Chapter 5

HABITAT USE
5.1. INTRODUCTION

Animals might be expected to live in places where the prevailing physical and biotic factors produce optimal conditions for them to feed, breed, escape from predators and shelter from bad weather (Partridge 1978, Rands 1988). These places or habitats, which are themselves a result of the geophysical events of the past, have presumably played a major role in shaping the evolution of the animal species that they support (Partridge 1978).

Preferences for certain types of habitats are inherited by animals, but new ones may also evolve if significant breeding occurs in new habitats (Partridge 1978). These new habitats come into existence as a result of natural or artificial processes. Animals must adapt to the changing environment to enhance the chances of their survival and that of their offspring. In recent times, however, man has brought about changes, often irreversibly, at a much accelerated pace with the result that a number of species became extinct, and a number of the remaining species are reduced to small isolated population threatened with extinction.

Quality of habitats plays a significant role in determining the survival and reproductive output of a population in an area, including the immigration into and emigration from that particular area (Rands 1988). The importance of the various habitat components such as food quality and nesting cover has been experimentally shown
to increase the density of game birds such as Red Grouse and Grey Partridge (Watson et al. 1977; Potts 1986; Rands 1985, 1986 all in Rands 1988). In order to understand the influence of the resources available to a population in an area, it is imperative to study how the animals are utilizing their habitat. The understanding gained from such a study would then be used for safeguarding the population against extinction by recommending measures for management of its habitat, and eventually perhaps for producing surpluses for economic exploitation.

The study of habitat preferences of a species involves comparing the observed level of utilization of different components of the habitat such as vegetation, topography, water etc. with the relative levels of availability of these factors in the habitat. This may be done at two levels: macro- and micro-level, depending upon the objectives of the study. The macro-habitat is assessed for ascertaining the presence or absence of a species from an area and to study the relationship of the animals with the environment, and investigating the relationship between two species, if co-existing in an area (Evans & Hill 1991).

Microhabitat determines the finer distribution of a species within a broad habitat type or a macro-habitat (Partridge 1978), and influences its relative abundance in that habitat type depending upon the presence of such daily resources as feeding areas, display areas, nest sites etc. (Evans & Hill 1991). The number of variables measured for micro-habitat assessment depends on the
nature of the study and on the attributes of the habitat
to which the study population is responding (e.g. Brenan
1987; McGowan 1989; Young et al. 1991 and Evans & Hill

Information available on kalij in the literature
gives an approximate idea of the broad habitat types in
which they are found. These reports, however, are not a
result of any systematic studies aimed at assessing the
habitat preferences of kalij, but result mostly from
rather superficial studies such as rapid status surveys
etc. (see section 1.4.).

Jerdon (1864) reports kalij as occurring in forests
of every description in the low to middle altitudes. Bump
& Bohl (1961) report kalij as inhabiting a very broad
range of habitats starting from the deciduous species in
the Himalayan foothills to the oak forests of the middle
altitudes. Roberts (1970) reports them as inhabiting
sclerophyllous forests on lower foothills and also found
them frequenting the subtropical Chir Pine forest zone.
Ali & Ripley (1983) report them as being present in a
variety of different forest types such as sal, oak,
spruce, and rhododendron. Gaston et al. (1981) reported
most of their sightings from places belonging to the
Himalayan moist temperate forest belt, principally of ban
oak, which places is associated with other species of
oak. A few of their sightings, however, were also from
the presence of kalij in all types of forest, and Garson
& Sharma (1987) report them from forests containing a mixture of deodhar and moru and ban oak.

Most of the above reports stress the presence of thick undergrowth in the habitats where they found kalij, and Gaston et al. (1981) found them abundant in the disturbed forests, presumably meaning the scrub that grows as a result of heavy lopping of trees. Some of the reports also mention openings and presence of water as being important components of the habitat of kalij.

The above reports evidently do not give any clear idea of which habitats were preferred by kalij, nor do they say how preferences change in relation to the seasonal changes in the habitat with climate. An important objective of the present study therefore was to assess the relative importance of the various habitat types present at each of the study areas, and to see how this changed over time.

At Waachum the pattern of habitat use by birds was studied at both the macro- and micro-level; at Ghanahaati only macro-habitat assessed. In order to get a balanced view of the use of different habitats by birds, the availability of each habitat was assessed at both the sites. Chapter 2 gives a detail of the methods employed in sampling vegetation and collecting data on habitat use by birds in the field.

This chapter gives details of the methods used in analyzing the data collected in the field, presents the results obtained, and discusses them in the light of findings of some other studies of game birds.
5.2 ANALYTICAL METHODOLOGY

A number of statistical methods, both multivariate and univariate, are available to analyze the data collected on habitat use by birds; their application depends on the nature of the study and on the way the data have been collected in the field. In this study three methods were used to analyze the data. They include the Bonferoni confidence intervals method, the Jacobs' preference index method and the Binomial test.

The Bonferoni method involves constructing confidence intervals describing probable use rates for each of the habitat types in an area, based on the proportion of their utilization (Byers et al. 1984). If the expected proportion of usage does not fall within the interval for that habitat type, it is concluded that the expected and actual utilization rates are significantly different at that level of confidence (Table 5.1). The confidence intervals are constructed by the formula:

\[
pi - Z_{\alpha/2} \sqrt{\frac{pi (1-pi)}{n}} \leq p_i \\
\leq pi + Z_{\alpha/2} \sqrt{\frac{pi (1-pi)}{n}}
\]

where \(pi\) is the actual proportion of utilization of a particular habitat type; \(Z_{\alpha/2}\) is the upper standard normal (z) table value corresponding to a probability tail area of \(\alpha/2\) (\(\alpha\) = the desired level of confidence and \(k\) is the number of habitat types.)
Table 5.1  Illustration of Jacobs' (1974) method of finding indices of preference for a number of habitat types available, and Byers' et al. (1984) method of finding statistical significance for different levels of their usage. Data used are from the Dev Nagar Road at Ghanahaati and pooled (N = 231) for spring 1988 and 1989. (see Fig. 5.7 for the distribution and extent of different habitat types at Ghanahaati, and Fig 5.12 for the graphic representation of this table)

<table>
<thead>
<tr>
<th>Habitat type&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Proportion of usage</th>
<th>Jacobs' index</th>
<th>Bonferoni intervals for two probability (P) levels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Observed</td>
<td>Expected</td>
<td></td>
</tr>
<tr>
<td>1. Oak</td>
<td>0.636</td>
<td>0.649</td>
<td>-0.028</td>
</tr>
<tr>
<td>2. Oak-Chir</td>
<td>0.126</td>
<td>0.037</td>
<td>0.579</td>
</tr>
<tr>
<td>3. Deodhar</td>
<td>0.048</td>
<td>0.024</td>
<td>0.344</td>
</tr>
<tr>
<td>4. Cypress</td>
<td>0.004</td>
<td>0.007</td>
<td>-0.274</td>
</tr>
<tr>
<td>5. Terracing</td>
<td>0.173</td>
<td>0.243</td>
<td>-0.211</td>
</tr>
<tr>
<td>6. Pasture</td>
<td>0.013</td>
<td>0.045</td>
<td>-0.563</td>
</tr>
</tbody>
</table>

<sup>a</sup> see text for full names of habitat types
<sup>*</sup> significant at the level shown in that column
<sup>ns</sup> not significant
The Bonferoni method was used to assess the preference of the macrohabitat at both the study sites, and in addition, for micro-habitat preference at Waachum. The preferences were tested at .05 and .01 levels (see Table 5.1). The Jacobs' method gives a simple index of preference for various types of food or habitats by the animals. It gives a value of between 0 and 1 if a given habitat is selected for, and a value of between -1 and 0 if it is avoided (Jacobs 1974). Jacobs' preference index is calculated by employing the formula:

\[ D = \frac{r - p}{r + p - 2rp} \]

where \( r \) is observed proportion of use of a given habitat, \( p \) is the expected proportion of utilization of a given habitat.

The Jacobs' method was used to calculate indices for preference of different habitat types at both the study sites including the microhabitat analysis at Waachum.

The Jacobs' method does not give the statistical significance of a particular proportion of utilization: it is possible to have a very high or low Jacobs' \( D \) without there being a statistically significant departure from what is expected. This is most likely to arise when sample sizes are small.

Whilst constructing confidence intervals for Bonferoni test, a small value of .001 was added if no observations (i.e. \( p_i = 0 \)) were made in a particular habitat type to see if it would, in any way, alter the
significance of preference for that particular habitat type.

As a result of low sample sizes the Binomial test was used to determine which of the two scrub height categories (<1.5m or >1.5m) was preferred. The following formula is suggested for use with sample sizes of less than 25 (Siegel 1956 p37):

\[ \sum (N_i)P_i Q^{N-i} \]

\(N\) is the sample size; \(P\) is the number of observations in one category; \(Q\) is number of observations in the other category.

5.2.1. Computation of the Expected Proportions

The expected proportion of utilization used in testing significance of preference for different habitat types in the Bonferoni procedure, and for calculating the Jacobs' preference indices were computed in two ways as a consequence of following two different methods for collecting data on preferences in the field at the two study sites.

At Waachum where I made observations from two vantage points, a formula was devised for macrohabitat analysis that took into account the varied areas of different habitat types observable from each vantage point, and variable amounts of time for which observations were made at each point. \(P_A\) the proportion of observations expected in habitat A is given by the following expression:
\[ P_A = \frac{\sum (A_i/\Sigma T_i)}{\Sigma \Sigma T_i} \]

where \( A_i \) is the area of habitat type A visible from vantage point \( i \); \( T_i \) is the total observation time at vantage point \( i \); \( H_i \) is the total area of ground visible from vantage point \( i \).

For microhabitat analysis at Waachum only those habitat sampling points were included in analyses which were within the areas visible from my two vantage points. The expected utilization was worked out as the frequency with which each category of the four variables measured were encountered in the total sample. The expected utilization pattern (at macro and micro levels) was calculated on a monthly basis as a result of the changing structure of vegetation (see chapter 2).

At Ghanahaati where only macrohabitat preferences were studied, the expected utilization along the Dev Nagar Road was calculated by measuring the length of road next to each habitat type on either side of the road. The different lengths of same habitat types were then summed and expressed as a proportion of the total length of the margin (i.e. two times the length of the road).

The observations in and around terracings at Ghanahaati were made from a single vantage point. The proportion of sightings expected to be made there were based on respective areas of different habitats expressed as a proportion of the total area observable from the vantage point.
5.3. HABITAT AVAILABILITY

The habitat at the two study sites differed both in terms of the total area they encompassed as well as the proportion of different habitat types present.

5.3.1. Waacham: Macrohabitat

At Waacham in 1986, three major habitat types were available to the birds (Fig. 5.1). The scrub covered most of the area (86.2%) observable from the vantage points, and the other two habitat types accounted for 11.2% and 2.6% of the area respectively.

In 1987, four major habitat types were defined at Waacham: ijer, scrub, pasture and forest (Fig. 5.2).

5.3.1.1. Ijer

The ijer accounted for the major proportion (57.1%) of the area observable from the two vantage points combined. This area changed in structure between the three periods considered (i.e. 15 March to 14 April, 15 April to 14 May and 15 May to 14 June). The area was under thick scrub until February 1987 when it was cleared by the local people for subsequent cultivation (see Chapter 2). Thus in period 1, all of this area was covered with cut scrub left there to dry.

In the early part of period 2 the cut scrub was burnt. Tilling and the sowing of phaphar continued until the end of the period. In a few places, the phaphar seedlings had begun to grow by the end of this period. In
Fig. 5.1 Proportion of various habitat types available to kalij in spring 1986 at Waacham.
LEGENDS:

- Scrub
- Forest
- Area observable from the vantage point
- Pasture
- Ijer
- ▲ Vantage point

Fig. 5.2 Proportion of various habitat types available to Kalij in spring in 1987 at Waacham.
period 3, the phaphar continued growing densely and eventually covered the whole of this area.

5.3.1.2. Scrub

This habitat type was present to the extent of 35.3% of the total area observable. The scrub became progressively thicker as the season progressed, and in period 2 the scrub species *Indigofera* and *Berberis* were respectively in flower and fruit. The ground cover in the less dense parts of the habitat also increased both in height and density during this time.

5.3.1.3. Pasture

This habitat, present on the steeper hill sides and as islands in scrub, represented about 5.2% of the total area observable. The ground cover in this habitat increased both in height and density as the season progressed.

5.3.1.4. Forest

Although the area of the forest observable from the forest was great, only the area in which birds could be seen was included. This area accounted for about 2.3% of the total area observable. This habitat type was thinner during period 1, but as the season progressed both the ground cover and the woody understorey became thicker with the growth of both ferns and foliage on ringal bamboo.
5.3.2. Waacham: Microhabitat

The availability of different microhabitat conditions was measured in circular plots of 5m radius, about 75m apart, on a grid (see Chapter 2). The components measured in each plot were tree cover, scrub height, scrub density, ground cover height and ground cover density.

5.3.2.1. Tree Cover

The trees, mostly oak, did not form a continuous stand, except in the forest habitat type, and were otherwise scattered in some parts of the study area. They were heavily lopped for fodder. Their assessment was restricted to presence/absence. Of the 28 sampling plots that were within the area observable from the vantage point, only 29% had some form of tree cover.

5.3.2.2. Scrub Height

The scrub was recorded as belonging to either of the two categories: <1.5m and >1.5m. The scrub height did not change significantly over (P>.05) the three periods and the only noticeable change was in <1.5m category which consisted principally of cut stumps (Fig. 5.3 a). As the season progressed new shoots sprouted on these stumps.

5.3.2.3. Scrub Density

The scrub density showed gradual changes over the three periods (Fig. 5.3 b ). In period 1 about 88% of the sample had a scrub cover of about 50% or less, and only
Fig. 5.3 Monthly changes in the scrub height (a) and scrub density (b) availability for microhabitat selection by kalij in spring 1987 at Waacham. Period 1 extended from 15 March to 14 April, Period 2 from 15 April to 14 May and Period 3 from 15 May to 14 June.
about 12% had more than 50% cover. In period 3 only 73% of sampling sites had 50% or less scrub cover while as the units with scrub cover thicker than 50% increased to 27%. However the majority of the sampling units in all the three periods fell in the category of 11-30% followed by 31-50%. The change in scrub density occurred principally in the scrub of >1.5m height.

5.3.2.4. Ground Cover Height

All the ground cover height categories were encountered in the sample in period 1, and majority of the units had a ground cover less than 10cm height (Fig. 5.4 a). In period 2 the ground cover was cleared for phaphar by burning the cut scrub and slashing all the new growth such as ferns etc., thus removing much of the vegetation in the height categories 31-50cm and >50cm. The ground cover from then onwards was the phaphar, which started growing towards the end of period 2 or earlier where it was sown early. About 90% sample points had ground cover which was less than 10cm height. The majority of the sampling points (75%) still had less than 10cm high ground cover in the period 3, although it had grown beyond that height in the remaining samples.

5.3.2.5. Ground Cover Density

The ground cover thickness changed as slashed scrub was burnt and phaphar sown. The majority of the samples (42%) in period 1 had between 51-70% ground cover and 38% of sample points had about 31-50% (Fig. 5.4 b). After
Fig. 5.4 Monthly changes in the ground cover height (a) and ground cover density (b) availability for microhabitat selection by kalij in spring 1987 at Waacham. Period 1 extended from 15 March to 14 April, Period 2 from 15 April to 14 May and Period 3 from 15 May to 14 June.
phaphar was sown, it started growing gradually and most of sample plots (63%) had 50% or less dense ground cover; only about 37% of the plots were covered with >50% thick ground cover. In period 3 most of the plots (72%) had a cover between 51-70% thick, and of the plots half had a ground cover of less than 50% density and the other half had greater than 70% ground cover.

5.3.3. Dev Nagar Road: Macrohabitat

At Ghanahaati the measurement of habitat availability was restricted to the Dev Nagar Road and the terracings, the two places where birds were regularly observed.

The following habitats were present along the road (Fig. 5.5):

5.3.3.1. Oak forest

The oak forest represented about 65% of the habitat along the road. In the early part of the season the oak trees underwent a partial leaf fall which continued till about the middle of April, after which new leaves started growing. The change of the understorey height in this forest was not appreciable, but the density of the scrub increased gradually through the study period. The ground cover increased perceptibly over the study period but its density remained low throughout.
Fig. 5.5 Proportion of different habitat types available to kalij along the Dev Nagar Road at Ghanahaati.
5.3.3.2. Oak-Chir forest

The mixed oak & chir forest occupied about 24.3% of the habitat along the road. It consisted of about 12.6% of mixed oak and chir stands, about 11.7% of a mixed oak, chir and cypress stand. These were therefore combined with the former on account of its similarity with that habitat type. In the rare situations in this habitat in which chir pine was dominant, the ground was covered with needles which restricted growth of annuals to some scattered blades of grass. In the rest of this habitat type dead grass from previous growing seasons was present, through which new shoots grew as the season progressed.

5.3.3.3. Pasture

The pasture was mostly present in the upper regions to the north of the study area. It was present only at one place along the road and therefore accounted for about only 3.7% of the area scanned regularly. This habitat type also had some relatively tall grass present from the previous growing season. Some new growth took place on the tussocks as the season progressed.

5.3.3.4. Terracing

The only terracing present along the road was the Forest Department Nursery which occupied about 4.5% of the length of the transect. The seedlings of several tree species such as oak, deodhar, accacia and chir pine were grown in these beds. Seeds were sown in Polyethylene bags in spring and transferred into beds during monsoon. The
seedlings, usually a year old, were extracted and distributed for planting in the neighbouring area.

5.3.3.4. Cypress

A stand of cypress was present to the north of the Nursery and a small portion of this stand represented about 0.7% of the length of the transect. The cypress trees formed a thick canopy and as a result there was very little ground cover present beneath them.

5.3.3.4. Deodhar

A small grove of the deodhar trees was present to the south-east of the Nursery and accounted for about 2.4% of the area of the transect. On account of its relatively open canopy, the grove had some understorey and some thin scattered ground cover which changed very little over the study period.

5.3.4. Terracings: Macrohabitat

The number of habitat types in and around the terracings was also six (Fig. 5.6); the cypress was absent, but scrub was present along with the other 4 habitats. The availability here was measured as the proportion of the area observed of each habitat type.

5.3.4.1. Oak forest

The oak patches were the major habitat type here accounting for about 31.4% of the area observable from the vantage point. The changes in these patches were more
LEGENDS:
- Oak Forest
- Chir Pine
- Oak-Chir Pine
- Dike or Toda
- Pasture
- Terracing
- Scrub

Fig. 5.6 Proportion of different habitat types available to kalij at the terracings site at Ghanahaati.
or less same as in the oak forest along the road, except that the oaks here were lopped regularly for fodder.

5.3.4.2. Terracings

The terracings were the next major habitat type here, representing about 20.8% of the observable habitat area. The major crops grown in these terracings were maize in summer and wheat in winter. The maize was sown in late May and wheat in late October. There was, however, no regular rotation of the crops among the terracings. In some of the terracings other crops such as potatoes, ginger and other vegetables were grown in smaller quantities. On the peripheries of these terracings in the bandhs (dykes) grew some scattered trees of a number of deciduous tree species which were lopped heavily for use as cattle fodder.

5.3.4.3. Scrub

The scrub was generally present along the bandhs that supported the terracings, accounted for 16.7% of the total area observable from the vantage points. The most common species of scrub were Rubus and Berberis. The Rubus bushes produced fruit in May and Berberis in June. These bushes were trimmed during the sowing as they interfered with ploughing and other work in the fields. The bandhs also had a tall or thick cover of grasses from the previous season present in them, in addition to a number of species of herbs which were plucked from the
field boundaries to prevent them from advancing into the crop fields.

5.3.4.4. Pasture

The pasture, which represented about 15.8% of the observable area, was present to the north and east of the terracings. This habitat type also included some abandoned fields which had not been cultivated for a long time and had a dense layer of tussocks growing in them. The hay in the pasture was harvested during the winter and continued till about late April. Fresh blades of grass started growing as the tussocks were exposed after the harvest. An occasional shower in late spring caused a temporary flush of green grass to grow throughout the pasture-land. The abandoned fields were grazed by cattle occasionally and thus also supported some fresh herbage; in shady area these fields also had some mosses growing in them.

5.3.4.5. Chir Pine

On the west and the northwest of the terracings are present small stands of chir pine, together representing about 7.8% of the area observable from the vantage points. They did not undergo much change except the growth of some scattered blades of grass beneath them in spring.
5.3.4.6. Oak-Chir Forest

A mixed stand of oak and chir pine occupying about 7.5% of the area observable, grows to the southwest of the terracings. It did not support much ground cover.

5.4. RESULTS

The analysis of habitat preferences of kalij was carried out on the basis of direct sightings of birds, in groups or as individuals (see Chapter 2), at the two study sites. On the terracings at Ghanahaati in 1989, the preferences were also estimated separately by using calling sites, which could be located with confidence within particular blocks of uniform habitat. Such analysis could not be carried out on call data from the road in Ghanahaati (1988/89) or from Waacham (1986/87) on account of small sample sizes. However, calls heard in these areas have been used, wherever possible, to indicate the use of those habitat types in which sightings were not made.

5.4.1. Macrohabitat Use

5.4.1.1. Waacham 1986

The analysis of sightings of the birds revealed no significant differences in the utilization of various habitats between the months during the study period in 1986; the data were therefore pooled. Of the three habitat types available, the birds used the grassy
openings provided by pastures in the scrub significantly more often (p<.01) than expected (Fig. 5.7 a). The scrub was significantly avoided (p<.01), and the oak-maple forest was used as expected from its availability.

The calls given by the birds during the study period indicated that scrub was the most used habitat for this activity (Fig. 5.7 b). In general the number of calls heard from this habitat far exceeded those from other habitats. It was the only habitat from which calls were heard in the period during which incubation was in progress. Birds were also heard calling from the oak-maple forest; and in contrast to the evidence from sightings, calls indicated that this habitat was used during period 2 also.

5.4.1.1. Waacham 1987

In this year the shifting cultivation carried out in the study area resulted in an increase in the number of habitats available to birds from three to four (Fig 5.8 a). The analysis of pooled sightings shows that the new habitat which covered more than half of the study area was significantly avoided by the birds (p<.01). Of the remaining three habitats, the scrub was used significantly more often than expected (p<.01), and the other two were used in accordance with their availability. However, the birds showed a significant preference (p<.05) for the open grassy areas.

The location of calling birds indicated a similar pattern of usage of different habitats (Fig. 5.8 b). The
Fig. 5.7 Jacobs' indices of preference for various habitat types by kalij as revealed by sightings of birds (a) and by their calls (b) in spring 1986 at Waacham.
Macrohabitat Use: Waacham 1987

Fig. 5.8 Jacobs' indices of preference for various habitat types by kalij as revealed by sightings of birds (a) and by their calls (b) in spring 1987 at Waacham.
majority of the calls were heard from scrub, with some also from oak-maple forest. Fewer calls were heard from open grassy areas and fewer still from the ijer area.

5.4.1.3. Terracings

The analysis of sightings on the terracings revealed that the birds followed a similar pattern of the usage of different habitats during the study period (1988-89) with only marginal differences between different months or before or after incubation. Of the six habitats present in and adjacent to the terracings, the birds used the terracings and the scrub significantly more often than expected (p<.01 and p<.05 respectively; Fig 5.9 a ). The remaining habitats were significantly avoided (p<.01). Of these the chir pine habitat was completely avoided by the birds after the onset of incubation.

The analysis of calling sites in 1989 on the terracings also revealed a pattern of usage of different habitat types that uniform over the season as a whole. Oak and oak-chir were found to be the two most preferred habitats (p<.01), whilst the remaining 4 habitats were significantly avoided (p<.01; Fig. 5.9 b). The oak patches were significantly more often used throughout the study period than the oak-chir habitat.

5.4.1.4. Dev Nagar Road

The number of habitats present along the Dev Nagar Road was the same as on the terracings, but only four habitat types were common to both the areas: oak, oak-
Macrohabitat Use: Terracings 1988-89

Fig. 5.9  Jacobs' indices of preference for various habitat types by kalij as revealed by sightings of birds (a) and by their calls (b) in spring 1988-89 at the terracings site at Ghanahaati.
chir, open pasture and terracings. The pattern of usage of these habitats that emerged from the analysis of the pooled sightings along the road for the entire study period was different from the terracings (Fig. 5.10). Here only oak-chir habitat was significantly preferred (p<.01). The terracings and open pasture were significantly avoided (p<.01 and p<.05 respectively) and the oak habitat was used as expected from its availability. The remaining two habitats, deodhar and cypress, present along the road were used as expected.

Analysis of the calling birds in 1989 along the road indicated a strong preference for oak (p<.01), and a strong avoidance (p<.01) for deodhar, pasture and terracings. The oak-chir habitat was used in accordance with its availability and the cypress was avoided but not significantly.

5.4.2. Microhabitat Use

Microhabitat use was only studied at Waach m in 1987. The data from the three periods were pooled as there were no significant seasonal changes in the usage of different categories of the four measured aspects of microhabitat.

The scrub taller than 1.5m was significantly more often used by the birds during the study period (p<.01; Fig. 5.11 a). Of the six categories of scrub density, the birds avoided the thinnest category (1-10%) significantly (p<.01) as compared to the rest, which were all used in accordance with their availability (Fig. 5.11 b).
Macrohabitat Use: D.N. Road 1988-89

(a) Sightings (N = 231)

Fig. 5.10 Jacobs' indices of preference for various habitat types by kalij as revealed by sightings of birds (a) and by their calls (b) in spring 1988-89 along the Dev Nagar Road at Ghanahaati.
Microhabitat Use: Waacham 1987 (I)

a) Scrub Height (N = 41)

b) Scrub Density (N = 40)

Fig. 5.11 Jacobs' indices of microhabitat preference for various scrub height and density categories by kalij as revealed by sightings of birds in spring 1987 at Waacham.
Microhabitat Use: Waacham 1987 (II)

a) Ground Cover Height (N = 55)

b) Ground Cover Density (N = 55)

Fig. 5.12  Jacobs' indices of microhabitat preference for various ground cover height and density categories by kalij as revealed by sightings of birds in spring 1987 at Waacham.
However, scrub with a thickness score of 31-51% was the most used category.

Of the five categories of ground cover, the birds showed a significant preference ($p < .01$; Fig. 5.12a) for the areas which had a ground cover of 10cm, and significantly avoided all the areas which were either very closely grazed (turf) or had a taller ground cover. The only density category for ground cover significantly preferred was 11-30% ($p < .01$; Fig. 5.12b). Categories that were significantly avoided ($p < .01$) were 31-50% and 51-70%. The remaining categories were used as expected.

5.5. DISCUSSION

Sightings of kalij at Waacham revealed that they preferred open pasture in 1986 and scrub in 1987, whilst avoiding scrub and ijer respectively in these two years. The location of calling sites revealed a preference for oak-maple habitats in 1986, and this plus scrub habitat in 1987, and avoidance of pasture and ijer respectively.

On the terracings in Ghanahaati, the birds were seen to prefer terracings and scrub, avoiding all other habitats. The sightings of birds along the Dev Nagar Road revealed a preference for oak-chir and avoidance of terracings and pasture there. The location of calling birds, however, revealed preference for oak and oak-chir habitats on the terracings and of oak along the road, and avoidance of the rest of the habitats.
Within preferred habitats also, the birds were selective of the areas they used. The microhabitat study at Waach m in 1987 revealed that the birds preferred only the tallest scrub and avoided the scrub of thinnest density. They preferred shorter, younger ground cover which was relatively thin.

These results give an apparently conflicting picture of habitat use by kalij: avoidance and preference of scrub respectively in 1986 and 1987 at Waach m; and avoidance and preference for terracings respectively along the road and on the terracing in 1988 and 1989 at Ghanahaati. The preferences revealed by location of calling sites are also at variance with those obtained from the sightings.

Types of habitats present at the two sites ranged from closed canopy forests through scrub to pastures and cereal crops. This array of structural diversity presented problems of observability: the birds in open habitats such as terracings and pasture could be seen more easily than birds in relatively dense habitats such as scrub and forests. Reduced observability of birds may therefore be one of the reasons for an apparent avoidance of scrub and preference for pasture by the birds in 1986.

As a result of ijer cultivation in 1987, the major portion of the remaining scrub was present immediately under my vantage points and the birds could often be seen in it from above. The preference for scrub by birds in this year could be attributed, in part, therefore to the resulting increased observability of birds in this
habitat. The preference for relatively open areas on the terracings and oak-chir forest, which lacks understorey along the road in Ghanahaati could also be explained in terms of the relative ease of observing birds in such places.

Another apparently conflicting result is the avoidance of the terracing along the road and its preference on the terracings in Ghanahaati. The average size of terraces on the terracings site was approximately 1740 sq m; and generally they had a strip of scrub of approximately 5m wide running along the entire length above and below them. They also had oak patches present on at least one side. The birds fed along the edges close to cover on these terraces early in the season, and fed further out only when the wheat grew to sufficient height and density to provide some cover. The terracing along the road, on the other hand, was of large size (approximately 3000 sq m) and had little cover on it or beside it. This feature probably resulted, in part, in the avoidance of this habitat. The terracing along the road in 1989 was under considerable disturbance from people working on it which might have also played a part in its avoidance.

Contrary to the sightings, the location of calling birds indicated that they had a preference for closed canopy habitats (i.e. oak, oak-chir etc.) or of the relatively dense habitats (i.e. scrub). This indicates the reluctance of birds to call in open habitats possibly because this places them at risk from avian predators.
(see Chapter 4). Equally importantly, however, it brings to light the problems of using observational technique alone in assessing habitat preferences. The use of calling sites in combination with sightings must give a more representative view of overall habitat use patterns. However, my results indicate that kalij use different habitats for different activities. This in turn suggests that they may require a mosaic of more than one type of habitat to satisfy all their daily or annual requirements.

Birds avoided large areas of uniform vegetational structure. The ijer at Waach-m in 1987 resulted in the clearance of about half of the study area. The birds used areas within scrub and parts of pasture not too far from cover.

Further evidence for the avoidance of large blocks of uniform structure was found at Ghanahaati. The track in the south of the study area represented such a type of habitat: a large area with unbroken canopy. Very few sightings of birds were made in this area although observability was good. On the other hand, there were a number of openings or relatively open areas along the road, and in those areas of it where the canopy was continuous, the road itself acted as an opening to which the birds came to feed regularly. A similar preference for openings in scrub was reported for the Cheer pheasant by Kaul (1989) who found that the majority of the food plants preferred by Cheer grew in the openings in scrub.
This study of habitat use by kalij in spring and early summer at Waacham and Ghanahaati revealed that the birds avoid large areas of uniform vegetational structure and prefer to feed in relatively open areas in early mornings and evenings; but they may also call at these times from relatively closed areas to which they retreat for the rest of the day.

This study used a combination of observational technique and location of calling sites to deduce the preferences for different habitats by populations of birds. The use of sightings alone to assess preferences probably resulted in underestimation of the importance of those habitats in which observability of birds was low and vice versa. The information on habitat use thus gained is true for the times of day when birds were active i.e. feeding and/or vocalizing, and of the season when birds call to attract mates and/or to keep away contenders. In order to gain a complete understanding of the habitat preferences of birds throughout the day or year radiotelemetry must be employed.