Chapter 2
STUDY AREAS AND METHODS
2.1. STUDY SITE 1: WAACHAM

This study site is named after the neighbouring village, Waacham, which is situated in the Himalayan foothills (Fig. 2.1) about 60 Kms north-east of Tehsil Bageshwar of District Almora (Fig. 2.2). Its approximate geographical location is 79.9° E and 30.1° N. Waacham lies on the south-facing slope of the Pindari Valley, where its two main head-waters tributaries, which drain from the Pindari and Sunderdunga Glaciers, converge. The area is connected by a well laid bridle-path to the road-head about 20 Kms in the south at Song.

The actual study area is situated above and to the north-east of Waacham village at an average altitude of 2470 meters (range 2340-2600m) and about 450m above the Pindari River (Fig. 2.3). The area consists of four valleys which are separated by ridges. For convenience the valleys were named as: 1. Scrub Valley (locally called Pigni); 2. Bhavan Singh Valley; 3. Home Valley (Ameda); and 4. Raj Singh Valley (Kulban).

The slopes of these valleys are gentle but are bounded on the upper and lower sides by steep cliff-sides. The Scrub Valley has a south-eastern aspect whereas the rest of the valleys have a southern aspect.

A perennial rivulet flows down through north-east of Scrub Valley. Perennial water sources are also present in the other valleys of the study area except the Bhavan Singh Valley. However, their flow diminishes in the dry (pre-monsoon) period.
Fig. 2.1 General location of the two study sites in northern India. Waacham is located in district Almora of Uttar Pradesh (UP) state, and Ghanahaati in district Shimla of Himachal Pradesh (HP).
Fig. 2.2 Location of the Waacham study site in district Almora, and in relation to other major towns in the Kumaun division.
Fig. 2.3 Waacham study site. Prominent topographical and physical features, and orientation of its four major valleys. Abbreviations: WV = Waacham Village, RSV = Raj Singh Valley, HV = Home Valley and BSV = Bhavan Singh Valley.
2.1.1. Climate

Systematic climatological data are not available for Kumaun, of which District Almora forms a part. However, the basic patterns of climate are orientated to the monsoons (Joshi et al. 1983).

Waacham generally experiences two wet periods and two dry periods. The first and the major wet period i.e. the monsoon occurs between late June and late September with July and August as the wettest months. The other wet period occurs between late December and late February when the study area receives heavy snows.

The major dry period occurs between late March and late June. The day-time temperatures are at their highest in May and June (25-30°C). The second dry period occurs between late September and late December with a considerable variation in day-time and night-time temperatures.

In some years, however, the monsoons may not arrive at all or may arrive late, resulting in a prolonged summer dry period as happened during 1987 when the rains only arrived in late July. Similarly, snowfall in December may get delayed, as was experienced again 1987 when there was no snow until early January.

2.1.2. Vegetation Types
2.1.2.1. Forests

These occurred mainly in the upper parts of the study area, but were also found in small scattered patches, as scattered stems and in some moist and narrow
ravines. The Kharshu oak (*Quercus semecarpifolia*) was the dominant tree species found in these forests. These trees were heavily lopped by the local people for use as fodder for their cattle and goats during the winter.

The other tree species found growing in association Kharshu Oak or as scattered stems were *Acer caesium*, *Rhododendron arboreum* and *Lyonia ovalifolia*. *Abies pindrow*, *Rhododendron campanulatum* and *Betula* sp. were found growing higher up in the study area.

The undergrowth of these forests were formed by *Arundinaria* sp., *Rosa macrophylla*, *Rubus niveus* and *Viburnum* sp. The ground cover was formed by plants such as *Clematis* sp. *Frageria indica*, *Rubia cardifolia* and *Viola* sp.

2.1.2.1. Scrub

The scrub was present in all the valleys between the steep upper cliffs and the arable terracings lower down. The local people take their cattle, goats and sheep to browse and graze in this area in the autumn and winter. The scrub in different parts of the study area is of varying age as a result of shifting cultivation system, which is locally known as *ijer* (see below).

The dominant scrub species were *Berberis kumaonensis*/*asciatica*, *Spiraea canscens*, *Indigofera* sp., *Prinsepia utilis* and *Rosa* sp. All these species occurred fairly evenly throughout the area. Other less important scrub species which only occurred in places, or at low frequency, were *Rubus niveus*, *R. hypargyus*, *Elshotzia*
polystachya, Viburnum contifolium, Desmodium sp, Rubia cordifolia and Hoboellia latifolia.

2.1.2.3. Open Pastures

These occurred mainly on steep slopes and cliff-sides. These areas were used by local people for production of hay which was harvested between September and November to feed the cattle during the winter months. Small clearings were also present in the scrub, some of which were used by local people as gots (night camps) on their way to and from bugial (alpine pastures). Some other clearings were used for growing tobacco.

2.1.2.4. Arable Terracings

These were usually found in the lower parts of the valleys and were used to produce crops such as the wheat (Triticum sp.), Millets (Panicum sp.), Barley (Hordeum sp.) and Buckwheat (Phagopyrum tartaricum).

2.1.2.5. The ijer system of shifting cultivation

This system although not much common now (Joshi et al. 1983), is still practiced at Waacham, and is similar to jhum practiced in north-eastern India.

For this purpose the local villagers have divided the scrub area in different valleys into segments in which ijer is conducted in rotation on a 6-10 year basis.

The scrub in the area to be cleared is cut near ground level in February and left to dry for about two
months. After the felled scrub has dried sufficiently, the villagers burn it on the respective parts of the area owned by them. The larger branches that do not burn fully are taken home for use as fuel-wood. The ash that remains on the ground helps improve the fertility and texture of the soil. The burning is followed by tilling of the ground and sowing of Buckwheat. The whole process of burning, digging and sowing takes about a month, and is a task in which all or most of the family members participate. The Buckwheat is harvested in August, and thereafter suitable (flatter) areas are sown with wheat as an over-wintering crop.

The scrub regenerates rapidly from the stumps that are apparently left for this purpose, and when the village herds return from bugials at the end of the monsoon they browse on the new shoots. It is, however, slashed again in places where wheat is sown. In the following years only browsing and grazing by cattle, goats and sheep takes place in the area. Their dung presumably fertilizes the soil, thus augmenting the growth of scrub before the next ijer rotation 6-10 years hence.

2.1.3. Wildlife

The following mammals and birds were sighted and/or heard (or reliably reported) during the period of study at Waacham.
2.1.3.1. Barking deer (*Muntiacus muntjak*)

These were sighted and/or heard mostly in the north of the study area, in the Scrub Valley. The maximum number of animals seen was 3 in two groups, one of which consisted of a mother and a calf.

2.1.3.2. Ghoral (*Nemorhaedus goral*)

These were seen and/or heard on the precipitous grassy cliffs of the study area.

2.1.3.3. Common Leopard (*Panthera pardus*)

The Leopard was not sighted during the study, but the local people occasionally reported that their animals had been killed by the Leopard.

2.1.3.4. Cheer Pheasant (*Catreus wallichii*)

Waacham is one of the only three sites in Kumaun where the endangered Cheer Pheasant definitely still survives. However, their number was low: about 10 birds were seen and/or heard during the study period (Kaul 1989; Young *et al.* 1987; Garson *et al.* 1991)

2.1.3.5. Monal Pheasant (*Lophophorus impejanus*)

These were seen and/or heard fairly frequently in the north of the study area. A maximum number of 2 birds were seen on two occasions: a male and a female and two males, both in the winter.
2.1.3.6. Chukor Partridge (*Alectoris graeca*)

These were seen in flocks of varying size (2-15) in the terracings in the lower parts of the study area.

The Mountain Hawk Eagle (*Spizaetus nipalensis*) and the Eurasian Kestrel (*Falco tinnunculus*) were seen occasionally attacking the kalij.

2.2. STUDY SITE 2: GHANAHAAATI

Here the study was conducted in parts of two of the 17 forests comprising the Ghanahaati Game Reserve. The Reserve gets its name after Ghanahaati, the major village in the area. Observations of birds were made in Bareli Reserve Forest and Bhanvar Ka Dhank. These forests are referred to as Forest Numbers D36 and D37 respectively in the working plans of the Kunihar Forest Division to which they belong. These forests are situated at a distance of about 15 Kms to the north-west of Shimla (see Fig. 2.1 for location of Shimla, and 2.4 for location of Ghanahaati in Shimla district), the capital of the Himachal Pradesh state. Their geographical location is approximately 77.5°E, 31.8°N.

The Bareli Reserve Forest (BRF) lies in a V-shaped valley with the Bhanvar Ka Dhank (BKD) situated in the middle (Fig. 2.5). The BRF consists of an area of 79 hectares whereas the BKD consists of about 17 hectares. The forests are bounded on the north by Mashobra village and by a Ban Oak forest, Bhag Ka Nallah (D34) on the east. The Ghanahaati village and the Shimla-Bilaspur Road
Fig. 2.4 Location of the Ghanahaati study site in relation to other major towns in district Shimla.
Fig. 2.5 Ghanahaati study site. Prominent topographical and physical features, and location of the intensive study area and of important land-marks mentioned in the text.
respectively form the southern and the western boundaries of the study area.

The altitude of these forests ranges between 1440 to 1720m above sea level, with the highest point at 1758m in the south-east in BRF. The slopes in BRF are generally moderate, but become steeper towards the north-east. The north-western part of the BRF and the BKD are relatively steep. The general aspect of BRF varies from north-east to north-west, whereas the BKD has a southerly aspect. Both the forests drain into a khad (seasonal stream) he water from which eventually flows into the Satluj River. Water, however, is present at some places in both the forests during the dry period.

An unmetalled road starting from the Shimla-Bilaspur Road in the south-west passes through the BRF and BKD and terminates in the east at Dev Nagar. This road is referred to as the Dev Nagar Road or simply as the road in the rest of this thesis. A number of paths run through the BRF, most of which converge on the Nursery (see below). Some of these paths are used regularly by the local people.

In the north-west and south-east are found privately owned fields which are no longer under cultivation. At the bottom of BRF towards the middle, is a Nursery in which the State Forest Department grows seedlings for plantation in the nearby forests. To the north-west of the Nursery are two Dams constructed to hold water for use in the Nursery. Two Cremation Grounds, one each for use by high and low caste families of the nearby areas,
are situated to the south-east of the Nursery. Privately owned cultivations are situated at the northern and the southern borders of BRF, one of which was used for the intensive study (Figs. 2.5 and 2.6).

2.2.1. History of the Study Area

2.2.1.1. The Forests

The BRF is one of the oldest mahfuza forests (protected and free of rights) in the Dhami Range which was demarcated in 1890, but with more areas being added to it in 1906 (Mathauda 1965). The forest originally belonged to the erstwhile Raja of Dhami, who exploited it for revenue by allowing felling, grass cutting and leaf litter collection. The forest was managed along lines prescribed in working plans which were revised from time to time. The forest was divided into compartments which were felled in rotation, initially on a 26 years basis, but later modified to 32 years.

In most of the compartments no planting was carried out following the felling, and vegetative regrowth from the cut stumps was relied upon for forest regeneration. The post-felling management in these compartments consisted solely of thinning down of this coppice growth. The first thinning was done three years after the felling, and subsequently 7 and 15 years later. In places where planting was done, the criteria for choosing the tree species is not known, but it seems Deodhar (Cedrus deodhara) was planted on cooler northerly slopes, and
LEGENDS:

- Forest
- Pasture
- Terracings
- Path

Approximate Scale: 1cm = 10m

Fig. 2.6 Major vegetational and physical features of the terracings study site at Ghanahaati.
Chil (Chir) Pine (*Pinus roxburgii*) was planted on the drier southerly slopes.

The BKD is a *mahdudah* forest (limited rights) which was probably demarcated in the early part of this century. This forest has no compartments on account of its size. It was probably exploited in the same way as the BRF, but has been extensively planted with Chir Pine and Cypress (*Cupressus torulosa*) trees.

Additional features of management in these forests included construction and maintenance of inspection paths, and the removal of grass, litter and dead wood to prevent fires from taking place. Fire-gaps 15-20 feet wide were also created and maintained for this purpose. The local people reported two or three fires occurring in the BRF, one as recently as early 1970's, although there is no record of this or of any other fire in the Sanctuary History File held by the Forest Department.

2.2.1.2. Hunting or Shikar

The Raja of Dhami used to organize a *shikar* in these forests exclusively for the entertainment of the officials of the British government, including the Viceroy of India. This area seems to have been a favourite place for shooting kalij pheasants. For this purpose tented colonies were erected between October and March, at Tanbu Ka Jubbar (where the Dev Nagar Road starts), and at Kufri near the Ghanahaati Forest Rest House. A number of *shikar ghats* (shooting points) existed throughout the area, two of which were located in BRF, one each near Tanbu Ka Jubbar and the present day Nursery
(Devi Ka Nallah), and one in the BKD. Parties of local people were sent to different areas of the forests from where they started beating their way down towards the shooting points. Only running and flying birds were shot. Sometimes bait was also used to attract the birds into the shooting points.

2.2.2. Climate

The study area experiences a sub-tropical climate (Shagotra 1977). There are two wet periods alternating with two dry periods. About 64% of the precipitation occurs during the monsoon which lasts from late June to late September (Mathauda 1965). The other wet period occurs during winter when snowfall may also occur in some years, as happened during winter 1991 (H.N. Sharma pers. comm.).

The major dry period occurs between late March and late June when the day-time temperature can rise to about 32°C. The other dry period occurs between early October and early December.

2.2.3. Vegetation Types

According to the classification of the forest types of India by Champion and Seth (1968), the study area falls into the Himalayan moist temperate forest group consisting mostly of the Ban Oak (Quercus incana) and the associated species. However, a number of new species have been introduced into the area following fellings, and as a result of planting the 'blanks' that existed in the
area (Shagotra 1977). The main vegetation types found in the study area are:

2.2.3.1. Oak Forest

The Oak forest covers most of the BRF and parts of BKD. It consists of two species: Ban (Q. incana) and Bani (Q. glauca). The local people think of the two species as the male (Ban) and female (Bani) of the same species. The Ban is the dominant species and is found throughout the study area while the Bani is usually found in the lower moister reaches and cool shaded areas. The age of the trees in different areas varies owing to the fellings in the past (see above).

To the north-east of the study area the Oak trees have been heavily lopped for use as cattle fodder, and towards the upper parts of this area are Oak thickets which are a result of felling followed by browsing by domestic animals. These areas have a number of other shrub species growing among them (see below).

2.3.3.2. Mixed Oak-Chir Forest

This type of forest covers small areas of the BRF in the north-west and the south-west, and in the BKD in the north-east. These areas were previously blank or had been felled and were later planted with Chir Pine. The Chir Pine also occurs as small pure stands in some of these areas.
2.3.3.3. Mixed Oak-Chir-Cypress Forest

This type covers most of the BKD. The Cheer Pine and the Cypress are later introductions which were planted following felling. The Cypress forms a pure stand near the Nursery.

2.3.3.4. Oak-Deodhar Forest

This forest covers a small area in the south of the study area below the Ghanahaati village. The Deodhar trees in this patch were probably planted late last century or early this century. There are small patches of Deodhar near the Nursery and in the middle of the BRF, both of which look rather younger.

2.3.3.5. Open Pasture or Ghasni

Ghasnis form a part of BRF and BKD in the north of the study area. In some areas of these pastures scattered Oak or Chir pines grow. The pasture in BRF is managed by the local Veterinary Hospital, and that of the BKD is on lease to local residents.

A number of other tree species are found in the study area occurring as scattered stems. They are: Rhododendron arboreum (locally known as Brass), Lyonia ovalifolia (Ailan), Myrcia nagi (Kaphal), Machillus sp. (Saincha) and Cornus sp. (Thumi).

The undergrowth throughout the study area is formed mostly by three woody shrub species: Randia tetrasperma, Rubus ellipticum (Heer) and Berberis lycium (Kashmal). Of these R. tetrasperma is found in the Oak forest wherever
the top canopy is not too thick. *R. ellipticum* and *B. lycium* usually grow on the degraded, overgrazed slopes particularly along the Dev Nagar Road, but also in some other openings where they may occur in association with Oak thickets and other scrub species such as *Pyrus pashia* (*Kainth*), *Zanthoxylum alatum* (*Tirmira*), *Myrsine* sp., *Prinsepia* sp., *Viburnum* sp. and *Rosa* sp. The climber species such as *Hedera helix* and *Smilax* sp. are also found occasionally growing on trees.

The ground layer is formed by a number of species of herbs and grasses. The important species of grasses found in the area are: *Heteropogan montanus* (*Makora*), *Cynodon dactylon* (*Dub*), *Chrysopogan montanus* (*Dhalu*) and *Cynopogan martinii* (*Labb*).

2.2.4. **Wildlife**

The following animals were encountered in the study area during the course of the observations:

2.2.4.1. Barking deer

The Barking deer was seen and heard throughout the study area. The maximum number of animals seen was two (a mother with her young) in the south-east of the study area. They were also seen sometimes feeding in the fields adjacent to the study area.

2.2.4.1. Langur

A small troop of Langurs (*Presbytis entellus*) was usually seen feeding on leaves of Oak trees in the south
of the study area. Solitary individuals were also seen occasionally at other places.

2.2.4.2. Common Leopard

Although during the study a number of kills by the Common Leopard were reported in the villages neighbouring the study area, no animal was sighted. However, a Leopard pug-mark was seen once on the Dev Nagar Road near the Nursery in 1989.

2.2.4.4. Palm Civet

A group of two Himalayan Palm Civets (Paguma larvata) was seen on two occasions in the study area. They are locally called as Ghuttoo.

2.2.4.5. Hare

The hares (Lepus nigricollis ruficaudatus) were seen occasionally feeding on young plants in the fields adjacent to the study area.

2.2.4.6. Peafowl

The Peafowl (Pavo cristatus) was sighted once each in the north-east and south-east of the study area. Their calls were, however, regularly heard from the area to the east of the study area where they lived close to terracings and human habitation. According to the local people, the Peafowl was quite common in the BKD forest before 1970's, but disappeared following the construction
of the Dev Nagar Road through the area, when blasting of rocks continued for a long time.

2.2.4.7. Red Jungle Fowl

Although sighted only once in the west of the study area, the Red Jungle Fowl (*Gallus gallus*) was heard frequently in the north and south-east of the study area. On all occasions, however, only one bird was heard calling. According to the local people their number in the study area was always low.

2.2.4.8. Shimla Hill Partridge

The Shimla Hill Partridge (*Arborophila torqueoloa millardi*) was seen and heard occasionally in the vicinity of the fields, and near open pasture in the north-east of the study area.

2.2.4.9. Eurasian Kestrel

The Eurasian Kestrel (*Falco tinnunculus*) was observed as the most common bird predator. Kestrels were occasionally seen attacking kalij feeding in the fields and other open areas. A Kestrel was once seen feeding on a freshly killed male kalij

2.2. STUDY METHODS

The methods used to study kalij largely depended on the resources and time available, and also on the conditions prevailing in the study areas. Radio-
telemetrey equipment, although available, could not be used at Waacham because of the likelihood of the endangered Cheer Pheasant getting caught in the snares which were to be used to catch the birds. At Ghanahaati a female and a male kalij were trapped and radio-collared, but the radio receiver went out of order. Thus purely observational study techniques were used to collect the data that form the basis for this thesis.

2.3.1. Observations of Birds

Birds were observed in two ways thereby generating two sets of data: spot checks and focal animal time budgets (Altman 1971). A third set of observations, opportunistic (chance) records, was made whenever possible.

2.3.1.1. Spot checks

These were designed to collect objective data on:

i. the size and composition of discrete groups of birds throughout the year;

ii. the dispersion pattern of the birds especially in the breeding season; and

iii. the way in which the birds use different types of habitat through the year.

The spot check data were collected principally from fixed vantage points at both Waacham and Ghanahaati, and were also collected along a transect (formed by Dev Nagar Road) at Ghanahaati.

At Waacham, elevated vantage points were selected which afforded an extended view of the area. The vantage
point observations at Ghanahaati were done in the terracings and the vantage points there offered a good view of almost all the terracings and neighbouring forests.

The vantage points at Waacham were reached before the day-break in the morning and were left after the birds moved into cover. In the evening the vantage points were reached before the birds emerged from cover, and were left about 20-30 minutes after the birds went to roost. The same schedule was followed at Ghanahaati except that in the morning observations were made along the transect before reaching the vantage point.

At each vantage point, the area under view was scanned at an interval of 15 minutes to locate groups of birds or individuals. Following information was collected for each spot check:

- Location of the bird(s) in relation to some known land mark (for translation into bi-coordinate reference);
- Time of day
- Weather details such as cloud cover, precipitation and wind.
- Visual estimates of microhabitat such as tree cover, scrub height and density and ground cover height and density. These were recorded in a 5m radius around the bird (or centre of group) usually after the birds had moved on.
- The number and sex/age of birds in the group: Any bird within 5m of another was defined as being in a group with that (and possibly other birds).

At Ghanahaati spot checks were also made along the Dev Nagar Road which was used as a transect. The spot checks there were in effect encounters with birds which were recorded whenever a bird or a group of birds was sighted on the road or beside it. For this purpose the Dev Nagar Road was traversed at a slow pace without making any noise, so as not to warn the birds of my approach. The same information was collected as for the vantage point observations with the additional data on distance of the bird from the observer, whether the bird called on being flushed (disturbed) and the habitat type into which the bird moved.

2.3.1.2. Time budgets

The method of focal animal sampling was used to measure the time budgets of birds (Altman 1971). The activities of the birds were classified into nine mutually exclusive categories and the type of activity the bird was performing and the change in it was recorded on a running dictaphone for a maximum period of 10 minutes. The different categories of activities were: moving (flying/running/walking); interacting (chasing/fighting/courting); vocalising; preening; digging and pecking at ground; pecking at ground vegetation; browsing/gleaning on scrub; and being vigilant (i.e. head up with neck vertical). In addition,
the size and composition of the group to which the focal bird belonged, the habitat in which they were situated, and distance between the observer and the focal bird, were also recorded.

2.3.1.3. Opportunistic records

These were chance encounters with the birds made during movement through the study area either on way to the vantage points or during habitat surveys. Information was recorded during these encounters in the same way as for spot checks, but were coded differently on data sheets so that they could be distinguished during later analysis.

Some other types of opportunistic records were also made. These included sightings of droppings and foot prints of the birds. The droppings of birds, both faecal and caecal, were seen occasionally in the study area, and their location and habitat details were recorded in the same way as the spot checks. The faecal droppings were dried under sun and preserved for diet analysis, and the caecal droppings were crushed to avoid seeing them again.

The foot prints were seen only at Ghanahaati along the road in places where soft, dry or wet soil was present. Their location and habitat details were also recorded in the same way as the spot checks. It was, however, not possible to identify whether a particular foot print or a dropping belonged to a male or a female.
2.3.2. **Calls and Wing-whirring**

Bird calls and wing-whirring were heard both from vantage points and whilst walking transects. However, it was difficult to pinpoint the exact location of a calling or a wing-whirring bird. Their location was therefore recorded at an approximate distance and direction from a known landmark, and in the broad habitat type from which they were heard.

Kalij calls were classified in advance into 11 types and all the calls heard in the field were logged accordingly. In addition, the weather, time, number of callers, duration of the call, the direction and the distance of the calling bird(s) from the observer, were also recorded. For those calling birds that were sighted also, the sex of the caller and the composition of the group it was in were noted.

Similar information was collected for wing-whirring: the type of wing-whirring, whether audible or inaudible (for those sighted only); the number of instances; and whether a particular bout was of extended or of brief duration.

2.3.3. **Habitat Availability**

In order to determine the preference or avoidance of certain habitat types by birds, it was important to have a random habitat profile against which to compare those used by the birds. Two methods were used to get information about habitat availability: habitat maps, and the random micro-habitat surveys.
2.3.3.1. Habitat maps

These maps were produced for both Waacham and Ghanahaati. The vegetation of both the study areas was divided into broad categories. For Waacham the categories were Forest, Scrub, Open Pasture and Terracings, and for Ghanahaati the categories identified were: Oak Forest, Chir Pine-Oak Forest, Oak-Chir Pine-Cypress-Forest, Open Pasture and the Terracings. From the elevated vantage points which afforded maximum possible view of the study area or the parts of it, the area covered by each habitat type was estimated visually and recorded on the study area maps. The extent of habitat types in obscured parts were verified by closer inspection.

2.3.3.2. Random microhabitat surveys

These surveys were conducted only at Waacham in 1987. Repeated visual estimates of vegetation were made by stratified random sample of points (Southwood 1966) within the area known to be used by birds. This was traversed along parallel lines about 75m apart and the sampling points identified about 75m from each other (by pacing). These points were marked with paint on rocks or cloth streamers on shrubs for subsequent repeat sampling.

The number of sampling points in different valleys was 59. The samples were taken every month except in June when they were done twice in the month to track the rapid growth of vegetation around the start of the monsoon.
2.3.4. Equipment Used

Most of the visual observations of birds, particularly on transects and for scans of areas, were done with the aid of Swift 8 X 30 binnoculars. The time budgets of birds at a distance were usually done with the help of 15-60X Swift Mark II zoomscope which at moderate magnifications (15-40X) permitted good observations of individuals provided there was no heat shimmer.

Time budgets were recorded on Panasonic RQ 342 or Sharp CE 152 cassette tape recorders. Bird calls were recorded by means of JVC MZ 230 directional microphone with either of the above cassette tape recorders. Spot checks and other observation were also recorded on these machines whenever the need arose, and tapes were later transcribed onto data forms.

The spectrographic analysis of calls was done using Loughborough Speech Workstation software on a PC 3286 in the Dept. of Speech at the University of Newcastle upon Tyne.

Photographs of birds, their signs, habitat and of changes in it were taken with a Chinon CP-5 SLR camera with 50 mm lens, and with a Yashica FX-7 SLR camera with 40-70 mm zoom and 70-210 Soligor zoom lens.

2.3.5. Data Preparation

The raw spot check data collected in the field in notebooks was codified and entered into prepared data sheets. The time budgets were transcribed measuring the time spent performing different activities on a stop-
watch. The time spent on each activity was then added up, codified and entered into prepared data sheets.

The methods of data analysis and of the statistical tests used to test the validity of conclusions drawn from them are given in the relevant chapters.