Chapter 6
CONCLUSIONS
6.1. INTRODUCTION

This chapter is a synthesis of the conclusions I have reached in the rest of this thesis, on various aspects of behaviour and ecology of the White-crested Kalij. It also includes some additional information from another study (Sharma 1992) conducted at Summerhill in Shimla, Himachal Pradesh.

The aim of this chapter is to bring together all the information that is now available on the ecology of kalij. This, I think, will give a clear impression of what we now know about this pheasant in the wild. It will also serve to emphasise gaps in our knowledge that need further investigation, and will serve as a bench-mark (background) against which to take decisions concerning any management of this species and its habitats.

The social organization and the associated pattern of dispersion in kalij vary with the different phases of its annual cycle. These phases coincide approximately with the three major climatic seasons in the Himalayas which are accompanied by marked changes in vegetation structure.

6.2. SPRING SEASON

Winter flocks of kalij break down probably in the month of March, as most birds are seen either as single individuals or in pairs at this time. The time of breakdown of flocks may vary between sites, perhaps due to
altitudinal/climatic difference. At Waacham, which was situated at a relatively high altitude (2,470m), a substantial proportion of birds were still in mixed-sex groups of relatively large size at this time. The number of birds seen in pairs increases as the season progresses, and reaches a peak in the month before the onset of incubation. Sharma (1992) observed a similar pattern among kalij at Summerhill.

Since almost all the groups of mixed sex seen in spring are male-female pairs, it seems logical to assume that kalij are monogamous. However, the length and constancy of pair bonds have not been determined. At Waacham, no females were seen after the onset of incubation, but at Ghanahaati, about half the number of females were still seen during this period. This suggests that they breed relatively asynchronously here. In these cases it may be possible for males to pair with another female (Emlen & Oring 1977). Johnsgard (1986) speculated about this possibility, and it seems more likely to happen at warmer lower altitudes, possibly at places where females occur at higher densities.

There appear to be both males and females that are not always resident within fixed home ranges, and mate and feed opportunistically. Such birds were seen at both the sites, but their identity could not be ascertained. They could have been birds from neighbouring ranges seeking additional matings, or they might have been true itinerants, having no fixed home range of their own.
The spatial arrangement of the birds is not clear in early spring, and may only become evident rather late in some years as observed in 1986 when it became clear in the month before the onset of incubation. A pre-breeding season behaviour makes sightings of birds more frequent, many seem to occupy discreet areas of ground. Male-female pairs and single birds are seen feeding in separate areas in the mornings and evenings. Although, the birds did not carry any identity marks, individuals under continuous observation generally restricted themselves to certain areas only. Other males and females evidently intruded on these areas, and when detected they were made to leave by the presumed occupants. It thus seems probable that they live in more or less exclusive home ranges, but a rigidly territorial system of land-tenure has yet to demonstrated.

In the case of unmarked birds which live in thickly vegetated habitats, it is always going to be hard to draw boundaries between home ranges (assuming that they overlap little). Thus range sizes and extent of over-lap between ranges can not be estimated accurately. Based on the movements of birds in the open areas, it was evident that certain vegetational and topographical features such as patches of trees and ridges or nallahs coincided with the apparent boundaries between home ranges.

Sharma (1992) found that, of four radio-tagged birds, the home range estimators called Minimum Polygon Areas (MPA) of the three males over the two month period (May-June) were larger (mean = 3 ha, range = 1.70 -
4.59 ha) than that of the single female (mean = 2 ha, range = 1.36 - 2.63 ha). The areas where these birds spent an estimated 85% of their time (Core Home Ranges or CHR) were also larger for the males (mean = 1.32 ha, range = 0.60 - 2.91 ha) than the female (0.73 ha). The female undertook a major shift in the location of her range in late May. She therefore occupied a different range during laying/incubation than earlier, and this twice the size of the pre-nesting MPA. Her CHR's were located within the MPA of one of the tagged males and the CHR's of both over-lapped both before and after the female's range shift.

There was some shift in the monthly MPA's of the males also, but at no stage did the MPA's of the two contiguously living radio-tagged males overlap, and perhaps no other males were resident in the vicinity (?). The MPA of the third male was located some distance away. Based on these findings Sharma concluded that his radio-tagged males lived in territories. However, there is no information on the dispersion pattern of the remaining unmarked males.

The process whereby a male establishes and then maintains himself in an exclusive home range has not been observed. Very few fights and calls are heard in early spring. The rate of calling and wing-whirring increases as the season progresses, and this trend seems to be correlated with the increase in the number of intrusions which are indicated by fights or by fighting calls heard in the vicinity. Birds call and whirr their
wings at significantly higher rates on these occasions, so it is fair to speculate that these are both forms of a 'keep out' signal.

The calling repertoire of kalij is diverse, consisting of about 11 basic call types. Most of these are given in definite circumstances such as upon flushing, during fighting, after wing-whirring, and during tidbitting. However, the bulk of calling is given as bouts of only one type (Clucking), although sometimes in combination with another type (Whistling). Both these call types are given, at both high and low rates on different occasions, and sometimes follow or lead to the other call types. Such transitions at least potentially enable kalij to convey an array of different messages.

The aggressive behaviour of males consists of a series of threat displays aimed probably at persuading rivals to leave the area. When interactions persist, calling and counter-calling may be heard, often then leading to a fight.

Kalij males perform two types of courtship displays to their females. The lateral display may be seen before or usually after mating, perhaps only in the early part of the season, and tidbitting takes place in the period just before the onset of incubation. The members of a pair seem to benefit from high levels of corporate vigilance, but there is no evidence that the male in pair guards the female through increasing his rate of vigilance.
Breeding season home ranges of the birds consist largely of covered areas but with some open space as well. They feed in the open areas in the mornings and evenings, and if not feeding, may call from covered areas at this time. They avoid large blocks of uniform habitat, which are devoid of either openings or cover. They prefer tall scrub and a ground cover which is short. They feed on young crop plants and weeds early in the season or on fresh sprouts of grass in openings, and on growing wheat grain or flowers and fruits of bushes and trees later in the season. According to Sharma (1992), the kalij at Summerhill centred all their activities within 20 metres of nallahs which were wet and were used by the local human population for sewage disposal and as a dump for refuse.

6.3. SUMMER OR MONSOON SEASON

Kalij become secretive after the onset of incubation. Chance sightings from early summer (late June) onwards are yielded at a rate that is about 10% of that typical before the onset of incubation. Calling and wing-whirring also virtually cease at this point. However, in 1988 when observations were also made during monsoon, single individuals of either sex and pairs continued to be seen in this period, and calls were also heard. It is not known whether these birds had failed to breed, or were those who for some reason deserted their chicks. Chicks were seen at the beginning of summer (late
June) in this year, and were apparently without parents. However, Sharma (1992) saw almost all his birds in family parties of greater than three birds in this year at this time.

One of the reasons for low number of sightings later in the summer may be that food stuffs are available in openings only in spring, grow in most of areas as a result of the rainfall during summer. The accompanying increase in the abundance of small insects is known to be an important part of the chick food in the first few weeks of their life (Hill and Robertson 1988).

6.4. WINTER SEASON

The transition from summer to winter in the Himalayas is rather abrupt, and the changes in vegetation begin to appear soon after the end of monsoon. The majority of birds by this time are seen in groups (presumably families) of mixed sex. At Ghanahaati in 1990, groups of young birds of mixed sex were seen joining those from neighbouring ranges, and very few adult birds were seen with them. Later in the season at Waacham, a large group of adult birds was regularly seen ranging over an area which in the spring probably comprised at least two breeding home ranges. Sharma (1992) found that the young birds which by November were indistinguishable from adults were still roosting with their parents, separately from other birds.
At this time groups of birds spend a great deal of time during the day in open areas further away from cover than in spring, and feed and dust themselves in these areas. These birds were seen moving and roosting together.

6.5. FUTURE STUDIES ON KALIJ

My studies have still left much unknown about the ecology and behaviour of kalij. It seems appropriate now to identify remaining questions, discuss why they remain, and how they could be answered through the future studies. A discussion first of the problems I faced in the collection of data during this study, and how these could have been minimised, will greatly facilitate the planning of future studies, and help fieldworkers to use their meagre resources and limited field time efficiently to collect reliable data.

The greatest difficulty faced during this study was that the birds were not individually recognizable. Thus many statements about how individuals typically behave could not be made with great confidence. The individual recognition of birds might have been possible through idiosyncracies in the plumage patterns or variations in the call structure of individuals; however, none of these were observed in kalij. Using these methods, however, one can identify only a part of the population. For instance, in pheasants differences in plumage patterns can readily be observed only in males which are generally more
colourful than females, and probably in most species of pheasants only the males call. Additionally, these differences, minor though they are, cannot be easily read at a distance when the bird is engaged in a behaviour requiring fast action and/or when it is in an obscuring habitat. These methods are thus not very dependable.

For more reliable recognition of individual birds, it is necessary to equip them with artificial identity marks. Birds are trapped using a variety of trap or net designs available (e.g. Schemintz 1982), and identity marks in the form of leg rings of different colour or numbered and/or lettered wing or back tabs are attached to the birds. Back tabs are more popular in game-bird studies (e.g. Ridley 1983, Hill & Robertson 1988), as a fin stands erect on the back, and the identity number or letter can be written on both sides of it which offers higher chances of its detection at a distance.

However, the use of these identity marks is limited to those habitats where birds can be readily seen and to those phases of the annual cycle of birds' life when they frequent open habitats. Once the birds become secretive as happens during hatching or chick-rearing, or when the vegetation grows thicker as it does during the monsoon in India, such methods are no longer useful. In the Himalayas, the fall in visibility due to low cloud cover during monsoon, and the accompanying rapid growth of vegetation make the observation of birds extremely
difficult in this season, leaving aside the difficulty of using binoculars in wet weather.

Radio-tracking is the only method which helps in surmounting these difficulties. A small radio-transmitter, attached to a bird on a neck-collar or harnessed to its back, emits signals of unique frequency (typically 1-200 MHz). A receiver with a directional antenna (aerial) allows one to determine the location of the individual by triangulation. Mercury tilt-switches can be incorporated into the transmitter 'package', which will enable one to determine whether an individual is active (feeding, moving) or resting, without disturbing or approaching it. A series of radio-locations recorded over a period of time, and plotted on a map of the area, reveal which areas and habitats the bird is using. Such information is unbiased as the bird is not disturbed at all. It is also possible to discover the location of nests and roosts using this equipment.

Radio-tracking can only reveal information on the spatial relationship between animals, and its contribution to our knowledge of the social system of a population is limited to indicating spatial correlations between or within sexes. Such information is of vital importance particularly in our understanding of the mating system of a population i.e. the process of acquiring mates, number of mates acquired, length of the association between mates, and the contribution of the sexes to the care of the young. Indeed, it is now clear from some studies on other animal species that different
individuals in the same population may be pursuing quite different mating strategies (e.g. Davies & Houston 1986). It has been concluded that accurate information on the mating systems involved, is impossible to obtain from conventional observational field studies because all individuals cannot be kept under observation all the time. Analysis of true mating system is only possible through laboratory techniques such as electrophoresis (e.g. Hanken & Sherman 1981, Foltz & Hoogland 1981), and the recently developed DNA finger-printing (e.g. Burke et al. 1989).

Whilst it is important to use these techniques in studies specifically aimed at unravelling the mating system of a population, these are not advisable in studies aimed at understanding the basic ecology of a species. For a study with limited resources, it will perhaps be advisable to mark a sizeable proportion of the birds in a population (more than 20 individuals), and to put radio-collars on some males and females (a minimum of 5 for each sex) living in the same vicinity.

This study attempted to address some aspects of the ecology and behaviour of kalij, but due to the constraints discussed above, it yielded only rather limited information on these aspects. Whatever has been concluded is true of this species at the two sites at which this study was conducted; it is not clear how general these conclusions are. The following are points
which should be the focus of future studies of this kind on the White-crested kalij:

1. This study revealed that kalij are probably monogamous, but the time when pairing occurs, and the nature of any mate selection procedures is not known. The duration of the pair bond, and the possibility of males associating with more than one female, particularly at lower altitudes where females may breed asynchronously, needs to be ascertained. The true social position of the 'occasional' males and females which appeared in this study also needs to be ascertained. Other aspects about its breeding biology such as nesting, clutch size, hatching success, chick mortality etc. need to be studied.

2. During this study the kalij were observed living in home ranges from which they excluded other birds. There is some indication from another study (Sharma 1992) that they may be territorial. However, there is not sufficient evidence to confirm this at present, and additional studies need to be carried out to ascertain dispersion pattern, and the nature and timing of dispersal behaviour.

3. The quantity and quality of different habitats within home ranges needs to be assessed, and then contrasted with the surrounding habitat, in order to deduce what factors lead to the preference of one area for a home range over others. The comparison between the quality and quantity of habitat in different home ranges may also help us to understand the cues used in the mate
attraction and in determining reproductive success. A study of the diet of the birds, both as chicks and adults, is also essential to understand the above relationship.

4. The vocalizations of kalij are many and varied. Although some have been shown to be associated with intrusion into home ranges, their functions will only become clear through making observations of birds normally (during intrusions and spontaneously) and during play-back experiments in different seasons. These experiments can be used to delineate the borders between home ranges, and will also identify the call types that can be used effectively in eliciting response from all or most groups of birds in order to assess their density.

5. This study identified some of the types of behaviour used by kalij during the mating season in its interactions with rivals and mates. However, the number of such observations was low, and thus the function of these behaviours could not be fully understood. It remains to be seen what changes occur in them over the year and what other behaviours are used during seasons other than spring and early summer. The behavioural interactions which take place between the birds during the establishment of the home ranges is not known. This study showed that males and females benefit from each other's presence whilst feeding in the open, suggesting that an advantage accrues to them from their corporate vigilance; however, the respective contribution of partners to it is not known, and a future study could
compare the individual and combined vigilance and feeding times of birds in pairs.

6.6. RECOMMENDATIONS FOR MANAGEMENT

Whilst all decisions concerning the management of kalij populations and their habitat should be based on studies with this specific objective in mind, a few points will be made here for consideration in the interim by managers.

The two sites at which the present study was conducted differed from each other chiefly in the quality and quantity of the vegetation present, and in the level of human interference. At Waacham the local people used the site to graze their cattle and sheep for a greater part of the year, and carried out shifting cultivation (ijer) on it every five to ten years. The resultant patchy structure of vegetation was thus a result of these activities. The vegetation present at Ghanahati, on the other hand, was primarily the result of the past regime of felling and replanting, although to some extent also due to the construction of the road in the north.

At both sites, however, observations were made which reflected a common pattern of preferences and avoidances for certain types of habitat. The kalij has long been known to prefer feeding in the open areas; in this study also, it was observed that openings in forest or scrub are an important component, suggesting that there are preferred food plants growing in these openings. The
The southern part of the Ghanahaati site had a thick cover of oak trees which did not have any openings in it, and probably as a result very few birds inhabited this area. At Waacham on the other hand, in 1986, the greater part of the habitat was covered with thick scrub, but owing to the presence of numerous openings in it birds were regularly seen using this area. At Ghanahaati, the birds were regularly seen feeding in the mornings at the edge of road, and the construction of the road has thus rendered habitable an area otherwise devoid of any openings.

The utility of these openings probably depends on their size. At Waacham, scrub clearance followed by phaphar cultivation in 1987 created a large opening which had a super-abundance of young cereal plants. The birds avoided this area, and usually fed in the openings amongst scrub. At Ghanahaati, the Forest Dept. Nursery consisted of two large terraces which had no cover in them, the birds generally avoided it. On the other hand, at the terracings site the individual fields were narrow and of small size, with cover present on at least two sides. The birds strongly preferred them. The importance of cover is further stressed by the calling behaviour of kalij. They rarely ever called whilst in the open, perhaps because it puts them at risk from aerial predators. Thus for this activity the presence of cover adjacent to openings may be crucial.

Many earlier reports mention sightings of kalij close to water sources. In this study also, birds were
sighted near nallahs, but no observations of birds 'going regularly to drink' were made. It is probably green herbs and grasses growing in the adjacent wet areas that attracts these birds to stream beds, or, in the case of adults with chicks, an abundance of insects for the young to consume. At the terracings site, most of the home ranges did not include a water source, and although the early breeding period coincides with the hottest weather and water scarcity, no daily movements to and from the water source were observed. At this time, however, a number of shrub species bore fruits which were taken by kalij. These together with flushes of green grass and herbs seem to fulfil the water requirements of the birds.

From the above discussion of its preferences, the best habitat for kalij seems to be one that will allow it to undertake all its different activities in a small area. Thus, a mosaic consisting of some open space for feeding, with a substantial measure of cover consisting of both scrub and trees, interspersed with some fruit bearing bushes, will probably be ideal for kalij. If active habitat management is to be undertaken, openings in the form of strips will probably be easier to cut. They can also act as fire-gaps in the habitat, and will facilitate the monitoring of kalij and other wildlife populations through their use as transects. It seems the abundance of kalij is likely to ultimately depend on the amount of edge-habitat available.