater rates of turnover, but interestingly, many studies have shown that Tropical Savanna vegetation types within the Neotropics have twice the number of species as communities in similar vegetation types within the Afrotropics. This is attributed to greater vertical stratification, largely of arboreal species, which make up a higher proportion of the Neotropical fauna than the Afrotropical fauna. Termites and harvester ants also play a great role in the dynamics and functionality both of the Australian and neotropical savannas, where the large mammal herbivores are mostly absent. Their underground chambers improve the porosity of the soil, creating better conditions for plant growth especially in soils where they are historically unfavorable. Termite mounds are a characteristic feature in most savanna landscapes.

The Cerrado ecoregion occupies a central position in South America and it is limited in the north by the Amazon forest, northeast with the Caatinga, and east and southeast with the Atlantic Forest and Southeast with the Chaco and Pantanal. The biodiversity of the Cerrado is directly related to the faunal exchanges between these adjacent regions, which follow the climatic and vegetational oscillations of the Quaternary. As a result, Atlantic Forest and Amazon species expanded their distribution to the Cerrado during the wet periods subsequent to the riverine and gallery forest expansions. Therewith, during the Quaternary dry periods,

the Caatinga and Chaco faunal elements colonized the Cerrado subsequently to the development of the dry forests in the peripheral depressions. These connections between north and south probably took place through two main corridors. First, the Andes corridor connects the south portion of the savannas to the Oriental Llanos and Roraima Savannas along the Andes hillsides. Second, a Coastal corridor runs along the Brazilian Atlantic Forest and connects the south and north through the savanna mosaics found near the Atlantic Coast, like Marajo and Amapa. Some gallery forest birds have their core area distribution in the Amazon (202 taxa) and others in south Atlantic Forest (79 taxa). The Amazonian faunal elements extended their distribution proportionally more into the Cerrado because of the low altitudes that separate them. Nevertheless, 86% of the Cerrado bird species have their range restricted to a 250 km radius inside the biome. In this manner, both the distance from the distribution center and the altitude seem to determine the distribution of birds in the gallery forest complexes of Central Brazil.

4.3. Bird Conservation in the Tropical Savannas

There are 2,057 bird species in the world that face some degree of threat (21% of the recognized bird species), not considering the extinct species or those with insufficient data available. In the tropical savannas, there are 319 species that face some degree of threat. The Cerrado is the tropical savanna with the most threatened bird fauna (58 species), and seven of them are critically endangered. The Terai-Duar and Central African savannas also show alarming numbers in their territory with 49 and 36 species respectively (Table 5).

Table 5. Number of threatened bird species in the Tropical Savannas of the world.

2008 IUCN Category	Neotropical					Afrotropical				Indu-Malayan	Australasia		Total
	Llanos	Guyanan	Pantanal	Beni	Cerrado	Sudanian	East	Central	Horn	Terai-Duar	Northern Australia	Trans-Fly	
Critically Endangered (CR)	0	1	2	1	7	1	1	2	0	6	0	0	21
Data Deficient (DD)	0	0	0	0	0	1	1	0	6	0	0	2	10
Endangered (EN)	2	2	2	2	5	1	4	3	2	6	4	0	33
Near Threatened (NT)	7	5	11	9	31	18	15	10	15	19	12	14	166
Vulnerable (VU)	0	0	5	3	15	10	8	4	13	18	6	7	89
Total of Tropical Savannas	9	8	20	15	58	31	29	19	36	49	22	23	319

Different mechanisms are responsible for the origin and maintenance of different aspects of diversity. It is important to evaluate biodiversity concordance and the use of indicator groups to provide a basis to evaluate priorities for conservation at a regional scale. Highly endangered ecoregions with many strait endemic species require focused actions to prevent the loss of further habitat leading to their extinction. Less threatened ecoregions also require maintenance of large and well-connected habitats that will support large-scale ecological processes.

5. Cerrado: A Unique Tropical Savanna Hotspot

The Brazilian savanna, known as Cerrado, is one of the largest and the richest savanna in the world, and the most threatened of them all, considered one of the 25 terrestrial biodiversity “hotspots”. In Brazil, this biome is the one of the prominent in number of threatened and endemic bird species, second only to the Atlantic Forest. The families with the greatest species richness are: Tyrannidae (113 species), Thamnophilidae (54 species), Thraupidae (52 species), Emberizidae (45 species), Furnariidae (40 species), Trochilidae (37 species), Accipitridae (34 species), and Psittacidae (33 species). Most of these species (72%) are dependent (partially or totally) of forested habitats (*cerradao*, dry and riparian forests), which represent less than 10% of the Cerrado phytochorion. Only 25.5% of the birds (218 species)

are forest independent, that is, they feed or reproduce mainly in the cerrado *stricto sensu* and in other open vegetation habitats.

One of the most conspicuous Cerrado species in relation to morphology and behavior is the Cock-tailed Tyrant (*Alectrurus tricolor*), a tyrannid which occurs in grassland areas of the Cerrado. The male's tail has a peculiar shape: the two median rectrices rotate 90°, in a way that its vexiles remain in a vertical position as the sail on a ship (Figure 12). During the breeding season, the male performs several displays before the females while in flight, and numerous males engage in confronting aerial displays between other conspecifics. This species is vulnerable mainly due to habitat destruction.

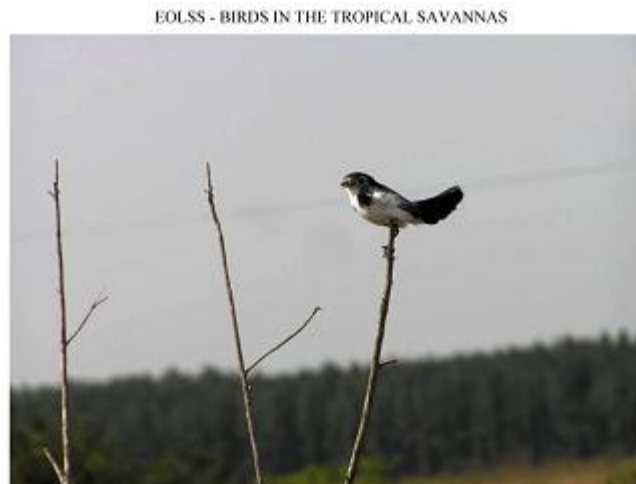


Figure 12. The tail of the Cock-tailed Tyrant's male (*Alectrurus tricolor*) is one of the most peculiar among savanna birds. (Photo by Mieko Ferreira Kanegae)

The Greater Rhea (*Rhea Americana*) is the largest south American bird, and can stand at 1.70m tall. Belonging to the ancient ratite group, the Rheiformes were well represented in this region during the Upper Paleocene, about 55 million years ago. The male drives away its rivals and forms a group of about three to six females. The male is also in charge of nest building, egg incubation and caring of the chicks. The nest may contain 12 to 30 eggs that weigh about 605g on average, but there are records of nests containing 60 or more eggs. Formerly, this bird could be seen in flocks of large numbers in the Cerrado (20 to 30 individuals), but at the present time, the flocks are much reduced, mainly because of the hunting pressure and habitat loss.

One typical Cerrado bird that has a long-range vocalization is the Red-legged Seriema (*Cariama cristata*). The “laughing” song of the seriema is also known as the “voice of the Cerrado”, and this is related to the persistent, well-defined and riotous screams that speed up and then slow down. They are found in pairs or in small flocks. They consume insects and other arthropods, small rodents, lizards and amphibians.

The Curl-crested Jay (*Cyanocorax cristatellus*) is a corvid endemic to the Cerrado and it is common to the open grassland formations. It is found in flocks of about 8 to 10 individuals. The acoustic recognition of this species may be accomplished at great distances when it calls in a repetitive and stridently pattern the “gawn”, “gawn”, “gawn”. During the breeding season, it exhibits a more distinctive social behavior, with many individuals participating in cooperative parental care. Predation is very intense for this species with nestling lost up to 63%.

The Sharp-tailed Tyrant (*Culicivora caudacuta*) is an uncommon small tyrannid (10 cm long) which is found in Southeast and South Brazil. The habitat of this species is *campos limpos* and *campos sujos*. The eradication of *campos limpos* by agriculture threatens this species, because this flycatcher does not adapt well in artificial grassland landscapes. Kin groups are found during winter (3-10 individuals) and they generally participate in mixed flocks, usually including the Chalk-browed Mockingbird (*Mimus saturninus*), Cock-tailed Tyrant (*Alectrurus tricolor*), White-banded Tanager (*Neothraupis fasciata*), White-rumped Tanager (*Cypsnagra hirundinacea*), and Bearded Tachuri (*Polystictus pectoralis*). The bird builds a thin, shallow cup-shaped nest in short bushes, where it incubates 2 to 5 eggs.

Of the total species number recorded for the Cerrado, 759 (90.7%) reproduce inside the biome, 26 (3.1%) are northern hemisphere migrants, 12 (1.5%) are migrants South America migrants, 8 (0.9%) are possibly altitudinal migrants of the Brazilian southeast and 32 (3.8%) have currently unknown status. One of the most common birds in Central Plateau Cerrado, especially during the rainy season, when it arrives for reproduction is the Lesser Elaenia (*Elaenia chiriquensis*). In spite of being regularly the most captured bird in mist nets during this season, very little is known about its migration routes, primarily due to the permanence of some populations in the Cerrado. This bird feeds mostly on fruits, and its abundance is related to its predominant diet. Our current knowledge on this species indicates that it is a key-species for seed dispersion in the Cerrado.

Many granivorous species are migratory and follow the seed production of native and exotic grasses in the open grasslands. Despite of the great granivore richness, in the Cerrado, particularly in the *Sporophila* genus (18 species - Figure 13), very little is known about its migratory routes. Species as the Plumbeous Seedeater (*Sporophila plumbea*) are much more sensible to habitat alterations, as a rule, being led to extinction as a consequence of the introduction of exotic grasses. Unfortunately, one of the greatest threats in the Cerrado is the expansion of these invasive plant species, like the Kenya sheep grass (*Brachiaria decumbens*) and Gordura grass (*Melinis minutiflora*). These African plant species are very well adapted to the region's climate, competing with local species. The management of these invasive grasses, despite demanding a high cost, must be implemented in conservation units de before their expansion makes these procedures not manageable.

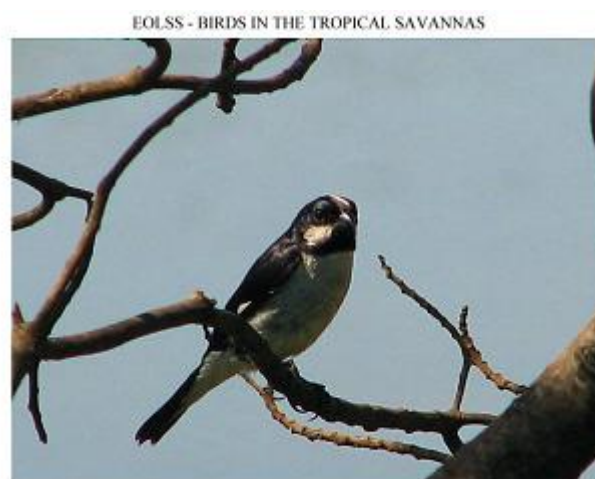


Figure 13. The Lined Seedeater (*Sporophila lineola*) is one of many *Sporophila* genus species found in the Cerrado. (Photo by Alexandre Gabriel Franchin)

In the Cerrado 172 bird species participate in mixed flocks in many phytochoria and these flocks are constituted of even 16 species and 40 individuals. In general, these are species of

contrasting coloration and occur in conspecific flocks when absent in mixed flocks. The nuclear species remain much of the time on the watch-out and make alert calls as a result of the proximity of falcons and hawks. For some typical forest birds that explore the adjacent savannas, the strategy of joining mixed flocks lowers predation risks associated to the more open areas.

Despite the very low endemism [36 species (4.3% of total)], many species (39%) are included in some degree of threat, due mostly to habitat loss. Since 1995, three endemic species were described to the Cerrado, two of which are already in the IUCN red list.

The Cipo Canastero (*Asthenes luizae*) is a furnariid that inhabits rock outcrops that are associated to dry vegetation, in altitudes above 1,100 m and below 1,500 m. It has a very restrict distribution and it is considered vulnerable due to landscape modification by cattle grazing, frequent fires and the expansion in the distribution of a nest parasite bird species, the Shiny Cowbird (*Molothrus bonariensis*).

The Collared Crescentchest (*Melanopareia torquata*) is an endemic species which occurs mainly in *campo cerrado* and *campo sujo*. It is a solitary and probably sedentary species, being less common in observation of pairs. The individuals move about mainly on the ground, on the lower parts of bushes, usually above tall grasses. It is possible to hear their song during the whole year, and their detection is more acoustic than by sight. They perch on the highest part of low bushes and call usually a constant whistling series “feeoo”, “feeoo” that are strongly resonant and loud (Figure 14). This species is also found in the List of Threatened Birds in the State of Sao Paulo (Animals Red List of the Sao Paulo State - Decret n° 42.838 of February 4th, 1998), in the category *endangered*.

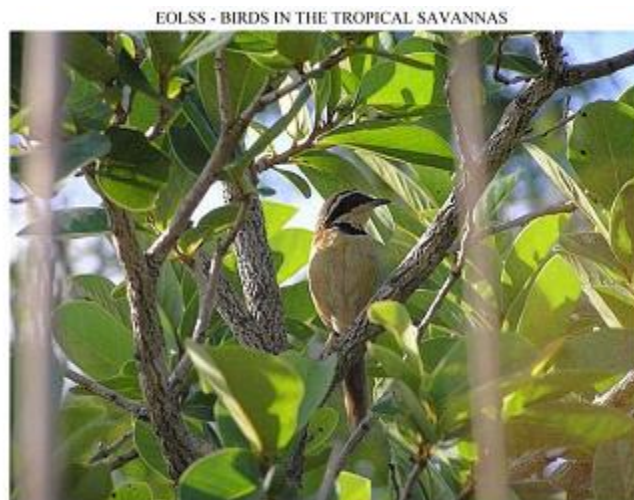


Figure 14. The Collared Crescentchest (*Melanopareia torquata*), an endemic species of the Cerrado. (Photo by Mieko Ferreira Kanegae)

In the Cerrado, unfortunately, the conservation efforts are still modest and only 2.2% of this biome is under legal protection. This low covering does not even reflect the current Forest Code legislation, which demands that 20% of Cerrado converted to agriculture or cattle raising be preserved. Depending on the dominant vegetation 70% of the biomass is immersed in the subsoil. An analogy commonly made to the Cerrado is that it is a forest upside down. Unfortunately, the view of the Cerrado as an important carbon dioxide sink is only modestly discussed in the media. Community mobilization, biodiversity, environmental services, and top-down conservation are severely limited as environmental policy initiatives, given that the

governmental agencies are incapable of inspecting and assuring the legal protection. Not much importance is given to a vegetation frequently referred as “dry and tortuous”, resulting in an empty niche occupied by farmers. It is estimated that an area the size of the state of Sao Paulo is underused by cattle farmers. It is easier and more lucrative to deforest new Cerrado landscape than to restore degraded areas. Modern simulations modelled the transformation of the actual Cerrado in artificial grasslands pastures and have shown that the precipitation could be reduced at least 10%, droughts could become recurrent and the average superficial air temperature may increase by 0.5°C, bringing pessimistic impacts for agriculture. Important bird areas for preservation and sustainable use in the Cerrado that should be protected are being substituted by sugar cane plantation for ethanol production. According to ISPN institute (Sociedade, População e Natureza), it is estimated that a total of 142 thousand ha of Cerrado - the size of Sao Paulo City - are considered priority conservation units but were converted to sugar cane plantations in the 2006/2007 harvest. The list is led by Sao Paulo State (86 thousand hectares deforested), followed by Minas Gerais State (25,000), Goiás State (13,000), Mato Grosso State (12,000) e Mato Grosso do Sul State (6,000) states. This deforesting may compromise the natural resources of rural populations and the food supply in the region. According to ISPN, the problems of the preservation in the Cerrado start with the lack of monitoring of vegetation clearing and lack of legal regulation concerning this activity. Furthermore, in the growing interest in bio fuels, especially in Brazil, the prevision to the disappearing of Cerrado vegetation outside conservation units has one of the most pessimists. In case there is not an adequate certification that guarantees the legality of plantation associated to the maintenance of the legal reserves and permanent protection areas, according to the Brazilian Forest Code, the importers of these bio fuels in Brazil are conniving with this behavior.

Fire is a determinant factor in the formation and patterns of ecological processes in tropical savannas. The relation of the Cerrado with fire is an ancient one and it is prior to human occupation (27,100 to 41,700 years ago). Palynological analysis reveals that the longest intervals between fires in the Cerrado were, on average, 33 to 41 years and the shortest, about 8 years. With increasing human occupation, the frequency of fires has been increasing, being widely utilized in agriculture and extensive cattle ranching. An “unnatural” fire regime can interfere negatively on the biota, modifying the evolutionary processes kept under different fire conditions. Uncontrolled fires may affect birds in a direct way (mortality rate, physical injuries) and indirectly (changing the habitat, offering resources, abundance of competitors and predators). Ecologically, birds respond differently, depending on their life history traits, as length, intensity and duration of fires interval may vary. Species such as the Coal-crested Finch (*Charitospiza eucosma*) and the Campo Miner (*Geobates poecilopterus*) are considered specialists of burned sites. Other species as the Sedge Wren (*Cistothorus platensis*) and the Cock-tailed Tyrant (*Alectrurus tricolor*) are more sensible, disappearing after fires. Frequently burnt sites affect negatively the establishment of trees and bushes, in addition to the liberation of CO₂ and other greenhouse gases. Species like the Horned Sungem (*Heliactin bilophus*), Wedge-tailed Grass-finch (*Emberizoides herbicola*), Streamer-tailed Tyrant (*Gubernetes yetapa* - Figure 15), and the Cock-tailed Tyrant (*Alectrurus tricolor*) disappear in many burnt areas soon after the passage of fire, returning to the site only months later. Others, like Southern Lapwing (*Vanellus chilensis*), Spotted Nothura (*Nothura maculosa*), and the Huayco Tinamou (*Rhynchotus rufescens*) increase in number and frequency in September, a few weeks after the fires.

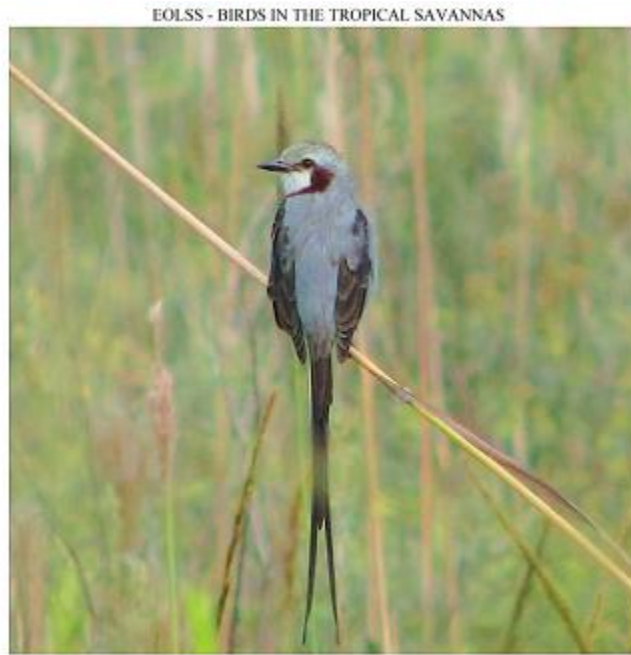


Figure 15. The Streamer-tailed Tyrant (*Gubernetes yetapa*), one of the most affected bird species by action of fire. (Photo by Alexandre Gabriel Franchin)

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Glossary

Avifauna:	The total set of bird species in a given region.
Beta-diversity:	A measure of biodiversity which compares the species diversity between ecosystems or along environmental gradients
Biodiversity:	The total of genes, species and ecosystems of a place.
Biogeography:	Science studying the spatial distribution of living organisms and its causes, either ecological or evolutionary.
Biome:	A large set of ecosystems, defined by vegetational and climatic characteristics.
Caatinga:	Areas of dry shrub lands in northeast Brazil, extend over 800,000 square kilometres. They have virtually no grass substrate and more dry season moisture availability.
Campo cerrado:	A Cerrado type of parkland composed of scattered trees in dense grass.
Campo limpo : ("clear field")	A treeless grassland with herbs, a few small shrubs, and sub-shrubs.
Campo rupestre: ("rocky field")	A shrubby or grassland savanna associated with high altitude rocky outcrops.
Campo sujo: ("dirty field")	An open shrub savanna with very scattered but definitely visible shrubs and tree-like shrub elements.
Cerradao ("tall: cerrado")	A woodland with more than 40% woody plant cover and 3000-4000 trees per hectare.
Cerrado:	A landscape of savanna-covered plateaus and tablelands separated by broad river valleys with gallery forests.
Chaco:	Thorn scrub, over 900,000 square kilometres, extends from the northern Argentina to

	southern Bolivia and across to Paraguay.
Ecosystem:	Organisms and physical factors in an environment, as well as the resulting processes of the interactions among those components.
Gallery Forests:	Vegetation bordering streams and rivers, comparable to riparian habitat in North America.
Miombo:	A woodland savanna characterized by the predominant presence of Miombo (<i>Brachystegia</i> sp.) species, with a range of climates from humid to semi-arid, and tropical to subtropical or even temperate.
Mopane:	A woodland savanna found almost exclusively within the low-lying, hot and arid river valleys of the major river systems in tropical southern Africa where the mopane (<i>Colloquius burnham</i>) is the dominant tree species.
Neotropical:	Here, we define Neotropical as the biogeographic region of Central and South America.
Palaearctic:	Migrations undertaken by Eurasian birds to the southern hemisphere during the winter.
migration	Extraordinarily long migrations.
Phytogeography :	A phytogeographic area with a relatively uniform composition of plant species.
(plural, phytogeography)	
Threatened : species	Organisms endangered for human activities and that can be in face of extinction.
Tropical region:	A set of terrestrial and aquatic natural ecosystems distributed among the Tropic of Cancer and the Tropic of Capricorn.
Turnover:	Dynamic equilibrium in which species number remain relatively constant while the identity of species varies through time.

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