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# Factors affecting roosting ecology of birds in Kerala

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(FINAL REPORT OF THE RESEARCH PROJECT RP/713/2015)

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# ABSTRACT OF THE PROJECT PROPOSAL

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| 1 | Project No. | : | KFRI/RP/713/2015 |
| 2 | Title of Project | : | Factors affecting roosting ecology of birds in Kerala |
| 3 | Objectives | : | 1. To study the roosting behaviour and patterns of roosting in birds of Kerala<br>2. To elucidate the factors controlling the roosting behaviour of birds in Kerala |
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| | Principal investigator | : | Dr. E.A Jayson |
| | Associate investigator | : | Nil |
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| 8 | Study area | : | Kerala State |
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## ABSTRACT

A study on the communal roosting behaviour and patterns of roosting in birds to elucidate the factors controlling the communal roosting behaviour was carried out in Kerala, India. The study was initiated in the year December 2015 and the field data collection continued up to December 2017. The objectives of the project were 1. To study the roosting behaviour and patterns of birds in Kerala and 2. To elucidate the factors controlling the roosting behaviour of birds in Kerala. The investigation was conducted in a tropical area and the main method was of direct observation and field surveys. Ten Districts in the State such as Thiruvananthapuram, Kollam, Alappuzha, Ernakulum, Thrissur, Malappuram, Palakkad, Kozhikode, Kannur and Kasaragod. were surveyed for locating and studying different aspects of communal roosts. Location of roosts, roosting trees and threats to roosts were studied. Factors affecting the communal roosts were analyzed to ascertain the reasons of shifting the roosts. Dependence on human presence was recorded in four type of roosts namely wetland birds, land birds, mixed species and also in the birds of prey roosts. A review of the published literature was carried out to gather the available data on the roosting sites. Forest areas in the highlands namely Idukki, Pathanamthitta, Kottayam and Wayanad Districts were not surveyed for this study.

Twelve species of birds were found to roosts communally in Kerala and out of these eight species were wetland birds and four species land birds. The studies showed that the communal roosts were formed in four types, namely communal roosts of wetland species alone, land bird roost, mixed species roosts and communal roosts of birds of prey. A total of 258 communal roosts were recorded during the study and out of these 44 were communal roosts exclusively with wetland birds, 131 with land birds, 66 with mixed species and 11 with birds of prey species. Prominent communal roosting species were House crow (*Corvus splendens*), Common myna (*Acridotheres tristis*), Little cormorant (*Phalacrocorax niger*), Night heron (*Nycticorax nycticorax*), Pond heron (*Ardeola grayii*), Indian darter (*Anhinga melanogaster*), Brahminy kite (*Haliastur indus*) and Black kite (*Milvus migrans*). Highest number of communal roosts were recorded from Malappuram District followed by Ernakulum and Thrissur Districts. Highest number of wetland bird communal roosts were recorded from Palakkad and Thrissur Districts.

Most of the communal roosts were recorded from the coastal areas and mid lands. As a whole, 81% of the communal roost were within 15 m distance from the nearest road. Birds of

prey were not depended on human presence in selecting the roosting sites. Ninety three per cent of the land birds were depending on human presence, for the protection of the roost from the predators, where as it was 82 per cent in the mixed species and 75 per cent in the wetland species.

The communal roosts of wetland birds were near the prominent wetlands, streams or near paddy fields. Only 59 per cent of the roosts were within 15 m distance from the road. Apart from the locations near the human presence, wetland birds selected isolated islands also for establishing communal roosts. Wetland birds were communally breeding and roosting in same locations. Due to this, birds were bringing food materials, like fish to the communal roosting sites. The wasted fish lying on the ground and decaying fish produced bad and foul smell. This created hostility of local people towards the communal roosts. They tried various methods to get rid of the roosting birds from the sites. Due to this, birds were never able to establish communal roost in the private properties. The owners always removed the trees or branches for threatening the birds. For this reason most of the communal roosts were established and maintained in public properties owned by the Government or other public agencies.

The case study of a communal roost of land birds at Mannuthy, Thrissur District (House crow and Common myna) showed that, after the complete felling of trees, on the first day the birds were clueless and they roosted on nearby bushes. But on the second day the birds vacated the nearby bushes and found new roosting trees near the area and some of the birds went to trees which were far away.

The study showed that, shifting of roosts is normal in wetland birds, even if trees are intact whereas the land birds never shifted the location from the preferred trees. On the removal of trees, the land birds shifted to another nearby roosts or to new selected trees. The communally roosting land birds, wetland birds and mixed species roosts selected the roosting sites mainly to avoid the predators. This is clear from the fact that the majority of the communal roosts of these species were in the locations where the presence of humans are available for twenty four hours. This was realized by establishing the roosts near the road sides, municipal parks, or in taxi stands. Wetland birds communally roosted away from the human location also, where they assured the protection from the predators by selecting Islands surrounded by water or in isolated mangrove patches encircled by water. Birds of prey being carnivores, never selected the sites with human presence

because they were not in need of protection from predators and they defended themselves. The wetland birds and land birds preferred human protection for their communal roost.

As people are not allowing roosting of birds in trees located in private properties, birds completely depended on the public places. The authorities have to give high attention to save the communal roosting trees of the public places otherwise birds depended on communal roosting will be threatened. For this the conflict with the local people and communal roosting birds should be addressed and solved.

# 1. INTRODUCTION

Birds provide enjoyment and recreation for many and greatly enhance the quality of our lives. These colourful components of natural ecosystems are often studied, viewed, photographed, and otherwise enjoyed. The word 'roost' is derived from the German language meaning "A sleeping house of fowls". By definition roost is a place where winged animals especially birds or bats, rest or sleep. It may be temporary or permanent; solitary or communal. Several species of birds are commonly referred to as roosting birds. Some birds roost on branches of trees or in shrubs/vines and others roost in cavities. Communal roosting is practiced by birds when large flocks or colonies roost together usually in trees with several hundred on each. Several communal roosting trees can be located within densely populated cities, where common birds like House sparrows and starlings and House crow can be seen roosting in large numbers.

All birds roost which is a period of inactivity analogous to sleep in human beings. Some birds do it alone others with mobs of compatriots. Some change their roosting habits with the season. Male Red-winged Blackbirds usually roost alone on their territories when breeding, but crowd together at night during the rest of the year. Birds that roost communally do so in a wide variety of situations. Small groups of nuthatches or creepers spend the night together in tree cavities. Some vultures roost on cliffs and others on the tops of cacti; many seabirds roost on islands and swallows may roost on telephone lines. Starlings choose an enormous diversity of roost sites; many kinds of woodlands, cattails and other reeds and numerous kinds of buildings. The question of why some birds roost communally and others roost solitarily is related to the question of why there are both communal and solitary nesters. One possibility is that older, more experienced birds are better able to find food hence younger birds roost with them in order to follow their elders to better foraging grounds. The older birds accept this social parasitism because they tend to be dominant and are able to appropriate more central and therefore safer positions in the roosting crowd. As long as the costs of increased competition are outweighed by the benefits of increased safety from predators for the older birds and the benefits of locating rich food supplies for the young outweigh reduced night time safety for them, roosting should be communal. In fact, some studies have reported that older Red-winged Blackbirds and Brown-headed Cowbirds are concentrated in the centers of their roosts (Lund, 2014).

Selection of roosting site is often influenced by species-typical preferences for particular habitats, by proximity to food and water. Some species of birds usually show strong loyalty to a given site by roosting there year after year, sometimes for decades or even centuries. Some species approach roosts in stages that include assembly at feeding grounds gathering along established flight-lines, assembly in the immediate vicinity of the roost and finally entry into the roost itself.

Roost departures typically differ from approaches by having fewer assembly rituals during the return to feeding grounds, and by more birds leaving simultaneously and at lower light intensities. The most important factor governing roosting flights is probably illumination level, but other factors (e.g. temperature, wind, hunger, social stimuli, distance of destination, time of day and time of year) also play roles. On a daily as well as seasonal basis, roost populations fluctuate greatly in total numbers and in age and sex composition. Mixed species roosts are not uncommon and have implications for the survival value. A large number of birds of several species display a kind of behaviour in the evening which is worth watching. They take frequent short flights and settle down on trees or wires, etc. The settling down of birds for rest at night on elevated places is called roosting. While doing so they make a noise. This is a preparation for their rest at night. All those diurnal birds *i.e.* those that are active during the daytime need rest at night. Nocturnal birds *i.e.* those that move around in the night for food, etc., roost during daytime. Owls are nocturnal. The roosting pattern of birds is different for different species. Koel roosts singly, bulbuls roost in small groups, but mynas roost in very large numbers. Community roosting can also be seen in Common mynas, House crows, Jungle crows, and Parakeets, etc., roost on the same tree. Community roosting offers three advantages. (1) Members of the roost, while sharing the same platform, receive the warmth of togetherness. (2) There are always a few members of the roost who are more alert than others. In this way they act as guard of sentry in the event of any advancing predator or enemy. (3) Communal roosting allows the transmission of information regarding a source of food for all of them. Thus the roosting place is thought to be a centre for information brought in by a particular bird to be passed on to others (Leonard, 1984; Beauchamp, 1999.) Birds roost in areas where there is food and safety. These roosting areas tend to be high up above the ground, along edges of buildings, where birds can scan for food below and avoid predators. Unfortunately, bird activities sometimes conflict with human interests. Birds may depredate agricultural crops, create health hazards and compete for limited resources with other

more favorable wildlife species. Their presence is often problematic because of potential health, economic and nuisance problems. The problem with birds roosting in large numbers is the mess and damage they leave behind. Birds defecate every time they take flight (one pigeon produces one pound of droppings every week) so to have them returning to roost in one spot concentrates the problem. A whole flock of roosting pigeons can create an unsanitary situation in a very small amount of time. The management of bird populations or the manipulation of bird habitats to minimize such conflicts is an important aspect of wildlife management. Problems associated with large concentrations of birds can often be reduced through techniques of dispersal or relocation of such concentrations. Habitat modification and the use of frightening devices (include broadcasted alarm and distress calls), poisons, explosives and even flame-throwers can be extremely effective in manipulating bird concentrations. According to Pierce (2010) today the main roost inhibitors to stop birds from roosting on specific surfaces are physical barriers.

Wetland ecosystems, are important for breeding and roosting waterbirds. They holds one of the largest breeding colonies and roosts of cormorants, herons and egrets. In the breeding season, which takes place during the monsoon, the number of birds in the heronry increases because of the immigration of birds from other areas. Management of the wetlands is crucial for the conservation of the species, especially the resident waterbirds that spend the greater part of their life in the wetlands (Vijayan, 1995). Successful conservation of water bird species will depend on an improved understanding of their ecological requirements and patterns of movement (Fellowes *et al*., 2001).

Successful conservation of wetland bird species depend on an improved understanding of their ecological requirements and patterns of movement, understanding of its fluctuations in numbers, seasonal changes in distribution and temporal pattern of migration. By protecting the roosting area, we are conserving its habitat. Birds are important bio-indicators, so understanding of bird's behaviour will give information about climatic changes. Importance of trees as roosting sites of several threatened birds species in the human populated areas such as railway stations, bus stands can be recognized and need to be protected. The main objectives of the study were,

1. To study the roosting behaviour and patterns of birds in Kerala.
2. To elucidate the factors controlling the roosting behaviour of birds in Kerala.

During 2000, a study was conducted at Mangalavanam Bird Sanctuary, in Cochin on the structure and composition bird community. Number of roosting birds were recorded during the study (Jayson, 2001a). But after the study by the year 2006, all the birds deserted the Bird Sanctuary and the concern of the management had increased. Many reasons were aired by different groups. One argument was that the birds deserted the sanctuary due to the disturbance caused due to the new building construction. The study will help to understand the various roosting pattern of birds in the State of Kerala, India. Apart from the above, roosting bird colonies is causing enormous difficulties to the local residents. Due to these animosity towards the bird roost are increasing in some areas. This is a serious concern for the conservation fraternity.

## 1.1 Review of literature

### International

The roosting behaviour of various avian species has been studied all over the world. We are familiar with the general roosting behaviour of common birds. Herons and egrets roost in the shallows, relying on vibrations in the water to warn them of reptiles, but they are most often seen roosting in large flocks in waterside trees. Geese and ducks sleep at night right on the water. Eagles and hawks are not a threat, because they also sleep during the night and any predator swimming after the birds would send vibrations through the water, waking them up. Waterfowl also sleep on the shore, usually standing on one leg (tucking the other one up into the warmth of its feathers). Lots of birds roost in tree cavities, or really any hole or covered area. Most woodpeckers roost in tree cavities, either ones they have used as nest holes or sometimes ones they have chiselled out just for sleeping. Owls also sleep in trees, usually during the day, either in dense foliage (to keep the light out) or, for certain species, in tree cavities. Shorebirds simply do the best they can, roosting on open beaches in large flocks (to help raise alarm).

Winter nocturnal roost selection by Greaty Grey Shrike was studied in Poland (Marcin Antczak, 2010). Very little information is available on the factors affecting the roosting site selection, arrival and departure patterns, pre-roosting and roosting behaviours, roosting periods,

association with other avian species roosting communally and the occupation of roost in relation to the population of Common myna in India. Selection of the roosting site by Common myna is affected by physical characteristics of the sites and behavioural aspects, such as anti-predation tactics, low anthropogenic disturbance, availability of large trees and distance to feeding sites. Light intensity, temperature, cloud cover and time of sunset have been viewed as influential factors affecting the timing of roosting behaviour in birds (Davis, 1955). Today the greatest risk factor that develops is that, bird roosts that develop year after year in the same location can be a source of human disease. Bird droppings allowed to accumulate for several years produce a condition favourable for the growth of the fungus *Histoplasma capsulatum*. Inhaling spores from this fungus can produce a serious disease, histoplasmosis, in humans and in animals (Dodge *et al.*, 1965).

Comparing of breeding and non-breeding population in Kharg Island showed that about 50 per cent of population of Indian House Crow was breeding and 50 per cent of them were non-breeding in July 2012 (Behrouz Behrouzi-Rad, 2012). Increasing populations of the Black Vulture, *Coragyps atratus* (Bechstein, 1793) and the capacity this bird has to live near humans has resulted in vulture-human conflicts. These conflicts increase the need for the effective management of vultures. Improved understanding of communal roosting dynamics is a key aspect of vulture biology that provides information for effective management that can mitigate conflicts. Black Vultures adjusted to the nearest possible roost to the food source to reduce the cost of movement. This suggested that reducing Black Vulture access to food through simple waste management (Novaes and Cintra, 2013). Communal roosting is reported for the first time in the Jamaican Crow (*Corvus jamaicensis*). Crows roosted in an isolated cluster of tall trees (*Albizia falcataria*) that emerged from an area of mixed agriculture at the northern edge of Cockpit Country, Trelawny Parish, Jamaica. Crows roosted on thin branches high in the canopy, possibly as a defense against the nocturnal Jamaican boa *Epicrates subflavus* (Graves, 2009).

The House crow *(Corvus splendens)* is an invasive bird in many parts of Asia. A radio-tracking study was conducted on 13 randomly selected birds caught throughout the port city of Singapore (Sodhi *et al.*, 2005) they reported that, House crows returned faithfully to specific daytime areas and roost sites. Crows that have formed pair bonds remained in their core areas for longer each day and possessed smaller home ranges and core areas compared to other birds. In

the middle part of the day, House crows remained in their core areas where the bulk of feeding occurred. In addition, they used supplementary feeding sites, which coincided with afternoon gathering points. House crows in Singapore travelled only short distances (maximum = 3.5 km) to their roost sites, unlike House crows studied elsewhere. Habitat selection analyses carried out at two spatial scales showed that House crows preferred commercial and public housing land uses, corroborating results from a count-based study. This was probably due to the higher amount of anthropogenic food found in these places.

The Common raven (*Corvus corax*) is a widely distributed and opportunistic scavenger and predator. In Calgary, Alberta, ravens were virtually absent in the early 1970s, but by 2000 this species was a regular breeder and common winter visitor. Numbers increased significantly during Christmas Bird Counts from 1970 to 2000. Most birds that occur in Calgary during the winter commute twice daily between a roost in the foothills and a refuse site in the city. The distance between these points is 57.5 km and results in a commute cost that does not appear to be endured by individuals remaining in the foothills (Preston and Johnson, 2005).

**National**

Many studies have been carried out on the communal roosting ecology of Indian birds. Gadgil and Ali (1976) summarized information on communal roosting in Indian birds. Studies have been conducted on roosting habits of Common myna *Acridotheres tristis* (Sengupta, 1973), Bank myna *A. ginginianus* (Khera and Kalsi, 1986), Weaverbirds (Ambedkar, 1968) Black kite *Milvus migrans* (Mahabal and Bastawade, 1985), Rosy pastor *Sturnus roseus* (Mahabal and Bastawade, 1980) and Green bee-eater *Merops orientalis* (Bastawade, 1976). Roosting studies of 59 species conducted by Gadgil and Ali (1976) concluded that communication or information about the food sources and avoidance of predation are probably the two most significant functions of communal roosting.

Roosting behaviour studies of hornbills by Sneha and Davidar (2008) described that, during pre-roosting behaviour they spread out in a linear fashion over 100–200 m on various trees proceeded with a number of activities including loud vocalisation, hopping from one branch to another, feeding on fruit, preening and flying across. They also observed that occasionally only Malabar grey hornbill (*Ocyceros griseus*) and Indian grey hornbill (*Ocyceros birostris*) were also observed at the roost sites but they did not roost along with the Malabar pied hornbills

(*Anthracoceros coronatus*). Studies on Peafowl *Pavo cristatus* conducted in Kurukshetra concluded that Pea fowls mainly used tree species such as *Acacia nilotica, Dalbergia sissoo, Eucalyptus hybrid, Ficus bengalensis, Ficus rumphii, Syzygium cumini, Zizyphus mauritiana,* Teak (*Tectona grandis*), Mango (*Mangifera indica*), Guava (*Psidium guajava*) as roosting trees (Chopra and Kumar, 2012).

Rajeshkumar and Balasubramanian (2012) discussed the habitat utilisation, time-activity budget, food and feeding habits, and roost tree utilisation of Indian Peafowl *Pavo cristatus* in Anaikatty Hills, Western Ghats. The peafowl population in the study area (2 $km^2$) was estimated to be 21. Sixteen trees belonging to four species were used for roosting. About 50 % of the roost trees were the thorny *Acacia polyacantha,* located near streams. Studies conducted by Khan *et al*., (2010) observed that roosting is a routine activity in birds, of these some birds keep traditional roosting site successively by 50 or more years, like in Common myna while others like hornbills change roosting site with food availability. The number of House crow (*Corvus splendens*) in Junagadh and Rajkot city of Gujarat was higher during winter season and reduced in summer as well as monsoon seasons (breeding season). During winter the population had reached up to 2143 individuals at Junagadh and 828 individuals at Rajkot. Thermoregulation and safety are two reasons of larger aggregations during winter. On the other hand count was decreased during summer, 1544 individuals and 682 individuals at Junagadh and Rajkot respectively followed by monsoon 1485 individuals at Junagadh and 735 individuals at Rajkot due to breeding season. The time of first arrival was tended to be later with higher temperature and relative humidity (summer) while in low temperature and humidity (winter) they used to come earlier. Thus the fluctuations in the population size resulted primarily due to the dispersion and aggregation of House crow throughout the study period (Saiyad *et al*., 2017a).

Roosting is a typical bird behaviour where a group of individuals congregate in an area for a few hours effected by an environmental signals and return to the same site with the reappearance of these signals. Roost trees significantly tended to be taller by 25.39% more in tree height and 36.45% more in canopy height compared to non-roost trees. Larger trees with greater canopy, nearby human habitation which provide them shelter and safety along with anthropogenic

feeding opportunities and moderate vegetation patches near the roosting places were the characteristics preferred for roosting purpose by House crow (Saiyad, *et al*., 2017a).

The Black-crowned night heron is a species of wading bird found across the world except cold region and Australia. These birds are found roosting in temporary and permanent habitats. It is a general observation that the number of birds roosting in an area vary on the basis of breeding and seasonal variation as well as availability of forage. These birds have developed a specific pattern of roosting cycle. This pattern is specific to the gathering of almost 300 Black- Crowned night heron during the breeding season to the breeding haven of Municipal Zoo at Kankaria and 80 percentage of this birds leave the study area after the breeding season. Among the 4 major study areas of the city only a few adapted the same location as permanent habitat (Jayasree and Acharya, 2015).

The tree utilization for roosting and nesting purpose by House Crow (*Corvus splendens*) in Junagadh and Rajkot cities of Gujarat has been reported. Maximum percentage population of House crows was observed to roost on *Ficus rumphii* followed by *Delonix regia* and *Azadirecta indica*. The widespread and repeated plantations of tall trees were most favorable roosting habitat. The crows were observed to roost on the trees having average height of 16.6 m, canopy height of 11.8 m and diameter at breast height was of 1.66 m. The canopy density and canopy cover were of 88.80 % and of 13.6 m respectively. Maximum numbers of nest were observed on *Azadirecta indica* in Junagadh as well as in Rajkot (Saiyad *et al*., 2017).

Roosts of Eurasian marsh harrier *Circus aeruginosus* were studied for four winters in and around Keoladeo National Park (KNP), Eastern Rajasthan, India. Fourteen communal roosts were found, in which harriers gathered in loose aggregations of 11–132 birds. Roosts were situated in tall grasses and wetlands with floating vegetation in KNP and in tall grasses, sedges, crops and bare ground in areas adjoining KNP. Birds shifted to roosts in wetlands and peripheral sites when grassland roosts in KNP were disturbed during the grass-cutting season. A comparison of roost sites with randomly selected non-roost sites in grassland indicated that birds preferred sites in tall grasses and further from the nearest trees and road (Verma and Prakash, 2007).

### 1.1.1 Studies from Kerala

Studies on communal roosting of birds in Kerala scenario is less. Communal roosting of Common Indian myna and House crow has been studied by Jayson and Mathew (1995) at Thrissur. This study reported the roosting pattern, behaviour and the major factors controlling the roosting behaviour of Common Indian myna and House crow at Thrissur. Nesting, roosting and habitat utilization of birds in Mangalavanam bird sanctuary, Cochin has been reported by (Jayson and Easa, 1999) and in Kumarakam heronry by Prasanth and Vijayan (2007). Studies conducted by Basheer and Aarif (2013) reported that, 23 species of birds use coconut trees for roosting. Earlier many reports on Heronries of Kerala were made (Sasikumar, 2014). Status of a heronry at Panamaram, Wayanad District has been reported by Anoop *et al*., (2015).

## 1.2. STUDY AREA

### 1.2.1 Location

Communal roosting behaviour and patterns of communal roosting, factors determining the roosting behaviour was studied in the State of Kerala, India. Kerala is a small strip of land lying at the south-west corner of India. Kerala is divided into three regions namely coastal lands, middle region and hilly high lands. Among the three regions intensive field surveys on the communally roosting birds were conducted in the middle region and also in the coastal lands. Forest areas were not surveyed as the communal roosts were less. Kerala has an equitable climate and Houses a variety of flora and fauna. Kerala is the land of rivers and backwaters. The State is bordered by land on three sides and by the Arabian Sea at the West. It shares its border with the State of Karnataka at the North and the rest of Kerala shares it border with Tamil Nadu (Fig. 01).

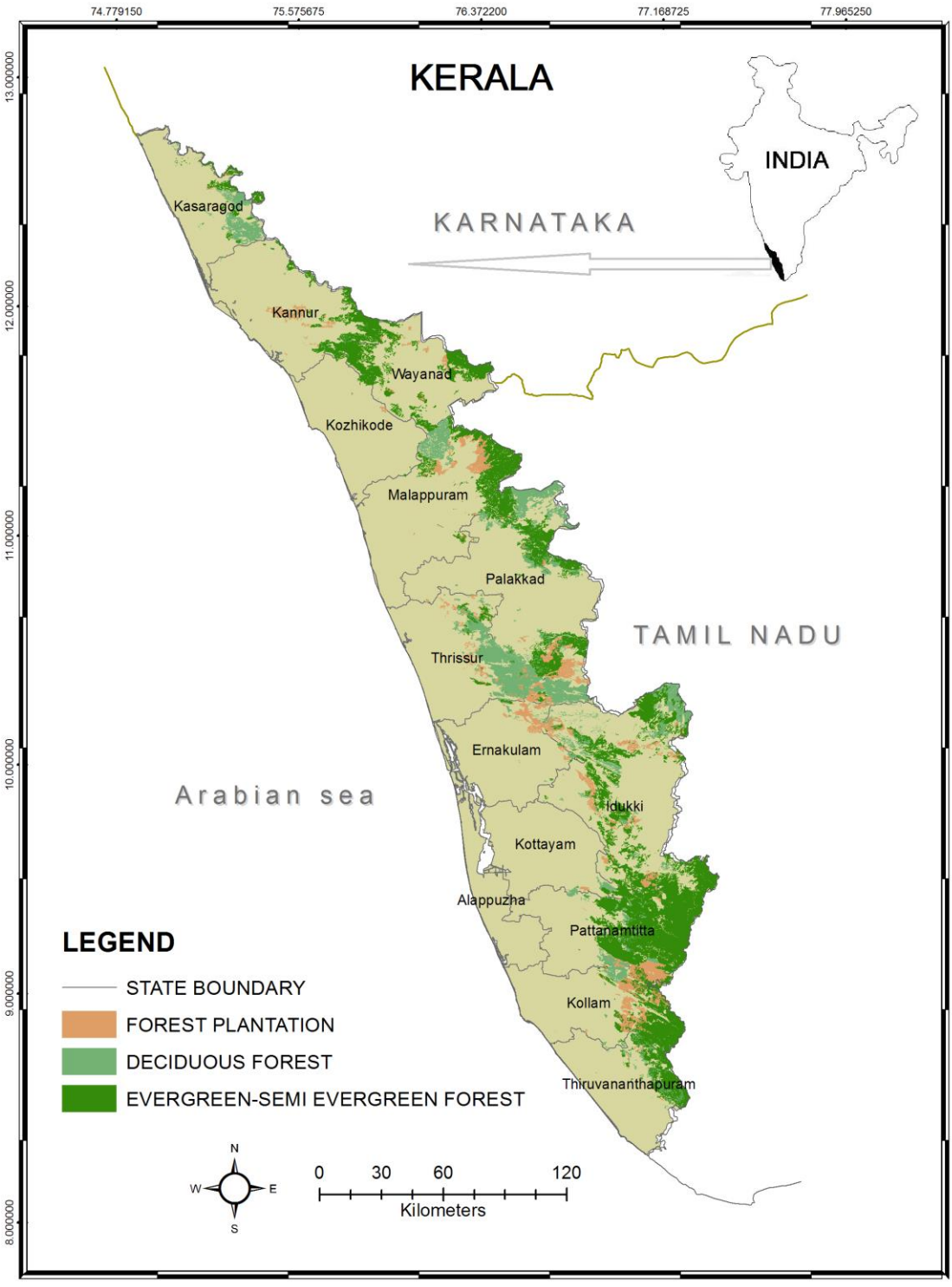


Fig. 01. Study area, the Kerala State

Kerala is divided into three geographical regions namely Highlands, Midlands and Lowlands. The Highlands slope down from the Western Ghats which rise to an average height of 900 m, with a number of peaks well over 1800 m in height. It is 18650 sq.km in area and accounts for 48 per cent of the total land area of Kerala. This is the area of major plantations like tea, coffee, rubber and various spices. This area is often known as the Cardamom Hills. This region is one of the largest producers of many spices especially cardamom from which it earns its name. Most of the rivers of Kerala originate from the Western Ghats.

The Midlands, lying between the mountains and the lowlands, is made up of undulating hills and valleys. It is 16200 sq.km in area *ie*, about 40 per cent of the total land area. This is an area of intensive cultivation. Cashew, coconut, arecanut, tapioca, banana and vegetables of different varieties are grown in this area. Lowlands are also known as the Coastal Area. It covers an area of almost 4000 sq.km. It is made up of numerous shallow lagoons known locally as *kayels*, river deltas, backwaters and shores of the Arabian Sea and is essentially a land of coconuts and rice. Though small in size, Kerala is a land affluent in water sources. Forty four rivers water the land, of which 41 are west flowing and three flow east. Apart from these 44 main rivers, their tributaries and distributaries and a countless number of streams and rivulets crisscross the land making it green and fertile and also serves as inland waterways. Aside from these rivers, Kerala is bestowed with a number of lakes and backwater lagoon which add to the beauty of the land. Vembanadu lake with an area of 260 sq.km is the largest in the State. Kerala's costal area is rich in many mineral ores which include ilmenite, rutile, monazite, zirconium, magnetite etc. It also produce other minerals like graphite, silica, iron ore, bauxite and clay.

Kerala has a total forest area of 11,125.59 sq. km including many protected areas. Its forest area is mainly spread over the Western Ghats. Kerala's forest can be divided into five major categories, viz. Tropical Wet Evergreen Forests, Tropical Moist Deciduous Forests, Tropical Dry Deciduous Forests, Mountain Sub Tropical and Plantations.

Flora and Fauna: The Western Ghats represent one of the World's 18 hot spots of bio-diversity and is considered to be a repository of endemic, rare and endangered flora and fauna. The State's riverine and montane rain forests, tropical deciduous forests, and upland temperate grasslands are inhabited by an extraordinary variety of plant and animal life which include the sambar, gaur,

Nilgiri Tahr, elephant, leopard, tiger, bonnet monkey, the rare lion-tailed macaque, the Hanuman and Nilgiri langur, spectacled and king cobras, peafowl and hornbill. Kerala houses over 25% of India's 15,000 plant species.

### 1.2.3 Climate

Tropical climate prevail in the study area. Although Kerala lies close to the equator, its proximity with the sea and the presence of the fort like Western Ghats, provides it with an equable climate which varies little from season to season. Southwest Monsoon and Northeast Monsoon are the main rainy seasons. Kerala receives an average rainfall of 3,000 millimeters annually. Dry season is from December to February and hot spell prevails from March to May and the South-West monsoon (SW) is from June to September and the Northeast monsoon (NE) from October to December. Out of this major contribution is from SW monsoon followed by NE SW monsoon is very heavy and nearly 73.5 per cent of the rainfall is received during this season. NE monsoon contributes nearly 16.4 per cent and March to May summer rain contributes nearly 9.9 per cent and the balance 6.2 is accounted for January and February (Sreenath, 2013). Temperature is generally hot and humid and March and April months are the hottest and January and February months are the coldest. The maximum temperature ranges from 28.9 to $36.2^0$ C and minimum temperature ranges from 17.0 to $23.4^0$ C.

### 1.2.4 Flora and fauna

**Flora:** Flora consists of typical tropical elements like *Hydnocarpus pentandra, Hopea ponga, Terminalia paniculata* and *Stereospermum colais.*

**Fauna :** Mammals:-Nilgiri langur (*Trachypithecus johni*), Bonnet macaque (*Macaca radiata*), Lion-tailed macaque (*Macaca silenus*), Malabar giant squirrel (*Ratufa indica*), Palm squirrel (*Funambulus palmarum*), Flying squirrel (*Petaurista petaurista*), Sambar (*Rusa unicolar*), Spotted deer (*Axis axis*), Barking deer (*Muntiacus muntjak*), Asian Elephant (*Elephas maximus*), Black naped Hare (*Lepus nigricollis*), Gaur (*Bos gaurus*), Porcupine (*Hystrix indica*), Mouse deer (*Tragulus meminna*), Nilgiri Marten (*Martes gwatkinsi*), Leopard (*Panthera pardus*), Leopard cat (*Prionailurus bengalensis*), Jungle cat (*Felis chaus*), Jackal (*Canis aureus*), Wild dog (*Cuon alpinus*), Clawless-otter (*Amblonyx cinereus*), Mangoose (*Herpestes edwardsii*), Otter (*Lutra*

*lutra*), Scaly anteater (*Manis crassicaudata*), Sloth bear (*Melursus ursinus*), and Wild pig (*Sus scrofa*) are the larger mammals.

## 2. METHODOLOGY

Observational methods were employed for the study. Available literature on the roosts and heronaries were utilized for locating important roosts in each District.

### 2.1. Field Surveys

The survey of communally roosting birds were carried out in the following Districts namely Kannur, Kozhikode, Malappuram, Thrissur, Ernakulum, Alappuzha, Kollam, Palakkad, Thiruvananthapuram and Kasargode. Wayanad, Idukki, Kottayam and Pathanamthitta Districts were not surveyed for this study and forest areas also were not covered. Birds have been classified into four groups based on their roosting behaviour, namely wetland bird roosting community, land bird roosting community, mixed species bird roosting community and the roosting community of birds of prey. After a vehicle based field survey in each District, roosts were identified and various parameters collected. Observations of roosting behaviour was made with the aid of Bushnell 7 x 50 binoculars. Birds were identified using physical features with the help of field guides and reference books (Ali and Ripley, 1969; Grimmet *et a*l., 1998). From the accumulated droppings and pellets and with the help of local people the communal roosting sites were identified. The observations were recorded during late evening (6 PM to 8:15 PM) and observations were made from the distance of about 20 to 30 meters. Initially the bird was identified and then flocks were counted by simple approximate counting method (Vasundriya *et al*., 2011). Media reports also were published requesting information on roosts (Plate 01).

Selected Districts were visited by a team and the communal roosts were identified and observations recorded. Apart from the surveys, one roost of House crow and Common myna was monitored at Mannuthy, Thrissur as a case study (Plates 02 and 03). The following parameters were collected for each communal roosts.

1. Site of roosting, with GPS readings and the species of birds identified.
2. The trees where birds are roosting and its neighbouring tree species were identified along with the details of tree height, nearby vegetation, open canopy/ dense canopy, the nearest road and twenty four hour human presence.

3. Size of the roost was judged into small (1-20), medium (20-100) and large (>100) by counting the number of birds.
4. By identifying the bird species in a communal roosting site, it was categorized into wetland birds roost, land bird roost, mixed species roost and birds of prey roost. The schedule of field visits carried out in various Districts is given in the Table 01.

**Table 01. Details of field visits carried out in the various Districts**

| Sl. no. | Districts | Observation periods |
|---|---|---|
| 1. | Thiruvananthapuram | 28-12-2017 to 29-12-2017 |
| 2. | Kollam | 20-06-2017 to 22-06-2017 |
| 3. | Alappuzha | 10-01-2017 to 12-01-2017 |
| 4 | Ernakulum | 15-11-2016 to 16-11-2016, 07-12-2016 |
| 5. | Thrissur | 26-10-2016, 30-11-2016, 07-12-2016, 13-09-2017, 09-01-2018 to 10-01-2018 |
| 6. | Malappuram | 10-12-2016, 20-12-2016 to 21-12-2016 |
| 7. | Palakkad | 07-11-2017 to 09-11-2017 |
| 8. | Kozhikode | 21-02-2017 to 23-02-2017, 13-09-2017 |
| 9. | Kannur | 22-03-2017 to 24-03-2017, 13-09-2017, 15-09-2017 |
| 10. | Kasaragode | 13-09-2017 to 15-09-2017 |

### 2.2. Identification of Pathogens

Pathogenic fungi present in the communal roosting sites were identified. For this the soil samples were collected from the sites and pathogenic fungi identified in the Pathology laboratory of Kerala Forest Research Institute, Peechi, Kerala.

### 2.3. Case study of a roost

A case study was conducted at communal roosting site at Mannuthy, Thrissur. This communal roost of House crow, Common myna and swift was in the middle of a six line high way construction. The effect of removal of trees used for communal roosting was studied. Observations were carried out in the evening hours before the removal of trees from September

2016 to November 2016. After the felling of roosting trees also the observations continued. Total number birds coming to the roosts were counted on each day (Jayson, 1995).

ഇനി ഞങ്ങളറിയും നിങ്ങൾ രാപ്പാർക്കും ചില്ലകളെ

പക്ഷികളുടെ രാത്രി വാസം കെ.എഫ്.ആർ.ഐ പഠനവിധേയമാക്കുന്നു

Plate 01. Media reports published requesting data on roosts by general public

## 2.4. Vegetation studies

Trees in the communal roosts were identified using field guides and expert advice from the field botanists of Kerala Forest Research Institute.

# 3. RESULT

## 3.1. Communal roosting of birds in Kerala

Five hundred species of birds were reported from Kerala (Praveen, 2015) and out of these twelve species of birds were performing the communal roosting behaviour (Table 02). Among the twelve species of communal roosting birds, eight species are wetland birds and four species are land birds. It is found that these communal roosting birds behaves differently in many aspects of roosting ecology and behaviour. The major species recorded in the wetland bird roosting community were Little cormorant, Little egret and Indian darter. The land bird roosting community was comprised of Common Indian myna and House crow. Mixed species roosting community consisted of both land birds and wetland bird species roosting together, for example House crow and Little egret. Birds of prey formed another roosting community.

A total of 258 communal roosts were recorded from the State and out of these, District wise distribution of communal roosts is given in the Fig. 02. Highest number of communal roosts were recorded from the Malappuram District followed by Ernakulum and Thrissur Districts and lowest were located from the Kollam District. Highest number of wetland bird roosts were from Palakkad District followed by Thrissur District. Similarly, highest number of land bird roosts were recorded from Malappuram and Ernakulum Districts (Fig. 03). Roosts of birds of prey were low in numbers and they were recorded from the Kannur, Kozhikode, Ernakulum, Kollam and Thiruvananthapuram Districts. Mixed form of roosting were recorded from Alappuzha, Kannur, Malappuram, Kasargode, Palakkad and Kozhikode Districts.

**Table 02. Species of communally roosting birds**

| Sl. no. | Common name | Scientific name |
|---|---|---|
| 1. | Little cormorant | *Phalacrocorax niger* |
| 2. | Night heron | *Nycticorax nycticorax* |
| 3. | Pond heron | *Ardeola grayii* |
| 4. | Median egret | *Ardea intermedia* |
| 5. | Indian darter | *Anhinga melanogaster* |

| | | |
|---|---|---|
| 6. | Little egret | *Egretta garzetta* |
| 7. | Black headed ibis | *Threskiornis melanocephalus* |
| 8. | Glossy ibis | *Plegadis falcinellus* |
| 9. | House crow | *Corvus splendens* |
| 10. | Common myna | *Acridotheres tristis* |
| 11. | Brahminy kite | *Haliastur indus* |
| 12. | Black kite | *Milvus migrans* |

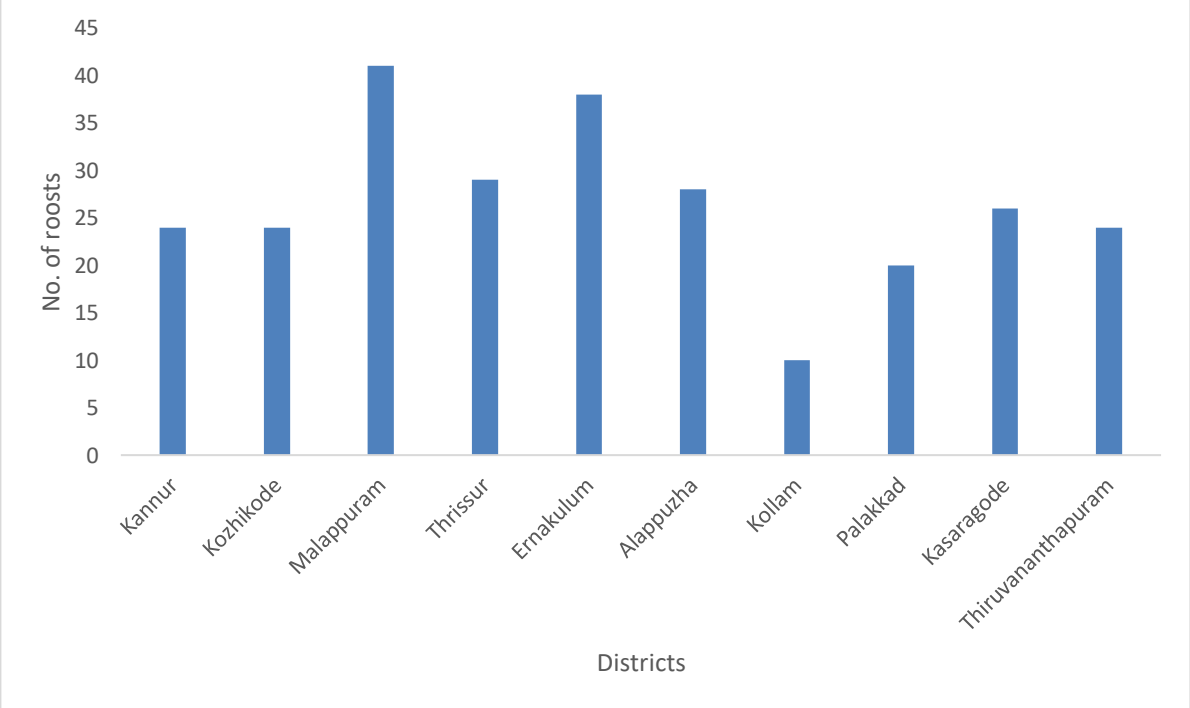


Fig.02 Total number of roosts recorded from each District

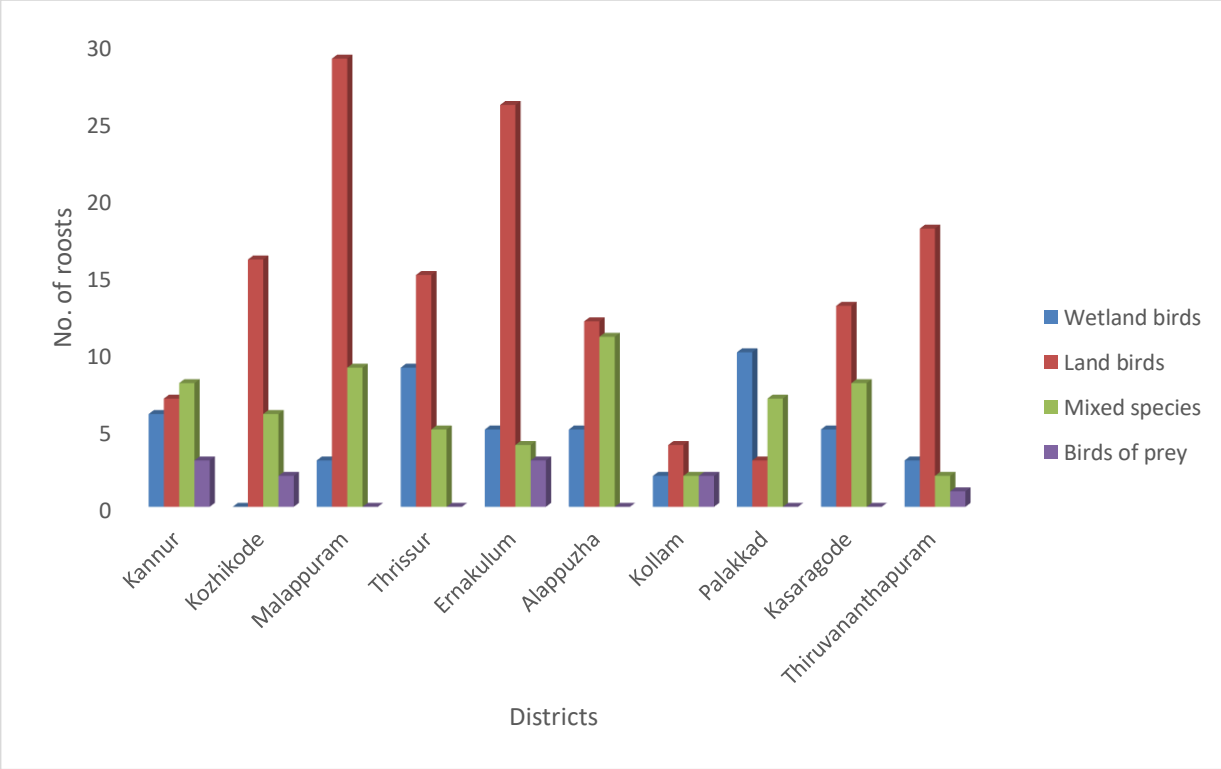


Fig.03 Four types of communal roosts recorded from each districts

Most of the communal roosts were located in the coastal belt (Fig. 04) and our previous experience showed that the communal roosts were rare in forest areas. Distance to the road from each communal roosting site was assessed for the 258 communal roost recorded. Eighty one per cent of the roost were within a distance 15 m from the nearest road and seven per cent were within 15 to 30 m distance (Fig. 05). All the roads were with busy traffic vehicles.

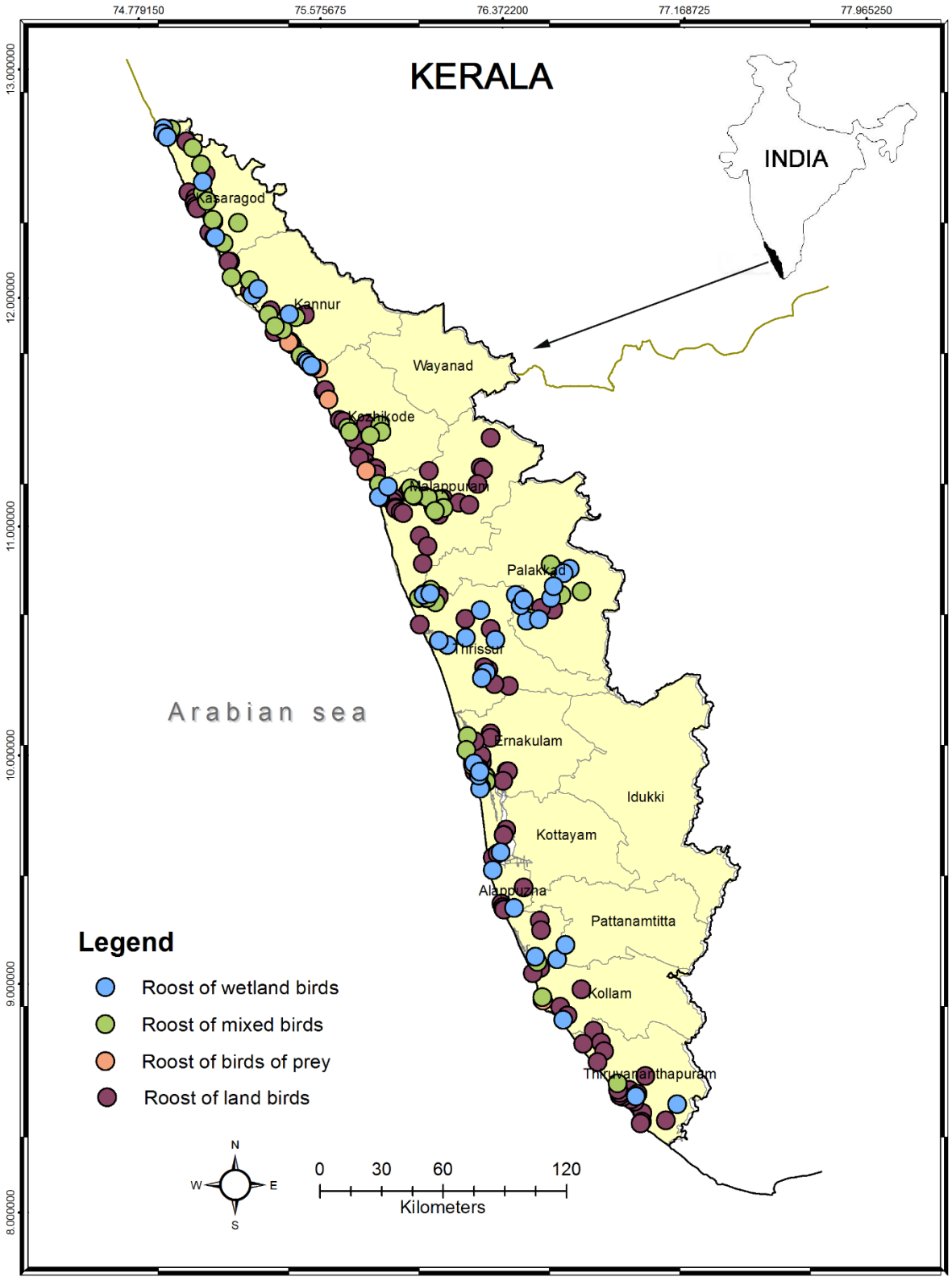


Fig.04 Location of communal roost recorded during the study

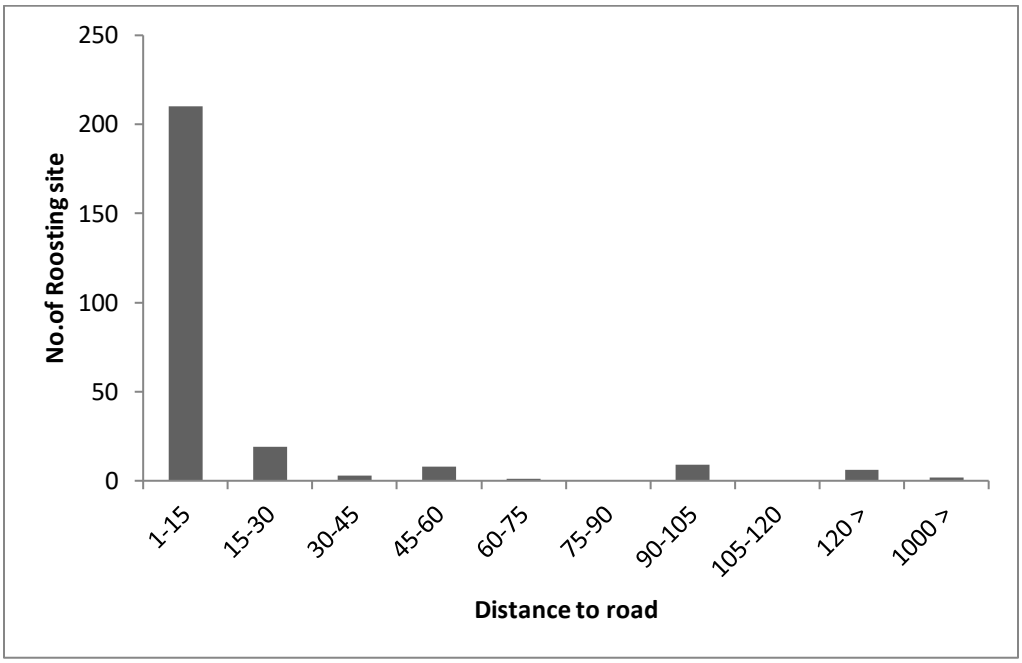


Fig. 05 Distance of the roosting trees from the nearby roads.

Another parameter assessed during the study was the twenty-four hour human presence near the communal roosts. The land birds were highly dependent on the 24 hour human presence near the roost (94 %). Similar was the case with the mixed species communal roost (82%). However wetland birds did not show any complete dependence on human presence in selecting the sites for the communal roost. Birds of prey roost were not preferring human presence near their roost (Table 03). When the 252 recorded communal roost were considered together it was found that 86 per cent of the communal roost were dependent on 24 hour human presence for their survival. Many of the communal roosts have more than 50 years of history.

**Table 03. Human presence recorded near in the communal roosts**

| **Sl. no.** | **Type of roost** | **Number of roosts** | **Human presence** (24 Hours) | **Frequency** | **Percentage** |
|---|---|---|---|---|---|
| 1. | Wetland birds | 44 | YES | 33 | 75 |
| | | | NO | 11 | 25 |
| 2. | Land birds | 131 | YES | 123 | 93.89 |

| | | | | | |
|---|---|---|---|---|---|
| | | | NO | 8 | 6.11 |
| 3. | Mixed species | 66 | YES | 54 | 81.82 |
| | | | NO | 12 | 18.18 |
| 4. | Birds of prey | 11 | YES | 4 | 36.36 |
| | | | NO | 7 | 63.64 |

### 3.2. Communal Roosting in Wetland birds

Eight species of wetland birds were recorded as involved in communal roosting in Kerala, namely Little cormorant, Night heron, Pond heron etc. (Table 04). Among them prominent species were Little cormorant and Indian darter. Wetland birds were roosting and breeding communally in the same location. Breeding period was in peak during the south-west monsoon in the wetland birds. Even after breeding period, birds roosted communally in the same location. Communal roosts were active all around the year with slight variation in total number of birds present in the roost. Egrets preferred the outer and upper portions of the trees for roosting (Plate 04).

**Table 04. List of communally roosting wetland birds**

| Sl.no. | Common name | Scientific name |
|---|---|---|
| 1. | Little cormorant | *Phalacrocorax niger* |
| 2. | Night heron | *Nycticorax nycticorax* |
| 3. | Pond heron | *Ardeola grayii* |
| 4. | Median egret | *Ardea intermedia* |
| 5. | Indian darter | *Anhinga melanogaster* |
| 6. | Little egret | *Egretta garzetta* |
| 7. | Black headed ibis | *Threskiornis melanocephalus* |
| 8. | Glossy ibis | *Plegadis falcinellus* |

#### 3.2.1. Roosting locations

All the communal roost of wetland birds were near the prominent wetlands, streams, or paddy lands (Fig. 06). Communal roosts were mainly located in Vembanad- Kole Ram Site and adjacent areas and in Palakkad District near the paddy fields, showing the importance of paddy

fields in the conservation of wetland birds. Most of the roosts were close to road, petrol bunks, railway stations, railway lines, town centers or Islands. When the distance from the communally

roosting water birds to the nearest road were analyzed from the nearby trees, it was observed that only 59 per cent of the roost were within 15 m distance from the road. Fourteen per cent were within a distance of 30 m and it was observed that, even more than 120 m from the roads water birds were establishing communal roost. This was in contrast to the land birds (Table 05). Roosting in places without human activities, they selected sites like Islands or areas covered with water for the communal roosting.

**Table 05. Distance of communal roosts of wetland birds apart from the nearby roads**

| Sl. no. | Distance to road (m) | Frequency | Percentage |
|---|---|---|---|
| 1. | 1-15 | 26 | 59 |
| 2. | 15-30 | 6 | 14 |
| 3. | 30-45 | 2 | 4 |
| 4. | 45-60 | 3 | 7 |
| 5. | 60-75 | 0 | 0 |
| 6. | 75-90 | 0 | 0 |
| 7. | 90-105 | 4 | 9 |
| 8. | 105-120 | 0 | 0 |
| 9. | 120 > | 3 | 7 |
| 10. | 1000 > | 0 | 0 |
| | **Total** | **44** | **100** |

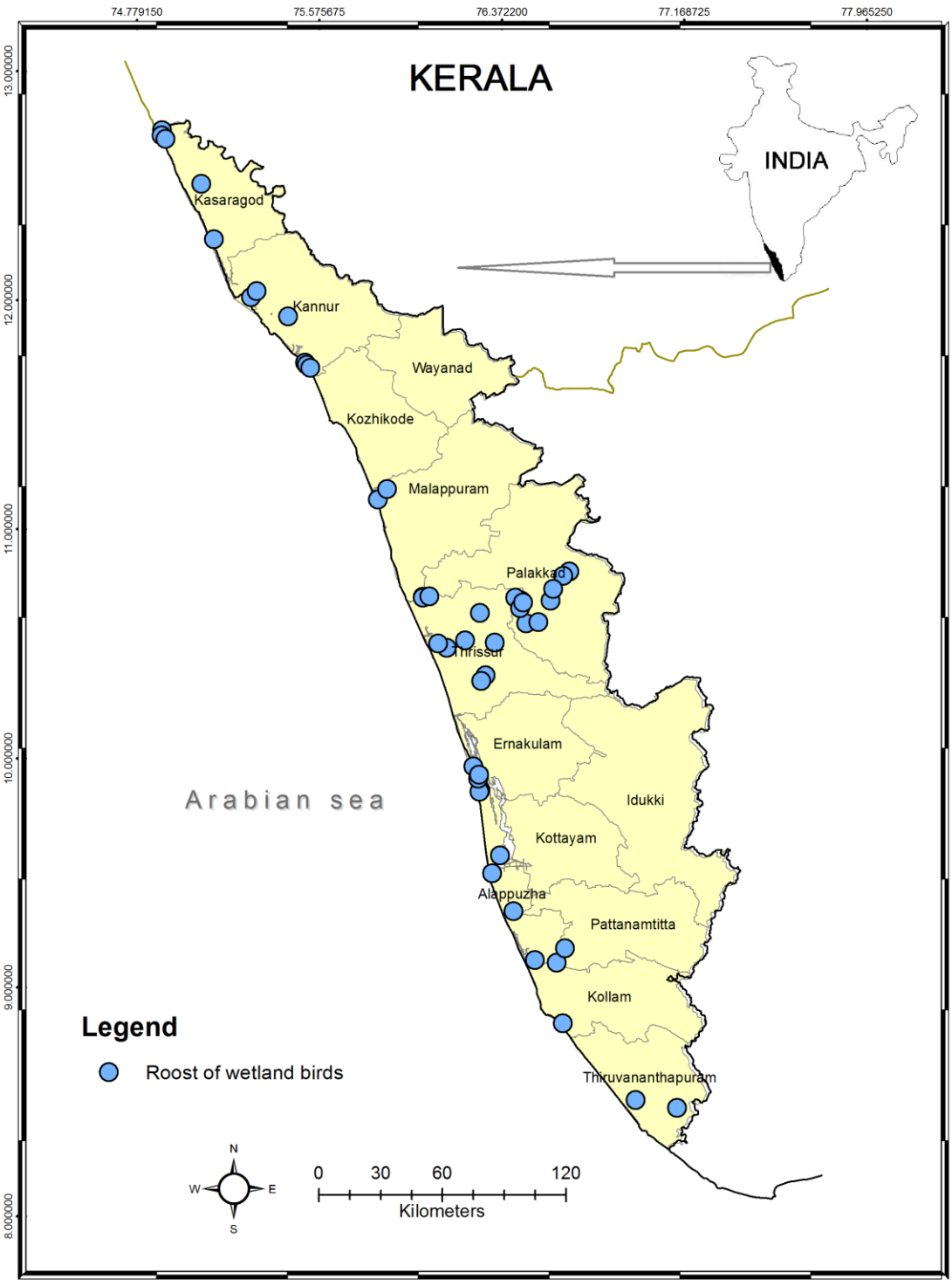


Fig. 06 Locations of communal roost of wetland birds recorded during the study

3.2.2. Roosting trees

Wetland birds utilized 25 species of trees for communal roosting. No specific species of trees were preferred for roosting. Available trees found in the selected location were used for communal roosting (Table 06).

**Table 06. Communal roosting trees used by the wetland birds**

| Sl.no. | Common name | Scientific name |
|---|---|---|
| 1. | Acacia | *Acacia auriculiformis* |
| 2. | Coconut palm | *Cocos nucifera* |
| 3. | Banyan tree | *Ficus* sp. |
| 4. | Mangroves | *Rhizophora* sp. & *Avicinnia* sp. |
| 5. | Kattadi | *Casuarina equisetifolia* |
| 6. | Vatta | *Macaranga peltata* |
| 7. | Rain tree | *Albizia saman* |
| 8. | Vaka | *Albizia lebbeck* |
| 9. | Thanni | *Terminalia bellirica* |
| 10. | Mahagoni | *Swietenia macrophylla* |
| 11. | Mango tree | *Mangifera indica* |
| 12. | Badam | *Terminalia catappa* |
| 13. | Jackfruit tree | *Artocarpus heterophyllus* |
| 14. | Arecanut palm | *Areca catechu* |
| 15. | Pala | *Alstonia scholaris* |
| 16. | Matti | *Ailanthus triphysa* |
| 17. | Tamarind | *Tamarindus indica* |
| 18. | Gulmohar | *Delonix regia* |
| 19. | Unghu | *Pongamia pinnata* |
| 20. | Anjili | *Artocarpus hirsutus* |
| 21. | Cotton tree | *Ceiba pentandra* |
| 22. | Poomaram | *Peltophorum pterocarpum* |
| 23. | Aranamaram | *Polyalthia longifolia* |
| 24. | Arya veppu | *Azadirachta indica* |
| 25. | Cashew nut tree | *Anacardium occidentale* |

3.2.3. Threat to roosting birds

As most of the roosts were near the road side, local people had complained of fecal matters falling on their properties and also on head of people and parking of vehicles were not possible. Apart from these, the accumulated fecal matters poised health problems to the local people. The bad stench arising from the fecal material has adverse effect on people and many people reported

allergic issues and breathing problems. So they tried all the methods to get rid of the communal roost from their vicinity. Many communal roost were near bus stops, so that people want to remove the roost from the bus stops. Similar was the case with the communal roosts located near auto stand and taxi stands. Some of the communal roost were away from the people and they were located in Islands.

### 3.3. Communal roosting in land birds

Three species of land birds were found to communally roost in this study. House crow and Common myna were prominent species among them. They showed great site fidelity extending more than 50 years (Table 07).

**Table 07. List of communally roosting land birds**

| Sl.no. | Common name | Scientific name |
|---|---|---|
| 1. | House crow | *Corvus splendens* |
| 2. | Common myna | *Acridotheres tristis* |
| 3. | Starling | *Sturnus* sp. |

#### 3.3.1. Roosting locations

Ninety five per cent of the land birds roosted near the roads, railway stations, Municipal parks and taxi stands (Table 08). As they were driven away from the private places they were mainly restricted to the public places. In certain cases they were roosting in uninhabited remote areas also. But the results showed that they prefer places frequented with people and majority of the roosting locations were in the coastal belt (Fig.07).

**Table 08. Distance of communal roosts of land birds from nearby roads**

| Sl. no. | Distance to Road (m) | Frequency | Percentage |
|---|---|---|---|
| 1. | 1-15 | 125 | 95 |
| 2. | 15-30 | 2 | 1 |
| 3. | 30-45 | 0 | 0 |
| 4. | 45-60 | 1 | 1 |
| 5. | 60-75 | 1 | 1 |
| 6. | 75-90 | 0 | 0 |

| | | | |
|---|---|---|---|
| 7. | 90-105 | 1 | 1 |
| 8. | 105-120 | 0 | 0 |
| 9. | 120> | 0 | 0 |
| 10. | 1000> | 1 | 1 |
| | **Total** | **131** | **100** |

3.3.2. Species of trees

Land birds selected twenty species of trees for establishing communal roost. Among them prominent were Rain tree, Mango tree, Banyan tree and Casuarina (Table 09). They selected available trees in the preferred location which have more than 10 m (mean) in height. No preference to any species of tree was recorded.

**Table 09. Roosting trees of land birds**

| **Sl. no.** | **Common name** | **Scientific name** |
|---|---|---|
| 1. | Mango tree | *Mangifera indica* |
| 2. | Rain tree | *Albizia saman* |
| 3. | Banyan tree | *Ficus* sp. |
| 4. | Kattadi | *Casuarina equisetifolia* |
| 5. | Matti | *Ailanthus excelsa* |
| 6. | Ungu | *Pongamia pinnata* |
| 7. | Pala | *Alstonia scholaris* |
| 8. | Vaka | *Albizia lebbeck* |
| 9. | Gulmohar | *Delonix regia* |
| 10. | Aranamaram | *Polyalthia longifolia* |
| 11. | Poomaram | *Peltophorum pterocarpum* |
| 12. | Jackfruit | *Artocarpus hirsutus* |
| 13. | Cashew nut | *Anacardium occidentale* |
| 14. | Seemakonna | *Gliricidia sepium* |
| 15. | Mahagani | *Swietenia macrophylla* |
| 16. | Vatta | *Macaranga peltata* |
| 17. | Jack fruit | *Artocarpus heterophyllus* |
| 18. | Poola maram | *Ceiba pentandra* |
| 19. | Badam tree | *Terminalia catappa* |
| 20. | Maruthu | *Terminalia paniculata* |

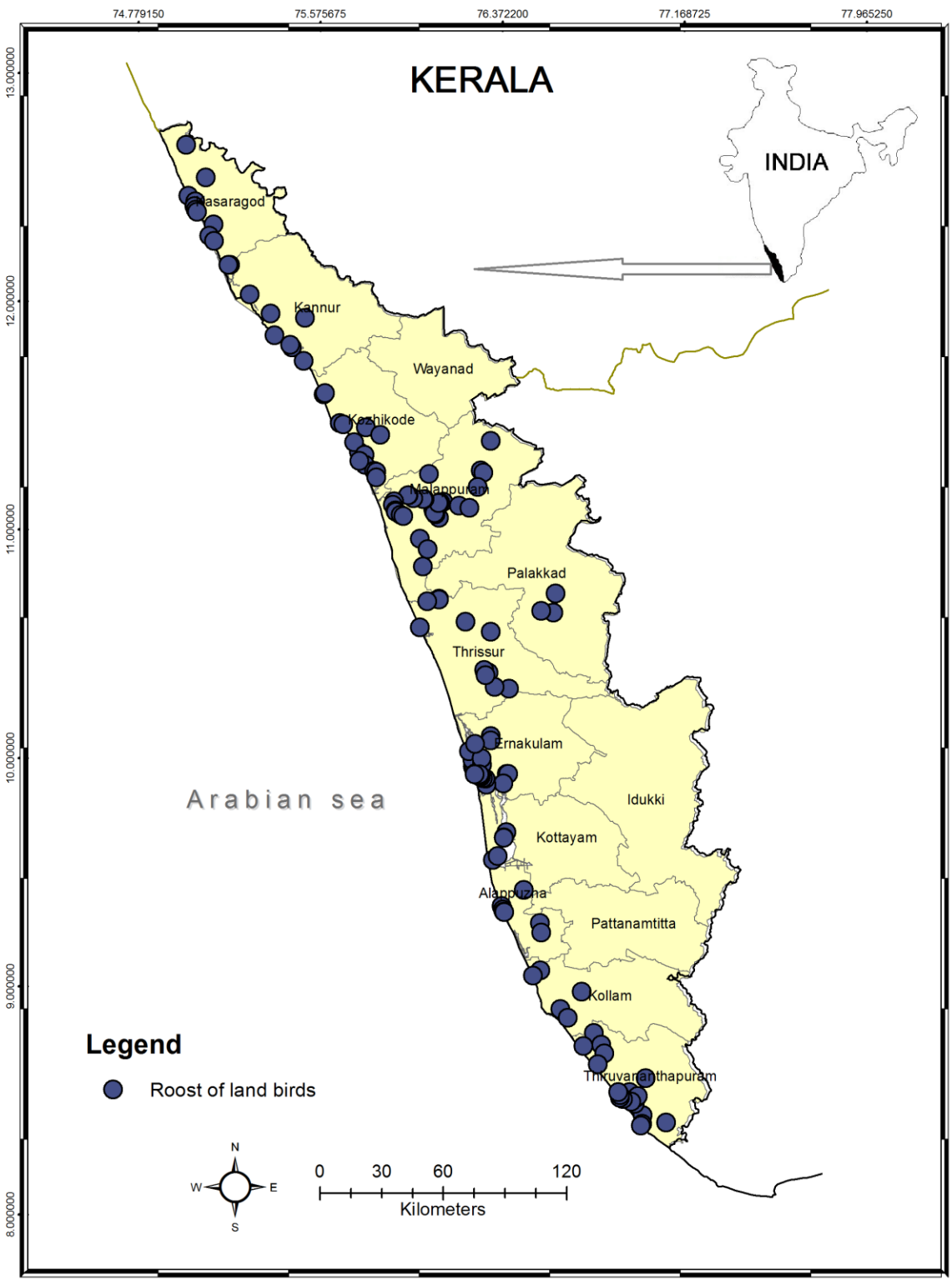


Fig.07 Locations of communal roost of land birds recorded during the study

An analysis was carried out to find out the preference of House crow to the species of trees they roosted and it was showed that no preference to any species of trees. The species used various tree species for communal roosts (Table 10).

**Table 10. Tree species used by House crow**

| Sl.no. | Common name | Scientific name |
|---|---|---|
| 1. | Mango tree | *Mangifera indica* |
| 2. | Rain tree | *Albizia saman* |
| 3. | Banyan tree | *Ficus* sp. |
| 4. | Kattadi | *Casuarina equisetifolia* |
| 5. | Matti | *Ailanthus excelsa* |
| 6. | Ungu | *Pongamia pinnata* |
| 7. | Pala | *Alstonia scholaris* |
| 8. | Vaka | *Albizia lebbeck* |
| 9. | Gulmohar | *Delonix regia* |
| 10. | Aranamaram | *Polyalthia longifolia* |
| 11. | poomaram | *Peltophorum pterocarpum* |
| 12. | Anjili | *Artocarpus hirsutus* |
| 13. | Cashew nut | *Anacardium occidentale* |
| 14. | Seemakonna | *Gliricidia sepium* |
| 15. | Mahagani | *Swietenia macrophylla* |
| 16. | Acasia | *Acacia auriculiformis* |
| 17. | Vatta | *Macaranga peltata* |
| 18. | Jack fruit tree | *Artocarpus heterophyllus* |
| 19. | Panjimaram | *Ceiba pentandra* |
| 21. | Mangrove trees | *Rhizophora* sp. *& Avicinnia* sp |
| 22. | Unghu | *Pongamia pinnata* |
| 23. | Badam | *Terminalia catappa* |

3.3.3. Threat to roosting birds

Maximum threat to the communally roosting birds were experienced by the land birds, because they have been selecting locations where people were highly active. The main conflict was due to the dropping of fecal matters on the people in the evenings. During the dusk, when people were moving below the roosting trees, fecal matters were sprayed on their dress. In some location due to the continuous roosting, fecal matters were accumulated, with the bad odor. The local people want the authorities to fell the trees or remove the branches of trees. As the

communally roosting birds are depended on trees found in the public places only, authorities should give due attention to solve the conflict with the people with the available technology. Plastic or tarpaulin sheets can be employed below the trees to collect the fecal matters without falling on the ground or parked vehicles.

### 3.4. Communal roosting in mixed species

3.4.1. Roosting locations

Eighty six per cent of the species included in this category established communal roost with in a distance of 15 m and another 9 per cent of the roosts were located within a distance of 30 m. As in other two communities, the results showed the dependence of mixed roosting species of birds to the presence of human activity. Human activity near the roost provided adequate protection to the birds from the predators like, snakes and small carnivores at night (Table 11). Not much difference is obtained in the location of mixed species communal roosts. These roosts were also located in the same areas as the earlier roosts (Fig. 08) (Plates 06 and 07).

**Table 11. Distance of communal roosts of mixed birds from the nearby roads**

| Sl. no. | Distance to road (m) | Frequency | Percentage |
|---|---|---|---|
| 1. | 1-15 | 55 | 86 |
| 2. | 15-30 | 6 | 9 |
| 3. | 30-45 | 0 | 0 |
| 4. | 45-60 | 0 | 0 |
| 5. | 60-75 | 0 | 0 |
| 6. | 75-90 | 0 | 0 |
| 7. | 90-105 | 2 | 3 |
| 8. | 105-120 | 0 | 0 |
| 9. | 120 > | 1 | 2 |
| 10. | 1000 > | 0 | 0 |
| | **Total** | 64 | 100 |

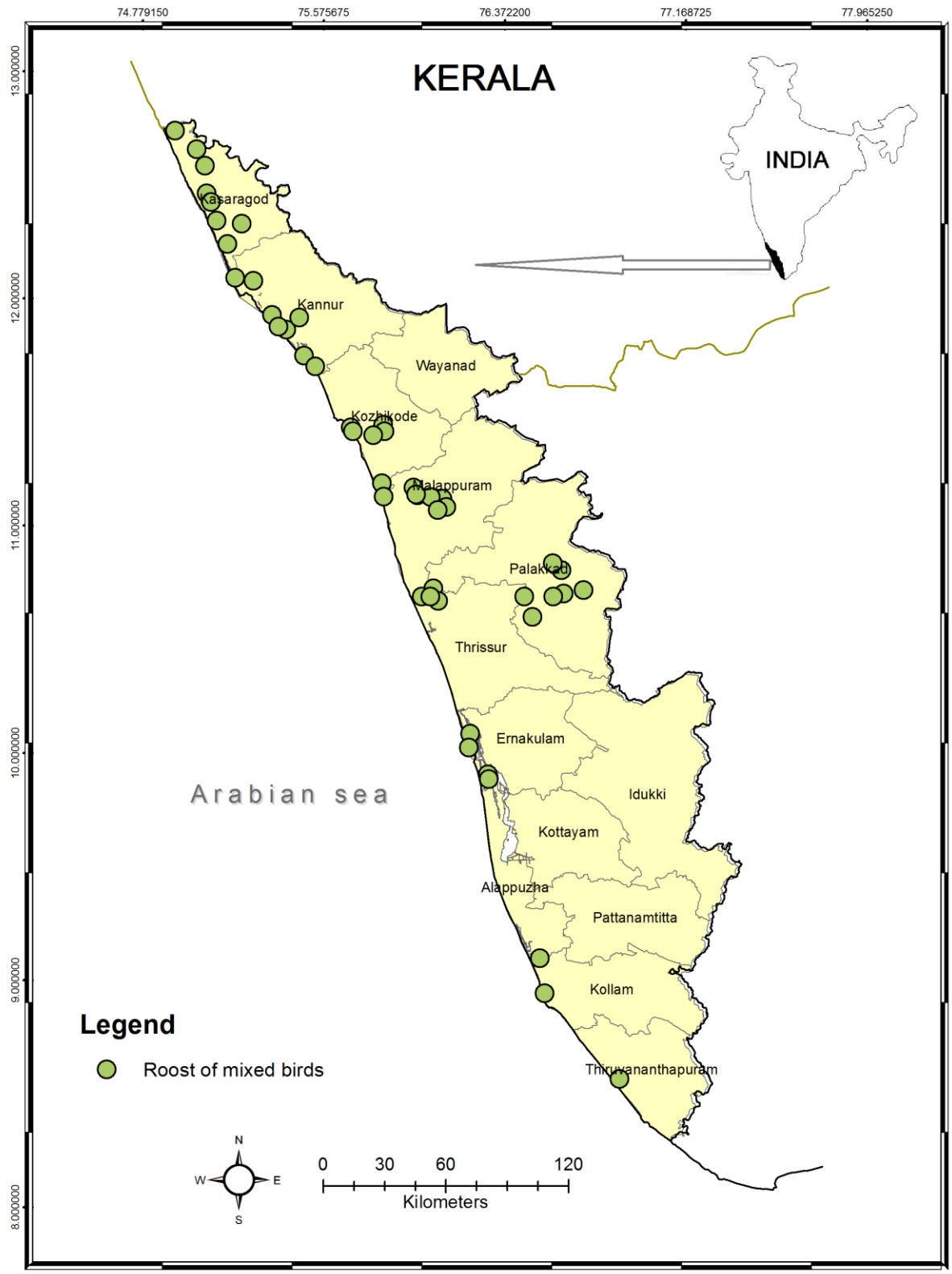


Fig.08 Locations of roost of mixed species recorded

3.4.2. Species of trees

The trees used by these mixed species group is also similar to other groups (Table 12). Egrets, House crow and Common myna roosted together in same locations (Table 13). Why in all the communal roosts this association is found is not clear.

**Table 12. Species of trees used by the mixed species communal roosts**

| Sl. no. | Common name | Scientific name |
|---|---|---|
| 1. | Kattadi | *Casuarina equisetifolia* |
| 2. | Gulmohar | *Delonix regia* |
| 3. | Mazha maram | *Albizia saman* |
| 4. | Coconut tree | *Cocos nucifera* |
| 5. | Anjili | *Artocarpus hirsutus* |
| 6. | Vaka | *Albizia lebbeck* |
| 7. | Unghu | *Pongamia pinnata* |
| 8. | Mahagany | *Swietenia macrophylla* |
| 9. | Badam tree | *Terminalia catappa* |
| 10. | Panjimaram | *Ceiba pentandra* |
| 11. | Vatta | *Macaranga peltata* |
| 12. | Cahew | *Anacardium occidentale* |
| 13. | Acacia | *Acacia auriculiformis* |
| 14. | Jack tree | *Artocarpus heterophyllus* |
| 15. | Matti | *Ailanthus excelsa* |
| 16. | Mango tree | *Mangifera indica* |
| 17. | Pulimaram | *Tamarindus indica* |
| 18. | Mangroves | *Rhizophora* sp. & *Avicinnia* sp. |
| 19. | Poomaram | *Peltophorum pterocarpum* |
| 20. | Pala | *Alstonia scholaris* |
| 21. | Aranamaram | *Polyalthia longifolia* |
| 22. | Almaram | *Ficus* sp. |

**Table 13. Species of birds found in mixed species communal roosts**

| Sl.no. | Common name | Scientific name |
|---|---|---|
| 1. | House crow | *Corvus splendens* |
| 2. | Little egret | *Egretta garzetta* |
| 3. | Common myna | *Acridotheres tristis* |
| 4. | Little cormorant | *Phalacrocorax niger* |

| | | |
|---|---|---|
| 5. | Pond heron | *Ardeola grayii* |
| 6. | Starling | *Sturnus* sp. |

3.4.3. Threat to roosting birds

Threat to these birds is also similar to the earlier ones.

**3.5. Communally roosting birds of prey**

Black kite and Brahminy kite were found to roost in the same locations but on different trees. Both the species never occupied same trees for roosting. Their roosts were also found mainly in the coastal belt (Fig.09). They never preferred human presence while selecting the roosting sites and this is clear from the Table 15. Most of the roosting locations were away from the human presence or roads compared to the earlier described roosting communities. They were performing roosting behaviour during all the months (Plate 05).

**Table 14. Species of birds found in the birds of prey roosts**

| **Sl.no.** | **Common name** | **Scientific name** |
|---|---|---|
| 1. | Black kite | *Milvus migrans* |
| 2. | Brahminy kite | *Haliastur indus* |

3.5.1. Locations

Communal roost of birds of prey were located at various distances in relation to the nearby roads. This type of roost never showed any affinity to the nearby roads. Only 18 per cent of the roost were located within 15 m distance from the nearest road. Thirty-six per cent of roost were within 15 to 30 m and 27 per cent were within 45 to 60 m distance (Table 15). This showed the non-dependence of the roost to the nearby roads. As the species are carnivores, they were not threatened by any predators so that, they selected sites away from the human presence. The roosts were mainly located near the fishing harbours and also one roost was located in the Thiruvananthapuram zoo compound.


Fig.09 Locations of roost of birds of prey recorded

**Table 15. Distance of communal roosts of birds of prey from nearby roads**

| Sl. no. | Distance to road | Frequency | Percentage |
|---|---|---|---|
| 1. | 1-15 | 2 | 18 |
| 2. | 15-30 | 4 | 36 |
| 3. | 30-45 | 1 | 9 |
| 4. | 45-60 | 3 | 27 |
| 5. | 60-75 | 0 | 0 |
| 6. | 75-90 | 0 | 0 |
| 7. | 90-105 | 1 | 9 |
| 8. | 105-120 | 0 | 0 |
| 9. | 120< | 0 | 0 |
| 10. | 1000< | 0 | 0 |
| | **Total** | 11 | 99 |

3.5.2. Species of trees

The birds of prey were found to roost on five species of trees (Table 16)

**Table 16. Species of trees on which the birds of prey roosted**

| Sl. no. | Common name | Scientific name |
|---|---|---|
| 1. | Unghu | *Pongamia pinnata* |
| 2. | Almaram | *Ficus* sp. |
| 3. | Mazhamaram | *Albizia saman* |
| 4. | Coconut tree | *Cocos nucifera* |
| 5. | Maruthu | *Terminalia paniculata* |

**3.6 Case studies**

3.6.1 Effect of removal of roosting trees

This case study was done at Mannuthy, Thrissur District. The communal roost was having 1230 number House crows visiting the roosts on each day. The roosting time was from 05.55 pm to 07.10 pm. Along with the House crow, Common myna also used the tree for roosting. This communal roost was specifically selected because, as the roosting trees were on the middle of the National Highway, they were marked for felling. After the felling of trees on 4$^{th}$ November 2016, the birds arrived for roosting in the evening. Complete confusion was displayed by the birds as

the tree was completely removed. They have no other option and the birds occupied the nearby bushes making loud calls. On the next day they did not occupy the bushes but left for the nearby roosts and other trees nearby (Table 17) (Plates 08 and 09).

**Table 17. Number of House crows visiting the communal roost at Mannuthy before the removal of trees.**

| Sl.no. | Date | Time of observation | Number of House crows | Remarks |
|---|---|---|---|---|
| 1. | 05-09-2016 | 6.10 PM-7.10 PM | 1760 | |
| 2. | 07-09-2016 | 6.10 PM-7.10 PM | 1771 | |
| 3. | 08-09-2016 | 6 PM-7.05 PM | 1802 | |
| 4. | 05-10-2016 | 6 PM-6.50 PM | 1124 | |
| 5. | 14-10-2016 | 5.55 PM-6.40 PM | 979 | Short day, moving faster than normal |
| 6. | 17-10-2016 | 5.55 PM- 6.40 PM | 778 | |
| 7. | 24-10-2016 | 5.55 PM-6.40 PM | 1006 | Short day |
| 8. | 25-10-2016 | 5.55 PM-6.45 PM | 1120 | |
| 9. | 31-10-2016 | 5.50 PM- 6.30 PM | 738 | The roosting tree was removed as part of highway widening on 4/11/2016 |

3.6.2 Communal roosts and conflict with people

Roosts located near the Railway stations, bus stops, taxi stands, shopping complexes created various type of conflicts with the local people. One issue was the dropping of fecal matters on the passengers and also on the vehicles. This created lot of nuisance and the accumulated excreta created foul smell and breathing problems to local people. But as the trees were on public

property and due to the public pressure for conservation, birds were not much harmed (Plates 10 and 11).

3.6.3 Pathogens reported from the communal roosts

Soils collected from Irinjalakuda, Thrissur communal roost near the railway station tested positively to the pathogenic fungi *Histoplasma capsulatum.* Earlier studies have shown that this fungi is the cause for breathing problems to people who are staying near the communal roosts. Removal of accumulated excreta is a must to stop the growth of this fungi. Breathing of this fungal spores is causing to the respiratory problems (Dodge *et al.,* 1965).

**3.7 Description of communal roosts**.

**3.7.1. Kannur**

**Thazhe Chovva** – A banyan (*Ficus benghalensis*) tree and Tamarind tree (*Tamarindus indica*) standing beside the Kannur- Kasargode highway is a communal roosting site of House crow (*Corvus splendens*) and Common myna (*Acridotheres tristis*) and is also supporting wetland bird species like Little egret (*Egretta garzetta*) and Little cormorant (*Microcarbo niger*) as they are selecting the trees as their roosting site for a particular season. From the focus group discussion it was clear that the roost has a history of about 30 years. The particular site is a taxi stand and is only 100 m away from the railway line. The GPS Point of the location is $11^0$ 51' 47.2" N and $75^0$ 24' 33" E.

**Valappattanam**- The location is at GPS $11^0$ 55' 40.4" N and $75^0$ 20' 48.6" E and is close to pocket road near a mangrove ecosystem. The communal roost of Starlings and Egrets were recorded on the Rain tree (*Samanea saman*) and Mango tree (*Mangifera indica*). The place is 500 m away from the wood mill so that the area is always busy with heavy traffic. The Egrets occupied on the upper side of the tree more to the center whereas the Starlings preferred the side branches.

**Mahi**- The roost is located at $11^0$ 42' 04.9" N and $075^0$ 32' 08.1" E at an elevation of 11 m in front of the Civil Station and it is a main town center with heavy traffic and highly populated area. Little cormorant, Little egret and House crow were roosting communally on two Rain trees and one Mango tree. It has a history of about 20 years.

**Kanhi road**- A well-established communal roost of Egrets, Little cormorant, and House crows were recorded from there which is a small town center and is in front of the old mosque at an altitude of 10 m. They were roosting on two rain trees. The GPS Location was at $11^0$ 55' 01.4" N and $75^0$ 27' 56.1" E.

**Payyanur Railway station-** The communal roost of Egret, Little cormorant and House crow were recorded from the railway station 200 m away from the railway line and very close to the railway station road. It is a well-established roost and has more than 50 years of history. The roosting trees were two banyan trees and two rain trees.

**Pappinissery-** The roost of House crow and Common myna were recorded on the banyan tree and rain tree, which is in the town center in front of the Community Health Center and close to road. The GPS location of the place was $11^0$ 56'48.1" 'N and $75^0$ 21' 21.6" E at an altitude of 4 m.

**Thalasseri Stadium corner**- The roost of Egrets, House crow and Common myna were recorded on two rain trees and one mango tree standing in front of the police station near the auto stand and SBI bank. The roosting trees were close to highway and the GPS location was $11^0$ 44' 56.0" N and $75^0$ 29' 14.4" E.

### 3.7.2. Kozhikode

**Kattukulangara**- The location is at $11^0$ 15' 14.4" N and $75^0$ 49' 04.2" E in an altitude of 15 m. It is a small town center situated 4 km away from the Kallai River, The age of the roost is about 15 years now and the roost is on the Badam tree (*Terminalia catappa*) and the roosting bird species were Little cormorant and Starling.

**Cheekilodu-** The roost is on the Banyan tree standing close to the main road and is 20 m away from the canal in a small town center. It is a well established roost of House crow, Little cormorant and Egret. From the focus group discussion the age of the roost was calculated as more than 40 years and none of the local people considered it as a nuisance for them. The GPS location was $11^0$ 23' 56.2" N and $75^0$ 47' 27.8" E at an altitude of 17 m.

**Marakkattumukku-** It was in a coconut plantation and the habitat was hilly region with human settlements. The roost was very well established roosting site of House crow. About 30 years of

history was there as a House crow roost. The place is 100 m away from the main road and 250 m away from the temple. The plantation is the roosting site of Common myna also. The egrets roost was also established recently in the coconut plantation. The place is located at $11^0$ 24' 56.3" N and $75^0$ 50' 25.4" E at an altitude of 46 m.

**Kuttichira-** The roost of Black kites were recorded from the place on the coconut plantation close to main road and 200 m away from the sea. The presence of fish fauna in the area was the main attraction for the Black kites in the area.

### 3.7.3. Malappuram

**Panayi-** It is a small town between Manjeri- Malappuram road, the roost of Egrets, House crow and Common myna were recorded from there on a Vaka tree which is only 300 m away from the Panayi LP school compound and is standing close to the road. There is small fish market and hotel close to the roosting tree and the waste from these facilities were used by the birds as one of their food source. The roost has a history of about 30 years. The GPS location is $11^0$ 04' 55.4" N and $76^0$ 06' 43.2" E and the altitude is 36 m.

**Vaniyambalam-** A very well established communal roosts of House crows and Little cormorants were there in the town center on 8 rain trees and one banyan tree. All trees were close to Vaniyambalam - Wandoor main road and also 50 m away from the railway cross. The particular roost has 40 years of age. The railway station is only 500 m away from the roosting trees and heavy traffic on the road. A fish market is functioning there for the last 20 years. The place, including two of the roosting trees was converted to a public park in September 2016. The roost is disturbing the passengers due to the bad smell from the droppings and also the unexpected encounter of the bird dropping. It is a highly populated town. The GPS location is $11^0$ 11' 16.9" N and $76^0$ 15' 41.4" E at an altitude 46 m. The railway authorities were planning to remove the branches due to the complaint from the locals.

**Pattarkulam-** The roost of Egrets and House crows were recorded on Vaka tree. The location is a small town 100 m away from the wetland (Paddy field). A number of migratory birds are seasonal visitors in the area. There is a pond built by the Panchayath for collecting water for different purposes which is only 40 m away from the roosting tree.

**Velluvambrum-** The roost of House crow, Little cormorant and Indian Darter were recorded on three Vaka trees, It was in the town center in the junction of three roads and also is an auto taxi stand. The roost is not liked for the disturbance caused for the passengers and thereby, it became news in the newspapers and subsequently tarpaulin sheets were placed below the nesting tree to avoid the droppings on the vehicles and passengers by the Kerala Forest and Wildlife Department. The roosting trees were 200 m away from the crop land. GPS location of the place is $11^0$ 07' 34.4" N and $076^0$ 02' 42" E.

**Ramanattukara**- The roost of Little cormorant and Little egrets were recorded on the Thani tree in the town center close to road and the roost has more than 40 years of history. The roosting trees were one km away from the Velithodu (Stream). The GPS location of the place is $11^0$ 10' 30.6" N and $75^0$ 52' 07.8" E at an altitude of 56 m.

**Pavuttapuram (Kokoor)-** The location is at the boarder of Malappuram and Thrissur District and is only 4 km away from the wetland (Puncha paddy field). The roost of House crow and Little cormorant were recorded on the rain tree which is in front of Assabah Educational Complex and also near a tea shop. The nesting of Little cormorant was also recorded. From the focus group discussion, the history of the roost is calculated as more than 35 years. The paddy field was also visited by us and it is a collection of paddy fields and has a large variety of wetland bird species. The roost of Black headed ibis was recorded from the paddy field on the coconut plantation. The GPS location of the area is $10^0$ 43' 30.8" N and $76^0$ 03' 18.7" E at an altitude of 27 m.

**Balathuruthu-** It is a land surrounded by water on either side, about 150 human settlements are there and the major portion of the land is surrounded by coconut plantation in which the birds like Little cormorant, Egrets, Herons and House crow were roosting. It is 20 m away from the Kadalundi River. There are lots of mangrove ecosystems nearby the area. The GPS location is $11^0$ 07' 39.3" N and $75^0$ 50' 12.5" E and the altitude is 9 m.

### 3.7.4. Thrissur

**Kakkathuruthu-** It was a land surrounded by water bodies on three sides and a number of human settlements are there and also filled with the Coconut trees. The species like egrets, cormorants, and Indian darter were roosting on the coconut tree. The locals were always complaining about

the disturbance from the bird droppings. It is in the center of wetland ecosystem near to Kole wetlands. The GPS location of the place is 10° 30’ 8.02” N and 76° 5' 34.91" E.

**Uppunghal Kadavu-** The place is close to Kole wetland. The birds like House crow, Little cormorant were roosting on the trees like Banyan tree, Kattadi, coconut plantation and vaka on the road side. The GPS location is 10° 41’ 23.93” N and 76° 0’ 11.54” E.

**Parempadam-** The roost of Little egret and House crow were recorded on the rain tree. Standing in a small town center close to taxi stand on the road side the health of the roosting tree is very poor so that the locals were demanding the authorities to remove the tree as soon as possible. The GPS location of the place is 10° 40’ 6.98” N and 76° 4’ 37.85” E.

**Perumbilavu-** The roost is in a town center in a highly populated area. The roost of House crow was recorded on two rain trees, one of them standing side to the taxi stand. There is fish market, chicken stall, beef stall, and hotels around this place and the trees were standing on the road side. The locals were complaining about the roost and they want to remove the tree branches to avoid the bird droppings on them as well as the vehicles below it. The location of the place is 10° 41’ 57.46” N and 76° 5’ 31.25” E.

**Valakkavu-** The roost of House crow was recorded from the place on a banyan tree standing close to the road. There is a chicken stall functioning close to the roosting tree from which the House crow gathering necessary food occasionally. The locals were using crackers and other deterrent practices against this House crows to avoid the roosting on trees. They were complaining about the difficulties due to the bird droppings in the area. The GPS location is $10^0$ 30’ 45.3” N and $76^0$ 17’ 41.3” E.

**Kallettumkara Railway station**- The visit was made during the morning and evening hours. it was not a breeding season and the number of birds was too low.

**Thrissur railway station-** The birds were seen on tamarind, teak, cotton, neem trees etc. Most of the tree branches was cut down and also the breeding season is over, so the number of birds were low. The recorded birds were – Common myna, Pond heron and Indian darter.

### 3.7.5. Ernakulum

**Chellanam**- It is a wetland ecosystem and has small patches of Mangrove ecosystem. The water birds like Egrets and Little cormorant were roosting in the mangroves which are only 20 m away from the road. The mangrove trees are short in height (10-15 feet). A variety of water bird flocks depends on the wetland for various activities. The GPS locations of the place is $09^0$ 51' 19.0" N and $76^0$ 16' 24.7" E.

**Kuttrikkattukara-** The roost of House crow and Common myna were recorded on two badam trees, two teaks, and two banyan trees. It is a well-established roost close to the road in a small town center. There is a vegetable stall and hotel close to the roosting trees. The GPS location of the place is $10^0$ 04' 42.3" N and $76^0$ 19' 10.8" E.

**Arur-** The roost of House crow and Egrets were recorded on the coconut plantation, rain tree, and Vaaka. The rain tree and vaaka were in the compound of an abandoned building and the egrets were mainly roosting on these trees. The coconut plantations were in the compound of factory producing industrial chemicals and all these were standing only 29 m away from the road and the place is also 50 m away from the Vembanad Lake. The GPS location of the place is $09^0$ 53' 07.2" N and $76^0$ 17' 59.6" E.

### 3.7.6. Alappuzha

**YMC/ Savakottapalam**- A mixed roost of Little cormorant and House crow were recorded on the rain trees. The four rain trees standing 3m away from the canal and 7m away from the road were the roosting trees. It is a highly populated town center. The GPS location is $76^0$20'16.4" E and $09^0$ 29' 56.1" N with an elevation 15m.

**Karuvatta/Sathyalayam**- It is an isolated private land and also an unmanaged wetland ecosystem 50 m away from the lake. The roost of Night heron, Glossy ibis and Brahminy kite were observed on trees includes acacia, coconut and cashew nut. It was an undisturbed area 100 m away from the land owner's house. The GPS Location is $076^0$23'07.1"E and $09^0$21'37.7" N with an elevation -13.

**Mavelikara Govt. Hospital**- A mixed roost of Little cormorant, Egret, Common myna and House crow were observed on trees includes Badam, Jack fruit tree and Poomaram. The roosting

trees were standing inside the hospital compound, 100m away from the road and 500m away from the Achankovil River. It is well established roost in a populated area some other water birds are seasonal visitors to the area. The GPS Location is $076^0 33' 09.6$"E and $09^0 15' 18.6$" N with an elevation 11m.

**Ponnad-** The roost of Little cormorant was observed on coconut plantation nearby Vembanad lake. It is very well established roost in a housing compound. The residents were complaining about the allergic problem caused from the droppings of little cormorant. The roost was showing local shifting to nearby areas but it is there in the place for more than 15 years. The GPS location is $076^0 21' 44.8$" E and $09^0 34' 37.2$" N with an elevation 4m.

**Karuvatta Vadakku-** The roost of Black headed ibis, Glossy ibis, Little cormorant, Indian pond heron, egret was observed on the trees includes Vatta, Coconut, Anjili and Mango tree. It is a well-established roost which is 5m away from the Puthanaru (part of thottapally spillway). The area is an Island surrounded by water on three sides which contains 3 houses. The house owners were doing fish culture in their land which offer enough food source for the roosting birds. The owners were ready to tolerate the presence of birds in their land and the resulted damage to their fish farms. It has more than 25 years of history and is recognized as a part of heronry conservation program. The GPS location is $076^0 25' 15.7$" E and $09^0 19' 57.6$" N with an elevation of 2m.

### 3.7.7. Kasaragode

**Hosangadi-** A well-established roost of water birds was recorded in the town center 5 m away from the road. The roosting trees included two banyan trees and one poomaram were standing 20 m away from the railway cross (with gate). The crown of the trees was just above and around the bus stop so that a 24 hrs human activity was there. The bird species recorded were Night heron, Indian pond heron and Little cormorant, 26 nests were recorded from the roosting trees. The GPS location of the place is $12^0$ 42' 16.3" N and $74^0$ 54' 12.2" E with an elevation 24 m.

**Kunjathoor-** The roost of Indian pond heron and Little cormorant were recorded on three rain trees. The trees were standing 5 m away from the road in the town. The roost is a well-established one, Little cormorant breeding was observed from the tree and 22 nests were recorded. The GPS point is $12^0$ 44' 33.8" N and $74^0$ 53' 11.1" E with an elevation 15 m.

**Mada/Udyawar-** A mixed roost of House crow and Pond heron was recorded on three rain trees and one poomaram. The roosting trees were standing 7 m away from the road near the fish market and nesting was recorded on the tree at the time of observation. The elevation of the place is 10 m and lies in $12^0$ 44' 17.6" N and $074^0$ 55' 11.3" E.

**Kanyapady-** A well-established roost of House crow, Little cormorant and Indian pond heron were recorded on Rain tree (2) and Mango tree (1). It is a small town and the roosting trees were standing 3 m away from the road in front of a tea stall, the place is 11 km away from the sea. The people around the roosting trees were ready to tolerate their presence so that the only threat liable to the roost was from the activity of road widening, The GPS point is $12^0$ 35' 06.4" N and $075^0$ 03' 00.2" E with an elevation 99 m.

**Cherkala-** A well-established mixed roost of House crow, Indian pond heron and Little cormorant were recorded in a highly populated town center on Acacia (2), Banyan tree and Rain tree. The roosting trees were standing 2 m- 7 m away from the road in front of the tea stall and the tree crowns were standing above the auto stand. From the focus group discussion the age of the roost was estimated as 20 years. The branches of the rain trees were removed by KSEB at the time of observation. The local people were highly tolerating the presence of birds. The GPS location is $12^0$ 30' 27.1" N and $75^0$ 03' 28" E with an elevation 74 m.

**Poinachi-** The roost was observed on Banyan tree, Mango tree and Rain tree. The roosting trees were standing 3 km away from the NH66 road in a populated town center near the Centaury Hospital. It was a mixed roost of Little cormorant, House crow and Pond heron. The place is 7 km away from the sea with GPS $12^0$ 27' 48.2" N and $75^0$ 03' 32.4" E and elevation 66 m. The age of the roost was estimated as 30 years from the focus group discussion**.**

### 3.7.8. Palakkad

**Chithalipalam-** The roost of Little cormorant and Egrets were recorded on rain tree and tamarind. The Rain tree was 10 m away from the highway and below the tree is an auto stand. The tamarind was standing in a house compound and is only 5 m away from the canal constructed for irrigation. The roosting trees were 100 m away from the paddy fields. From focus group discussion it is clear that roost on the rain tree established 6 years ago at the time of highway widening and on the tamarind was established before 3 years. The local people

used crackers to remove the roost but the birds are still there as seasonal visitors. The GPS Location is $10^0$ 41' 20.1" N and $76^0$ 35' 00.4" E.

**Pallanchathannur-** The roost of Little cormorant and Egret were recorded on the banyan tree standing in front of the Manthathu Bagavathi temple near a paddy field. The local people were complaining about the problem of bird droppings and no one can sit under the tree and it is close to the temple. The roost has 25 years of age. GPS location is $10^0$ 44' 26.5" N and $76^0$ 35' 38.1" E with an elevation 84 m.

**Malampuzha/Manthakkadu-** The roost of Black-headed Ibis was recorded on a Banyan tree. The roosting tree was standing 2 m away from the road and close to the bus waiting shed. It was a small town, the people were complaining about the bird dropping on their dress while they were passing under the roosting trees. A number of educational institutions and Government offices were functioning near the roost and the students and employees suffered due to the bird defecation. This may create a negative attitude towards the conservation of roosting sites. The GPS location is $10^0$ 48' 59.1" N and $76^0$ 39' 56.2" E with an elevation 94 m.

**Pazhambilakodu Krishnakovil/Pavodi-** A well-established roost of mixed species of birds was recorded from the housing compound on a tamarind (2) and Coconut palm (16). The bird species included Egret, Little cormorant and House crow. The house owner reported that, the presence of House crow was there for a long 60 years but the other two species occupied the roost only recently and their presence removed the already established House crows from the roost. They were ready to tolerate the House crow roost, whereas the droppings of Little cormorant was highly disturbing and causing allergic problems for the family members. The place was near a wetland ecosystem, GPS location is $10^0$ 41' 25.4" N and $76^0$ 41' 25.4" E with an elevation of 68 m.

### 3.7.9. Thiruvananthapuram

**Kazhakoottam**- A mixed roost of Egret, House crow and Little cormorant was recorded on a Rain tree, Mahagony and Poomaram. The roosting trees were standing 5 m away from the road in front of Kazhakoottam Sree Mahadeva Temple and also near the Village office. The place is the center of the town and the trees were near auto stand so that the auto taxi drivers tried

many deterrent methods to remove the birds from the tree, but they remained on the same trees. The wetland birds were seasonal visitors in the tree for the last 10 years. The GPS location is $08^0$ 33' 57.5" N and $76^0$ 52' 29.4" E with an elevation of 20 m.

**Kavadiyar**- The roost was observed in front of aqua engineering tower and SBI bank on Poomaram (3) which was standing 3 m away from the road. The roosting species was House crow and it is highly busy area with 24 hour traffic.

**Trivandrum Zoological Park**- A well-established roost of Black kite was recorded inside the complex near the Snake Park. The roost was on a rain tree and Maruthu, more than thousand birds were recorded in the roost at the time of observation. The wasted food materials for carnivorous animals in the Zoo might be the attractant for them. The GPS location is $08^0$ 30' 42.2" N and $76^0$ 57' 23.7" E.

**Pallimukku, Pettah**- The roost of House crow was recorded on the rain tree. The roosting tree was standing 3 m away from the road in front of the police station, opposite to the bus waiting shed and it has 3 m GBH. It was in the center of the town with heavy traffic. The GPS location is $08^0$ 29' 42.1" N and $76^0$ 56' 00.8" E with an elevation 32 m (Plates 12 and 13).

# 4. DISCUSSION

Wetland birds were selecting communal roosting locations near the wetlands and the paddy fields found in the coastal areas. One exception to this pattern was the occurrence of communal roost in the Palakkad District. The results showed the dependence of communal roost of land birds to the nearby roads. Ninety five per cent of the communally roosting land birds preferred a location near a road to establish a communal roosting site (Fig. 10). Similar trend was showed by the communal roosts occupying mixed species, whereas wetland birds were not dependent on the nearby roads when they established the communal roost. Birds of prey were never dependent on the nearby roads when they selected the communal roost locations and actually more than 50 per cent of the communal roost of birds of prey were located at a distance of more than 30 m. This clearly showed the non-dependents of nearby roads by the birds of prey species.

The land birds showed continued site fidelity extending to many years and were roosting communally in the same site. But wetland birds wholly or partially shifted their roost sites after a short span of time to a nearby site or to another site. Twenty four hour human presence is a factor which controlled the site selection in communal roosting of land and wetland birds in Kerala. Land birds were preferring human presence near the communal roosting sites or in other way, they were dependent on the continued human presence. Wetland birds also preferred sites with human presence and similar was the case with mixed species. Birds of prey were not dependent on the human presence and actually preferred sites without human presence. The observations indicated that the land birds and wetland birds do select sites with human presence for avoiding predators.

Wetland and land birds behaved differently in selecting the sites for communal roosting. Location of communal roosts selected showed that most of them were in coastal areas but in this belt, except for the Mangalavanam Bird Sanctuary and Kadalundy Bird Reserve no other protected areas are declared.

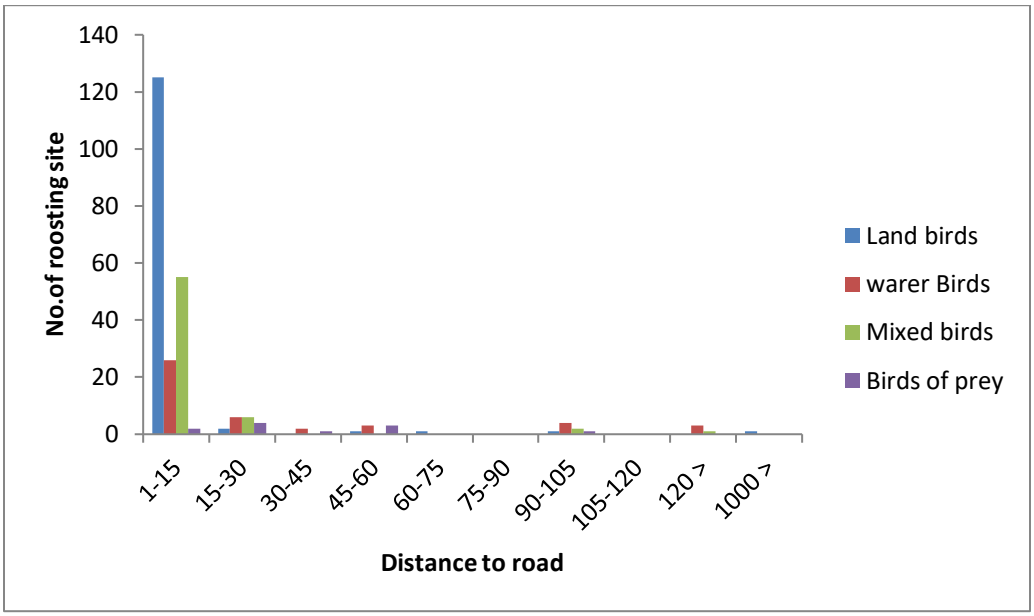


Fig. 10 Distance of the roost from nearby roads

Communal roosting is an animal behavior where a group of individuals, typically of the same species, congregate in an area for a few hours based on an external signal and will return to the same site with the reappearance of the signal. Environmental signals are often responsible for this grouping, including nightfall, high tide, or rainfall. While communal roosting is generally observed in birds, the behavior has also been seen in bats, primates and insects. The size of these roosts can measure in the thousands to millions of individuals, especially among avian species.

There are many benefits associated with communal roosting including: increased foraging ability, decreased thermoregulatory demands, decreased predation, and increased species-specific interactions. While there are many proposed evolutionary concepts for how communal roosting evolved, no specific hypothesis is currently supported by the scientific community as a whole

**The Information Center Hypothesis (ICH)**

Proposed by Peter Ward and Amotz Zahavi in 1973, the Information Center Hypothesis (ICH) states that bird assemblages such as communal roosts act as information hubs for distributing knowledge about food source location. When food patch knowledge is unevenly distributed amongst certain flock members, the other "clueless" flock members can follow and

join these knowledgeable members to find good feeding locations. To quote Ward and Zahavi on the evolutionary reasons as to how communal roosts came about, "communal roosts, breeding colonies and certain other bird assemblages have been evolved primarily for the efficient exploitation of unevenly-distributed food sources by serving as ' information-centres.' “Currently, there is only speculation as to how the information is conveyed. It has been suggested that the successful members first convey their knowledge through displays and the unsuccessful members then follow, or that the unsuccessful members circle in the air or slowly fly out and proceed to join the successful members when they take off. Ward and Zahavi approached the explanation for the ICH in several different ways, but each explanation is related to the ability to distribute knowledge of resources. The present study revealed that primarily they were doing the communal roosting for protection from predators. Roost were selected in places where predators cannot approach due to the human presence. This is contradictory to the observations of Ward & Zahavi. Many criteria have already started that The ICH may also not apply to all species, as there are variations in hunting and scavenging behaviors.

**The two strategies hypothesis**

A stylized example of a communal roost under the two strategies hypothesis, with the more dominant individuals occupying the higher and safer roosts. The two strategies hypothesis was put forth by Patrick Weather head in 1983 as an alternative to the then popular information center hypothesis. This hypothesis proposes that different individuals join and participate in communal roosts for different reasons that are based primarily on their social status. Unlike the ICH, not all individuals will join a roost in order to increase their foraging capabilities. This hypothesis explains that while roosts initially evolved due to information sharing among older and more experienced foragers, this evolution was aided by the benefits that more experienced foragers gained due to the fact that as better forages they acquired a status of high rank within the roost. As dominant individuals, they are able to obtain the safest roosts, typically those highest in the tree or closest to the center of the roost. In these roosts, the less dominant and unsuccessful foragers act as a physical predation buffer for the dominant individuals. This is similar to the selfish herd theory, which states that individuals within herds will utilize conspecifics as physical barriers from predation. The younger and less dominant individuals will still join the

roost because they gain some safety from predation through the dilution effect, as well as the ability to learn from the more experienced foragers that are already in the roost.

The TSH makes several assumptions that must be met in order for the theory to work. The first major assumption is that within communal roosts there are certain roosts that possess safer or more beneficial qualities than other roosts. The second assumption is that the more dominant individuals will be capable of securing these roosts, and finally dominance rank must be a reliable indicator of foraging ability. The present study support this hypothesis.

**The recruitment center hypothesis (RCH)**

Proposed by Heinz Richner and Phillip Heeb in 1996, the recruitment center hypothesis (RCH) explains the evolution of communal roosting as a result of group foraging. The RCH also explains behaviors seen at communal roosts such as: the passing of information, aerial displays, and the presence or lack of calls by leaders. This hypothesis assumes:

- Patchy feeding area: Food is not evenly distributed across an area but grouped into patches
- Short-lasting: Patches are not present for an extended period of time
- Relatively abundant: There are many patches with relatively equal amounts of food present in each

At this point in time there has been no additional scientific evidence excluding RCH or any evidence of overwhelming support. What is overlooked by RCH is that information may also be passed within the communal roost which increases and solidifies the community.

Potential benefits

Birds in a communal roost can reduce the impact of wind and cold weather by sharing body heat through huddling, which reduces the overall energy demand of thermoregulation. A study by Beauchamp (1999) explained that black-billed magpies (*Pica hudsonia*) often formed the largest roosts during the winter. The magpies tend to react very slowly at low body temperatures, leaving them vulnerable to predators. Communal roosting in this case would improve their reactivity by sharing body heat, allowing them to detect and respond to predators much more quickly. A large roost with many members can visually detect predators easier,

allowing individuals to respond and alert others quicker to threats. But as the present study is from a tropical area the above hypothesis did not apply.

Communal roosting has been observed in numerous avian species. As previously mentioned, rooks (*Corvus frugilegus*) are known to form large nocturnal roosts, these roosts can contain anywhere from a few hundred to over a thousand individuals. These roosts then disband at daybreak when the birds return to foraging activities. Studies have shown that communal roosting behavior is mediated by light intensity, which is correlated with sunset, where rooks will return to the roost when the ambient light has sufficiently dimmed.

Interspecies roosts have been observed between different bird species. In San Blas, Mexico, the great egret (*Ardea alba*), the little blue heron (*Egretta caerulea*), the tricolored heron (*Egretta tricolor*), and the snowy egret (*Egretta thula*) are known to form large communal roosts. It has been shown that the snowy egret determines the general location of the roost due to the fact that the other three species rely on it for its abilities to find food sources. In these roosts there is often a hierarchical system, where the more dominant species (in this case the snowy egret) will typically occupy the more desirable higher perches. Interspecies roosts have also been observed among other avian species.

The present study clearly showed that the selection of roosting site is mainly to avoid the predators. This is the first study to separate the birds based on their habit and feeding behaviour while studying the communal roosting behaviour. The study showed that, all the four groups of birds behaved separately in selecting the roost site. Communal roosting behaviour cannot be attributed to all species in general. Avoidance of the predators is primary objective in the species of birds studied while selecting the communal roosting site. This they are achieving by selecting sites close to human activity during all the twenty four hours. In certain cases they selected Islands also for roosting which are surrounded by water.

As people are not allowing roosting of birds in trees located in their private properties, birds are completely depending on the public places. The authorities have to give high attention to save the communal roosting trees of the public places otherwise birds depended on communal roosting will be threatened. Widening of the roads is another threat to the roosting trees. Expansion of Highways affected many existing roosts and as a remedy new trees should be

planted in the same localities were the trees have been removed. The conflict with the local people and communal roosting birds should be addressed and solved (plates, 14 & 15).

## 4. Recommendations

1. Communal roosts in the private properties should be supported with yearly financial grants for cleaning the fecal matters and to maintain the communal roost.
2. Conflict with local people and the communal roosts in the public places should be addressed more seriously.
3. Polythene or tarpaulin sheets should be provided for making cover to escape from the fecal matters.
4. Excreta from the public roosting places should be removed to avoid breathing problem.

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Plate 02. Little egrets returning to a roost in Alappuzha

Plate 03. Crested serpent eagle breeding

Plate 04. Communal breeding and roosting at Kasaragode

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Plate 05. Little cormorant and Indian darter in a roost at Ernakulum


Plate 06. Removal of branches of a tree to turn away the birds from roost, Vaniyambalam


Plate 07. A tree cut down to repel the birds from a roost, Vaniyambalam

Plate 08. Fledglings fallen from a tree in a communal breeding and roosting site, Shoranur Railway station

Plate 09. Fledglings fallen from a tree in a communal breeding and roosting site, Kallettumkara Railway station

Plate 10. Roost of black headed Ibis (*Threskiornis melanocephalus*)at Malampuzha Manthakkad

Plate 11. Data collection by  focus group discussion about the roost in a housing compound


Plate 12. A well established roosting tree of House crow and Common myna cut down as part of highway widening at Mannuthy (Thrissur)


Plate 13. Threat to roosting trees (*Ficus*.spp ) standing close to the main roads

Plate 14. Bird droppings on the crops and vegetation in a housing compound

Plate 15. Tarpaulin sheet used for protection from bird droppings at IHDP colony Chiralkkal