

Avian Diversity in Paddy Ecosystems in India

By Raju Sankaran



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Front cover photograph

Whiskered Tern (*Chlidonias hybrida*)

Feeds on small fish by picking from surface, not splash diving like typical terns. Also feeds on aerial insects. Common around Wetlands, lakes and rivers.

Migratory status: migrant

Food: fish, tadpoles, crabs and odonata larvae

Feeding guild: aquatic insectivore-piscivore

Photograph © Raju Sankaran

Spot-billed Pelican (*Pelecanus philippensis*)

Often seen in a variety of deep or shallow wetlands, man-made and natural, large lakes and vast water-logged paddy fields fishing in groups.

Migratory status: migrant

Food: mainly fish in large quantity

Feeding guild: piscivore

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Introduction

Wetlands are complex ecosystems. They have been reported to prevent floods, trap sediments, reduce pollution, serve as sources of water, recharge groundwater, protect shorelines, regulate biogeochemical cycles, and support rich biodiversity. Conserving wetlands helps shield communities from water scarcity, flooding, environmental pollution, and impacts of microclimatic changes. In India, Kerala has the largest proportion of land area under wetlands among all the states. Compared with other states of the country, wetlands in Kerala are under severe anthropogenic pressure, mainly due to high population density and the uneven distribution of human settlements across the state.

Rice is classified mainly as a tropical and sub-tropical crop and is grown in over 100 countries worldwide. It is the staple food of more than half of the world's population. Rice cultivation is considered to be one of the oldest forms of intensive agriculture practiced by humans. Rice field ecosystems are rich in biological diversity and it sustain not only the people whose staple food is rice, but also the farmers whose livelihoods depend on rice fields. These ecosystems provide shelter, food, breeding grounds, and nesting sites for a wide variety of plant and animal life. They also serve as temporary refuges for many animals that visit rice fields. Some species of birds, mammals, amphibians and reptiles are among the common visitors.

Many human-made disturbances, including habitat destruction, extensive land conversion, and the use of toxic chemicals in rice fields have disrupted the ecological balance of rice ecosystems and drastically reduced biodiversity in both in quality and quantity. Changes in bird communities may reveal patterns of ecological succession during habitat change. Birds have long been a preferred taxonomic group for studying the impacts of chemical farming. They are the dominant group of vertebrates that visit rice fields. Most bird species use rice fields primarily for foraging, although some also nest there. Because rice is generally grown under flooded conditions, rice fields provide important habitats for many wetland bird species. In addition, many grassland species, as well as birds associated with human settlements, open habitats, and scrublands also make extensive use of rice fields.

Few studies have been conducted on birds that use rice fields. Weeraratne and Fernando (1984) noted that the majority of birds observed in the rice fields of Sri Lanka were aquatic species. Mist-netting catches in the Muda rice scheme in Malaysia yielded mainly granivorous birds such as weaver birds and munias during both dry and wet seasons (Abdullah and Ho, 1998). In 1991, the Department of Wildlife and National Parks of Malaysia documented 158 bird species associated with rice fields in Malaysia, including both resident and migratory birds (Burhanuddin, 1992). For Sri Lanka, the most comprehensive account of birds frequenting rice fields are given by Bambaradeniya and Ranawana (2000), who listed 92 bird species, including several migratory species, from rice fields across the island. Sundar and Subramanya (2010) reported rice fields in the Indian subcontinent are used by 351 bird species, and that 2.7 % of these species breed in rice fields. Most of research in this area has focused on birds as pests of rice.

Sundar and Subramanya (2010) have reported rice fields in the Indian subcontinent are used by 351 bird species and 2.7% of birds occurring in the subcontinent breed in rice fields.



Indian Pond-Heron (*Ardeola grayii*)

Very common in most aquatic habitats. Although typically solitary, large numbers often gather where food is plentiful.

Migratory status: resident

Food: voracious feeder on frogs and fish besides aquatic insects

Feeding guild: aquatic carnivore

Photograph © Raju Sankaran

Importance of Avian Diversity in Paddy Ecosystems

Birds as Indicator of Ecosystem Health

An indicator species is any living organism used to assess environmental conditions such as habitat loss, pollution, climate change, and ecosystem health. Birds are good indicators of biodiversity and environmental change. They are among the most visible components of biodiversity and are often the first to respond to environmental disturbances. Because they occur in a wide range of habitats and in considerable numbers, birds reflect changes in other life forms and are highly responsive and sensitive to environmental change. Changes in bird populations and habitats can therefore help guide strategic conservation planning and broader environmental management decisions. Birds can serve excellent indicators of the health of the environment and the sustainability of human activities (Bibby, 1999; Niemi et al., 1997). Habitats are continually exposed to alterations, unpredictable anthropogenic disturbances, and developmental activities, and the effects of these disturbances are often reflected in bird populations.

Contribution of Birds to Biodiversity

Birds are among the most extensively studied components of global biodiversity. They occupy a wide range of habitats, from urban to rural areas, plains to deserts, and forests to mountains. Despite being one of the best-studied groups of organisms, substantial gaps remain in our knowledge of bird distribution, abundance, and population densities. Nevertheless, birds play vital roles in ecosystems by supporting plant reproduction and seed dispersal, thereby helping maintain ecological balance. To protect these vital ecosystem services and ensure the long-term health and productivity of ecosystems, it is essential to conserve bird habitats, reduce human impacts on ecosystems, and educate the public about the importance of bird conservation. Through such efforts, we can support thriving bird populations and promote sustainable and resilient ecosystems for future generations.

Ecological Functions of Birds

Birds play many important ecological roles including pollination, seed dispersal, pest control, scavenging and predation. They are among the most diverse groups of organisms and help maintain ecological balance and functioning of ecosystems. Their value in providing ecological and economic services, however, is often underestimated due to insufficient information. Globally, bird populations are in decline, which means the ecosystem services they provide are also declining. Healthy bird populations and well-conserved habitats are therefore essential for protecting various ecological services that support both biodiversity and human well-being.

Pollination

Pollination is an essential process for the survival of flowering plants. Since most flowering plants cannot pollinate on their own, they depend on other organisms for pollination. Many small birds, such as sunbirds, flowerpeckers, and hummingbirds, play an important role in this process. Plants that are pollinated by birds are adapted in ways that accommodate their pollinators. These plants often have sturdy structures that support perching and flowers with recurved, tube-like shapes that prevent birds from becoming entangled.

They are among the most visible components of biodiversity and are often the first to respond to environmental disturbances.

Photograph: page 3, top

Blue-tailed Bee-eater (*Merops persicus*)

Elegant, slender bird of open country, frequently seen in flight or perched on exposed snags or telephone/electric wires near *jheels*, irrigation tanks, reservoirs, Canals, sandy seashores and paddy fields. Keeps close to water.

Migratory status: migrant

Food: mainly dragonflies, wasps and bees

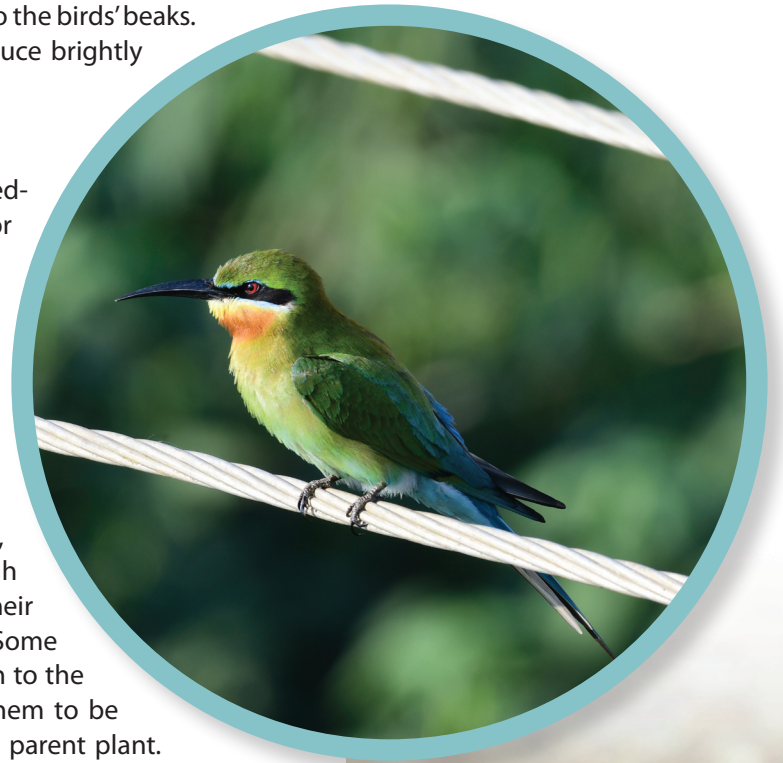
Feeding guild: insectivore-sallying open

Photograph © Raju Sankaran

The flowers are also shaped to allow easy access to the birds' beaks. In addition, bird-pollinated plants typically produce brightly coloured flowers rich in nectar.

Seed dispersal

Seed dispersal is an adaptive mechanism in seed-bearing plants that involves the movement or transport of seeds away from their parent plant to ensure the germination and survival of at least some offspring. Seeds can be dispersed through various agents or vectors. There are many ways by which seeds from a parent plant are dispersed. These include dispersal by wind, water, gravity, explosion, and animals, including birds. Animals and birds are often attracted to brightly coloured fruits. They consume the fruits, and the seeds that are not digested pass through their digestive systems and are later excreted their droppings, which can give rise to new plants. Some plants also produce seeds with hooks that attach to the fur or feathers of animals and birds, allowing them to be carried away over long distances away from the parent plant. Examples of plants whose seeds are dispersed by animals and birds include berries, dates, tamarind, fruit trees, sunflower, and tomato plants.



Pest control

One of the most significant ecological roles birds is the control of pest populations, a service that is essential to both natural ecosystems and human agricultural systems. Natural ecosystems are sustained through complex networks of interactions among various organisms. Birds, particularly insectivorous species, help maintain ecological balance by controlling populations of insects and other small organisms. Through their feeding activities, they regulate the number of these organisms and help prevent extensive damage to plant life. The pest control services provided by birds are not limited to natural ecosystems; they are equally important in agricultural landscapes, where pest species can cause severe crop damage and substantial economic losses. Studies have shown that the presence of birds in agricultural fields can significantly reduce pest populations, thereby improving crop yields. For instance, birds such as swallows, sparrows and starlings feed on insects that are harmful to crops. By reducing the need for chemical fertilisers and pesticides, birds contribute to more sustainable farming practices and help minimise potential harm to non-target species and the wider environment.

Scavenging

Scavengers are animals that consume dead and decaying organisms that have died from causes other than predation or have been killed by other predators. They play an important role in ecosystems by consuming dead animals and plant material. Decomposition and detritivores complete this process by breaking down the remains left by scavengers. Scavengers help stabilise ecosystems by recycling nutrients and preventing the accumulation of decaying organisms, thereby serving as a natural sanitation system. They also aid in energy conservation and nutrient cycling, as nutrients obtained from carcasses within the upper trophic levels can be dispersed and reused farther away. In addition, scavengers contribute to the redistribution of energy derived from carcasses and help reduce the spread of diseases associated with decomposition. Birds such as vultures, eagles, kites, crows are common examples of scavengers.



Grey-headed Swampfen (*Porphyrio poliocephalus*)

An inhabitant of marshy, vegetated freshwater bodies such as swamps, rivers and lakes; usually in small groups. Feeds often clumsily, at muddy water edges, in reeds and often on floating vegetation.

Migratory status: resident
Food: chiefly vegetarian (seeds and grains), also molluscs and insects
Feeding guild: aquatic omnivore

Photograph © Raju Sankaran

Predation

Birds of prey are apex predators and play an important ecological role in maintaining the environmental health of their natural habitats. Their hunting habits remove old, sick and weak animals from prey populations, thereby helping to keep these populations under control. Birds of prey are also indicator species, as fluctuations in their populations often reflect the overall health of the habitat. For example, populations of birds of prey tend to thrive in areas where rodent populations are high and food sources such as seeds and grains are abundant. This group includes hawks, owls, buzzards, eagles, and falcons, which are found on every continent except Antarctica. Birds of prey hunt small animals, rodents, rabbits, fish, lizards, and even other birds. They possess keen eyesight and remarkable visual acuity, along with sharp talons and hooked beaks that are well adapted for capturing prey from the air, water, or ground and carrying it away.

Agroecology to Support Avian Diversity and Vice Versa—Success Stories from Farms

Several studies have suggested that agroecology supports avian biodiversity and the use of pesticides affects avian biodiversity in the farms. A few examples of the studies are shown below.

1. A comparative study of the diversity and abundance of the avifauna in three different survey locations in Kole wetlands selected according to the difference in the use of chemicals and farming practices (from November 2011 to October 2016)

The Kole wetlands is one of the largest and highly productive wetlands in Kerala. The Kole wetland lies between 10° 20' and 10° 40' N latitudes and 75° 58' and between 76° 11' E longitudes. Spread over two districts, three municipalities, five taluks, 11 blocks and 38 panchayaths Kole Wetlands covers 13,632 ha. The name Kole refers to the peculiar type of paddy cultivation carried out from December to May and this Malayalam word indicates bumper yield. The Kole wetlands are low lying tracts located 0.5 to 1 m below sea level and remain submerged for about six months a year. These lands were formerly shallow lagoons, which gradually got silted up. Two rivers mainly bring flood waters to the area, namely Keecheri and Karuvannur which finally empty into the Arabian Sea.

The International Convention of Wetlands recently designated three wetland ecosystems in Kerala as Ramsar sites for conservation of biological diversity and for sustaining human life through the ecological and hydrological functions they perform. The Vembanad–Kole wetland is one of these priority ecosystems and is classified as a Category I site under the Ramsar Convention. Together with the Vembanad backwaters, it has been recognised as one of the largest Ramsar sites in India since 2002. The Vembanad–Kole wetland system was further designated as an Important Bird Area (IBA) in 2004, highlighting its critical role in supporting bird populations. Overall, these wetlands are exceptionally rich in biodiversity. This wetland is declared High Value Biodiversity Area since 2009. The Kole Wetlands contribute 3.2 % of the paddy cultivated area in the state.

The International Convention of Wetlands recently designated three wetland ecosystems in Kerala as Ramsar sites for conservation of biological diversity and for sustaining human life through the ecological and hydrological functions they perform.



The saucer shaped Kole wetlands with paddy lands and vegetations in the fringes and bunds can provide important habitat for diverse life forms both in flora and fauna. Wetland-dependent herbs and shrubs dominate the vegetation of Kole wetlands. True aquatic marshy forms, water ferns and algae, trees that can withstand inundation with water over long duration are also present. Numerous herbaceous plants—whether submerged, free-floating, or rooted with floating leaves—also occupy the area. Various studies conducted in the Kole wetlands have documented rich biodiversity, 140 species of plants, 35 species of aquatic macrophytes, 90 species of algae, 43 species of fishes, 20 species of mammals, 14 species of reptiles, six species of amphibians and 250+ species of birds.

The biggest threat to Kole wetlands is the use of chemical pesticides and fertilisers in farming. This study is an attempt to compare the diversity and abundance of the avifauna in three different survey locations in Kole wetlands selected according to the difference in the use of chemicals and farming practices. The survey locations selected for the study were Adat, Enamavu and Maranchery. Adat is a region where pesticide use in paddy cultivation is minimal, with only weedicides applied prior to the start of farming. About 15 years ago, organic farming practices were adopted here under the leadership of the then Panchayath President Sri Anil Akkara (Later he has been elected as the MLA of Vadakkanchery constituency). In contrast, Enamavu is a region where conventional method of farming practices is carried out characterised by the intense use of pesticide and fertilisers. This is one of the areas in Kole where two crop system is implemented. In addition, a non-cultivated area in Maranchery is also selected for the study.

Normally absolute counts are used to record the birds in wetlands. So, the same can be used in paddy fields. In paddy fields the team covered the

Black-tailed Godwit (*Limosa limosa*)

A predominant freshwater species, found in inland *jheels*, shallows and mud banks of rivers, lakes and reservoirs sometimes also in brackish lagoons, tidal waters and coastal salt pans. Rarely seen in paddy fields.

Migratory status: migrant

Food: chiefly carnivorous (molluscs and crustaceans)

Feeding guild: carnivore-mud probers and gleaners

Photograph © Raju Sankaran

entire area (as much as possible) and recorded the absolute number of birds seen there. Details of transects, name of observers, climate, habitat changes, starting time, ending time and breeding activities are also noted. The study primarily focused on the diversity and abundance of avifauna in Kole wetlands. The abundance of bird species of Kole wetland was determined by maximum method. The maximum count of each species is determined (considering every survey in each location). Maximum count in Kole = sum of maximum count of each species. Though maximum count cannot be considered as the actual count, this method is used to compare bird counts of different regions and different locations in farming as well as in non-farming seasons. When in 2009 as part of the Travancore-Cochin Ornithological survey (*Along the Trail of Salim Ali*, is the official Kerala Forest Department publication), organised by Kerala Forest department, the maximum counts were taken from Kole and Vembanad using the similar method, the counts were almost similar to the bird counts taken during the Asian Water fowl census (the census counts the bird species of the wetlands during the same day in same time by different survey teams) in the same year.

All these areas were surveyed once in a month. For the analysis the maximum count method is adopted. The present study tries to find out whether the birds have a preference over Adat region, the area of least pesticide use than the other areas in the study. The study tried to find out whether more diversity and abundance was seen in cultivated areas on Adat or Enamavu or in the non-cultivated area of Maranchery. The study results also compared the guild structure, number of endangered species, Schedule 1 species, specialists species, water birds and migratory birds in Adat, Enamavu and Maranchery regions in Kole.

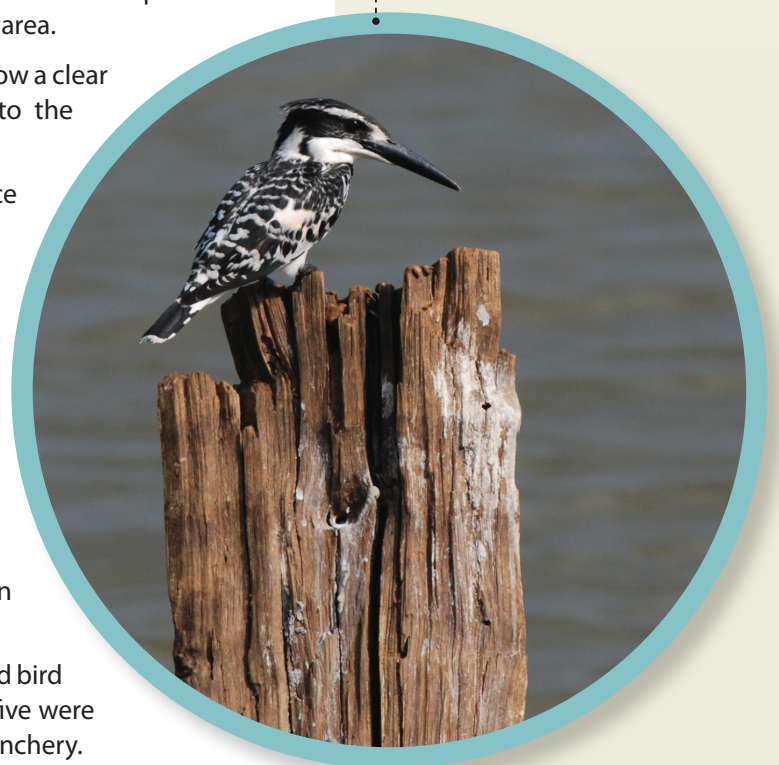
Findings from the study

- ▶ Greater bird diversity is observed in Adat, where pesticide use is relatively low, compared to Enamavu, where pesticides are used intensively, and Maranchery, a non-cultivated area.
- ▶ Similarly, bird abundance is higher in Adat, where pesticide use is relatively low, compared to Enamavu, which experiences intensive pesticide application, and Maranchery, a non-cultivated area.
- ▶ Together, these findings suggest that birds show a clear preference for the Adat region, likely due to the lower use of pesticides.
- ▶ A comparison of bird diversity and abundance across guilds in Adat, Enamavu, and Maranchery shows that the highest number of guilds occurs in Adat, followed by Enamavu and then Maranchery, in both the farming and off-farming seasons.
- ▶ Certain guilds such as mud probers and gleaners (CMP)—the waders were totally absent in the non-cultivated area in Maranchery. The numbers of Egrets, Herons, Storks (carnivore aquatic-CAQ), etc were also less in Maranchery and Enamavu when compared to their huge flocks in Adat.
- ▶ As per IUCN Red List Category, seven threatened bird species were recorded in the Adat area. Only five were recorded in Enamavu and only two from Maranchery.

Pied Kingfisher (*Ceryle rudis*)

Frequently seen perched in pairs or small groups. Often hovers over water when seeking prey. Inhabits a wide range of waterside habitats, from lakes to estuaries to mangroves.

Migratory status: resident
 Food: mainly fish, tadpoles and aquatic insects
 Feeding guild: piscivore
 Photograph © Raju Sankaran



- ▶ 18 Schedule 1 species were recorded from the Adat area. Only 12 were recorded from Enamavu and only six from Maranchery.
- ▶ A total of 14 specialist species were recorded in the Adat area, compared to 10 in Enamavu and only four in Maranchery, indicating a clear decline in specialist diversity across the gradient.
- ▶ When waterbirds and migrants birds were compared—Adat recorded 20,255 waterbirds almost double that of Enamavu (10,847) and almost nine times that of Maranchery (2,345). In the case of diversity, Adat was well ahead of Enamavu and Maranchery.
- ▶ When migrant birds were compared—Adat recorded 14,468 migrant species belonging to 43 species while Enamavu recorded only 7,457 migrant species belonging to 28 species. Maranchery was in the last place with only 2,099 migrant birds belonging to 16 species of birds only.

2. A study on the status and distribution of the avifauna in different rice field ecosystems of Kerala and Tamilnadu in the current context of extensive land conversion, habitat destruction and pesticide use

This research study was done as part of the Save Our Rice Campaign (SOR), one of the main campaigns of CREATE. Save Our Rice Campaign is an attempt to bring in and network with everyone interested in sustaining rice cultivation and culture—farmers, consumers, leaders, policy makers, media, academicians, scientists and in a broader sense—the general public. This a campaign initiated by PANAP that covered the region of Asia and it is connected and coordinated by various organisations and groups. CREATE is associated with this campaign in South India, West Bengal, Orissa and Chattisgarh.

The five Pillars of Rice wisdom projected by SOR are: Rice Culture, Community Wisdom, Biodiversity based Ecological Agriculture (BEA), Safe Food and Food Sovereignty. BEA refers to agriculture that works in harmony with the environment and local communities. It emphasises the preservation of traditional rice varieties and the protection of agroecosystems that support biodiversity. It promotes ecologically sound farming practices that are safe, sustainable, and beneficial for rice-farming communities.

This study was carried out to assess the population and diversity of avifauna in the different rice ecosystems in South India in the context of extensive land conversions, habitat change and pesticide use. The duration of the study was for one year starting from January 2013 to February 2014 and a detailed assessment was carried out of the avifauna in farming season as well as in off-farming season in the different paddy ecosystems of Kerala and Tamil Nadu.

The areas selected in Kerala and Tamil Nadu for the study are listed below:

1. Rice fields in Palakkad district, Kerala.
2. Kole wetlands (Thrissur and Malappuram Districts), Kerala.
3. Rice fields in Wayanad district, Kerala.
4. Rice fields in Thanjavoor District, Tamil Nadu.
5. Rice fields in Kanyakumari district, Tamil Nadu.

The five Pillars of Rice wisdom projected by SOR are Rice Culture, Community wisdom, Biodiversity based Ecological Agriculture (BEA), Safe Food and Food sovereignty.

Findings from the study

- ▶ A total of 257 species of birds were recorded from the study area during the farming and off-farming season together representing 61 families and subfamilies.

Kerala has a total of 484 species of birds representing 76 families and sub-families, i.e., 53 % of the birds seen in Kerala were recorded from the paddy fields of Kerala and Tamil Nadu. One hundred and seventy-five (175) species of birds were recorded from the study area with a count of 8,064 in the off-farming season representing 51 families and sub families. On the other hand, 246 species of birds representing 61 families and subfamilies were recorded from the study area with a count of 65,230 in the farming season. Most of the species were observed in the farming season. Bird abundance increased more than eight times in farming season than the off-farming season. These results show the importance of rice farming and the role of rice farming in conserving the avian diversity.

- ▶ Regions selected for the study—Wayanad, Palakkad, Kole wetlands, Thanjavoor and Kanyakumari, showed considerable differences in avian diversity and abundance in farming as well as in off-farming seasons.

- ▶ Total number of species of birds were higher in the Wayanad region and many forest species were recorded here in the paddy fields. Proximity of the paddy fields to the forest regions in Wayanad can be one reason for this. Paddy fields of Wayand recorded 162 species of birds in the farming season, 134 species in the off-farming season and 182 species as a whole. Kole wetlands in Thrissur district recorded the next highest diversity of birds with 157 species in the farming season, 84 species in the off-farming season and a total of 162 species overall. Kanyakumari ranked last, with 94 species recorded during the farming season, 52 species during the off-farming season, and a total of 95 species overall. In the case of abundance, the bird count in Kole was far ahead with 52,649 in the farming season where all the other regions recorded bird counts below 4,400. In the off-farming season Palakkad was on the top with 3,143 birds followed by Kole with 1,506 birds and Cape Comorin was on the last place with only 509 birds. In the farming season maximum bird count was recorded from Kole (80.71 %).

- ▶ Water birds are essential component of a healthy wetland ecosystem. As natural wetlands decline, water birds using agricultural lands and rice fields are increasing. The use of rice habitats by certain waterbird species is considered important for sustaining their populations (Czech and Parsons, 2002). In the present study, a total of 85 waterbird species (33% of the 257 total bird species recorded) were documented. During the farming season, 80 waterbird species were recorded out of 246 total species, while in the off-farming season, 46 waterbird species were recorded out of 175 total species. Waterbird diversity was notably higher during the farming season, and waterbird abundance increased substantially, nearly fifteen-fold compared to the off-farming season. The study also revealed considerable variation in both the number of waterbird species and the abundance of individuals across different families. There were more representations of birds in different families in farming season than in off-farming seasons. Number of waders, ducks, teals, terns, cormorants, storks, ibises, spoonbills, herons, egrets were more in farming season. Water birds belonging to different regions were analysed. It was found that the Kole region recorded the maximum number of birds—species wise and count wise in the farming season. Out of the total 80 water birds sighted from the study area, 76 were recorded in Kole. Total water bird count from the whole study area was

Western Reef-Heron (*Egretta gularis*)

Primarily a coastal inhabitant, foraging on shorelines and in estuaries but can also be found at some inland water bodies and paddy fields.

Migratory status: migrant

Food: fish, crab and molluscs

Feeding guild: aquatic carnivore

Photograph © Raju Sankaran



48,984 in farming season. Kole recorded 42,044 waterbirds. Feeding guild analysis was done on the water birds identified from the study. Birds belonging to the carnivore guild are in majority (47) among the 80 water birds in the farming season. Among the 47 species, carnivorous aquatic birds, along with carnivorous mud-probers and gleaners, constituted a substantial proportion both in terms of species richness and abundance. This reflects the capacity and ecological quality of rice fields to support a diverse assemblage of birds in large numbers.

▶ Raptors include kites, hawks, buzzards, falcons, eagles, harriers and vultures consisting of a total number of 313 species worldwide (Naoroji, 2006). India's diverse biogeographical zones support a rich diversity of raptors, with 69 resident and migratory species and a total of 104 forms, including subspecies and races (Naoroji, 2006). Raptors inhabit a variety of habitats including forests, grasslands and wetlands while a few species depend on aquatic ecosystems for food. They feed on insects, crabs, fishes, frogs, snakes, birds and small mammals. Raptors occupy topmost position in the food web, and their presence shows the abundance of prey in an area. Their presence in greater number indicates diverse lifeforms in the particular ecosystem. They are declining throughout the world due to the habitat degradation and use of toxic chemicals like pesticides. The study showed fairly good number of raptors from different regions of the study. A total of 18 species of raptors were recorded from the study area, 17 in the farming season and 11 in the off-farming season. Total count of these species was 414 in the farming season and 221 in the off-farming season. Among the total number of raptors seven were migrant species and 11 were residents. All the seven migrant species were observed in the farming season and only two migrant species were observed in the off-farming season. The migrants observed were Booted Eagle (*Hieraaetus pennatus*), Western Marsh-Harrier (*Circus aeruginosus*), Common Kestrel (*Falco tinnunculus tinnunculus/objurgatus*), Pallid Harrier (*Circus macrourus*), Greater Spotted Eagle (*Aquila clanga*), Indian Spotted Eagle (*Aquila hastate*) and Besra Sparrow Hawk (*Accipiter virgatus besra*). Brahminy Kite (*Haliastur indus Indus*) was the most abundant raptor seen in most of the paddy fields followed by Black Kite (*Milvus migrans govinda*). Booted Eagle, Crested Serpent Eagle (*Spilornis cheela melanotis*), Oriental Honey-Buzzard (*Pernis ptilorhynchus ruficollis*) and Shikra (*Accipiter badius badius*) were frequently observed. Common Kestrel and Pallid Harrier were the rarest raptors seen from the study area. Black Eagle (*Ictinaetus malayensis perniger*) and Black-Shouldered Kite (*Elanus caeruleus vociferous*) were the two habitat specialists. All the raptors recorded in the study area belong to three different feeding guild categories and six sub categories. Greater Spotted Eagle and Indian Spotted Eagle are the two threatened birds which comes under Vulnerable category as per IUCN Red list. Besra Sparrowhawk was observed in the off-farming season only.

▶ Restricted range species are those that have a total world range of <50,000 sq. km. An area where the ranges of two or more restricted range species overlap is known as an endemic bird area (EBA). Such areas are considered as important hotspots for the conservation of bird diversity. Western Ghats is an important EBA with 16 endemic species occurring here. A total of six endemic species were recorded from the study area. In the farming season all these six species were recorded. All were forest birds recorded from the fringes and edges of paddy fields in Wayanad Region. The count increased almost three times in the farming season. Out of these, Malabar Grey Hornbill (*Ocyrceros griseus*) is a Schedule 1 species as per 1972 WPA. All are habitat generalists, two are under frugivores category, two are under insectivore category, one

Raptors occupy topmost position in the food web and their presence shows the abundance of prey in an area. Their presence in greater number denotes the diversity of lifeforms in the particular ecosystem.



is a nectarivore and one is an omnivore. White-bellied Blue Flycatcher (*Cyornis pallipes*) was observed only in the farming season. The Indian Rufous Babbler (*Turdoides subrufus subrufus/hyperythrus*) was the most abundant endemic species recorded in the study area, with a total count of 16 individuals. It was observed along the edges and fringes of paddy fields across the Wayanad region. Although this forest-dwelling species does not have a direct association with paddy fields, its presence is closely linked to the variety of surrounding habitats that include these agricultural landscapes.

- ▶ As per IUCN Red List Category, 37 globally threatened species were reported from Kerala and Tamil Nadu, seven threatened bird species were recorded from the study area. All the seven species were sighted in the farming season and only two in off-farming season. The count increased 17 times in the farming season. Threatened species count was 2,308 in farming season and 134 in off-farming season. This is mainly due to the presence of water birds such as Oriental White Ibis and Painted Stork. The raptors species, Greater Spotted Eagle and Indian Spotted Eagle are the two Schedule 1 species among them. All are generalists and four are migrant species. The seven threatened species belong to two feeding guild categories and four subcategories. Two are piscivore, the rest five are carnivore.
- ▶ Total of 24 species in Schedule 1 category were recorded from the study area. Two of them were habitat specialists—Black Eagle and Black-shouldered Kite. There were eight migrant species and the other 16 species are resident species. Eighteen are raptors out of which 16 falls under carnivore category, one is a piscivore (Osprey) and two are scavengers (Black Kite and Brahminy Kite). Among the other six Schedule 1 category birds, one is an insectivore (Indian Edible-nest Swiftlet (*Collocalia unicolor*)), one is a carnivore (Eurasian Spoonbill) and three are frugivores (Southern Hill Myna (*Gracula indica*), Indian Grey Hornbill (*Ocyrceros birostris*) and Malabar Grey Hornbill). In the farming season, 23 species of Schedule 1 category birds were seen while in the off-farming season there was only 15 species. During the farming season the count of Schedule 1 category birds increased by 2.5 times. Besra sparrow Hawk was seen only in the off-farming season. Booted Eagle and Western Marsh Harrier were the only Schedule 1 category birds which are the migrant species seen in the off-farming season. Malabar Grey Hornbill is the only endemic Schedule 1 category species which was seen in the farming as well as in the off-farming season. Greater spotted Eagle and Indian Spotted Eagle were the two threatened species seen only in the farming season.
- ▶ Out of the 257 species of birds recorded from the study area, 72 are migrant birds, 183 are resident birds and two are breeding visitors. There are four threatened species—Black-tailed Godwit (*Limosa limosa limosa*), Greater Spotted Eagle, Indian Spotted Eagle and Painted Stork among the migrant species. There are eight Schedule 1 category species. A part of the population of six migrant species shows a resident behaviour. Similarly, a small population of resident species show a migrant bird behaviour, two such species were recorded from the study area (Common Kestrel and Oriental Honey-Buzzard). The migrants species belong to six different feeding guilds. Two breeding visitors were recorded in the study area but only in the off-farming season—Indian Cuckoo (*Cuculus micropterus micropterus*) and Pied Crested Cuckoo (*Clamator jacobinus*). Pied Crested Cuckoo is known as the bird of the monsoons. A total of 15 birds were counted from eight different survey locations in Thanjavoor (6) and Kole (2). In Thanjavoor in all the paddy fields where Pied Crested Cuckoos were seen, they

All the seven species were sighted in the farming season and only two in off-farming season. The count increased 17 times in the farming season. Threatened species count was 2,308 in farming season and 134 in off-farming season.

were very active both physically and vocally and they were moving with small groups of White-headed and Jungle Babblers.

- A guild is defined as a group of species that exploit the same class of environmental resources in a similar way. This term groups together species without considering the taxonomic position that overlap significantly in their niche requirements. Guilds can be useful tools for biologists in planning impact studies.

According to Simberloff and Dayan (1991), the role of foraging method is to be emphasised because of its potential importance in affecting the differences in resource use. Changes in habitat structure may influence habitat selection and foraging efficiency of all birds, one of the most notable impacts has been the disproportionate effect within different foraging guilds.

In the present study the feeding guild of all the 257 species observed were classified into eight main categories based on their food habits and then again categorised into 31 different feeding guilds based on their habitat association, habitat selection, resource use, niche requirements, foraging methods and behaviour. Kerala has a total of nine main categories and 32 subcategories. The only missing category was Pelagic (PEL). The insectivore category was on the top with 88 species followed by carnivore category with 77 species. While comparing the guild structure of the avifauna in farming and off-farming season, there were noticeable differences between the diversity and abundance of birds in certain feeding guild categories and subcategories. In the main categories the number of species in the carnivore group doubled in the farming season. On the other hand, the bird count increased almost 12 times. Similarly, the number of species in the insectivore group increased 1.37 times in the farming season while the bird count increased by 7.5 times. There was not much difference in diversity and abundance in frugivore, granivore, nectarivore and scavenger groups. But the bird count in omnivore group increased 12 times and the bird count in piscivore group by 16 times in the farming season. The increase in the number of piscivore species clearly indicates the richness of fish diversity and abundance in the region especially in Kole region. The role of rice farming from these data are apparent in preserving the inland fish wealth.

Baya Weaver (*Ploceus philippinus*)

Known for its nest—a long hanging nest made of grass with a bulbous chamber and a narrow tubular entrance. Occur as flocks, particularly in breeding season.

Migratory status: resident
Feeding guild: granivore-insectivore

Photograph © Raju Sankaran

3. Agro Biodiversity Restoration Programme— The Padetty experience

The Agro Biodiversity Restoration Programme (ABRP) was a three year long (2008–2011) project, started by KSBB (Kerala State Biodiversity Board) in the Padetty village under the Erimayoor Grama panchayath of Palakkad district. Consequent to the declaration of the Organic farming policy Strategy and Action plan of Kerala State in 2008, the KSBB was keen in starting an experimental implementation of the policy. Padetty was a village was selected. The project was a collaborative initiative of KSBB, Erimayoor Krishi Bhavan and Erimayoor Grama Panchayat and Thanal. The ABRP intent to develop a model of biodiversity based ecological agriculture and to document and bring out changes that happens over time and to help in formulating policies that support and restore the farm diversity in Kerala. The primary objective



of the programme was to restore the degraded Agro biodiversity of the area.

Kerala Biodiversity Board decided to conduct a study on the avifauna of the 400 acres of land as part of the biodiversity monitoring programme in Padetty from November 2008. The study investigated the diversity and abundance of bird species in an agricultural village Padetty in Palakkad district, Kerala which has adopted measures towards a chemical free farming culture. The study area includes Padetty biodiversity village and the neighbouring Marakkavu paddy fields. Padetty biodiversity village extends about 400 acres of land of which 100 acres are paddy fields (organic), 50 acres are house yards and surrounding areas, and the rest of the 250 acres are forest area. The forest area includes dry deciduous forest, scrub jungle, and rocky areas.

Two 2-km transects were established through homestead yards and forest areas surrounding the organic paddy fields. To achieve the study objectives, an exhaustive species list was compiled, and the abundance of each species was estimated. Considering the topography of the study area, vegetation structure, and study duration, the encounter rate method (Bibby et al., 1998) was used to collect and analyse data from the homestead yards and forested areas. In contrast, absolute counts were conducted within the paddy fields including both organic and conventional fields.

The paddy fields were surveyed once in a month. To identify and record birds, the survey team made use of sightings and calls. The team walked slowly through the transects (speed 1 km per 1 hr), frequently stopped to detect movements in the undergrowth as well as in the canopy. Time of each of the encounters, time spent in the field (field hours) and the number of individuals of each species observed were recorded. Considering the peak activity period of birds, the surveys were conducted in between 6.30 am and 12.30 pm. The team explored the study area in the afternoon from 3.00 pm till sunset. Time and number of birds in each encounter was also noted. Details of transect, name of the observers, climate, habitat, starting time, ending time was also noted. Some special observations were also noted like nesting, behaviours and breeding details. Soaring raptors, swifts, swallows and others were recorded by watching the sky at open places or vantage points. Nocturnal birds were identified by listening to calls in the night and occasionally by accidental encounter during daytime.

Surveys were done in the project period from 2008 to 2011. A team of students from Erimayoor HSS and two volunteer students from Chittur Government College and Alathur Government College joined the surveys.

Findings from the study

- ▶ A total of 145 species belonging to 51 families were identified from the survey region. Out of these 145, only 114 species were observed during the survey hours. The analysis was done on the observed 114 species. The encounter rate of all these 114 birds was calculated. Based on the encounter rate values birds were classified into different ordinal scales to assess abundance. Spotted Dove was the most Abundant bird in the study area with the highest encounter rate of 213.51 followed by Asian Palm Swift and Red-vented Bulbul.
- ▶ In Padetty the feeding guild of all the 145 species observed were classified into eight main categories based on their food habits. They were categorised again into 30 different feeding guilds based on their habitat association, habitat selection, resource use, niche requirements,

Oriental Darter (*Anhinga melanogaster*)

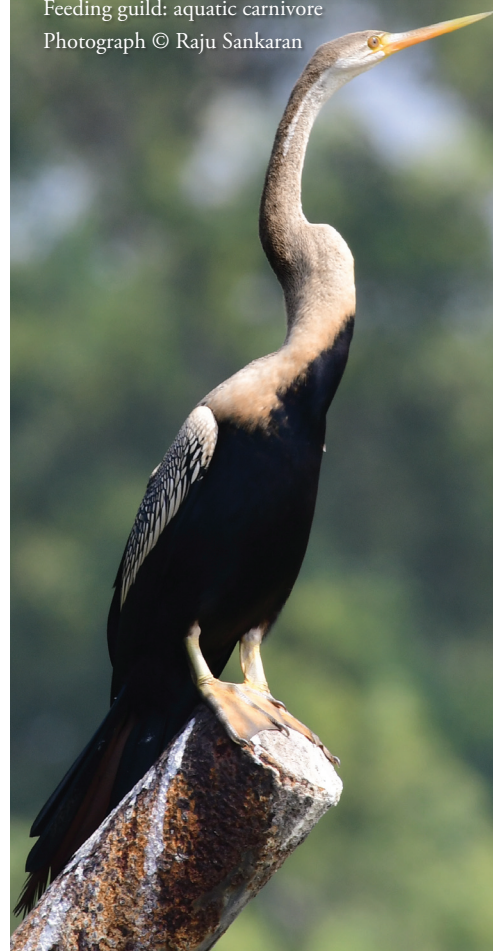
Impales fish underwater with its dagger like bill. Often perches upright on rocks and tree branches, drying itself with outstretched wings. Seen singly or in small groups in inland or coastal water bodies.

Migratory status: resident

Food: chiefly on fish, occasionally swallows too large ones.

Feeding guild: aquatic carnivore

Photograph © Raju Sankaran



Common Greenshank (*Tringa nebularia*)

Usually seen as singles or small groups.

Feeds mainly by striding in shallow water, picking, wading and sweeping with its slightly upcurved bill.

Migratory status: migrant

Food: Tadpoles, molluscs crustaceans and insects

Feeding guild: carnivore-mud probers and gleaners

Photograph © Raju Sankaran



foraging methods and behaviour. Birds in insectivore guild were the major category and this group mainly consists of swifts, swallows, woodpeckers, shrikes, cuckoos, warblers, leaf birds, drongos, bee-eaters, flycatchers, babblers and pipits. 52 species of insectivore birds were observed from the study area. The volume of insects consumed by this group must be having a tremendous impact on the ecosystem. The second largest group of birds belongs to carnivore category consisting of 33 species of birds which includes storks, bitterns, herons, egrets, owls, kites, eagles, buzzards, accipiters and others. Another major group of birds belonged to the frugivore category which includes bulbuls, orioles, parakeets, starlings, barbets etc. 23 species of birds were observed from the area in this category.

- Out of the 145 identified birds from Padetty study area 19 species belonging to 13 families were specialists and rest were generalists. Out of the 19 specialists, seven species of birds are from seven families that are typical of the open dry scrub habitat. They are Stone curlew, Small Green-billed Malkoha, Jerdon's Bush Lark, White-browed Bulbul, Syke's Warbler, White-browed Fantail flycatcher and Black-shouldered Kite. Asian Open-billed Stork feed mainly on snails in water bodies. Bronze-winged Jacana is a bird of floating vegetation of wetlands. Indian Great Reed Warbler, Black-headed Munia, Red Munia and Baya Weaver inhabit on short reeds, grass and shrubs in the edges of water bodies. These species can be assumed to be associated with paddy land. Ninety percent of the Baya Weaver population depend on rice cultivation. Yellow Bowed bulbul, Ruby-throated Bulbul, Black-naped Monarch flycatcher, Bronzed Drongo needs well wooded forest areas to survive. Among this Ruby-throated Bulbul was seen only in forest fringes. These 19 specialists were coming under different habitats ilike paddy fields, open dry scrub jungles, forest areas, short reeds, grass, and scrubs in the edges of water bodies. In short, the conservation of these habitats is very important for the survival of these specialist species.
- The migratory status of all the identified birds were also detected. Out of the 145 species observed in Padetty, 21 were migrant species, 119 are residents, four species that were resident as well as migrant species, (birds of this species are resident but a small population migrates). Indian Cuckoo is the only breeding visitor identified from the study area. A comparison of the encounter rates of migrant birds in 2009 survey shows that Blyth's Reed-Warbler is the most abundant migratory bird of the area, followed by Cattle Egret, Asian Paradise Flycatcher and Ashy Drongo. Blyth's Reed Warbler, Asian Paradise Flycatcher and Ashy Drongo are Insectivores and Cattle Egret is a Carnivore (Aquatic).
- Among threatened birds, Darter was recorded from the study area. Darter comes under near threatened category and is a piscivore.
- During the study period a total of 10 species of raptors were identified. Three of them are migrant birds—Crested Gowhawk, Western Marsh Harrier and Booted Eagle. Two raptors, Black shouldered kite and Black Eagle, that were identified from the study area were in the specialist's category. All the 10 species of raptors found in the study area are included in Schedule 1 list. Out of the 10 raptor species, eight are carnivore, Brahminy Kite is an aquatic scavenger while Black Kite is a scavenger. Most of the raptor sightings were from paddy fields and they mainly hunt Egrets, Pond Herons, small birds, reptiles and mammals.
- Bulbuls are one of the dominant birds in southern Western Ghats at any habitat or altitude. Five species were identified from the study area. All these bulbuls are frugivore/insectivore species, where they mainly eat fruits but also feed on insects. The White browed bulbul is a dryland

Indian Great Reed Warbler, Black-headed Munia, Red Munia and Baya Weaver inhabits on short reeds, grass and shrubs in the edges of water bodies. These species can be assumed to be associated with paddy land. 90 % of the Baya Weaver population depend on rice cultivation.

specialist, while Yellow-browed bulbuls and Ruby-throated bulbul are specialists forest species. The Red-whiskered Bulbul is a widespread generalist, which can be seen in almost all types of habitats. Though a generalist Red-vented Bulbul has an affinity towards dryland habitat.

- ▶ The breeding of 39 species was observed from the study area. Out of these 21 species depend directly on the rice fields for breeding. The breeding records include sightings of nests, nest with eggs, nest making, nest with chicks, carrying nesting materials, courtship flights/display/song, mating, juveniles, feeding chicks, and carrying food. Indian Grey Hornbill which has a limited patchy distribution in Kerala breeds on a palm tree in the Padetty study area. The courtship display of raptor—Oriental Honey Buzzard, Crested Serpent Eagle, Black Eagle and Crested Goshawk were observed during the survey. One active nest of Oriental Honey Buzzard was recorded from the forest area and nest of Indian robin was found on the ground at the edge of the paddy fields. In February eggs were found in the nest and in March the adults were seen feeding the chicks.
- ▶ A total of 63 birds were identified from both the paddy fields (conventional and organic together) including the birds that were seen and heard at the edges of the paddy fields. The survey team could find an apparent difference in the number of birds in species wise as well as count wise from both the fields. A total of 55 bird species were identified from the organic field whereas the number of species from the conventional field were only 39. When average birds in the fields were taken, a 229.5 were from the organic field and 143.25 were from conventional field. There were 24 species of birds found specifically in the organic field. Only eight species were found from the conventional field and its edges that were not found in the organic paddy field which were the Small Blue Kingfisher, Stork-billed Kingfisher, Indian Roller, Paddyfield Pipit, Black-headed Cuckoo-Shrike, Rufous-backed Shrike, Purple-rumped Sunbird, Black-headed Oriole. The most common birds found in the organic field (11 species) were Little Egret, Cattle Egret, Indian Pond-Heron, Spotted Dove, Small Bee-eater, Red-vented Bulbul, House Crow, Common Myna, Black Drongo, White-breasted Kingfisher, Baya Weaver and those found most common in conventional field (six species) were Cattle Egret, Indian Pond Heron, Asian Palm-Swift, Common Myna, House Crow and White-headed Babbler. It is very interesting to observe that the Spotted Dove and Red-vented bulbul which were abundant species in Padetty study area (organic) are not a common species in conventional paddy field.
- ▶ Forty six species of birds found directly depending on water. The population of water birds are closely related with the agricultural pattern and agricultural practices.

The wetlands and paddy lands in the country are increasingly facing several anthropogenic pressures. A rapidly expanding population, large scale changes in land use and land cover, burgeoning development projects, and the improper use of watersheds have all contributed to the substantial decline of wetland resources.

Threats and Conservation Issues

The wetlands and paddy lands in the country are increasingly facing several anthropogenic pressures. A rapidly expanding population, large scale changes in land use and land cover, burgeoning development projects, and the improper use of watersheds have all contributed to the substantial decline of wetland resources. The absence of reliable and updated information on the extent of wetlands, their conservation value, and their socioeconomic importance has greatly hampered the development of policy, legislation and administrative interventions by the state.

Paddy cultivation in Kerala has witnessed a steady decline since the 1980s. The sharp decrease in both the area under paddy cultivation and the quantity of the rice produced in the State has had significant. The lush green paddy is one of the most captivating features of Kerala's landscape. The area under paddy cultivation increased substantially during the first fifteen years after the State's formation—from 760,000 hectares in 1955–56 to 880,000 hectares in 1970–71. In 1965–66, rice accounted for the highest share of gross cropped area in Kerala (32 % of the total). However, from the 1980s onward, the area devoted to rice cultivation steadily declined—from 850,000 hectares in 1980–81 to 560,000 hectares in 1990–91, 320,000 hectares in 2001–02 and 230,000 hectares in 2007–08. Today, rice ranks only third among Kerala's agricultural crops in terms of cultivated area, far behind coconut and rubber.

Reclamation of land and changes in land use pattern are the most serious threats faced by the paddy fields under study in Kerala. These paddy fields are being converted into coconut, areca nut, banana cultivations and cash crops plantations, at an alarming rate. Real estate ventures that continue to encroach upon these areas also pose a major threat to the wetlands. Rapid urban sprawl has already consumed many of the smaller wetlands, giving way to huge constructions. In many places following of land is becoming very common. Brick kilns are widespread in many parts of the study area, especially in Thrissur South Kole. The use of toxic pesticides and fertilisers in the paddy fields, and their impact on various life forms, is another issue that must be addressed with serious concern. Sand mining also poses a significant threat. All these factors have resulted in the loss of biodiversity habitats, particularly those of birds that depend on the paddy field ecosystem. Bund roads, highways, and bridges that crisscross paddy fields, along with new development projects that are either being implemented or planned, constitute major threats to the sustainability of the paddy field ecosystem.

In the previously mentioned comparative study on the diversity and abundance of avifauna across three survey locations in the Kole wetlands, selected based on differences in chemical use and farming practices (conducted from November 2011 to October 2016), large quantities of weedicides and herbicides were used to eliminate weeds. The vegetation along the bund roads passing through the fields was entirely cleared through the application of weedicides. Although most farmers are aware of the harmful health effects of pesticides, awareness regarding the dangers posed by weedicides and herbicides remains limited. Many farmers consider these chemicals an easy solution for weed control and labor shortages. This practice is widespread across the fields, including those officially declared as "organic". Such practices have adverse impacts on bird communities, particularly on their nesting and foraging activities.

Poaching of birds is a major problem in paddy fields, especially in vast wetlands such as the Kole fields, where birds often congregate in large numbers. In several areas, the Kerala State Forest Department has installed signboards prohibiting poaching. However, the lack of regular monitoring has rendered these measures largely ineffective. Incidents of poaching continue to be repeatedly reported in the Kole wetlands. In some areas pesticides are illegally used for poaching. These chemicals are used to capture birds and fish, which are then sold in nearby local hotels and toddy shops.

Oriental Darter (*Anhinga melanogaster*)

Impales fish underwater with its dagger like bill. Often perches upright on rocks and tree branches, drying itself with outstretched wings. Seen singly or in small groups in inland or coastal water bodies.

Migratory status: resident
Food: chiefly on fish, occasionally swallows too large ones

Feeding guild: aquatic carnivore

Photograph © Raju Sankaran



Such activities widen the extent of ecological damage in ways that often go unnoticed by the general public. Apart from a few sporadic surveys, no comprehensive studies have been conducted on the impacts of pesticides on birds and other life forms in wetlands and paddy fields anywhere in India.

Burning has become a common practice in wetlands. During the farming season, the edges of bund roads and fringes of paddy fields are often burned to enable farmers to move freely and transport agricultural materials more easily. However, the natural vegetation along these bund roads serves as an important breeding habitat for bird families such as Ardeidae, Rallidae, Ploceinae, and Estrildinae. Fire also disrupts birds feeding in the paddy fields. During the study period, large groups of storks, ibises, and egrets were observed flying away to escape fire and heat.

The spread of exotic vegetation is another major threat to paddy field habitats. The two major invasive weeds found in the paddy fields of Kerala are *Eichhornia crassipes* and *Salvinia molesta*. These invasive species not only disrupt the growth of native flora but also contribute to fish mortality. Such ecological changes, in turn, adversely affect bird life. Moreover, the excessive growth of exotic vegetation in canals, streams, and other water bodies obstructs water flow. This vegetation also negatively affects crop quality and agricultural yield.

Call For Action—What Can Be Done?

In the world almost all the bird ecosystems have already been fragmented. The number of habitat specialist birds are drastically declining and at the same time the number of generalist birds which can survive in hot climate are increasing. The wetlands and swamps converted for agricultural lands, human habitation and industrial development are actually habitats of specialist birds. Yellow-wattled lapwing, Stone Curlew, Grey Francolin, Quails and Larks are at the edge of local extinction. The destruction of wetlands and paddy fields for mal-development is the main environmental problem in South India. Farming systems and crop practices have sustained for hundreds of years as part of culture. Birds surviving in these ecosystems are adjusted and adapted to this environment and yet their survival is under threat. The unusual congregation of huge numbers of water birds in protected wetlands may indicate destroyed wetland habitats elsewhere. The use of chemical pesticides and fertilisers have drastically affected the bird community. The news about birds dying because of chemical poisoning are now common in newspapers. In this context appropriate remedial measures should be taken to conserve birds and their precious habitats.

The following are some suggestions.

- Most of the wetlands in India are not under protected area network, although some are designated as Ramsar sites of international conservation importance. However, these wetlands are in various stages of ecological degradation. As many of these wetlands are on private lands or used by the community for common uses like fishing, their protection will only be possible with

Restrictions in the usage of toxic chemicals such as pesticides and fertilisers will also contribute a great deal for the conservation of the wetlands.

Asian Openbill (*Anastomus oscitans*)

Got its name from a distinctive gap in the bill. Inhabit wetland habitats including shallow marshes, flooded agricultural fields and lakes. Usually wades slowly through shallow water.

Migratory status: resident
Food: molluscs, frogs, fishes and other small animals
Feeding guild: aquatic carnivore
Photograph © Raju Sankaran



the active participation of local people and Grama Panchayats. Hence many of the wetlands could be declared as Community Reserves, as has been done in the case of Kadalundi in Kerala. One good example is the Koondakulam in Tamil Nadu. Restrictions in the usage of toxic chemicals such as pesticides and fertilisers will also contribute a great deal for the conservation of the wetlands.

- Strict enforcement of laws/policies should be ensured to conserve wetlands and paddy fields. Kerala State has a powerful law for Wetland conservation and one powerful policy for organic farming.
- Like other wetland ecosystems, paddy fields are highly fragile, and even minor disturbances can have significant ecological impacts. Although paddy fields directly influence the diversity of rice-field ecosystems, the broader extent of these impacts remains poorly understood. There is a clear need for regular monitoring of wetlands to identify emerging threats and conservation challenges. In addition, detailed and in-depth studies are required on the various pressures affecting paddy fields and their consequences for avian diversity as well as other forms of biodiversity.
- The study on avian diversity and abundance in the wetlands will reveal the close relation between the bird life and rice farming and the role of avifauna in maintaining the quality of the rice fields and how the biodiverse rich rice fields are supporting avian diversity. Richness in the bird life of the paddy fields also reveals the richness of other form of life forms, species in the lower strata of food web. The research studies will strengthen the existing paddy land conservation laws and will help in covering loop holes and also will help in strategic planning for biodiversity conservation.
- The results of this study can be used to recommend biodiversity-based ecological agriculture as a model for future farming systems. They can also serve as a foundation for policy-level interventions aimed at strengthening ecological farming practices. Such approaches would benefit the entire rice ecosystem, including farming communities and associated biodiversity. A deeper understanding of ecosystem functions within rice fields and their interrelationships would emerge from this assessment. Overall, the findings can inform policies that promote ecological farming while conserving paddy-field biodiversity, thereby supporting a more sustainable, biodiversity-based rural economy. This would also enable farmers to design and manage their fields based on ecological principles, showing the importance of detailed biodiversity studies in paddy landscapes.
- Research on selected indicator species of birds is also recommended. These species should be regularly monitored, with focused studies on their breeding biology and population dynamics, and their habitats should be effectively protected.
- In addition, socio-economic surveys are needed to assess the true value of wetlands, which would further strengthen efforts toward their conservation.
- Tourism can be used as an opportunity for the conservation of birds and their habitats. From a conservation perspective, it is important to balance the promotion of tourism with its proper regulation and management. Well-managed tourism can serve as a platform to raise awareness among visitors about the importance of conserving wetlands and bird habitats. A considerable number of international naturalists and birdwatchers visit wetlands and paddy fields each year, and many maintain species lists from their observations. Encouraging them to share copies of these checklists could provide a valuable long-term dataset. Over time, such information could be analysed to detect trends in bird populations and community composition, thereby contributing to regular monitoring and informing policy decisions for bird conservation. While farm tourism and wetland tourism are becoming increasingly popular in India, they can also pose threats to waterbirds if not properly managed. Therefore, such activities should be carefully regulated and limited to sustainable levels to ensure minimal disturbance to bird habitats.

Plain Prinia (*Prinia inornata*)

Common in various habitats, especially farms and wetlands. Usually solitary or in pairs skulks in grass and shrubs, forages by hopping flies low over vegetation.

Migratory status: resident

Food: insects

Feeding guild: insectivore-grassland and shrubbery

Photograph © Raju Sankaran



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Eurasian Spoonbill (*Platalea leucorodia*)

Found in wetlands with shallow water including tidal flats. Feeds by sweeping its bill side-to-side.

Migratory status: migrant
Food: frogs, small fish, crustaceans, aquatic insects, occasionally lizards and scorpions

Feeding guild: aquatic carnivore

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