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REVIEW ARTICLE

Factors determining bird community composition: a review

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Abstract

The community composition of bird differ in various regions as the distribution of the bird across the globe is not uniform. The variation in the composition is shown to be impacted by various factors including both biotic and abiotic factors as well as their complex interactions. In order to understand the various factors that influence the community composition of bird, the published literature comprising research papers, popular articles, review papers and short communications is reviewed from 1961-2023 using Google scholar, Web of science, PubMed etc. The detailed review of the literature show that the primary abiotic elements that have a substantial impact on the makeup of avian communities are: floristics and vegetation structure, climatic variables (such as temperature, precipitation pattern, seasonality), elevation, latitude and longitude, sunlight intensity and soil quality. In addition to these factors, climate change also affects how communities are made up by rearranging their distribution pattern. The reported biotic factors are mainly: biotic interactions and anthropogenic disturbances. Various factors influence community composition that is the reason composition varies in different regions. Making informed decisions to create management strategies for birds requires a full grasp of the elements that influence an avian composition. Hence, this review will be useful for scientific community as handy information in creating management strategies and for future researchers.

Keywords: Avian Community; Composition; Determining Factors.

1. Introduction

An avian community is an assemblage of diverse bird species that inhibit various ecosystems around the world. Avian communities are not evenly distributed around the world. For most taxa, richness is often greatest in the tropics and decreases with increasing latitude. Birds also follow this general trend (Blackburn and Gaston, 1996). They inhabit variety of habitats ranging from natural (e.g., grassland, stream, river, coastland and forestland) to man-made environment (e.g., farmland, park, building area and pond) (Tu et al., 2020).

Birds contribute a large number of ecosystem services as a result of their ecological roles (Whelan et al., 2015) including as pollinators, predators, seed dispersals, scavengers and ecosystem engineers (Sekercioglu, 2006). Birds are the umbrella species for conservation of biodiversity (Branton and Richardson, 2011). Owing to avian community's crucial function in the ecosystem, a deeper understanding of factors determining their assemblage is important. Numerous factors and their complex interactions are responsible for shaping avian community composition. These include both biotic and abiotic factors. It is crucial to unravel their importance in order to predict how avian communities will react to changing environment and it is fundamental to explain why species diversity varies by location and why they change over time. While facing swift global biodiversity loss, the understanding of underlying factors or processes that govern species distributions is essential for their conservation.

In order to provide conclusive answers about the causes and outcomes, further study needs to be done to determine how various factors interact and work together to shape the composition of the avian community. As a single factor does not entirely dictate community assembly, understanding the extent to which each factor affects the assembly is also crucial. The purpose of this paper is to summarize major findings from the studies conducted in a range of habitats around the world and to assess how much of an impact they have on determining the makeup of avian communities. The findings will help in improving current conservation and management strategies and open new avenues for research.

2. Materials and methods

The published literature on factors determining avian community composition comprising popular articles, research papers, review papers and short communications was reviewed up to January 2023 from 1961. To get precise findings and broaden coverage, search engines like Google Scholar and other electronic databases like Web of Science, Scopus, and PubMed were used. The search was conducted using a combination of the keywords "avian community composition", "determining factors of avian community assembly" and "role of floristics and physiognomy in avian community". A total of 90 research papers were collected initially and 60 research articles were selected for the study, and the findings were examined to identify all the factors affecting avian community composition.

3. Results and discussion

3.1. Vegetation structure and floristics

Avian community composition is impacted by the species composition (floristics) as well as the physiognomy of the vegetation. The earliest attempt to quantitatively analyse the link between bird assemblages and vegetation was done by MacArthur and MacArthur (1961). Many subsequent studies have been done in order to find out the relative significance of physiognomy versus species composition of the vegetation in avian community assemblage.

In earlier studies, some found physiognomy of vegetation to be more important determinant of avian assemblage than the floristics of the vegetation (Hilden, 1965; Weins, 1969; Anderson and Shugart, 1974) while in another studies floristics appears more significant (Weins and Rottenberry, 1981). These early studies had produced conflicting findings. Methodological challenges in

assessing the physiognomy of the vegetation (Weins and Rottenberry, 1981) and statistical challenges in predicting the makeup of avian groups based on floristics and physiognomy of vegetation (Muller et al., 2010) had hampered studies. These limitations have been lifted thanks to the recent development of many high-resolution remote sensing technologies. Muller et al (2010) used lidar (Airborne laser scanning) to measure vegetation structure and canonical correspondence and co-correspondence analysis to predict the composition of avian communities from species composition and structure of vegetation. In this study they found physiognomy to be more powerful determinant of avian community composition than floristics of vegetation.

The vegetation structure such as canopy openness, number of trees and even the depth of litter on the forest ground can affect avian community (Terborgh, 1985; Cintra et al., 2006). For foraging many species of birds require shady understory and areas having more trees provide more structural complexity sustaining many more species (MacArthur et al., 1996). Abundance of snags and tree logs may also offer more area for nesting and foraging, while providing specialist species a specific substrate (Adis, 1988). Abundance of plant litter is directly related to the abundance of large invertebrates and small vertebrates which is the prime food resource of birds (Adis, 1988). The diverse niches created by complex floristic composition also increases avian diversity (Diaz, 2006). The diverse tree species provide varied opportunities for nesting, shelter and foraging (Lee and Rotenberry, 2005). Any species of bird may appear or disappear and may increase or decrease with varying vegetation along different geographical gradients (Lee and Rotenberry, 2005).

3.2. Climate factors

Climate is an important driver of diversity patterns. The influence of climate can be either direct or indirectly via vegetation and resource availability (Ferger et al., 2014). The most studied climate variables are precipitation patterns, temperature and productivity.

(i) Temperature: Species diversity decreases with decreasing temperature (Gaston, 2000). Temperature is therefore vital for species diversity (Currie, 1991; Hessen, 2007). Many biological activities including growth rate to enzyme kinetics is dependent on temperature (Hessen et al., 2007). Temperature can affect animal's metabolic rate producing varying degrees of physiological response (Porter and Gates, 1969) such as birds lay earlier in the warm temperature (Visser et al., 2009). Temperature also affects community composition indirectly via changing vegetation (Delire et al., 2008).

(ii) Precipitation pattern: Precipitation influences food availability which ultimately determine avian assemblage and their distribution (Poulin et al., 1992; Hawkins et al., 2003). Precipitation patterns influence insect abundance and vegetation productivity (flower, fruit and seed production etc.), all of which are important food sources for many birds (Albright et al., 2010). Precipitation can directly affect avian populations through the offspring's survival as well as indirectly through blooming and fruiting of plant, availability or number of invertebrates and lastly through their effect on vegetation structure (Goncalves et al., 2017).

(iii) Seasonality: A season is a time of year that can be identified by unique climatic features. Spring, summer, autumn, and winter all occur in regular succession. Each season has recurring yearly cycles of light, temperature, and weather which affects vegetation structure. Through seasonal migration, seasonal resource availability, and seasonal habitat preferences, seasons affect the makeup of bird communities. In order to avoid harsh seasonal climate, migratory birds track their preferred seasonal climatic conditions (Joseph and Stockwell, 2000), resulting in seasonal changes in the composition of avian community in a particular habitat. Nearly 20% of all bird species migrate (Kirby et al., 2008). Thus, seasonality also has a significant impact on avian community composition.

(iv) Climate change: Climate change can cause changes in precipitation patterns and temperature causing rearrangement of different climatic zones resulting in the change of species geographical distribution as they track their optimal climatic area (Thomas et al., 2004; Peterson et al., 2002; Loarie et al., 2008). Species failing to keep up with the new ecological conditions may decline in population or even become extinct (Thomas et al., 2004). For example, warming of climate may push bird species to higher elevations and eventually shrink their habitats (Seimon et al., 2007; Peh, 2007). Rising sea levels will affect the bird diversity of coastal regions (Sekercioglu et al., 2012). Sea level rise can also transform wetlands areas into salt flats greatly degrading their ability to host many bird populations (Traill et al., 2009).

3.3. Elevation

Different biological communities are assembled at particular elevations as a result of complex biotic and abiotic forces working along elevation gradients. Mountains are very good natural system to study different biodiversity patterns along elevation gradients (Martin et al., 2021). Gradients of abiotic and biotic factors dispersed over mountain elevation determine community composition (Sanders and Rahbek, 2012; Laiolo et al., 2018; Martin et al., 2021).

Earlier, species richness is predicted to be inversely related with elevation as land area in higher mountains is generally smaller, isolated with simpler vegetation structure (MacArthur, 1972). However, later studies revealed four typical patterns: mid-elevation peak (humped-shape pattern), decreasing, low plateau with a peak at mid-elevation and low plateau (McCain, 2009). Birds displayed all four patterns (McCain, 2009) with 45% showing peak at mid-elevation, 25% decreasing, 15% low plateaus and lastly 14% low plateaus with middle elevation peaks (McCain and Grytnes, 2010). Although significant number of studies has been done on examining the patterns of biodiversity along different elevation gradients, understanding of the mechanism underlying these patterns has received less attention (Ding et al., 2021). Mountains with more precipitation tended to show monotonic decline in diversity, while mountains with less precipitation showed the mid-elevation peak (MacCain, 2009; Martin et al., 2021). Generally, at low elevation competition is considered to shape communities where densities and growth rate of population are higher (Machac et al., 2011).

3.4. Latitude and longitude

Majority of taxonomic groups exhibit a pattern of increasing species richness from high latitudes to the equator (Cardillo ,2002). This pattern is called latitudinal diversity gradient. This trend has been documented through empirical studies across different geographical locations and in variety of animals (Kinlock et al., 2017). Numerous hypotheses such as geographical area hypothesis, climate stability hypothesis, historical perturbation hypothesis, biotic hypothesis and species energy hypothesis have been put out to explain this pattern (Behera and Roy, 2019) but a universally acceptable answer has not been found yet (Cardillo, 2002).

Although, climatic gradients such as temperature and precipitation linked to coastal to interior lands may also result in a longitudinal pattern of biodiversity (Morse et al., 1993; Behera and Roy, 2019), longitude is rarely taken into account in studies of global biodiversity patterns (Proches et al., 2023).

3.5. Sunlight intensity

Rate of photosynthesis is determined by light intensity (Wimalasekera, 2019) and the rate of photosynthesis determines plants productivity. Due to the rotation of earth on its axis, solar insolation is not evenly distributed on it. Many animals are dependent on the productivity of primary producers for their sustenance. This is the reason for greater diversity in equatorial regions with light as compared to polar areas with reduced solar insolation (Hillbrand, 2004).

3.6. Soil quality

Avian community composition varies with soil pH and soil calcium (Pabian and Brittingham, 2012). The availability of soil calcium and pH are correlated with vegetation traits and invertebrate abundances (Bigelow and Canham, 2002; Hottop, 2002). Birds need a lot of dietary calcium to raise young and produce eggs successfully (Graveland and Van Gijzen, 1994). In calcium depleted

and acidic soils, calcium rich foods such as snails are less common. This reduces the amount of calcium available for birds (Hotopp, 2002). As a result, their eggs become thin or laid without eggshells (Graveland et al., 1994).

3.7. Biological interactions

Contrary to popular believe that biological interactions have a little impact on large scale distribution, biotic interactions have a significant impact on species distribution at global scales (Wisz et al., 2013). Biotic interactions such as competition, host-parasite interactions, resource-consumer interactions, predation, facilitation and mutualism affect spatial pattern of species (Van Dam, 2009; Bascompte, 2009). The geographical distribution patterns of species and their range can be determined by competition as in case of competitive exclusion (Wisz et al., 2013). Further, species richness and distribution pattern are also geographically correlated with the diversity of food plants (Kissling et al., 2007). So, biotic interactions could influence how a community is made up.

3.8. Anthropogenic activities and disturbances

Pollution, urbanisation and other disturbances brought about by humans can have a big impact on the makeup of bird communities. Due to increased human activity over the past few decades, the conversion of natural forests into semi-natural and artificial landscapes has accelerated (Xianwen and Hailong, 2002).

(i) Urbanization: Urbanization is mainly responsible for species decline (Mckinney, 2002). Natural habitats are fragmented, altered, or lost as a result of human activity (such as agricultural expansion, deforestation, and road construction) which alter species communities (DeClerk et al., 2010; Allen et al., 2019). Depending on how drastic the changes are to the landscape, different bird groups are affected.

The intermediate disturbance hypothesis states that where disturbance intensity is moderate, species diversity would be higher (Connell, 1978). As habitat changes at intermediate levels could increase environment heterogeneity, they provide more diverse habitats for more diverse species (Chapman and Reich, 2007). The way certain species respond to disturbance depends on the functional traits of that species (Neuchulz et al., 2011). For example, forest specialist appears more vulnerable to human impact and consequently generalist species might replace them in disturbed habitats (Peh et al., 2005; Farwig et al., 2008). Habitat generalists are common in human-dominated settings and may live in a variety of situations (Bonier et al., 2007; Aronson et al., 2016). Some specialists such as some large-bodied raptors and seed-eating birds are drawn to human-made landscapes and frequently found in agricultural lands with an abundance of cereals and open views (Benton et al., 2003; Bain et al., 2020).

But species vulnerable to human disturbances are also vulnerable to changes in the landscape brought on by humans (Bonier et al., 2007). The first bird taxa to vanish from human-modified habitats are often insectivorous birds (Stratford and Stouffer, 2015; Jarrett et al., 2021). Few species can persist in a certain level of disturbances created by humans (Peh et al., 2005) or may even benefit from it (Ranganathan et al., 2008). However, in many cases human disturbances decrease the species richness (Turner, 1996; Philpott et al., 2008).

(ii) Hunting: Hunting is another important anthropogenic factor as well affecting avian population dynamics. Hunting has been a source of sustenance from the very beginning of human history, and many traditional rural communities still engage in this practice (Jepson and Ladle, 2005; Shepherd, 2006; Bonta, 2008). Millions of birds die from illegal shooting each year in Europe, including species that are under strict protection or reintroduction programmes (Hernandez and Margalida, 2009; Smart et al., 2010) such as seabirds (Raine et al., 2013) and grouse (Rojas et al., 2011).

(iii) Other activities: Birds are also employed by human societies all throughout the world for a variety of different purposes, including adornment, folk medicine, and magic-religious practices (Kizungu et al., 1998; Constantino et al., 2008; Purnama and Indrawan, 2012). Wild birds are also caught and kept as pets due to their aesthetics or singing, contributing to the decline in their population size (IUCN, 2010). According to Brazil's Federal Police, the illegal trade of wild birds generates up to $3 million in revenue for those involved each year, and these birds are worth about $100 million in Europe (Interpol, 2010).

4. Conclusion

The composition of an avian community is determined by a large number of interconnected biotic and abiotic factors. Abiotic factors such as soil quality, height, latitude, longitude, sunlight intensity, and vegetation structure and floristics have a considerable impact on avian assembly. Biological interactions and anthropogenic disturbances are the biotic factors.

Avian communities are significantly shaped by both floristics and vegetation structure. However, vegetation structure is a stronger determinant than floristics. Climatic factors can have direct or indirect effect on avian community. The most important climatic variables are temperature, precipitation patterns and seasonality. The changes in climate also influence avian community resulting in rearrangement of their distribution patterns. Elevation has an impact on an avian community's composition as well. Biodiversity studies have recorded four patterns of biodiversity along elevation gradients. Community composition is also influenced by the latitude and longitude of the earth. However, longitudinal biodiversity pattern has not been studied as much as latitudinal biodiversity pattern. Generally, biodiversity is observed to increase from poles to the equator (latitudinal diversity gradient). As primary productivity is associated with sunlight availability, sunlight is also another critical factor. The composition of the avian community depends on the soil's condition, including its pH and calcium content. Predation, competition, mutualism etc. are important biotic interactions that influence avian community. Human activities such as urbanization, hunting and poaching etc. can also determine community assembly.

In order to ensure the continued sustenance of avian communities and the ecosystems they inhabit, a deeper knowledge of the drivers of avian community composition is vital. Such information is also vital for developing conservation strategies in a rapidly changing environment. Based on the results from previous studies, it can be concluded that the prevailing biotic and abiotic conditions of a particular area may be used to predict the composition of bird community which are likely to be found in that area. Therefore, assessment of degree of influence of each, these factors are also essential. However, aside from comparative research between floristics and physiognomy, the degree of influence exerted by each of these factors has not yet been investigated. More details about these factors and their degree of influence in shaping community composition may be obtained from a thorough examination of the trends in biodiversity over longitude.

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Author's contributions

The first author contributed in drafting of manuscript while the second author contributed in proofreading and finalization of the manuscript.

Conflict of interest

The authors declare that there is no conflict of interest.

References

Adis J. 1988. On the abundance and density of terrestrial arthropods in Central Amazonian dryland forests. Journal of Tropical Ecology 4(1): 19-24.

Albright TP, Pidgeon AM, Rittenhouse CD, Clayton MK, Flather C H, Culbert PD, Wardlows BD, and Radeloff VC. 2010. Effects of drought on avian community structure. Global Change Biology 16(8): 2158-2170.

Allen DC, Bateman HL, Warren PS, de Albuquerque FS, Arnett-Romero S, and Harding B. 2019. Long-term effects of land-use change on bird communities depend on spatial scale and land-use type. Ecosphere 10(11): e02952.

Anderson SH, and Shugart Jr HH. 1974. Habitat selection of breeding birds in an east Tennessee deciduous forest. Ecology 55(4): 828-837.

Aronson MF, Nilon CH, Lepczyk CA, Parker TS, Warren PS, Cilliers SS,and Zipperer W. 2016. Hierarchical filters determine community assembly of urban species pools. Ecology 97(11): 2952-2963.

Bain G C, MacDonald MA, Hamer R, Gardiner R, Johnson CN, and Jones ME. 2020. Changing bird communities of an agricultural landscape: declines in arboreal foragers, increases in large species. Royal Society Open Science 7(3): 200076.

Bascompte J. 2009. Mutualistic networks. Frontiers in Ecology and the Environment 7(8): 429-436.

Behera M D, and Roy PS. 2019. Pattern of distribution of angiosperm plant richness along latitudinal and longitudinal gradients of India. Biodiversity and Conservation 28: 2035-2048.

Benton T G, Vickery JA, and Wilson JD. 2003. Farmland biodiversity: is habitat heterogeneity the key? Trends in ecology & evolution 18(4): 182-188.

Bigelow SW, and Canham CD. 2002. Community organization of tree species along soil gradients in a north-eastern USA forest. Journal of Ecology 188-200.

Blackburn TM, and Gaston KJ. 1996. The distribution of bird species in the New World: patterns in species turnover. Oikos 146-152.

Bonier F, Martin PR, and Wingfield JC. 2007. Urban birds have broader environmental tolerance. Biology letters 3(6): 670-673.

Bonta M. 2008. Valorizing the relationships between people and birds: Experiences and lessons from Honduras. Ornitologia Neotropical 19(Suppl): 595-604.

Branton M, and Richardson JS. 2011. Assessing the value of the umbrella-species concept for conservation planning with meta-analysis. Conservation Biology 25(1): 9-20.

Cardillo M. 2002. Body size and latitudinal gradients in regional diversity of New World birds. Global Ecology and Biogeography 11(1): 59-65.

Chapman KA, and Reich PB. 2007. Land use and habitat gradients determine bird community diversity and abundance in suburban, rural and reserve landscapes of Minnesota, USA. Biological Conservation 135(4): 527-541.

Cintra R, Maruoka AE, and Naka LN. 2006. Abundance of two Dendrocincla woodcreepers (Aves: Dendrocolaptidae) in relation to forest structure in Central Amazonia. Acta Amazonica 36: 209-219.

Connell JH. 1978. Diversity in tropical rain forests and coral reefs: high diversity of trees and corals is maintained only in a nonequilibrium state. Science 199(4335): 1302-1310.

Constantino PDAL, Fortini LB, Kaxinawa FRS, Kaxinawa AM, Kaxinawa ES, Kaxinawa AP, Kaxinawa LS, Kaxinawa JM, and Kaxinawa JP. 2008. Indigenous collaborative research for wildlife management in Amazonia: The case of the Kaxinawa, Acre, Brazil. Biological Conservation 141(11): 2718-2729.

Currie DJ. 1991. Energy and large-scale patterns of animal-and plant-species richness. The American Naturalist 137(1): 27-49.

DeClerck FA, Chazdon R, Holl KD, Milder JC, Finegan B, Martinez-Salinas A, Imbach P, Canet L, and Ramos Z. 2010. Biodiversity conservation in human-modified landscapes of Mesoamerica: Past, present and future. Biological conservation 143(10): 2301-2313.

Delire C, Ngomanda A, and Jolly D. 2008. Possible impacts of 21st century climate on vegetation in Central and West Africa. Global and Planetary Change 64(1-2): 3-15.

Diaz L. 2006. Influences of forest type and forest structure on bird communities in oak and pine woodlands in Spain. Forest ecology and management 223(1-3): 54-65.

Ding Z, Hu H, Cadotte MW, Liang J, Hu Y, and Si X. 2021. Elevational patterns of bird functional and phylogenetic structure in the central Himalaya. Ecography 44(9): 1403-1417.

Farwig N, Sajita N, and Böhning-Gaese K. 2008. Conservation value of forest plantations for bird communities in western Kenya. Forest Ecology and Management 255(11): 3885-3892.

Ferger SW, Schleuning M, Hemp A, Howell KM, and Böhning-Gaese K. 2014. Food resources and vegetation structure mediate climatic effects on species richness of birds. Global Ecology and Biogeography 23(5): 541-549.

Gaston KJ. 2000. Global patterns in biodiversity. Nature 405(6783): 220-227.

Goncalves GSR, Cerqueira PV, Brasil LS, and Santos MPD. 2017. The role of climate and environmental variables in structuring bird assemblages in the Seasonally Dry Tropical Forests (SDTFs). PloS One 12(4): e0176066.

Graveland J, and Van Gijzen T. 1994. Arthropods and seeds are not sufficient as calcium sources for shell formation and skeletal growth in passerines. Ardea 55(1–2): 299-314.

Graveland J, Van Der Wal R, Van Balen JH, and Van Noordwijk AJ. 1994. Poor reproduction in forest passerines from decline of snail abundance on acidified soils. Nature 368(6470): 446-448.

Hawkins BA, Field R, Cornell HV, Currie DJ, Guegan JF, Kaufman DM, Kerr JT, Mittelbach GG, Oberdorff T, O'Brien EM, Porter EE, and Turner JRG. 2003. Energy, water, and broad-scale geographic patterns of species richness. Ecology 84(12): 3105-3117.

Hernandez M, and Margalida A. 2009. Poison-related mortality effects in the endangered Egyptian vulture (Neophron percnopterus) population in Spain. European Journal of Wildlife Research 55(4): 415-423.

Hessen DO, Bakkestuen V, and Walseng B. 2007. Energy input and zooplankton species richness. Ecography 30(6): 749-758.

Hilden O. 1965. Habitat selection in birds: a review. In: *Annales Zoologici Fennici* (Vol. 2, No. 1, pp. 53-75). Finnish Zoological and Botanical Publishing Board.

Hillebrand H. 2004. On the generality of the latitudinal diversity gradient. The American Naturalist 163(2): 192-211.

Hotopp KP. 2002. Land snails and soil calcium in central Appalachian Mountain Forest. Southeastern Naturalist 1(1): 27-44.

Interpol. 2010. Brazilian police target international wildlife smuggling network in Interpol-supported operation. Downloaded from http://www.interpol.int/Public/ICPO/PressReleases/PR2010/PR056.asp

IUCN. 2010. Red List of Threatened Species. Version 2010.3. http://www.iucnredlist.org

Jarrett C, Smith TB, Claire TT, Ferreira DF, Tchoumbou M, Elikwo MN, Wolfe J, Brzeski K, Welch AJ, Hanna R, and Powell LL. 2021. Bird communities in African cocoa agroforestry are diverse but lack specialized insectivores. Journal of Applied Ecology 58(6): 1237-1247.

Jepson P, and Ladle RJ. 2005. Bird-keeping in Indonesia: conservation impacts and the potential for substitution-based conservation responses. Oryx 39(4): 442-448.

Joseph L, and Stockwell D. 2000. Temperature-based models of the migration of Swainson's Flycatcher (Myiarchus swainsoni) across South America: A new use for museum specimens of migratory birds. Proceedings of the Academy of Natural Sciences of Philadelphia 293-300.

Kinlock NL, Prowant L, Herstoff E M, Foley CM, Akin-Fajiye M, Bender N, Umarani M, Ryu HY, Sen B, and Gurevitch J. 2018. Explaining global variation in the latitudinal diversity gradient: Meta-analysis confirms known patterns and uncovers new ones. Global Ecology and Biogeography 27(1): 125-141.

Kirby JS, Stattersfield AJ, Butchart SH, Evans MI, Grimmett RF, Jones VR, O'Sullivan J, Tucker GM, and Newton I. 2008. Key conservation issues for migratory land-and waterbird species on the world's major flyways. Bird Conservation International 18(S1): S49-S73.

Kissling WD, Rahbek C, and Böhning-Gaese K. 2007. Food plant diversity as broad-scale determinant of avian frugivore richness. Proceedings of the Royal Society B: Biological Sciences 274(1611): 799-808.

Kizungu B, Ntabaza M, and Mburunge M. 1998. Ethno-ornithology of the Tembo in Eastern DRC (former Zaire): part one, Kalehe zone. African Study Monographs 19(2): 103-113.

Laiolo P, Pato J, and Obeso JR. 2018. Ecological and evolutionary drivers of the elevational gradient of diversity. Ecology Letters 21(7): 1022-1032.

Lee PY, and Rotenberry JT. 2005. Relationships between bird species and tree species assemblages in forested habitats of eastern North America. Journal of Biogeography 32(7): 1139-1150.

Loarie SR, Duffy PB, Hamilton H, Asner GP, Field CB, and Ackerly DD. 2009. The velocity of climate change. Nature 462(7276): 1052-1055.

MacArthur RH. 1972. *Geographical Ecology: Patterns in the distribution of species*. Harper & Row Publishers Inc. New York, New York.

MacArthur RH. 1984. *Geographical ecology: patterns in the distribution of species*. Princeton University Press.

MacArthur RH, and MacArthur JW. 1961. On bird species diversity. Ecology 42(3): 594-598.

MacArthur R, Recher H, and Cody M. 1966. On the relation between habitat selection and species diversity. The American Naturalist 100(913): 319-332.

Machac A, Janda M, Dunn RR, and Sanders NJ. 2011. Elevational gradients in phylogenetic structure of ant communities reveal the interplay of biotic and abiotic constraints on diversity. Ecography 34(3): 364-371.

Martin K, Altamirano TA, de Zwaan DR, Hick K G, Vanderpas A, and Wilson S. 2021. Avian ecology and community structure across elevation gradients: The importance of high latitude temperate mountain habitats for conserving biodiversity in the Americas. Global Ecology and Conservation 30: e01799.

McCain C M. 2009. Global analysis of bird elevational diversity. Global Ecology and Biogeography 18(3): 346-360.

McCain CM, and Grytnes JA. 2010. Elevational gradients in species richness. eLS.

McKinney ML. 2002. Urbanization, Biodiversity, and Conservation.The impacts of urbanization on native species are poorly studied, but educating a highly urbanized human population about these impacts can greatly improve species conservation in all ecosystems. Bioscience 52(10): 883-890.

Morse LE, Kutner LS, Maddox GD, Honey LL, Thurman CM, Kartesz JT, and Chaplin SJ. 1993. The potential effects of climate change on the native vascular flora of North America. A preliminary climate envelopes analysis (No. EPRI-TR-103330). Electric Power Research Inst., Palo Alto, CA (United States); Nature Conservancy, Arlington, VA (United States); North Carolina Botanical Garden, Chapel Hill, NC (United States); Nature Conservancy, Minneapolis, MN (United States). Midwestern heritage Task Force.

Muller J, Stadler J, and Brandl R. 2010. Composition versus physiognomy of vegetation as predictors of bird assemblages: The role of lidar. Remote Sensing of Environment 114(3): 490-495.

Murgui E. 2014. When governments support poaching: a review of the illegal trapping of thrushes Turdus spp. in the parany of Comunidad Valenciana, Spain. Bird Conservation International 24(2): 127-137.

Neuschulz E L, Botzat A, and Farwig N. 2011. Effects of forest modification on bird community composition and seed removal in a heterogeneous landscape in South Africa. Oikos 120(9): 1371-1379.

Pabian SE, and Brittingham MC. 2012. Soil calcium and forest birds: Indirect links between nutrient availability and community composition. Ecosystems 15: 748-760.

Peh KS. 2007. Potential effects of climate change on elevational distributions of tropical birds in Southeast Asia. The Condor 109(2): 437-441.

Peh KSH, de Jong J, Sodhi NS, Lim SLH, and Yap CAM. 2005. Lowland rainforest avifauna and human disturbance: persistence of primary forest birds in selectively logged forests and mixed-rural habitats of southern Peninsular Malaysia. Biological Conservation 123(4): 489-505.

Peterson AT, Ortega-Huerta MA, Bartley J, Sánchez-Cordero V, Soberón J, Buddemeier RH, and Stockwell DR. 2002. Future projections for Mexican faunas under global climate change scenarios. Nature 416(6881): 626-629.

Philpott SM, Arendt WJ, Armbrecht I, Bichier P, Diestch TV, Gordon C, Greenberg R, Perfecto I, Reynoso-Santos R, Soto-Pinto L, Tejeda-Cruz C, Williams-Linera G, Valenzuela J, and Zolotoff J M. 2008. Biodiversity loss in Latin American coffee landscapes: review of the evidence on ants, birds, and trees. Conservation Biology 22(5): 1093-1105.

Porter WP, and Gates DM. 1969. Thermodynamic equilibria of animals with environment. Ecological Monographs 39(3): 227-244.

Poulin B, Lefebvre G, and McNeil R. 1992. Tropical avian phenology in relation to abundance and exploitation of food resources. Ecology 73(6): 2295-2309.

Proches S, Watkeys MK, Ramsay LF, and Cowling RM. 2023. Why we should be looking for longitudinal patterns in biodiversity. Frontiers in Ecology and Evolution 11: 1032827.

Purnama S, and Indrawan M. 2012. Entrapment of wetland birds: local customs and methods of hunting in Krangkeng, Indramayu, Central Java. In: *Ethno-ornithology* (pp. 89-94). Routledge.

Raine AF, Borg JJ, Raine H, and Phillips RA. 2013. Migration strategies of the Yelkouan Shearwater Puffinus yelkouan. Journal of Ornithology 154: 411-422.

Ranganathan J, Daniels RR, Chandran MS, Ehrlich PR, and Daily GC. 2008. Sustaining biodiversity in ancient tropical countryside. Proceedings of the National Academy of Sciences 105(46): 17852-17854.

Rojas M, Gonzalez I, Pavon MA, Pegels N, Hernandez PE, Garcia T, and Martin R. 2011. Development of a real-time PCR assay to control the illegal trade of meat from protected capercaillie species (Tetrao urogallus). Forensic Science International 210(1-3): 133-138.

Rosenzweig ML. 1992. Species diversity gradients: we know more and less than we thought. Journal of Mammalogy 73(4): 715-730.

Sanders NJ, and Rahbek C. 2012. The patterns and causes of elevational diversity gradients. Ecography 35(1): 1.

Seimon TA, Seimon A, Daszak P, Halloy SR, Schloegel LM, Aguilar, CA, Sowell P, Hyatt AD, Konecky B, and Simmons JE. 2007. Upward range extension of Andean anurans and chytridiomycosis to extreme elevations in response to tropical deglaciation. Global Change Biology 13(1): 288-299.

Sekercioglu C H. 2006. Increasing awareness of avian ecological function. Trends in ecology & evolution, 21(8), 464-471.

Sekercioglu CH, Primack RB, and Wormworth J. 2012. The effects of climate change on tropical birds. Biological Conservation 148(1): 1-18.

Shepherd CR. 2006. The bird trade in Medan, North Sumatra: an overview. BirdingASIA 5 (2006): 16-24.

Smart J, Amar A, Sim IM, Etheridge B, Cameron D, Christie G, and Wilson JD. 2010. Illegal killing slows population recovery of a re-introduced raptor of high conservation concern–the red kite Milvus milvus. Biological Conservation 143(5): 1278-1286.

Stratford JA, and Stouffer PC. 2015. Forest fragmentation alters microhabitat availability for Neotropical terrestrial insectivorous birds. Biological Conservation 188: 109-115.

Terborgh JOHN. 1985. Habitat selection in Amazonian birds. In: Cody ML (Ed.) *Habitat selection in birds, pp.* 311, 338.

Thomas CD, Cameron A, Green RE, Bakkenes M, Beaumont LJ, Collingham YC, Eramus BFN, De Siqueira MF, Grainer A, Hannah L, Hughes L, Huntley B, Van Jaarsveld AS, Midgly GF, Miles L, Ortega-Huerta MA, Peterson AT, Philips OL, and Williams SE. 2004. Extinction risk from climate change. Nature 427 (6970): 145-148.

Traill LW, Bradshaw CJ, Field HE, and Brook BW. 2009. Climate change enhances the potential impact of infectious disease and harvest on tropical waterfowl. Biotropica 41(4): 414-423.

Tu HM, Fan MW, and Ko JCJ. 2020. Different habitat types affect bird richness and evenness. Scientific Reports 10(1): 1221.

Turner IM. 1996. Species loss in fragments of tropical rain forest: a review of the evidence. Journal of Applied Ecology: 200-209.

Van Dam NM. 2009. How plants cope with biotic interactions. Plant Biology 11(1): 1-5.

Visser ME, Holleman LJ, and Caro SP. 2009. Temperature has a causal effect on avian timing of reproduction. Proceedings of the Royal Society B: Biological Sciences 276(1665): 2323-2331.

Whelan CJ, Sekercioglu CH, and Wenny DG. 2015. Why birds matter: from economic ornithology to ecosystem services. Journal of Ornithology 156: 227-238.

Wiens JA. 1969. An approach to the study of ecological relationships among grassland birds. Ornithological Monographs (8): 1-93.

Wiens JA, and Rotenberry JT. 1981. Habitat associations and community structure of birds in shrubsteppe environments. Ecological monographs 51(1): 21-42.

Wimalasekera R. 2019. Effect of light intensity on photosynthesis. Photosynthesis, Productivity and Environmental Stress 65-73.

Wisz MS, Pottier J, Kissling WD, Pellissier L, Lenoir J, Damgaard CF, Dormann CF, Forchhammer MC, Grytnes JA, Guisan A, Heikkinen RT, Hoye TT, Kuhn I, Luoto M, Maiorano L, Nilsson MC, Normand S, Ockinger E, Schmidt NM, Termansen M, Timmermann A, Wardle DA, Aastrup P, and Svenning JC. 2013. The role of biotic interactions in shaping distributions and realised assemblages of species: implications for species distribution modelling. Biological Reviews 88(1): 15-30.

Xianwen J, and Hailong W. 2002. Wild Animal resources and its management in the south of Anhui province. Journal of Huaibei Teachers College (supported by Coal Industry) 23(2): 51-54.