CHAPTER II

REVIEW OF LITERATURE

2.1 Wetland studies

Wetlands are among the most productive life support systems in the world. Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water (Cowardin et al., 1979). Maltby (1986) described wetland as water logged wealth. Wetlands are known as ‘biological super markets’ because of the extensive food chain and rich biodiversity they support, providing unique habitats for wider range of flora and fauna (Mitsch and Gosselink, 2000). Keddy (2000) described wetland as a shallow water community dominated by truly aquatic plants growing in and covered by at least 25cm of water.

Status of wetlands of the world was reported by Maltby and Turner (1983). Cowardin et al., (1979) gave a clear idea on the classification of the wetlands and deep water habitats of United States. According to them 6.4% of total land surface of world is wetland (8.6 million km²). Over the past 100 years 50% of the wetlands have been lost all over the world.

During the 20th century European wetlands were reduced to 10 to 20% of their previous extent, with reclaimed land converted mainly to agricultural production (Finlayson et al., 1992). Rice fields may constitute a valuable surrogate habitat only for a few species or for specific periods of their life cycle, during migration or wintering (Sanchez et al., 2010, Lourenco and Piersma, 2008). Rice fields are highly variable habitat, both between seasons and within seasons. During rice growing period rice fields undergo marked changes as a consequence of agricultural practices (Longoni, 2010).

Studies of Indian wetlands were conducted after the establishment of Ramsar convention in 1971. (Odum, 1983b) observed that wetland habitat, coastal and freshwater marshes supported the largest population of birds. According to the Directory of Indian Wetlands, Wetland in India occupy 58.2 million hectares including areas under paddy cultivation (Prasad et al., 2002). It is estimated that fresh
water wetlands alone support 20% of known range of biodiversity in India (Deepa & Ramachandra, 1999)

Kaul and Handoo (1990) made some recommendations on the ecology and management of some typical wetlands in Kashmir. Patel et al. (1990) studied the ecology and management of wetland of Khedha District, Gujarat. Singh (1999) studied the ecology of Harike wetland, the biggest wetland of North India and recommended ways for its management.

Vijayan (1991) reported on various management issues affecting the ecology of Keoladeo National Park (KNP), Bharatpur and gave recommendations for its proper management. The study also recommended for launching an Integrated Development Programme for the management of the Park including the maintenance of water bodies inside and outside the park. Abbasi (1997) studied the ecology of wetlands of India. Mukherjee et al. (2002) studied the ecological requirements of waterfowl in man-made reservoirs in Khedha District Gujarat, with a view towards its conservation, management and planning. The study also stressed on the necessity of the bank vegetation that supplied cover and food to the birds.

The wetlands of Kerala have been studied by Abdul Azis (1990) who made a detailed study on certain wetland ecosystems in Kerala. Nayar and Nayar (1997) noticed that among the various states of India, Kerala stands first in India, in having the largest area under wetlands. Various threats faced by wetlands of Kerala and its impact and need for their conservation were studied by Nair and Varma (2002).

A geomorphological classification of wetlands in Kerala was given by Nair and Sankar (2002). According to them the total wetland area in Kerala consists of 1,27,930 hectares and 217 units. Coastal natural wetlands comprise 67% of the total wetlands in Kerala and Inland wetlands comprise only 25.72%.


Very few studies were conducted in kole wetlands based on habitat changes and seasonal variations. Johnkutty & Venugopal (1993) described general account and agriculture of kole wetland. John et al. (2010) studied the emerging trends of land
use practices and its implications on the species diversity of Muriyad wetlands within
the Vembanad-Kol Ramsar site.

James and Anitha (1987) studied the hydrology of basins draining into the
Vembanad-Kole wetland system. Sreekumar and Thomas (2004) studied the
ecological changes of Muriyadu Kayal within Vembanad-Kole system due to human
intervention. John (2010) studied the impacts of land use changes on the ecology of
kole wetland. Nameer (2010) compiled the various aspects of biodiversity research
works done in kole wetland and made a list of plants, fishes, amphibians, reptiles,
birds and mammals. Nameer and Balachandran (2010) studied various aspects of Kole
wetlands and gave recommendations for the conservation and management of Kole
wetlands.

2.2 Physico – Chemical Parameter Studies of Wetlands

A number of studies related to various Physico-chemical and biological
aspects of wetlands were carried out in India. Some of the important contributions
carried out during the last two decades include works of Ali and Vijyan (1986),
Bhuneya and Mohanty (1990), Ahmad and Singh (1990), Seshavatharam (1990),
Vijayan (1991), Akram (1992), Lokeshwari and Chandrappa (2005), and Panigrahi et
al. (2007).

Physico-chemical properties of water in Keoladeo National Park was studied
studied various physico-chemical properties in relation to faunistic composition of
Ansupa lake, Orissa. Various physico-chemical features of Kawar lake, a natural
wetland in Bihar had been discussed in detail by Ahmad and Singh (1990). Seshavatharam et al. (1990) studied various Physico-chemical properties of water in Kolleru lake, Andhapradesh. Akram (1992) studied the physical and chemical
environment of Wular lake, Kashmir. Lokeshwari and Chandrappa (2005) studied
extensively the physico-chemical properties of water of Bellandur lake, Bangalore
and noted that the dissolved oxygen was considerably less and thereby made the lake
an ecologically inactive one. Panigrahi et al. (2007) studied the anthropogenic impact
on water quality of Chilka Lagoon in Orissa using statistical approach.

The studies related to various physico-chemical characteristics of water in
wetlands of Kerala were also carried out. Remadevi and Aziz (1996) studied the
physico-chemical parameters of Ashtamudi estuary, Kerala. Sreejith (1996) studied physico-chemical parameters of Sasthamkotta lake. Vasu et al. (1998) studied physico-chemical parameters of Kattampilly wetland. A few studies on the water quality of southern part of Thanneermukkam barrage including bacterial pollution of the wetland system were carried out (Thomas et al., 2001, Padmakumar et al., 2002, Abhirosh et al., 2008). Radhika et al. (2004) conducted physico-chemical studies of water samples of lake Vellayani in Thiruvananthapuram District, and found that the temperature, pH and dissolved oxygen were higher during the monsoon seasons.

Krishnakumar (2002) studied physico-chemical properties of water of Vellayani lake, Thiruvananthapuram. Prakasam (1991) studied physico-chemical characteristics of water of Sasthamkotta wetland. Nirmala and Shoba (2003) studied physico-chemical properties of Chalakudy river. Nikhil and Azeez (2009) studied the spatial and temporal changes of water chemistry of Bharathapuzha river and reported that the temporal variation of water chemistry was mainly due to land use changes in the catchment areas as well as impact of dams on river.


Munawar (1970) reported that in smaller water bodies the water temperature quickly reacting to atmospheric temperature would be always lower than atmospheric temperature. Klein (1957) obtained a relation between the water temperature with dissolved oxygen and reported that the rise of water temperature in streams leading to decline of oxygen was due to increased microbial activity.

Studies on the effect on pH on aquatic system have been carried out by various workers. According to Patrick and Mikkelson (1971) the major factors governing pH
of soil include concentration of reduced iron, manganese, hydroxides, carbonates, carbonic acid and humic acid.

Minns (1989) considered $P^H$ as an indicator of overall productivity that can cause habitat diversity. A significant correlation of $P^H$ was noticed with species richness of phytoplankton, invertebrates, fishes and amphibians and water birds, which depend on these organisms. Verma et al. (2006) observed that the hydrogen ion concentration regulates most of the biological processes and biochemical reactions in the wetland. The seasonal variation of $P^H$ and nutrients of different wetland systems of Kuttanad were also carried out by Sylas (2010).

Dissolved oxygen is an index of physiological and biological processes in water. It is moderately soluble in water and its solubility decreases with increase in temperature. According to Hutchinson (1967) the important biological processes associated with oxygen distribution were photosynthesis, respiration and decomposition.

Seema (2002) estimated the amount of dissolved oxygen in the water samples of fragile ecosystem habitat of Salim Ali Bird Sanctuary, Thattekkad. Sreekanth et al. (2004) estimated a range of dissolved oxygen in different water samples analysed from Pallom region in Kuttanad, Kerala. Kaladharan et al. (2005) noticed in Periyar river that the abundance of phytoplankton and submerged aquatic plants liberate high amount of oxygen into the Periyar river system.

Water depth is an important factor in determining species occurrence (Kushlan 1989). Summerfelt (1971) reported that water depth was primarily responsible for the species community structure and diversity in the wetland and that it could influence significantly their use by water birds. Water depth influences the accessibility of the prey to birds. According to Frederickson and Taylor (1982) shallow flooded croplands provide habitat for migratory shore birds. Watnabe and Roger (1985) worked out the importance of flooding in improving paddy soil fertility through decomposition. According to them flooding of soil benefits the rice plants by eliminating the water stress, regulating the micro climate, controlling weeds and thus provides a favourable physical, chemical and microbiological environment within the root zone.

Bourne (1987) reported that the aquatic bird diversity was directly related to the percentage of area flooded and its water depth. According to Karen and Johnson
precipitation changes and temperature had a greater impact on water level. Weller (1994) compared avian species composition under different water conditions and observed that the Bitterns, tricoloured Herons and White Ibis, which feed in water, were common during low water level habitats but less frequent in the drier year and more terrestrial species such as Black necked Stilts and Meadow Larks were frequent in drier condition.

Watanabe and Roger (1985) worked out the importance of flooding in improving the paddy soil fertility through decomposition. According to them flooding of soil benefits the rice plant by eliminating water stress regulating micro biological environment within root zone. The relationship between moist soil impoundments and bird population had been reviewed by Fredrickson and Taylor (1982) and Yates et al. (1993). The anaerobic nature of paddy soil and adaptations of plants which grow in flooded soil had been described by Rowell (1994).

2.3 **Wetland Macrophytes**

Studies on aquatic macrophytes had attracted the attention of botanists since early 20th century. A wide variety of macrophytes occurs naturally in wetland environments. *Aquatic Plant Book* (Cook, 1990) and *Aquatic and Wetland Plants of India* (Cook, 1996) were the major contribution to the study of macrophytes in India. Aquatic macrophytes play an important role in the food chain of an aquatic ecosystem. The macro invertebrates were usually associated with the macrophytes. Subramanyam (1962) described the morphology and distribution of 117 taxa of aquatic angiosperms in India. Sculthrope (1967) studied the structure and biology of hydrophytes. Studies on aquatic plant- macro invertebrates association was conducted by Krull (1970) and reported that aquatic macro invertebrates were more abundant in the vegetated area than non-vegetated area. Wetland vegetation often act as nutrient pump, taking up nutrients from the soil, translocating them to shoots and releasing them on marsh surfaces when plant die. (Klopatek, 1978).

distribution and production of macrophytes in different wetlands of 13 states including Kerala.

A series of studies on aquatic macrophytes were carried out in Keoladeo National Park, Bharatpur, Rajasthan. The important contributions of aquatic macrophytes of Keoladeo National Park, Bharatpur include the works carried out by Ali and Vijayan (1986) and Vijayan (1991). Bhupathy (1991) and Urfi (1993) correlated the biomass of aquatic vegetation with the increased number of certain herbivorous bird species (such as Moorhen and Coot). Ramachandran and Vijayan (1995) reported that Bronze winged Jacana and Pheasant tailed Jacana showed some preference to certain wetland plants in Keoladeo National Park. Prasad et al. (1989) studied in detail the flora and wetland angiosperms of Keoladeo National Park, Rajasthan.

Seshavatharam (1990) studied the aquatic macrophytes and documented aquatic macrophytes and their standing Biomass in Kolleru Lake, Andrapradesh. Lavania et al. (1990) compiled a list of aquatic and wetland plants of Indian subcontinent and included 470 taxa from aquatic and semiaquatic habitats. Nirmal Kumar et al., 1991 studied seasonal variations in the macrophytes of Ratheshwar and Tarapur ponds in Central Gujarat. The total number of aquatic plant species exceeded 1200 and a partial list of animals of wetland system was given by Gopal (1995). Rout and Durani (1993); Kar and Sahu (2002) and Haridasan and Ravi (2008) conducted studies on aquatic macrophytes in Chilika Lake. Kakavipurae and Yeragi (2006) conducted studies on aquatic macrophytes of Khativali-Vehloli Lake, Shahapur District, Thane, Maharashtra.

Studies on the aquatic flora of Kerala were carried out by Schelpyl (1961) Thomas (1976). Manilal and Sivarajan (1975) published a check list of hydrophytes of Northern Kerala (Malabar). Cook (1996) listed 352 aquatic and wetland plants from Kerala, of which 15 species were endemic to Kerala. Sunil (2000) studied the flora of Alapuzha district and listed 1082 species of plants of which 202 species were aquatic and semi aquatic. Centre of Environment and Development (CED, 2003) compiled a total of 725 vascular plants from major wetlands of Kerala which includes 8 Pteridophytes and 717 Angiosperms. These plants belonged to 81 families. Among these 503 species were confined to wetland and remaining were seen in wet and moist areas around wetlands. Centre of Environment and Development (CED, 2003) also
studied the plants of entire Vembanad-kole, Ramsar site, and recorded a total of 347 plants which included 26 trees, 14 shrubs, 21 climbers, 273 herbs and 13 mangroves.


Seema (2002) studied the seasonal variations in the biomass of aquatic macrophytes of Salim Ali Bird Sanctuary, Thattekkad, Kerala. Floristic studies in Ambalamedu, an industrial belt of Kerala was conducted by Rashmi et al. (2010). Rachana and Azeez (2010) studied floral diversity of Kottuli wetland, Kozhikode and reported a total of 219 species (terrestrial and aquatic) belonging to 75 families and 176 genera.

Thirty three species of aquatic plants were identified from the rice fields of Kuttanad by Thresiamma et al. (1990). *Echinochloa* species, *Monochoria vaginalis* and *Oryza rufipogon* were observed as major weeds in puncha crops of Kuttanad by Abraham et al. (1990). Sylas et al. (2008) studied aquatic macrophytic diversity of Kuttanad wetland ecosystem. Sylas (2010) studied in detail the flora of Kuttanad wetland ecosystem and documented a total of 130 species of aquatic macrophytes with 123 species of angiosperms belonging to 38 families and 7 species of pteridophytes belonging to six families. The diversity, seasonal distribution, ecology and biomass production of native and exotic plants in Kuttanad wetland ecosystem, Kerala were also studied.

(2010) conducted a rapid biodiversity assessment in kole wetlands and reported a total of 114 species (41 families) of plants including 4 aquatic ferns.

2.4 Fish Fauna

A comprehensive and authoritative account on the fishes of Indian region was published during 1889 by Day Francis. Day included 1,418 species of fishes found in territories of present Republic of India, Bangladesh, Mayanmar and Sri Lanka. The other important contributions to the Indian fish fauna were made by Hora (1923), Tilak (1987), Talwar (1995), Jayaram (1981) and Talwar and Jhingran (1991) supplemented information on the Inland fish fauna of India.


Studies on freshwater fishes of Kerala were conducted by Pillai (1929) and listed a total of 369 species belonging to 74 families. John (1936) studied the freshwater fishes of Travancore and listed 73 freshwater fishes along with its local name. Jayasree et al. (1993) conducted a survey of indigenous freshwater fish fauna in the coastal region of Kerala. Shaji and Easa (1995) studied freshwater fish diversity in Wayanad, Kerala, and reported 59 species, of which 25 species were endemic to Western Ghats. Gopi (2000) reported a total of 207 species of fishes from Kerala. Raju (2002) studied the habitat and distribution of hill stream fishes of Southern Kerala and compiled a list of 127 species freshwater fishes with notes on distribution of endemic and endangered species.

fauna of pokkali wetlands, Ernakulam district, Kerala and reported 50 species of fishes.

Biju and Sushama (2000) reported a total of 88 species of fishes belonging to 15 orders, 41 families and 64 genera from Bharathapuzha river, Kerala. Raju et al. (2007) reported Ichthyofauna of Periyad river.

Thobias (1973) studied the ecology, systematics and bionomics of freshwater fishes in the paddy field and rivers of Thrissur district, Kerala. Antony (1977) studied the systematics ecology, bionomics and distribution of hill stream fishes of Thrissur district. Inasu (1993) reported the occurrence of freshwater puffer fish *Tetraodon travancoricus* from the inundated brickyards at Pudukad, Thrissur. Inasu (1991) studied the systematics and bionomics of inland fishes of Thrissur district, and reported 98 species of fishes from the study area. Kader (1993) reported 22 species of freshwater fishes from Karuvannur river, Thrissur district. Ajith et al. (1999) reported 98 species of fishes including 10 species of endemic fishes to Kerala and five new species from Chalakudy river, Thrissur district. Raju (2006) reported a total of 112 species of freshwater fishes belonging to 57 genera of 26 families of 10 orders from the rivers flowing through Thrissur district.

Bijoy and Unnithan (2004) reported 38 species of fishes from Vembanad-Kole wetland.


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2.5 Avian Fauna

Avian community is a important component of a wetland ecosystem. Birds are one of the best indicators of health of an ecosystem. They are highly mobile and easily observed indicators of change in the environment (Holmes et al., 1986). Most waterfowl species are near or at the top of food chain and are thus sensitive to the health of the freshwater and marine ecosystems. Since water birds play a significant role as bio-indicators of changing environments, it is essential to understand the ecology of the major species that utilize it (Sivaperuman, 2004).

Custard and Osborn (1977) reported the importance of wetland birds as biological indicators of environment. Kroodsma (1978) studied the values and functions of wetland and concluded that wetlands are one of the favourite habitats of one third of North America’s avifauna. Kelso et al. (1986) observed the affinity of piscivorous birds for wetlands of low acidity. Eriksson (1985) indicated that the presence of fishes support many piscivorous birds in wetlands. Smith (1990) noticed that loss of fish reduces the survival and reproductive success of fish eating birds like Herons. Velasquez et al. (1992) surveyed the seasonal abundance, habitat selection and energy consumption of water birds at the Berg river estuary in South Africa.

Waterfowl is a group that has been well studied in Europe and North America. Davis and Smith (1998) reported the species composition, abundance and migration chronology of shore birds at Playa Lake, Texas. Shufford et al. (1998) documented the population dynamics of migratory and wintering shore birds at California Central Valley in Western North America.

Many authors have studied the different aspects of wetland birds in other countries. Food and feeding ecology of Cattle Egrets were studied in South Africa by Siegfried (1972). Guillet and Crowe (1985) described the pattern of distribution, species richness, endemism and guild composition of water birds in Africa. Dostine and Morton (1988) reported on the food and feeding habits of Cormorants in a tropical flood plain. Kalejta and Hockey (1994) examined the foraging density in relation to prey and habit of Curlew Sandpiper, Grey Plover at Berg River estuary, South Africa. Martucci and Giovacchini (1994) described the feeding habits of Cormorant wintering in Maremmna National Park, Central Italy by analyzing the pellets.
Shallow flooded crop fields and mud flat habitat provide seeds and vertebrates to birds. So huge number of shore bird migrants depend on these wetland habitats for foraging, resting and staging (Hands et al. 1991). There are complex food-web interaction among various biotic components of rice ecosystem maintaining a balance in the population on animals through biological control (Schoenly et al., 1998; Catling and Islam, 1999). According to Borad et al. (2000) foraging activities of birds in harvesting rice fields help in reducing the inoculum load of insect pests and weeds by selectively feeding on them. Tourenq et al. (2001) reported that rice fields were intensively used up by prenuptial migrants (Wood Sandpipers and Common Sandpiper) and breeders (Gull-billed Tern and Black-headed Gull) with the flooding of rice fields.

Literature on the field characteristics, status, distribution and notes on the general ecology of most of the Indian birds were contributed by Baker,(1922-1935), Ali, (1969), Ali and Ripley, (1983). Ripley (1982) recorded 2,094 forms of birds belonging to 120 species and 400 genera from the subcontinent covering India, Sri Lanka, Pakistan, Nepal, Bangladesh, Bhutan and Southeast Tibet. Among these, 417 forms belonging to 318 species and 146 genera were found in wetlands of India.

Ali (1962) reported on the behavior of Whiskered Tern in Point Calimere, and emphasized the importance of Point Calimere as the wintering quarter for migrating birds. Hussain et al. (1984) studied the movement pattern and population structure of avifauna of Chilika lake. Population fluctuation, species diversity, habitat utilization, food and feeding habits of aquatic birds of Keoladeo National Park, Bharatpur were reported by Ali & Vijayan (1986) and Vijayan (1991). Sampath (1991) assessed the status of shore birds of salt ponds at the Great Vedaranyam salt swamp, Tamil Nadu.


Kumar and Choudhary (2010) reported 34 bird species from Jagatpur wetland, Bihar. Gajendrasingh and Mamata (2011) studied avifauna of wetlands of Amravati region, Maharashtra. Anirban et al. (2012) studied water bird diversity and abundance in a newly constructed wetland in Birbhum district, South Bengal and reported that the wetland supported a population greater than 1% threshold of Greylag Goose and Ruddy Shelduck.

Agricultural ornithology aims at obtaining scientific information of birds in relation to agriculture and using this information for their management. Avifauna and agricultural landscape include all kinds of birds namely Granivores, Piscivores, Carnivores, Insectivores and Omnivores. Most bird species play a useful role in agriculture by having a potent check on insects and rodents whereas granivorous bird species cause economic losses to crops and stored grains. Toor et al. (1986) recorded 240 species of birds from intensively cultivated state like Punjab. According to Connor and Shrub (1986) rice fields provide concentrated and highly predictable source of food to many birds and several migratory birds use rice ecosystem as stopover because of the easy food availability. Though a large number of species occur in the cropped area, only five percent of bird species may cause any economic damage to the crops (Dhindsa and Saini, 1994).

Parasharya et al. (1994) emphasized on the importance of birds in biological control of rice field pests. Subramanya and Veeresh (1998) reported that out of 81 species of birds recorded from rice fields, 19 were migrants and noticed that some
bird species showed numerical response to the high density of food in the agricultural landscape. Borad et al. (2000) listed 67 species of birds feeding on crop residues of paddy in central Gujarat and about 310 species of birds in intensively cultivated area of Anand and Kheda district of central Gujarat. Ravinder (2008) studied the avian biodiversity in paddy agro ecosystem in relation to different crop stages of paddy land in Rajendra Nagar, Hyderabad. Sunder and Subramanya (2010) have reviewed the bird use of rice fields in the Indian subcontinent and have listed 351 species (27% of species of the subcontinent).

Several studies were carried out in India regarding migration, breeding, food and feeding of water birds. Breeding ecology of Bronze-winged Jacana and Pheasant-tailed Jacana in Keoladeo National Park was conducted by Ali and Vijayan (1986). Perennou (1989) elucidated the southern wintering range of some water birds.


Mukherjee (1969) carried out studies on food and feeding habit of different species of water birds of the Sunderbans in West Bengal. Ajithkumar (1972) described the food habits of water birds of West Bengal. Krishnaraju (1980) reported the feeding habitat of selected waders at Point Calimere, Tamilnadu. Sodhi (1986) investigated the feeding ecology of Pond Heron, Cattle Egret and Little Egret at Chandigarh, Punjab. Sampath (1991) examined the food habits of shore birds from the Great Vedaranyam salt swamp, Tamilnadu. Nagarajan and Thiagesan (1998) reported that Little Egret and Medium Egret preferred shallow water for food.

Hume (1876) initiated the studies on Birds in Kerala and published the list of birds of Travancore Hills. Golden Era of Ornithology in Kerala started with the ornithological survey of Travancore and Cochin by Salim Ali. He along with Hugh Whistler published the results of survey in 8 volumes. The ‘Birds of Kerala’ published first in 1969 by Salim Ali is still the authentic record of birds in the state.
Neelakantan et al. (1993) authored the book entitled ‘A Book of Kerala Birds’ in which various aspects of bird behavior is included.


Sugathan and Aby (1996) reported 270 bird species from Salim Ali Bird Sanctuary, Thattekkad, Kerala. A detailed study on birds of Mangalavanam, Kochi was conducted by Jayson and Easa (2000). Seema (2002) conducted studies on the management of fragile wetland ecosystem in Salim Ali Bird Sanctuary, Thattekkad, Kerala and reported 90 species of birds from the wetland area of Thattekkad. Among these 25 species were aquatic birds and the rest were land birds.

Easa and Jayson (2004) reported 475 species of birds belonging to 19 orders and 65 families in Kerala. Comparative study of avifauna of three wetland habitats i.e. Parambikulam, Point Calimere and Thattekkad Bird Sanctuary was carried out by Sugathan et al. (2004). The studies by Sashikumar et al. (2007) on the birds of Aralam wild life sanctuary, have provided interesting insights into the bird community dynamics of Aralam, which contribute to the formulation of conservation policy for birds at Aralam Wildlife Sanctuary. Vijayakumar (2006) reported 30 shore birds and 12 seabirds at Panagad estuary, Kadalundy, Kerala.

Bijukumar (2006) reported 140 species of birds from Bharathapuzha river, Kerala. Among these 91 species were resident and 49 were migrants. Praveen and Nameer (2008) reported bird diversity of Siruvani and Muthikulam hills, Western Ghats, Kerala and reported 158 avian species. The waterbirds of Mavoor wetlands, Kerala was studied by Arif and Muhammad (2012) and a total of 57 species of birds belonging to 16 families were reported. Deepa (2014) reported 119 species of birds belonging to 45 families and 17 orders from pokkali wetlands of Ernakulam district, Kerala. The seasonal variations in avifauna with respect to habitat changes in the pokkali wetlands were also studied.
Waterfowl studies got a momentum after the introduction of Asian Waterfowl Census (AWC) in 1987. Comprehensive bird surveys were carried out as a part of AWC in Kole wetlands for three consecutive years i.e. from 1992-1994 (Nameer, 1992b, 1992d, 1993a, 1993b, 1994a).

From 2001 onwards regular bird surveys were carried out in Kole wetland (Nameer, 2013) and Vembanad wetland (Prasanth and Sreekumar, 2012).

Mary (2003), Narayanan (2004), Sreekumar and Narayanan (2004), Narayanan et al. (2005 a, b) reported various aspects of the avifauna of Kuttanad wetland, Kerala. Mary (2003) studied the successional changes in bird population during paddy cultivation season in Kuttanad agricultural wetland ecosystem and reported 54 species of birds. Prasanth and Sreekumar (2012) compiled a checklist of 232 bird species, belonging to 58 families of 14 orders from Kuttanad wetland ecosystem.

Kole wetland is an important water bird habitat studied in Kerala. The high avian species richness recorded for Vembanad-kole Ramsar site is due to presence of different micro habitats. According to Perennou (1989) out of nine endangered waterfowl recorded in Kerala, four were recorded in Kole wetlands. Jairaj and Kumar (1990) reported the presence of Spoon-bill from the Kole wetlands. Ravindran (1992, 1995, 2005) noted the breeding of Purple Moorhen and occurrence of Glossy Ibis and White-necked Stork in Kole wetlands. Need for protecting Kole wetland for transcontinental migration of birds were discussed by Sivaperuman and Jayson (2001). Jayson (2000) reported the presence of Black Stork (Ciconia nigra) from Kole wetland area. Ravindran (2001a) reported White-winged Black Tern, Jayson and Sivaperuman (2002 and 2003) recorded Northern Shoveller (Anas clypeata) and Lesser Frigate (Fregata ariel) from Kole wetlands.

Sivaperuman (2004) reported 182 species of birds from Kole wetlands of Thrissur district. These birds belonged to 50 families and 15 orders. Nameer (2013) reported 248 species of birds belonging to 60 families under 16 orders from Kole wetlands.