V. DISCUSSION

1 Population Dynamics

a. Nesting Population

Brown (1976) has stated that the health of any population of birds of prey depends largely on its breeding success. To assess the breeding statistics of birds of prey he has recommended to obtain quantitative data on the commoner, and more easily observed species rather than the very rare species, from which it takes years to acquire adequate data. He has also suggested to acquire knowledge through the breeding studies by assessing the total number of breeding pairs in an area, the total numbers of eggs laid and the total number of young reared within a period of time. The present investigation in the above said lines indicates that Brahminy kite is reproductively healthy during the study period (1986-1992) in Cauvery delta. Although the number of nesting pairs seems to be fluctuating during the earlier period of this study at both study locations (Mayiladuthurai and Poompuhar) it remains relatively stable during the later part of the study period (1991 and 1992). The fluctuations in the nesting population of Brahminy kite during certain years of this study show possible migrations due to demographic pressures in terms of nesting from their conspecifics such as Pariah kite *Milvus migrans*, during the same breeding season. The earlier study of Jayabalan (1985) has revealed that both these species nest in Cauvery delta during the same breeding season. Galushin (1974) has contented the major population fluctuation may occur when raptor seek more favourable breeding areas. Similarly, during their study on Ferruginous hawks at North Dakota Gilmer and Stewart (1983) have suspected the immigration of other
Ferruginous hawks into their intensive study area from the surrounding region. They have also suggested other factors for population fluctuations, such as increased survival rate of the hawks and recruitment of newly breeding pairs in the same study area.

**b. Nesting Density and Spacing**

The density of breeding pairs (pair/Km²) at both the study locations (Mayiladuthurai; range:0.36 pair/Km² to 0.68 pair/Km²; Poompuhar; range:0.64 pair/Km² to 0.76 pair/Km²) is encouraging while compared to that of some western raptors such as Golden eagle (pair/20 sq.miles), Ferruginous hawk (pair/9 sq.miles), Red-tailed hawk (pair/11 sq.miles), Swainsons hawk (pair/80 sq. miles), Prairie falcon (pair/40 sq.miles), Marsh hawk (pair/27 sq.miles), and Sparrow hawks (pair/80 sq.miles) at eastern Great Basin, Utah, USA, as reported by Smith and Murphy (1973). But, the findings of Schmutz (1977), in the Prairie parkland ecotone of Alberta, Canada on the nesting density of co-existing Buteos have revealed a higher density rate (0.10 nest/Km²) than the above mentioned species. Ratcliffe (1963) has felt that the differences in the breeding density of Peregrine falcons are due to varying intensity of territorial activities. Kochert (1972) has also supported his view by stating that the territorial intolerance of raptors may have been the dominant force for nest spacing. However, territorial intolerance may not be a factor influencing nest spacing and distribution in Braminy kites, since, Sekar (1989) and Murugan (1994) have located a communal roosting site of Braminy kites in Cauvery delta, where communal nesting also been reported by them. Another concept on nest spacing of raptors has been put forward by Newton (1979), as the smaller raptor species usually occur at higher density.
than larger species. This idea has been supported by Debus (1984) in establishing the higher breeding density of Little eagles than that of the larger Wedge-tailed eagle at Armidale, Australia. But the size criteria in Brahminy kites does not seem to be in accordance with the foregoing views on nest spacing, since they are considerably larger among the diurnal raptors of cauvery delta. Although, the nesting density of Brahminy kites has been relatively higher than the estimates on other raptor species in western countries, significant difference has been observed in the nesting density of the kites among the study locations of the present investigation. This may be due to the difference in the habitat use pattern and availability of potential nesting sites in the study areas, in which Mayiladuthurai urban area shows lesser density than the Poompuhar rural habitat.

c. Reuse of Old Nests:

Reuse of old nests of previous years (Nest site fidelity) has been observed in Brahminy kites. One pair reused their old nest for 7 consecutive years repeatedly after carried out nest repairing, while most of the breeding pairs have been observed to utilise their old nests atleast for three breeding seasons continuously. Seventy five percent of the total nests in 1986-87 breeding season are reused nests. The faithfulness of birds to their nesting places and mates has long been of interest to ornithologists (Darley et al., 1971, Lenington and Mace 1975, Greenwood and Harvey 1976, and Harvey et al., 1979). Rowley (1983) listed advantages for birds breeding in the same place with the same partner, including physiological and behavioural characteristics associated with the age of the partners, the best breeding sites, and efficiency of mating with a familiar partner. Harvey et al., (1979) have
suggested that birds with long life span and birds living in stable environments such as Bald eagles may be more faithful to their nest sites and mates than other birds. Smith and Murphy (1973) have stated that the tendency of pairs to reoccupy nesting sites and territories has the effect of stabilising the raptor population. According to them this tendency is apparently prevalent in almost all raptors. Craighead and Craighead (1956) have reported that almost 75% of the raptor pairs in the Michigan and Wyoming study areas reoccupied their same nesting vicinity. Luttich et al., (1970) have reported that only 12.4% of Red-tailed hawk pairs built new nests during the four-year study in Canada. Newton (1979) has cited several examples of raptors that show a high degree of nest site fidelity. Newton and Marquiss (1982) have reported strong nest site fidelity for a population of the Sparrow hawks in south Scotland. Additional reports have been presented for the Flammulated owl in Colorado (Reynolds and Linkhart 1987; the ural and Tawney owls in Finland (Saurola 1987); urban breeding Merlins in Saskatchewan, Canada (Warkentin et al., 1991) and Ospreys in the eastern USA (Poole 1989). White (1969) has expressed the opinion that a traditional or "genetic" linkage may be responsible for the almost continuous occupancy of certain nest sites by Perigrine falcons in Alaska. Matray (1974) has felt that species with extended breeding seasons must begin nest-building and egg-laying quickly, so that the young have sufficient time to complete their development. With the male and female kites returning to the nest site of the previous year within a few days of each other (Ames 1964 and Green 1976), already mated kites could eliminate the time required to find a new nest site and reduce the need for extensive courtship. Emlen and Oring (1977) have
discussed the significance of nest-site fidelity as an advantage of "long-term monogamy". Conceivably, such a tradition may apply to Brahminy kites equally as well, as nest sites have been reused by them continuously for long periods of time.

d. Nesting Chronology

Remarkable variations have been observed in the timing of breeding cycles among individual Brahminy kite pair and among different breeding seasons. During 1986-87 and 1990-91 breeding seasons kites have started nest-building on the first week of December and egg-laying has been initiated more earlier (3rd week of December 1986-87). Late egg-layers have been recorded during 4th week of January during 1988-89 and 1989-90 seasons. Early dispersal of fledglings has been observed during 1st week of March 1986-87 and 1987-88 seasons, while the late fledging has taken place in the 1st week of May. Many reasons have been attributed for the variations in the breeding chronology of raptors. Cave (1968) has indicated large annual variations in egg laying date of Kestrels and it has been related with differences in prey abundance. According to his observations, in the years of high mice or vole numbers Kestrel lay eggs early than the years when prey availability is less. Olsen and Olsen (1980) have suggested that the raptors fix the time of their breeding according to the time of greatest food demand during nestling or fledgling phase. They have observed such a correlation of Kestrels' breeding time, so that the kestrels had nestlings or fledglings when large numbers of young inexperienced mice, the predominant prey item, were available. They have also pointed out the obvious advantages for the raptors as they can more easily feed their nestlings and fledglings, and older
fledglings have a greater chance of surviving and developing their hunting skills. In the timing of their breeding cycle, Brahminy kites have been found in accordance with the above hypothesis, since during the dispersal of their fledglings there may be abundance of aquatic organisms, becoming accessible to the young ones due to receding levels of water in the rivers, canals and fresh water ponds due to the onset of summer. Although, food undoubtedly plays a role in the timing of breeding and the formation of eggs, the breeding chronology of Brahminy kites seems to be coinciding with the onset of north east monsoon at Cauvery delta each year, again indirectly indicate the correlation between the timing of annual peaks in prey numbers and their breeding chronology. From their artificial stimulation studies on day length and breeding initiation, Olsen and Olsen (1980) have inferred that day length does not act as a precise timer for the start of breeding in Kestrels. However, they have got encouraging results from experiments carried out to establish link between the hormone levels in the prey species, which act as the "proximate timer" for breeding in raptors.

\textbf{e. Clutch Size:}

Clutch size of Brahminy kites has fluctuated from 1 to 2 eggs in Cauvery delta, although Shodde and Tidemann (1986) have reported 1 to 3 eggs in the Australian Brahminy kites. More numbers of single egg clutches have been observed during 1988-89 breeding season and it may be due to the shortage of annual rainfall level during the onset of the breeding season (October, November, and December) according to the meteorological data. Annually, the prey base of Brahminy kites become enriched only during this period due to monsoon rains. This view has been reflected by Lack (1968)
and Klomp (1970) in their report, that females adjust clutch size in response to variation in food resources. As per their contention, in fluctuating environments such as Cauvery delta with changing annual water level cycles, kites may have difficulty in estimating future environmental quality reliably. Individuals that overestimate environmental quality, may pay the cost of wasted reproductive effort and possibly the additional cost of decreased reproductive success due to brood reduction or nestling failure (Bryant 1979, Stagsvold 1984 and Morris 1987). Therefore, in this unpredictable environment, female Brahminy kites may be tempted to lay smaller clutches, particularly during low rainfall years.

**f. Productivity**

Productivity data of breeding Brahminy kites during the present investigation has been comparatively higher (Range: 61.11 ± SE 7.35% to 93.75 ± SE 4.27%) in contrast with the available productivity data of some western raptors. Reynolds and Wight (1978) have estimated the hatching success as lowest for Sharp-shinned hawks (69.6%), intermediate for Cooper's hawks (74.01%), and highest for Goshawks (81.2%) at Oregon, USA. The productivity estimation of Smith and Murphy (1973) for western raptors seems to be higher in some cases such as Golden eagle (100%), Swainson's hawk (100%), and sparrow hawk (80%), but this may be due to the smaller size of the sample they have analysed (Range: 2 to 6 eggs). Even in this smaller sample, Ferruginous hawks (47.6%), Red-tailedhawks (46.2%), Prairie falcons (20%), and Marsh hawks (50%) show lower productivity rates. Smith and Murphy (1979) have cited several factors that decreased the productivity of a raptor during unfavourable years. Among
these are, (1) failure of pairs to nest, (2) failure of pairs to achieve maximum clutch size, and (3) failure to hatch brood for maximum number of young. Thus, for a breeding avian predator population to have a productive year there must be a certain minimum prey density which provides the stimulus and physiological ability to breed. Beissinger (1986) has correlated the water levels of the lakes, the prey source of Snail kite, with the nesting success and their population size in Florida. However, Luttich et al., (1970) have suggested that regional raptor populations may exhibit different adjustment patterns to a fluctuating prey base. Their view has been reflected in the present productive statistics of Brahminy kites in the Cauvery delta, where the prey availability may not be a problem (Jayabalan 1985, and Sudha 1991), except in the years of minimum mean annual rain fall, and lower levels of annual Cauvery water discharge from the reservoirs during which the kites adapt a dietary shifting to the available prey taxa (Jayabalan 1985). However, changes in the annual water level cycle of Cauvery delta probably would have the most direct impact on Brahminy kite productivity, because successful breeding depends upon five consecutive months (December to April) of favourable water conditions to keep the prey sources like ponds, canals, rivers and agricultural lands, flooded at the nesting habitats which support local freshwater fish and crab populations.

Although, hatching failure of eggs is an important factor reducing annual productivity of Brahminy kites, this species suffers its greatest losses during the nestling period. Death of nestlings due to starvation, falling of young from the nest, and "sibbling aggression" (Bartolotti et al., 1991) are the 3 important factors seem to reduce fledging success of
Brahminy kites. Incidence of predation has not been recorded throughout the study period in the Brahminy kite nests. Reynolds and Wight (1978) have described nest predation in the nest sites of Cooper's hawks, since their nests are sufficiently open to allow the entry of large predators such as crows, ravens, and Great horned owls while the body size of Cooper's hawks may not be sufficiently large to repel these predators. In the case of Brahminy kites, their larger size (mean weight of 98 kites: 566g), and the bi-parental care during the entire period of the breeding cycle may be the predominant factors for discouraging the entry of a nest predator in their open platform nests.

g. Experimental Clutch Size Manipulation:

Egg manipulation experiments to analyse clutch size fixation in raptors have previously been carried out only to find out their "determinate" or "non-determinate" nature of egg-laying decision. Meijer (1988) has carried out experiments in kestrels *Falco tinnunculus* to study the effects of clutch manipulation on their "decision" for egg laying and to understand the mechanism by which kestrels adjust their clutch size to the time of the breeding cycle. Available reports on such analysis in other bird species have revealed that in the course of egg laying, the responsiveness of the birds to egg removal is switched off at some point of time and this indicates the suppression of further ovarian follicle development beyond the normal number of eggs (Paludan 1952, Wiedmann 1956, Eisner 1958, and Lehrman 1959). When the findings of the present study has been interpreted in the light of these earlier report, the clutch size manipulation experiments in Brahminy kites have shown that clutch fixation, ie, the the inability to develop extra
ovarian follicles in response to egg removal, occurs just earlier before the kite lays her last egg. Meijer (1988) has stated that this is the stage at which some more eggs are maturing in the ovary of raptors and the female's "decision" to suppress the development of another follicle is the crucial event in determining the final clutch size. This "decision" appears to be related with the time of the breeding season. In the present study, the females breeding late in the season (3rd week of January) have taken this "decision" sooner, after laid 2 eggs, than by the females breeding early (3rd week of December) after laid 4 eggs. The normal egg laying season of Brahminy kites in Cauvery delta has been studied by Jayabalan (1985) as commencing from 3rd week of December to 3rd week of January. For the females that lay in the middle of the breeding season (1st week of January) clutch fixation has occurred after the laying of their third egg. Similar observations have been made in female Herring gulls *Larus argentatus* (Parsons 1976) and in Kestrels *Falco tinnunculus* (Meijer 1988). In contrast, all early breeding Brahminy kites (2 females) have maintained the normal clutch size (2 eggs), even when 1 or 2 extra eggs are added. However, 2 late breeding females have showed their response through follicle suppression, when one or two extra eggs added to the already laid one egg clutch. Meijer (1988) has observed that the incubation behaviour of the female is a good predictor of clutch size. According to him, the late breeders develop incubation behaviour more rapidly than the early breeders. That may be the reason for development of incubation behaviour in the Brahminy kites, during egg additions to their clutch, which is normally below than the average size. On the basis of clutch manipulation experiments several researchers have also suggested that the
termination of egg laying is associated with increasing contact of the female brood patch with the eggs (Paludan 1952, Wiedmann 1956, and Porter 1975). Extensive studies by Haftorn (1981) in the Great tit (Parus major) have revealed that the stimuli from the eggs onto the brood patch create a positive feedback leading to enhanced incubation behaviour and eventually to the termination of egg laying. His hypothesis strongly correlates with the results of the present experiments positively. Therefore, it can be surmised that the tendency to incubate the eggs, in the egg laying females of late breeding season, is higher due to more rapid follicle suppression and resulted in laying less number of eggs than the early breeding kites.

h. Brood Size Manipulation Experiments

Brood sizes of tropical land birds have been manipulated by Ward (1965), Morton (1971), Mader (1982), Tarburton (1987), and Beissinger (1990). Mader (1982) and Beissinger (1990) have reported the negative effects of brood size manipulation in raptors such as, Savannah hawk Buteogallus merdionalis, and Snail kite Rostrhamus sociablis respectively, as they have not been able to raise enlarged broods. Beissinger (1990) has also estimated that snail kite parents could not raise four young, had trouble in raising three young, and did not increase feeding rates proportionally for these enlarged broods. Moreover, enlarged snail kite broods of four young, fledged fewer young ones than the small and medium sized broods. Similar trend has been observed in the present experiment of brood manipulation, carried out at Brahminy kite broods. Five pairs have raised 3 young each when their brood size was enlarged in the range of 3 to 5 chicks. No Brahminy kite parents could raise four young. Offspring mortality occurred (n=6 young) at the five
enlarged broods. It may be due to starvation, the result of low prey deliveries by the parents. Thus, the results from the experimental studies on Brahminy kite support Lack's (1968) view that clutch and brood sizes may be limited by food. Two instances of "Sibbling aggression" (Bortolotti et al., 1991) have been recorded from the enlarged broods of Brahminy kites (5 chick and 3 chick broods) during this experiment. The pattern of nestling mortality has shown that the youngest of the brood dies. However, cannibalism has not been recorded in Brahminy kites either by the parents or other nestlings. However, Bartolotti et al., (1991) have observed cannibalism of nestling in American kestrels by their parents and sibblings. They have also pointed out that as proximate food resources play a more important role in birds of prey with facultative siblicide cannibalism should be more frequent in that group of birds. But the results of the present study coincide with other raptor research work (Ingram 1959, Reese 1972, Meyberg 1974 and Newton 1986), in which brood size reduction has been observed, but the fate of the carcass of a dead nestling seems to be unknown.

i. Food Consumption by Different Sized Broods

Differences have been observed in the amount of food delivery to different sized broods. Males delivered a fairly uniform supply of prey, which was supplemented by females during late chick rearing at which the food requirement of the young are greatest. This pattern of food delivery may reflect a limited capacity in the male Brahminy kite for prey capture and a need for the female to hunt in late chick rearing period (Collopy 1984). Snyder and Snyder (1973) and Newton (1978) have suggested that total amount of food captured by adult raptors may be determined primarily by
their foraging success and not by the food requirement of the young. Beissinger's model on brood size and parental threshold relates parental-care patterns to reproductive benefits. His model is similar to that of the "Marginal value Model" of parental feeding effort of Patterson et al., (1980), which assumes that parental care can be given in smaller increments such as feeding the nestlings. Beissinger's (1990) model has estimated the threshold value of parental investment to successfully raise all nestlings in broods of a given size. It is assumed that parents can assess offspring age and local food supply in relation to demand by the brood. Parents can easily determine offspring age from the size and state of development of their young. However, Beissinger (1990) also accepts the contention of Snyder and Snyder (1973) and Newton (1978) as the food supply to brood may be assessed by rates of foraging success of the parents. Although a higher food delivery rate can be associated with greater levels of local food availability, it may also be an effect of individual differences among parents in hunting ability or experience (Beissinger and Snyder 1987).

2. Nesting Ecology

a. Nesting Habitat

The raptor living habitat serves the two main functions of providing a nest site and food. A suitable nesting habitat can consists of a very small patch, whereas the foraging areas are much more larger (Tjernberg 1983 and Lindell 1984). In the present study, Brahminy kites have been found breeding throughout Cauvery delta (Jayabalan 1985, Sekar 1989 and Murugan 1994). They have been observed nesting in agricultural wetland, agricultural dryland, coastal dry land, river and canal banks and amidst human habitations.
such as gardens, Coconut groves, road side trees and farmyards. This pattern of distribution suggest that breeding Brahminy kites can adapt to wide range of habitat conditions. The habitat diversity and increased amount of edge between the habitats undoubtedly contribute to an increased prey population or at least increase the diversity of prey species available (Karr and Roth 1971 and Shugart et al., 1975) to the nesting raptors.

Despite the intensive agriculture in the Cauvery delta region, 25.32% of the total nests at Mayiladuthurai area and 55.51% of the total nests in Poompuhar area have been found in the agricultural wetland and dryland habitats thereby it shows a noticeable tolerance to agricultural disturbance. This may be due to their dependence on extensive hunting areas to obtain food such as the freshwater crabs Paratelphusa. sp., fishes and amphibians from water logged agricultural wetlands along with field rats from bunds of fields (Jayabalan 1985). In contrast to the findings of the present investigation, raptor response to agricultural development has been studied in the agricultural habitats in USA and Canada (Schnell 1968, Gilmer and Stewart 1983 and Shumutz 1984) wherein significant reductions in the abundance of raptors on agricultural land area have been reported. Schnell (1968) has reported decreased use of intensively cultivated land by Red-tailed hawk and Rough-legged hawk in North America. Nesting density of Ferruginous hawks declined with increased percentages of the landscape under cultivation in south east Alberta and north Dakota (Gilmer and Stewart 1983 and Shumutz 1984). Leptich (1994) has also stated that agricultural lands with mixed cropping pattern, result in decreased raptor population and diversified bird species.
b. Proximity to Foraging Sites

Theoretically, the proximity of adequate food supplies, as measured by the distances to possible hunting areas, such as seasonal water, permanent water and agricultural lands, may be of profound significance in the choice of a nest site by any avian species (Hilden 1965) and an important limiting factor for the populations of many raptors (Snyder and Snyder 1975). Thereby, the role of food supplies in nest site selection by Brahminy kites is very clear. Nest site selection during the onset of North-east monsoon in Cauvery delta, is evident to procure prey species easily for nestlings. Thus, food supply may be of unquestionable use as a proximate cue in nest site selection of Brahminy kites as suggested by Hilden (1965) and Sturman (1983) for western raptors. However, the findings of Morris and Lemon (1983) in Red-shouldered Hawks at Quebec, Canada, differ from the above said view, as they consider that the use of food supplies as a proximate cue in nest site selection is questionable.

c. Central Place Foraging

In single-prey loaders, such as birds of prey, the prey load-size effect may select for transportation of large prey to the nest, if the distance from the capture site to the nest site is above a certain limit (Orians and Pearson 1978 and Stephens and Krebs 1986). Because the net benefit (i.e., ratio of energy content to transportation costs) of small prey in a single prey loader decreases more with distances to the nest than that of large prey, the best prey size to take to the nest increases with the distances to the nest (Schoener 1979 and Stephen and Krebs 1986). Therefore, transportation distances of small prey items should be shorter than those of medium-sized
ones, which in turn should be carried less than large prey items. Moreover, for each forager, there should be a positive correlation between prey-size classes and transportation distances. Orians and Pearson's (1978) model makes different predictions because it assumes that prey items are grouped into patches at a given distance from the Central place. Both small and large prey items should be taken at intermediate distances, whereas only small items should be preyed upon nearby and large items far away. The results of the present study on the effect of load-size in central place foraging by Brahminy kites have revealed that, among both male and female kites, there is relationship between mean transportation distances and mean prey weights. Among the females, transportation distances of intermediate prey types are observed to be longer than those of both small and large prey types. However, in male kites, the division of prey types into three size classes has showed that transportation distances of small prey types seemed to be short and those of intermediate and large prey types long. Accordingly, the effect of load-size on prey transportation distances of male has been stronger than that of the female kites. These differences between male and female kites in the transportation distances and prey-size types may be due to the "nest attendance instinct" of the female kites have been more than that of males. As a result, female kites carry more of the captured prey to their nests from medium distances, irrespective of the size-classes of the prey, rather than taking risk in the offspring protection, which is a critical part of parental care (Trivers 1972 and Carlisle 1982).
d. Rate of Seclusion From Human Habitations

Variation in the topographic data suggests that Brahminy kites may be quite flexible in this aspect of their nest site selection in Cauvery delta. In spite of disturbances in the form of more human activities such as vehicular traffic, tree climbing to harvest plantation products, scaring the nesting raptors to protect their poultry and fish drying yards, a greater proportion of nesting kites have preferred to construct their nests at human habitations at both the study areas. Though the reason for this higher nesting of Brahminy kites within human habitations is unclear, perhaps it may probably be related to their adaptation to parasitic life with humans as stated by Ali and Ripley (1983).

Earlier predictions concerning the impact of human activities on the behaviour of birds of prey and nesting success (Fyfe and Olendorff 19767) have been refuted by the results of this study. The experiences during this study have revealed that entering the nests of Brahminy kites during incubation and brood-rearing has no noticeable effect on reproductive success. Thus, it is clear that the range of human activities that have been exposed to the Brahminy kites during this study is within the tolerance level of this species. Although Brahminy kites may nest surprisingly close to human habitations, they probably prefer seclusion but have tolerated some human intrusions associated with vehicular traffic, agricultural activities, and even nest tree climbing for harvesting purposes. Similar observations have been made in the studies carried out by Sitter (1983) and Grier and Fyfe (1987) on Prairie falcons. However, Stachlecker and Alldredge (1976) have reported that the potential productivity of 14 nesting territories of Red-tailed hawks and
Golden eagles has been reduced by 20% as a result of an underground nuclear explosion in which 22% of the nests were destroyed. Moreover, White and Thurow (1985) have reported that the Ferruginous hawks have been very sensitive to experimentally controlled sound levels and in some cases have abandoned their nests. These studies illustrate that the response of raptors to human activities may vary considerably among and within species (Newton 1979). Absence of direct persecution and abundance of prey can attract for settlement of raptors, in areas of high human activity as demonstrated by the establishment of Peregrine falcons, European sparrow hawks, Hobbies (Falco subbuteo) and Merlins (Falco columbarius) in metropolitan cities (Ratcliffe 1980, Newton 1986 and White and Emison 1988).

**e. Breeding Territories**

The definition and concept of a territory has been much discussed in the literature (Noble 1939, Nice 1941, 1943, Odum and Kunezler 1955). Smith and Murphy (1973) have stated that home range of a breeding raptor might have been the area encompassed within the extreme positions and movements of raptors, plotted and connected. They have included the hunting sites also in their "maximum home range" category as described by Odum and Kunezler (1955). However, in the present investigation, the area defended by the breeding Brahminy kites around their nests, exhibited by inter and intra-specific interactions has been considered as their breeding territory, following Marquiss and Newton (1981), who have suggested that home ranges of raptors, during breeding have been centered around nests, and that ranges are smallest when the adults are attending the nests during Pre-incubation, incubation, and brooding. They have also indicated an
increase in the territory size as the age of the nestling increases. In contrast, a reverse trend has been observed in breeding territory sizes of Brahminy kites in relation with the phases of the breeding cycle. The breeding territories have been largest when the adults are attending the nests during pre-incubation, and incubation and shrunked during brood rearing period. This may be due to the fact that the breeding kites have to defend their breeding territories intensively during establishing their breeding territories from other nesting bird species of the same breeding season.

f. Nest Site Selection

To understand the nest site affinities of a raptor species, it is necessary to know whether the species randomly settles and nests in a habitat, or makes an active selection of a nesting habitat. Reynolds et al., (1982) have examined nest sites of Accipiters in North America by comparing within-to among-species variation of the habitat variables within nest sites. Their analysis has shown a significantly greater variation among species demonstrating that the association of these species within their habitat is at least not random. They have also suggested that the use of dense stands by Accipiters has been adaptive in that vegetation, which protected the adults and their young ones from predators and provided shaded mild environments. If this is true, then Accipiters probably choose nest sites on the basis of the stands overall appearance (eg., density, height, and presence of water bodies), and, after settling in to the stand, select a nest tree. Thus, according to them, choice of a nest tree may be secondary; if a pair settles in an acceptable stand, many suitable trees will be available.
Biologists frequently assume that nesting birds seek nesting substrates or trees which are unique and infer some benefit of them (Mosher and White 1976 and Titus and Mosher 1981). However, there exists several reasons why nesting substrates or trees may not differ from the available pool of suitable substrates or trees. First, available nesting trees may be fairly uniform and common in the environment. Given that suitable nesting substrates or trees common, birds may select nesting structures based on other criteria, such as social and territorial reasons as suggested by Edwards and Collopy (1988). In the present study, the lack of a consistent pattern in distribution of nest trees among the study locations provides little support for social factors as important criteria. Furthermore, Brahminy kites are known to nest as solitary pairs and in semi-colonial situations (Sekar 1989 and Murugan 1994), making it difficult to ascertain whether social or habitat constraints are most important. Moreover, if certain trees do infer some benefit and are limited, then better nest trees should be occupied first (Fretwell and Lucas 1970). No such pattern of occupancy by Brahminy kites, as evidenced by certain nest trees being selected from year to year, was apparent at either study locations from 1986 to 1992 during the period of this study.

Brahminy kites at both study locations do not appear to exhibit preference for any particular aspects of available trees. Brahminy kites have used trees that did not differ from the surrounding trees. In general, Brahminy kites in Cauvery delta prefer trees that are relatively high and in the periphery of a grove or solitary trees. Based on comparisons with neighbouring trees surrounding the nests at both the study areas, such trees are fairly common. Thus, the views of many authors (Matray 1974, Mosher and White 1976,
Reynolds et al., 1982 and Woffinden and Murphy 1983) on the preferences of raptors in some aspects of nest site characteristics have differed from the results of the present investigation on Brahminy kites. With the exception of preference for higher trees in relatively peripheral or remote areas, Brahminy kites nesting in Cauvery delta appear to have a fairly wide tolerance for nesting trees.

In Cauvery delta, Coconut tree groves, Palmyrah groves, aggregated Tamarind tree stands and solitary Rain trees, Ficus trees and Banyan trees appear to meet most of the nesting requirements of Brahminy kites. Characteristics of nest sites in these vegetation types include a well developed mature trees, with a reduced crown foliage, and species richness. This prominence of reduced crown foliage at the Brahminy kite nest site has showed their preference of either the monocot trees such as coconut and palm, or the dicot tree species like Tamarind tree, Rain tree, and Ficus tree, since phenological defoliation in these tree species at the onset of the summer season, enable the kites for easy accessibility to their nests for feeding their young ones, and the post fledgling young ones get flight exercise in the branches of their nest trees without any interruption. On the contrary, Reynolds et al., (1982) have reported that in Oregon, as well as throughout North America and Europe, the most consistent vegetative characteristic of Accipiter nest sites is high foliage density. According to them, dense vegetation certainly provides screening cover and physical protection from predators. They have also stated that having evolved primarily in shaded forests and woody conditions, Accipiters may have low tolerances of high temperatures and direct sunlight. But the preference to exposed nests in less
dense foliage by Brahminy kites may be due to their high thermal tolerance levels and positive orientation towards sunlight. Moreover, the breeding season of Brahminy kites begins at the onset of winter (December-January) during which warmth is mostly required for incubating parents and their altricial nestlings.

**g. Multivariate Relationships of the Nest Sites**

Principal component analysis has identified the variables which are most useful in the selection of nest sites by Brahminy kites in Cauvery delta. The analysis has also shown the similarity between the preference of the kites for the vegetation and topographic characteristics in Mayiladuthurai and Poompuhar study areas. The two most important Principal components in the analysis are the distance from the feeding sites and human activities. Analysis of vegetation characteristics suggests that, the basal area coverage and canopy height at the nest sites are the important factors determining the nest site selection of Brahminy kites. Any habitat alteration in the form of tree felling either by extensive cutting or by annual cyclonic winds during monsoon may drastically reduce the basal area/hectare, and canopy height at the potential nest sites of Brahminy kites. However, it is difficult to predict the response of nesting Brahminy kites to such alteration of the habitat. The results of their population dynamics have shown no evidence of a lower density of nesting Brahminy kites in an area like Cauvery delta, where the habitat has been modified by both the above mentioned factors periodically.
3. Reproductive Effort

a. Nest Building

Male Brahminy kites have contributed more nest sticks to the nests (79.61 ± 2.75%) during nest building. The average sticks loaded per day by male and female kites significantly differed (P > 0.05). However, no significant differences have been observed among the nesting pairs either in the mean number of stick loading/day (P < .05) or in the mean bout length per nest stick loading (P < 0.05). Although, Brown (1976) has not presented enough details about nest building activities of raptors, he has doubted the participation of both sexes in nest construction. According to him, in fish and sea-eagles the male may contribute more effort in nest building; but in most species of raptors the female alone builds the most part of the nest. He has also indicated that in the case of male nest building, the female is usually present at the nest territory. He has cited that male Goshawk alone builds the entire nest in one account, but opined that this would differ from any other accipiter known. In polygamous Harriers, the female builds the most part of the nest while the male brings some nest materials but spend little time in nest building (Brown and Amadon 1968). Weston (1969) and Smith and Murphy (1973) have indicated that both the male and female Ferruginous hawks bring nest materials to the nest site, but the female does the actual arranging.

b. Prey Deliveries

All the prey deliveries to the nest during Pre-incubation and incubation phases were exclusively by male Brahminy kites. Out of the total prey brought to the nest, male kite has delivered 73.96 ± 27.08% during the entire nesting cycle. The average number of prey items delivered by male to
the female kite during Pre-incubation phase have been $3.7 \pm 0.15$ prey items/day and significant variations have been observed among the nesting pairs in this aspect ($P > 0.05$). Carlier and Gallo (1995) have suggested that, the function of food bringing behaviour by male to the female during courtship and nest building may facilitate contact with the mate for future bondage. They have also pointed out that, in the course of incubation, the male may bring prey to the female in order to sit on the eggs, a male's instinct to express his parental care behaviour, by relieving the female from the incubation duties for a while. Cade (1960) has assumed that food bringing by male to female is an outlet of the male's internal sexual motivation. His explanation is that the males utilise this opportunity as a convenient strategy for courtship with the female. However, Calier and Gallo (1995) have viewed that the prey to the female should be the only outlet of a male's sexual impulse, because copulation usually stops when incubation begins. According to their explanation it would be the motivation of the male to incubate the eggs, which would mainly lead the male to bring a prey to the female. Thus, pre-incubation period prey offerings by male to female, prepare the pair with more courtship contacts, and lead them to a bi-parental incubation. Carlier and Gallo (1995) have considered that, this sexual contact has become a necessity for the male to convince his mate, who usually resists the access of male to the nest due to the fear of filicide (Bartolotti et al., 1991). Hence, the bi-parental incubation behaviour of Brahminy kites justifies the view of Carlier and Gallo (1995) on the male food bringing behaviour.

During nestling period, Monnert (1974), cited by Carlier and Gallo (1995), has concluded that hatching of eggs results in an aggressiveness
in the females’s behaviour. Therefore, the male hunts and offers prey to appease the female. But Carlier and Gallo (1995) have not supported this hypothesis since the female monopolises the young so that she prevents the male from approaching them through the breeding season except in a few occasions, when the male feeds the offspring strictly in the absence of female Peregrine falcon. However, in the present study, the male Brahminy kites have been observed to deliver most of the prey items to the nestlings and fledglings in the presence of female kites and in most of the occasions, when the female being at the nest itself. Moreover, the results of brooding behaviour by male Brahminy kite have confirmed the idea of inhibition of "brooding aggressiveness" by female kite due to bi-parental care, mate fidelity and previous experience with her mate. However, the percentage of brooding by the male kite is lesser than that of the females in Brahminy kites. On the otherhand, it can be assumed that the evolutionary trend of "Reversed Sexual size Dimorphism" in the Brahminy kite (Meenakshi 1990) may have resulted in the larger and more powerful female, with high motivation to brood the young. Therefore, the results of the present study have supported Cade's (1960) hypothesis by assuming that a reproductively successful pair bond can result only when the female kite is clearly dominant to the male and when the male kite makes a biologically adequate adjustment to his subordinate role in the pairing situation.

c. Incubation

The average incubation period of Brahminy kite in Cauvery delta has been observed ranging between 27 to 28 days. Ali and Ripley (1983) have noted that the period extends upto 28 days. However, Shodde and
Tidemann (1986) have pointed out that the Australian Brahminy kite incubates for a period ranging between 26 to 27 days. Newton (1979) has divided the incubating raptors into three categories, according to the participation of males in incubation such as, the males that fail to incubate or provide partial relief for the incubating female or share equally in incubation. In some Falcons such as Merlin (*Falco columbarius*), Pergrine falcon (*Falco perigrinus*) and Gyr falcon (*Falco rusticolus*), males may incubate for as much as one third of the daylight period (Enderson et al., 1973, Platt 1977, Newton et al., 1978 and Newton 1979). However, Ali and Ripley (1983) are of the opinion that male Brahminy kite's participation in incubation is doubtful. This view has also been supported by Shodde and Tidemann (1986), who have described that incubation is performed almost entirely by female Brahminy kite. In contrast, the results of the present study have confirmed the participation of male Brahminy kite in incubation (16.65%) of the total daylight hours. The female Brahminy kite has incubated most of the daylight hours (75.32%), and the male relieved the female from incubation during the time of food transfers from the male. The percent daytime incubation shifts of the female Brahminy kite is longer than the shifts reported by Platt (1977) for female Gyr falcons (67%), and by Enderson *et al.*, (1973) for female Pergrine falcon (60-70%), depending on the stage of incubation. Kaiser (1986) has also reported that male Peregrine falcon incubated 22% of the daylight hours and female 74%, while Hunt (1979) has given an estimation of 44% daylight hours incubation by male and 52% of the day by female falcons. Although strong bi-parental care has been observed in Brahminy kites, the eggs have been found unattended by both the parents for 8% of the
total day light hours of the incubation period. According to Drent (1975) and Hunter et al. (1976) leaving eggs unattended for long periods of time may cause embryo mortality, lower hatching success and depressed productivity. Since, the duration of unattended clutch in the present study is not such lengthy, it may be assumed that this is not contributing much for the un-hatched eggs observed in some nests. Moreover, most of the un-attended incubation bouts have been observed during "Nest relief" periods in Brahminy kites. Thirty three female incubation shifts have ended when the male returned with prey and transferred it to the female. Nelson (1977) has also observed the "food transfer-nest relief" sequence in the Prairie falcons, where the male incubates while the female is engaged in eating. However, in the present study the female Brahminy kite has not ended all incubation shifts when the male returned with prey. The male has arrived at the nest rim without prey on 8 occasions and after the female departed, the male began incubation. On eleven occasions, the female kite ended incubation by pursuing territory intruders that she has detected from the nest.

d. Brooding

Jenkins (1978) has defined brooding in a raptor is close sitting or standing over the nestlings by an adult to afford protection from external factors. Young ones of large raptors cannot regulate body temperature until about 2 weeks after hatching and require brooding by a parent, usually the female (Enderson et al., 1973, Ratcliffe 1980, Poole and Boag 1988 and Holthuijen 1989), since un attended small young may face death due to chillness or overheat (Fyfe and Olendorff 1976), thus resulting in lower productivity. In the present study, female Brahminy kites have been engaged
in brooding the young mostly during the day time (70.43%) and entirely during night time. Participation of male kite in brooding has also been observed, but with a lesser frequency (4.27±0.18 to 4.32±0.21/day) than the female kite (5.75±0.25 to 6.33±0.14/day). The average time spent for each brooding shift by male kite (range:22.17±4.53min to43.42±2.44min) has been shorter than that of female (range:35.25±1.66min to 75.08±10.22min).

The variation has revealed that the parental role of male during brooding has been more devoted to hunting and feeding the young ones than the female kite. This has been clearly indicated by Collopy (1984) from the parental role of male Golden eagle during brooding period as to provide food for the young, because he has observed no time has been invested in brooding the young by the male. Similar observations have also been made by Hunsicker (1972), Hoechlin (1974) and Ellis (1979) in male golden eagles, which rarely brood the young. The nest relief sequence during the brooding phase in Brahminy kite has been the same as observed during incubation. The male brings the food to the nest and the female Brahminy kite flies out to meet him with considerable calls. After prey transfer, the female begins to eat, while the male broods the young.

The percentage of day light brooding hours of the female Brahminy kite has decreased rapidly in the course of this study as the age of the nestlings progressed. No chicks have been brooded after 40 to 46 days of age. Overall daytime attendance at nests by both parents has declined in nest attentiveness in brooding and shading as age of the chicks progressed. This decrease in attentiveness correspond with the increased ability of nestlings to thermoregulate, walk and feed themselves (Collopy 1980). However, in
Brahminy kites the cessation of brooding does not occur suddenly. Instead, the young ones have been left unbrooded gradually with the advancement of nestling growth. Brooding behaviour has began to wane after the nestlings attained their second down feather coat. During the cessation of brooding, the female Brahminy kite has not left the vicinity of the nest, but frequently spends the time perched within a short distance from the nest. Only during the late fledgling phase the female kite has been observed to spend increasingly longer periods away from the nest, presumably to hunt at the feeding sites. Brahminy kites exhibit a division of labour between sexes in brooding and feeding the young ones. One factor responsible for this habit may be the altricial growth of the nestlings. Ricklefs (1974) has suggested that altricial young ones are poikilothermic for several days after hatching and almost be brooded by an adult bird until they are able to thermoregulate. He has also pointed out that the young ones also require some protection from nest predators even after being able to thermoregulate. Therefore, as pointed out by Cupper and Cupper (1981) in monogamous birds like Brahminy kite with altricial young, both adults usually must help in raising the young to independence.

In comparison with male Brahminy kite, female remains relatively less active in hunting prior to fledging of the young. Two possible reasons for this difference have been suggested by Mosher and Matray (1974) and Ricklefs (1974). First, the foraging by males may be less expensive energetically than foraging by females, because of the relationship between their body size (Revised Sexual Size Dimorphism) and metabolism and the second may be the energy requirement for egg-laying by female raptor,
necessitates additional energy intake. Applegate (1977) has also supported this idea by suggesting that the female kite could conserve energy by remaining relatively sedentary than the male kites during the brooding phase. However, during the late fledgling phase the female Brahminy kite has contributed more in feeding the young ones relatively similar to that of male. This may be due to the factor that, when the young approach the time of fledging, they no longer needed to be protected from temperature variations, and moreover, their energy requirements may exceed the resources that the male is capable of providing. Therefore, during the young reaches fledging stage, both male and female kites hunt and deliver the prey to their fledglings. Similar view has been expressed by Levenson (1979) from the results of his study on Ospreys.

e. Nest Defense

Breeding territories have been defended by Brahminy kites, both by patrolling and through aggressive interactions with intruders. Patrols by nesting pairs have reached maximum during pre-incubation, then declined and remained at approximately the same level during incubation and brood rearing. Patrolling may function to establish and advertise nesting territories during pre-incubation, as has been reported for other raptors (Newton 1979 and 1986). Once territorial boundaries have been established they are regularly patrolled during incubation and brood rearing by the breeding pair.

The nest defense behaviour of a raptor may be influenced by the factors such as, past experience with potential nest predators (Knight and Temple 1986), and a high probability of future reproduction (Barash 1980) and the ability to inflict injury to potential nest predators (Montgomerie and
Weatherhead (1988). As for other large raptors, reported by Newton (1979), Brahminy kites are also considered to be relatively longlived and have the opportunity to learn from encounters with potential territory intruders (including humans) through several breeding seasons and particularly in the period of their life from fledgling to first breeding. Hence, the intensity of nest-defense behaviour may be influenced by the number of outcome of previous encounters with intruders. This has been reflected in the present investigation, that the breeding pairs have exhibited a tolerance to the human intruders within their nest territories, unless the intruders climb the nest trees either for harvesting coconut, or extracting palm juice or picking tamarind from the trees concerned.

Trivers (1972) and Barash (1975) have predicted that parent birds should defend nestlings more aggressively as nestling age increases. This idea has also been reflected in the hypothesis of Harvey and Greenwood (1978) and Anderson et al., (1980) that nest-defense intensity should increase with nestling age due to increased conspicuousness to predators of nestlings during the nestling period. Studies of the nest defense behaviour of passerine birds have also documented an apparent increase in defense intensity through the nesting period (Knight and Temple 1986 and Montgomerie and Weatherhead 1988). Compared to many passerine birds, most Falconiformes are relatively longlived (Newton 1979) and possess the ability to attack and seriously injure potential nest predators (Knight and Temple 1986). However, Newton (1979) has suggested that most nest predation and reproductive failure in raptors occur early in the nestling phase or during incubation and considered the nest defense may be more intensive during this period. The
results of the study on nest defense behaviour of Brahminy kite have also been in accordance with the idea of Newton (1979), as the intensity of nest defense behaviour has a peak both in the incubation and early nestling periods, and gradually decreases towards the late nestling and fledgling phases of the breeding cycle. Moreover, it is unlikely that nestling visibility increases nest defense intensity with nestling age in Brahminy kites as reported by Anderson (1990) in Rough legged hawks. Uneaten prey remains in the nest, which may attract potential nest predators (Newton 1979) have also been less frequent in the Brahminy kite nests. Thus, intensity of nest-defense behaviour in Brahminy kite has decreased during the later phases of the breeding cycle in contrast to the earlier views.

In predatory birds, nest defense behaviour has been quantified in three species such as Merlins (*Falco columbarius*) (Fox and Donald 1980), Rough-legged hawk (*Buteo legopus*) (Anderson and Wiklund (1987), and Red-tailed hawk (*Buteo jamaicensis*) (Knight *et al.*, (1989) and Anderson(1990). Several authors (Storer 1966, Reynolds 1972, Snyder and Wiley 1976, Anderson and Norberg 1981, and Cade 1982) have suggested that larger females are more effective in deterring potential nest predators than smaller males, and advocated that distinct sex role partitioning in combination with female offspring protection and thus emphasised the "Female nest defense hypothesis". Although, Mueller and Meyer (1985) have found no support for this hypothesis in published accounts of nest defense behaviours in raptors they themselves have supported this hypothesis and also identified the sex role partitioning among raptors, in which males provide food and females brood and defend the nestlings. The idea of female nest defense rests on two
assumptions; i.e., distinct sex role partitioning in combination with female nest duties, other than offspring protection, ties her to the nest during longer periods of time than the male and that larger size (RSD) is advantageous in predator deterring actions. Although, the results of this study confirm the existence of a distinct sex role partitioning among male and female Brahminy kites during offspring protection in the form of patrolling and chasing intruders, in contrast to the female "Nest defense hypothesis", male Brahminy kites have defended the nests mostly. Thus, the female Brahminy kites have falsified the "Female Nest-defense Hypothesis" during the present investigation on nest defense behaviour of the raptors with Reversed Sexual Size Dimorphism. Anderson and Wiklund (1987) have also obtained similar results from the nest defense behaviour of Rough-legged buzzards (Buteo lagopus). They have also opined that the larger size of female raptors reduce their aerial agility and in contrast the males successfully attack the intruders, may be a selective factor constraining male's size.

**f. Parental Investment**

Trivers (1972) has formalised a "Theory of parental investment", which recognised that mating systems of raptors may be a function of the relative disparity in "Reproductive Effort" invested by sexes. Triver's (1972) hypothesis predicts that "Reproductive Effort" by the sexes in a given reproductive bout is unequal, the parent that invests less than its mate should be more tempted to desert its mate. Dawkins and Carlisle (1976) and Boucher (1977) have pointed out that desertion "decisions" should be based on the expected costs and benefits (future reproductive success) of desertion to the deserter, regardless of their past investments.
If the relative amount of parental effort expended by a parent bird at a nest is assumed to be important in determining which sex will be tempted to desert, the contribution of a parent in investing in one parental activity may be related to its contribution in future parental effort activities. Dawkins and Carlisle (1976) have formulated these ideas in their "Concorde Fallacy Hypothesis", which attempts to determine whether past expenditure of parental effort affects future expenditure of parental effort. The results of the parental effort correlation of breeding Brahminy kites have been weakly predictive of participation in future parental behaviour. Within the parental effort correlates of the six major behaviours such as patrolling, nest-building, incubation, brooding, prey deliveries to the nest and nest defense, there has been only a few significant relationships between expended effort and future efforts. For example, the males that contributed more effort in nest-building than their mates also delivered more prey to the nest and chased more nest intruders but in contrast, the males that contributed more effort in nest building have been less involved in incubating the eggs or brooding the nestlings.

Thus, the past parental effort expenditure of Brahminy kite parents neither affect the future expenditure of parental effort, nor influence mate desertion by either sexes. Although, Beissinger (1987b) has reported similar trend in the parental effort correlates in Snail kite parents, he observed mate desertion by either sex and concluded that it is not clear whether differences in reproductive effort act as solely as a causal factor in the desertion decision of Snail kites. He has also suggested that some of the differences in reproductive effort among the parents are a result of parental
adjustment of their expenditure of reproductive effort in response to other factors.

Moreover, the vast differences in male and female Brahminy kites' behaviour have been amplified by differences in their Daily Energetic Expenditures (DEE) for each parental care period such as incubation, brooding and patrolling. Due to quantification difficulties, other parental care activities such as prey transport and defensive interactions have not been included. However, the results of time activity budgets of male Brahminy kites have revealed expenditure of more effort by them in these activities than the female kites. Analysis of variance has revealed significant variations, in the DEE of male and female Brahminy kites (P > 0.05) among different phases of the breeding cycle but no variations (P < 0.05) among breeding pairs. Many authors have suggested that egg production is generally expensive and females are likely to have invested more energy than the males at the moment of conception (Trivers 1972, Wilson 1975, and Dawkins 1976), particularly of monogamous species (Burger 1981, and Werschkul 1982). But the average energetic cost to males to gaining access to matings has been much higher than the combined costs to females' egg production and daily activities (Beissinger 1987b). In addition, male Brahminy kites are more active in nest-building, hunting for prey, chasing predators or other intruders and patrolling the territory more, whereas female kites remain perched near the relatively safe nest site, or incubating or brooding the young; therefore males have to spend greater DEE than females.

Inspite of these differences in relative parental investments by the sexes of breeding Brahminy kites, no trend has been observed influencing "mate
desertion" behaviour among the pairs in the present study. It may be due to the rarity of mate desertion among most of the monogamous bird species (Lack 1968, and Oring 1982). The pair bondage of breeding Brahminy kites observed in the present study and also the report by Cupper and Cupper (1981) on Australian Brahminy kites in Queen's Land have revealed that this species normally retains the same mate of the previous year. It has also been observed that during non-breeding seasons, a particular pair used the same breeding territory for daily roosting, but in different trees or at least in different branches of a tree.

4. Management Recommendations

Although a single study on the ecology of breeding Brahminy kites may not provide conclusive results, compatible data compiled from several isolated bits of information, may be utilised for better understanding of the Brahminy kite's basic ecological informations such as habitat use, predator prey relationships, and population dynamics, before intelligent management programs can be planned, implemented and evaluated.

The food requirements of Brahminy kites, including the quantity and diversity of prey species, should be studied in the context of Prey-habitat associations. Knowledge of food habits of Brahminy kites and the place of their prey availability will be useful for identifying key habitats and areas on which wildlife managers should concentrate their efforts to conserve this top-carnivore of the food chain.

In an area like Cauvery delta, where most of the suburban areas undergo rapid development (eg., timber harvest, oil exploration activities, construction of human dwellings), disturbance (eg., recreation, transportation
and agricultural operations) and contamination of food web (eg., chemical pesticide application for intensive agriculture), changes in the habitat and the responses by Brahminy kites should be studied. These "experimental" (disturbed) and "control" conditions can provide useful data about the effects of disturbance as well as an insight into ecological processes.

The results of the present study have revealed that there are potential dangers for the breeding Brahminy kites especially on their nests and young ones by the coconut-pluckers, palm juice-tappers, tamarind pod-pickers and mango-harvesters, who normally consider their nesting as a hinderance to their operations and take all measures to scare the breeding birds, thereby discouraging them from nesting in their lands. In such cases, the land owners may be properly advised through mass media, in the agricultural programs, to postpone their harvesting operations, particularly in the nesting trees, until the breeding season ceases.

Moreover, management procedures, such as buffer zones around the nests of Brahminy kites, should be evaluated, taking into account the variability of vegetation structure, prey density and other environmental factors as well as the variables directly concerned with the management objectives (eg., amount of disturbance by humans).

More effort must be made to make the public aware of threats to Brahminy kites and to involve them in this species conservation activities. The results of on-site studies should be converged to conservation agencies, Forest and wildlife departments of the States, local residents, agriculturalists and development planners.
A sound conservation program must be found by well-designed investigations and the conscientious application of the results. The immediate need appears to be the collection of base line data on Brahminy kite distribution, density, and habitat utilisation throughout its range and monitoring of potential impacts on them.