4.1) **GENERAL**

The wetlands have been described as complex communities of living organisms interacting with their physical environment. Because of high productivity of macrovegetation and the efficient use of ecosystem by a variety of birds especially the ducks and geese, wetlands have been of special interest to man for long time but the study of these communities is still in a state of infancy. Their structure and functions including a scientific study of the ecological values and need for conservation is still poorly understood. They are recognised as important waterfowl habitats and most of the studies available pertain to this waterfowl-wetland relationship, with special reference to food and feeding habits, vegetational patterns, habitat use and management.

Wildlife biologists and others interested in the
study of wetland ecology have developed various wetland classification systems to study the various aspects of wildlife relationships. These include Shaw and Fredine (1956), Stewart and Kantrud (1971), Cowardin and Johnson (1973), Golet and Larson (1974), Jaglum et al. (1974), Bergman et al. (1977), Miller (1976) and Cowardin et al. (1979). Of these three major ones in use are those of Shaw and Fredine (1956), Stewart and Kantrud (1971) and Cowardin et al. (1979). The first two are mainly used on permanency of water and vegetation types (Table 1). The classification proposed by Cowardin et al. (1979) is most comprehensive, it takes into account the inventory and mapping, resource management and uniformity in concepts and terminology (Table 2).

Bourn and Cottam (1939) studied the effects of lowering water levels on the wildlife of wetlands and found that plant-water relationship bring about dramatic changes in the vegetational pattern.

Beecher (1942) was the first to study the wetland vegetation substrates in relation to nesting and demonstrated that number of bird nests was positively correlated with a number of plant communities.
A COMPARISON OF TWO WETLAND CLASSIFICATIONS

<table>
<thead>
<tr>
<th>Shaw and Fredin 1956</th>
<th>Stewart and Kantrud 1971</th>
<th>Main identifying Vegetation type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Seasonally flooded basins or flats.</td>
<td>1. Epiphemeral ponds</td>
<td>Wet prairie grasses or annual weeds.</td>
</tr>
<tr>
<td>2. Inland fresh meadows</td>
<td>2. Temporary ponds</td>
<td>Meadow sedges, rushes, grasses and broad leaves.</td>
</tr>
<tr>
<td>4. Inland deep fresh marshes</td>
<td>4. Semipermanent ponds and lakes</td>
<td>Cattail, hard stem bulrush, submergent pond weeds.</td>
</tr>
<tr>
<td>5. Inland open fresh marshes</td>
<td>5. Permanent ponds and lakes</td>
<td>Type IV emergents as a rim.</td>
</tr>
</tbody>
</table>

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TABLE 2: CLASSIFICATION PROPOSED BY COWARDIN et al. (1979)

<table>
<thead>
<tr>
<th>System</th>
<th>Subsystem</th>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Riverine</td>
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<tr>
<td></td>
<td></td>
<td>Unconsolidated bottom</td>
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<td></td>
<td></td>
<td>Aquatic bed</td>
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<tr>
<td></td>
<td></td>
<td>Reef</td>
</tr>
<tr>
<td>Estuarine</td>
<td>Subtidal</td>
<td>Rock bottom</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Unconsolidated bottom</td>
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<td>Aquatic bed</td>
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<td></td>
<td></td>
<td>Reef</td>
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<tr>
<td></td>
<td>Intertidal</td>
<td>Rocky shore</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Unconsolidated shore</td>
</tr>
<tr>
<td>Marine</td>
<td>Subtidal</td>
<td>Rock bottom</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Unconsolidated bottom</td>
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<td>Reef</td>
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<tr>
<td></td>
<td>Intertidal</td>
<td>Stream bed</td>
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<tr>
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<td></td>
<td>Rocky shore</td>
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<tr>
<td></td>
<td></td>
<td>Unconsolidated shore</td>
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<tr>
<td></td>
<td></td>
<td>Emergent wetland</td>
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<tr>
<td></td>
<td></td>
<td>Scrub-shrub wetland</td>
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<td></td>
<td></td>
<td>Forested wetland</td>
</tr>
<tr>
<td>Type</td>
<td>Bottom</td>
<td>Bed</td>
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<td>------------------</td>
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</tr>
<tr>
<td>Lower pereniel</td>
<td>Rock bottom</td>
<td>Aquatic bed</td>
</tr>
<tr>
<td></td>
<td>Unconsolidated bottom</td>
<td></td>
</tr>
<tr>
<td>Upper pereniel</td>
<td>Rocky bottom</td>
<td>Unconsolidated bed</td>
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<tr>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Intermittent</td>
<td></td>
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</tr>
</tbody>
</table>
Rock bottom
Unconsolidated bottom
Aquatic bed

Lacustrine

Limnetic

Littoral

Rock bottom
Unconsolidated bottom
Aquatic bed
Rocky shore
Unconsolidated shore
Emergent Wetland

Palustrine

Rock bottom
Unconsolidated bottom
Aquatic bed
Unconsolidated shore
Moss-lichen wetland
Emergent wetland
Scrub-shrub wetland
Forested wetland
Hochbaum (1944) is of the opinion that in order to maintain and increase the dwindling duck populations, three steps - restoration of lost breeding habitats, improvement of wintering waters and less gunfire were necessary.

According to Salyer II (1945) waterfowl refuges, necessary to save the breeding stock essential for repopulating the breeding grounds, have proved themselves to be one of the important tools of waterfowl management, spreading the birds with fair uniformity over the entire region. Hochbaum (1946) found that an important factor in keeping population levels low is the symptom of an unbalanced sex ratio. McKnight (1974) demonstrated an increase in waterfowl production on newly created aquatic habitat and speculated that this increase was a response by breeding birds to an abundant invertebrate population.

Sugden et al. (1974) investigated wintering mallard population at Calgary Alberta to determine why they failed to migrate. The authors concluded that available food, open water and protection from hunting were considered the main factors causing mallards to forego migration and cessation of feeding was the most acceptable and efficient way to reduce numbers.

Leopold (1933) worked out the importance of residual cover from the previous year and concluded that any activity which reduces residual cover from the previous year may adversely affect waterfowl production.

Beecher (1942) and Weller and Spatcher (1965)
demonstrated an efficient use of habitat to be dependent on the structure rather than taxonomic composition of emergent marsh plants that was of greatest importance to nesting birds.

Lack (1940) studied the role of habitat selection in speciation and adaptive radiation, and emphasized the importance of habitat segregation in closely related species and a habitat diversity in the multiplication on congeneric species.

The habitat selection is regarded as a species constant character that acts as an attractant for the birds. While studying the competition and habitat selection in birds, Svardson (1949) found that the physical characters of the vegetation, presence of water and the general aspect of surrounding community were important for habitat selection by birds. He further emphasized that while intraspecific population pressure tended to broaden habitat use, interspecific competition tended to limit the same. The vegetational patterns provide important cover for the various life activities and their relative importance varies.

Earl (1950) found that winter wheat and barley formed important nesting covers for mallards in the Sacramento Valley of California. Bue et al. (1952) noted that grassy shore line had more mallard, pintail and blue winged teal pairs than could be found on shores. DiAngelo (1953) considered aquatic plant succession to be responsible for the pattern of habitat use by waterfowl.

There have been a number of studies on the densities
of breeding waterfowl in relation to wetland habitat (Evans and Black, 1956; Benson, 1964; Jensen et al. 1964; Drewien and Springer, 1969; Sauder, 1969; Smith, 1971; Stewart and Kantrud, 1973, 1974; Kantrud and Stewart, 1977.) In most of these studies, different systems of classifications have been followed and therefore, their results cannot be easily compared. In addition to this the studies pertain to short transects on small block of land and therefore, they may not provide convenient or standard samples.

Evans and Balck (1956) observed that duck use per acre of natural wetlands varied inversely with size and that, although most of the pairs were on larger ponds, the smallest areas received the heaviest use per acre. According to Moyle (1956) behavioural spacing mechanisms and the availability of food resources are two factors considered to be of major significance in the regulation of duck populations. Among closely related species habitat selection forms one of the major means of avoiding competition (Mc Arthur, 1958).

Dane (1959), Kadlec (1960, 1962); and Harris and Marshall (1963) studied the ecology of wetlands with respect to plant water relationship and observed that in both observational and experimental studies the relationships are very significant.

Weller and Spatcher (1965) found that the habitat relationships are of prime importance in the study of ecology and distribution of waterfowl and were of the opinion that habitat changes permitted a measure
of habitat preference and adaptability in several species. Simth (1969) documented the waterfowl habitat relationship on the Lousiana, Alberta waterfowl study area and concluded that the numbers of potential breeding pairs returning to an area were related to the number of ducks produced in that area previous year.

Slobodkin and Sanders (1969) studied the relationship between environmental predictability to species density and different life history stages in species in unpredictable environment to show different sensitivity to environmental changes.

Bartonek and Hickey (1969) studied the food habits of Canvasbacks, Redheads and Lesser scaup and noted that the diving ducks normally spent a greater part of their time on the relatively deep open water areas where luxurient beds of submerged aquatic plants occurred.

The habitat use by water fowl forms an interesting area of study. Dwyer, (1969) studied waterfowl habitats in agricultural and non-agricultural land and found that non-agricultural land potholes completely surrounded by trees were attractive to blue-winged teal and mallard.

Stewart and Kantrud (1971) made an extensive analysis of the vegetation cover in the wetlands and maintained that attractiveness of wetlands to water-fowl may be related to annual changes in the ratio of emergent vegetation to open water. While comparing the hatching success on idled Grazed, moved and cultivated land. Miller (1971) found that the hatching success was higher
on idled land than on land subject to other uses. As a part of waterfowl land use relationship project in United States studies have been made to assess the principle factors limiting duck production on intensively cultivated land. Smith, 1971; Stoudt 1971; Duebbert and Kantrud 1974; Higgins, 1977.

According to Lack (1971) "shifts in habitat use from summer to winter, common among migratory land birds imply either a shift in proximate cues used by individual birds or use of cues that are much closer to those of ultimate importance than those implied as important through breeding season. Two important viewpoints have been advocated in respect of habitat use responsible for stimulating migration in waterfowl from the breeding grounds in palaearctic region to the Indian plains.

1) Welty, (1963) pointed out that the birds are driven out of their breeding areas by periodic climatic cycles which bring on food shortage, however, he regarded the shortage to be aggravated by the annual increase in bird populations. Merne (1974) found that birds in the northern hemisphere are driven out of their breeding grounds by the approaching ice and snow of winter and consequent shortage of food and unfrozen water;

2) The advent of spring triggers the gonadal system. The lack of inadequate nesting cover in their winter habitats together with lack of adequate protein rich food needed before and after laying initiates return migration (Duebbert, 1969; Miller, 1971; Krapu and Swanson, 1977).
Fretwell (1972) was of the view that selection for survival in wintering habitats could affect choice of breeding habitats and even dominate adaptive morphology and that the adaptations to breeding habitat could thus be far from optimal.

In a mixed population of birds habitat selection forms one of the major means of avoiding a direct competition between closely related species. Weller (1975) studied the ecological conditions of waterfowl in Falkland Island and in order to reduce direct competition in food rich habitats, species tended to have different feeding adaptations and behaviour.

In a study of stock watering ponds in western north Dakota, Lokemoen (1973) noted that pond size was the major factor influencing duck use and that older ponds and ponds with grassy shore lines received significant utilization by duck pairs. Krapu and Duebbert (1974) suggested that the extensive network of open water channels that exist on a major portion of the marsh forms as important habitat component that contributes to the high density of water birds.

The role of environmental heterogeneity in the regulation of duck population was investigated by Patterson (1976). On the basis of this he postulated that association of several small wetlands, temporary as well as seasonal around a large body of water provided the greatest diversity or heterogeneity that can serve a variety of birds and other wildlife. Roth (1976) emphasized that vegetational structure might vary
horizontally forming patchy or heterogenous habitats and with the scale of this patchiness being small, bird diversity might be enhanced as different species could find different patches or mixes of their liking.

Hazelwood (1976), Blem (1976), Owen and Cook (1977), Raveling (1979), Reinecke et al. (1982), Whyte et al. (1986) have studied body composition and conditions in relation to energy content in a large number of waterfowl.

According to Gochfeld (1977) habitat selection involves a series of selection that include general habitat selection, territory selection and nest site selection. These three choices need not to be made at the same time or even by the same member of a pair.

Burger et al. (1977), demonstrated close relationship between food availability and switches in habitat use by birds, while according to Partridge (1978) habitat selection involved the choice of particular habitats among the available habitats and resulted in birds being randomly distributed in space. Sugden (1978) thoroughly studied the habitat use by Canvasbacks (Aythya valisnaria) in Saskatchewan parkland and related the pair densities to be directly related to total available area of the favoured wetland. This increased with both pond permanancy and size class. Weller (1979) reviewed the impact of habitat loss on waterfowl and other marsh birds in Iowa and demonstrated the importance of habitat quality in maintaining species richness and numbers. He also stressed that the precise data that would allow predictive modelling were vital to
the conservation of wetland biota. One of the reasons for the reduction in the marsh bird species and their extirpation was attributed to drainage.

Dwyer et al (1979) and Kirby and Reichmann (1985) have used the method of radiocollaring in the study of estimates of home range size for mallards (*A. platyrhynchos*).

Buckley and Buckley (1980) ascribed the habitat selection to be genetic or learned or might vary from season to season for individuals or species.

Faanes (1982) worked out the avian use of Sheyenne lake and associated habitats and recorded very high species diversity in that small area which he related to close interspersion of many native habitats, several of which were unique to North Dakota.

There has been a gradual loss of wetlands all over the world. The cumulative magnitude of which is not readily apparent. In U.S.A. alone Frayer et al. (1983) has estimated that 116 million acres of wetland have been lost from presettlement days which represents a cumulative loss of 54 percent. This has resulted in great shrinkage of the waterbird habitat. Attempts are afoot to protect the critical wetlands through the International Council for bird preservation, Howe (1987).

Cody (1985) maintained that the pattern of habitat use during non-breeding season were simultaneously
based on extrinsic factors that predisposed birds to use a given habitat or not and on the intrinsic quality of the habitat itself, which appeared to be determined in part by food availability.

4.2) **FEEDING:**

Amongst the earlier studies on the food of ducks and geese based primarily on fall and winter collections are the contribution of Mabbott (1920); Campbell (1936); Martin & Uhler (1939), Kortright (1943); Campbell (1946, 1947) undertook the detailed investigation of the food of wigeon, Brentgoose, and other British wildfowl on the basis of these, they concluded that the animal food was injusted accidentally; the main food being particularly *Zostera*, *Ruppia* and *Enteromorpha*. Munro (1949) found 88 per-cent animal food by volume in the stomachs of downy American Wigeon, this comprised chiefly of insects. However, Glegg (1943) had suggested that wigeon was adaptable enough in its feeding habits and foods to survive any loss of feeding area. He further maintained that since wigeon depended on a wide variety of foods they would be able to modify their habits to overcome any shortage of the main food item in their diet. Dement'yov and Glend'kov (1970) found *Ruppia* species, *Salicornia* species and *Atriplex* species to form chief components of food at certain times of the year in mallards contrary to this Engelmann (1952) found them to browse on glabrous leaved plant in preference/narrow hairy ones. Taylor (1957) in his studies on utilization, preference and nutritional value of winter grain, agricultural crops in the food of *Branta canadensis* (Canada geese), did not find any relationship between preferences and nutritive
value of food items. Ranwell and Downing (1959) found the eel grass, *Zostera* sp. to be the traditional food of brant goose and the wigeon.

Feeding has generally been described as a function of several factors operating simultaneously which includes a combination of features belonging to the predator and also characteristic of prey (Ivlev 1961). It has also been observed that animals in search of their food have been able to discover/provide food for other organisms. Sheerwood (1960) found that Swans wasted valuable food plants by rooting them up more than they consumed. Other ducks were able to exploit this and obtain food that would normally be unavailable. Chura (1961) discussed foods found in oesophagus—proventriculus—gizzard of 94 young mallards (*A. platyrhynchos*) and found that the proportion of plant food continued to increase until at flying age. Perret (1962) analysed oesophagus—proventriculus contents of 62 mallards, measured the availability of food and concluded that to a large extent, mallards ate those most available. Keith (1961) examined the stomach contents of pintails at different stages—adult, flying young and flightless young and found that the seeds of aquatic plants made the bulk of identifiable material while Galsgow and Bardwell (1962) found the grass seeds to form the major part of diet of the pintails. Based on the anatomy of feeding apparatus, the feeding method Goodman and Fischer (1962) classified ducks into the two groups—those that used grasping actions to secure its food and those that used straining actions for this.

Scott and Holm (1964), however, concluded that basic food requirements were the same for diving and dabbling ducks. Johnsgard (1965) reported that mature
pintails frequently dived for food while Smith (1966) did not observe any diving behaviour of the ducks.

Olney (1963, 1965) studied the food of waterfowl in autumn and winter from saltish brakish water areas and found that in case of mallard the most frequent item was the mollus and in case of wigeon it was the leaves of *Potamogeton* and some algae in terms of both frequency of occurrence and volume. Seeds made up 10 percent of the total volume and there was no animal matter. Most of the birds used pastures and ditches while others fed in intertidal zones and salt marshes.

There are several density dependent factors that have been considered as important in regulating the number of wildfowl. Lack (1966) regarded the limited food outside the breeding season as the most important factor in this regard. Oglivia (1968) suggested that disturbance and drainage of habitat was responsible for diminishing importance of several sites as wintering grounds for waterfowl. Although hydrophytes might sometimes be regarded as poor waterfowl food plants but they are believed to be indirectly important to waterfowl in harbouring large quantities of macro invertebrates which furnish a source of animal protein to the ducks (Krull, 1970) Bartonek and Hickey (1969) and Bartonek and Murdy (1970) analysed the gut contents of canvasbacks, (*Aythya valisnaria*), read heads (*A. americana*) and lesser scaup (*A. affinis*) and found that at the young stage the ducks had eaten almost 100 percent invertebrates and as they grow the plant component increased. Similar pattern of feeding has been described by Bartonek (1972) in the summer foods of Wigeon, Mallard and Green winged teal. A great degree of bias exists with regard to the analysis of dietary items in the gizzard of the ducks. Swanson and Bartonak (1970) studied this in the gizzards of
Blue winged teal and found that some soft food items broke down with in minutes of their intake whilst some hard seeds remained intact for days.

Sugden (1973) studied in detail the various aspects of food including feeding behaviour, food sampling, selection categories and the factors affecting food use of pintail, gadwall, wigeon and lesser scaup ducklings and found that - the early diet of pintail was dominated by surface invertebrates that were latter replaced by aquatic invertebrates and to a lesser extent by plants.

Gadwalls ate chiefly surface invertebrates during their first few days, these were gradually replaced by aquatic invertebrates and plants till they become herbivorous.

Wigeons followed a similar pattern of that of gadwalls and lesser scaups were essentially carnivorous feeding mostly on amphipods, dipterous larvae and gastropods.

Nilsson (1969, 1972) studied the food choice of diving ducks in the non-breeding season and found that Aythya fuligula fed mostly on chironomid larvae and Pscidium sp.; Aythya clangula fed mainly on chironomid larvae and Trichoptera while Aythya ferrina fed on chironomid larvae and seeds. Mukherji (1968 - 76) investigated that gut contents - crop and stomach of 2617 birds, including moorhen, coot and dab chick. He found that the size of prey and the taste greatly
influenced the choice of food in these.

Selection of food by members of anatidae has been shown to be influenced by several factors including biological demands, feeding behaviour, ecology of the available invertebrates and the general nature of aquatic system (Swanson and Meyer, 1973, 1977). Swanson (1977, 1984, 1985) made a series of studies on the food and feeding habits of ducks. In the case of ducks feeding, waste stabilization system, he was able to find a high invertebrate consumption of the order of 98 percent by volume with midges and cladocera each accounting for 44 percent of the diet, however, the actual composition varied at various periods of the days. With adult insects accounting for 89 percent between sunset and midnight and sunrise. He was able to find that the food consumed by breeding mallards greatly varied. Triticum aestivum and the seeds of Echinochloa crusgalli were found to be the most dominant food items of the laying females while Echinochloa crusgalli was the dominant seed in the diet of nonlaying females and males. He also found that the food of laying hens of 5 species of dabbling ducks consisted largely of invertebrates, comprising snails, aquatic insects, crustacea and earthworms.

The winter feeding ecology of wigeon has been studied by Owen (1973, 1975 a,b) in which it was found that the birds, roosted on mud flats during the day and fed mainly at night, that the food consisted largely of grass leaves. Besides, developing a technique for evaluating faecal analysis, Owen (1973) also studied the effect of cutting and fertilising grasslands for
goose management during winter and demonstrated the preference of goose feeding on fertilised grasslands, however, in another study Owen and Thomas (1979) described wigeon as chiefly diurnal feeder with more than 80 percent of the diet consisting of grass leaves. Krapu (1974) described the diet of drake and hen pintails in three foraging habitats - nontilled shallow wetlands, tilled wetlands and croplands. It was found that the consumption of invertebrates was highest during egg formation and occurred principally on nontilled shallow wetland basins. Krapu and Swanson (1975) suggested the Barnyard grass, Echinochloa crusgalli and other plant foods consumed on wetland and cropland were inadequate to meet the nutrient needs of breeding pintail hens.

Seigfred (1976) described feeding behaviour of 4 sympatric species of diving ducks on southern Manitoba and emphasized that selection for different foraging sites appeared to be important in segregating species whose diets overlap most.

Serie and Swanson (1976) described feeding ecology of breeding gadwalls in relation to sex ratio, pair mates, reproductive status, food availability and wetland type during spring and summer.

Danell and Sjoberg (1978, 1980) studied the habitat selection of breeding ducks and found that water bodies with less than 0.1 hectare in area were utilized only by mallard and teal and that the diet of both duckling and adult wigeon, teal, mallard and pintail consisted of seeds of Potamogeton, Sparganium, Carex, Hippuris vulgaris,
Thomas (1980, 1981, 1982) studied the feeding ecology of waterfowl. He found that coot, moorhen did not show any preference during spring flood waters; gadwall, wigeon, moorhen and coot mainly consumed vegetative food; mallard, pintail, teal; pochard fed extensively on fruit while shoveller, pochard and tufted duck consumed greater amounts of invertebrates.

Hirst and Easthope (1981) found that waterfowl used agricultural lands on opportunistic basis as an extension of traditional coastal winter habitats while Kantrud (1981) found that avian species richness tended to decrease with increasing grazing intensity in the wetlands. Light and moderate grazing resulted in increased species richness (Kantrud and Kologiski, 1982). Hickey and Titman (1983) studied diurnal activity budget of black ducks and found that they fed less and rested more with increasing tide levels.

Whyte and Bolen (1984) studied corn consumption by wintering mallards during morning feed flights and found that mallards increased corn consumption at the coldest time of the year presumably allocating more time for feeding activities during their morning stay in the cornfields and this high energy diet allowed them to meet thermoregulatory demands during cold weather.

The other aspects of waterfowl biology that have received considerable attention include reproductive ecology, movements and migration, disease, effects of drought, physiology, hunting, management and economics. Although these do not fall within the preview of the present work, it is thought necessary to mention the important contributions in these fields.
The reproductive ecology has been studied by Craighead and Stockstad (1964), Balser et al. (1968), Dwyer (1970), Sargeant (1972), Stewart and Kantrud (1973), Reed (1975), Brewster et al. (1976), Miller and Johnson (1978). It is interesting to note that during the period of present study and an earlier one on Hokarsar (Shah, 1984), none of these ducks were found to breed in any of these setland. There are, however, reports of the breeding of mallard, coot and pochard in Hokarsar (Osmaston, 1927), Bates and Lowther, 1952).

Most of the studies in the field of movement and migration pertain to the ducks and geese in United States and Canada. (Salamonsen, 1968; Bellrose, 1968; Thornburg, 1973; Ravelling, 1976 and Derrickson, 1978).

The ducks and geese arriving in the Indian subcontinent are known to arrive from their palaearctic grounds in Europe and Siberia. Tugarinow (1931) described eight routes that were based mainly on known flights over long distances in Northern Asia. Austin (1949) and Kuroda (1961) mapped duck migration in Japan, however they lacked information concerning their origin in north and eastern Siberia. Hachisuka and Udagawa (1950) discussed the bird migration in eastern Asia and extended the routes in China, Farmosa and Phillipines. In the case of ducks in the Indian subcontinent, Moreau (1952) found thirty-seven species which breed in Siberia, thirtythree
in Africa, and 10 that overwintered both in India and Africa. Although 13-15 species of waterfowl visiting the wetlands of the valley form a part of the same flock but there has been no study with regard to the pattern of migration from here to the plains of India and viceversa.

Waterfowl are known to suffer on account of various diseases and environmental contaminants. Botulism caused by *Clostridium botulinum* is reported to be very common and has been studied by Cooch (1961), (1964); Jensen and Gritman (1967); Jensen and Micuda (1970); Smith (1976). The ducks are known to suffer from duck plague, aspergillosis and fowl cholera. Important contributions in this field are those of Gerschman et al. (1964), Horshfield (1965), Vaught et al. (1967), Friend and Pearson (1982).

Waterfowl swallow lead shots/pellets while feeding upon seeds and animal life from the bottom of wetlands, ponds and other lakes. Within the digestive track they erode by the action of HCl aided by grit. The soluble lead salts are absorbed in the blood stream inducing anaemic condition. The effect has been studied by Jordan and Bellrose (1951), Bellrose (1959), Jordan (1968) and Bellrose (1975).

Changes in the distribution of waterfowl has been shown to be directly linked to the abundance of water. The shifts of duck populations during droughts has been discussed by Hansen and McKnight (1964), Rogers (1964), Cressay (1969), Smith (1970).

In the management of wetlands for wildlife especially waterfowl major objectives have been to preserve wetlands
and marshes in a natural state and to maintain their productivity. Most of the studies, Beecher (1942), Weller and Spatcher (1965), Weller (1978) indicate that it is the structure rather than taxonomic composition of the emergent plants that is of greatest importance to the birds. The responses of wetlands wildlife to dramatic changes in vegetation and water have been studied by several workers, Wolf (1955), Evans and Black (1956), Johnsngard (1956), Rogers (1964), Kirsch (1969), Hansen (1971), Stewart and Kantrud (1974), and Schroeder et al. (1976). Most of the wetlands are being managed for providing a sport for the hunters. Of the various ducks, mallard has long been highly regarded by hunters and makes up a large proportion of the waterfowl harvest. The various types of hunting, patterns and role of hunting regulations in migratory bird management has been described by Geis and Crissey (1970), Jessen (1970), Stott and Olsen (1972), Hopper et al. (1975), Nelson and Low (1977).