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Birds as Indicators of Active Restoration in the Western Ghats

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Review Article

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ABSTRACT

The birds present in an area help in the up-grading the normal biodiversity. They portray the regular environmental factors of that particular area. They have always been considered as natural indicators of environmental change. They help in seed scattering, which aids in the germination of new trees that assist us with looking into the botanical variety of a specific region. Assuming we change the infertile grounds into forested regions by establishing trees, the birds are the initial ones to arrive at and occupy the area. The animals, especially the birds, are threatened by the changing environmental conditions. Moreover, they are the initial ones to get impacted. The birds select their

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habitats depending on their size, how they build their homes, and food propensities. Due to land use by humans, the habitat occupied by birds is subjected to fragmentation. The bird populations start getting isolated. In these isolated populations, many genetic changes take place that changes the wild gene pool into something different. This review paper deals with how effective birds are as indicators of restoration and the need to conserve the biodiversity of the Western Ghats.

Keywords: Biodiversity conservation; Western Ghats; active restoration; forest recovery; fragmentation; avifaunal restoration; ecological indicators.

1. INTRODUCTION

The earth, our home, is where animals, plants and human civilizations thrive together. But, over many years, the earth and its extensive flora and fauna have been facing problems from the encroachment of human activities. Many species have long become extinct, and some are on the verge of extinction. Most highly diversified countries, especially in species richness, are found in and around the tropics [1]. There is also the presence of economically backward countries in the tropics. So, they depend solely on nature for their livelihood. This puts tremendous pressure on the local flora and fauna. Class Aves constitute the warm-blooded vertebrates, characterized by their flight capability and other adaptations that let them occupy a wide range of ecosystem positions. Birds play a key role in making a region floristically diverse by seed dispersal [2]. The changes in vegetation in an ecosystem affect its fauna; thus, many species of fauna can be considered as bioindicators, especially birds. The research article on the topic "Active restoration fosters better recovery of tropical rainforest birds than natural regeneration in degraded forest fragments" by Hariharan and Raman (2022) [3] deals with birds as indicators of active restoration in and around the southern regions of Western Ghats, particularly in the Annamalai hills, that lies within the 220 km^2 Valparai plateau and rainforests adjoining the 985 km^2 Annamalai tiger reserve [3,4]. Furthermore, birds are also indicators of changes in vegetation type, forest fragmentation, urbanization patterns, climate changes, migration patterns and many other happenings that disturb the balance of the ecosystem.

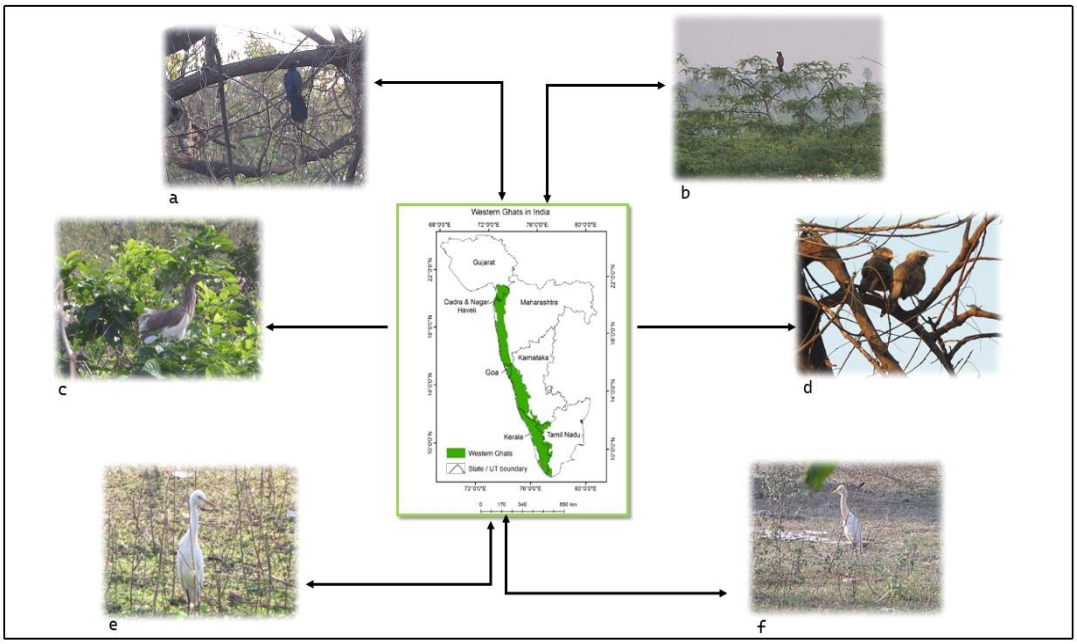

Fig. 1. An image showing the Western Ghats map and the following birds present there (a) *Eudynamys scolopaceus* (b) *Acridotheres tristis* (c) *Ardeola grayii* (d) *Argya caudata* (e) *Ardea intermedia* (f) *Bubulcus ibis*

2. FOCUSING ON THE WESTERN GHATS

Many national and international programs have been started for biodiversity conservation. IUCN is one organization founded in 1948 that deals with conservation and sustainable development strategies. It also publishes a Red List of threatened species known as IUCN Red list or Red data book comprising a list of threatened species and species at risk of endangerment.

Based on the Red List of IUCN and because it deals with most of the vulnerable and critically endangered species, 34 regions of the world had been identified as biodiversity hotspot [4]. Later, the 35th hotspot, that is the forests of East Australia were added [5]. Hotspots are those areas that contain the presence of one or more endangered species which need special protection. The concept of 'biodiversity hotspot' was put forward by Myers [6]. Four out of 35 hotspots are present in India: Indo-Burma hotspot, Himalaya hotspot, Western Ghats-Sri Lanka hotspot and Sundaland hotspot [4]. The Western Ghats Mountain ranges is one of the top global biodiversity hotspots that stretches along the south-western border of the Indian peninsula [7]. The main reason why many varieties of flora and fauna are favouring it is because of its strategic location and the combination of geographic and climatic features [8].

The altitudinal variation is combined with plain tropical areas and coastal plains. This provides for various geographic contours like mountains, grassy plains, coasts, etc. Hence, it supports the existence of diverse fauna and flora and even many endemic species [9]. Looking into the formation of the Western Ghats, the Indian peninsula was formed of rocks when all the land masses formed a single continent called Gondwana millions of years ago [10]. After separation from the African continent, the Indian peninsula drifted northwards and hit the Asian subcontinent which led to the formation of the Himalayas [Himadri]. On the western side, upliftment of landmass led to the formation of a mountain range called Sahyadri, now called the Western Ghats [11]. The Western Ghats form almost parallelly to the Arabian Sea. Researches in these coastal areas showed the presence of molluscan shells in the primitive soil, indicating that this area would have been submerged under water a few millennium ago [12-14]. The Western Ghats were first inhabited by people in the Paleolithic era, 12000 years ago. These people were hunters and gatherers and would not have caused many problems to the surrounding vegetation. With the advent of the Mesolithic era 12000-5000yrs, a transition was observed in the pattern of humans, where they started growing their own food [14-17]. Due to these practices, the forest areas were disturbed, which led to changes in the region's climatic conditions. The experiments conducted in the Nilgiris by Sukumar et al. (1993) [10] found that during 6000-3500 years, there was a shift in the type of vegetation. The C3 plants that were originally growing were lost and were changed by C4 plants. The speciality of C3 plants is that they grow in moist conditions, whereas C4 plants grow in arid conditions. This proved that there was the shift in vegetation due to climatic changes [18-20].

There are 26 different bird species that are endemic to the Western Ghats which have been recognised by the IUCN Red List of threatened species [15,21]. Black-and-rufous flycatcher (*Ficedula nigrorufa*), Malabar wood shrike (*Tephrodornis sylvicola*), Malabar grey hornbill (*Ocyceros griseus*), Nilgiri wood pigeon (*Columba elphinstonii*), Kerala laughingthrush (*Trochalopteron fairbanki*), Grey-headed bulbul (*Pycnonotus priocephalus*) are a few among them [22]. However, these areas are being driven by population increase threats. Humans have greatly encroached into these territories, mainly affecting the bird population [23]. Since birds have always been considered as the natural indicators of climatic change, the increasing temperatures due to deforestation and other events are changing the residing habitats of birds, migration patterns, etc. [24]. The effect of this pressure exists mostly along the region where tea cultivation is common which is the main reason for the fragmentation of the native vegetation [25]. Tiny, isolated protected areas in Western Ghats are interspersed among various land uses, the majority of which comprise agro-forests [26]. In these small pockets, animals like leopards, elephants, etc., and humans reside together. This leads to unnecessary competition between the two species [27]. Biological restorations have been started in some areas of the Western Ghats to avoid these problems [28]. Three different study conditions of restoration were considered [28-30].

- Active restoration: Active removal of weeds and leaving only the plants found in the rainforests.

- They are naturally regenerating: All plants were allowed to grow along with the weeds.
  • Undisturbed benchmark rainforests kept as reference

In this study, researchers examined actively restored forest areas and naturally regenerating forest areas. Twenty-three different sites of each type were studied, and 23 undisturbed benchmark rainforests were kept as references. They were able to find out the preference of birds; that is, benchmark and active restoration areas favoured more rainforest species, and the naturally regenerating areas favour more open country birds. It also showed how the vegetation affected the type of bird species found in the area [28].

3. BIRDS BEING INDICATORS

Diverse according to their ecological characteristics, such as body size, home range size, food niche, and site fidelity, species living in the Western Ghats select different landscapes for their habitat [29]. Due to human meddling, the Western Ghats's tropical rainforests are gradually losing their richness of specialised and indigenous species of birds to the more generalist and ubiquitous birds [30-32]. In Southern parts, the Ghats are heavily utilised due to the practice of turning the natural forests into plantations. This change in vegetation type may have rendered the area less suited for a particular species while it makes some other species to fit well in that atmosphere [33]. Monocultures result in localised species extinctions and a decline in species diversity [34]. Loss in the habitation and separation are the main driving force of loss in the diversity of life. Due to this, there are many carbon emissions happening that are responsible for global warming [35-38]. Rainforest rehabilitation could be done through particular rainforest species plantations and the pruning of unnecessary climbers that inhibit plant growth [39]. On the other hand, it was found that the measures used for making the biodiversity grow more are responsible for carbon emission or increasing carbon stock, which adversely affects biodiversity [40]. This fragmentation of the environment causes variations in habitat structure and resource availability [41]. Essential food resources cause species abundance in the altered environment and seasonal variations. Due to reduced temperature seasonality in the tropics, bird species of such areas exhibits a narrow thermal niche which can affect their distribution shift in response to climate change [42-45]. Generally, birds of forest habitats have a narrow niche where they tend to live in the forest, whereas the species in other habitat types have broader niches [46].

Western Ghats is one of the biodiversity hot spots where the population of human densities is high and has faced a higher percentage of depletion in size of the forest [47]. The Spread of plantations has become a significant cause of forest fragmentation that the species can survive in the clefts of the forest, and the survival is based on the habitat in their surroundings [48]. Plantations, including land fragments adjacent to greater tree canopy have found, more favourable habitats for both rainforest birds and open country birds in the Western Ghats [49]. Bird community composition positively correlates with the species residing on the trees of such area. The prolongation of such habitat's aids in the conservation of bird species of that area [50]. Studies have shown that agroforestry plantations and secondary successional forests changes the constitution of bird species compared to ancient forests [51]. Different bird species of a particular community will affect habitat alteration differently. Habitat fragmentation can retard the migration of species and their capability to withstand the environmental crisis. This is because habitat quality and species composition greatly affect

Table 1. Table depicting the different species of birds found in the 3 types of study areas [3]

Type of study area	Species found
Benchmark site	*Cyornis pallidipes* *Hypothymis azurea* *Acritillas indica*
Benchmark + Actively regenerating sites	*Muscicapa muttui* *Phylloscopus nitidus* *Leptocoma minima*
Actively regenerating + Naturally regenerating sites	*Pycnonotus jocosus* *Orthotomus sutorius*
Naturally regenerating	*Acrocephalus dumetorum* *Cinnyris asiaticus*

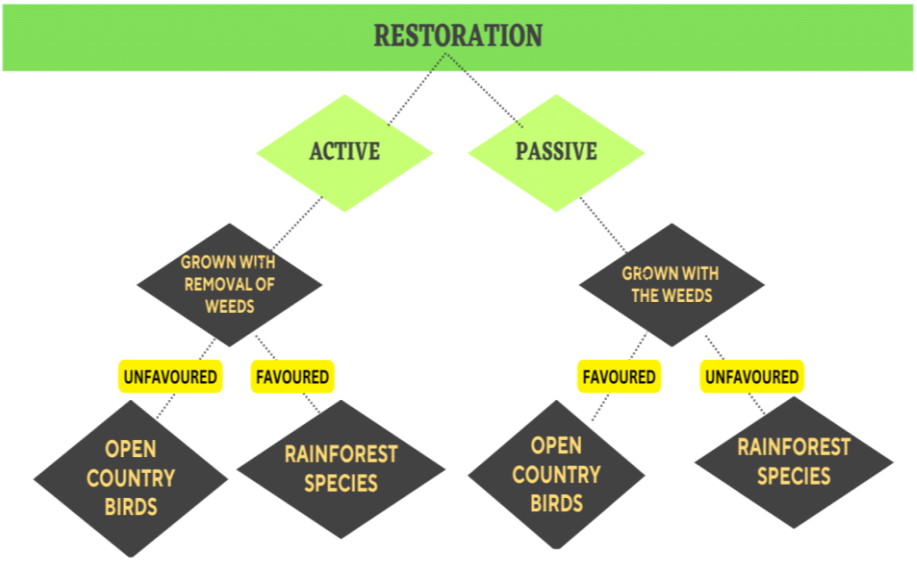

Fig. 2. Flowchart showing the relation of birds and restoration methods

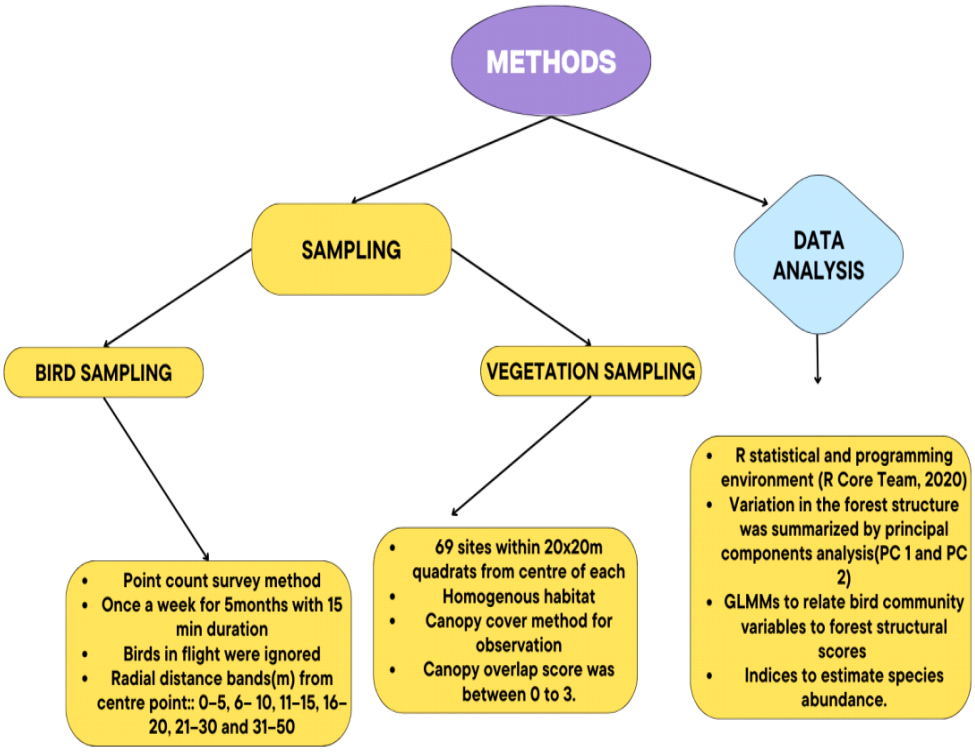

Fig. 3. Due to the positive correlation between open-country species and Principal Component 1, places with lower levels of variety in tree richness, tree density, vertical stratification, basal area, and canopy covering have been observed to have more open-country bird species. According to a negative association with main component 1, more mid-storey and canopy bird species have been discovered in areas with higher tree species richness, canopy covering, vertical stratification, and tree density. The quality of the environment is significantly impacted by the availability of food, which is influenced by vegetation structure [7]

Table 2. Different Forest types and the distinct vegetation found in that area [27]

Elevation types	Forest types	Climatic conditions		Characteristic vegetation
		Annual rainfall	Mean temperature(ºC)	
Low elevation types	DKS [*Dipterocarpus indicus – Kingiodendron pinnatum – Strombosia ceylanica*]	2000 – 5000mm	23 – 31	The plant species that gives the name to the forest type are found abundantly in this region. *Kingiodendron pinnatum* is the dominant species found in the region. This forest type is divided into 2 types based on the vegetation found like *Hopea* spp. Those are a rare species found. Also Myristaceae family found in the swamps and mangroves regions.
	DDS [*Dipterocarpus indicus – Dipterocarpus bourdilloni – Strombosia ceylanica*]	2000 – 5000mm	23 – 31	*Kingiodendron pinnatum* replaced by *Dipterocarpus bourdilloni*, which became the dominant species there. Formed of disturbed forests. This type is found among the secondary moist deciduous forest and as degraded stages represented by thickets.
Medium elevation types [800-1450m]	CMPG [*Cullenia exarillata – Mesua ferrea – Palaquiun ellipticum – Gluta travancorica*	2000 – 5000mm	19 – 25	In both the forest types, *Cullenia exarillata* is the most common species found. Characterized by an abundance of gymnosperm tree species
	CMP [*Cullenia exarillata – Mesua ferrea – Palaquiun ellipticum*	2000 – 5000mm	19 – 25	Highly fragmented, in the form of thickets and savannas.
High elevation types [1400-1800m]	BGL [*Bhesa indica – Gomphandra coriacea – Litsea* spp.	3000 – 5000mm	16 – 20	Found in high elevations. Also drop in mean temperature observed. Low elevation species disappeared.

population responses to climatic events [52]. Forest structure plays a vital role in the traits of the birds during rehabilitation. Based on the vegetation successional stage, there will be a change in the composition of the assortment of birds [53]. This fact can be utilized to consider birds as biological gauge for monitoring the ecosystems under restoration [54]. So, alterations in rehabilitated forests can affect bird species taxonomic and functional composition [55]. The native shade trees grown within the tea plantations help in bird conservation. This is because of the dependency on trees for nest building and food. However, recent studies indicate a wide range of decline in the bird population in the Western Ghats [52-56].

4. BIRDS AND RESTORATION

The birds are the first ones to inhabit a particular barren geographical area. They are fascinating examples of animal migration and can cover any barrier and cross any gap in the necessity of migration. Birds settle where it is most suitable for their particular vegetation zone [57]. Any plant species can be prevented from supporting bird colonies by frequent disturbances. Any creature that finds ample of food in its habitat eventually depends on that particular habitat. Species of birds from each vegetation have been classified based on their preferred foods, habitats, and geographic distribution across the nation [58]. Identifying regions for bird conservation by classifying birds as unfamiliar to any specific environment is a highly useful task. It is anticipated that both site-specific features and characteristics of the topography in which a revegetation site is found would affect how effectively revegetation provides habitat for fauna [59]. Forest structure can also be used as a continuous predictor variable while estimating the taxonomy of the birds in restoration sites. Species with varying levels of reliance on forests forage in various strata. Since birds have high geographical mobility, it is possible to separate the arrangement of the trees in the forest from those of spatial obstacles to the movement of the birds to sites undergoing restoration [60].

5. CONCLUSION AND FUTURE PERSPECTIVES

Forest fragments are essential havens for rainforest birds despite degradation and ongoing human pressure, with their species richness roughly equivalent to continuous forest environments. So, in addition to restoring avian variety in the fragmented forest, we should promote bird survival. Biological indicators can mark the rate and pace of ecological restorations. Active restoration of degraded forests often aids the recolonization of fauna which further will allow better vegetation recovery. The ability of restored areas to support the faunal diversity like the native state has been observed to show varying results. Ecological restoration is major key to mitigating adverse effects of climate change and biodiversity loss. So, it is inevitably important to have biological strategies to observe, interrupt and modify the methods to develop sustainable ecological restorations.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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