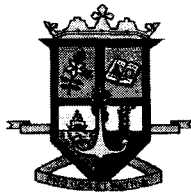


**BIRD COMMUNITIES IN THE FOREST
HABITATS OF WAYANAD,
SOUTH INDIA**

*Thesis submitted in partial fulfillment of the requirements for
the award of the degree of Doctor of philosophy (Ph.D.) to the
University of Calicut*

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Certificate

This is to certify that this thesis entitled "**Bird communities in the Forest Habitats of Wayanad, South India**" is an authentic record of the bonafied research work carried out by Sri. Antoney P.U. from April 1999 to November 2005 under our supervision and guidance; in partial fulfillment of the degree of **Doctor of Philosophy (Ph. D.)** in the faculty of Science of the University of Calicut. No part of this thesis has been presented for any other degree. We also certify that Sri. Antoney P.U. has passed the Ph. D. preliminary qualifying examination held in December 2001.



Dr. V. J. Zacharias
Research Guide

Dr. T. M. Benny
Co-Guide

Declaration by Candidate

I (Antoney P.U.) hereby declare that this thesis entitled “**Bird communities in the Forest Habitats of Wayanad, South India**” is an authentic record of the bonafied research work carried out by me from April 1999 to November 2005 under the supervision and guidance of Dr. V. J. Zacharias (Research Guide) and Dr. T. M. Benny (Co-Guide); in partial fulfillment of the degree of **Doctor of Philosophy (Ph. D.)** in the faculty of Science of the University of Calicut. No part of this thesis has been presented for any other degree/diploma.

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Abstract

The shifting cultivation in Wayanad mostly contributed to the destruction of natural vegetation cover in Wayanad. Increased specialization in farming as a result of post war revolution resulted in the loss of diversity of farming practices. Large scale use of pesticides and chemical fertilizers has resulted in the disappearance of several bird species from the cultivated lands of Wayanad. Bird species diversity is related to the structure of habitat, environmental productivity, environmental stability and the available size range of prey. It is also influenced by the extent and fragmentation of mature forest and the landscape level (Cushman and Mc Garigal, 2003). Fragmentation is occurring at a rapid rate in tropical forests causing a tremendous loss of biodiversity. Pristine forests are being replaced by scrubs, grassy plateau, scattered trees, cultivations and village environs. A study of changes in community structure along continuously changing gradients can answer many of the questions regarding community ecology. A comprehensive study on the natural and man made vegetations of Wayanad district in South India was undertaken to determine the extent of forest fragmentation; its impact on bird community structure and to suggest remedial measures and strategies for conservation of birds in the fragmented habitats and human habitations. Conservation of high elevation areas in the Western Ghats and maintenance of tree species against habitat alteration due to large scale tea plantations in the slopes are important for bird conservation particularly endemics in these rain forests. It is crucial to combine coffee tracts with companion tracts of remnant forests in order to maintain healthy bird populations (Beehler, Krishna Raju & Sahid, Ali 1986). The land under Coffee plantation serves as additional useful foraging habitat to birds that are primarily forest dwelling and whose populations might decline or disappear in the absence of their primary habitat. Nesting and foraging habitats are also provided by the pepper, rubber plantations etc. Coconut, arecunut, and banana plantations attract nectarivores also. The extensive Paddy fields seem to harbour several wet land birds.

1. Introduction

1.1 RELEVANCE OF COMMUNITY ECOLOGY:

Ecological investigations on various organisms are essential to formulate proper management plans for Protected Areas. In the light of global onslaughts on natural habitats and the surge of interest in conserving the diversity of life on earth; biological communities represent useful foci for conservation research and action. The fundamental aspect of the study of communities is the description of the species they include, the abundances of these species, ranging from common to the rare and variations in these attributes over space and time- what may be called the *pattern* of community structure. Historically much of the theoretical work, empirical analysis and debates in community ecology have focused on determining if these patterns are predictable results of any underlying factor or ecological *process*. The main debate in community ecology is regarding the true nature, stability, and predictability of community structure. There are two opposing views about this. One view is that the structure of a community always attains 'equilibrium' with a certain number of species and fixed relative abundances. Another view states that such constancy is rare in nature and communities are in a state of non-equilibrium because of random fluctuations in the numbers, kinds and abundances of species. An intermediate possibility is what has been called *dynamic equilibrium* where the number of species is expected to remain constant at equilibrium because of a perfect balance between immigration and extinction of species. When the number of new species arriving and the number of existing species going extinct are equal, there is no change in

the total number of species in the area, although the species composition is dynamically changing all the time. A study of changes in community structure along continuously changing gradients can answer many of the questions regarding community ecology. These gradients may extend over time, space, or along altitudinal gradient.

1.2 SIGNIFICANCE OF AVIAN STUDIES:

The health of an ecosystem can perhaps be best assessed by the species of birds present in it. Among all known terrestrial vertebrates birds are the richest in species. How ever individual species differ in their responses to human disturbances and therefore communities which represent sets of species enable a better and more holistic assessment of the effects of various disturbances. Any scheme for the protection of wild life would be incomplete without due provision for the protection of birds. Quite apart from a sentimental value, birds render incalculable service to man. While certain species may damage crops, such harm as is done by birds is overwhelmingly offset by the benefits we derive from them. Through their sheer diversity, numbers, mobility and functional roles as predators, prey and dispensers of pollen and plant seed, are necessary for the survival of natural ecosystems. Without their protection, our crops, our orchards our food supplies would be devoured or destroyed by hordes of ravaging insects. Birds are the principal agency that controls the bewildering multiplication of insect life; which if unchecked, would overwhelm all life forms on this planet. Birds by reason of their predominating insect food are an indispensable balancing force in nature. The abundant bird life of this country is one of its valuable possessions. Those who appreciate its value cannot but strive for its conservation. It is time that measures were taken for the protection of birds in land under cultivation and even in urban areas. Due to their remarkable utility as biological 'thermometers' or indicators the study of changes in communities of birds has given us great insights in the related fields of conservation biology. Many ecological processes interact to determine the structure of bird communities; presenting a provocative field of inquiry aimed at probing and establishing the relative influence of different factors.

1.3 BACKGROUND:

Various aspects of avian communities in the temperate and neo tropical forests were studied extensively and intensively by Terborgh (1971, 1977, 1980, 1985a, 1985b.), Karr (1971, 1976a, 1976b, 1981, 1982), Robinson and Holmes (1982, 1984), Thiollay (1994), Munn and Terborgh (1979) and Munn (1985). These studies have shown that bird species diversity was related to the structure of habitat. Pioneer studies carried out by Mac Arther and Mac Arther (1961) in North Eastern United States have shown that bird species diversity could be best predicted in terms of the height profile of the vegetation. Subsequent studies by Recher (1969) in Australia and Cody (1970) in Chile have supported the above findings. Further Recher (1971) has demonstrated that bird species diversity was clearly related to the environmental productivity, environmental stability and the available size range of prey. Holmes et. al. (1979) have shown that bird community composition within and between forest habitats is largely dependant on the physical structure of the vegetation, the kind of distribution of the foraging substrates and the availability and abundance of insect resources, all of which are influenced by the species composition of plant community. Birds might use the same resources in the same way but at different times of the year or at different times of the day (Cody 1974).

Recent studies mention that bird community was influenced by, both the extent and fragmentation of mature forest and the landscape level (Whitcomb, et. al. 1981) (Kattan et al.,1994), (Laurance et. al., 1997) (Stratford, 1999), (Sekercioglu., 2002). Further, species richness and diversity responded more strongly to mature forest area (Saunders, 1989), (Simberloff, 1994) than to fragmentation and were significantly lower in landscapes that were completely dominated by mature forests than in landscapes with a mixture of several stages. Climate is the primary environmental factor that determines the distribution pattern of all life forms. Birds reach the highest levels of diversity in the zones of maximum rain fall.

When compared with temperate habitats only fewer studies were carried out in tropical habitats. Notable among them include those by Orians (1969), Karr (1976a), Fogden (1972), and Yorke (1984). Tropical areas have substantially greater diversities than

temperate ones of the same size (Karr 1971). Tropical diversity would be a response to increased patchiness or final habitat selection by birds. The greater bird diversity of the tropics appears to result from a combination of increased specialization in resource utilization and increased habitat complexity. Since early studies of Mac Arthur and his co-workers, on avian community diversity, it has been clear that the precision of correlations between habitat and avian diversity is tied to the varying availability and exploitation of substrates, food types and other resources among habitats. According to Karr (1976b), seasonal variation in avian community structure decreases with increasing vegetation complexity. Many tropical species are able to survive as a result of their ability to switch among food resources (Karr 1976b).

One major advantage of bird community study and estimating abundance of avian species in forested habitats is that similar studies when repeated after several years could help in assessing the status of bird species themselves. The study could also help in understanding changes taking place in the habitat and how that changes influence the composition of bird fauna. In fact, such time span studies are rare in India. In India ecological studies on birds have been conducted by Ripley (1978), Gaston (1978, 81), Price (1979), Palat (1985), Beehler et. al (1986), Daniels (1989), Zacharias and Gaston (1993) Pramod (1994), Shankar Raman (2001) etc. These studies have given baseline data on bird communities in certain habitats in India which could be used for future comparison.

1.3.1 RELATION BETWEEN FOREST AREA AND BIRD SPECIES:

Many studies on the effects of forest fragmentation on plants and animals have examined the relationship between forest area and species number (E.g. Kitchener et. al 1980, Burgess & Sharpe 1981; Weaver and Kellman, 1981). For birds, smaller forests have fewer species than larger forests (Moor & Hooper, 1975; Galli et al, 1976; Martin, 1980; Willis 1980; Ambuel and Temple, 1983; Woodhouse 1983; Blake & Karr, 1984)). Lynch & Whigham (1984), Ford (1987), Fuller (1987) and Williams (1964) suggested that a larger area supports more species because it contains a greater diversity of habitat types. A more heterogeneous forest for example could support more bird species because of different preferences among species for habitats with particular vegetation structure

and/or composition (cf. Pitelka 1941, James 1971; Holmes and Robinson, 1981). Species could also couple habitat types within heterogeneous forests to meet seasonal requirements (e.g. Root, 1967, Rice et. al, 1980) or to obtain their needs as conditions vary within habitats over an extended period of time (e.g. Karr & Freemark 1983). Greater habitat heterogeneity has been related to more bird species on islands (Power 1976, Reed 1983) and mountains (Johnson 1975, Thompson 1978).

1.3.2 IMPACTS OF FRAGMENTATION:

The largest single problem that causes conservation problems is habitat loss (Orians 1969). Forest fragmentation is occurring at a rapid rate in tropical forests **causing a tremendous loss of biodiversity**. When forests die, traditions and livelihoods vanish. Humans have utilized large fractions of land surface for agriculture. Of the remaining areas, many have been fragmented or broken up into small patches. Human activities in an ecosystem result in restructuring of its communities. However, the influence differs in different ecosystems (Brash, 1987). **12 percent of the approximately 10,000 bird species are threatened with extinction in the next 10 to 100 years, and another 8% are near-threatened**. The loss of species due to fragmentation is likely to result in the collapse of significant ecosystem processes and free ecosystem services to people, such as pest control by insectivorous birds. Tropical forest insectivorous birds, present a good example of an important, species-rich group of small, non-charismatic organisms who do not get much public attention, but whose demise may have significant negative ecological and financial consequences. They are among the species most likely to go extinct as a result of forest fragmentation and their loss may result in insect pest outbreaks in tropical forests and surrounding agricultural areas.

Habitat loss and fragmentation are known as casual agents of species extinction (Leck, 1979; Brash, 1987). Fragmentation reduces the total area of contiguous habitat available. It increases the isolation of habitat and leads to increased “edge” habitat, which is successfully exploited by a variety of predators that eat the eggs and young ones of birds. Opportunistic and adaptable animals such as Foxes, Skunks, Squirrels, Rat snakes,

Crows, Blue jays etc. operate well in fragmented habitats. In migratory birds fragmentation results in nesting failure. Hunting is a less significant problem. However all birds are not sensitive to habitat fragmentation. Birds with larger body size are more susceptible to extinction with habitat reduction (Thiollay & Meyburg, 1988).

The diversity in bird species is reflected in the diversity of their responses to habitat disturbances. A babbler that forages on insects in the forest floor may be expected to respond differently to a response, such as the logging of trees, as compared to a species of woodpecker that forages for insects on tree trunks and nests in tree holes. The removal of forest under storey of a Coffee plantation may affect a species of under storey fly catcher more than a wide ranging fruit eating pigeon that visits the fruiting trees of the canopy. Some of these changes may be obvious and direct, leading to local extinction of species or the unexpected appearance of another. Others are more subtle and occur gradually. Between 1981 and 1990, humans deforested over 150 million hectares of tropical forests in the world which contained a great proportion of the world's birds (Brown and Lugo 1990, Myers 1991, Laurance and Bierregaard 1997, Whitmore 1997). This undoubtedly contributes significantly to the present global extinction crisis (Wilson 1992). The effects of habitat loss are often immediate and directly palpable. In addition to shifting the ecosystem balance towards species that are highly adaptable, the loss of habitat associated with habitat fragmentation may simply cause a decline in interior species populations, which are not as easily adaptable to changing environments. (Saunders 1989) noted an example of how changing large vast areas of intact habitat into fragmented islands affects avifauna. He researched changes in the avifauna of the wheat belt of Western Australia due to fragmentation. He showed that 41% of the birds native to the region have decreased in range or abundance since the 1900's and indicated that almost all of these changes resulted directly from habitat fragmentation and the decline in abundance of native vegetation. Although some species have increased in abundance, he noted that many more species have been adversely affected than have benefited.

Most of our pristine forests have been replaced by such habitats as thorn and scrub, rocky and grassy plateau, scattered trees and cultivation and village environs. Thus creation of National Parks and Sanctuaries or legislation is not sufficient by themselves for

conservation of wild life. More than 75% of our wild fauna lives in areas other than those legally declared as National Parks or Sanctuaries. The various Natural reserves, national parks and other areas which provide complete protection to wild animals constitute hardly 1% of the earth's land area. Most of the other areas i.e.; 99% are used for production of food, timber, pulpwood or other raw materials. These areas, usually labeled *secondary forest*, contain mixed vegetation or forest in various stages of regeneration, and support populations of many species of birds including ones that inhabited the original forests that once stood there. Wild life conservation in these areas is not up to the degree which is found in the protected areas. However these areas have the potential and can sustain some species of birds, if we understand the requirements and manage them with sufficient amount of planning and integration. Thus we can amalgamate the commercial field practices, forest practices, pasture management and various other land use patterns with wild life management. Another major force of habitat transformation world wide is the conversion of remaining habitats from large relatively compact and contiguous tracts to a complex of patches, such as pockets of forest in an otherwise denuded developed landscape. This process has been labeled *habitat fragmentation*. Most of our remaining natural habitats occur as fragments.

The Western Ghats faces severe threats from human disturbances due to deforestation, developmental activities, conversion to plantations and habitat fragmentation (Nair 1991). Menon and Bava (1997) estimated that between 1920 and 1990 forest cover in the Western Ghats declined by 40 %, resulting in a four-fold increase in the number of fragments and an 83% reduction in size of forest patches. This is not surprising given that this region is one of the biodiversity hotspots with the highest human population density (Cincotta *et al.* 2000) Recent studies have highlighted continuing threats to tropical rainforest and wild life species in the western Ghats (Daniels *et al.* 1995, Kumar *et al.* 1995, Umopathy and Kumar 2000). There is an urgent need to comprehensively study the long term impacts of such habitat changes and landscape alteration on birds and identify ameliorative conservation measures. We have to know what fragments contain and how species can be conserved therein, if all or most of the remaining habitats occur as fragments. Individual species and ecosystems have evolved over millions of years into a complex interdependence (Corker 2001). The biological effects of habitat fragmentation

are many. There are environmental changes in temperature, humidity, and wind speeds, which affect plant establishment, growth and survival. If remnant patches or fragments are small, they may be inadequate to meet the year round food and space requirements of many bird species. Changes are pronounced particularly along the edges of fragments, and plant and bird species that thrive in the more open, disturbed environment may begin to proliferate where as shy and specialized species of the rain forest interior may decline. The more the habitats and the species are lost, the greater the danger of a total collapse.

Much of the current theory and information concerning bird habitat selection and community structure derive from studies of temperate forest birds (e.g. Lack 1933, Mac Arthur 1958, Hilden 1965, and James 1971). These forests offer a wide variety of habitats, that differ in extent, physical structure and availability to birds over both space and time (Sherry & Holmes 1988). Most species breeding in temperate forests are migratory insectivores that take most of their prey from plant foliage or from ground (Mac Arthur, 1959; Holmes et. al. 1979). Because of the seasonality of temperate environment and the migratory habit; these species must re establish residence annually and quickly in appropriate habitats (Sherry & Holmes, 1985). Many studies have been conducted on the associations of particular bird species with habitats along environmental gradients (e.g. Bond, 1957; James, 1971; Codey, 1975; Able and Noon, 1976; Smith, 1977), along serial stages (Johnston and Odum, 1956; Martin, 1960; Shugart & James, 1973; Kendeigh and Fawver, 1981; Smith, 1982; May 1982), and in habitats with either similar or contrasting physical characteristics (e.g. Maurer & Whitmore 1981; Sabo & Holmes 1983; Landres & Mac Mohan, 1983). Most of these studies have demonstrated a strong correlation between bird species and certain habitat features with major emphasis on vegetation structure (Mac Arthur and Mac Arthur, 1961; James 1971; Whitcomb et. al, 1981; James and Warmer, 1982). Population changes in several species correlate strongly with changes in forest structure that occur during natural successional processes (Sherry and Holmes 1985, Holmes et al. 1986, Holmes and Sherry 1988). The character of vegetation should reflect the character of bird life. Character of bird life depends upon the availability of habitat (Gole, 1996). Bird species are distributed differently within what appears to be a "homogenous" habitat. Their responses depend on subtle dependence on vegetation structure and floristic, on the presence or absence of other bird species and

their influence on the species' social system. Habitat selectivity is greatly affected by the scale at which dispersion is measured (Sherry & Holmes, 1985). Niche partitioning and guild organization in bird communities has been studied for one group of bird species occupying one habitat (e.g. Hartely 1953; Mac Arthur 1958, Root 1967; Morse 1968, Weins 1969, Feinsinger 1976; Wolf et. al 1976; Eckhardt 1979) or from comparative studies of bird community patterns in similar habitat types (e.g. Cody 1968, Morse 1971, 1976b, Diamond 1975, Pearson 1975, 1977, Karr 1976b, Rabenold 1978, Noon & Able 1978).

Studies that have compared communities in contrasting habitats have generally focused on bird distributions along environmental gradients (e.g. Jonston and Odum 1956, Bond 1957, Terborgh 1971, 1977, Able and Noon 1976). Sabo and Holmes studied how the differences in habitat structure, environmental factors and species origins affect the species compositions, guild configurations and species niche relationship of selected bird communities (1983). Studies were undertaken showing the correlation between bird species occupying terrestrial habitats and various aspects of vegetation structure or composition, including foliage height diversity (Mac Arthur & Mac Arthur 1961, Recher 1969); plant species diversity (Tomoff 1974, James and Warner 1982); habitat openness (Wilson 1974, Probst 1976) and habitat patchiness (Karr & Roth 1971, Roth 1976).

Food resources are ultimately involved in how vegetation characteristics affect the distribution of bird communities (Karr 1976, Terborgh 1980). Forests with phylogenetically distinct plant species also differ in the types, sizes and qualities of available fruits, which in turn influence the frugivores present in the communities (Diamond, 1973, Karr, 1976b; Pearson, 1977). But since most temperate forest passerines are largely insectivorous, relationship between vegetation structure and food resources for such birds is likely at best (Robinson; Holmes 1984). Vegetation structure strongly influences a bird's foraging behavior and success. Grass height in open habitats has a major impact on both foraging tactics and foraging success (Smith 1974 a, b; Roth 1979, Eiserer 1980; Power 1980). Mauser and Whitemore (1981) found differences in the foraging behaviour of five species of forest dwelling birds in two forests with contrasting structure. Some bird species prefer to forage entirely in certain kinds of trees, and their

foraging tactics often change when the birds capture insects in different tree species (Holmes and Robinson 1981). Franzreb (1978), Hunter (1980) and Weins and Rotenberry (1981) also report close associations between birds and particular plant species.

1.3.3 FOOD HABITS OF BIRDS:

The different ways in which forest birds search for and capture prey appear to be influenced by the spatial arrangement of leaves, branching patterns and other parameters of foliage structure (Robinson and Holmes 1982). The primary role of vegetation structure is to provide a set of opportunities and constraints that influence how and where birds perceive and obtain their arthropod prey (Holmes 1981, Robinson and Holmes 1982). There is a difference occurring between tropical and temperate forests in the size distribution of arthropods on foliage (Thiollay, 1988) with more larger sized prey available in tropical sites suggesting that food resource niche access there are longer (Orians, 1969). A Swedish study found that insectivorous birds visited trees colonized by wood ants less frequently than trees that had no ants (Haemig, 1992). There is increasing evidence that predation pressure can be an important factor in selection of habitat, nest site or feeding site (Ekman 1986; Kelly 1993, Suhonen 1993). Presence of predator may reduce the number of colonist individuals to such a low level that a persistent population does not become established (Weins, 1989). The view that competition is the process that leads to community structuring and patterns has been widely adopted as a basic truth about nature. Few ecologists doubt that competition is a potent ecological force or that it has guided the evolution of species relationships within communities. Diamond (1979) concluded that few ornithologists question the widespread role of competition. The idea of food resource competition as a structuring force in communities gained popularity from the theoretical arguments and analyses of Hutchinson (1959), Mac Arthur (1972), Codey (1974) and others. A number of recent studies involving birds, especially those employing experimental manipulations have shown that food resources can be limiting (e.g., Rodenhouse, (1986), Martin (1987), Arcese and Smith ,(1988), that competition for food does occur (e.g., Minot, 1981, Grant, 1986, Gustafsson, 1987), and that community patterns are affected (e.g., Grant, 1986, Sherry and Holmes, 1988). Birds burn up energy in the act of foraging. So they should generally forage in such a way and seek such foods

that they get the maximum energy in return. An optimal foraging theory is based on the rationale that natural selection has shaped certain rules whereby birds make decisions as to what kind of foods to eat; where to forage and when to feed in a new spot etc. (Krebs, 1978, Krebs et al. 1983). The major foods for breeding birds are insects, particularly Lepidoptera larvae. These larvae are particularly important food items for nestlings (Good bred and Holmes 1996) and newly hatched independent fledglings because of their large size and their ease of transport to the nest. In most years, Evidence from both field observational and experimental studies show that breeding bird densities are strongly correlated with the abundance of Lepidoptera larvae (Holmes et al. 1986, 1991), mostly operating through their effects on annual reproductive success and fledgling survival (Roden house and Holmes 1992, Holmes et al. 1992, 1996). Furthermore, the recruitment of yearling birds into the breeding populations is strongly correlated with the previous summer's reproductive output (Sherry and Holmes 1992, Holmes et al. 1992), illustrating the importance of breeding success to the maintenance of population levels. Even though other factors are undoubtedly important food resources can not be discounted, and their effects on bird populations and communities are in need of renewed attention and critical study (Holmes, 1990).

1.3.4 ELEVATIONAL DISTRIBUTION OF BIRDS:

Bird species may be separated in their altitudinal ranges especially common on steeper mountain sides. There have been relatively few well documented studies on elevational distribution patterns of tropical forest birds. Most significant study about this aspect was carried out by Terborgh (1971, 1977). Competition played a defining role in the elevational distributions of two-thirds of the bird species, while gradients and ecotones influenced equal parts of the remaining one-third (Terborgh, 1971, 1977, 1985a and Terborgh & Weske, 1975). A pattern of decreasing species richness with increasing elevation is believed to mirror the well recognized latitudinal gradient in species richness (MacArthur 1972) and has been considered general enough to merit its inclusion in standard texts dealing with the subject (Begon et al. 1990, Whitmore 1998). Cody, (1974) have published results on altitudinal survey of birds in New Guinea mountains and found that as many as four species occur in a sequence along a transect up an elevation gradient.

This is due to vertical stratification of feeding zones, differences in food and feeding behavior. In contrast to the general gradient pattern species richness may show a non-monotonic, hump shaped pattern with diversity peaking at mid-elevations. This pattern parallels changes seen on diversity productivity gradients (Rosenzweig and Abramsky 1993, Rosenzweig 1995). An inverse U-shaped pattern of species richness with peaks (or plateaus, depending on the constraints) occurs at mid elevations (Colwell and Hurtt 1994, Rahbek 1997, Veech 2000). This pattern is termed the 'mid domain effect' (Colwell & Hurtt 1994, Colwell & Lees 2000). The variation in distributional range size of constituent species may itself be influenced by macro ecological factors such as habitat availability, environmental tolerance, dispersal ability and abundance (Brown 1995, Gaston 1996). Elevational range size of species will increase with increasing elevation, as suggested by Stevens (1989). As higher elevations experience wider climatic fluctuations, species found at higher elevations are expected to tolerate a wider range of environmental conditions and hence have wider elevational ranges. Lower elevations that contain species of more restricted distribution, in addition to wide ranging species of higher elevations, thus have more species, resulting in monotonic decline in species richness with increasing elevation (Stevens 1989). Patterns of species richness may vary also in response to avian diet guild and habitat structure (Terborgh, 1977, Blake & Loiselle 2000) or between typically low land versus montane species (Stotz, 1998).

1.3.5 NESTING IN BIRDS:

Birds are the most expert and most industrious nest builders among all the animals. They build nests of many different materials in a bewildering variety of forms, and locate them in more varied sites. Nests are used by birds to protect themselves, their eggs and particularly their young ones from predatory animals and adverse weather during breeding season, the most vulnerable period in the lifecycle. For protection against predators birds mainly rely on inaccessible, armoured and camouflaged nests. For inaccessibility nests are commonly constructed at the tip of tree branches, on ledges of cliffs, in burrows or in cavities. Each of these varied building sites rules out whole class of potential predators. Nest form and structure may be useful as taxonomic characters distinguishing genera of swallows, swifts, weaver birds and new world and old world flycatchers (Collias & Collias, 1984). The form of a nest may be influenced by nesting

success. Roofed over nests and hole nests have probably evolved as a result of predation pressures. It was found that losses due to predation are higher in open nests than in covered nests (Rosberry and Klimstra 1970; Baeyens, 1981). In a study of numerous species, Nice (1957) found that about two thirds of 94,400 eggs from hole nests survived success fully whereas only about one half of 22000 eggs from open nests met with success. Lack of suitable nest sites may be a critical limiting factor in bird populations.

1.3.6 KEY STONE TREE SPECIES:

A few authors have stressed the importance of key stone species in the conservation of birds (Vijayakumar 1993, Neginhall, 2002). Among trees, 'Ficus' is considered as a key stone species-the species that have ramifying effects on eco system. Ficus controlled the structure and function of a community of birds. Keystone plants like ficus, Singapore cherry (*Muntingia latifolia*) bear fruits all year round and so support a broad spectrum of frugivorous birds during the time of scarcity of food. In an observation twenty different species of birds were seen on a ficus (*Ficus mysorensis*) (Neginhal, 2002). Extension of Keystone species of trees is likely to cause major changes in the composition of species. It is environmentally necessary to maintain viable flowering (Nectar bearing) and fruiting (edible) populations of plants species for the health of bio-diversity both in rural and urban environs.

1.4 THE PRESENT STUDY:

With respect to native bird populations, the scientific literature abounds with direct and indirect studies of the environmental effects of habitat change in temperate forests (e.g. Mac Arthur and Mac Arthur 1961, Karr 1968, Robinson & Holmes 1984, Neimi & Hanowski 1984). But similar data for forest habitats in the tropics including India are comparatively limited. Studies have proved that tropical areas have substantially greater diversities than temperate ones (Karr 1971). But unlike African rain forests and neo tropical forests diversity of birds is rather low in the tropical rain forests of Malabar (Daniels, 1989). In any part of Malabar a maximum of about 150 species of birds may be present in an area of 15 square kilometer.

No studies have been done on the bird fauna of primary moist deciduous and deciduous

forests of Kerala though some check lists of birds have been prepared for those ecosystems. Studies by Jerdon (1844), Davison (1883), Hume (1877) Primrose (1904), and Whistler & Kinnear (1930-37) highlighted the presence of an interesting avifauna in Wayanad. Wayanad is an extension of the Deccan Plateau to the Western Ghats and once harboured extensive forests and rich wild life. The increasing population and subsequent human pressure have removed major portion of the natural forests on the plateau; leaving only fringes along the interstate borders, inaccessible hills and ravines. Little information is only available on the avifauna of Wayanad. Preliminary studies by Davison (1883), Primrose (1904) and Baker & Inglis (1930) have shown that the area harboured a rich bird fauna. Salim Ali's bird surveys in Kerala (Ali 1969) did not adequately cover Wayanad even though it is perhaps faunistically the richest area in Kerala. Studies by Palat (1983), Vijayakumar (1994) and Zacharias and Gaston (1993) have highlighted the changes on the avifauna taken place in the area due to deforestation. The recent survey of the birds of Wayanad conducted by Zacharias and Gaston (1993) recorded a total of 275 species including 15 which were new additions to the state of Kerala. Their survey presented evidence of decline in numbers of some species. Comparison of their results with previous surveys has indicated that 20 resident species have undergone a considerable decline and 17 resident species were found missing. Many species and population of birds in Wayanad have undergone declines in abundance in recent decades. The extent and cause of such changes in abundance are much debatable. Some explanations are focused on the effects of deforestation and habitat degradation (Zacharias and Gaston, 1993).

1.5 STATEMENT OF THE PROBLEM:

North Wayanad is a geographically important area, harbouring different types of vegetation and wild life. This is also an area where the forest is undergoing drastic decline. Through a comparative account of bird populations and their ecology and biology in various grades of vegetations; the present study tries to analyze the scope for developing strategies to preserve the fast diminishing avifauna in various micro ecosystems. Studies on bird community in selected ever green, semi evergreen, and deciduous habitats in degraded and non degraded areas were carried out aimed at collecting data on the current status of forest birds in the area and the impact of land use

patterns on various bird groups. The land under cultivation provides at once the opportunity for a clash between the interests of man and animal. Cultivated lands in India are extending and continue to extend to meet the needs of a rapidly increasing population. The need of increasing the available sources of food supply can be met only by the continued absorption of wastelands or forest, the natural domain of wild life. The intensive development of agricultural resources of our country may accompany a sane adequate policy for conservation of its birdlife. So preparation of a baseline data for selected forest areas of North Wayanad will go a long way in the formulation of conservation strategies for this region.

1.6 THE OBJECTIVES OF THE STUDY:

The objectives of the present study are to

- 1] Determine the extent of forest fragmentation in Wayanad.
- 2] Determine the densities of various species in natural forests and man made plantations
- 3] Study of the bird community structure and habitat utilization patterns of the bird species of Wayanad.
- 4] Compare the avian fauna in the undisturbed to most disturbed areas in a sequential pattern.
- 5] Suggest remedial measures and strategies for conservation of birds in the fragmented habitats and human habitations.

A comprehensive planning for the protection of avifauna in our innumerable micro ecosystems requires a complete understanding of the complex ecological principles operating in the bird communities. A thorough study of these ecological aspects in various grades of vegetations is a pre-requisite for determining conservation strategies for micro ecosystems.

1.7 PLAN OF THESIS:

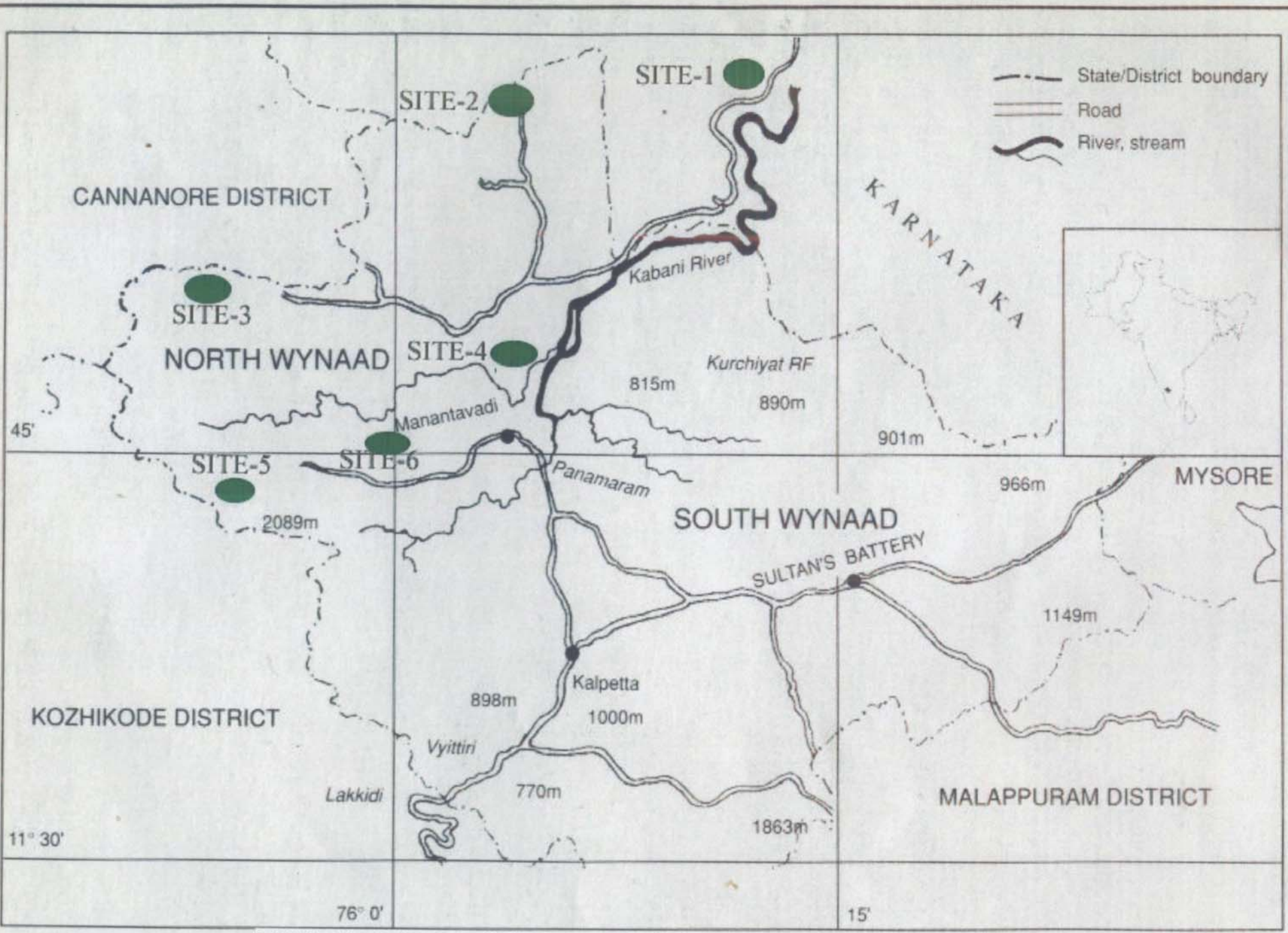
After examining the background and stating the objectives in the introductory chapter, the details of the study area and the methodology adopted are explained in chapter 2 and 3 respectively. Chapter 4 gives the results and discussion. A separate chapter on farming practices and bird communities in Wayanad follows chapter 4. Conclusion, bibliography and annexure on weather data, plates of the study areas and a few birds identified during the study are incorporated at the end.

2. Study Area

2.1.1 LOCATION AND GEOGRAPHY:

Wayanad is an elevated plateau in the Western Ghats, lying between 11° 58'N and 11° 30'N and 75° 45'E and 76° 28'E. The name 'WAYANAD' is derived from two local words-'Vayal' meaning swamps and 'Nadu' meaning place. It is an extension of the Deccan plateau to the west, bounded by Coorg and Mysore in the north and east; Nilgiri in the south and Malappuram and Calicut in the south west. The Ghat Section is separated by the Brahmagiri Dindimal ranges, running at right angles to the Western Ghats with the Nilgiri Kunda ranges forming the south-eastern limit and the eastern portion merging into the Karnataka table land. Formerly Wayanad consisted of south-east Wayanad (Nilgiri Wayanad), south Wayanad and north Wayanad. South-east Wayanad was transferred to Tamil Nadu leaving the other two regions to form the current Wayanad district with the area of 2,125 km². The average altitude of the plateau is 700m, but many peaks exceed 1500 m. The only river, the Kabani originates in the Western Ghats and flows east. The climate on the plateau is quite different from that of the plains. The temperature of the former ranges from 13°-33° C; where as at the foot of the ghats the range is from 21°-38°c. From November to January mist is common and following a few showers in April and May, the south-east Monsoon brings 75% of the annual rainfall from June to August. There is a rainfall gradient from west to east, a fact that is reflected in the vegetation.

Wayanad, traditionally, refers to the region encompassed by the Wayanad plateau (about 3000 km²) situated at the confluence of three biologically distinct and diverse regions - the western



MAP OF WAYANAD SHOWING THE STUDY AREAS

17

and mature trees. Portions of such degraded areas were declared as protected areas. Over the 200 year history of Wayanad we discern two processes of ecological changes. The first is the deforestation and transformation of ecosystems caused by the introduction of biota and the spread and intensification of mixed horticulture plantations in the area. The second is the continuous process of modification of the ecosystems caused by the process of sequential exploitation of forest produce, mainly in the form of timber. Thus from a mosaic of climax forests and different successional stages brought about by shifting cultivation, the forests were sequentially exploited for timber trees, depleting stocks and altering the composition of vegetation. The opening of the canopy by the exploitation of the forests further increased the savannisation process and increased the incident of fire in the area (Prabhakar, 1994). A study by the Kerala Forest Research Institute reports that there has been massive change in the land use pattern in the Wayanad District between 1950 and 1982.

Table 1: Shift in land use pattern in Wayanad district (km²)

Land cover	1950	1982	Difference
Forest	1811.35	724.54	- 1086.81
Agricultural plantation	63.93	532.75	+ 468.82
Cultivation	255.72	873.71	+ 617.99
Total	2131.00	2131.00	

Source: 1950 SOI topographical maps 49 M 13 & 14

There is a reduction of 1086 km² of forests in 32 years with the corresponding increase in area under plantations and cultivation. The intact and once continuous vegetation cover has got fragmented throughout the district. Wayanad forests are now restricted to the state border as an irregular strip starting from Kerala-Karnataka-Tamil Nadu tri-junction point and extending along northeast directions up to Pulpally area. The forests in Wayanad are broken by Pulpally encroachments and beyond this a small strip of forests included in South Wayanad Forest Division exists on the eastern border of Kabani river. On the side of Kabani in Kerala, there are a number of human settlements like Shanamangalam, Bavali, etc. On the northeast side of Mananthavady- Mysore highway the forest areas are again broken into pockets due to human settlements but do have continuity with the Brahmagiri forests of Karnataka.

2.2 ADMINISTRATIVE DIVISIONS OF WAYANAD FOREST:

For administrative purpose the forests of Wayanad are divided into three divisions-North Wayanad division, South Wayanad division and the Wayanad Wild Life Division. The North Wayanad division with its head quarters at Mananthavady has an area of about 21689.580 ha. The South Wayanad division with its head quarters at Kalpetta has an area of 32363 ha. The Wayanad Wildlife Division with its head quarters at Sulthan Bathery has an are of 344.44 km², comprising two discontinuous units of which the larger unit falls in the Sulthan Bathery taluk and the smaller in the Mananthavady taluk. The natural habitat contiguity between the two portions was completely severed as a result of incessant encroachments in Pulpally. Wayanad Wildlife Division is divided in to four ranges viz; **Tholpetty, Kurichiat, Sulthan Bathery and Muthanga**. This study was carried out in the Wayanad Wild life Division and the North Wayanad Division, which will here after be referred to as **study area-1** and **study area-2** respectively.

2.2.1 STUDY AREA-1 (WAYANAD WILD LIFE DIVISION)

The Wayanad Wildlife Division has an area of 344.44 km². It consists of two discontinuous units- WS-II (266.77 km²) and WS-I (77.67 km²). The larger of the two (WS-II) lies within the geographical extremes of latitudes 11°35' N-11°49'N and longitudes 76°13' E-76°27' E and falls in the Sulthan Bathery taluk of Wayanad revenue district. The other bit (WS-I) lies within latitudes 11°50' N-11°59' N and longitudes 76°02' E-76°7' E and fall in the Mananthavady taluk of Wayanad District. As per available records and verbal accounts the natural habitat contiguity between WS-I and WS-II portions was completely severed in late 1970s as a result of incessant encroachments in Pulpally vested forests. The sanctuary consists of two units separated by a chunk of revenue land as well as RF. The main portion is constituted by Kurichiat, Sulthan Bathery and Muthanga Ranges. Tholpetty Range, where intensive studies were conducted lies in the Northwest side of this main portion. The Tolpetty Range is bounded by Mananthavady Kutta road to the north, the coffee estates of Karnataka (Coorg) to the east, The Kartikulam and Edakode RF of North Wayanad division to the south and the Begur and Alathur reserve forests of Norht Wayanad Division and Kurichiat reserve forest to the west.

2.2.2 STUDY AREA-2 (NORTH WAYANAD DIVISION):

The entire forest tract of Mananthavady taluk of Wayanad revenue district except those in Tholpetty wild life range falls within North Wayanad Division. The tract dealt with falls between north latitude 11° 45' and 11° 58' and east longitude 75° 50' and 76° 5'. Total extension of the division is 21,689.580 ha. Including 13,421.530 ha .reserve forest and 1506.400 ha. Proposed reserve forest and 6761.650 ha. of vested forests

2.3.1 TERRAIN:

It is a continuation of the Mysore plateau of western Ghats and slopes down to the east and north to Karanataka. Terrain is undulating, dotted with rolling hills, which are steep at Banasura hill range. The area predominantly shows western aspect though locally all possible aspects can be seen due to rugged nature of the country and innumerable sundry hillocks, the place is peppered with. Several, small streams and swamps dot this interspersed undulating terrain. The general slope varies from 5° to 10°. The altitude varies from 600 m to 2050 m. The highest peak is the Banasuramala (2050 m).

2.3.2 ROCK:

The principal rock types are granite and their gneiss derivatives. The rocks are typically biotite gneiss, their chief constituents being quartz, feldspar, biotite and granite. The crystalline rock formation shows a tendency to weather out into white, yellow or red feldspar clayey rocks in many parts and become lateritic in certain parts due to high rainfall. The Charnockites are exposed in eastern portion of the North Wayanad division covering the areas of Chandanathodu, Peria RF, Archaean formation like cordierite, hornblend, Biotite gneiss and other unclassified crystalline rocks are concentrated on western portion of the North Wayanad division covering hilldale RF, Thrissilery.

2.3.3 SOIL:

The main soil types of the area are **forest peat, sandy ferruginous forest loam and lateritic**. The soil strata have well developed profiles due to intensive leaching. It is rich in gravel indicating good internal drainage. The upper layer is highly enriched with organic matter derived from the decomposed leaves. Accumulation of humus in the top soil gives it darker reddish brown to dark brown colour, which changes to red in the sub soil due to dehydration.

The surface soil has structure favouring root development. The laterites occur at much lower depths. The soil is non calcareous in character and acidic in reaction. Major part of the North Wayanad division except the eastern strip is composed of forest loam. It is rich in nitrogen, but poor in bases. The soil is quite fertile under forest cover and promotes prolific undergrowth. In denuded areas, protection against soil erosion is recommended. The lateritic soil, a typical product under humid tropical conditions occurs in the eastern strip of the division covering part of Chandanathodu RF areas. Though the soil, in general, is acidic and poor in available nitrogen, phosphorus, potash and organic matter, it is well drained and responds to management practices

2.4.1 CLIMATE:

The plateau has monsoon climate which has changed considerably in the past few decades with hotter summers and lower rainfalls. Both the southwest and northeast monsoons are received with major contribution from the former. Based on rainfall pattern, 3 seasons have been identified viz; Dry season (February-April), Rainy season (May-October) and Cool season (Nov-Jan). Despite the changed climate patterns, it is still quite chilly during rainy season.

2.4.2 RAINFALL PATTERN AND DISTRIBUTION:

Both the southwest and northeast monsoons bring rains, but major portion of the rain is from South-West monsoons, which starts with pre-monsoon showers by middle of April. The heaviest rainfall is received during July. September-October brings Northeast monsoon. Occasional rains are received in November. Precipitation during the period from December to March is very rare. The average annual rainfall varies from 3000 mm to 3500 mm. There are distinct rainfall gradients across the entire Wayanad plateau, with increasing rainfall from east and west and from north to south. Significant rainfall may occur during northeast monsoon, but in shorter and lighter bouts. Breaks in monsoon are not infrequent. Due to the location of the area near the junction of western and Eastern Ghats and adjoining to the drier areas of Karnataka and Tamil Nadu, there are significant patterns of to and fro movements of wild animals in this area. The rainfall data for Wayanad is appended as Annexure.

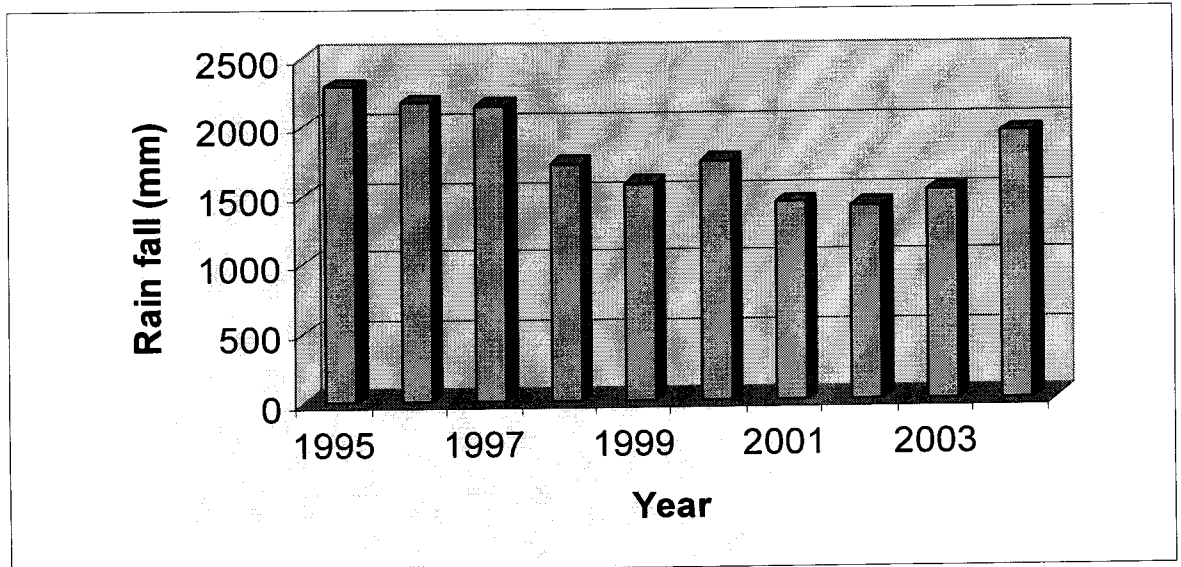


Fig 1: Graphical representation of rainfall data for the last ten years in Wayanad

The rainfall data of past 10 calendar years is given in the table. The mean annual figure is 2,024.30 mm. during this period with minimum and maximum annual limits of 1,435.30 and 2,692.20 mm.

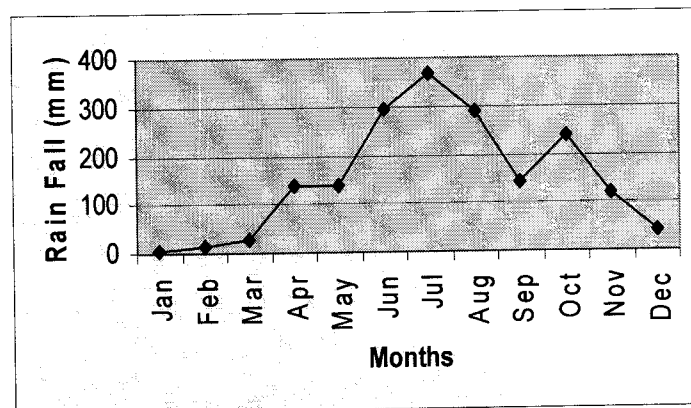


Fig 2: Graphical representation of average monthly rain fall in wayanad

Number of rainy days in a year varied from 99 to 128 with mean figure of 114 over last 10 years. A marked decline in rainfall since 1965 has been noted.

2.4.3 TEMPERATURE:

The temperature in these tracts varies between 13° and 35° C. The reduction in temperature is mainly attributed to the altitude. Frost is almost unknown in this tract. The dry season commences from February and last till may. Mist is common during November to February, mostly at higher elevations. The temperature profile is given as **Annexure** for the period of last 10 years.

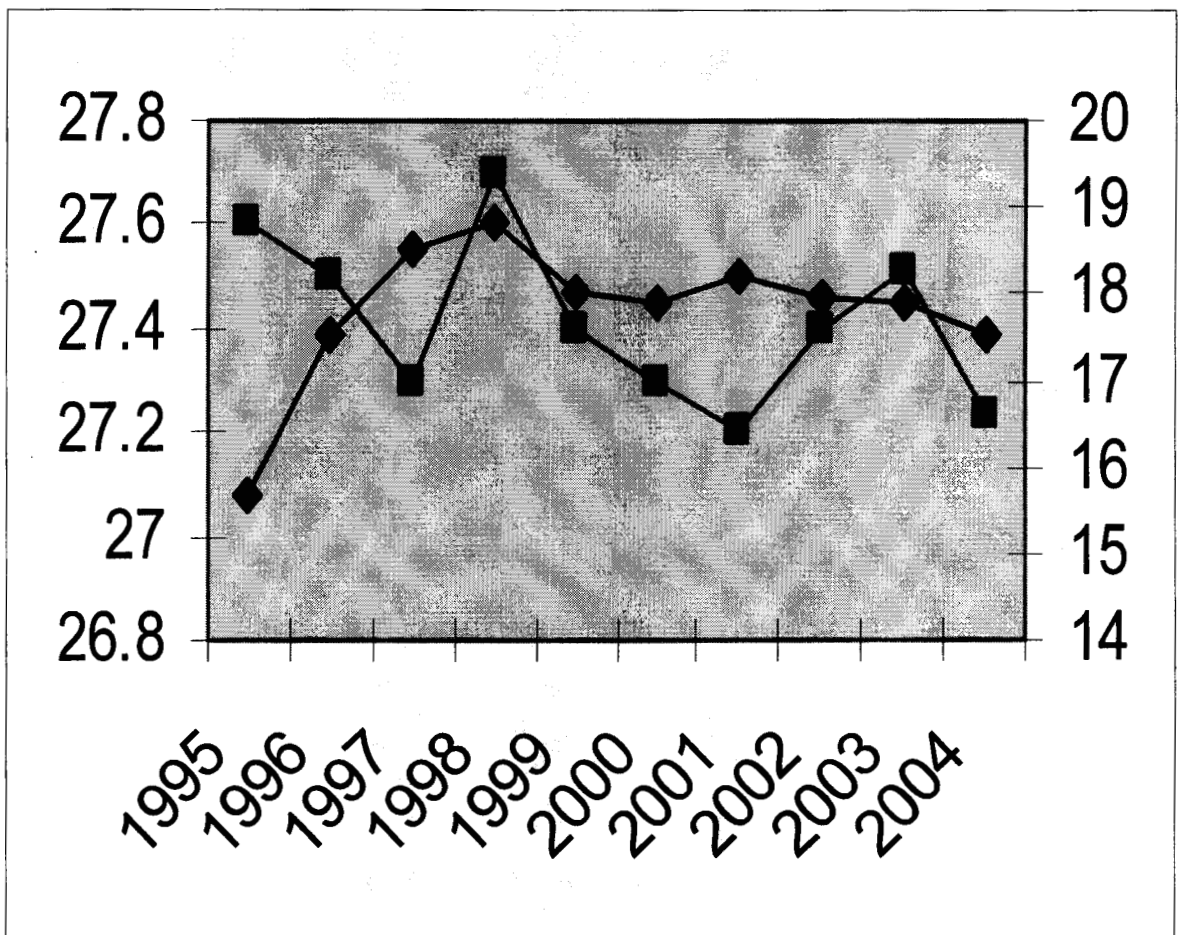


Fig 3: Mean maximum and minimum annual temperatures for the last ten years in wayanad

The mean monthly minimum temperature ranges from 15.0° C to 19.4° C and monthly mean maximum and minimum temperatures range from 31.2° C and 15.0° C respectively.

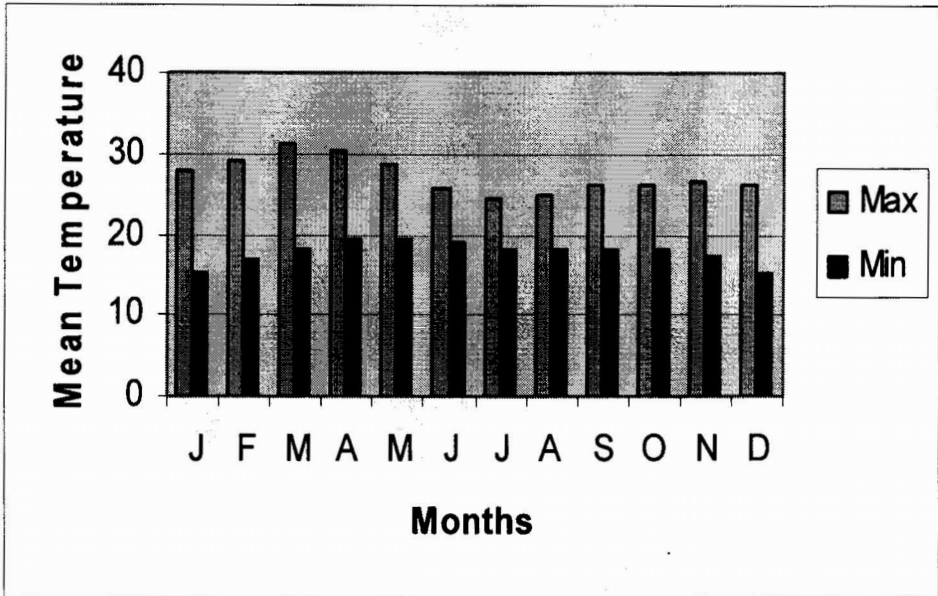


Fig 4: graphical representation of mean monthly temperature for the last ten years in Wayanad.

2.4.4 HUMIDITY:

The relative humidity data of last 10 years is given as **table**. The maximum and minimum RH in the last 10 years was 93.6% and 42.9% respectively. The relative humidity gradients follow the rain pattern.

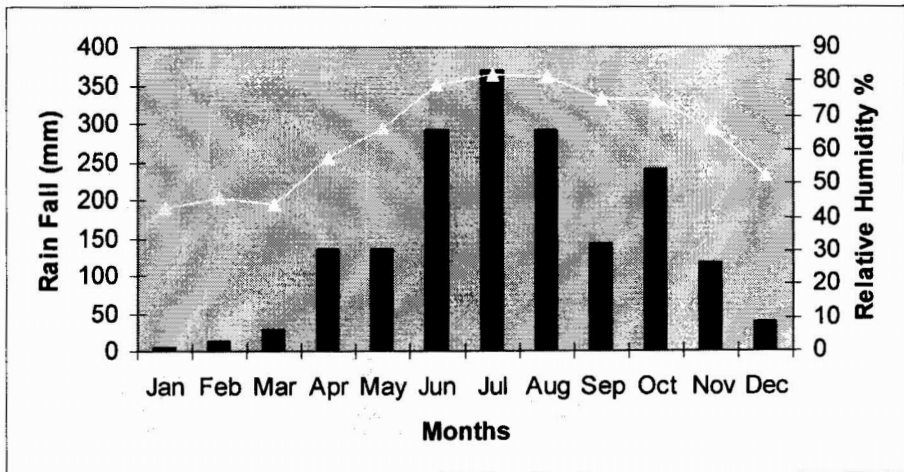


Fig 5: Graphical representation of mean monthly rain fall and relative humidity in Wayanad for the last ten years

2.4.5 WIND SPEEDS:

As is clear from the table, the wind velocity in this area is comparatively high from November to February with peak in December. June- July months also show high incidence of winds. Westerly winds, which blow during Southwest monsoons, are generally mild. Strong dry winds that blow from east between November and April cause some damage to the forests. **Table 3** in appendix shows monthly wind velocity figures for last 10 years.

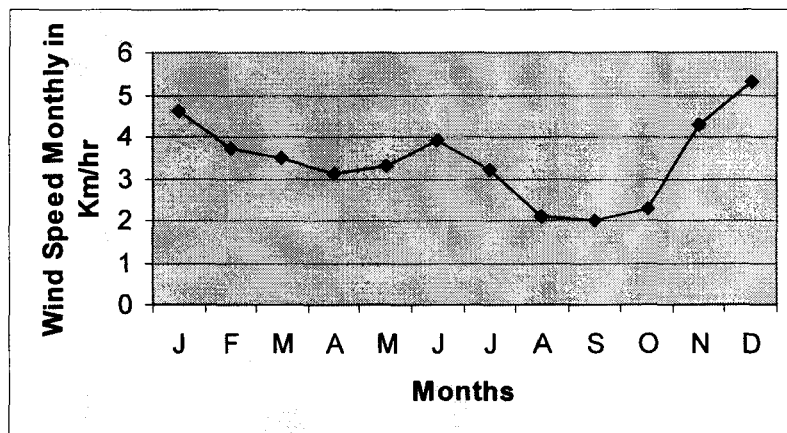


Fig 6: graphical representation of mean monthly wind speed for the last ten years.

This combined with the lower relative humidity figures in these months; clearly explain the reasons for fire proneness from December to April. Westerly wind blows during southeast monsoon over whole area. In addition, there are strong dry winds blowing from east between November and April.

2.5.1 WATER SOURCES:

Most of the streams flowing in the sanctuary are shallow, sludgy and frequently rocky. Water levels are usually low except during the monsoons. Map VI shows the drainage patterns in the sanctuary along with names of major streams flowing through sanctuary. The seasonal and perennial streams differentiation is also shown.

2.5.2 NATURAL:

The study area is drained by numerous perennial and seasonal streams, many of them originating from within the sanctuary. Most of these streams ultimately drain into Kabani River, which is formed by the confluence of Mananthavady puzha, Panamaram puzha Bavali puzha and Periya puzha. The main drainage is to the east and north through Kabani and its tributaries. Kabani is an important tributary of the Cauvery River, one of the largest east flowing river systems of South India.

2.5.3 WATER QUALITY OF THE STREAMS FLOWING THROUGH THE AREA:

Sand, mud, gravel and boulders are the most abundant and common substrates in the Kabani river system. The flow patterns at study locations were low to high with neither stagnant water nor high flow regimes. The results of estimation of the water quality parameters showed high conductivity in the entire east flowing streams indicating high amount of dissolved solids. High conductivity, alkalinity and total hardness were influenced by upland activities. Dissolved Oxygen was never found to be a limiting factor. Most of the streams are disturbed due to unscientific fishing, retting of palm leaves and the drainage from agricultural fields. The leaching of pesticides and herbicides from the nearby estates pollute the streams.

2.6.1 RANGE OF WILDLIFE, STATUS DISTRIBUTION AND HABITAT:

The distribution of wildlife in the sanctuary varies seasonally. During summer the wildlife concentration is more in WS-II because of the migration from the adjoining Bandipur and Mudumalai National Parks. With the onset of monsoon larger animals return to Bandipur and Mudumalai, reducing the number of animals in the sanctuary.

WAYANAD WILDLIFE DIVISION

N

0 1 2 3 km

TO MYSORE
BRAHMAGIRI WILDLIFE SANCTUARY

TO MYSORE
NAGARHOLE NATIONAL PARK

THOLPETTY RANGE

TO YEMUNELLY

TO MYSORE

KARNATAKA

BANDIPUR TIGER RESERVE

TO MANATHAVADY

KURICHYAT RANGE

TO MYSORE

BANDIPUR TIGER RESERVE

KERALA

SULTHAN BATHERY RANGE

TO KALPETTA







SULTHAN BATHERY

MUTHRANGA RANGE

MUDUMALAI WILDLIFE SANCTUARY

TAMILNADU

LEGEND

-  INTERSTATE BOUNDARIES
-  DIVISION BOUNDARIES
-  P.W.D. ROADS(TARRED)
-  FOREST ROADS
-  TRECK PATHS
- 

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2.7 VEGETATION STUDY

2.7.1 METHODOLOGY:

Topography, vegetation characteristics, litter deposition patterns and land use in the study sites were analyzed by visiting the sites at regular intervals. Diversity was measured simply by the number of species (Species richness) and by the Shannon-Wiener index of diversity (Shannon & Wiener, 1949). An appropriate Plot each was marked in all the study sites (Holmes and Sturges, 1975). Vegetation structure and foliage profiles were recorded in all these plots. The plant species present and their approximate height above ground were recorded. Litter deposition patterns were analyzed by first hand observation and weight measurements. Data on flora were collected from forest and cultivations using the strip transect method. A 600m. long strip was marked in each study site by tying nylon ribbons to the trees in a line. Boundaries were made narrow with only 4m. width. Walking along the centre of the 600m. strip canopy assessments were made at 120 points at 5 m intervals. Canopy density was scored based on the amount of sky visible right above the point of sampling. When the sky was fully and uninterruptedly visible canopy density was scored as 0. When a few branches met or barely crossed each other interrupting the sky it was scored 1. If branches and foliage crossed over making the sky visible as if through a coarse mesh it was scored 2, and if the sky was scarcely visible through the canopy, it was scored 3. The minimum height for canopy was fixed as 10 m. Ten quadrates (10 m x 10 m) were laid alternating on either side of the 600m. line at intervals of 50 m. Within these quadrate the total number of trees were recorded for each transect. The number of tree species per quadrate was also noted.

Plants were identified with the assistance from M.S Swaminathan Research Foundation, Puthurvayal, Kalpetta. The individual woody plants were assigned to 7 different height classes viz., 0-1 m, 1-2 m, 2-4 m, 4-8 m, 8-16 m, 16-32 m and <32 m as the plant were being enumerated on the 600m. tract.. Height classes were used since the height measurements were approximation.

2.7.2 LITTER STUDY:

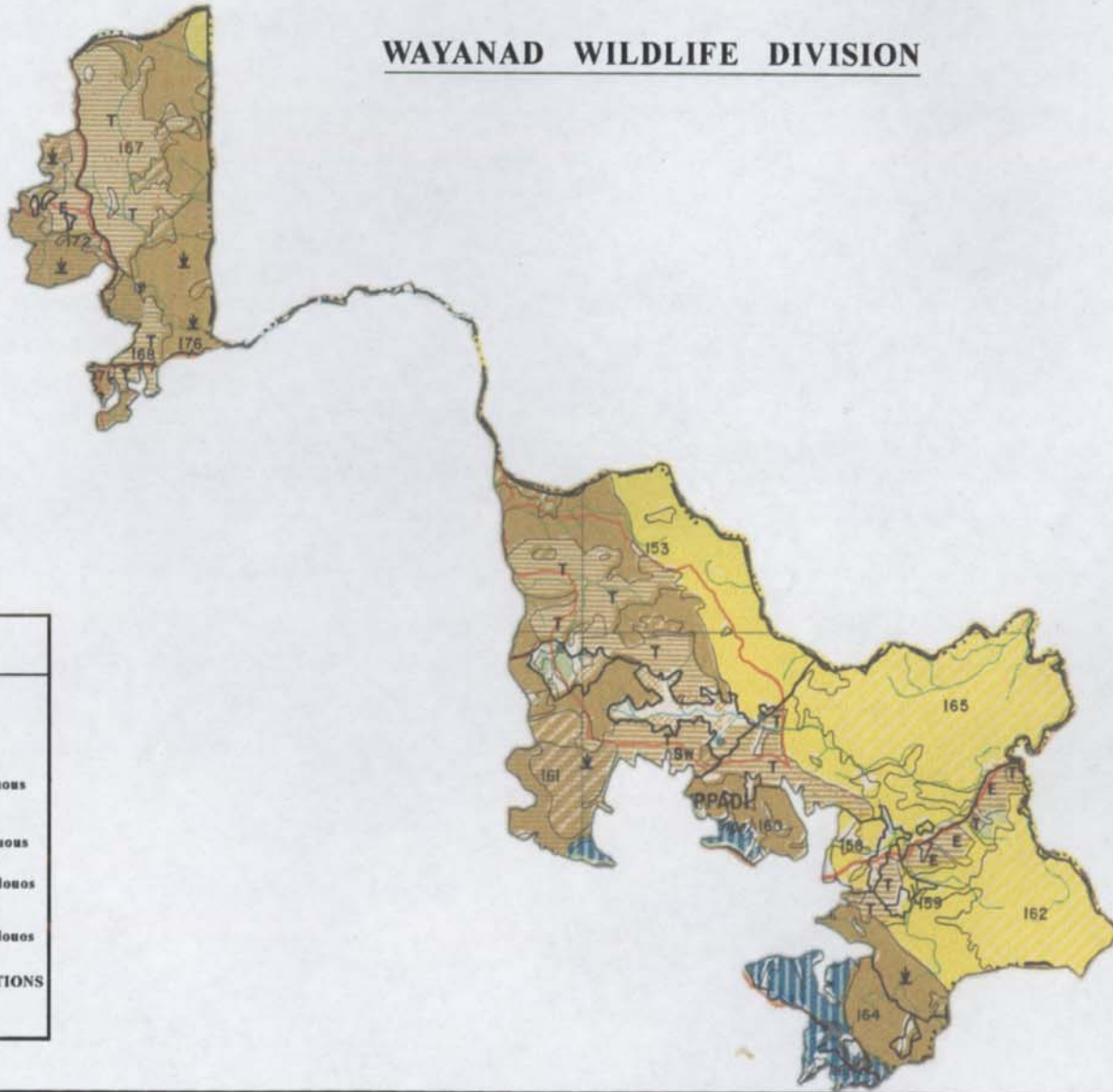
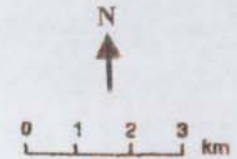
Litter quality of a forest ecosystem influences the bird population of the area in two different ways- 1).It directly influences the abundance of insectivorous and worm eating ground feeding birds by providing a rich supply of food from the decomposing litter and 2).Indirectly by increasing the productivity of the soil and there by helping in the growth of a floristically heterogeneous vegetation. Litter plays a considerable role in the transfer of energy and nutrients in the forest ecosystem. Litter fall data have been used to predict the productivity of the ecosystem (Toky and Singh, 1993). Litter fall forms one of the facets of nutrient cycling in forests, representing a major process for the transfer of nutrients from above ground vegetation to soils (Ananthkrishnan, 1996). Litter weight was estimated in a 1x1m. quadrat within the 10x10m. quadrat by using a spring balance. From the mean weight average litter fall per annum per hectare was calculated.

2.8 RESULTS:

The comparison of structure and composition of forest types of Wayanad indicate that the anthropogenic pressures coupled with the adverse climatic conditions have brought about changes in the vegetation types in the past and these pressures are continuing. Though the total area of the Wayanad Wild life Sanctuary is 344.44 sq km, natural forests constitute only 242.954 and remaining 101.487 sq km. are the plantations. The vegetation cover is depicted in Map VII.

Micro climatic fluctuations coupled with edaphic, topographic and biotic factors have endowed Wayanad Wildlife Sanctuary with considerable floral diversity. The presence of large chunks of tropical evergreen forests makes the North Wayanad division very important. Though the locality factors are conducive for luxuriant growth of evergreen vegetation here, the mismanagement of such rich forests in the past, by the erstwhile owners with the sole objective of gaining maximum economic returns, had caused irreversible damage to these forests. Out of a total forest area of 20626.487 ha, the net extent of private forests vested with Government is 6499.12 ha. Due to the indiscriminate removal of valuable trees coupled with poor protection from fire, grazing and such other biotic interventions, the area is severely degraded.

WAYANAD WILDLIFE DIVISION



LEGEND

- INTERSTATE BOUNDARIES
- DIVISION BOUNDARIES
- DENSE FOREST(Dry Deciduous Forest)
- WOODLAND TO SAVANNA WOODLAND (Dry Deciduous Forest)
- DENSE FOREST(Moist Deciduous Forest)
- WOODLAND TO SAVANNA WOODLAND (Moist Deciduous Forest)
- MISCELLANEOUS PLANTATIONS
- DISTURBED FOREST

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The natural forests of Wayanad fall under three broad types as shown below vide “Revised classification of forest types of India” by Champion and Seth.

1. The West Coast Tropical Evergreen Forest - IA/C4
2. West Coast Semi Evergreen Forest - 2A/C2
3. Southern Tropical Moist Deciduous Forest - 3B/C1C

The study sites can be graded from most complex to the simplest, as follows. Site no-3 with the ever green vegetation having canopy density 3 and highest richness index ($R1=6.28$), formed the most complex habitat among the six sites. Site no-3 with richness index 5.32 and canopy density 2 fell second in the list. It was followed by site no -1 and 4. Site-5 had the least richness and canopy density.

	Site-1	Site-2	Site-3	Site-4	Site-5	Site-6
Description	Moist deciduous plane stretch	Semi evergreen slope	Ever green slope	Semi-Ever green patch	The highest peak in N Wayanad division	Agricultural field with mixed cultivation
Human disturbance	Nil	Moderate	Light	Moderate	Heavy	Nil
Average canopy height	10-12m	14-16m	15-17m	14-16m	8-10m	12-14m
Canopy density	1	2	3	2	0	0

Table 2: Structure and composition of the study sites

The cultivated land selected for study consisted of an incomplete over story of fast growing exotic trees like ‘silver oak’ *Grevillea robusta* and fruiting trees like jack tree, mango tree etc. which were planted in the openings for coffee shading. The under story had rich density of mature coffee.

Indices	Site -1	Site-2	Site -3	Site-4	Site -5	Site-6
S or R0	22	32	42	34	14	11
R1	3.67	5.20	6.28	5.32	2.36	2.03
R2	1.26	1.42	1.61	1.53	0.89	0.94

Table 3: Richness indices for the vegetation of the study sites

One hectare of evergreen and semi- evergreen forests in Wayanad contains 50 to 70 species of trees. An average of 40 species in a strip of 0:24 ha (600x4) are recorded. This figure for a moist deciduous forest is around 30. An average number of less than 160 trees are recorded from the first 3 sites (> 4 m height).

2.8.1. LITTER FALL:

The highest litter fall recorded in site no-3, followed by 4 and 2. The least litter fall is reported from site no-5.

Study Site	Litter fall Kg/ha/a
Site-1	7,692
Site-2	8,211
Site-3	8,943
Site-4	8,344
Site-5	6,912
Site-6	2,876

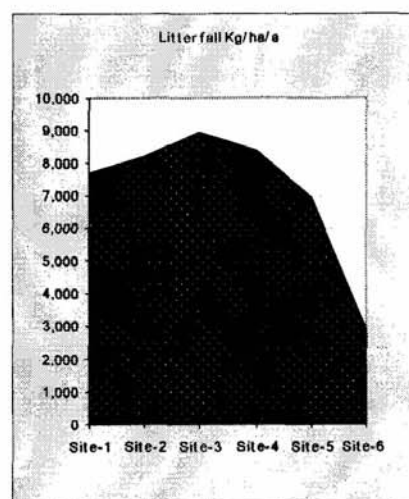


Table 4: Litter fall data for the study sites

Fig 7: Graph showing Litter fall pattern in the Study sites

2.9 VEGETATION OF EACH STUDY SITE:

Six localities were selected in Wayanad for intensive studies based on topography, vegetation and land use. Of these five fell under North Wayanad Division and one under Wayanad Wild Life Division. These localities will be here after referred to as site-1, site-2, site-3, site-4, site-5 and site-6. All the study sites except site-6 were forests.

2.9.1 SITE-1 KAIMARAM:

It is a moist deciduous tract close to the boarder of Nagar Hole N.P of Karnataka and towards the eastern boarder of Tholpetty Range of Wayanad wild life Sanctuary- W- I. It is a vast totally undisturbed area that has got continuation with the Nilgiri Biosphere reserve. Vegetation consists of valuable species, mostly deciduous with height of 30-40 m. The trees of upper canopy are usually light demanders. Fluting is common. Bamboo undergrowth and climbers are abundant. These forests are subjected to annual fires resulting in the destruction of seeds and soil, flora and fauna. Deciduous forests obviously have more combustible materials on ground during summer.

Sl. No	Botanical name	Local name	Family
Trees of top storey			
1	<i>Dalbergia latifolia</i>	Veetti	Papilionacea
2	<i>Grevia tiliaefolla</i>	Chadachi	Tillaceae
3	<i>Lagerstroemia lanceolata</i>	Venteak	Lythraceae
4	<i>Pterocarpus marsupium</i>	Venga	Fabaceae
5	<i>Schleichera oleosa</i>	Poovam	Sapindaceae
6	<i>Stereospermum colais</i>	Poopathiri	Bignonaceae
7	<i>Tectona grandis</i>	Teak	Verbenaceae
8	<i>Terminalia tomentosa</i>	Karimaruthu	Combretaceae
9	<i>Terminalia bellerica</i>	Thanni	Combretaceae
10	<i>Tetrameles mudiflora</i>	Cheeni	Datisceae
Trees of middle storey			
1	<i>Adina cordifolia</i>	Manjakadambu	Rubiaceae
2	<i>Mitragyna parvifolia</i>	Neerkadambu	Rubiaceae
3	<i>Anogeissus latifolia</i>	Mazhukanjiram	Combretaceae
4	<i>Butea monosperma</i>	Plasu	Fabaceae
5	<i>Dillenia pentagyna</i>	Vazhapunna	Dilleniaceae
6	<i>Lannea coromandelica</i>	Kalasu	Anacardiaceae
7	<i>Spondias pinnata</i>	Ambazham	Anacardiaceae
8	<i>Stercura guttata</i>	Peenari	Sterculiaceae
9	<i>Sterculia urens</i>	Thondi	Sterculiaceae
10	<i>Terminalia paniculata</i>	Pillamaruthu	Combretaceae
11	<i>Trema orientalis</i>	Aamapetti	Ulmaceae
12	<i>Xylia xylocarpa</i>	Irul	Mimosaceae

Trees of lower storey

1	<i>Aporosa lindleyana</i>	Vetti	Euphorbiaceae
2	<i>Bambusa arundinaceae</i>	Mula	Poaceae
3	<i>Careya arborea</i>	Pezhu	Lecythidaceae
4	<i>Cycas circinalis</i>	Eentha	Cycadaceae
5	<i>Ficus hispida</i>	Erumanaakku	Moraceae
6	<i>Xeromphis spmosa</i>	Malamkaara	Rubiaceae

Epiphytes

1	<i>Cymbidium aloifolium</i>		Orchidaceae
2	<i>Pholidota pallida</i>	Panna	Orchidaceae

Undergrowths and climbers**a. Woody climbers and Stragglers**

1	<i>Acacia intsia</i>	Incha	Mimosaceae
2	<i>Calycopteris floribunda</i>	Pullani	Combretaceae
3	<i>Celastrus paniculata</i>		Vitaceae
4	<i>Butea parviflora</i>		Papilionaceae

b. Herbaceous climbers

1	<i>Caesalpinia bonduc</i>		Caesalpinaceae
2	<i>Hemidesmus indicus</i>	Naruneendi	Asclepiadaceae
3	<i>Naravelia zeylanica</i>	Karuppakodi	Ranunculaceae
4	<i>Passiflora foetida</i>	Poochapazham	Passifloraceae

c. Shrubs

1	<i>Abutilon persicum</i>	Thutti	Malvaceae
2	<i>Eupatorium odoratum</i>		Communist pacha
3	<i>Helecteris isora</i>	Idampiri valampiri	Sterculiaceae
4	<i>Hibiscus aculeatus</i>	Uppanachakam	Malvaceae
5	<i>Lantana camera</i>	Poochedi	Verbenaceae

d. Herbs

1	<i>Glycosmis pentaphylla</i>	Paanal	Meliaceae
2	<i>Desmodium triquetrum</i>	Adakkapaanal	Papilionaceae
3	<i>Cida cordifolia</i>	Kurumthotti	Malvaceae

2.9.2 SITE-2, THIRUNELLY:

It is a semi evergreen reserve forest spread into about 5080 ha., close to the Coorg boarder lined by the Brahmagiri ranges in the north, the Udayagiri hills in the east, Karimala in the west and the Narinirangi mala in the south. It is connected to the Sreemangalam range of the Brahmagiri Wld Life Sanctuary of Karnataka and the Aralam section of Kannur Division also. In the east, it has continuation with the Wayanad Wild Life Division.

The presence of the Kalindi River, shoala forests in the hill ranges, farm lands and habitations in the valleys and its continuity with other forests add to the diversity of the habitat and

consequently the region harbours an interesting bird fauna.

2.9.2.1 CHARACTERISTIC FEATURES OF THE VEGETATION

This forest type is an intermediate between the tropical evergreen and moist deciduous forms. This is mainly because of the change in environment or human interference or both. The West coast semi evergreen forests accordingly form a close high forest but usually inferior to that of tropical evergreen. This type includes both evergreen and deciduous trees. The bark tends to be thick and rough. The density of the canopy of this type is less than that of evergreen. The climbers and under growths are seen in abundance. This type occurs mostly on the hill slopes and plains.

Sl. No	Botanical name	Local name	Family
1. Trees of top storey			
1	<i>Artocarpus integrifolia</i>	Plavu	Moraceae
2	<i>Dalbergia latifolia</i>	Veetti	Fabaceae
3	<i>Lagerstroemia latifolia</i>	Venthekku	Lythraceae
4	<i>Machilus macarantha</i>	Kulamavu	Lauraceae
5	<i>Mangifera indica</i>	Maavu	Anacardiaceae
6	<i>Pterocarpus marsupium</i>	Venga	Moraceae
7	<i>Stercuila guttata</i>	Peenari	Sterculiaceae
2. Trees of middle storey			
1	<i>Bischofia Javanica</i>	Mlachathayan	Euphorbiaceae
2	<i>Lanea coromandelica</i>	Kalash	Anacardiaceae
3	<i>Macaranga peltata</i>	Vatta	Euphorbiaceae
4	<i>Knema attenuate</i>	Chorappayin	Myristicaceae
5	<i>Olea dioica</i>	Edana	Oleaceae
3. Trees of lower storey			
1	<i>Aporosa lindleyana</i>	Vetti	Euphorbiaceae
2	<i>Cinnamomum Malabaricum</i>	Vayana	Lauraceae
3	<i>Ficus hispida</i>	Parakam	Moraceae
4	<i>Laea indica</i>	Maniperandi	Laeaceae
4. Epiphytes			
1	<i>Aeschynanthus perrottetti</i>		Gesneriaceae
2	<i>Medinilla beddomei</i>		Melastomacaceae
3	<i>Sirhookera latifolia</i>		Orchidaceae
5. Undergrowth and climbers			
a. Woody climbers and Stragglers			
1	<i>Entada scandens</i>	Kakkumvalli	Mimosaceae
2	<i>Bauhinia phoenicea</i>	Vallimandaram	Caesalpinaceae
b. Herbaceous climbers			
1	<i>Merremia tridentate</i>	Prasarini	Convolvulaceae

2	<i>Myxopyrum serratum</i>	Chathuramulla	Oleaceae
c. Shurbs			
1	<i>Antidesma diandrum</i>		
2	<i>Calamus sp.</i>	Chooral	Palmae
3	<i>Clerodenaron serratum</i>	Cheruthekku	Verbinaceae
4	<i>Costus speciosus</i>	Channakoova	Zingiberacea
d. Herbs			
1	<i>Glycosmis pentaphylla</i>	Paanal	Meliaceae
2	<i>Spilanthes calva</i>	Kuppa Manjal	Asteraceae

2.9.3 SITE- 3, CHANDANATHODE:

It is an evergreen stretch in the edge of Chandanathodu reserve forest in the Peria Range of North Wayanad division. The site is moderately disturbed by human activities due to the presence of the Sri Naryana Gurukulam Botanical gardens and the adjacent cultivations. Steep slopes, paddy fields in the valley, rich litter fall, presence of the periya puzha and comparatively open canopy adds to the featuristic variety of the habitat. To the interior of this site canopy is dense and closed.

2.9.3.1 CHARACTERISTIC FEATURES OF THE VEGETATION:

Luxuriant growth of evergreen trees of different sizes and shapes arranged in storey is a peculiarity of tropical evergreen forest type in this site. The under growth consists of canes, *Strobilanthes* species and ferns. Grass is absent.

Evergreen vegetation as a whole can be recognized into four distinctive layers. The evergreen species is briefly mixed with deciduous species without affecting the evergreen nature of the forest e.g. *Terminalia bellirica*. Co-associations i.e. gregariousness of dominants are not present in this type of forests. The tropical evergreen vegetation in the plains and moderate slopes show this type of growth conditions characterized by tall cylindrical boles with closed canopy and stratification. As one proceeds into the interior, slight variations in the typical characteristics could be noticed and finally towards ridges and hilltops, the growth changes drastically. The stem becomes lass and less clean and the canopy more and more open until on the hill top and peaks where the tree growth altogether becomes absent. Towards the ridges and hilltops, the canopy shows no line of demarcation from the foliage of trees or shrubs and result in an irregular mass of foliage from the treetops down to the level of terrestrial herbaceous plants. The herbaceous vegetation grows profusely where the tropical evergreen canopy is

moderately open and is almost completely absent in ridges and hilltops and in sheet rocks. The rocky outcrops are surrounded by grass and are covered with masses of broken ferns and lichens.

The common terrestrial ferns found in the area are of the genera *Allophylus*. Epiphytic vegetation of the tropical evergreen forests is abundant. Orchids with thin water storing roots are common but not as frequent as the ferns, which range from the hydrophilous to small xerophilous. The bulk of epiphytic vegetation is of mosses and lichens, which indirectly serve as a water-retaining substratum for larger forms. Climbers are abundant along the banks of watercourses and are less abundant where canopy is closed. The common species of climbers are *Enteda scandens*, *Gnetum scantons*, *Calamus sp.*, *Acacia intsia*, *Caesalpinia sp.*, *Calycopteris floribunda*, *Celastrus paniculata* and *Butea parviflora*. Canebrakes of varying density are found in flat and very well drained areas.

2.9.3.2 ECOLOGY OF THE FOREST TYPE:

The common concept is that the tropical evergreen forest represents a climax stage without retrogression or progressive change or in other words as fairly stable. The view of single climatic climax for any given type of climate, the mono-climax theory, (Clement) has been challenged by the later authors who feel that it is not enough to consider climate alone as a limiting factor thereby excluding possibilities of progressive changes. The alternate theory is a poly climax theory, which accepts same general view of succession considering that each pronounced variation in site conditions within a given type of climate will tend to have its own recognizable climax, typically as edaphic climax pre and post climax developing on a particular soil type. Of late much preference is given to poly climax view, leading to a dynamic rather than static equilibrium, with possible cyclic alterations of varying complexity. The well-known ecologist Watson summarizes that the tropical evergreen forests should be considered as continuum in which the parts are in unstable equilibrium. So much so it could be seen that a forest type maintaining itself as a whole as a single complex unit but is continually changing at given spot.

As a whole, whatever effect plant populations may have in climax composition, there is no absolute climax for any area, and the prevailing climax for any area is a function of the sum total of all the factors of the ecosystem i.e. climate, soil, other site factors, biotic influence,

presence of different species and their characteristics, dispersal and regeneration. Thus all climaxes should be at the same time physiognomic, edaphic, biotic as well as climatic and further more distinction between the climatic climax, sub and pre-climax, edaphic climax etc, have no logical basis. The climax hence should accordingly be viewed as an average of most probable population.

In view of the above facts the tropical evergreen forests of Wayanad Division has to be viewed as the most probable population that could exist under given ecological factors like climate, soil, site factors, availability of species and their characteristics. Since the tropical evergreen forests of Wayanad Division covers a comparatively smaller area, the climate prevailing in the area could be treated as one and the same as the variation of climate over a small area is comparatively negligible. Taking into account the characteristics of species it could be seen that most of the species occupying the 1st storey are of evergreen character. But 60% of the composition has been occupied by deciduous species like *Terminalia bellirica*. Eminent foresters like Champion and Richard's stated that the presence of the top storey trees of deciduous character would not affect the evergreen nature of the forest as a whole or warrant recognition of the type to a lower order.

As far as the 2nd storey of the vegetation is concerned, the species are predominantly - evergreen. However 4.06% of the composition is of the deciduous type. The occurrence of deciduous species in the order of 4.06% is negligible to warrant classifying the vegetation as a whole as semi-evergreen. But the occurrence of deciduous species in the lower canopy (4.06%) lends to think and conclude that existence of deciduous species in the community under given climatic and edaphic conditions is quite normal. The percentage of occurrence of deciduous species in the community may increase in due to biotic interference.

The deciduous species in the lower canopy may be occurring due to site factors or due to biotic interference. Of which the biotic interference bears much direct effect than the edaphic. The existing communities of vegetation of this area have been subjected to indiscriminate felling by their owners. If this plant community is protected from biotic interferences, and is subjected to cultural operations such as artificially inducing natural regeneration of evergreen

species, and is left un-disturbed, it will help the nature itself to play its role. Given adequate opportunity the ecology itself, as a rule of succession will eliminate the deciduous species from the community in the battle for the survival of the fittest.

2.9.3.3 FLORISTIC COMPOSITION:

The density of species is very high unlike in the moist deciduous type of forest. A few species of top canopy may remain deciduous over a short period. The dominant species found in the area are shown below.

Sl.No	Botanical name	Local name	Family
Trees of top storey			
1	<i>Artocarpus hirsu</i>	Anjily, Aini	Moraceae
2	<i>Bombax ceiba</i>	Elavu	Bombacaceae
3	<i>Calophyllum elatun</i>	Punnapai	Celastraceae
4	<i>Cullenia excelsa</i>	Vediplavu	Bombacaceae
5	<i>Elaeocarpus tuberculatus</i>	Bhadraksham	Elaeocarpaceae
6	<i>Garcinia Morella</i>	Chigiri	Clusiaceae
7	<i>Hopea parviflora</i>	Kambakam	Dipterocarpaceae
8	<i>Mesua ferrea</i>	Nanku	Chusiaceae
9	<i>Palaguium ellipticum</i>	Paali	Sapotaceae
10	<i>Persea macarantha</i>	Kulamaavu, Ooravu	Lauraceae
11	<i>Polyalthia fragrans</i>	Nedunaar	Anonaceae
12	<i>Terminalia bellirica</i>	Thanni	Combretaceae
13	<i>Vateria indica</i>	Venapine	Dipterocarpaceae

2. Trees of middle storey

1	<i>Acrocarpus fraxinifolius</i>	Narivenga	Caesalpinioideae
2	<i>Bischofia javanica</i>	Mlachathayam	Euphorbiaceae
3	<i>Canarium strictum</i>	Thellippayin	Burseraceae
4	<i>Elaeocarpus serratus</i>	Kara	Elaeocarpaceae
5	<i>Knema attenuate</i>	Chorappayin	Myristicaceae
6	<i>Macaranga peltata</i>	Vatta	Euphorbiaceae
7	<i>Myristica dactyloides</i>	Adakapayin	Myristicaceae
8	<i>Nephelium longana</i>	Chempunna	Sapindaceae
9	<i>Stercuila guttata</i>	Peenari	Sterculiaceae
10	<i>Toona ciliate</i>	Mathagiri vembu	Meliaceae

3. Trees of lower storey

1	<i>Actinadaphne bourdillonii</i>	Malavirinja	Lauraceae
2	<i>Antidesma menasu</i>	Putharaval	Euphorbiaceae

3	<i>Aporosa lindleyana</i>	Vetti	Euphorbiaceae
4	<i>Bambusa arundinaceae</i>	Mula	Poaceae
5	<i>Cinnamomum malabratrum</i>	Vayana	Lauraceae
6	<i>Ixora axborea</i>	Soochimulla	Rubiaceae
7	<i>Laea indica</i>	Maniperandi	Laeaceae
8	<i>Olea dioica</i>	Edana	Oleaceae

4. Epiphytes

1	<i>Aeschynanthus perrottetti</i>	-----	Gesneriaceae
2	<i>Medinilla beddomei</i>	-----	Melastomataceae
3	<i>Sirhookera latifolia</i>	-----	Orchidaceae

5. Undergrowth and climbers

a. Woody climbers and Stragglers

1	<i>Acacia intia</i>	Incha	Mimosaceae
2	<i>Calycopteris floribunda</i>	Pullani	Combretaceae
3	<i>Celastrus paniculata</i>	----	Ulmaceae
4	<i>Butea parviflora</i>	----	Papilionaceae
5	<i>Gnetum scantona</i>	Karuthoda	Gnetaceae
6	<i>Entada scandens</i>	Kakkumvalli	Mimosaceae

b. Herbaceous climbers

1	<i>Myxopyrum serratulum</i>	Chathuramulla	Oleaceae
2	<i>Smilax macrophylla</i>	----	Smilacaceae

c. Shrubs

1	<i>Calamus sp.</i>	Chooral	Palmae
2	<i>Costus Speciosus</i>	Channakoova	Zingiberaceae
3	<i>Mallotus philippenensis</i>	Manjana, Shemkolli	Euphorbiaceae
4	<i>Psychotria sp.</i>	----	Rubiacea
5	<i>Strobilanthus</i>	Kurinji	Acanthaceae

d. Herbs

1	<i>Elephantopus scaber</i>	Aanachuvadi	Asteraceae
2	<i>Molineria trichocarpa</i>	Nilappana	Amaryllidaceae

2. 9. 4 SITE- 4 ONDEYANGADY:

It is a semi-evergreen patch spread into 140 ha. in the Thrissilery reserve forest of Begur range. It is a highly disturbed and isolated patch, without having any continuity with other natural forests of the area. It is surrounded by the Mananthavady-Mysore road towards the eastern boundary, paddy fields of the Thrissilery villages to the west and pepper, Coffee and other mixed cultivations to the north and south.

There are three small perennial streams flowing through it. Villagers from the western side have

accessibility to the Mananthavady- Mysore road crossing through this stretch of forest. Fire wood collection, moderate cattle grazing, usage of stream water for bathing and washing clothes form other human disturbances in the site. The vegetation is similar to that of Thirunelli.

2.9.5 SITE 5- BANASURAN MALA:

It is a steep rolling hillock falling under Mananthavady range towards the southern boundary of the North Wayanad division. It lies along the boundary line between North Wayanad and South Wayanad divisions and the Wayanad- Kozhikode districts. The Hill was approached from Makkiyad, a village on the Mananthavady- Kuttiady road. This hill is the highest peak in the North Wayanad division with an altitude of 2050 m. The site selected under the Makkiyad forest station was part of a 2499 ha. tract of vested forest. It was bounded in the west by Vadagara taluk, east by Vellamunda village, North by Pakramthalam Niravilpuzha road and human habitations. In the south of Banasuran is the Kurumbanad taluk of Calicut district. The Perinchery mala, Poovirinji mala, Mecheri mala, Mundakumbu mala, Cherunmundi mala, Kolipad, Pannipad, Chembil and Puliyarkotta are parts of this hill range. The vegetation consists of mainly grasslands and stunted trees; interspersed huge rocks are common. The valleys are farm lands.

2.9.5.1 CHARACTERISTIC FEATURES OF THE VEGETATION:

The shoala type of vegetation present here includes both tropical and sub temperate genera mixed together. This type of forest is restricted to the depressions of the mountain, where the moisture content is high. They are isolated, compact and usually small woods composed of stunted evergreen trees.

The main floristic composition of the shoals are *Acronychia pedunculata*, *Apollonias arnottii*, *Atlanta wightii*, *Allophylus distachys*, *Diospyros saldanhae*, *Euonymus indicus*, *Eurya nitida*, *Eldeocarpus munronii*, *E. serratus*, *Glochidion ellipticum*, *G. velutinum*, *Gordonia obtuse*, *Meliosma simplicifolia*, *Lasidnthus jackianus*, *Ligustrum robustum subsp. Walkeri*, *Litsea ligustrina*, *L. oleoides*, *Microtropis stocksii*, *Prunus ceylanica*, *Schefflera racemosa*, *S. venulosa*, *S. wallichiana*, *Symplocos cochinchinensis* and *S. foliosa*. Some of the semi parasites

like *Dendrophthoe falcate*, *Helixanthera wallichiana*, *Macrosolen parasiticus*, *Taxillus tomentosus*, *Tolypanthes lagenifer* and *Viscum angulatum* are common on the branches of trees. The straggling species of *Fagraea ceilanica*, *Gardneria ovata* and *Elaegmus kologa* are also found. Some of the species of shola margins are *Debregeasia longifolia*, *Laportea crenulata*, *Maesa indica*, *Nilgirianthus asper*, *Nothopegia spp.*, *Syzygium tamilnaddensis*, *Vernonia arborea* and *Turpinia malabarica*.

The grasslands of this hill tract have some of the important species of grasses like *Arundinella setosa*, *Chrysopogon hackelii*, *Eulalia trispicata*, *Jansenella griffithiana* and *Themeda spp.* The following species are commonly interspersed with grasses: *Curcuma neligherrensis*, *Euphorbia rothiana*, *Exacum bicolor*, *Hypericum mysurense*, *Habenaria longicorniculata*, *Justicia neligherrensis*, *Knoxia mollis*, *Laggera alata*, *Leucas vestita*, *Murdannia lanuginose*, *Peristylis spiralis* and *Swertia lawii*. Along the hill tops *Phoenix humilis var. pedunculata* grows in a scattered manner.

2.9.6 SITE 6- AYILAMOOLA:

This is an agricultural field with plantation crops, fruit trees, vegetables, cereals and pulses etc. Annual and seasonal tilling operations are carried out. Paddy fields, small perennial streams, wells etc. are present in the area. The ground will be usually covered with weeds from June to October.

2.9.6.1 VEGETATION:

CROPS AND SIMILAR ECONOMICALLY IMPORTANT PLANTS:

The major cereals like *Oryza sativa* and *Eleusine coracana* are cultivated. Pulses like *Cajanus cajan*, *Cicer arietinum* and *Vigna mungo* are also cultivated. The chief vegetables and fruits grown are *Amorphophallus paeoniifolius*, *Anacardium occidentale*, *Citrus spp.*, *Citrullus lanatus*, *Colocasia esulenta*, *Lablab purpureus*, *Mangifera indica*, *Manihot esulenta*, *Musa spp.*, *Artocarpus heterophyllus* etc. Besides these plantation crops such as *Coffea arabica*, *C. robusta*, *Hevea brasiliensis*, *Thea chinensis* and *Theobroma cocoa* are largely cultivated. Some of the condiments and spices like *Cinnamomum verum*, *Curcuma longa*, *Elettaria cardamomum*, *piper nigrum* and *Zingiber officinale* are also cultivated. Other economically important plants like *Areca catechu*, *Cocos nucifera*, and *Saccharum officinarum* are also cultivated in some areas.

3. Methodology

Abundance and diversity of avifauna in the five sites falling under the two study areas were analyzed in detail by visiting each site once a month from April 1999 to March 2004. Bird population studies were carried out by line transect, variable distance line transect, point count and opportunistic observation methods. Standardized timed bird censuses were conducted in the morning from 7 am to 12 noon and in the evening from 3 pm to 6 pm. The first year of the study was dedicated only for secondary data collection. Most intensive sampling efforts were done during 2001 -2004. All the birds seen or heard in the transects were recorded. An 8x40 zenith prismatic binocular and a portable tape recorder were used for identifying the birds and recording their sounds. The data obtained were compiled and correlated.

3.1.1 PRIMARY DATA COLLECTION:

This was done by visiting the areas and doing the actual survey.

3.1.2 SECONDARY DATA COLLECTION:

This was done by verbal or other modes of communication with the locals, forest and other department officials, referring to published work etc.

3.2 AVIAN COUNTING TECHNIQUES:

A large amount of potential biases may occur in avian counting techniques. Birds vary greatly in traits that affect how well they can be counted. Some species are more detectable than others, depending on such factors as song, movement pattern and social behavior. These factors may vary even within the species through the breeding season due to different breeding schedules or mating systems. All census techniques can be influenced by weather conditions. Days with high wind and poor visibility can greatly affect results. Characteristics of the study design can greatly bias results of counting techniques. Small study sites may tend to exclude species found at low densities, while too large sites may result in inadequate coverage for good estimates. Taking all these limitations in to consideration, the following area-intensive sampling techniques are used in the present study.

3.2.1. LINE TRANSECT:

A permanently marked two km. long tract was made in each study site. The width of the sampling area was 100 meter; i.e.; 50m. on both side .Bird observations were carried out walking through this tract in a uniform speed, counting the birds in the forward direction only. Birds flew above 40m. height were ignored. Standard printed data sheet were used in the field.

Bird communities in the forest habitats of Wayanad						
Line transect data sheet						
Site :			Transect No :			
Date :			Weather :			
Time :			Direction :			
No	Name of the bird	No of Birds	Height	Position	Activity	Remarks

Table 5: Bird communities in the forest habitats of Wayanad , South India –Sample data sheet.

3.2.2. VARIABLE-DISTANCE LINES TRANSECT:

This technique involves a straight-line transect and measures the distance and angle of observation for each bird seen. These measures can be used to compute distances of separation between individual of the same species and to derive estimates of densities. This technique was originally designed by Emlen (1971) but has been modified in many ways (Burnham et al. 1980). Here all birds occurring along the transect are counted, but no birds are counted more than once during a single count along the transect. This technique is perhaps the best general technique for measuring the avian densities, because of its flexibility to the characteristics of different species and to built-in, species-specific measures of detectability. A magnetic compass was used in the field to maintain a straight line and the distance was paced out by foot.

	A	B	C	D	TOT
WIDTH OF STRIP (FT)	50	50	100	212	412
NO. BIRDS DETECTED	60	42	41	12	155
PROJECTED NO. PRESENT	60	60	120	250	490

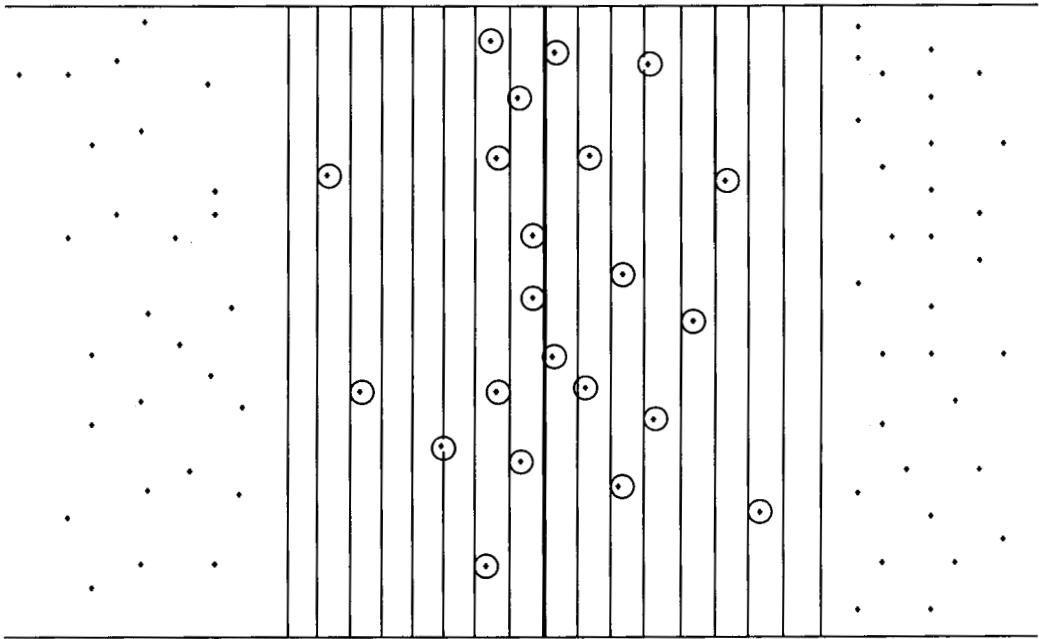


Fig 8: Schematic model of the Emlen transect technique.

The figure shows the location of a transect (median line) through randomly scattered birds (dots). Birds detected by eye or ear are circled. The line parallel to the transect denote strips of coverage. However this method was not used for specific data collection. It was used occasionally in association with line transect method to supplement data collection by that method.

3.2.3 POINT COUNT:

It is a line transect done at zero speed for short duration of time (Verner, 1985). Data is collected standing at a fixed point in the study site for approximately 15 minutes. Distance between two such points was about 200m. The points were selected at random

in the study area. These data were used only for activity pattern. Social association, food habits, courtship behavior etc. only. Not for species diversity.

3.3 RICHNESS INDEX:

A number of indices have been proposed to measure species richness that are independent of the sample size. They are based on the relationship between S , the total number of species in a community and the total number of individuals observed, n , which increases with increasing sample size.

Two well-known richness indices are used for calculations in the present study. They are:

Index 1, the Margalef (1958) index,

$$R1 = \frac{S-1}{\ln(n)}$$

and index 2, the Menhinick (1964) index

$$R2 = \frac{S}{\sqrt{n}}$$

To find out the usefulness of these indices consider the practical consequences of applying $R2$, the Menhinick index. Suppose $R2$ is used as a measure of species richness of avian communities at three sample locations along a mountain gradient. At the lowest elevation, let $S=30$, $n=100$ and, thus, $R2=3$. At the middle elevation, $S=15$, $n=25$ and, again, $R2=3$. Finally, at the highest elevation, $S=10$, $n=25$ and, now, $R2=2$. Based on these values for $R2$, should we conclude that species richness of the avian communities is greatest at the lower to mid-elevations on the mountain and that there are no differences until the highest elevation is reached? Before drawing any conclusions, it is important to recognize that the use of $R2$ presupposes that a functional relationship exists between S and n in the community and is, in fact, given by $S=k\sqrt{n}$, where k is constant. This must hold or $R2$ will vary with samples containing different values of n and, consequently, communities cannot be compared. Therefore, in preceding example, conclusions regarding species richness are conditional on whether or not the functional relationship between S and n is actually given by $S=k\sqrt{n}$ and, if so, that k is constant. As Peet (1974)

points out, if these assumptions fail to hold, the richness index will vary with sample size in some unknown manner.

3.4 DIVERSITY INDEX:

Diversity indices incorporate both species richness and evenness into a single value. Because of this, Peet (1974) terms these heterogeneity indices. Probably the biggest obstacle to overcome in using diversity indices is interpreting what this single statistic actually means. For example, in some cases a given value of a diversity index may result from various combinations of species richness and evenness. In other words, the same diversity index value can be obtained for a community with low richness and high evenness as for a community with high richness and low evenness. It follows, then, that if you are given just the value of a diversity index, it is impossible to say what the relative importance is of species richness and evenness.

The series of diversity numbers presented by Hill (1973b) are probably the easiest to interpret ecologically.

In equation form, Hill's family of diversity numbers is

$$N_A = \sum_{i=1}^S (p_i)^{1/(1-A)}$$

Where p_i is the proportion of individuals (or biomass, etc.) belonging to the i th species. The derivation of this equation is given in Hill (1973b). Hill shows that the 0th, 1st, and 2nd order of these diversity numbers [i.e., $A=0, 1,$ and 2 of the above equation] coincide with three of the most important measures of diversity. Hill's diversity numbers are

Number 0: $N_0 = S$

Where S is the total number of species

Number 1: $N_1 = e^{H'}$

H' is Shannon's index (defined below), and

Number 2: $N_2 = 1/\lambda$

Where, ' λ ' is the Simpson's index.

N_0 is the number of all species in the sample, N_1 measures the number of abundant species in the sample, and N_2 is a measure of very abundant species. Thus two indices are needed to compute Hill's diversity numbers; Simpson's index and Shannon's index.

3.4.1 DIVERSITY INDEX 1- SIMPSON'S INDEX, λ :

Simpson (1949) proposed the first diversity index used in ecology as

$$\lambda = \sum_{i=1}^S P_i^2$$

Where P_i is the proportional abundance of the i^{th} species, given by

$$P_i = \frac{n_i}{N}, \quad i=1, 2, 3, \dots, S$$

Where n_i is the number of individuals of the i^{th} species and N is the known total number of individuals for all S species in the population. Simpson's index, which varies from 0 to 1, gives the probability that two individuals drawn at random from a population belong to the same species. Simply stated, if the probability is high that both individuals belong to the same species, then the diversity of the community sample is low.

This equation applies only to finite communities where all of the numbers have been counted i.e., $n=N$, where n is the total number of individuals in the sample and N is the total individuals in the population.

3.4.2 DIVERSITY INDEX 2- SHANNON'S INDEX, H' :

The Shannon index (H') has probably been the most widely used in community ecology. It is based on information theory (Shannon and Weaver 1949) and is a measure of the Peage degree of "uncertainty" in predicting to what species an individual chosen at random from a collection of S species and N individuals will belong. This average uncertainty increases as the number of species increases and as the distribution of individuals among the species becomes even. Thus, H' has two properties that have made it a popular measure of species diversity: $H=0$ if and only if there is one species in the sample and H' is maximum only when all S species are represented by the same number of individuals, that is, a perfectly even distribution of abundances.

The equation for the Shannon function, which uses natural logarithms, is

$$H^1 = -\sum_{i=1}^{s^*} (P_i \ln p_i)$$

Where H^1 is the average uncertainty per species in an infinite community made up of 'S' species with a non-proportional abundance $P_1, P_2, P_3, \dots, P_s$

3.5 EVENNESS INDICES:

A number of evenness indices have been used to quantify evenness component of diversity. A series of five indices are used here. They are all expressed as a ratio of Hill's numbers (Alatalo 1981).

3.5.1. EVENNESS INDEX 1 (E1).

The most common evenness index used by ecologists is

$$E1 = \frac{H^1}{\ln(S)} = \frac{\ln(N1)}{\ln(N0)}$$

This is the familiar J' of Pielou (1975, 1977), which expresses H^1 relative to the maximum value that H^1 can obtain when all of the species in the sample are perfectly even with one individual per species (i.e., $\ln S$).

3.5.2 EVENNESS INDEX 2 (E2).

Sheldon (1969) proposed an exponentiated form of E1 as an evenness index:

$$E2 = \frac{e^{H^1}}{S} = \frac{N1}{N0}$$

3.5.3 EVENNESS INDEX 3 (E3):

It was proposed by Heip (1974) and is expressed in the following way.

$$E3 = \frac{e^{H'} - 1}{S - 1} = \frac{N1 - 1}{N0 - 1}$$

3.5.4 EVENNESS INDEX 4 (E4):

Hill (1973b) proposed the ratio of N2 to N1 as index of evenness.

$$E4 = \frac{1/\lambda}{e^{H'}} = \frac{N2}{N1}$$

3.5.5 EVENNESS INDEX 5 (E5):

It is written in the form of the following equation.

$$E5 = \frac{(1/\lambda) - 1}{e^{H'} - 1} = \frac{N2 - 1}{N1 - 1}$$

Using the BASIC programme, SPDIVERS. BAS, (Ludwig and Reynolds, 1989) species richness, diversity and evenness indices were computed and summarized in tables.

3.6. SIMILARITY INDEX:

Similarity index is calculated from the number of species in each site and number of species common to two sites using the following formula.

Similarity index (Simpson) = $2B/A+C$

Where A= number of species in site number-1

B= number of species in site number-2

C= number of species in site number 1&2.

3.7 ASSOCIATION BETWEEN SITE NUMBER AND DIET/ FEEDING SUBSTRATUM:

Relation between site number and the food/ feeding substratum of the bird is determined by finding out the Chi square values and using the hypothesis

H₀: There is no association between site number and diet/ feeding substratum

H₁: There is an association between site number and diet/ feeding substratum

Chi square values are calculated from the tabular column using the formula

$$X^2 = \sum \frac{(O-E)^2}{E}$$

Where O = Observed value; E= Expected value

$$E = \frac{\text{Row total} \times \text{Column total}}{n}$$

Where n= grand total of row total/column total

Degrees of freedom: $df = (r-1)(c-1)$ where r is the total number of rows and c is the total number of columns

4. Results and Discussion

4.1. RESULTS

4.1.1. NUMERICAL ABUNDANCE:

Wayanad district lying along the Western Ghats is one of the endemic bird areas home to nearly 300 bird species. Zacharias and Gaston (1993) have reported 275 species from Wayanad during their recent survey. In the present study involving only the forests of North Wayanad, an avifauna of 210 species are identified. Since the goal of the present study was to obtain samples for statistical comparison between sites, a complete species-list for each habitat is not represented by these samples. The data are only samples of avian use of the study sites. The size of the sampled population varied considerably: Site-1 with 1860 individuals stood first in the list. Site no-4 with 1809 individuals represented the second largest sample. Site no-2 with 1713 individuals stood third in the list followed by Site no-6 (1702 individuals) Site no-3 (1612) and site no-5 (1040). It is interesting to note that site-no-4 being a degraded patch recorded the second highest number of birds compared to other continuous stretches. It is notable that samples from site-1 & 2 showed a difference of 147 individuals only.

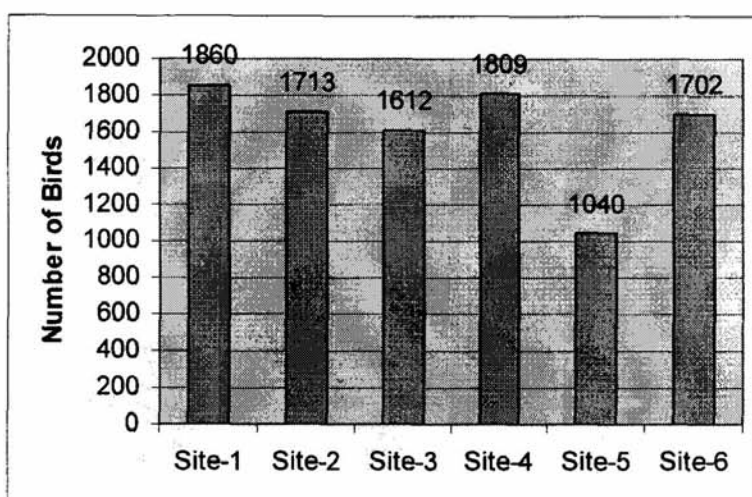


Fig 9: Graphical representation of the numerical abundance of birds in the different study sites

4.1.2 TAXONOMIC CATEGORIES:

Taxonomically the avifauna of the forests of North Wayanad represents 38 families under 13 orders. All the 13 orders were represented only at site no.-2. Birds from maximum families were also recorded in this site (37). This was followed by site no.-2, 3, and 5. Site.no-4 & 6 had the same number of families and orders. The order Passeriformes singly dominates by having 119 species of birds. The next order with most representatives is Ciconiformes (23 species). Turniciformes was represented by 13 species. Coraciformes and Cuculiformes were represented by 7 species and 11 species each. There were 7 species each from Galliformes and Columbiformes. Other orders were represented by fewer number of taxa, the least being Upupiformes and Trogoniformes with a single representative each. Study site-1 had no representatives from four families (Trogonidae, Batrachostomidae, Alaudidae and Fringillidae). Order Trogoniformes was also not represented here. Site no-2 was devoid of members from family Coracidae. The evergreen vegetation at site no.-3 lacked members from 6 orders viz. Upupidae, Hemiprocnidae, Batrachostomidae, Caprimulgidae, Alaudidae, and Fringillidae. Order Upipidae was not represented here. Eight orders-Upupidae, Trogonidae, Apodidae, Hemiprocnidae, Batrachostomidae, Caprimulgidae, Alaudidae, and Fringillidae were not

represented at site no.4; the degraded semievergreen vegetation. Three orders—Upupiformes, Trogoniformes, and apodiformes were also absent in this site. The hill at site no.- 5 had no members from the families Upupidae, Coracidae, Centropodidae, Hemiprocnidae, Batrachostimidae, Caprimulgidae, and Alceidae. The orders Upupiformes and Coraciformes were also absent. The site no. 6 lacked members from family Bucerotidae, Upupidae, Trogonidae, Hemiprocnidae, Batrachostomidae, Caprimulgidae, Sittidae and Alaudidae. Orders Bucerotiformes, Upupiformes and Trogoniformes were also not represented here.

It is seen that the eastern part of north Wayanad with the moist deciduous forests and the northern part with the semi evergreen zones have higher number of birds than the evergreen forests of north western region of the district. A few taxa of birds were restricted to certain particular sites. For example The Greater Flameback, Crested Goshawk, Montagus Harrier, Bright headed Cisticola, Blue winged Leaf Bird, and Ceylone Frog Mouth etc. were sighted only at site-2. The Grey Francolin, Indian Pea Fowl, Blue faced Malkoha, Sirkeer Malkoha, White browed Fan tail, Wire Tailed Swallow etc.were seen only at site-no.1.Grey Horn Bill was seen only in site no.-1 & 2. Grey Breasted Laughing Thrush was recorded only from site-no 5.

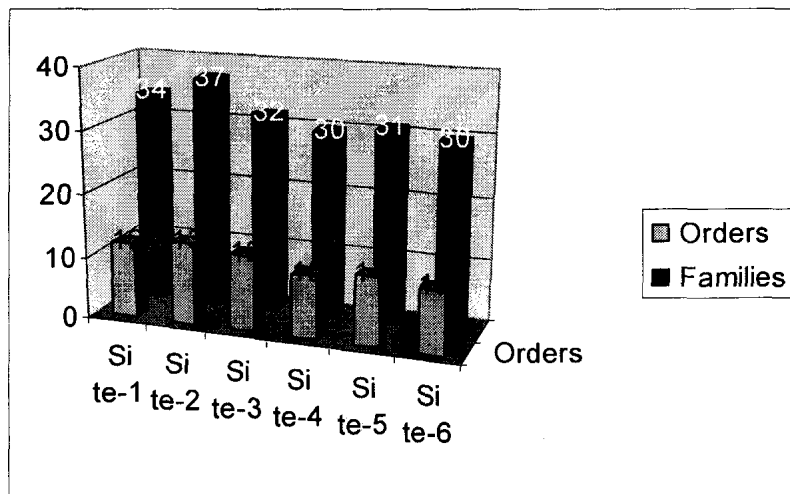


Fig. 10: Graphical representation of the number of families and orders in the various study sites

The total number of species belonging to each order recorded from the different study

sites is shown in the table. Orders- Coraciformes, Psittaciformes, and Strigiformes showed similarities in the number of species at site numbers 4 and 6. Maximum species from order Ciconiformes was recorded at siteno.-2.

Orders	S-1	S-2	S-3	S-4	S-5	S-6
GALLIFORMES	6	3	2	2	2	1
TURNICIFORMES	10	10	7	9	5	6
BUCEROTIFORMES	2	2	2	1	1	0
UPUPIFORMES	1	1	0	0	0	0
TROGONIFORMES	0	1	1	0	1	0
CORACIFORMES	5	3	5	4	2	4
CUCLIFORMES	11	3	6	4	1	5
PSITTACIFORMES	5	3	5	4	2	4
APODIFORMES	6	5	3	0	5	2
STRIGIFORMES	6	5	5	2	1	2
COLUMBIFORMES	5	6	6	6	5	2
CICONIFORMES	12	18	14	10	8	8
PASSERIFORMES	85	86	76	72	75	67
TOTAL NUMBER	154	146	132	114	108	101

Table 6: Table showing the number of species belonging to each order in the different study sites

Turniciformes, Cuculiformes and Ciconiformes showed a most uneven pattern of distribution among the six sites.

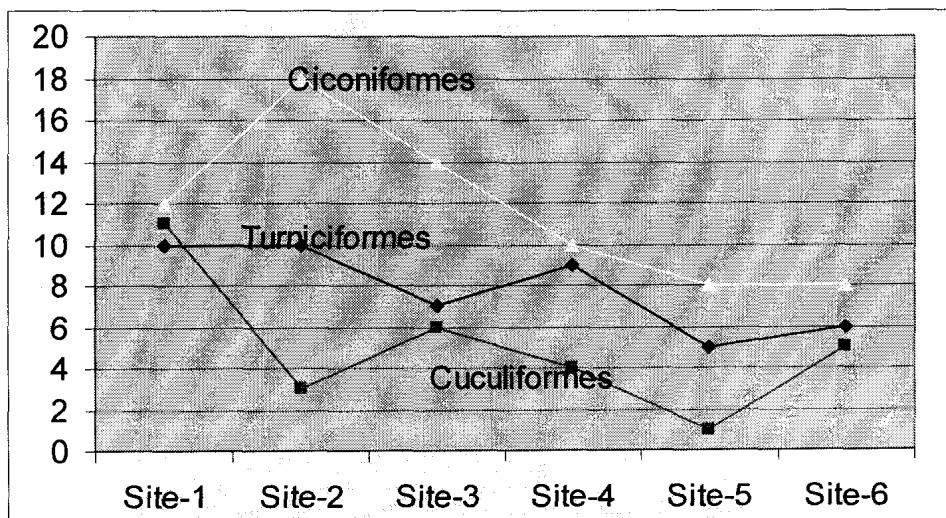


Fig 11: Graph showing the uneven distribution of three orders among the study sites.

Order Upupiformes was sighted only in site-no.1 & 2. The highest number of species from Ciconiformes was sighted in the semievergreen forests of Thirunelly. Galliformes showed maximum abundance in the largest forest among the six study areas i.e. Site-1. Their number gradually decreased and in site-no-1; the farmland only one species was recorded. Passeriformes were almost equally distributed among site-no. 1 & 2.

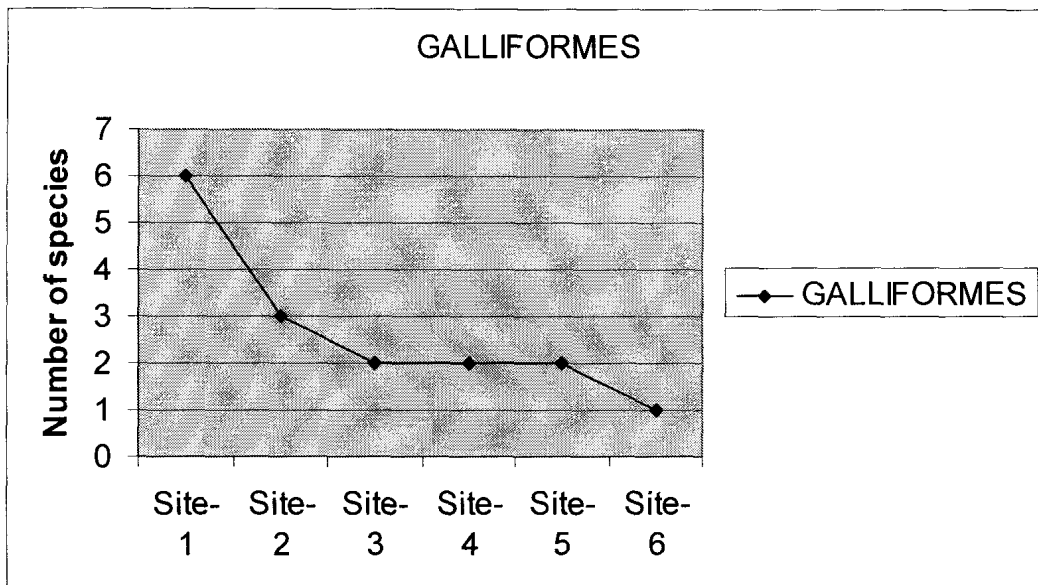


Fig 12: Graph showing the distribution of Galliformes among the study sites

4.1.3 BREEDING VS. MIGRATORY STATUS:

Out of the total 210 birds recorded during this study, 169 are breeding in Wayanad according to the previous records and the present observations, 38 are migrants, one is a Seasonal visitor and the status of two (Jerdon's Baza and Peregrine Falcon) are unknown. If the status of the birds are analysed sitewise, it can be observed that site no.4 has the maximum percentage of resident birds and the minimum percentage of migratory birds.

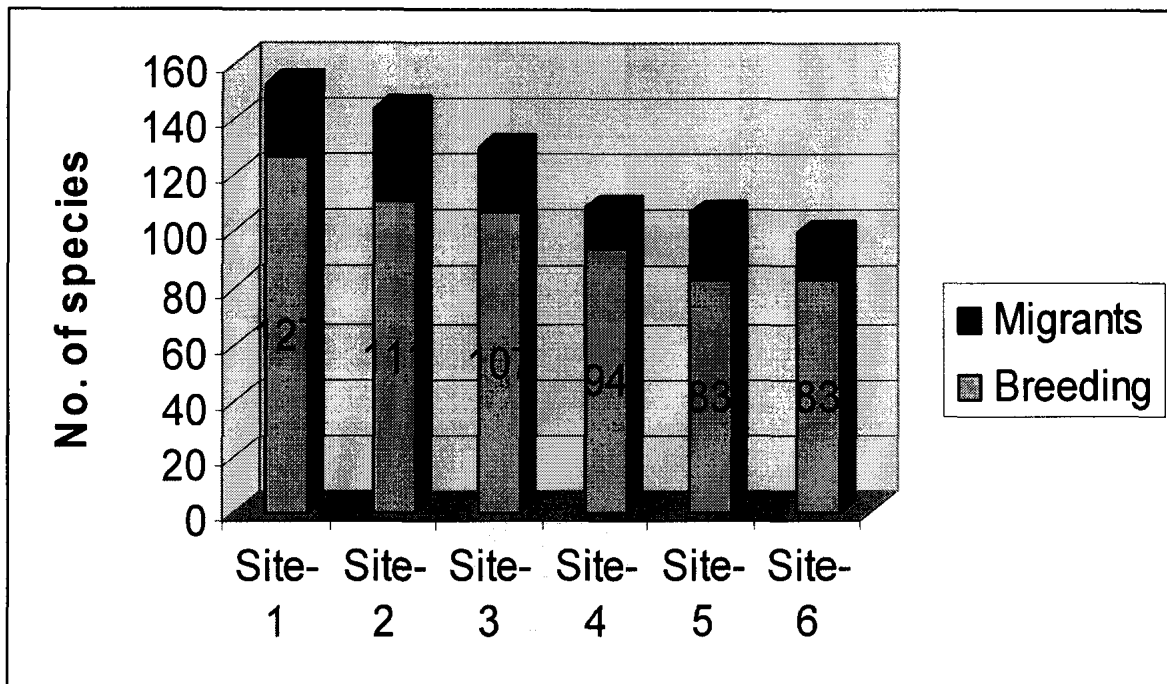


Fig 13: Chart showing the migratory status of birds in the study sites

Site no.2 has the maximum percentage (23 %) of migratory birds followed by site no. 5&3 respectively having 22%& 18% each. The percentage distribution of resident and migratory birds in the evergreen forest and farm land was almost similar. Similarity is observed in the distribution of these two categories in site no.2 and 5 also.

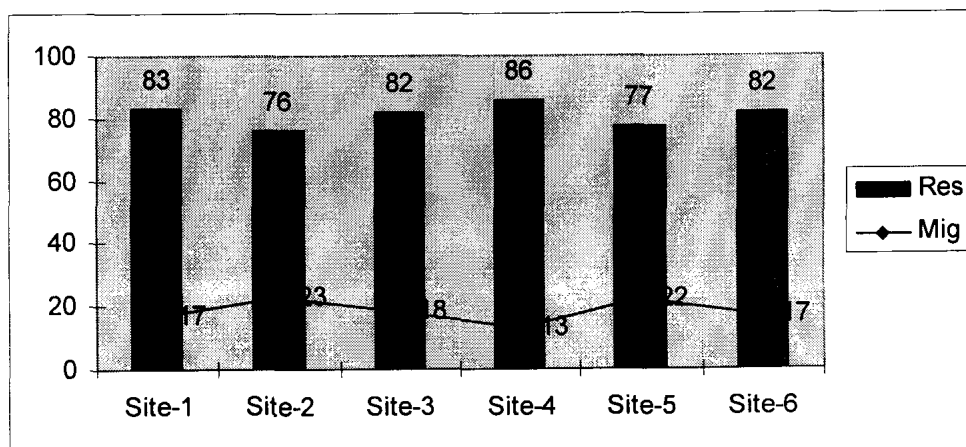


Fig 14: Chart showing the percentage abundance of resident vs. migratory birds among the study sites

4.1.4. BODY SIZE:

A correlation between the size of the bird and the area of the habitat is evident if the total number of species belonging to three orders (Galliformes, Strigiformes, and Ciconiformes) with larger birds is examined. Thus in the present study site numbers 1, 2 and 3 which were the larger ones among the six habitats had the maximum number of larger species belonging to these three orders as shown below.

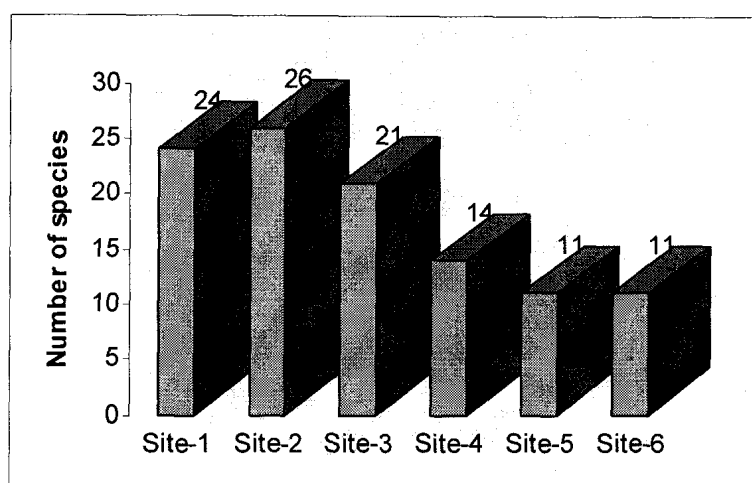


Fig 15: graphical representation of the distribution of larger birds among the study sites

4.1.5. SPECIES RICHNESS AND DIVERSITY:

There is a clear difference in the bird fauna among the six study sites on the ghats with evergreen area having 132 species, semi evergreen 146 species, degraded semi ever green fragment 114 species, deciduous area 154 species, hill area 108 species and the farm land 101 species. In terms of species numbers site no-1 (deciduous) was the richest. Between the two largest forests a difference of only 8 species was observed, irrespective of their deciduous and semievergreen nature. The farm land recorded the least number of species. Between the disturbed semi evergreen patch and the farmland a difference of 13 species was noticed. Site no.5 (Hill area) was also relatively species poor. Despite the similarity between the habitat types, a difference of 32 species was noticed between site-no 2 & 4. Site numbers 1 & 2 were the most diverse among all the habitats studied. There was close similarity in the diversity values between site- no.4 & 6. Whereas the diversity values for site no. 2&4 showed wide differences despite their similarity in the vegetation

Richness	Site-1	Site-2	Site-3	Site-4	Site-5	Site-6
R0 or 'S'	154	146	132	114	108	101
R1	20.32	19.47	17.47	15.07	15.40	13.44
R2	3.57	3.53	3.29	2.68	3.35	2.45
Diversity						
^	0.023	0.018	0.028	0.029	0.024	0.029
H	4.37	4.28	3.81	3.72	3.79	3.73
N1	79.04	72.24	45.15	41.26	44.26	40.16
N2	43.47	55.56	35.71	34.48	41.66	32.11
Evenness						
E1	0.87	0.86	0.78	0.78	0.81	0.80
E2	0.51	0.49	0.34	0.36	0.41	0.40
E3	0.51	0.49	0.34	0.36	0.40	0.39
E4	0.55	0.77	0.79	0.84	0.94	0.78
E5	0.55	0.77	0.79	0.83	0.94	0.79

Table 6: Species Richness, Diversity and Evenness indices for the six study sites

The abundance and diversity of bird species in the first site compared to the second and third which had more tree diversity, dense canopy and thicker litter deposits has to be attributed to various aspects like the continuity of this site with the Nagarhole national park and Bandipur tiger reserve of Karnataka, the patchiness of the habitat, the rich under growth etc. Roth (1976) has suggested that closed forests are less patchy and support less bird diversity than forests with broken canopy. Site-3 with its closed canopy recorded comparatively lesser value for bird diversity than site-1&2. Among the last three species poor habitats site-no-5 showed the highest value for evenness.

4.1.6. SIMILARITY INDICES:

Sites	Similarity index
Site-1 & 2	0.643
Site-2 & 3	0.581
Site-3 & 4	0.642
Site-4 & 5	0.637
Site-5 & 6	0.637
Site-4 & 6	0.614
Site-2 & 4	0.561

Table 8: Similarity indices between the study sites

The high value of similarity between site no-1& 2 may attributed to the fact that both of them are natural vegetations continuous with other such vegetations But the high value for similarity index between site-4 & 6 (Table) is significant since the former is a highly disturbed natural vegetation and the latter a man made ecosystem. Site no.-2&3 showed the least value for similarity index and that is quite possible since both of them are totally different kinds- One is semievergreen continuous stretch and the other is a an evergreen moderately disturbed patch.Though site no.-2 & 4 were similar types of habitats with semi evergreen vegetation. Site no.2 was a less diturbed continuous forest where as site-4 was a highly disturbed fragment. Hence the low value for similarity index between them.

4.1.7. FEEDING BEHAVIOUR:

The basic feeding adaptations of any species lie in such fundamentals as method and speed of locomotion; acuteness of sense organs, psychological bent, diurnal or nocturnal activity, character of beak and tongue; shape and strength of feet etc. A bird,s bill may place constraints on what food it can process in the least amount of time, since handling time also cn be costly in terms of energy.In a laboratory study ,Wilson(1971) found that given the opportunity to choose between seeds of high caloric content versus seeds with fewer calories that could be husked more quickly, birds tende to choose the latter.Smaller seeds are more easily handled and more quickly swallowed by smallerbirds , permitting the birds to keep moving and suffer less risk of predation. Birds forage in areas and manners yielding the maximum in energy return. Exploratory sips enable birds to detect flowers yielding the highest return of energy.

Availability of food seems to be an important factor in determining local bird diversity. Bird's nesting success and survival are influenced by food abundance, particularly of *lepidopteran* larvae. Bird species differ in the exploitation of food resources, primarily in foraging maneuvers. Food resources and how they are exploited are some how important to the structure and functioning of bird communities. Food is potentially important in the ecology, morphology, behaviour, abundance, and distribution of bird species, and hence community structure (Holmes, 1990). Many birds are more catholic in tastes. They

quickly learn from experience where and how food may be obtained. In food collection, birds initially respond to wide range of stimuli, later modified by learning. The resource use may largely depend on the available food resources and their abundance. Their ability to obtain a living in unpromising circumstances is remarkable. Availability of nectar determining the patterns of distribution and habitat use of many taxa of birds is reported from New Zealand. Among the birds that frequently visited the coniferous plantations, nectarivorous birds were noticeable (Clont & Gaze, 1984). It is known that insectivorous birds subsist on nectar during the cold seasons when insect availability is lean. Similarly nectarivorous birds feeding on sap oozing from trees or on small insects attracted there to is reported from temperate forests in north America (Miller and Nero, 1983; Holmes *et. al.*, 1986). Among insectivorous birds, variations in the availability of particular arthropod prey can affect the foraging opportunities. Foliage arthropods vary markedly between different forest types. The sampling of over 2,300 birds with mist nets revealed that the abundance and species richness of understory insectivorous birds were significantly lower in small fragments (Sekercioglu, C.H 2002). Abundance and species richness of birds in other guilds, such as granivores, nectarivores, and omnivores, did not differ or were greater in small fragments. The limited dispersal capabilities of understory insectivores may be the most important reason behind their sensitivity to fragmentation. Insectivorous birds were significantly underrepresented in the nonforest matrix surrounding forest fragments. The opposite was true for other guilds, such as granivores, nectarivores, and omnivores. The weak dispersal across nonforest habitats is the main reason behind the disappearance of many insectivorous species from forest fragments.

In north temperate forests; Lepidoptera larvae comprise the largest part of the arthropod biomass on foliage (Graber and Graber, 1983, Holmes *et. al.*, 1986; Thiollay, 1988) and are a major prey item for insectivorous birds during their breeding period. Their abundances vary markedly from year to year, leading in years of their low abundance to food limitations for at least some bird species (Rodenhouse, 1986; Martin, 1987; Holmes, 1988). In tropical forests, Orthopterans are the major insect defoliators (Greenberg and

Gradwohi, 1980; Greenberg, 1987; Thiollay, 1988). Since most Orthopterans feed at night and hide during the day, they are probably much less available to foraging birds than the Lepidoptera larvae in temperate forests. Since the Orthopterans hide during the day in dead leaf clusters only certain species with appropriate search behaviours will exploit them (Greenberg, 1982; Greenberg, 1987). Among frugivorous birds, the size, type and qualities of available fruits determine the individuals present in the community.

Based on food habits the bird communities in the study area were grouped as insectivores, frugivores, nectarivores, omnivores and predators and generalists. The generalists are those birds which feed on more than two types of food often at the same trophic level. The insectivores based on their foraging niche show a clear segregation into bark gleaners and ground gleaners. Birds which feed from more than two trophic levels are treated as omnivores (Giller, 1984). Omnivory seems to work as a buffer to the changing food availability. Birds switch over from one food to another more often in developed forests. Fluctuations in food availability are more here (Pramod, 1995).

INSECTIVORES

- Grey Francolin
- Rain Quail
- Jungle Bush Quail
- Painted Bush Quail
- Red Spur fowl
- Grey Jungle Fowl
- Indian Pea Fowl
- Speckled Piculet

- Brown Capped Wood pecker
- Yellow crowned woodpecker
- Rufous Wood pecker
- White bellied Wood pecker
- Common Flame back
- Black Rumped Flame back
- Greater Flame back
- White Naped Wood pecker
- Heart Spotted Woodpecker
- Eurasian Hoopoe

- Eurasian Black bird
- White bellied Shortwing
- Asian Brown flycatcher
- Rusty tailed flycatcher
- Brown breasted Flycatcher
- Red breasted flycatcher
- Verditor flycatcher
- Nilgiri flycatcher
- White bellied Blue Flycatcher
- Blue Throated Fly Catcher
- Tickell's blue flycatcher
- Blue Throat
- Indian Blue Robin
- Oriental Magpie-robin
- Pied Bush chat
- Chestnut Tailed Starling
- Brahminy Starling
- Common Myna
- Jungle Myna

- Plum Headed Parakeet
 - Alexandrine Parakeet
 - Malabar Parakeet
 - Nilgiri Wood Pigeon
 - Spotted Dove
 - Emerald Dove
 - Pompadour Green Pigeon
 - Yellow Footed Green Pigeon
 - Mountain Imperial Pigeon

 - Hill Myna
 - Rose Ringed Parakeet
- RAPTORS**
- Oriental Scops Owl
 - Spot Bellied Eagle Owl
 - Brown Fish Owl
 - Jungle Owlet
 - Brown Hawk Owl
 - Jerdons Baza
 - Oriental Honey Buzzard

Malabar Trogon	Chestnut bellied nuthatch	Black Winged Kite
Indian Roller	Velvet fronted nuthatch	Black Kite
Blued Bearded Kingfisher	Great Tit	Brahminy Kite
Little Green bee-eater	Black lored Tit	White Rumped Vulture
Blue Tailed bee-eater	Dusky crag martin	Crested Serpant Eagle
Chestnut Headed bee-eater	Barn Swallow	Pallied Harrier
Pied Cuckoo	Hill Swallow	Montagu's Harrier
Large Hawk-Cuckoo	Wire tailed Swallow	Crested Goshawk
Common Hawk-Cuckoo	Red rumped Swallow	Shikra
Indian Cuckoo	Grey Headed Bulbul	Besra
Banded Bay Cuckoo	Bright Headed Cisticola	Eurasian Sparrow-hawk
Grey bellied cuckoo	Grey Breasted Prinia	Common Buzzard
Drongo Cuckoo	Plain Prinia	Black eagle
Blue Faced Malkoha	Ashy Prinia	Rufous bellied Eagle
Sirkeer Malkoha	Blyth's reed Warbler	Changeable HawkEagle
Indian Swiftlet	Thick billed Warbler	Mountain hawk-eagle
White Rumped Spine tail	Booted Warbler	Common Kestrel
Brown backed Needle tail	Common Tailor bird	Red necked Falcon
Asian Palm swift	Tickell's leaf Warbler	Peregrine falcon
Alpine swift	Greenish Warbler	OMNIVORES
Crested tree swift	Yellow breasted Warbler	White Throated Kingfisher
Ceylon frogmouth	Tytlers Leaf Warbler	Greater Coucal
Grey Nightjar	Western Crowned Warbler	House Crow
Indian Pitta	Broad Tailed Grass bird	Large Billed crow
Grey headed Canary Fly catcher	Wayanad Laughing Thrush	Cattle Egret
Asian Fairy Blue bird	Grey Breasted Laughing Thrush	Indian Pond heron
Blue winged Leaf Bird	Puff Throated Babbler	GRAVIVORES
Golden fronted Leaf Bird	Indian scimitar Babbler	Blue Rock Pigeon
Brown Shrike	Tawny bellied Babbler	House Sparrow
Bay backed Shrike	Dark Fronted Babbler	NECTARIVORE
Long tailed Shrike	Yellow eyed Babbler	Oriental White Eye
Rufous Tree Pie	Rufous Babbler	Purple rumped Sunbird
White Bellied tree pie	Jungle Babbler	Crimson Backed sunbird
Ashy wood swallow	Brown cheeked Fulvetta	Purple Sunbird
Eurasian Golden Oriole	Oriental sky lark	Long billed Sun bird
Black headed oriole	Forest wagtail	Little spider hunter
Large Cuckoo Shrike	White Browed wagtail	Common Rose Finch
Black Headed Cuckoo Shrike	Yellow wagtail	GENERALISTS [I/Be/N/F]
Small Minivet	Grey wagtail	Black Crested Bulbul

Scarlet Minivet	Paddy field Pipit	Red whiskered Bulbul
Bar Winged Fly Catcher	Olive Backed Pipit	Red vented Bulbul
Shrike		
White Browed Fan tail	Nilgiri Pipit	White browed Bulbul
Black Drongo	White rumped Munia	Yellow browed Bulbul
Ashy drongo	Black Throated Munia	Black Bulbul
White bellied drongo	Scaly breasted Munia	Thick billed Flower pecker
Bronzed drongo	Black headed Munia	Pale billed Flower pecker
Hair Crested Drongo	FRUGIVORES	Plain Flower pecker
Greater racket-tailed Drongo	White Cheeked Barbet	
Black naped Monarch	Crimson Fronted Barbet	
Asian Paradise flycatcher	Coppersmith Barbet	
Common Iora	Malabar Grey Hornbill	
Large Wood Shrike	Malabar Pied Hornbill	
Common Wood Shrike	Great Horn bill	
Blue Capped Rock Thrush	Asian Koel	
Blue Rock Thrush	Vernal Hanging Parrot	
Malabar Whistling Thrush	Rose Ringed Parakeet	

Table 9: Table showing the classification of birds according to their food habits

Among all the study sites insectivores showed maximum abundance and richness in site no.1. Frugivores showed almost uniform distribution among the first three sites. Then among the last three sites it showed a gradual decrease with the least number of species in the last site (Farm land).

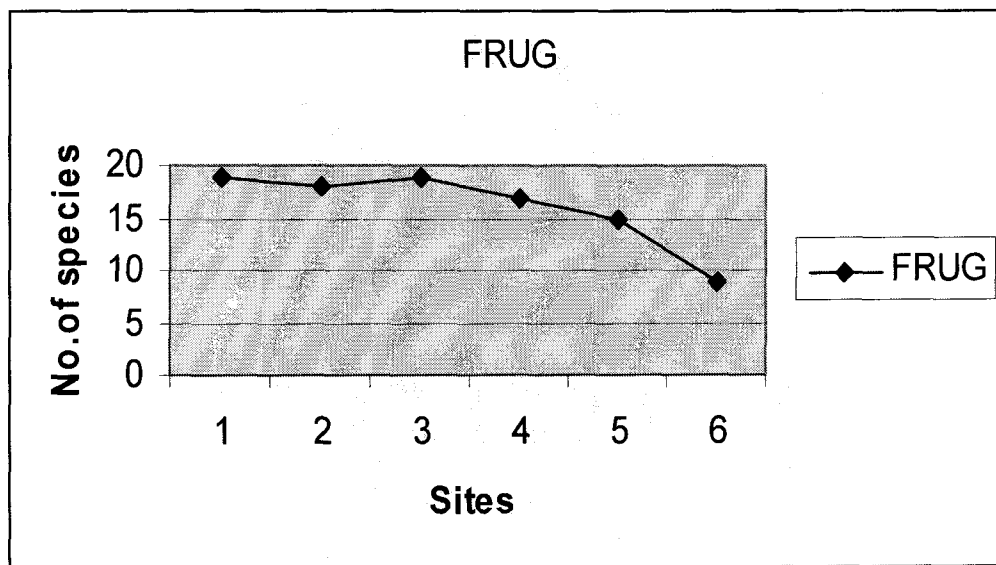


Fig 16: Graph showing the uniform distribution of frugivorous birds among the first three

sites

REA SITE-	INSE	FRU	OMNI	RAP	GR	NE	MIS	Total
1	108	19	4	15	2	4	2	154
2	95	18	4	20	0	5	4	146
3	83	19	3	19	0	5	3	132
4	72	17	6	10	2	4	3	114
5	75	15	1	9	0	5	3	108
6	70	9	5	8	2	5	2	101

Table 10: Table showing the number of species belonging to various communities of birds in the forests of Wayanad based on their food habits

Omnivores showed highest richness in site-no 4 and 6. Raptors were more in site no.2 and 3. Gravivores were present only in site.no- 1, 4 and 6. Nectarivores showed almost uniform distribution among all the habitats. My investigations into temporal and spatial patterns in the structure of bird communities occupying the tropical forests of Wayanad have drawn conclusions on niche partitioning and guild organization in these communities. Insectivores showed highest abundance in the deciduous forest and raptors were more in the semievergreen and evergreen vegetation. Insectivores were the largest groups among all the sites followed by frugivores and Raptors. Among the four less disturbed habitats site no.5 (Hill area) showed the least number of insectivores, frugivores, omnivores and raptors.

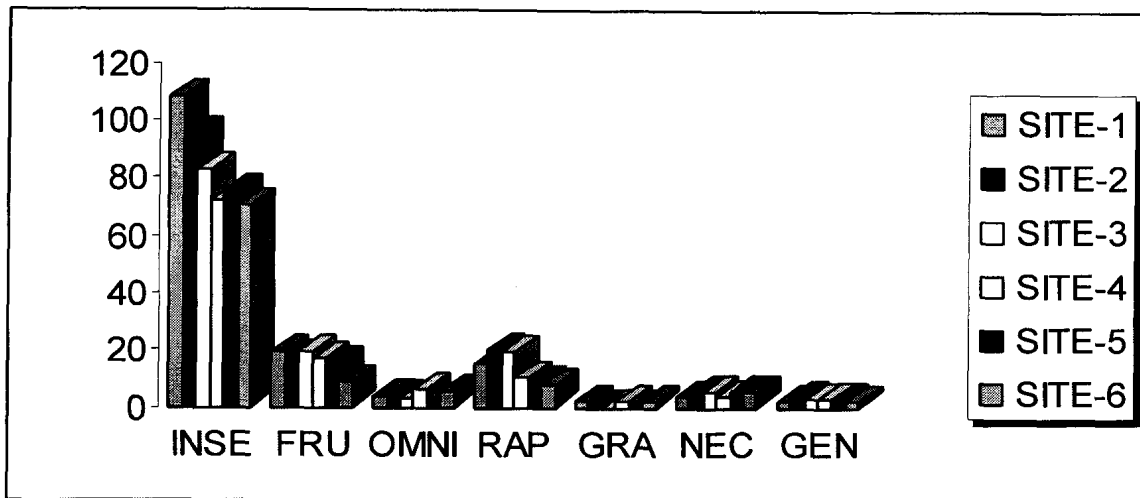


Fig 17: Graph showing the distribution of various bird communities according to their diet guilds among the study sites.

4.1.8 FEEDING ZONES:

Based on the microhabitats where the birds forage for their food, various feeding zones are recognized. The galliformes and a few other species like babblers, wag tails and pipits feed on the ground; wood peckers, barbets, hornbills, cuckoos, parakeets and pigeons feed on trees, warblers, minivets etc. feed in the canopy, some others in the air and a few others feed in more than one of these zones. Based on the difference in feeding zones also the birds are divided in to many communities.

GROUND FEEDING

Grey Francolin
Rain Quail
Jungle Bush Quail
Painted Bush Quail
Red Spur fowl
Grey Jungle Fowl
Indian Pea Fowl
Eurasian Hoopoe
Blue Rock Pigeon
Spotted Dove
Cattle Egret
Indian Pond heron
Indian Pitta

Long tailed Shrike
Rufous Tree Pie
White Bellied tree pie
House Crow
Large Billed crow
Eurasian Golden Oriole
Black headed oriole
Large Cuckoo Shrike
Black Headed Cuckoo Shrike
Common Iora
Large Wood Shrike
Common Wood Shrike
Eurasian Black bird
Chestnut Tailed Starling

Booted Warbler
Common Tailor bird
Broad Tailed Grass bird
Wayanad Laughing Thrush
Grey Breasted Laughing Thrush
Tawny bellied Babbler
Dark Fronted Babbler
Yellow eyed Babbler
Rufous Babbler
Jungle Babbler
House Sparrow
White rumped Munia
Black Throated Munia
Scaly breasted Munia

Blue Capped Rock Thrush
 Blue Rock Thrush
 Malabar Whistling Thrush
 Orange headed Thrush
 White bellied Shortwing
 Blue Throat
 Indian Blue Robin
 Oriental Magpie-robin
 Common Myna
 Jungle Myna
 Puff Throated Babbler
 Oriental sky lark
 Forest wagtail
 White Browed wagtail
 Yellow wagtail
 Grey wagtail
 Paddy field Pipit
 Olive Backed Pipit
 Nilgiri Pipit
TREE
 Speckled Piculet
 Brown Capped Wood
 pecker
 Yellow crowned
 woodpecker
 Rufous Wood pecker
 White bellied Wood pecker
 Common Flame back
 Black Rumped Flame back
 Greater Flame back
 White Naped Wood pecker
 Heart Spotted Woodpecker
 White Cheeked Barbet
 Crimson Fronted Barbet
 Coppersmith Barbet
 Malabar Grey Hornbill
 Malabar Pied Hornbill
 Great Horn bill
 Malabar Trogon
 Pied Cuckoo
 Large Hawk-Cuckoo

Brahminy Starling
 Hill Myna
 Chestnut bellied nuthatch
 Velvet fronted nuthatch
 Black Bulbul
 Thick billed Flower pecker
 Pale billed Flower pecker
 Plain Flower pecker
 Purple rumped Sunbird
 Purple Sunbird
 Long billed Sun bird
 Common Rose Finch
CANOPY
 Small Minivet
 Scarlet Minivet
 Great Tit
 Black lored Tit
 Oriental White Eye
 Tickell's leaf Warbler
 Greenish Warbler
 Yellow breasted Warbler
 Tytlers Leaf Warbler
 Western Crowned Warbler
FOREST
 Oriental Scops owl
 Spot Bellied Eagle Owl
 Brown Fish Owl
 Jungle Owlet
 Brown Hawk Owl
 Oriental Honey Buzzard
 White Rumped Vulture
 Crested Serpant Eagle
 Pallied Harrier
 Montagu's Harrier
 Crested Goshawk
 Shikra
 Besra
 Eurasian Sparrow-hawk
 Common Buzzard

Black headed Munia
AERIAL
 Indian Roller
 White Throated Kingfisher
 Black Capped Kingfisher
 Blued Bearded Kingfisher
 Little Green bee-eater
 Blue Tailed bee-eater
 Chestnut Headed bee-eater
 Indian Swiftlet
 White Rumped Spine tail
 Brown backed Needle tail
 Asian Palm swift
 Alpine swift
 Crested tree swift
 Ashy wood swallow
 Bar Winged Fly Catcher Shrike
 White Browed Fan tail
 Black Drongo
 Ashy drongo
 White bellied drongo
 Bronzed drongo
 Hair Crested Drongo
 Greater racket-tailed Drongo
 Black naped Monarch
 Asian Paradise flycatcher
 Asian Brown flycatcher
 Rusty tailed flycatcher
 Brown breasted Flycatcher
 Red breasted flycatcher
 Verditor flycatcher
 Nilgiri flycatcher
 White bellied Blue Flycatcher
 Blue Throated Fly Catcher
 Tickell's blue flycatcher
 Dusky crag martin
 Barn Swallow
 Hill Swallow
 Wire tailed Swallow

Common Hawk-Cuckoo	Black eagle	Red rumped Swallow
Indian Cuckoo	Rufous bellied Eagle	BIRDS WITH MIXED FEEDING GROUNDS
Banded Bay Cuckoo	Changeable HawkEagle	Nilgiri Wood Pigeon
Grey bellied cuckoo	Mountain hawk-eagle	Black Winged Kite
Drongo Cuckoo	SRUB	Black Kite
Asian Koel	Blue Faced Malkoha	Brahminy Kite
Vernal Hanging Parrot	Sirkeer Malkoha	Common Kestrel
Rose Ringed Parakeet	Greater Coucal	Red necked Falcon
Plum Headed Parakeet	Emerald Dove	Peregrine falcon
Alexandrine Parakeet	Brown Shrike	Indian scimitar Babbler
Malabar Parakeet	Grey Headed Bulbul	Brown cheeked Fulvetta
Ceylon frogmouth	Black Crested Bulbul	Crimson Backed sunbird
Grey Nightjar	Red whiskered Bulbul	Little spider hunter
Pompadour Green Pigeon	Red vented Bulbul	
Yellow Footed Green Pigeon	White browed Bulbul	
Mountain Imperial Pigeon	Yellow browed Bulbul	
Jerdon's Baza	Bright Headed Cisticola	
Grey headed Canary Fly catcher	Grey Breasted Prinia	
Asian Fairy Blue bird	Plain Prinia	
Blue winged Leaf Bird	Ashy Prinia	
Golden fronted Leaf Bird	Blyth's reed Warbler	
Bay backed Shrike	Thick billed Warbler	

Table 11: Table showing the classification of birds according to their feeding zones

Ground feeding birds are represented more in semievergreen and deciduous habitats. They were least represented in evergreen forests. Tree feeding birds were more or less uniformly distributed among the first four sites. Canopy feeders were more in the deciduous and semievergreen forests. They were also least represented in the thick evergreen vegetation. Shrub and aerial feeders were mostly present in the deciduous forest.

SITE NO.	GR	TR	FR	CAN	SHR	AER	OTHERS (T/G, O/FR, S/T)	TOTAL
SITE-1	25	50	11	8	26	29	5	154
SITE-2	24	41	16	8	22	26	9	146
SITE-3	15	45	13	4	22	23	10	132
SITE-4	21	41	6	5	17	19	5	114
SITE-5	18	28	6	6	19	23	8	108
SITE-6	18	33	4	6	17	18	5	101

Table 11: Table showing the distribution of birds according to their feeding substratum

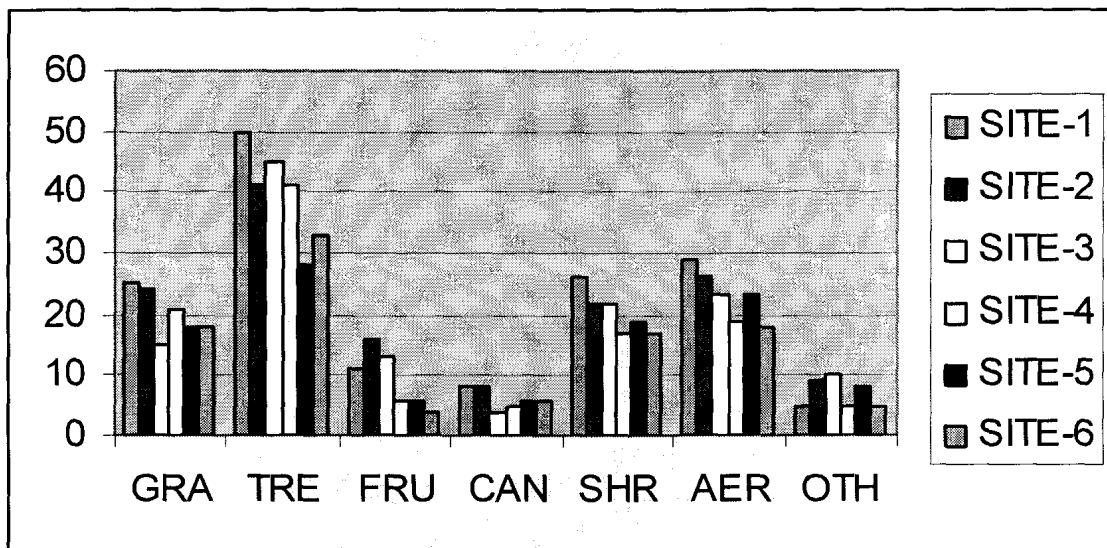


Fig 18: Table showing the number of species in each study area according to their feeding zones

There is an inverse relationship seen between the species richness of ground feeding birds and the amount of litter deposited in the area as seen in the following graph. Site no.3 with the maximum litter deposit showed the minimum number of ground feeding bird species.

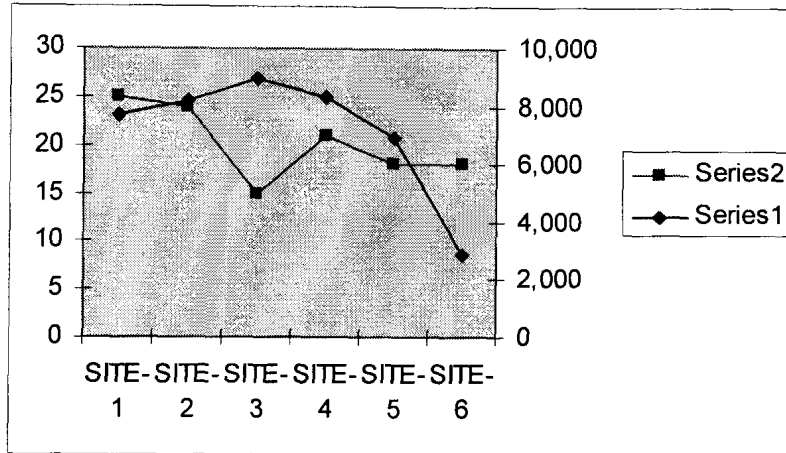


Fig 19: graph showing the inverse relation between ground feeding birds and litterfall

4.1.9 ASSOCIATION BETWEEN SITE AND DIET/ FEEDING SUBSTRATUM:

There seems to be no relation between the site number and the diet/ feeding substratum of the bird. A frugivorous bird will remain frugivore irrespective of the site where it is present. Ground feeding bird will invariably feed on the ground, irrespective of whether it is in a deciduous or ever green forest. Shifting of habitats or the abundance or scarcity of a particular diet/ feeding substratum in the habitat least influences the feeding habit of the bird. This is clear from the Chi square figures calculated (Refer annex). For diet Vs.site relation, the calculated value of χ^2 was less by **23.23** from the table value. Similarly for feeding substratum Vs. site relation the difference was **28.76**.

4.1.10 SEASONAL ACTIVITY:

A thorough analysis of the seasonal activity of various species in the six sites revealed that the maximum number of species was present in all the study sites during January and the minimum number during June every year. Months from November to February recorded highest species richness while, June to August showed the least number of species in all the habitats. This can be attributed to the arrival of migratory species during the winter months and their return during the monsoon. Site number- 4 showed minimum annual fluctuations in bird species richness followed by site no.6 and 3 and 5. Site numbers 1 and 2 showed maximum annual fluctuations. The following table shows the percentage of total species present in each month of the year among all study sites.

Sites	Months											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Site-1	100	91	80	73	65	63	63	63	68	80	90	91
Site-2	100	99	94	75	67	65	66	66	71	81	94	98
Site-3	100	99	99	87	82	74	74	75	76	93	100	100
Site-4	100	100	100	89	88	88	88	88	89	95	99	100
Site-5	100	100	96	81	78	72	72	72	78	92	98	99
Site-6	100	99	91	85	77	75	79	76	82	91	99	100

Table 12: showing the percentage abundance of various species in each month of the year for all study sites.

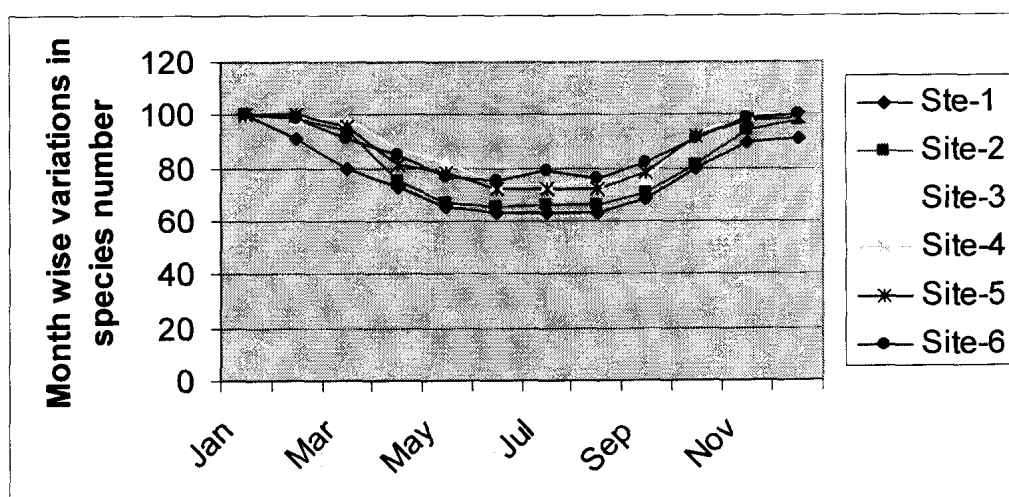


Fig. 20: Graph showing the yearly fluctuations in bird species for the 6 sites

4.1.11 NEST BUILDING IN BIRDS:

Simply because they can fly birds are practically unlimited in their choice of nest site. Birds have no peers in this regard. They have an instinctive talent for seeking out sheltered niches in which they build their nests. There are anatomical, physiological and ecological limitations for different species that prevent a completely free choice of nest locations. Swallows with their weak, wide bills could not possibly chisel out nest cavities in solid wood as do wood peckers.

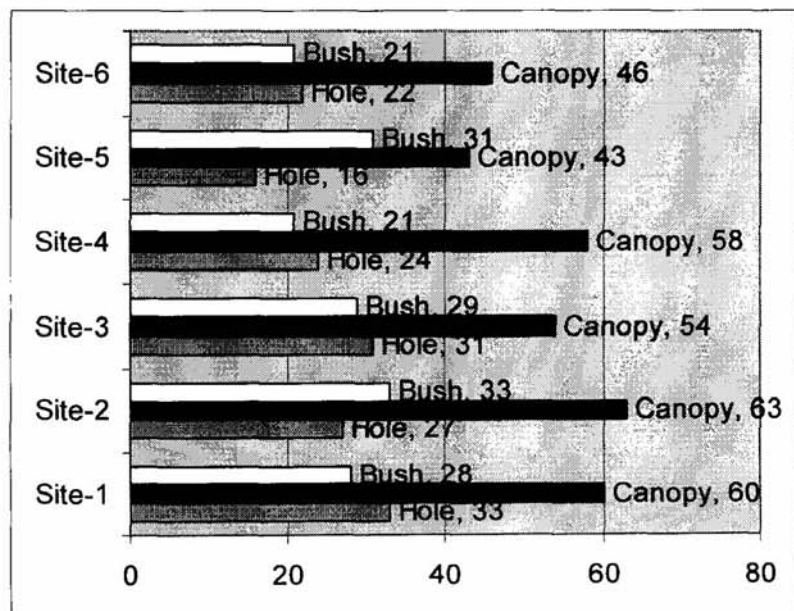
Canopy nesters were the most abundant group sighted during this study (89 species). Hole nesters (43) and Bush nesters (41) came next. Ground nesters were the least represented (12 species). Other birds like Brood parasites, Mud nesters, Birds that lay eggs on ground without building a nest etc. constituted 25 species. Among the ground nesters the maximum number was noticed in site no. 1 & 2. Maximum number of species from Hole nesting birds were observed at site no. 2. Canopy nesters and Bush nesters were most abundant in site no.-2. Generally the hole nesters were more in number than the bush nesters in all the habitats except for siteno.2 & 5.

Sites	Ground	Hole	Canopy	Bush	Others
1	9	33	60	28	24
2	9	27	63	33	14
3	6	31	54	29	12
4	5	24	58	21	6
5	7	16	43	31	11
6	4	22	46	21	8

Table: 13 Table showing the distribution of bird species in the study sites according to their nesting substratum.

Highest percentage of canopy nesting birds were noticed in the two most disturbed habitats among the study sites (siteno.4: 51%; site no. 6: 46%).

Fig 21: Graph showing the Distribution of birds In the six study sites according to their most common nesting sites



An inverse relation between ground nesters and litterfall is noticed. Site no.3&4 with maximum litter fall recorded the least number of bird species among the five natural habitats.

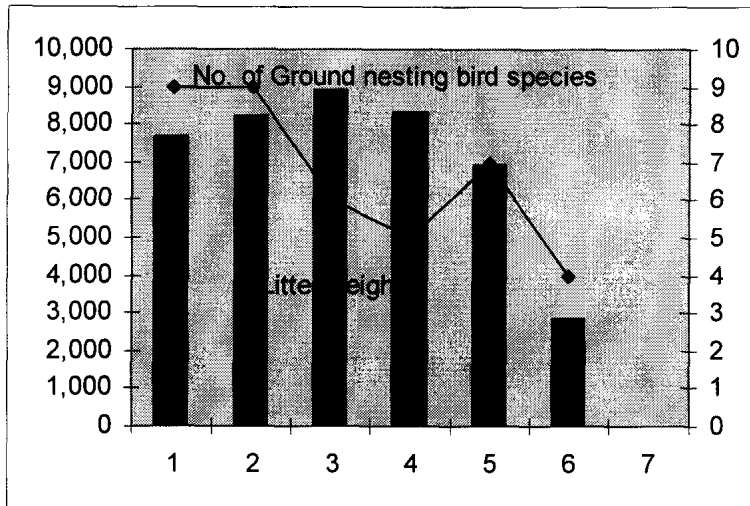


Fig 22: graph showing the inverse relation between litter fall and the richness of ground nesters

4.1.12 ENDEMIC SPECIES:

Among the 16 species endemic to Western Ghats 14 are sighted from North Wayanad. The Nilgiri Wood Pecker and Black and Orange Fly catcher were not observed in any of the study sites. It is interesting to note that all these endemic species are seen in the Banasuran Hills. Except Grey Breasted Laughing Thrush all the other 13 species were observed in the semi evergreen forests of Thirunelly also. Grey Breasted Laughing Thrush was sighted only at the Banasuran hills.

Sl. No	English Name	Scientific Name	1	2	3	4	5	6
1	Malabar Grey Hornbill	<i>Ocyceros griseus</i>		x	x		x	
2	Malabar Parakeet	<i>Psittacula colomboides</i>	x	x	x	x	x	x
3	Nilgiri Wood Pigeon	<i>Columba elphinstonii</i>		x	x		x	
4	White Bellied tree pie	<i>Dendrocitta leucogastra</i>		x	x		x	
5	White bellied Short wing	<i>Brachypteryx major</i>		x			x	
6	Nilgiri flycatcher	<i>Eumyias albicaudata</i>		x	x	x	x	
7	White bellied Blue Flycatcher	<i>Cyornis pallipes</i>		x			x	
8	Grey Headed Bulbul	<i>Pycnonotus priocephalus</i>		x			x	
9	Broad Tailed Grass bird	<i>Schoenicola platyura</i>		x	x		x	
10	Wayanad Laughing Thrush	<i>Garrulax delesserti</i>		x	x		x	
11	Grey Breasted Laughing Thrush	<i>Garrulax jerdoni</i>					x	
12	Rufous Babbler	<i>Turdoides subrufus</i>	x	x	x	x	x	x
13	Crimson Backed sunbird	<i>Nectarinia minima</i>		x	x		x	
14	Nilgiri Pipit	<i>Anthus nilghiriensis</i>		x			x	

Table 14: Table showing the endemic species recorded from Wayanad

4.2. DISCUSSION:

Some patterns are clear in the distribution and abundance of forest birds. There is no such thing as a ‘typical forest bird community’. Variations are found in the abundance of individual species, the total density of birds and the numbers of species found in woods. Each bird species is affected by and responds to the forest environment in unique and often complex ways (Holmes, 1990). It is important to recognize that the numbers, types and abundances of species present in any forest, or part of a forest, will be the product of many factors. It would be misleading, for instance, to attempt to explain forest bird communities solely in terms of vegetation structure or of tree species. There is interaction between the different characteristics of forests and it can be immensely difficult to disentangle the effects of one factor from another. For example, forest structure itself is affected by the dominant tree species. Further, different factors operate on different scales; some apply at the level of the entire forest (e.g. geographical location, area), others can be far more local, often varying appreciably within the forest (e.g. structure, tree species).

It is notable that samples from site-1 and site-2 produced quite disparate population estimates (a difference of 147 individuals) where as samples from site no-4 showed an excess of 197 individuals in spite of the fact that site-3 was a less disturbed natural evergreen stretch. This comparative abundance can be largely attributed to the edge effect. Close resemblance between site-4 and 6 both in species richness and abundance is an indication that cultivation as such is not the prime reason for reduction in avian diversity and abundance in Wayanad, but the large scale fragmentation is responsible for the depletion. Site No. 5 which is a hill tract with practically no human disturbance showed the highest value for evenness among the three species poor habitats (Site-4, 5 & 6). Greater evenness often typifies the more complex and less disturbed habitats (Mac Arthur, 1972).

Factors shaping forest bird communities are forest area, geographical location, climatic difference, soil type, altitude, land productivity, forest isolation, edge effect, growth stage and patchiness, tree species etc. Some of these cannot be used for a comparison of data with respect to the present study sites. Geographical location, altitude, and land productivity are essentially invariable, for they are less readily altered by human activity than the other factors, though this is not strictly true of land productivity. Forest area and isolation can be thought of as landscape attributes. Edge effects, growth stage, patchiness and stand structure are aspects of the physical structure of the woodland vegetation. Tree species composition is concerned with the floristics of the vegetation. Finally, behavioral and demographic attributes of the bird species themselves such as social attraction, population size and dispersal ability, may be important forces determining local distributions. To this last group one could add interactions between the bird species, especially competition. Other factors influencing bird abundance and distribution are food resource availability, presence of other species; predation rate and winter mortality. Nest sites also seem to be influenced by nest predation. The temporal variability in numerous environmental factors that influence bird population in a forest can be accounted only through considering the demographic and habitat responses of constituent species at several spatial scales and over a long enough time periods.

4.2.1. GEOGRAPHICAL LOCATION:

Why should there exist regional trends in the abundance and distribution of birds? Many pairs or larger groups of a species occupy largely overlapping or only partially overlapping geographical ranges and are called geographical replacements. Competition through overall physiological, morphological and ecological abilities determines where the dominance of one species ends and that of the other begins and thus reinforces any initially existing physiological differences within species groups. There are at least three possible explanations, some of which may be related to the large climatic differences that exist within a country. The distribution of soil types is one possibility. The higher altitudes are generally associated with the less productive soils which are known to support lower populations of many birds.

4.2.2 FOREST AREA:

A widespread pattern in nature is that more species live in larger patches of habitat. This applies to many groups of organisms, including birds in forest.. The bird species composition can also vary with forest area (Fuller, 1982; Nilsson, 1986b). In Britain, it seems that several species tend to avoid the smallest woods, for example Nightingale, Chiffchaff, Marsh Tit and Jay. Conversely, no species are confined to small woods. In addition to the number of species, two other attributes of bird communities are affected by forest area; these are stability of bird communities and the density of birds. Small forests undergo much larger year to year changes in bird species composition than do larger forests. Moreover, the turnover between years in individual adult birds was very high in these small woods. This suggests that bird populations in these woods were being sustained by immigration. In contrast to the number of species, the overall density of birds appears to be lower in larger forests than in small woods (e.g. Nilsson, 1986b; Ford, 1987). In the present study site no.-4 which is the smallest forest among all the five natural forests studied, had the second highest number of birds. It is to be noted that though this ravine patch of semievergreen forest was poor in avian diversity the avian abundance of the site was almost equal to that of site No-1.

This effect probably arises because small forest patches have relatively large amounts of edge habitats which often carry higher densities of birds than interior forest. MacArthur & Wilson (1967) proposed that the number of species on an island resulted from a dynamic equilibrium in which rates of immigration balanced those of species extinctions. Extinctions are considered to decrease with greater isolation. This equilibrium theory has been widely assumed to apply to both real islands and habitat islands, such as patches of forest in open country. Several attempts have been made to apply it to the design of nature reserves. Implicit in the theory is the assumption that area influences the number of species through the size of the population supported and hence the probability of extinction. In other words, by chance alone, populations are expected to become extinct more often in small woods. Some species may have a minimum area within which all their needs can be met. This effect would contribute to the relationship between species number and area because a proportion of species would be excluded from the smallest wood. There is a broad relationship between the body sizes of birds and the sizes of their territories or home ranges, so in general one would expect the larger species to occupy large woods more frequently than small woods.

Species that avoid forest edges are more likely to be accommodated within larger forests, thus theoretically contributing to higher species richness in large than in small forests. Small forests may be unsuitable habitats for some species because nest predation can be much higher at the extreme edge of the forest than in the interior. As the area increases so does the number of habitats and hence the number of species. A large area is likely to contain suitable habitats for more species than a small area. This effect can be seen in a simple way in many plantations. Within a plantation of some 100 ha, a randomly chosen block of, say 3 ha, is likely to be composed of just one or two ages of trees, whereas the entire plantation may embrace many different growth stages providing habitats for a far wider range of species. I have pointed out previously (Fuller, 1982) that several species typical of scrub or young-growth forest occur more frequently in large woods. This may be because larger woods are more likely to have glades, rides and shrubby areas.

The larger the forest, the more individual birds it will tend to contain, though, as explained above, the density of birds is usually highest in small forests as a result of edge

effects. A large sample of individual birds is more likely to contain a large number of species than a small sample, purely by chance. Therefore, large forests can be thought of as offering relatively large samples of the species pool. Species-area relationships in birds are affected by various factors such as the distance of the specific site to the nearest extensive forest tract, the number of linking features (e.g. hedges) between forests and the overall amount of forest in the region. The occurrence of some species in forests could be linked to isolation; the more isolated a wood the less likely is a species to colonize it. In the present study, a difference of 32 species is noticed between site no.-2 and site no.-4. Though both of them were of the similar types the former was a continuous tract and the latter, an isolated patch. This is particularly true for species that do not disperse far; hence, isolation could be an especially relevant influence on bird communities in small wood where rates of species extinction may be highest. Bird communities are less likely to be affected by the isolation of woods than are those of less mobile groups of plants and animals. For example, few species of birds seem totally deterred from nesting in the scattered small woods.

While fragmentation of natural vegetation results in decrease of avian diversity, it is also to be noticed that such fragments of natural ecosystems will be invaded by species that are characteristic of man made ecosystems which surround them. A quick look at the avian list of site-4 proves this fact. It included a few forest birds not found in the cultivations that surround it, but over all the community was impoverished. It is to be assumed that this peculiarity is the product of the plot's very small size and its isolation from other such true forest habitats. This remnant patch serves as a warning. In this site the forest patch was structurally and floristically rich but small in size. Local extinction without re-colonization brought about the local loss of a number of forest bird species (Karr, 1982) in site No-3. Though such remnant patches of natural forests are not very rich faunistically, their survival is very critical in the preservation of the avifauna of Wayanad, since their destruction may result in the total disappearance of some of the key species that are supported by the vast expanses of cultivations in this district. Fragmentation affects the distribution of migratory birds. In the present study the percentage of migratory species present in the continuous tracts of site-1 and site-2

surpassed the number of migratory species present in the fragmented tracts like site no.4&2. The vastness and stability of the habitat, the constant weather, the richness of the natural soil etc may be very satisfactorily utilized by these birds in the natural sites.

4.2.3 STAND STRUCTURE:

The diversity of bird species occupying terrestrial habitats has often been shown to be correlated with vegetation structure and composition, including foliage height diversity (Mac Arthur and Mac Arthur 1961, Recher 1969), plant-species diversity (Tomoff 1974, James and Wamer 1983), habitat openness (Willson 1974, Probst 1976), and habitat patchiness (Karr and Roth 1971, Roth 1976). The more complex the vegetation, the more complex is the bird community. Studies in North America and Europe have shown that the bird community becomes richer as more layers of foliage are added (MacArthur & MacArthur, 1961; Moss, 1978). These studies measured habitat structure in terms of an index called Foliage Height Diversity (FHD); high values of FHD are found in woods with many layers of foliage. However several studies have been unable to confirm any link between birds and FHD, while others have found that different measures of habitat structure, such as crown volume, are better predictors of the number of bird species (Verner & Larson, 1989).

Some further discussion of the effects of the vertical and horizontal aspects of forest structure is an order at this point. Forest birds differ considerably in the heights at which they forage. The canopy the shrub layer and the field layers each have their own species. There is also much variation between birds in the heights at which they nest and the types of nest sites they prefer. So it is not surprising that, all other things being equal, woods with more layers of foliage tend to be the richest in birds for they offer feeding and nesting sites for a wider range of species. Dense foliage is also important in offering shelter.

Forests with sparsely developed shrub layers are poorer in birds than those with a dense shrub layer. A difference of 22 species and 248 individuals is noticed between site no.-1 (with dense shrub layer) and site no.-3 (with poorly developed shrub layer). Not all

species select woods with dense undergrowth. Eg: Pied Flycatcher. Left to its own devices, the canopy of most woods will gradually become more open as trees die and gaps form. In the absence of severe grazing, this will stimulate regeneration and the growth of shrubby vegetation. These gaps may then be colonized by warblers and other birds needing a dense shrub layer. Furthermore, insects and fruits can be more abundant in gaps so that the food resources for birds can be higher there than under the closed canopy. Thinning of stands can have a similar effect to natural gap formation, by releasing shrub growth, which can lead to increases in numbers of warblers (Fuller, 1990). Hence, there can be considerable interaction between the horizontal structure of a stand and its vertical structure. Structural 'micro-features' of vital importance to some species are holes and dead wood. Their availability is strongly influenced by tree species and by management practices. Nest sites can limit the numbers of some hole-nesting birds such as Pied Flycatcher.

Dead wood is an important source of invertebrate food for woodpeckers, particularly in winter. A huge number of invertebrates depend on dead wood and dying wood. Many of these creatures live within dead wood for just a part of their life cycle; therefore, they form a potential food resource for many insectivorous birds, not just woodpeckers. It is possible that the amount of dead wood is of wide importance to forest bird communities for, in a study of Swedish woods, Nilsson (1979b) found that the overall density and richness of birds was closely associated with the amount of standing dead timber (snags). Others have found relationships between snags and densities of hole-nesting birds (e.g. Haila et al., 1987). A comparison of pisciformes in the five natural forests of North Way and shows an increasing order of complexity from hill forests (shoala) to the deciduous forests. In conclusion, there is ample evidence that bird communities are richer in forest habitats that are structurally diverse.

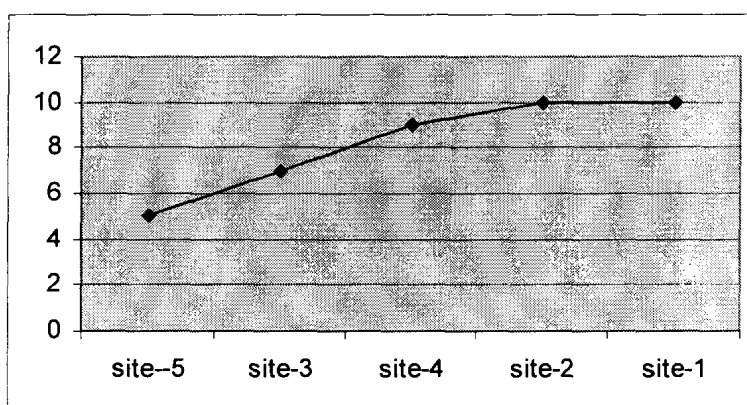


Fig.23: Graph showing the increasing order of complexity of pisciformes from hill forests to the deciduous forests

Several investigators have suggested that food resources are ultimately involved in vegetation characteristics, deciding bird populations in an area (Karr 1976, Terborgh 1980). Since most temperate forest passerines are insectivorous, the relationship between vegetation structure and food resources for such birds is likely to be indirect at best (Robinson & Holmes, 1984). Smith (1974a, b) Roth (1979), Eiserer (1980), and power (1980) have demonstrated that grass height in open habitats has a major impact on both bird foraging tactics and foraging success. Maurer and Whitmore (1981) found differences in the foraging behaviour of five species of forest-dwelling birds in two forests with contrasting structure. Bird species also were found to forage preferentially in certain kinds of trees and their foraging tactics often change when insects are captured in different tree species (Holmes and Robinson 1981).

Birds with tree as their feeding zone were abundant in site number-1. This site was rich in large and well developed trees. Bark provides feeding niches to birds as the tree grows older and larger. Thus adding shrubs and then trees along a vegetation gradient from grass land to forest not only increases the vertical habitat dimension and as a consequence the foliage layering and complexity (Karr and Roth 1971) but also provides supporting structures (e.g. the tree holes and branches) as foraging regions. Because the portion of foliage at different heights is also a function of the structure of the trees the 2 components are closely linked. The resulting increase in foraging opportunities explain both the

general increase in BSD and FHD along such a gradient and Wilson's (1974) finding that the presence of trees has a dis-proportional effect on increasing BSD. The poor BSD of site No-5 is to be viewed in connection with these findings. Abundance of insectivores in deciduous forests is also explained by the different foraging opportunities that exist according to the plant morphology in a deciduous habitat compared to an evergreen forest. Plant species frequently differ in branching patterns (Whitney, 1976) or in leaf arrangements and densities (Horn, 1971). Such differing physical structures provide different arrays, combinations and abundances of substrates and their associated insect faunas, which may require specialized search strategies for optional utilization by foraging birds. The physical array of branches and leaves may place constraints on birds' movements or on how they search for suitable prey. Thus hawking for insects may be difficult for birds in the dense foliage of evergreen forest.

Birds exploiting caterpillars on the undersides of leaves must use energy-expensive hovering techniques compared to birds that glean similar prey from upper leaf surfaces (Holmes et al. 1979). The changing patterns of such flecks, which are also dependent on the leaf and branch structure of a forest canopy, will likewise affect insect activity and visibility, and as a consequence the ability of birds to capture prey (Pearson 1975, 1977). Thus the tree morphology of a deciduous forest is more favorable for food collection by insectivorous bird than the evergreen forests. Variation among plant species in insect fauna or abundance may be caused by differences in plant chemistry, by differences in morphological complexity which provide different types and qualities of hiding places for insects (Orians et al. 1977), by historical factors (South wood, 1961) or by combinations of all these because plant species association change geographically and topographically. Differences in this habitat component may explain the variation in BSD (bird species diversity) between forest habitats noted by Wilson, (1974).

Tree fall gaps increase structural heterogeneity influencing the composition and richness of the bird community. Gaps offer more foraging opportunities for birds along the edges. This observation was proved to be correct for tropical forests by workers like Daniels (1989) and Pramod (1995). The present study also confirms this view. Mac Arthur and

Mac Arthur (1961) found a positive correlation between vertical stratification and bird diversity in the temperate forests.

But this observation was contradicted by Daniels (1989) who showed that the more stratified natural forests have less number of bird taxa, than the less stratified vegetation. Pearson (1982) disagrees with the established classical generation regarding bird habitat relationships. Negative correlation between plant species diversity and bird diversity was established by other investigators also (Daniels, 1989). My observations on vegetation-bird relationship strike a balance between these two views. I could find a wide fluctuation in the bird abundances of these two habitats viz; deciduous forests with less tree diversity and evergreen forests with rich tree species diversity. Avian activities and abundances in these forests are affected by a variety of other environmental factors. High tree density, plant species diversity, canopy density and vertical stratification index are all associated with the least disturbed forests. The higher bird diversity in evergreen forests is associated with a more disturbed condition. Thus among the evergreen forests, the degraded areas have a greater bird diversity than the undisturbed ones. This aspect suggested by Daniels is observed in my study also.

4.2.4 GROWTH STAGE AND PATCHINESS:

Very different communities of birds occur in the various stages of both man-made ecosystems and natural forests. As a general rule, the numbers of species and overall density of birds in European woods tend to increase as the trees grow (Helle & Monkkonen, 1990). Numbers of species and densities sometimes decrease in the oldest stages. Many species of birds clearly prefer a particular stage of growth. Some are confined to the earliest stages when the vegetation is open, others to the period when the canopy is starting to close and the vegetation is very bushy. Other species, including most hole-nesters in the absence of nests boxes, select those stages with mature trees. The richness of hole nesting birds in the semievergreen forests of Thirunelly with plenty of old trees is a case to the point. A general point to be made here is that because species differ in their preferred stages of growth, woods with the greatest variety of growth stages provide more habitats for birds, and hence support more species, than uniform woods

4.2.5 EDGE EFFECTS:

An edge effect occurs when the numbers of a species increase or decrease at the interface between two different types of vegetation or habitat, one of which may be open space. There are three types of edges that can potentially influence the distribution of birds within a wood: the edges of rides or glades, the boundaries between forest compartments (i.e. areas at different stages of growth), and the external edge of the wood. Each widening rides and creating linear strips of grass, herbs and shrubby vegetation along them is conventional conservation practice in forest ecosystems.

Those rides with wide marginal strips of scrub or shrubby vegetation are likely to be the most attractive to birds. Rides with sharply defined margins, where the trees directly about the track itself, are the least attractive. There is evidence from Sweden that edge effects exist between forest compartments of different ages. Numbers of forest birds like babblers robins wag tails etc are higher in forest adjacent to a clear-fell than in the interior of the forest.

There are two likely explanations for these effects. One is that the shrub layer may be more strongly developed at the edge of a compartment than the interior. The other is that there could be more food in the form of insects and berries at the edge. An implication of such edge effects is that the structure of the forest, in terms of the sizes and shapes of compartment, could influence the overall distribution and abundance of many bird species.

Several breeding bird species strongly prefer certain external edges, particularly in fairly uniform mature woods. The birds associated with edges include most of those that use young-growth within forest. The reason why birds prefer to nest near some external forest edges are that the vegetation structure at the edge is often different from that in the interior. The shrub layer is often denser at the edge; perhaps because of the extra light. Not all edges are equally attractive for birds. In part, this may be a consequence of vegetation structure, for those edges with few birds often have relatively little in the way

of shrub layer. It is also possible that north-facing edges are the least attractive to birds because these are relatively heavily shaded and may be poorer for insects, though there seems to be no published evidence to support this idea.

The communities of shrubs and trees at the forest edge are often different, for instance richer in species, from those of the interior. This presumably leads to greater amounts of insects, seeds and berries. Food resources at the edge will be further enhanced because many shrubs flower more regularly there than in the interior, and the light, warm conditions at the edge benefit many insects. External edges may offer more suitable habitats for birds than internal edges because they tend to be older. Many rides and compartment boundaries are relatively recent. Both the structure and the plant composition will be more complex along old, established edges where there has been a constancy of light penetration.

4.2.6 LITTER FALL:

Lesser tree diversity results in a poor variety of litter sources and unfavourable conditions for many litter faunal elements. Topography of the forest plays an important part in relation to the nature of litter fall. High altitude forests are very poor in their litter production—a fact that may result from the less abundance of trees and the frequent occurrence of high velocity wind. Consequently the insect fauna associated with litter and the insectivorous ground feeding birds like Pitta, ground thrushes, Jungle fowls, are absent at higher altitudes.

Patterns of litter fall tend to vary with climate and exposure. Heavy litter fall occurred during the dry season, the maximum being during January to March with peak in February. The leaf shedding patterns differ according to the species. For some, like *Persea macarantha* and *Prunus ceylonica* the leaf shedding takes place from January to February, in *Cassia glauca* from January to March, in *Drypetes elata* and *Turpinia malabarica* from December to January. For others like *Messua ferrea*, the leaf-fall was massive in only one year, while others like *Aglaia anamallayana* and *Calophyllum polyanthum* have two periods of leaf-fall in both dry and wet seasons. The heavy litter

fall during February-March is co-related with the reduction of ground feeding carnivorous birds like babblers, quails, jungle fowls, Pitta and ground thrushes in the evergreen forest floors of Wayanad during this period.

In evergreen forests, the stands being floristically heterogeneous, litter contribution by different species partly explain the variation in nutrient concentration in different seasons. The humid environment with a dense forest cover, low temperature, higher moisture content and relatively undisturbed nature of forest, support a luxuriant growth of several species resulting in greater production of litter. Litter accumulation may vary by several magnitudes even in forests under similar climatic zones. If soil type influences total bird density, it probably influences species number in a similar manner because overall density and number of species usually closely related secondly, insect food for many birds may be less abundant in the relatively cool and wet climate of the north and west.

When all other factors are equal, density of birds in forest increases with the fertility of the soil. Newton et al. (1986) suggested that the abundance of songbirds was closely linked with soil productivity. Presumably these trends are driven by larger amounts of insect and plant food being available for songbirds in the richest habitats. Indeed, a combination of land productivity and climate may act to reduce the primary productivity of woods in the west and north. In a study of birch woods in the Scottish Highlands, Bibby et al. (1989a) found that the density of birds and numbers of species declined from east to west. They interpreted this gradient in terms of diminishing productivity towards the west, where the production of foliage and abundance of insects may have been lower than in the east.

In the present study an inverse relationship is observed between the occurrences of ground feeding and ground nesting birds and the amount of litter deposited in a habitat. Thus in site No-3 and 4 which recorded maximum litter deposit litter gleaners were least represented. Naturally the various kinds of insect larvae and worms that inhabit the degrading litter should attract such birds to these habitats. But the vast number of hiding places offered by the rich litter deposit for the insects and their larvae and the excessive

effort that these birds have to put in to such a search prevents them to attempt. For the ground nesting species the dampness of the ground and the chances of the nests being covered by the rich litter and the confusion it can create in locating the nest by the parent birds may be the reason for their nesting restriction in such habitats. The least litter deposit of the high altitude forest at site no.-5 and the corresponding absence of ground feeding insectivorous birds there should be attributed to high incidence of winds poor vegetation and cold and harsh climate.

4.2.7. NESTING SUCCESS:

In birds, nests are often inconspicuous being built of materials present in the immediate vicinity. Nests in grassy habitats are made of grass; in reed beds of reeds; in trees and shrubs, of twigs or branches. Some times the outsides of nests are covered with disguising materials like mosses or lichens which decrease their visibility. This inconspicuousness is achieved in some species even by not building a nest at all and laying the eggs with concealing colours directly on the bare ground. Nests among stones approximating their body size is a behaviour that helps to camouflage a bird. Even though the 'nest' in such cases matches perfectly with its environment, other useful functions of a nest may be lacking. The sheltering warmth of the nest in conjunction with the heat supplied by the brooding parent parallels the warm protection of the uterus for an embryo of a mammal. This parental intimacy cannot be achieved by such eggs laid on open grounds. Among birds with special requirements such as those nesting in tree cavities there is undoubtedly the keenest competition for nest site. Nest location affects the rate of predation and breeding success. Ecological limitation profoundly affects the nesting sites of some birds. Climatic or topographic requirements restrict the nest size distribution of many species. Even the nest orientation may be affected by the climate. Certain birds orient their nest openings in one direction in the spring to avoid cold prevailing winds and in another direction in summer to take advantage of cooling breezes (Ricklefs & Hainsworth, 1969).

The richness of ground nesting birds in the deciduous and semievergreen habitats (site-1&2) can be attributed to the availability of light and warmth on ground compared to the

dark and damp ground of an evergreen vegetation. The dry grass and the grey soil offer sufficient opportunities for camouflage and escape from predators. Richness and abundance of canopy nesting birds in the most disturbed habitats among the study sites is undoubtedly due to the hiding opportunities it provides to the eggs and young ones of these birds. The high incidence of bush and hole nesting birds utilizing the semievergreen habitat at site-2 is to be attributed to the rich undergrowth and plenty of old and dead trees in this site.

4.2.8 ALTITUDE:

Woods at higher altitude are generally poorer in bird species and overall numbers of birds than lower-lying woods. Decreases in numbers of breeding bird species associated with increase in altitude have been demonstrated in France, Germany and North America (Able & Noon, 1976; Lebreton & Broyer, 1981; Wink & Wink, 1986). In Britain and in Germany, within similar types of woodland, the densities of woodland songbirds are lower at higher altitudes (Newton et al., 1986; Wink & Wink, 1986). The explanation of these altitudinal trends undoubtedly lies with an inter-related set of factors. With increase in altitude, the climate typically becomes harsher, the soils less productive, the number of tree and shrub species fewer, and the vegetation less luxuriant. Almost certainly, the amount of insect food will be less, and birds may also forage less efficiently, because of poorer weather. It is likely that the breeding productivity of many woodland birds declines with increasing altitude. This fact is evident in the bird population patterns of Banasuramala of North Wayanad where most of the species that are present in the low lands are not represented. However the presence of all the endemic species in this site is a special feature to be noticed. This is a result of the uniqueness of this habitat among all the study sites- its variety due to the water sources, open and closed canopies, rock formations, grasslands etc.

Bird species may be separated in their altitudinal ranges, especially common on steeper mountain sides. Related species often congeness, may replace each other in sequence along a transect up an elevation gradient. Diamond (1972) has published results of an altitudinal survey of birds in New Guinea Mountains and finds that as many as four species may occur in this sequence. He noticed a vertical stratification of feeding zones,

differences in food and feeding behaviour, difference in feeding time etc. Birds might use the same resources in the same way but at different time of the year or at different times of the day.

4.2.9 TREE SPECIES:

Tree species differ in the foods they offer birds (insects, seeds, fruits, leaves), they also vary in the amount of cover and nest sites they offer. Relationships between bird communities and tree species composition are most likely to be detected when habitats of similar structure are compared (Fuller & Henderson, 1992; Fuller, 1994). Insectivorous birds show preferences for feeding in certain species of trees (Ulfstrand, 1975; Holmes & Robinson, 1981; Morrison et al., 1985; Peck, 1989). Preferences for particular trees are likely to be underpinned by variations in the amount and types of insect food they provide. The morphology of the bird species themselves is also important, for some birds are better adapted to feed in certain types of tree foliage than in others. This leads to the prediction that woods with more tree species should support more bird species. But this prediction is disapproved by the present study. Site no.1&2 with lesser number of tree species supported more bird species than site no.3 which was floristically rich. Although food is the main mechanism by which tree species influence bird communities, nest sites may be important for some birds. Trees differ greatly in their structure in terms of foliage density, availability of holes and dead wood. This will certainly affect the suitability of different trees as nesting sites.

4.2.10 SEASONAL VARIATIONS:

There are large seasonal differences in the uses made of forests by birds (Fuller 1995). The comparative abundance of birds in site No-3 and 4 especially during summer suggests a large influx into these habitats from natural forests in search of protein rich food especially the cultivated fruits like Jack fruit, mango, banana etc. This will reduce their foraging efforts to a considerable extent and help in saving lot of time and energy. Optimal foraging theories predict that an animal's diet will be determined by the energy gain per unit time associated with its potential food items, and by the relative probabilities of encountering, pursuing and handling each type of prey (Schoener,

1969). Short term changes in bird populations should therefore be related to environmental factors that affect food availability. An upward trend in the population of frugivorous birds in cultivations was specially noticed during the beginning of summer. Nectarivores also showed abundance patterns in site No-4 during the summer season.

Insectivorous birds tend to increase in their number during the month of October to January in the cultivated areas of Wayanad. The de-weeding and pruning of shade trees during these months in the farm lands disturb insects and their larvae which attract lot of insectivorous birds during this period especially the ground feeding insectivores and the gleaners. It was interesting to note that when ever a population change occurred in the cultivations a corresponding fluctuation occurred in the semi evergreen patch also suggesting a strong correlation between both the habitats though floristically both of them have the least resemblance. A summer abundance of bird populations noticed at site -no-5 may have correlation with the mild climate that persists here during summer.

While all the five study sites displayed maximum species diversity during winter the evergreen (site-2), semi- evergreen (site-3) cultivation (site-4) and the high altitude (site-5) habitats were characterized by a high bird activity during summer especially during the early months. In site number 3 and 4 seasonal increase in frugivorous birds were noticed, February, March and April months recorded the maximum number of frugivorous birds in these habitats. Insectivorous birds were found in maximum abundance in site number-1 (deciduous forest) among all these six sites. While the trunk feeders like night jar wood peckers, are more in deciduous forest and cultivation gleaning insectivores like swifts, bee-eaters, swallows, drongo, warblers, etc. were found to be distributed in a gradation of maximum to minimum from site-no-1 to site number-5 in the order. Ground feeders like Indian pitta, Whitethroated ground thrush, Babblers, Jungle fowl etc. showed abundance in semi evergreen habitats and deciduous forests. While the nectarivorous birds were abundant in evergreen and cultivated habitats, omnivores were abundant in the more human disturbed ecosystems like cultivated land and the semi evergreen patch.

Observations on trophic interactions involving birds at Wayanad have implications for forest management and the maintenance of biodiversity. The kinds of tree or plant species present in an habitat influence the species of birds present in various seasons, because of architectural constraints on bird foraging, abundance and accessibility of particular insect prey, and the kinds and availability of fruits or seeds provided. Forest management practices that selectively favor or remove particular tree species will thus influence the communities of consumer organisms. Avian consumers can potentially influence plant productivity and reproduction indirectly via consumption of herbivorous insects, and thus may be able to influence ecosystem structure and perhaps other aspects of biodiversity more than previously thought. Birds may also potentially influence plant distribution and abundance patterns via seed fall from fruit-bearing plants common in early secondary successional habitats. These indirect effects of birds on ecosystem structure and processes are generally poorly understood, and are in need of more intensive study.

5. Farming Practices and Avian Diversity In Wayanad

While looking at the 200 year history of ecology and culture of Wayanad, we see a gradual shift from subsistence resource use in the Pre-British period to a commercialization wave (Prabhakar, 1994). During the British period cash crops like Coffee, tea, cinchona and rubber were introduced into Wayanad. It was followed by process of sequential exploitation of forest resources especially teak controlled by the forest department. The second stages commercialization brought in by the migration of people from the central travancore to Wayanad. They intensified cash cropping and horticultural operations resulting in large scale deforestation and marginalization of the natives. Wayanad with its dense moist deciduous forests intergressed with evergreen and semi- evergreen trails and paddy cultivation in the swamps changed radically with clearing of forest and introduction of exotic biota.

5.1.1 LAND USE PATTERNS AND AVIAN DIVERSITY IN WAYANAD:

Murton and Westwood (1974) distinguish two ways in which agricultural development affecting bird population. The first is by engulfing and totally destroying particular habitats within farm land such as paddy fields, hedges etc. and the second is by agricultural practice modifying the nature of the surviving habitats thereby altering the niches they offer in ways that make them less attractive to birds. Extensive tracts of

pristine forests were mercilessly destroyed for agricultural operations in Wayanad especially by people who migrated from Travancore. The major damage occurred in the pulpally belt separating Wayanad wild life division into W I and W II (Chapter 2). This resulted in the breaking of continuity between protected areas, Nagar hole and Bandipur in the Nilgiri Biosphere. Massive trees were cut and undergrowths were burnt. The humus rich soil was digged and ploughed to plant coffee, tea and exotics to support pepper. Massive grazing by cattle and other domestic livestock occurred in the grasslands. This resulted in large scale soil erosion and consequent choking of rivers and streams with the silt. As a result of silt deposition in Kabani, the only river in Wayanad and its tributaries like Mananthavady Puzha, Panamaram Puzha etc. were narrowed down and the wetlands on their banks slowly become uncultivable.

The shifting cultivation in Wayanad mostly contributed to the destruction of natural vegetation cover in Wayanad. 60 to 70 years ago the immigrants started exploiting the fertile soil by planting plantation crops like Coffee and Pepper. Natural woods were cut and soft woods like Silver oak were planted to provide support for pepper plants. Paddy was the traditional cultivation in the marshes. The farmers introduced other fruit trees and crops to their small segments of farm lands. When we examine the change in land use pattern in Wayanad over the past 80 to 90 years, one can see severe alterations in the original environment and disappearance of several species of birds (Zacharias & Gaston, 1993). How ever Wayanad still harbours a rich bird fauna, mostly due to the presence of coral trees, figs etc. Farm land can support several species of birds due to the protein rich food like nectar, fruits, cereals, and nuts which are readily available in these lands.

5.1.2 FACTORS WHICH LIMIT THE DISTRIBUTION OF FARM LAND BIRDS:

Few species of birds are successful on farm land. How ever soil type and quality limit invertebrate diversity which in turn limits the distribution and abundance of a number of bird species. The distribution of farm land birds may be affected by the soil P^H as it influences the density of soil organisms, but the major effect on soil invertebrates is probably due to drainage. In summer lapwing densities are highest on sand and gravel, and are relatively scarce on clayey soils. The well drain soils are also preferred in winter.

Murton (1971) remarks on the absence of large number summer visitors on farmland due to the absence of major spring flush or invertebrate food on farm land and in part because the resident species are highly efficient at exploiting what ever food is available there. Farming practice varies regionally due to the geographical variation in soil, climate etc these factors make themselves limit the distribution of some species. But regional variation in farm land bird communities is also effected by regional agricultural practice. In many species the higher densities are found where mixed farming is at its most diverse.

5.1.3 FARM LAND AS A NESTING HABITAT.

Pepper an important cash crop in site-6 provides nesting sites for various species of birds like Bulbuls, Spotted dove, Iora, Munias etc. The old and dead trees especially coconut trees and *Erythrina indica*, *Lithosperma* sp., *Grerellia robusta*, *Nesopsis emini*, *Garugia pinnata*, *Ailanthus* sp. etc. which are grown as a support tree for pepper provides sites for hole nesters like mynas, barbets, parakeets etc. They in addition provide insect food from their decaying wood to Speckled spiculets, Pigmy woodpeckers; Malabar Golden backed Woodpecker, Rufous Wood pecker, Drongos etc. Large Brown fish owl once common in homesteads and cultivations has almost completely disappeared. Scopes Owl also has become very rare. The fearsome calls of Mottled Wood Owl are rarely heard. These hole nesting birds vanished, mainly due to large scale felling of trees which supported their nesting sites. Exotic trees like *Eukalyptus*, *Acacia*, and *Silver Oak* etc. which replaced the old varieties of trees are not suitable for these hole-nesters; though barbets are getting adapted to the new situation. Fairy blue bird, yellow browed bulbul, Iora and Wood peckers find it difficult to survive. Building of nests in open space increases chances of predation by large birds. Though the litter fall is negligible in the study area it is properly mixed with the soil due to annual tilling operations.

5.1.4 FOOD AND FEEDING BEHAVIOR:

Farms provide three major sources of food for birds.

1. The invertebrates of the soil, crops and naturally occurring plants
2. The green vegetation of the growing plants mostly crops and grass.
3. Green seeds, hedge row fruits and berries.

Farmlands with minimal drilling techniques and cultivations are known to increase the mass of soil invertebrates present (Edwards 1984) but the lack of ploughing and tilling reduces the number of feeding opportunities for birds. In the plot studied there was annual drilling to remove weeds during October and November every year attracting Mynas, Herons, Egrets, Magpie robins and Babblers. Soil invertebrates which form food for birds comprise various species of earth worms, tipulid larvae, beetles and molluscs (Murton 1971). In the study area termites, millipedes, centipedes, frogs etc. also form food of birds. During summer many invertebrate species aestivate in deep burrows where they are inaccessible to birds and this gives better explanation for the less abundance of farmland birds during summer. Tilting operations and the consequent lack of weeds results in a high soil temperature in farm land during summer compared to other habitats of Wayanad.

5.1.5 SURFACE DWELLING INVERTEBRATES AS FOOD:

Carabid, Staphylinid and Scarabeid beetles, some weevils and Aranoid spiders form important food on the top soil. Their biomass decrease far less in summer than does that of soil dwellers. Some birds have learned to associate farm work with food.

5.1.6 MODERN AGRICULTURE; THE CONSEQUENCES OF SPECIALIZATION:

Increased specialization in farming as a result of post war revolution resulted in the loss of diversity of farming practices. Modern agricultural practices and indiscriminate use of synthetic fertilizers and pesticides have significantly affected the birds and biodiversity as a whole. Carson (1972) has documented the harmful effects of pesticides on birds. Large scale use of pesticides and chemical fertilizers has resulted in the disappearance of

several bird species from the cultivated lands of Wayanad. Casual observations over the last 10 years have confirmed this tendency particularly with birds like Herons, Ducks, Jungle fowls, Quails etc. Birds in the higher levels of food chain like Raptors, Owls and egrets suffer from abnormalities like thinning of shells and weakening of flying abilities due to the application of pesticides like thimlets. Large populations of pond herons considered true indicators of unpolluted paddy fields have shrunk to an alarmingly low level. Crop protection procedures like shooting and scaring away have resulted in the reduction of birds like doves, pigeons, parakeets, munias, sparrows etc.

5.1.7 FARM STRUCTURE AND BIRD HABITATS:

Land use pattern and changes in farm structure were found adversely affecting birds feeding there. For example the conversion of paddy fields in to dry lands for cultivation of crops like banana, ginger, arecunut, pepper etc. resulted in the disappearance of many wet land birds in Wayanad. Till the beginning of 1980s Wayanad with its vast stretches of paddy fields and rich homesteads was a paradise for very rare and endemic birds. Invasion of banana and arecunut in to paddy fields and shift in agricultural practices have resulted in the disappearance of “heronries” which were once common in the swampy areas of the district. The whistling teals which were once commonly observed in paddy fields are now seen only in the inland lakes of sanctuaries and a few sites near to reserviours. The ruddy crakes once common along the grass thickets and swamps have almost disappeared. White breasted water hen is struggling for survival. Baya weaver bird is almost rare due to the shrinking paddy fields. Population of house sparrow is also dwindling.

5.1.8 THE EFFECT OF HEDGES AND HEDGE ROW LOSS ON FARM LAND BIRDS:

Hedges were once abundant in the farm lands of Wayanad. Their replacement by concrete walls or other stone structures recently has deprived of the foraging habitats for birds like Warblers, Babblers, Bulbuls, sunbirds, flycatchers etc. Consequently many of these small birds have become less abundant in the cultivated lands of Wayanad over the last 10 years.

Several species of forest birds occur in farm lands due to the availability of protein rich diet. It reduces their foraging efforts considerably and saves lot of energy and time which would otherwise have been spent searching for food in the wild. What a frugivorous bird can get in 1 hour from the wild can be collected within 10 minutes from a farm land. Coconuts, Arecanut, Corals, Plantains and other flowering/fruited trees provide rich nectar/fruit supply to the nectarivorous/frugivorous birds. Similarly, many of the cultivated crops attract insect pests which form food for birds.

Conclusion

The study analyzed the influence of various factors in the occurrence and distribution of bird communities in the various habitats of Wayanad. Continuity and variability of the habitat seems to be the prime factor deciding the bird population in any area. Structural heterogeneity of the habitat decides the composition and richness of the bird community that inhabits it. Closed forests are less patchy and support less bird diversity than forests with broken canopy. Plant species diversity and bird diversity are often negatively correlated. It is the stratification of the vegetation that is more important in the avian use of any area. Deciduous forests are less diverse in plants, less closed, and less dense than evergreen forests and consequently they harbour more number of bird species than the closed, dense evergreen forests. Localities with similar vertical layering of vegetation have similar bird assemblages. Availability of food also seems to determine the local bird diversity.

Habitat structure and landscape heterogeneity are not the major influences on the local bird diversity in Wayanad. While each habitat can have its own endemic species the abundance and species diversity of any habitat can be altered under the influence of other factors. Further more, species which fluctuate in abundance independently of others is being influenced by a different constellation of regulatory factors, not merely the vegetation type. These factors appear to operate at different spatial and temporal scales (e.g. winter vs. summer, local vs. regional, patterns of food abundance, etc). Thus to understand bird community dynamics, one must consider the ecological responses of the individual species comprising that community.

The species that typically increase in abundance or range when habitat fragmentation occurs are those, which are adapted for being adaptable (Saunders 1989). Their resource needs can be met by a variety of conditions, and thus often benefit by human activities by reducing their competition with other species. Because of this, these species that benefit by human activities are not the ones we need to manage and protect. Instead, we need to protect those species that are adapted solely for survival in the rapidly disappearing unfragmented habitat. Forces like the chronic, unregulated extraction of natural produce such as minor forest products and timber, the invasion and spread of exotic species, predators, parasites, and weeds are all symptomatic of habitat deterioration and can impinge on bird communities gradually. Habitat loss does not always result in the replacement of a natural habitat by one that is sterile or completely unsuitable for birds. Often man-made habitats such as plantations and crop-fields replace them. In regions of tropical forests, there are innumerable areas today that were abandoned after being used, for selective logging of timber, for creation of plantations, or for agriculture. The responses of birds to fragmentation may depend on specific life history attributes. Species groups that may be particularly susceptible include large bodied frugivores and carnivores (Leck 1979, Terborgh and Winter 1980, Thiollay 1989, Kattan et. al. 1994), and terrestrial and understorey insectivores (Leck 1979, Stouffer and Bierregaard 1995a, Canaday 1996, Stratford and Stouffer 1999). Other factors that increase vulnerability include high population variability (Karr 1982) and restricted range (Simberloff 1994).

Feeding and nesting behaviour of birds are greatly influenced by the area of the forest. Ground feeding and ground nesting birds seems to have a greater affinity towards larger tracts of deciduous forests. Insectivores were the largest groups among all the sites followed by frugivores and Raptors. Insectivores showed highest abundance in the deciduous forest and raptors were more in the semi evergreen and evergreen vegetation. Nectarivores showed almost uniform distribution among all the habitats. A positive correlation between body size of the bird and area of the forest is also evident. Larger birds to larger forests seem to be the rule. Canopy nesters were the most abundant group sighted during this study. Hole- nesters and bush nesters came next. Ground nesters were

the least represented. Canopy nesting birds are less in thick evergreen forests; where as such birds are more abundant in disturbed habitats. High altitude forests having the least disturbance and a more even distribution of birds exhibited the presence of all endemic species. The maximum number of species was present in all the study sites during January and the minimum number during June every year. Among the 16 species endemic to Western Ghats 14 are sighted from North Wayanad. The Nilgiri Wood Pecker and Black and Orange Fly catcher were not observed in any of the study sites. It is interesting to note that all these endemic species are seen in the Banasuran Hills. The data obtained from the hill area highlights the importance of rainforest areas at higher elevations for conserving rain forest bird diversity; particularly endemics. Conservation of high elevation areas in the Banasuran belt and maintenance of tree species against habitat alteration due to large scale tea plantations in the slopes are therefore important for bird conservation in these rain forests of the Western Ghats.

Evergreen forest is a source of bird taxa to many habitats of secondary origin including the degraded forests and human settlements. This can be seen in the resemblances between the bird taxa of the degraded semi evergreen patch and the farmland in many aspects, like nesting sites, feeding behaviour etc. When all other factors are equal, density of birds in forest increases with the fertility of the soil. Within the same forest types, the density of birds is consistently greatest on the most productive soils. Newton et al. (1986) suggested that the abundance of songbirds was closely linked with soil productivity. Presumably these trends are driven by larger amounts of insect and plant food being available for birds in the richest habitats.

The extent of changes due to habitat alteration in bird species populations depend on attributes such as diet-guild, endemism, and body size. All species are not equally susceptible to habitat alterations. Various attributes of species influenced their persistence. Species that are larger, rarer, or more restricted in distribution tended to be more vulnerable to human induced habitat alteration. Species responses were also linked to their dietary ecology and habits. Birds such as terrestrial insectivores bark surface feeders, carnivores and frugivores appear to be more vulnerable to changes in habitat.

Malabar Trogon, Wood shrikes, Flycatchers etc. are more sensitive to habitat modifications. These variations across species may be utilized more effectively to target conservation and monitoring efforts at the more vulnerable species. Landscapes containing fragments of rain forest in a matrix of plantations, pose several challenges for conservation. If fragments fall below a threshold area there will be significant declines in rain forest bird species richness. Medium sized fragments may not contain all species particularly large raptors. But they may hold populations of majority of rain forest bird species. This is also true to some extent, of coffee estates that retain rain forest trees in the canopy for shade. Since such sites help support larger populations of rain forest birds in man- modified landscapes, and increase connectivity between patches or wide ranging birds in latitudinal migrants; they need to be included in bird conservation plans as potential refuges for birds.

Despite the multifold damage inflicted on the natural vegetation of Wayanad the district still harbors a rich and diverse avifauna. This is mainly due to the combination of rich evergreen, moist deciduous dry deciduous forests, shoalas, grasslands, hillocks, fresh water marshes, Paddy fields, rivers, mixed plantations etc. This typical heterogeneity of Wayanad offers available opportunities for a diverse bird population to colonize the district. Coffee plantations in Wayanad involve the use of remnant forest over story locally supplemented by a planted over story and in many instances the added cash-crop of black pepper. It is an integrated structurally and taxonomically complex system. Such an artificial habitat supports a relatively large and diverse bird population. When interspersed with remnant tracts of forest like site-3, these artificial habitats appear to provide an environment that is satisfactorily compatible with the requirements of much of the avifauna. It is crucial to combine coffee tracts with companion tracts of remnant forests in order to maintain healthy bird populations (Beehler, Krishna Raju & Sahid, Ali 1986). In the absence of such tracts of forests, the coffee avifauna will suffer disproportionately. The land under Coffee plantation serves as additional useful foraging habitat to birds that are primarily forest dwelling and whose populations might decline or disappear in the absence of their primary habitat. Coffee plantation can not be a sufficient resource by itself to support many of the forest species all year round. My observations

agree with the finding of Beehler, et. al (1986) that the ecotone where mature coffee meets forest is one that is particularly rich in avian activity. Coffee plantations provide a rich, well spread, uniform under storey with lot of nesting opportunities and foraging niches to many of the wild birds like flycatchers, bulbuls, iora, babblers etc. nesting and foraging habitats are also provided by the pepper, rubber plantations etc. Coconut, arecunat, and banana plantations attract nectarivores also.

The shifting cultivation in Wayanad mostly contributed to the destruction of natural vegetation cover in Wayanad. Increased specialization in farming as a result of post war revolution resulted in the loss of diversity of farming practices. Large scale use of pesticides and chemical fertilizers has resulted in the disappearance of several bird species from the cultivated lands of Wayanad. Large populations of pond herons considered true indicators of unpolluted paddy fields have shrunk to an alarmingly low level. Crop protection procedures like shooting and scaring away have resulted in the reduction of birds like doves, pigeons, parakeets, munias, sparrows etc. Conversion of paddy fields in to dry lands for cultivation of crops like banana, ginger, arecunat, pepper etc. resulted in the disappearance of many wet land birds in Wayanad.

Meeting the requirements of growing human inhabitants while protecting biodiversity and natural ecosystems; has come forth as a major global challenge. Finding a way for human actions and conservation goals to be compatible is important. Fully informed decision-making has to be given top priority. Environmental consciousness must grow to the point where the independent and collaborative actions of individuals, communities, governments, corporations, small businesses, and non-government organizations take into consideration what impacts their decisions have on the environment (Miller 1995). Future conservation programme for the forests of Wayanad should consider all the remnant patches of natural forests that persist among the vast expanse of cultivations in the district. Touching those patches in the name of tribal rehabilitation or any other developmental programme will further deteriorate the delicate balance of nature.



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ANNEXURE – I WEATHER DATA FOR NORTH WAYANAD

1. Rainfall Data for the period (1995-2004), month wise*

Month	1995		1996		1997		1998		1999		2000		2001		2002		2003		2004		Mean of 10 year data	
	Total Rainfall in mm	No. of raining days	Total Rainfall in mm	No. of raining days	Total Rainfall in mm	No. of raining days	Total Rainfall in mm	No. of raining days	Total Rainfall in mm	No. of raining days	Total Rainfall in mm	No. of raining days	Total Rainfall in mm	No. of raining days	Total Rainfall in mm	No. of raining days	Total Rainfall in mm	No. of raining days	Total Rainfall in mm	No. of raining days	Rainfall in mm	Raining days
Jan	2.6	1	19.2	1	21.0	1	0.6	0	0.0	0	0.0	0	0.0	0	15.4	2	4.8	1	0	0	6.36	0.7
Feb	20.6	2	0.0	0	21.8	1	0.0	0	16.0	2	1.4	0	47.2	3	0.6	1	16	2	10.0	1	13.36	1.1
Mar	2.6	1	0.0	0	53.8	7	35.8	4	18.4	2	1.4	0	12.0	2	29.0	3	104.2	6	35.8	6	29.3	3.1
Apr	261.2	10	131.6	12	138.6	5	61.2	8	100.2	4	110.8	9	206.2	8	94.4	10	131.4	10	132.4	13	136.8	8.4
May	253.4	10	121.8	3	101.8	7	96.8	7	162.6	13	107.0	9	101.6	9	89.0	6	74.6	8	249.0	21	135.76	9.2
Jun	253.6	16	446.4	12	305.0	14	353.2	18	187.2	12	335.0	22	232.0	21	170.8	25	208.0	13	442.6	20	293.38	17.8
Jul	513.6	24	408.8	20	527.4	25	524.8	27	429.8	24	222.4	14	312.4	19	168.2	23	281.4	21	299.4	30	368.82	23
Aug	442.0	17	251.4	18	379.8	20	200.0	17	192.8	13	395.3	22	194.1	19	291.3	23	211.8	17	357.8	25	291.63	18.2
Sep	199.8	13	252.8	11	164.0	11	132.8	15	35.0	6	271.5	17	140.8	9	48.2	5	55.6	3	142.0	16	144.25	11.4
Oct	222.6	11	368.4	11	237.0	13	167.6	14	395.0	21	138.2	11	100.2	11	266.1	17	349.6	13	171.2	14	241.23	13.6
Nov	116.0	8	49.8	5	160.6	12	120.6	8	40.6	3	53.8	3	88.8	9	242.2	4	83.2	3	108.4	6	118.65	6.17
Dec	0.0	0	130.6	6	40.0	4	34.4	3	0.6	0	106.2	2	0.0	0	0	0	0	0	0	0	39.13	1.5
Total	2288.0	113	2180.8	99	2150.8	120	1727.8	121	1578.2	100	1743.0	109	1435.3	110	1415.2	119	1520.6	97	1948.6	152	1818.7	114

2. Temperature data for the period (1995-2004) month wise*

1995		1996		1997		1998		1999		2000		2001		2002		2003		2004		Mean of 10 year data	
Max °C	Min °C	Max °C	Min °C	Max °C	Min °C	Max °C	Min °C	Max °C	Min °C	Max °C	Min °C	Max °C	Min °C	Max °C	Min °C	Max °C	Min °C	Max °C	Min °C	Max °C	Min °C
27.7	13.5	28.2	12.1	26.4	15.9	29.2	16.9	27.5	15.0	28.1	16.5	27.6	16.0	27.7	16.1	28.5	17.0	28.5	15.8	27.8	15.0
29.9	15.6	29.5	14.8	28.5	16.6	29.3	17.7	30.1	16.8	28.5	17.2	29.4	18.2	29.4	17.5	29.7	16.5	29.8	16.9	29.2	16.8
31.5	16.7	32.3	17.8	30.1	17.9	31.4	19.0	31.5	19.0	31.3	18.9	30.7	18.7	31.8	18.3	30.4	18.3	31.7	18.7	31.2	18.2
30.4	17.4	30.6	19.5	29.5	19.0	31.9	20.8	29.7	19.3	30.0	19.8	29.9	19.1	30.2	19.7	29.8	19.2	29.8	20.0	30.3	19.2
28.3	17.4	29.5	20.0	29.6	20.2	30.5	20.8	26.3	19.2	28.9	19.1	28.6	19.5	29.2	20.1	29.5	19.9	26.7	19.5	28.8	19.4
26.3	16.9	26.6	19.0	26.9	19.9	26.1	19.7	26.1	18.6	24.8	18.6	24.9	18.6	24.9	18.6	26.1	18.6	24.8	18.6	25.7	18.8
24.3	16.5	24.4	18.6	24.7	19.3	24.8	19.2	24.3	18.4	25.2	18.2	24.5	18.3	25.3	18.7	24.9	18.1	24.7	19.1	24.4	18.3
25.4	16.6	25.1	18.6	24.7	18.8	25.6	19.5	27.0	18.6	24.3	18.2	24.3	18.7	24.2	17.8	25.4	18.8	24.4	18.0	24.9	18.3
26.3	15.6	26.0	18.7	26.3	18.9	25.6	18.8	27.0	18.4	26.6	18.3	26.8	18.4	26.3	17.0	25.6	17.7	26.4	17.3	26.3	18.1
27.1	15.8	26.3	17.7	27.2	18.7	25.6	18.5	26.3	18.9	26.4	17.8	26.3	18.7	26.2	18.7	26.1	18.3	26.6	16.7	26.3	18.1
26.5	14.8	26.3	17.7	26.6	19.0	26.1	18.1	26.5	17.6	27.3	17.2	26.8	17.8	26.1	17.7	26.8	17.1	26.5	15.9	26.4	17.3
27.2	11.0	25.1	15.7	26.8	18.2	25.9	16.7	26.5	16.1	25.6	15.1	26.6	16.0	27.8	15.3	27.4	15.4	26.9	14.0	26.3	15.2
27.6	15.7	27.5	17.5	27.3	18.5	27.7	18.8	27.4	18.0	27.3	17.9	27.2	18.2	27.4	17.95	27.5	17.9	27.23	17.5	27.3	17.7

* : Regional Agricultural Research Station, Ambalavayal of Kerala Agricultural University.

3. Relative Humidity data for the period (1995-2004) month wise*

Month	1995		1996		1997		1998		1999		2000		2001		2002		2003		2004		Mean of 10 year data	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
Jan	85.6	44.9	80.4	40.6	90.0	53.0	90.0	49.0	89.0	42.0	90.0	45.0	89.0	47.0	96	54	90.1	57	93.5	60.8	86.0	42.9
Feb	88.0	43.3	82.9	37.0	89.0	43.0	89.0	49.0	86.0	45.0	94.0	55.0	94.0	51.0	79	43	95	69	95.5	77.1	88.5	45.6
Mar	94.6	38.1	88.1	34.6	92.0	46.0	86.0	53.0	94.0	44.0	93.0	45.0	90.0	49.0	90	42	96	57	95	68	89.5	43.6
Apr	88.1	55.2	90.5	56.6	89.0	51.0	91.0	56.0	92.0	59.0	94.0	63.0	93.0	62.0	93	61	94	66	92.8	67.5	90.7	57.6
May	89.3	66.3	88.5	61.4	91.2	60.2	92.0	67.0	95.0	79.0	90.0	64.0	94.0	69.0	91	68	92	65	93.5	79.9	90.9	66.1
Jun	91.1	77.8	90.1	72.5	91.0	74.0	95.0	81.0	92.0	76.0	93.0	84.0	94.0	80.0	92	81	98	80	94.3	86.6	92.5	78.8
July	92.2	81.3	90.6	79.5	44.0	84.0	96.0	84.0	95.0	85.0	91.0	78.0	94.0	83.0	94	84	97	88	92.1	85.2	88.0	82.2
Aug	92.6	80.2	91.5	77.6	91.0	79.0	97.0	84.0	94.0	80.0	96.0	84.0	97.0	85.0	96	94	98	86	98.8	83.6	93.6	81.2
Sep	90.6	70.5	91.2	78.8	91.0	78.0	96.0	82.0	91.0	71.0	95.0	76.0	93.0	73.0	94	95	91	75	95.8	77.8	91.8	74.8
Oct	91.5	69.3	91.0	73.8	92.0	73.0	95.0	78.0	96.0	79.0	93.0	71.0	95.0	74.0	91	89	92	82	94.3	77.5	92.8	74.3
Nov	90.0	65.8	89.1	63.3	93.0	77.0	94.0	76.0	90.0	62.0	89.0	57.0	94.0	66.0	92	81	92	74	93.6	76.6	90.7	66.1
Dec	78.2	35.4	88.8	57.9	94.0	68.0	92.0	62.0	91.0	52.0	86.0	50.0	88.0	50.0	92	73	88.5	59.1	92.6	69.2	87.9	52.6
AVG for the year	89.3	60.7	88.6	61.1	87.3	65.5	92.8	68.4	92.1	64.5	92.0	64.3	92.9	65.8	91.7	72.1	93.6	71.5	94.3	75.8	90.2	63.8

*Source : Regional Agricultural Research Station, Ambalavayal of Kerala Agricultural university.

4. Wind Velocity data for the period (1995-2004) month wise (M/V)* km/hr

Month	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	Mean of 10 year data
January	3.8	4.6	3.0	4.4	3.0	4.4	3.8	2.9	2.9	2.7	4.6
February	3.8	4.1	3.2	3.8	4.2	2.9	2.6	4.5	2.6	2.9	3.7
March	3.9	4.1	3.2	3.0	3.0	3.4	2.8	3.1	2.7	3.2	3.5
April	3.2	3.5	2.8	3.1	3.0	3.3	2.6	2.3	2.3	2.7	3.1
May	3.0	3.6	3.0	2.6	3.8	3.1	3.2	3.2	2.5	3.2	3.3
June	2.9	4.6	3.3	5.2	3.1	3.6	3.8	3.5	3.1	3.9	3.9
July	2.3	4.2	2.9	2.9	3.4	4.3	2.9	2.1	2.3	2.0	3.2
August	1.6	1.9	3.1	1.7	2.4	2.7	1.8	2.5	1.9	2.4	2.1
September	1.8	1.1	2.4	2.4	2.3	2.1	2.3	2.4	2.1	1.9	2.0
October	2.7	2.5	2.8	2.7	2.4	1.9	2.1	2.8	18.6	3.7	2.3
November	1.4	4.9	3.8	2.3	4.2	5.5	3.2	3.1	5.2	5.7	4.3
December	7.0	5.1	3.3	4.8	4.9	5.2	6.3	4.8	3.7	3.2	5.3
AVG for the year	3.1	3.7	3.1	3.2	3.3	3.5	3.1	3.1	4.2	3.1	3.3

M/V = Monthly in Km/hr

*Source : Regional Agricultural Research Station, Ambalavayal of Kerala Agricultural University.

5. Yearly Rain fall data for the last ten years in North Wayanad

Year	Rain Fall (MM)
1994	2304.9
1995	1175.7
1996	1368.6
1997	1728.4
1998	1261.9
1999	1656.9
2000	1782.8
2001	1526.7
2002	1191.2
2003	449.5

ANNEXURE –II

**CHECK LIST OF BIRDS FROM WAYANAD WITH THEIR BREEDING STATUS,
FEEDING ZONES, DIET AND NESTING SUBSTRATUM**

Sl.no	Common Name	Scientific Name	ST	1	2	3	4	5	6	F/Z	D	N/S
ORDER: GALLIFORMES												
Family: Phasianidae												
1	Grey Francolin	<i>Francolinus pondicerianus</i>	B	x						G	I	G
2	Rain Quail	<i>Coturnix coromandelica</i>	B	x			x			G	I	G
3	Jungle Bush Quail	<i>Perdica asiatica</i>	B	x						G	I	G
4	Painted Bush Quail	<i>Perdica erythrorhynchus</i>	B		x			x		G	I	G
5	Red Spur fowl	<i>Galloperdix spardicea</i>	B	x	x	x			x	G	I	G
6	Grey Jungle Fowl	<i>Gallus sonneratii</i>	B	x	x	x	x	x		G	I	G/T
7	Indian Pea Fowl	<i>Pavo cristatus</i>	B	x						G	I	G
ORDER: TURNICIFORMES												
Family: Picidae												
8	Speckled Piculet	<i>Picumnus innominatus</i>	B		x	x	x	x		T	I	H
9	Brown Capped Pigmy Wood pecker	<i>Dendrocopos nanus</i>	B	x	x		x		x	T	I	H
10	Yellow crowned woodpecker	<i>Dendrocopos mahrattensis</i>	B	x					x	T	I	H
11	Rufous Wood pecker	<i>Micropternus brachyurus</i>	B	x	x		x		x	T	I	H
12	White bellied Wood pecker	<i>Dryocopus javensis</i>	B	x	x					T	I	H
13	Common Flame back	<i>Dinopium javenense</i>	B		x	x	x	x		T	I	H
14	Black Rumped Flame back	<i>Dinopium benghalense</i>	B	x	x	x	x		x	T	I	H
15	Greater Flame back	<i>Chrysocolaptes lucidus</i>	B		x					T	I	H

16	White Naped Wood pecker	<i>Chrysocolaptes festivus</i>	B	x		x			T	I	H	
17	Heart Spotted Woodpecker	<i>Hemicircus canente</i>	B	x	x	x	x	x	x	T	I	H
Family: Megalainidae												
18	White Cheeked Barbet	<i>Magalaima viridis</i>	B	x	x	x	x	x	x	T	F	H
19	Crimson Fronted Barbet	<i>Magalaima rubricapilla</i>	B	x	x	x		x		T	F	H
20	Coppersmith Barbet	<i>Magalaima haemocephala</i>	B	x			x		x	T	F	H
ORDER: BUCEROTIFORMES												
Family: Bucerotidae												
21	Malabar Grey Hornbill	<i>Ocyceros griseus</i>	B		x	x	x	x		T	F	H
22	Malabar Pied Hornbill	<i>Anthracoceros coronatus</i>	B	x		x				T	F	H
23	Great Horn bill	<i>Buceros bicornis</i>	B	x	x					T	F	H
ORDER : UPUPIFORMES												
Family:Upupidae												
24	Eurasian Hoopoe	<i>Upupa epops</i>	B	x	x				x	G	I	H
ORDER: TROGONIFORMES												
Fmily: Trogonidae												
25	Malabar Trogon	<i>Harpaetes faciatus</i>	B		x	x		x		T	I	H
ORDER: CORACIFORMES												
Family: Coracidae												
26	Indian Roller	<i>Coracias benghalensis</i>	B	x		x	x		x	A	I	H
Family: Halcyonidae												
27	White Throated Kingfisher	<i>Halcyon smyrnensis</i>	B	x	x		x	x	x	A	O	H
28	Black Capped Kingfisher	<i>Halcyon pileata</i>	B		x	x				A	?	H
Family: Meropidae												
29	Blued Bearded Bee eater	<i>Nyctyornis athertoni</i>	B	x						A	I	H
30	Green bee-eater	<i>Merops orientalis</i>	B	x		x	x		x	A	I	H
31	Blue Tailed bee-eater	<i>Merops philippinus</i>	M	x		x	x		x	A	I	H

32	Chestnut Headed bee-eater	<i>Merops leschenaulti</i>	B	x	x		x	A	I	H
ORDER: CUCULIFORMES										
Family: Cuculidae										
33	Pied Cuckoo	<i>Oxylophus Jacobinus</i>	M	x				x	T	I O
34	Large Hawk-Cuckoo	<i>Cuculus sparverioides</i>	B	x		x			T	I O
35	Common Hawk-Cuckoo	<i>Cuculus varius</i>	B	x		x	x		x	T I O
36	Indian Cuckoo	<i>Cuculus micropterus</i>	M	x		x			T	I O
37	Banded Bay Cuckoo	<i>Cacomantis sonneratii</i>	B	x	x	x	x	x	x	T I O
38	Grey bellied cuckoo	<i>Cacomantis passerinus</i>	M	x	x	x	x		T	I O
39	Drongo Cuckoo	<i>Surniculus lugubris</i>	B	x					T	I O
40	Asian Koel	<i>Eudynamys Scolopacea</i>	B	x				x	T	F O
41	Blue Faced Malkoha	<i>Phenicophaeus viridirostris</i>	B	x					S	I C
42	Sirkeer Malkoha	<i>Phenicophaeusleschenaultii</i>	B	x					S	I C
Family: Centropodidae										
43	Greater Coucal	<i>Centropus sinensis</i>	B	x	x	x	x		x	S O C
ORDER: PSITTACIFORMES										
Family: Psittacidae										
44	Vernal Hanging Parrot	<i>Loriculus vernalis</i>	B	x	x	x	x	x	x	T F H
45	Rose Ringed Parakeet	<i>Psittacula krameri</i>	B	x		x	x		x	T F/G H
46	Plum Headed Parakeet	<i>Psittacula Cyanocephala</i>	B	x	x	x	x		x	T F/G H
47	Alexandrine Parakeet	<i>Psittacula eupatria</i>	B	x		x			T	F/G H
48	Malabar Parakeet	<i>Psittacula colomboides</i>	B	x	x	x	x	x	x	T F/G H
ORDER: APODIFORMES										
Family: Apodidae										
49	Indian Swiftlet	<i>Collocalia unicolor</i>	B	x	x	x		x	x	A I O
50	White Rumped Spine tail	<i>Zoonavena sylvatica</i>	B	x	x	x		x	A	I O
51	Brown backed Needle tail	<i>Hirundapus giganteus</i>	B	x	x			x	A	I O

52	Asian Palm swift	<i>Cypsiurus balasiensis</i>	B	x	x		x	x	A	I	O
53	Alpine swift	<i>Tachymarptis melba</i>	B	x	x	x		x	A	I	O
	Family: Hemiprocnidae										
54	Crested tree swift	<i>Hemiproctne Coronata</i>	B	x					A	I	O
	ORDER: STRIGIFORMES										
	Family: Strigidae										
55	Oriental Scops owl	<i>Otus sunia</i>	B	x	x	x	x		FR	R	H
56	Spot Bellied Eagle Owl	<i>Bubo nipalensis</i>	B	x		x			FR	R	H
57	Brown Fish Owl	<i>Ketupa zeylonensis</i>	B	x	x	x			FR	R	H
58	Jungle Owlet	<i>Glaucidium radiatum</i>	B	x	x	x	x	x	FR	R	H
59	Brown Hawk Owl	<i>Ninox scutulata</i>	B	x		x		x	FR	R	H
	Family: Batrachostomidae										
60	Sri Lanka frogmouth	<i>Batrachostomus moniliger</i>	B		x				T	I	O
	Family: Caprimulgidae										
61	Grey Nightjar	<i>Caprimulgus indicus</i>	B	x	x				T	I	O
	ORDER: COLUMBIFORMES										
	Famiy: Columbidae										
62	Rock Pigeon	<i>Columba livia</i>									
63	Nilgiri Wood Pigeon	<i>Columba elphinstonii</i>	B		x	x		x	T/G	F	C
64	Spotted Dove	<i>Streptopelia chinensis</i>	B	x	x	x	x		G	F	C
65	Emerald Dove	<i>Chalcophaps indica</i>	B	x	x	x	x	x	S	F	C
66	Pompadour Green Pigeon	<i>Treron pompadora</i>	B	x	x	x	x	x	T	F	C
67	Yellow Footed Green Pigeon	<i>Treron phoenicoptera</i>	B	x	x	x	x	x	T	F	C
68	Mountain Imperial Pigeon	<i>Ducula leadia</i>	B		x	x	x	x	T	F	C
	ORDER: CICONIFORMES										
	Family: Acipitridae										
	Acipitrinae										

69	Jerdons Baza	<i>Aviceda jerdoni</i>	?	x				T	R	C		
70	Oriental Honey Buzzard	<i>Pernis ptilorhyncus</i>	B	x	x	x	x	x	FR	R	C	
71	Black Winged Kite	<i>Elanus caeruleus</i>	B	x	x	x		x	O/F	R	C	
72	Black Kite	<i>Milvus migrans</i>	B	x		x	x		x	O/F	R	C
73	Brahminy Kite	<i>Haliastur Indus</i>	B	x		x	x		x	O/F	R	C
74	White Rumped Vulture	<i>Gyps bengalensis</i>	B	x		x			FR	R	C	
75	Crested Serpant Eagle	<i>Spilornis cheela</i>	B	x	x	x	x	x	FR	R	C	
76	Pallied Harrier	<i>Circus macronrus</i>	M		x	x			FR	R	C	
77	Montagu's Harrier	<i>Circus pygarus</i>	M		x				FR	R	C	
78	Crested Goshawk	<i>Accipiter trivirgatus</i>	B		x				FR	R	C	
79	Shikra	<i>Accipiter badius</i>	B	x		x	x		x	FR	R	C
80	Besra	<i>Accipiter Virgatus</i>	B		x	x			FR	R	C	
81	Eurasian Sparrow-hawk	<i>Accipiter nisus</i>	M	x	x			x	FR	R	C	
82	Common Buzzard	<i>Buteo buteo</i>	M		x				FR	R	C	
83	Black eagle	<i>Ictinaetus malayensis</i>	B		x	x	x	x	FR	R	C	
84	Rufous bellied Eagle	<i>Hieraactus kienerii</i>	B		x				FR	R	C	
85	Changeable HawkEagle	<i>Spizaetus cirrhatus</i>	B	x	x	x	x		x	FR	R	C
86	Mountain hawk-eagle	<i>Spizaetus nipalensis</i>	M		x			x	FR	R	C	
Family: Falconidae												
87	Common Kestrel	<i>Falco tinnunculus</i>	B	x	x	x	x	x	x	O/FR	R	C
88	Red necked Falcon	<i>Falco chiquera</i>	B		x				O/FR	R	C	
89	Peregrine falcon	<i>Falco peregrinus</i>	?		x	x		x	O/FR	R	C	
Family: Ardeidae												
90	Cattle Egret	<i>Bubulcus ibis</i>	S/V	x		x			x	G	O	C
91	Indian Pond heron	<i>Ardeola grayii</i>	B	x	x				x	G	O	C

ORDER: PASSERIFORMES

Family: Pittidae

92	Indian Pitta	<i>Pitta brachyura</i>	M	x	x	x	x	x	x	G	I	C
	Family: Irenidae											
93	Grey headed Canary Fly catcher	<i>Culicicapa ceylonens</i>	B		x			x		T	I	C
94	Asian Fairy Blue bird	<i>Irena puella</i>	B	x	x	x	x	x	x	T	I	C
95	Blue winged Leaf Bird	<i>Chloropsis cochinchinens</i>	B		x					T	I	C
96	Golden fronted Leaf Bird	<i>Chloropsis aurifrons</i>	B	x		x	x		x	T	I	C
	Family: Laniidae											
97	Brown Shrike	<i>Lanius cristatus</i>	M	x	x	x	x	x	x	S	I	C
98	Bay backed Shrike	<i>Lanius vittatus</i>	B	x			x		x	T	I	C
99	Long tailed Shrike	<i>Lanius schach</i>	B	x		x	x		x	T	I	C
	Family: Corvidae											
	Corvini											
100	Rufous Tree Pie	<i>Dendrocitta vagabunda</i>	B	x		x	x		x	T	I	C
101	White Bellied tree pie	<i>Dendrocitta leucogastra</i>	B		x	x		x		T	I	C
102	House Crow	<i>Corvus splendens</i>	B				x		x	T	O	C
103	Large Billed crow	<i>Corvus levaillantii</i>	B	x		x	x		x	T	O	C
	Artamini											
104	Ashy wood swallow	<i>Artamus fuscus</i>	B	x			x	x	x	A	I	C
	Oriolini											
105	Eurasian Golden Oriole	<i>Oriolus oriolus</i>	M	x	x	x	x		x	T	I	C
106	Black headed oriole	<i>Oriolus xanthornus</i>	B	x		x	x		x	T	I	C
107	Large Cuckoo Shrike	<i>Coracina macei</i>	B	x			x		x	T	I	C
108	Black Headed Cuckoo Shrike	<i>Coracina melanoptera</i>	B		x	x				T	I	C
109	Small Minivet	<i>Pericrocotus cinnamomeus</i>	B	x			x		x	C	I	C
110	Scarlet Minivet	<i>Pericrocotus flammeus</i>	B	x	x	x	x	x	x	C	I	C
111	Bar Winged Fly Catcher Shrike	<i>Hemipus picatus</i>	B	x	x	x	x	x		A	I	C

Dicrurinae											
Rhipidurini											
112	White Browed Fan tail	<i>Rhipidura aureola</i>	B	x				A	I	C	
Dicrurini											
113	Black Drongo	<i>Dicrurus macrocereus</i>	B	x	x	x	x	A	I	C	
114	Ashy drongo	<i>Dicrurus leucocephaeus</i>	M	x	x	x	x	A	I	C	
115	White bellied drongo	<i>Dicrurus caerulescens</i>	B	x				A	I	C	
116	Bronzed drongo	<i>Dicrurus aeneus</i>	B		x	x	x	A	I	C	
117	Hair Crested Drongo	<i>Dicrurus hottentottus</i>	B	x	x		x	A	I	C	
118	Greater racket-tailed Drongo	<i>Dicrurus paradiseus</i>	B	x	x	x	x	A	I	C	
Monarchini											
119	Black naped Monarch	<i>Hypothymis azurea</i>	B	x	x	x	x	A	I	C	
120	Asian Paradise flycatcher	<i>Terpsiphone paradisi</i>	M	x	x	x	x	A	I	C	
Aegithininae											
121	Common Iora	<i>Aegithina tiphia</i>	B	x	x	x	x	T	I	C	
Malaconotinae											
122	Large Wood Shrike	<i>Tephrodornis gularis</i>	B	x	x	x		T	I	C	
123	Common Wood Shrike	<i>Tephrodornis pondicerianus</i>	B					x	T	I	C
Family: Muscicapidae											
Turdinae											
124	Blue Capped Rock Thrush	<i>Monticola cinclorhynchus</i>	M	x	x		x	x	G	I	G
125	Blue Rock Thrush	<i>Monticola solitarius</i>	M		x	x	x		G	I	G
126	Malabar Whistling Thrush	<i>Myiophonus horsfieldii</i>	B		x	x	x		G	I	G
127	Orange headed Thrush	<i>Zoothera citrina</i>	B	x	x	x	x	x	G	I	G
128	Eurasian Black bird	<i>Turdus merula</i>	B		x	x	x		T	I	C
129	White bellied Shortwing	<i>Brachypteryx major</i>	B		x		x		G	I	C

Muscicapinae												
Muscicapini												
130	Asian Brown flycatcher	<i>Muscicapa dauurica</i>	B	x	x	x	x	x	x	A	I	C
131	Rusty tailed flycatcher	<i>Muscicapa ruficauda</i>	M		x	x		x		A	I	C
132	Brown breasted Flycatcher	<i>Muscicapa muttui</i>	M	x	x		x	x		A	I	C
133	Red breasted flycatcher	<i>Ficedula parva</i>	M	x	x	x		x		A	I	C
134	Verditor flycatcher	<i>Eumyias thalassina</i>	M	x	x	x		x	x	A	I	C
135	Nilgiri flycatcher	<i>Eumyias albicaudata</i>	B		x	x	x	x		A	I	C
136	White bellied Blue Flycatcher	<i>Cyornis pallipes</i>	B		x			x		A	I	C
137	Blue Throated Fly Catcher	<i>Cyornis rubeculoides</i>	M		x		x			A	I	C
138	Tickell's blue flycatcher	<i>Cyornis tickelliae</i>	B	x	x	x	x	x	x	A	I	H
Saxicolini												
139	Blue Throat	<i>Luscinia svecica</i>	M	x						G	I	B
140	Indian Blue Robin	<i>Luscinia brunnea</i>	M		x	x		x		G	I	B
141	Oriental Magpie-robin	<i>Copsychus saularis</i>	B	x	x	x	x	x	x	G	I	B
142	Pied Bush chat	<i>Saxicola caprata</i>	B	x	x	x		x		S	I	B
Family: Sturnidae												
143	Chestnut Tailed Starling	<i>Sturnus malabaricus</i>	M	x	x	x	x	x	x	T	I	H
144	Brahminy Starling	<i>Sturnus pagodarum</i>	B	x		x			x	T	I	H
145	Common Myna	<i>Acridotheres tristis</i>	B	x		x	x		x	G	I	H
146	Jungle Myna	<i>Acridotheres fuscus</i>	B	x		x	x		x	G	I	H
147	Hill Myna	<i>Gracula religiosa</i>	B	x	x			x		T	I/F	H
Family: Sittidae												
Sittinae												
148	Chestnut bellied nuthatch	<i>Sitta castanea</i>	B	x			x			T	I	H
149	Velvet fronted nuthatch	<i>Sitta frontalis</i>	B	x	x	x	x	x		T	I	H

	Family: Paridae									
	Parinae									
150	Great Tit	<i>Parus major</i>	B	x		x	x	C	I	C
151	Black lored Tit	<i>Parus xanthogenys</i>	B	x	x	x	x	C	I	C
	Family: Hirudinidae									
152	Dusky crag martin	<i>Hirundo concolor</i>	B	x	x	x	x	A	I	O
153	Barn Swallow	<i>Hirundo rustica</i>	M	x	x	x	x	A	I	O
154	Hill Swallow	<i>Hirundo domicola</i>	B		x		x	A	I	O
155	Wire tailed Swallow	<i>Hirundo smithii</i>	B	x				A	I	O
156	Red rumped Swallow	<i>Hirundo daurica</i>	B	x	x	x	x	A	I	O
	Family: Picnonotidae									
157	Grey Headed Bulbul	<i>Pycnonotus priocephalus</i>	B		x		x	S	I	B
158	Black Crested Bulbul	<i>Pycnonotus melanicterus</i>	B		x	x	x	S	I/Be	B
159	Red whiskered Bulbul	<i>Pycnonotus jocosus</i>	B	x	x	x	x	S	I/Be	B
160	Red vented Bulbul	<i>Pycnonotus cafer</i>	B		x	x	x	S	I/Be	B
161	White browed Bulbul	<i>Pycnonotus luteolus</i>	B	x				S	I/Be	B
162	Yellow browed Bulbul	<i>Lole indica</i>	B		x	x	x	S	I/Be	B
163	Black Bulbul	<i>Hypsipetes leucocephalus</i>	B		x		x	T	I/B/N	B
	Family: Cisticolidae									
164	Bright Headed Cisticola	<i>Cisticola exilis</i>	B		x			S	I	B
165	Grey Breasted Prinia	<i>Prinia hodgsonii</i>	B	x	x		x	S	I	B
166	Plain Prinia	<i>Prinia inornata</i>	B	x			x	S	I	B
167	Ashy Prinia	<i>Prinia socialis</i>	B	x		x		S	I	B
	Family: Zosteropidae									
168	Oriental White Eye	<i>Zosterops Palpebrosus</i>	B	x	x	x	x	C	I/N	C

Family: Sylviidae												
Acrocephalinae												
169	Blyth's reed Warbler	<i>Acrocephalus dumetorum</i>	M	x	x	x		x	x	S	I	B
170	Thick billed Warbler	<i>Acrocephalus aedon</i>	M	x	x	x	x	x		S	I	B
171	Booted Warbler	<i>Hippolais calligata</i>	M	x	x	x				S	I	B
172	Common Tailor bird	<i>Orthotomus sutorius</i>	B	x	x	x	x	x	x	S	I	B
173	Tickell's leaf Warbler	<i>Phylloscopus affinis</i>	M	x	x					C	I	C
174	Greenish Warbler	<i>Phylloscopus trochiloides</i>	M	x	x	x	x	x	x	C	I	C
175	Yellow breasted Warbler	<i>Phylloscopus nitidus</i>	M	x	x					C	I	C
176	Tytlers Leaf Warbler	<i>Phylloscopus tyleri</i>	M		x			x		C	I	C
177	Western Crowned Warbler	<i>Phylloscopus occipitalis</i>	M		x	x		x		C	I	B
Megalurinae:												
178	Broad Tailed Grass bird	<i>Schoenicola platyura</i>	B		x	x		x		S	I	B
Garrulacinae												
179	Wayanad Laughing Thrush	<i>Garrulax delesserti</i>	B		x	x		x		S	I	B
180	Grey Breasted Laughing Thrush	<i>Garrulax jerdoni</i>	B					x		S	I	B
Sylvinae												
Timaliini												
181	Puff Throated Babbler	<i>Pellorneum ruficeps</i>	B		x	x	x	x	x	G	I	B
182	Indian scimitar Babbler	<i>Pomatorhinus horsfieldii</i>	B	x	x	x	x	x	x	S/T	I	B
183	Tawny bellied Babbler	<i>Dumetia hyperythra</i>	B	x		x	x		x	S	I	B
184	Dark Fronted Babbler	<i>Rhopocichla atriceps</i>	B	x	x	x	x	x	x	S	I	B
185	Yellow eyed Babbler	<i>Chrysomma sinense</i>	B	x						S	I	B
186	Rufous Babbler	<i>Turdoides subrufus</i>	B	x	x	x	x	x	x	S	I	B
187	Jungle Babbler	<i>Turdoides striatus</i>	B	x	x	x	x		x	S	I	C
188	Brown checked Fulvetta	<i>Alcippe poioicephala</i>	B		x	x	x	x		S/T	I	B

	Family: Alaudidae									
189	Oriental sky lark	<i>Alauda gulgula</i>	B	x		x	G	I	G	
	Family: Nectariniidae									
	Nectariniinae									
	Dicaeini									
190	Thick billed Flower pecker	<i>Dicaeum agile</i>	B		x	x	x	x	T	I/F/N C
191	Pale billed Flower pecker	<i>Dicaeum erythrorhynchos</i>	B	x	x	x	x	x	T	I/F/N C
192	Plain Flower pecker	<i>Dicaeum concolor</i>	B	x	x	x	x	x	T	I/F/N C
	Nectariniini									
193	Purple rumped Sunbird	<i>Nectarinia zeylonica</i>	B	x	x	x	x	x	T	I/N B
194	Crimson Backed sunbird	<i>Nectarinia minima</i>	B		x	x		x	T/S	I/N B
195	Purple Sunbird	<i>Nectarinia asiatica</i>	B	x		x	x		T	I/N B
196	Long billed Sun bird	<i>Nectarinia lotentia</i>	B	x		x	x		T	I/N B
197	Little spider hunter	<i>Arachnothera longirostra</i>	B		x			x	T/S	I/N B
	Family: Passeridae									
	Passerinae									
198	House Sparrow	<i>Passer domesticus</i>	B	x			x	x	S	G O
	Motacillinae									
199	Forest wagtail	<i>Dendronanthus indicus</i>	M	x	x	x	x	x	G	I C
200	White Browed wagtail	<i>Motacilla maderaspatensis</i>	B	x			x		G	I O
201	Yellow wagtail	<i>Motacilla flava</i>	B		x	x		x	G	I ?
202	Grey wagtail	<i>Motacilla cinera</i>	M	x	x		x	x	G	I B
203	Paddy field Pipit	<i>Anthus ruficulus</i>	B	x	x		x	x	G	I B
204	Olive Backed Pipit	<i>Anthus hodgsoni</i>	B	x	x		x	x	G	I B
205	Nilgiri Pipit	<i>Anthus nilghiriensis</i>	B		x			x	G	I B
	Estrildinae									

206	White rumped Munia	<i>Lonchura striata</i>	B	x	x	x	x	x	x	S	I	B
207	Black Throated Munia	<i>Lonchura kelaarti</i>	B	x	x	x		x		S	I	B
208	Scaly breasted Munia	<i>Lonchura punctulata</i>	B	x		x			x	S	I	B
209	Black headed Munia	<i>Lonchura Malacca</i>	B	x			x		x	S	I	B
	Family: Fringillidae											
	Carduelini											
210	Common Rose Finch	<i>Carpodacus erythrinus</i>	M		x			x	x	T	N	B

Status: B= Resident, M= Migrant, S/V= Seasonal Visitor

F/Z= Feeding Zone: G= Ground, T= Tree, FR= Forest, C= Canopy, S= Shrub, A= Aerial, T/G= Tree/Ground, O/FR= Open Forest S/T= Shrub/Tree.

D= Diet: I= Insectivore, F= Frugivore, O= Omnivore, R= Raptor (Bird of Prey), G= Granivore, F/G= Frugivore/Granivore, I/F= Insectivore/Frugivore, I/Be= Insects/Berries, N= Nectarivore, I/N= Insectivore/Nectarivore.

ANNEXURE III
SEASONAL OCCURRENCE OF BIRDS IN DIFFERENT STUDY SITES
1. Seasonal occurrence at Site-1 (Tholpetty)

Sl.no	Common Name	Scientific Name	J	F	M	A	M	J	J	A	S	O	N	D
1	Grey Francolin	<i>Francolinus pondicerianus</i>	x	x	x	x	x	x	x	x	x	x	x	x
2	Rain Quail	<i>Coturnix coromandelica</i>	x	x	x								x	x
3	Jungle Bush Quail	<i>Perdicula asiatica</i>	x		x		x						x	x
4	Red Spur fowl	<i>Galloperdix spardicea</i>	x	x	x	x	x	x	x	x	x	x	x	x
5	Grey Jungle Fowl	<i>Gallus sonneratii</i>	x	x	x	x	x	x	x	x	x	x	x	x
6	Indian Pea Fowl	<i>Pavo cristatus</i>	x	x	x	x	x	x	x	x	x	x	x	x
7	Brown Capped Pigmy Woodpecker	<i>Dendrocopos nanus</i>	x	x	x	x	x	x	x	x	x	x	x	x
8	Yellow crowned woodpecker	<i>Dendrocopos mahrattensis</i>	x	x	x	x	x	x	x	x	x	x	x	x
9	Rufous Woodpecker	<i>Micropternus brachyurus</i>	x	x	x	x	x	x	x	x	x	x	x	x
10	White bellied Woodpecker	<i>Dryocopus javensis</i>	x	x										
11	Black Rumped Flame back	<i>Dinopium benghalense</i>	x	x	x	x	x	x	x	x	x	x	x	x
12	White Naped Wood pecker	<i>Chrysocolaptes festivus</i>	x	x	x								x	x
13	Heart Spotted Woodpecker	<i>Hemicircus canente</i>	x	x	x	x	x	x	x	x	x	x	x	x
14	White Cheeked Barbet	<i>Magalaima viridis</i>	x	x	x	x	x	x	x	x	x	x	x	x
15	Crimson Fronted Barbet	<i>Magalaima rubricapilla</i>	x	x	x	x	x	x	x	x	x	x	x	x
16	Coppersmith Barbet	<i>Magalaima haemocephala</i>	x	x	x	x	x	x	x	x	x	x	x	x
17	Malabar Pied Hornbill	<i>Anthracoceros coronatus</i>	x					x				x	x	x
18	Great Horn bill	<i>Buceros bicornis</i>	x	x	x	x	x	x	x	x	x		x	x
19	Eurasian Hoopoe	<i>Upupa epops</i>	x	x	x		x	x	x	x	x	x	x	x
20	Indian Roller	<i>Coracias benghalensis</i>	x	x	x	x	x	x	x	x	x	x	x	x
21	White Throated Kingfisher	<i>Halcyon smyrnensis</i>	x	x	x	x	x	x	x	x	x	x	x	x
22	Blued Bearded Kingfisher	<i>Nyctyornis athertoni</i>	x	x	x	x	x	x	x	x	x	x	x	x

23	Little Green bee-eater	<i>Merops orientalis</i>	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
24	Blue Tailed bee-eater	<i>Merops philippinus</i>	x	x														x
25	Pied Cuckoo	<i>Oxylophus Jacobinus</i>	x	x	x													x
26	Large Hawk-Cuckoo	<i>Cuculus sparverioides</i>	x			x												x
27	Common Hawk-Cuckoo	<i>Cuculus varius</i>	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
28	Indian Cuckoo	<i>Cuculus micropterus</i>	x	x	x	x												
29	Banded Bay Cuckoo	<i>Cacomantis sonneratii</i>	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
30	Grey bellied cuckoo	<i>Cacomantis passerinus</i>	x	x														x
31	Drongo Cuckoo	<i>Surniculus lugubris</i>	x	x	x													x
32	Asian Koel	<i>Eudynamys Scolopacea</i>	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
33	Blue Faced Malkoha	<i>Phenicophaeus viridirostris</i>	x	x														x
34	Sirkeer Malkoha	<i>Phenicophaeusleschenaultii</i>	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
35	Greater Coucal	<i>Centropus sinensis</i>	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
36	Vernal Hanging Parrot	<i>Loriculus vernalis</i>	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
37	Rose Ringed Parakeet	<i>Psittacula krameri</i>	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
38	Plum Headed Parakeet	<i>Psittacula Cyanocephala</i>	x	x														x
39	Alexandrine Parakeet	<i>Psittacula eupatria</i>	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
40	Malabar Parakeet	<i>Psittacula colomboides</i>	x	x														x
41	Indian Swiftlet	<i>Collocalia unicolor</i>	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
42	White Rumped Spine tail	<i>Zoonavena sylvatica</i>	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
43	Brown backed Needle tail	<i>Hirundapus giganteus</i>	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
44	Asian Palm swift	<i>Cypsiurus balasiensis</i>	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
45	Alpine swift	<i>Tachymarptis melba</i>	x	x	x													x
46	Crested tree swift	<i>Hemiprocne Coronata</i>	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
47	Oriental Scops owl	<i>Otus sunia</i>	x	x	x													x
48	Spot Bellied Eagle Owl	<i>Bubo nipalensis</i>		x	x	x												x
49	Brown Fish Owl	<i>Ketupa zeylonensis</i>	x															

50	Jungle Owlet	<i>Glaucidium radiatum</i>	x	x	x	x	x	x	x	x	x	x	x	x
51	Brown Hawk Owl	<i>Ninox scutulata</i>	x	x	x	x			x			x	x	x
52	Grey Nightjar	<i>Caprimulgus indicus</i>	x		x	x								x
53	Blue Rock Pigeon	<i>Columba livia</i>	x	x	x	x	x	x	x	x	x	x	x	x
54	Spotted Dove	<i>Streptopelia chinensis</i>	x	x	x	x	x	x	x	x	x	x	x	x
55	Emerald Dove	<i>Chalcophaps indica</i>	x	x										
56	Pompadour Green Pigeon	<i>Treron pompadora</i>	x	x	x	x	x	x	x	x	x	x	x	x
57	Yellow Footed Green Pigeon	<i>Treron phoenicoptera</i>	x	x								x	x	
58	Oriental Honey Buzzard	<i>Pernis ptilorhyncus</i>	x	x	x	x	x	x	x	x	x	x	x	x
59	Black Winged Kite	<i>Elanus caeruleus</i>	x	x	x	x						x	x	
60	Black Kite	<i>Milvus migrans</i>	x	x	x	x	x	x	x	x	x	x	x	x
61	Brahminy Kite	<i>Haliastur Indus</i>	x	x	x	x	x	x	x	x	x	x	x	x
62	White Rumped Vulture	<i>Gyps bengalensis</i>	x	x	x	x	x	x	x	x	x	x	x	x
63	Crested Serpant Eagle	<i>Spilornis cheela</i>	x	x	x	x	x	x	x	x	x	x	x	x
64	Shikra	<i>Accipiter badius</i>	x	x	x	x	x	x	x	x	x	x	x	x
65	Eurasian Sparrow-hawk	<i>Accipiter nisus</i>	x											x
66	Changeable HawkEagle	<i>Spizaetus cirrhatus</i>	x	x	x	x	x	x	x	x	x	x	x	x
67	Common Kestrel	<i>Falco tinnunculus</i>	x	x	x	x	x	x	x	x	x	x	x	x
68	Cattle Egret	<i>Bubulcus ibis</i>	x	x	x							x	x	x
69	Indian Pond heron	<i>Ardeola grayii</i>	x	x	x	x				x	x	x	x	x
70	Indian Pitta	<i>Pitta brachyura</i>	x											x
71	Asian Fairy Blue bird	<i>Irena puella</i>	x	x										x
72	Blue winged Leaf Bird	<i>Chloropsis cochinchinens</i>	x											
73	Golden fronted Leaf Bird	<i>Chloropsis aurifrons</i>	x	x	x	x	x	x	x	x	x	x	x	x
74	Brown Shrike	<i>Lanius cristatus</i>	x	x	x	x						x	x	x
75	Bay backed Shrike	<i>Lanius vittatus</i>	x	x	x	x	x					x	x	x
76	Long tailed Shrike	<i>Lanius schach</i>	x	x	x	x	x					x	x	x

2. Seasonal occurrence of birds at Site-2 (Thirunelly)

Sl.No.	Common Name	Scientific Name	J	F	M	A	M	J	J	A	S	O	N	D
1	Painted Bush Quail	<i>Perdicula erythrorhynchus</i>	x	x									x	x
2	Red Spur fowl	<i>Galloperdix spardicea</i>	x	x	x	x	x	x	x	x	x	x	x	x
3	Grey Jungle Fowl	<i>Gallus sonneratii</i>	x	x	x	x	x	x	x	x	x	x	x	x
4	Speckled Piculet	<i>Picumnus innominatus</i>	x	x	x	x	x	x	x	x	x	x	x	x
5	Brown Capped Pigmy Wood pecker	<i>Dendrocopos nanus</i>	x	x	x	x	x	x	x	x	x	x	x	x
6	Rufous Wood pecker	<i>Micropternus brachyurus</i>	x	x	x	x	x	x	x	x	x	x	x	x
7	White bellied Wood pecker	<i>Dryocopus javensis</i>	x	x	x	x	x	x	x	x	x	x	x	x
8	Common Flame back	<i>Dinopium javenense</i>	x	x	x	x	x	x	x	x	x	x	x	x
9	Black Rumped Flame back	<i>Dinopium benghalense</i>	x	x	x	x	x	x	x	x	x	x	x	x
10	Greater Flame back	<i>Chrysocolaptes lucidus</i>	x	x	x	x	x	x	x	x	x	x	x	x
11	Heart Spotted Woodpecker	<i>Hemicircus canente</i>	x	x	x	x	x	x	x	x	x	x	x	x
12	White Cheeked Barbet	<i>Magalaima viridis</i>	x	x	x	x	x	x	x	x	x	x	x	x
13	Crimson Fronted Barbet	<i>Magalaima rubricapilla</i>	x	x	x	x	x	x	x	x	x	x	x	x
14	Malabar Grey Hornbill	<i>Ocyceros griseus</i>	x	x	x	x	x	x	x	x	x	x	x	x
15	Great Horn bill	<i>Buceros bicornis</i>	x	x	x	x	x	x	x	x	x	x	x	x
16	Eurasian Hoopoe	<i>Upupa epops</i>	x	x	x	x	x	x	x	x	x	x	x	x
17	Malabar Trogon	<i>Harpaetes faciatus</i>	x	x	x	x	x	x	x	x	x	x	x	x
18	White Throated Kingfisher	<i>Halcyon smyrnensis</i>	x	x	x	x	x	x	x	x	x	x	x	x
19	Black Capped Kingfisher	<i>Halcyon pileata</i>	x	x	x	x	x	x	x	x	x	x	x	x
20	Chestnut Headed bee-eater	<i>Merops leschenaulti</i>	x	x	x	x	x	x	x	x	x	x	x	x
21	Banded Bay Cuckoo	<i>Cacomantis sonneratii</i>	x	x	x	x	x	x	x	x	x	x	x	x
22	Grey bellied cuckoo	<i>Cacomantis passerinus</i>	x	x									x	x
23	Greater Coucal	<i>Centropus sinensis</i>	x	x	x	x	x	x	x	x	x	x	x	x

24	Vernal Hanging Parrot	<i>Loriculus vernalis</i>	x	x	x	x	x	x	x	x	x	x	x
25	Plum Headed Parakeet	<i>Psittacula Cyanocephala</i>	x	x	x	x	x	x	x	x	x	x	
26	Malabar Parakeet	<i>Psittacula colomboides</i>	x	x	x	x	x	x	x	x	x	x	x
27	Indian Swiftlet	<i>Collocalia unicolor</i>	x	x	x	x	x	x	x	x	x	x	x
28	White Rumped Spine tail	<i>Zoonavena sylvatica</i>	x	x	x	x	x	x	x	x	x	x	x
29	Brown backed Needle tail	<i>Hirundapus giganteus</i>	x	x	x	x	x	x	x	x	x	x	x
30	Asian Palm swift	<i>Cypsiurus balasiensis</i>	x	x	x	x	x	x	x	x	x	x	x
31	Alpine swift	<i>Tachymarptis melba</i>	x	x	x	x	x					x	x
32	Oriental Scops owl	<i>Otus sunia</i>	x	x	x								x
33	Brown Fish Owl	<i>Ketupa zeylonensis</i>	x	x	x	x	x					x	x
34	Jungle Owlet	<i>Glaucidium radiatum</i>	x	x	x	x	x	x	x	x	x	x	x
35	Ceylon frogmouth	<i>Batrachostomus moniliger</i>	x	x	x								
36	Grey Nightjar	<i>Caprimulgus indicus</i>	x	x	x								x
37	Nilgiri Wood Pigeon	<i>Columba elphinstonii</i>	x	x	x	x	x	x	x	x	x	x	x
38	Spotted Dove	<i>Streptopelia chinensis</i>	x	x	x	x	x				x	x	x
39	Emerald Dove	<i>Chalcophaps indica</i>	x	x	x	x	x	x	x	x	x	x	x
40	Pompadour Green Pigeon	<i>Treron pompadora</i>	x	x	x	x	x	x	x	x	x	x	x
41	Yellow Footed Green Pigeon	<i>Treron phoenicoptera</i>	x	x	x	x	x	x	x	x	x	x	x
42	Mountain Imperial Pigeon	<i>Ducula leadia</i>	x	x	x	x	x	x	x	x	x	x	x
43	Jerdons Baza	<i>Aviceda jerdoni</i>			x								
44	Oriental Honey Buzzard	<i>Pernis ptilorhyncus</i>	x	x	x	x	x	x	x	x	x	x	x
45	Black Winged Kite	<i>Elanus caeruleus</i>	x	x	x	x		x	x	x	x		
46	Crested Serpant Eagle	<i>Spilornis cheela</i>	x	x	x	x	x	x	x	x	x	x	x
47	Pallied Harrier	<i>Circus macronrus</i>	x	x	x							x	x
48	Montagu's Harrier	<i>Circus pygarrus</i>	x	x	x							x	x
49	Crested Goshawk	<i>Accipiter trivirgatus</i>	x	x	x	x						x	x
50	Besra	<i>Accipiter Virgatus</i>	x	x	x	x					x	x	x

3. Seasonal occurrence of birds in Site-3. (Chandanathode)

Sl.no	Common Name	Scientific Name	J	F	M	A	M	J	J	A	S	O	N	D
1	Red Spur fowl	<i>Galloperdix spardicea</i>	x	x	x	x	x	x	x	x	x	x	x	x
2	Grey Jungle Fowl	<i>Gallus sonneratii</i>	x	x	x	x	x	x	x	x	x	x	x	x
3	Speckled Piculet	<i>Picumnus innominatus</i>	x	x	x	x	x	x	x	x	x	x	x	x
4	Common Flame back	<i>Dinopium javenense</i>	x	x	x	x	x	x	x	x	x	x	x	x
5	Black Rumped Flame back	<i>Dinopium benghalense</i>	x	x	x	x	x	x	x	x	x	x	x	x
6	White Naped Wood pecker	<i>Chrysocolaptes festivus</i>	x	x	x	x	x	x	x	x	x	x	x	x
7	Heart Spotted Woodpecker	<i>Hemicircus canente</i>	x	x	x	x	x	x	x	x	x	x	x	x
8	White Cheeked Barbet	<i>Magalaima viridis</i>	x	x	x	x	x	x	x	x	x	x	x	x
9	Crimson Fronted Barbet	<i>Magalaima rubricapilla</i>	x	x	x	x	x	x	x	x	x	x	x	x
10	Malabar Grey Hornbill	<i>Ocyceros griseus</i>	x	x	x	x	x	x	x	x	x	x	x	x
11	Malabar Pied Hornbill	<i>Anthracoceros coronatus</i>	x	x	x	x	x	x	x	x	x	x	x	x
12	Malabar Trogon	<i>Harpaetes faciatus</i>	x	x	x	x	x	x	x	x	x	x	x	x
13	Indian Roller	<i>Coracias benghalensis</i>	x	x	x	x	x	x	x	x	x	x	x	x
14	Black Capped Kingfisher	<i>Halcyon pileata</i>	x	x	x	x	x	x	x	x	x	x	x	x
15	Little Green bee-eater	<i>Merops orientalis</i>	x	x	x	x	x	x	x	x	x	x	x	x
16	Blue Tailed bee-eater	<i>Merops philippinus</i>	x	x	x	x							x	x
17	Chestnut Headed bee-eater	<i>Merops leschenaulti</i>	x	x	x	x	x	x	x	x	x	x	x	x
18	Large Hawk-Cuckoo	<i>Cuculus sparverioides</i>	x	x	x	x	x	x	x	x	x	x	x	x
19	Common Hawk-Cuckoo	<i>Cuculus varius</i>	x	x	x	x	x	x	x	x	x	x	x	x
20	Indian Cuckoo	<i>Cuculus micropterus</i>	x	x	x	x						x	x	x
21	Banded Bay Cuckoo	<i>Cacomantis sonneratii</i>	x	x	x	x	x	x	x	x	x	x	x	x
22	Grey bellied cuckoo	<i>Cacomantis passerinus</i>	x	x	x							x	x	x
23	Greater Coucal	<i>Centropus sinensis</i>	x	x	x	x	x	x	x	x	x	x	x	x

51	Besra	<i>Accipiter Virgatus</i>	x	x	x	x	x	x	x	x	x	x	x	x
52	Black eagle	<i>Ictinaetus malayensis</i>	x	x	x	x	x	x	x	x	x	x	x	x
53	Changeable HawkEagle	<i>Spizaetus cirrhatus</i>	x	x	x	x	x	x	x	x	x	x	x	x
54	Common Kestrel	<i>Falco tinnunculus</i>	x	x	x	x	x	x	x	x	x	x	x	x
55	Peregrine falcon	<i>Falco peregrinus</i>	x	x	x								x	x
56	Cattle Egret	<i>Bubulcus ibis</i>		x	x								x	x
57	Indian Pitta	<i>Pitta brachyura</i>	x	x	x								x	x
58	Asian Fairy Blue bird	<i>Irena puella</i>	x	x	x	x	x	x	x	x	x	x	x	x
59	Golden fronted Leaf Bird	<i>Chloropsis aurifrons</i>	x	x	x	x	x	x	x	x	x	x	x	x
60	Brown Shrike	<i>Lanius cristatus</i>	x	x	x	x							x	x
61	Long tailed Shrike	<i>Lanius schach</i>	x	x	x	x	x	x	x	x	x	x	x	x
62	Rufous Tree Pie	<i>Dendrocitta vagabunda</i>	x	x	x	x	x	x	x	x	x	x	x	x
63	White Bellied tree pie	<i>Dendrocitta leucogastra</i>	x	x	x	x	x	x	x	x	x	x	x	x
64	Large Billed crow	<i>Corvus levaillantii</i>	x	x	x	x	x	x	x	x	x	x	x	x
65	Eurasian Golden Oriole	<i>Oriolus oriolus</i>	x	x	x								x	x
66	Black headed oriole	<i>Oriolus xanthornus</i>	x	x	x	x	x	x	x	x	x	x	x	x
67	Black Headed Cuckoo Shrike	<i>Coracina melanoptera</i>	x	x	x	x	x	x	x	x	x	x	x	x
68	Scarlet Minivet	<i>Pericrocotus flammeus</i>	x	x	x	x	x	x	x	x	x	x	x	x
69	Bar Winged Fly Catcher Shrike	<i>Hemipus picatus</i>	x	x	x	x	x	x	x	x	x	x	x	x
70	Black Drongo	<i>Dicrurus macrocereus</i>	x	x	x	x	x	x	x	x	x	x	x	x
71	Ashy drongo	<i>Dicrurus leucocephaeus</i>	x	x	x	x							x	x
72	Bronzed drongo	<i>Dicrurus aeneus</i>	x	x	x	x	x	x	x	x	x	x	x	x
73	Greater racket-tailed Drongo	<i>Dicrurus paradiseus</i>	x	x	x	x	x	x	x	x	x	x	x	x
74	Black naped Monarch	<i>Hypothymis azurea</i>	x	x	x	x	x	x	x	x	x	x	x	x
75	Asian Paradise flycatcher	<i>Terpsiphone paradisi</i>	x	x	x	x							x	x
76	Common Iora	<i>Aegithina tiphia</i>	x	x	x	x	x	x	x	x	x	x	x	x
77	Large Wood Shrike	<i>Tephrodornis gularis</i>	x	x	x	x	x	x	x	x	x	x	x	x

105	Oriental White Eye	<i>Zosterops Palpebrosus</i>	x	x	x	x	x	x	x	x	x	x	x	x
106	Blyth's reed Warbler	<i>Acrocephalus</i>	x	x	x							x	x	x
107	Thick billed Warbler	<i>Acrocephalus</i> <i>dumetorum</i>	x	x	x							x	x	x
108	Booted Warbler	<i>Hippolais calligata</i>	x	x	x							x	x	x
109	Common Tailor bird	<i>Orthotomus sutorius</i>	x	x	x	x	x	x	x	x	x	x	x	x
110	Greenish Warbler	<i>Phylloscopus</i>	x	x	x							x	x	x
111	Western Crowned Warbler	<i>Phylloscopus</i> <i>trophiloides</i>	x	x	x							x	x	x
112	Broad Tailed Grass bird	<i>Schoenicola platyura</i>	x	x	x	x	x	x	x	x	x	x	x	x
113	Wayanad Laughing Thrush	<i>Garrulax delesserti</i>	x	x	x	x	x	x	x	x	x	x	x	x
114	Puff Throated Babbler	<i>Pellorneum ruficeps</i>	x	x	x	x	x	x	x	x	x	x	x	x
115	Indian scimitar Babbler	<i>Pomatorhinus horsfieldii</i>	x	x	x	x	x	x	x	x	x	x	x	x
116	Tawny bellied Babbler	<i>Dumetia hyperythra</i>	x	x	x	x	x	x	x	x	x	x	x	x
117	Dark Fronted Babbler	<i>Rhopocichla atriceps</i>	x	x	x	x	x	x	x	x	x	x	x	x
118	Rufous Babbler	<i>Turdoides subrufus</i>	x	x	x	x	x	x	x	x	x	x	x	x
119	Jungle Babbler	<i>Turdoides striatus</i>	x	x	x	x	x	x	x	x	x	x	x	x
120	Brown cheeked Fulvetta	<i>Alcippe poioicephala</i>	x	x	x	x	x	x	x	x	x	x	x	x
121	Thick billed Flower pecker	<i>Dicaeum agile</i>	x	x	x	x	x	x	x	x	x	x	x	x
122	Pale billed Flower pecker	<i>Dicaeum</i>	x	x	x	x	x	x	x	x	x	x	x	x
123	Plain Flower pecker	<i>Dicaeum</i> <i>erythrorhynchos</i>	x	x	x	x	x	x	x	x	x	x	x	x
124	Purple rumped Sunbird	<i>Nectarinia zeylonica</i>	x	x	x	x	x	x	x	x	x	x	x	x
125	Crimson Backed sunbird	<i>Nectarinia minima</i>	x	x	x	x	x	x	x	x	x	x	x	x
126	Purple Sunbird	<i>Nectarinia asiatica</i>	x	x	x	x	x	x	x	x	x	x	x	x
127	Long billed Sun bird	<i>Nectarinia lotentia</i>	x	x	x	x	x	x	x	x	x	x	x	x
128	Forest wagtail	<i>Dendronanthus indicus</i>	x	x	x							x	x	x
129	Yellow wagtail	<i>Motacilla flava</i>	x	x	x	x	x	x	x	x	x	x	x	x
130	White rumped Munia	<i>Lonchura striata</i>	x	x	x	x	x	x	x	x	x	x	x	x
131	Black Throated Munia	<i>Lonchura kelaarti</i>	x	x	x	x	x	x	x	x	x	x	x	x

132 Scaly breasted Munia

Lonchura punctulata

x x x x x x x x x x x x x

4. Seasonal occurrence of birds at Site-4 (Ondeyangadi)

Sl.no	Common Name	Scientific Name	J	F	M	A	M	J	J	A	S	O	N	D
1	Rain Quail	<i>Coturnix coromandelica</i>	x	x	x								x	x
2	Grey Jungle Fowl	<i>Gallus sonneratii</i>	x	x	x	x	x	x	x	x	x	x	x	x
3	Rufous Wood pecker	<i>Micropternus brachyurus</i>	x	x	x	x	x	x	x	x	x	x	x	x
4	Speckled Piculet	<i>Picumnus innominatus</i>	x	x	x	x	x	x	x	x	x	x	x	x
5	Brown Capped Pigmy Wood pecker	<i>Dendrocopos nanus</i>	x	x	x	x	x	x	x	x	x	x	x	x
6	Common Flame back	<i>Dinopium javenense</i>	x	x	x	x	x	x	x	x	x	x	x	x
7	Black Rumped Flame back	<i>Dinopium benghalense</i>	x	x	x	x	x	x	x	x	x	x	x	x
8	Heart Spotted Woodpecker	<i>Hemicircus canente</i>	x	x	x	x	x	x	x	x	x	x	x	x
9	White Cheeked Barbet	<i>Magalaima viridis</i>	x	x	x	x	x	x	x	x	x	x	x	x
10	Crimson Fronted Barbet	<i>Magalaima rubricapilla</i>	x	x	x	x	x	x	x	x	x	x	x	x
11	Coppersmith Barbet	<i>Magalaima haemocephala</i>	x	x	x	x	x	x	x	x	x	x	x	x
12	Malabar Grey Hornbill	<i>Ocyrceros griseus</i>	x	x	x	x	x	x	x	x	x	x	x	x
13	Indian Roller	<i>Coracias benghalensis</i>	x	x	x	x	x	x	x	x	x	x	x	x
14	White Throated Kingfisher	<i>Halcyon smyrnensis</i>	x	x	x	x	x	x	x	x	x	x	x	x
15	Little Green bee-eater	<i>Merops orientalis</i>	x	x	x	x	x	x	x	x	x	x	x	x
16	Blue Tailed bee-eater	<i>Merops philippinus</i>	x	x	x							x	x	x
17	Common Hawk-Cuckoo	<i>Cuculus varius</i>	x	x	x	x	x	x	x	x	x	x	x	x
18	Banded Bay Cuckoo	<i>Cacomantis sonneratii</i>	x	x	x	x	x	x	x	x	x	x	x	x
19	Grey bellied cuckoo	<i>Cacomantis passerinus</i>	x	x	x								x	x
20	Greater Coucal	<i>Centropus sinensis</i>	x	x	x	x	x	x	x	x	x	x	x	x
21	Vernal Hanging Parrot	<i>Loriculus vernalis</i>	x	x	x	x	x	x	x	x	x	x	x	x
22	Rose Ringed Parakeet	<i>Psittacula krameri</i>	x	x	x	x	x	x	x	x	x	x	x	x
23	Plum Headed Parakeet	<i>Psittacula Cyanocephala</i>	x	x	x	x	x	x	x	x	x	x	x	x
24	Malabar Parakeet	<i>Psittacula colomboides</i>	x	x	x	x	x	x	x	x	x	x	x	x
25	Oriental Scops owl	<i>Otus sunia</i>	x	x	x	x	x	x	x	x	x	x	x	x
26	Jungle Owlet	<i>Glaucidium radiatum</i>	x	x	x	x	x	x	x	x	x	x	x	x
27	Blue Rock Pigeon	<i>Columba livia</i>	x	x	x	x	x	x	x	x	x	x	x	x

28	Spotted Dove	<i>Streptopelia chinensis</i>	x	x	x	x	x	x	x	x	x	x	x	x
29	Emerald Dove	<i>Chalcophaps indica</i>	x	x	x	x	x	x	x	x	x	x	x	x
30	Pompadour Green Pigeon	<i>Treron pompadora</i>	x	x	x	x	x	x	x	x	x	x	x	x
31	Yellow Footed Green Pigeon	<i>Treron phoenicoptera</i>	x	x	x	x	x	x	x	x	x	x	x	x
32	Mountain Imperial Pigeon	<i>Ducula leadia</i>	x	x	x	x	x	x	x	x	x	x	x	x
33	Oriental Honey Buzzard	<i>Pernis ptilorhyncus</i>	x	x	x	x	x	x	x	x	x	x	x	x
34	Black Kite	<i>Milvus migrans</i>	x	x	x	x	x	x	x	x	x	x	x	x
35	Brahminy Kite	<i>Haliastur Indus</i>	x	x	x	x	x	x	x	x	x	x	x	x
36	Crested Serpant Eagle	<i>Spilornis cheela</i>	x	x	x	x	x	x	x	x	x	x	x	x
37	Shikra	<i>Accipiter badius</i>	x	x	x	x	x	x	x	x	x	x	x	x
38	Changeable HawkEagle	<i>Spizaetus cirrhatus</i>	x	x	x	x	x	x	x	x	x	x	x	x
39	Common Kestrel	<i>Falco tinnunculus</i>	x	x	x	x	x	x	x	x	x	x	x	x
40	Black eagle	<i>Ictinaetus malayensis</i>	x	x	x	x	x	x	x	x	x	x	x	x
41	Cattle Egret	<i>Bubulcus ibis</i>	x	x	x	x								x
42	Indian Pond heron	<i>Ardeola grayii</i>	x	x	x	x	x	x	x	x	x	x	x	x
43	Indian Pitta	<i>Pitta brachyura</i>	x	x	x							x	x	x
44	Asian Fairy Blue bird	<i>Irena puella</i>	x	x	x	x	x	x	x	x	x	x	x	x
45	Golden fronted Leaf Bird	<i>Chloropsis aurifrons</i>	x	x	x	x	x	x	x	x	x	x	x	x
46	Brown Shrike	<i>Lanius cristatus</i>	x	x	x	x					x	x	x	x
47	Bay backed Shrike	<i>Lanius vittatus</i>	x	x	x	x	x	x	x	x	x	x	x	x
48	Long tailed Shrike	<i>Lanius schach</i>	x	x	x	x	x	x	x	x	x	x	x	x
49	Rufous Tree Pie	<i>Dendrocitta vagabunda</i>	x	x	x	x	x	x	x	x	x	x	x	x
50	House Crow	<i>Corvus splendens</i>	x	x	x	x	x	x	x	x	x	x	x	x
51	Large Billed crow	<i>Corvus macrorhyncus</i>	x	x	x	x	x	x	x	x	x	x	x	x
52	Ashy wood swallow	<i>Artamus fuscus</i>	x	x	x	x	x	x	x	x	x	x	x	x
53	Eurasian Golden Oriole	<i>Oriolus oriolus</i>	x	x	x							x	x	x
54	Black headed oriole	<i>Oriolus xanthornus</i>	x	x	x	x	x	x	x	x	x	x	x	x
55	Large Cuckoo Shrike	<i>Coracina macei</i>	x	x	x	x	x	x	x	x	x	x	x	x
56	Small Minivet	<i>Pericrocotus cinnamomeus</i>	x	x	x	x	x	x	x	x	x	x	x	x
57	Scarlet Minivet	<i>Pericrocotus flammeus</i>	x	x	x	x	x	x	x	x	x	x	x	x
58	Bar Winged Fly Catcher Shrike	<i>Hemipus picatus</i>	x	x	x	x	x	x	x	x	x	x	x	x

59	Black Drongo	<i>Dicrurus macrocereus</i>	x	x	x	x	x	x	x	x	x	x	x
60	Ashy drongo	<i>Dicrurus leucocephaeus</i>	x	x	x							x	x
61	Bronzed drongo	<i>Dicrurus aeneus</i>	x	x	x	x	x	x	x	x	x	x	x
62	Hair Crested Drongo	<i>Dicrurus hottentottus</i>	x	x	x	x	x	x	x	x	x	x	x
63	Greater racket-tailed Drongo	<i>Dicrurus paradiseus</i>	x	x	x	x	x	x	x	x	x	x	x
64	Black naped Monarch	<i>Hypothymis azurea</i>	x	x	x	x	x	x	x	x	x	x	x
65	Asian Paradise flycatcher	<i>Terpsiphone paradisi</i>	x	x	x							x	x
66	Common Iora	<i>Aegithina tiphia</i>	x	x	x	x	x	x	x	x	x	x	x
67	Malabar Whistling Thrush	<i>Myiophonus horsfieldii</i>	x	x	x	x	x	x	x	x	x	x	x
68	Orange headed Thrush	<i>Zoothera citrina</i>	x	x	x	x	x	x	x	x	x	x	x
69	Eurasian Black bird	<i>Turdus merula</i>	x	x	x	x	x	x	x	x	x	x	x
70	Asian Brown flycatcher	<i>Muscicapa dauurica</i>	x	x	x	x	x	x	x	x	x	x	x
71	Brown breasted Flycatcher	<i>Muscicapa muttui</i>	x	x	x							x	x
72	Nilgiri flycatcher	<i>Eumyias albicaudata</i>	x	x	x	x	x	x	x	x	x	x	x
73	Blue Throated Fly Catcher	<i>Cyornis rubeculoides</i>	x	x								x	x
74	Tickell's blue flycatcher	<i>Cyornis tickelliae</i>	x	x	x	x	x	x	x	x	x	x	x
75	Oriental Magpie-robin	<i>Copsychus saularis</i>	x	x	x	x	x	x	x	x	x	x	x
76	Chestnut Tailed Starling	<i>Sturnus malabaricus</i>	x	x	x							x	x
77	Common Myna	<i>Acridotheres tristis</i>	x	x	x	x	x	x	x	x	x	x	x
78	Jungle Myna	<i>Acridotheres fuscus</i>	x	x	x	x	x	x	x	x	x	x	x
79	Chestnut bellied nuthatch	<i>Sitta castanea</i>	x	x	x	x	x	x	x	x	x	x	x
80	Velvet fronted nuthatch	<i>Sitta frontalis</i>	x	x	x	x	x	x	x	x	x	x	x
81	Black lored Tit	<i>Parus xanthogenys</i>	x	x	x	x	x	x	x	x	x	x	x
82	Great Tit	<i>Parus major</i>	x	x	x	x	x	x	x	x	x	x	x
83	Dusky crag martin	<i>Hirundo concolor</i>	x	x	x	x	x	x	x	x	x	x	x
84	Red rumped Swallow	<i>Hirundo daurica</i>	x	x	x	x	x	x	x	x	x	x	x
85	Black Crested Bulbul	<i>Pycnonotus melanicterus</i>	x	x	x	x	x	x	x	x	x	x	x
86	Red whiskered Bulbul	<i>Pycnonotus jocosus</i>	x	x	x	x	x	x	x	x	x	x	x
87	Red vented Bulbul	<i>Pycnonotus cafer</i>	x	x	x	x	x	x	x	x	x	x	x
88	Grey Breasted Prinia	<i>Prinia hodgsonii</i>	x	x	x	x	x	x	x	x	x	x	x
89	Yellow browed Bulbul	<i>Lole indica</i>	x	x	x	x	x	x	x	x	x	x	x

90	Orientai White Eye	<i>Zosterops Palpebrosus</i>	x	x	x	x	x	x	x	x	x	x	x
91	Thick billed Warbler	<i>Acrocephalus aedon</i>	x	x	x							x	x
92	Common Tailor bird	<i>Orthotomus sutorius</i>	x	x	x	x	x	x	x	x	x	x	x
93	Greenish Warbler	<i>Phylloscopus trochiloides</i>	x	x	x							x	x
94	Puff Throated Babbler	<i>Pellorneum ruficeps</i>	x	x	x	x	x	x	x	x	x	x	x
95	Indian scimitar Babbler	<i>Pomatorhinus horsfieldii</i>	x	x	x	x	x	x	x	x	x	x	x
96	Tawny bellied Babbler	<i>Dumetia hyperythra</i>	x	x	x	x	x	x	x	x	x	x	x
97	Dark Fronted Babbler	<i>Rhopocichla atriceps</i>	x	x	x	x	x	x	x	x	x	x	x
98	Rufous Babbler	<i>Turdoides subrufus</i>	x	x	x	x	x	x	x	x	x	x	x
99	Jungle Babbler	<i>Turdoides striatus</i>	x	x	x	x	x	x	x	x	x	x	x
100	Brown cheeked Fulvetta	<i>Alcippe poioicephala</i>	x	x	x	x	x	x	x	x	x	x	x
101	Thick billed Flower pecker	<i>Dicaeum agile</i>	x	x	x	x	x	x	x	x	x	x	x
102	Pale billed Flower pecker	<i>Dicaeum erythrorhynchos</i>	x	x	x	x	x	x	x	x	x	x	x
103	Plain Flower pecker	<i>Dicaeum concolor</i>	x	x	x	x	x	x	x	x	x	x	x
104	Purple rumped Sunbird	<i>Nectarinia zeylonica</i>	x	x	x	x	x	x	x	x	x	x	x
105	Purple Sunbird	<i>Nectarinia asiatica</i>	x	x	x	x	x	x	x	x	x	x	x
106	Long billed Sun bird	<i>Nectarinia lotentia</i>	x	x	x	x	x	x	x	x	x	x	x
107	House Sparrow	<i>Passer domesticus</i>	x	x	x	x	x	x	x	x	x	x	x
108	Forest wagtail	<i>Dendronanthus indicus</i>	x	x	x							x	x
109	White Browed wagtail	<i>Motacilla maderaspatensis</i>	x	x	x	x	x	x	x	x	x	x	x
110	Grey wagtail	<i>Motacilla cinera</i>	x	x	x	x	x	x	x	x	x	x	x
111	Paddy field Pipit	<i>Anthus ruficulus</i>	x	x								x	x
112	Olive Backed Pipit	<i>Anthus hodgsoni</i>	x	x	x	x	x	x	x	x	x	x	x
113	White rumped Munia	<i>Lonchura striata</i>	x	x	x	x	x	x	x	x	x	x	x
114	Black headed Munia	<i>Lonchura Malacca</i>	x	x	x	x	x	x	x	x	x	x	x

5. Seasonal occurrence of birds at Site-5 (Banasuran hill)

Sl. No	Common Name	Scientific Name	J	F	M	A	M	J	J	A	S	O	N	D
1	Painted Bush Quail	<i>Perdica erythrorhynchus</i>	x	x									x	x
2	Grey Jungle Fowl	<i>Gallus sonneratii</i>	x	x	x	x	x	x	x	x	x	x	x	x
3	Speckled Piculet	<i>Picumnus innominatus</i>	x	x	x	x	x	x	x	x	x	x	x	x
4	Common Flame back	<i>Dinopium javenense</i>	x	x	x	x	x	x	x	x	x	x	x	x
5	Heart Spotted Woodpecker	<i>Hemicircus canente</i>	x	x	x	x	x	x	x	x	x	x	x	x
6	White Cheeked Barbet	<i>Magalaima viridis</i>	x	x	x	x	x	x	x	x	x	x	x	x
7	Crimson Fronted Barbet	<i>Magalaima rubricapilla</i>	x	x	x	x	x	x	x	x	x	x	x	x
8	Malabar Grey Hornbill	<i>Ocyrceros griseus</i>	x	x	x	x	x	x	x	x	x	x	x	x
9	Malabar Trogon	<i>Harpaetes faciatus</i>	x	x	x	x	x	x	x	x	x	x	x	x
10	White Throated Kingfisher	<i>Halcyon smyrnensis</i>	x	x	x	x	x	x	x	x	x	x	x	x
11	Chestnut Headed bee-eater	<i>Merops leschenaulti</i>	x	x	x	x	x	x	x	x	x	x	x	x
12	Banded Bay Cuckoo	<i>Cacomantis sonneratii</i>	x	x	x	x	x	x	x	x	x	x	x	x
13	Vernal Hanging Parrot	<i>Loriculus vernalis</i>	x	x	x	x	x	x	x	x	x	x	x	x
14	Malabar Parakeet	<i>Psittacula colomboides</i>	x	x	x	x	x	x	x	x	x	x	x	x
15	Indian Swiftlet	<i>Collocalia unicolor</i>	x	x	x	x	x	x	x	x	x	x	x	x
16	White Rumped Spine tail	<i>Zoonavena sylvatica</i>	x	x	x	x	x	x	x	x	x	x	x	x
17	Brown backed Needle tail	<i>Hirundapus giganteus</i>	x	x	x	x	x	x	x	x	x	x	x	x
18	Asian Palm swift	<i>Cypsiurus balasiensis</i>	x	x	x	x	x	x	x	x	x	x	x	x
19	Alpine swift	<i>Tachymarptis melba</i>	x	x	x	x	x					x	x	x
20	Jungle Owlet	<i>Glaucidium radiatum</i>	x	x	x	x	x	x	x	x	x	x	x	x
21	Nilgiri Wood Pigeon	<i>Columba elphinstonii</i>	x	x	x	x	x	x	x	x	x	x	x	x
22	Emerald Dove	<i>Chalcophaps indica</i>	x	x	x	x	x	x	x	x	x	x	x	x

50	Orange headed Thrush	<i>Zoothera citrina</i>	x	x	x	x	x	x	x	x	x	x	x	x
51	Eurasian Black bird	<i>Turdus merula</i>	x	x	x	x	x	x	x	x	x	x	x	x
52	White bellied Shortwing	<i>Brachypteryx major</i>	x	x	x	x	x	x	x	x	x	x	x	x
53	Asian Brown flycatcher	<i>Muscicapa dauurica</i>	x	x	x	x	x	x	x	x	x	x	x	x
54	Rusty tailed flycatcher	<i>Muscicapa ruficauda</i>	x	x	x								x	x
55	Brown breasted Flycatcher	<i>Muscicapa muttui</i>	x	x	x	x							x	x
56	Red breasted flycatcher	<i>Ficedula parva</i>	x	x	x								x	x
57	Verditor flycatcher	<i>Eumyias thalassina</i>	x	x	x								x	x
58	Nilgiri flycatcher	<i>Eumyias albicaudata</i>	x	x	x	x	x	x	x	x	x	x	x	x
59	White bellied Blue Flycatcher	<i>Cyornis pallipes</i>	x	x	x	x	x	x	x	x	x	x	x	x
60	Tickell's blue Flycatcher	<i>Cyornis tickelliae</i>	x	x	x	x	x	x	x	x	x	x	x	x
61	Indian Blue Robin	<i>Luscinia brunnea</i>	x	x	x								x	x
62	Oriental Magpie-robin	<i>Copsychus saularis</i>	x	x	x	x	x	x	x	x	x	x	x	x
63	Pied Bush chat	<i>Saxicola caprata</i>	x	x	x	x	x	x	x	x	x	x	x	x
64	Chestnut Tailed Starling	<i>Sturnus malabaricus</i>	x	x	x								x	x
65	Hill Myna	<i>Gracula religiosa</i>	x	x	x	x	x	x	x	x	x	x	x	x
66	Velvet fronted nuthatch	<i>Sitta frontalis</i>	x	x	x	x	x	x	x	x	x	x	x	x
67	Black lored Tit	<i>Parus xanthogenys</i>	x	x	x	x	x	x	x	x	x	x	x	x
68	Dusky crag martin	<i>Hirundo concolor</i>	x	x	x	x	x	x	x	x	x	x	x	x
69	Barn Swallow	<i>Hirundo rustica</i>	x	x	x								x	x
70	Hill Swallow	<i>Hirundo domicola</i>	x	x	x	x	x	x	x	x	x	x	x	x
71	Red rumped Swallow	<i>Hirundo daurica</i>	x	x	x	x	x	x	x	x	x	x	x	x
72	Grey Headed Bulbul	<i>Pycnonotus priocephalus</i>	x	x	x	x	x	x	x	x	x	x	x	x
73	Black Crested Bulbul	<i>Pycnonotus melanicterus</i>	x	x	x	x	x	x	x	x	x	x	x	x
74	Red whiskered Bulbul	<i>Pycnonotus jocosus</i>	x	x	x	x	x	x	x	x	x	x	x	x
75	Yellow browed Bulbul	<i>Lole indica</i>	x	x	x	x	x	x	x	x	x	x	x	x
76	Black Bulbul	<i>Hypsipetes leucocephalus</i>	x	x	x	x	x	x	x	x	x	x	x	x

77	Grey Breasted Prinia	<i>Prinia hodgsonii</i>	x	x	x	x	x	x	x	x	x	x	x	x
78	Oriental White Eye	<i>Zosterops Palpebrosus</i>	x	x	x	x	x	x	x	x	x	x	x	x
79	Blyth's reed Warbler	<i>Acrocephalus dumetorum</i>	x	x	x	x						x	x	x
80	Thick billed Warbler	<i>Acrocephalus aedon</i>	x	x	x							x	x	x
81	Common Tailor bird	<i>Orthotomus sutorius</i>	x	x	x	x	x	x	x	x	x	x	x	x
82	Greenish Warbler	<i>Phylloscopus trochiloides</i>	x	x	x							x	x	x
83	Tytlers Leaf Warbler	<i>Phylloscopus tytleri</i>	x	x								x	x	x
84	Western Crowned Warbler	<i>Phylloscopus occipitalis</i>	x	x	x								x	x
85	Broad Tailed Grass bird	<i>Schoenicola platyura</i>	x	x	x	x	x	x	x	x	x	x	x	x
86	Wayanad Laughing Thrush	<i>Garrulax delesserti</i>	x	x	x	x	x	x	x	x	x	x	x	x
87	Grey Breasted Laughing Thrush	<i>Garrulax jerdoni</i>	x	x	x	x	x	x	x	x	x	x	x	x
88	Puff Throated Babbler	<i>Pellorneum ruficeps</i>	x	x	x	x	x	x	x	x	x	x	x	x
89	Indian Scimitar Babbler	<i>Pomatorhinus horsfieldii</i>	x	x	x	x	x	x	x	x	x	x	x	x
90	Dark Fronted Babbler	<i>Rhopocichla atriceps</i>	x	x	x	x	x	x	x	x	x	x	x	x
91	Rufous Babbler	<i>Turdoides subrufus</i>	x	x	x	x	x	x	x	x	x	x	x	x
92	Brown cheeked Fulvetta	<i>Alcippe poioicephala</i>	x	x	x	x	x	x	x	x	x	x	x	x
93	Oriental sky lark	<i>Alauda gulgula</i>	x	x	x	x	x	x	x	x	x	x	x	x
94	Thick billed Flower pecker	<i>Dicaeum agile</i>	x	x	x	x	x	x	x	x	x	x	x	x
95	Pale billed Flower pecker	<i>Dicaeum erythrorhynchos</i>	x	x	x	x	x	x	x	x	x	x	x	x
96	Plain Flower pecker	<i>Dicaeum concolor</i>	x	x	x	x	x	x	x	x	x	x	x	x
97	Purple rumped Sunbird	<i>Nectarinia zeylonica</i>	x	x	x	x	x	x	x	x	x	x	x	x
98	Crimson Backed sunbird	<i>Nectarinia minima</i>	x	x	x	x	x	x	x	x	x	x	x	x
99	Little spider hunter	<i>Arachnothera longirostra</i>	x	x	x	x	x	x	x	x	x	x	x	x
100	Forest wagtail	<i>Dendronanthus indicus</i>	x	x	x	x						x	x	x
101	Yellow wagtail	<i>Motacilla flava</i>	x	x									x	x
102	Grey wagtail	<i>Motacilla cinera</i>	x	x	x							x	x	x
103	Paddy field Pipit	<i>Anthus ruficulus</i>	x	x	x							x	x	x

104	Olive Backed Pipit	<i>Anthus hodgsoni</i>	x	x	x	x					x	x	x	x
105	Nilgiri Pipit	<i>Anthus nilghiriensis</i>	x	x	x	x	x	x	x	x	x	x	x	x
106	White rumped Munia	<i>Lonchura striata</i>	x	x	x	x	x	x	x	x	x	x	x	x
107	Black Throated Munia	<i>Lonchura kelaarti</i>	x	x	x	x	x	x	x	x	x	x	x	x
108	Common Rose Finch	<i>Carpodacus erythrinus</i>	x	x	x							x	x	x

6. Seasonal occurrence of birds in Site. No: 6 (Ayilamoola-Farm land)

Sl. No	Common Name	Scientific Name	J	F	M	A	M	J	J	A	S	O	N	D
1	Red Spur fowl	<i>Galloperdix spardicea</i>	x	x	x	x	x	x	x	x	x	x	x	x
2	Brown Capped Pigmy Wood pecker	<i>Dendrocopos nanus</i>	x	x	x	x	x	x	x	x	x	x	x	x
3	Yellow crowned woodpecker	<i>Dendrocopos mahrattensis</i>	x	x	x	x	x	x	x	x	x	x	x	x
4	Rufous Wood pecker	<i>Micropternus brachyurus</i>	x	x	x	x	x	x	x	x	x	x	x	x
5	Black Rumped Flame back	<i>Dinopium benghalense</i>	x	x	x	x	x	x	x	x	x	x	x	x
6	White Cheeked Barbet	<i>Magalaima viridis</i>	x	x	x	x	x	x	x	x	x	x	x	x
7	Coppersmith Barbet	<i>Magalaima haemocephala</i>	x	x	x	x	x	x	x	x	x	x	x	x
8	Indian Roller	<i>Coracias benghalensis</i>	x	x	x	x	x	x	x	x	x	x	x	x
9	White Throated Kingfisher	<i>Halcyon smyrnensis</i>	x	x	x	x	x	x	x	x	x	x	x	x
10	Little Green bee-eater	<i>Merops orientalis</i>	x	x	x	x	x	x	x	x	x	x	x	x
11	Blue Tailed bee-eater	<i>Merops philippinus</i>	x	x								x	x	x
12	Pied Cuckoo	<i>Oxylophus Jacobinus</i>	x	x	x						x	x	x	x
13	Common Hawk-Cuckoo	<i>Cuculus varius</i>	x	x	x	x	x	x	x	x	x	x	x	x
14	Banded Bay Cuckoo	<i>Cacomantis sonneratii</i>	x	x	x	x	x	x	x	x	x	x	x	x
15	Asian Koel	<i>Eudynamys scolopacea</i>	x	x	x	x	x	x	x	x	x	x	x	x
16	Greater Coucal	<i>Centropus sinensis</i>	x	x	x	x	x	x	x	x	x	x	x	x
17	Vernal Hanging Parrot	<i>Loriculus vernalis</i>	x	x	x	x	x	x	x	x	x	x	x	x
18	Rose Ringed Parakeet	<i>Psittacula krameri</i>	x	x	x	x	x	x	x	x	x	x	x	x
19	Plum Headed Parakeet	<i>Psittacula cyanocephala</i>	x	x	x	x	x	x	x	x	x	x	x	x
20	Malabar Parakeet	<i>Psittacula colomboides</i>	x	x	x					x		x		x
21	Indian Swiftlet	<i>Collocalia unicolor</i>	x	x	x	x	x	x	x	x	x	x	x	x
22	Asian Palm swift	<i>Cypsiurus balasiensis</i>	x	x	x	x	x	x	x	x	x	x	x	x

ANNEXURE –IV

Association between site and diet

AREA	INS		FRU		OMNI		RAP		GRA		NE		MIS	
	OV	TV	OV	TV	OV	TV	OV	TV	OV	TV	OV	TV	OV	TV
SITE_1	108	103	19	20	4	5	15	17	2	1	4	6	2	4
SITE_2	95	98	18	19	4	4	20	16	0	1	5	5	4	3
SITE_3	83	88	19	17	3	4	19	14	0	1	5	5	3	3
SITE_4	72	76	17	15	6	4	10	12	2	1	4	4	3	3
SITE_5	75	72	15	14	1	3	9	12	0	1	5	4	3	2
SITE_6	70	67	9	13	5	3	8	11	2	1	5	4	2	2

Table for testing association between site and diet

OV: Observed value; **TV:** Theoretical value

H₀: There is no association between site number and diet

H₁: There is an association between site number and diet

Calculated value of $X^2 = 20.47$

df = 30

Table value of $X^2 = 43.7$

H₀ accepted as calculated value < table value

ANNEXURE –V

Association between site number and feeding substratum:

AREA	GR		TR		FR		CAN		SHR		AER		OTHERS	
	OV	TV	OV	TV	OV	TV	OV	TV	OV	TV	OV	TV	OV	TV
SITE_1	25	25	50	49	11	11	8	8	26	25	29	28	5	9
SITE_2	24	23	41	46	16	11	8	7	22	24	26	27	9	8
SITE_3	15	21	45	42	13	10	4	6	22	22	23	24	10	7
SITE_4	21	18	41	36	6	8	5	6	17	16	19	21	5	6
SITE_5	18	17	28	34	6	8	6	5	19	18	23	20	8	6
SITE_6	18	16	33	32	4	7	6	5	17	16	18	18	5	6

Table: Table for testing association between site number and feeding substratum

OV: Observed value; TV: Theoretical value

H₀: There is no association between site number and feeding substratum

H₁: There is an association between site number and feeding substratum

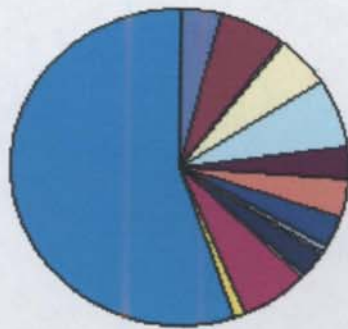
Calculated value of $X^2 = 15.01$
 $df = 30$

Table value of $X^2 = 43.773$

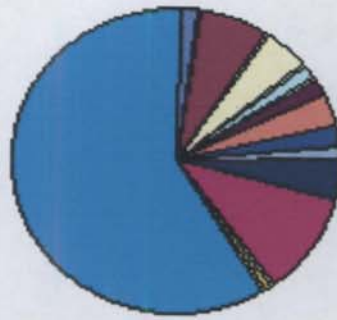
H₀ accepted as calculated value < table value

ANNEXURE -VI

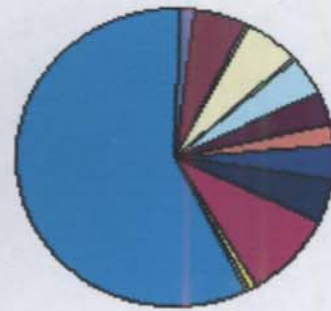
Pie- charts



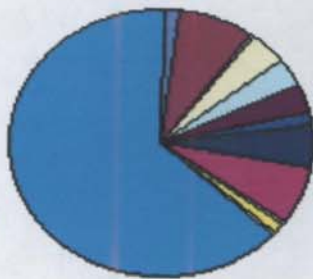
SITE-1



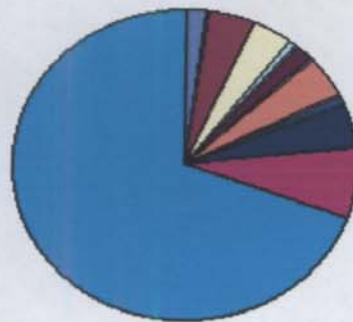
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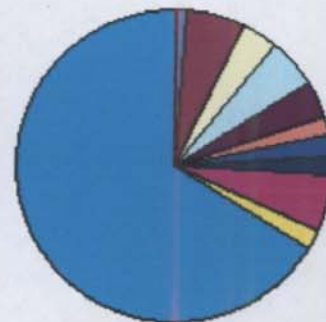
SITE-3



SITE-4



SITE-5



SITE-6

■ GALLIFORMES

□ CUCLIFORMES

□ CORACIFORMES

■ STRINGIFORMES

■ PSITTACIFORMES

■ FALCONIFORMES

■ APODIFORMES

■ CICONIFORMES

■ PICIFORMES

■ CAPRIMULGIFORMES

■ COLUMBIFORMES

■ PASSERIFORMES

Fig: Pie- chart showing the proportion of various orders of birds in the six Study sites

ANNEXURE -VII (PLATES)



Plate: 1 Canopy density-0 (Site-5)



Plate 2: Canopy density-1 (Site-1)



Plate3: Canopy density-2(site-2&4)



Plate 4: Canopy density-3 (site-3)



Plate5: A view of the deciduous tract at Kaimaram



Plate6: A view of the semi evergreen tract at Thirunelly from the Brahmagiri hills with Narinirangimala in the background



Plate 7: A view of the ever green vegetation at Chandanathode



Plate 8: A view of the semi evergreen tract selected for study at Ondeyangadi, from the Mysore- Mananthavady road



Plates 9&10: Some characteristic features of the vegetation at Banasuran hills



Plate11: A view of the agricultural field selected for study



Plate12: A complex stratified forest at Thirunelly with lesser bird taxa



Plate13:An edge with rich shrub layer in the semievergreen forest of Site-4



Plate14: The litter floor of semievergreen forest at Thirunelly.



Plate15: The cultivated land after de-weeding and ploughing



Plate16: A view of the paddy fields being replaced by cash crops in Wavanad



Plate 17: **Jungle babbler (*Turdoides striatus*)** - A common bird spotted in all the study sites except site-5



Plate 18: **White bellied tree pie (*Dendrocitta leucogastra*)** - a forest bird recorded from evergreen and semi ever green forests of Wavanad



Blue parakeet (*Psittacula columboides*)



the habitat of Red headed Fantail Warbler (*Cysticola exilis*)



Plate-21: Malabar Wood Shrike (*Tephrodornis gularis*)



Plate-22: Loten's Sunbird (*Nectarinia lotentia*)

Plate-23: Great hornbill (*Buceros bicornis*)



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