CHAPTER I

Chapter I

Introduction

An age-old pursuit of many biologists has been on relating the distribution and abundance of organisms in their natural environment. Knowledge of external environmental factors, their influence on the organisms and interactions help in explaining the distribution patterns of life forms in natural ecosystems. In the field of biodiversity conservation anthropogenic factors are considered important driving forces that lead to biodiversity loss; yet till date there are only a few empirical assessments on how human actions affect biodiversity qualitatively and quantitatively. The proximate causes of biodiversity loss are attributed to be of biological origin while the ultimate causes are social, economical and political (Machlis & Forester 1996). Qualitative statistical analysis of the interrelationships of plants, animals and their environment has been an area of active pursuit in biodiversity assessment studies undertaken in the recent years. Moreover, as the biodiversity is reeling under tremendous pressure in most of the regions of the world; determination of key relationships between plant and animal populations in an ecosystem have become an area of extensive research in the field of conservation biology. It is assumed that, if the factors determining the distribution of animals are known, then specific predictions can be

made concerning the response of animals to some disturbances. Thus, certain animals can respond and indicate the nature and quantum of environmental changes either individually or as a community.

1.1 Background

The precise meaning of community in ecology is one of the most debated concepts (Wiens 1989, Peter 1991). Several theoretical and practical difficulties plague community ecology. Properties of multispecies system, which exist in a constant state of flux, both in time and space, are difficult to investigate and decipher. Even, if it can be done, easily measurable attributes such as relative abundance estimate from samples are of questionable significance (Wiens 1989). Further, trying to make sense by correlation analysis of various communities, resource and habitat parameters provide no sure guide to underlying causes for observed community pattern (Gilbert 1984). Despite these obvious problems, community ecology has grown and flourished with tremendous applications, particularly with respect to conservation.

Habitat destruction is considered the most widespread anthropogenic cause of biodiversity loss (Brown 1985, Wilson 1988, Hannah *et al.*1995). It may differentially increase vulnerabilities as some species show poorer level of adaptation to habitat alteration

(Lovejoy 1986, Vermeij 1986). Therefore, extinction selectivity suggests that certain habitats and species are more at risk (Teborgh & Winter 1980, Slobodkin 1986). Particular attention has been paid to high biodiversity areas and accelerated rate of deforestation (Myers 1988). A decline in biodiversity has been associated with specific land-use changes, such as urbanisation (Leidly & Fiedler 1985), colonisation adjacent to protected areas (Neuman & Machlis 1989), and the fragmentation of forest as a result of resource extraction (Harris 1984, Hanson *et al.* 1990). The comparative studies are rare, and predictive ability is especially meagre. Hence there is a need to better understand relationship between human actions, habitat alterations and biodiversity loss (Machlis & Forester 1994).

1.2. Rationale for selecting the site

Sikkim is a small Indian state and belongs to one of two 'Biodiversity Hotspots' of India (Myers 1990). The Eastern Himalaya (Khanchendzonga area) supports a wide diversity of birds due to complex physiography and bioclimatic zonation (Ives & Messerli 1989) and its location at convergence of the Paleoartic and Oriental Zoogeographic Realms (Inskipp 1989). The area was identified by Birdlife International as a priority I endemic bird area since it supports 25 restricted range bird species, of which 21 are confined to the region (Bibbly 1992). In recent years, Carpenter

(1996) studied the altitudinal distribution of 251 bird species reporting 49% as frequent, 24% as long distant migrants and 27% as common in the Nepal part of Khanchendzonga region. Among the 8 species of birds, which were considered to be at risk in this area and listed as rare, vulnerable or endangered in the region, four species viz. satyra tragopan, Nepal cutia, short billed minivet and little pied flycatcher were recorded in present study from the temperate forest beyond the zone of agriculture activities (unpublished observation).

Yuksam and Yuksam-Dzongri trekking corridor is an important destination for nature tourists in Sikkim. Though, this trekking route is extremely important part of the tourism zone and needs to remain a pristine state to continue to attract the tourists; it faces impact of tourism pressure. Over the years this impact has made certain visible changes in the landscape and the ecology. Inspite of being tourism zone of Khanchendzonga Biosphere Reserve, Yuksam-Dzongri trekking corridor faces tremendous pressure on its natural resources, which brought out some visible changes during the last decade. Resources utilization in terms of firewood, fodder, timber, non-timber forest products (NTFPs) and open grazing are age-old practices for the people living here. The rise in tourist number, increase in resource use by the local population and use of the area for adventure and climbing courses

by the Himalayan Mountaineering Institute, the pressure on natural resources has increased manifold. Study on the intensity of habitat disturbances and consequent impact on flora and fauna are the issues that have not attracted the desired level of attention from the concerned conservation organisations. The information gap is so wide that even checklist of flora and fauna are not available; and records are not maintained properly. Information to the tourists about the biodiversity of the trekking route and the area is completely lacking. Broadly speaking, the present work is an attempt to focus on such issues and also on the consequences of resource extraction on forest quality and wildlife inhabiting the forests. In addition to this, an attempt has been made to compile comprehensive checklists of avifauna and butterflies and woody tree species along the corridor.

1.3. Sikkim Biodiversity and Ecotourism Project

The Sikkim Biodiversity and Ecotourism Project was a collaborative initiative designed to initiate conservation activities for protection of the biological diversity of tourism promotion zones. The core activities of the project encompassed participatory approaches that link tourism related diverse enterprises and traditional cultural practices with conservation action. Working with communities, the private sector and government, the project built upon their skills, interests and knowledge, to enhance: (i)

community and private sector conservation practices and ethics; (ii) economic returns from ecotourism services and enterprises; and (iii) contribution to policies that meet ecotourism and conservation goals. The Project was a joint effort of The Mountain Institute and G.B. Pant Institute of Himalayan Environment and Development. Project collaborators include the Travel Agents Association of Sikkim (TAAS), The Green Circle (a Sikkimese NGO), Khanchendzonga Conservation Committee (a Yuksam based rural Sikkimese NGO) and local communities at the sites.

The activities of the project included the following three broad groups:

1. Increasing community and private sector biodiversity conservation initiatives.

- Community ecotourism plans covering site-enhancement, trail and site maintenance, natural resource management and monitoring, and conservation education.
- Supporting fuelwood reduction measures by trek operators and local lodges.
- Supporting local NGOs working in ecotourism and conservation.

2. *Increasing economic returns from community-based and Travel Agents' ecotourism.*

- Training in ecotourism services, e.g., for guides, lodge-owners, cooks, porters;
- Supporting new community ecotourism enterprises-vegetables growing, indigenous foods, fuelwood-saving equipment hire for treks, short guide treks;
- Developing marketing strategies for community-based ecotourism and Travel Agents' ecotourism activities; and
- Conducting market research and developing new ecotourism products, e.g., off-season activities, eco-lodge designs.

3. *Improving and contributing to policy-making on conservation and ecotourism.*

- Scientific and participatory monitoring of project activities and impacts;
- Applied research on conservation and ecotourism;
- Sharing of research and monitoring findings among policy-makers, communities and the private sector; and

- Promoting public-private sector dialogue through workshops, exchanges and policy review.

The multi-disciplinary group of experts and research team was involved in monitoring and applied research. Various thrust areas identified for research input in the project were (i) dynamics of tourism growth and assessment of landscape change; (ii) socio-economic development, tourism growth and environmental degradation; (iii) holistic study of sacred Khecheopalri lake ecosystem; (iv) impact of grazing on plant diversity and productivity in an alpine pasture; and (v) impact of habitat disturbances on bird and butterfly communities along the trail. The present work specifically deals only on the effect of habitat disturbances on bird and butterfly communities.

1.4. Rationale for choosing birds and butterflies

Butterfly, as a taxon for community investigation has been largely neglected *vis-à-vis* birds. Butterflies have played a little role in the development of general theories on community organisation. This is surprising, as they are unique by suited for such works, being observable and identifiable with much more suited for manipulative laboratory studies that could supplement/verify conclusions drawn for field investigations. Precisely, because of complex linkages with environment and their

pivotal position in trophic level, bird and butterfly offer opportunity to explore many ecological questions with a single system. Typical host specific requirement of butterflies and well-designated guild structure of birds, provide best indication of habitat quality (Gilbert 1984, Javed 1996). Thus, they became the ideal organism to investigate the impact of habitat disturbances and many species may thus serve as bio-indicators (Wong 1985, Kremen 1992,1994, Debinski & Brussard 1994).

Historically, Clement (1920) detailed the root of the concept with potential use of animals as tool for forest quality assessment and became ingrained in the scientific literature. Plants have been the most widely used predictors of physical conditions and specific site factors but their application has been primarily confined to plant ecology. Many taxa of animals were used for this purpose in assessment of habitat quality. In the noted literatures, plant (Cronk 1988), butterflies (Brown 1991, Kremen, 1992,1994, Debinski & Brussard 1994), tiger beetle (Pearson & Cassola 1992, Rodriguez *et al.*1998), birds (ICBP 1992, Debinski & Brussard 1994, Kremen 1994) and mammals (Mittermeier 1988) were extensively used as indicator for assessment of biological diversity. Even Odum, noted in his *Fundamentals of Ecology* (1971 p 138) "...the ecologist constantly employs organisms as indicators in exploring new situations or evaluating large areas." Being ecologically diverse

and sensitive to various kinds of perturbation, bird community acts as a better predictor of the quality and health of the habitat than single species (Javed 1996). Bird and butterfly communities are particularly suitable for studying the process of ecosystem recovery, conservation to vegetation succession and dynamics of their changes. These two taxa are emerging as a biodiversity assessment tool in conservation (Debinski and Brussard 1994, Kremen 1994). Moreover, recent literatures accept the indicator concept as doctrine (Block 1989).

Conservation prioritisation of areas often relies on comparison of the relative or absolute number of species (species richness - e.g. Myers 1990). However, this information is not often readily available. Even for small well-studied groups as birds and butterflies, data are often sparse, especially for region with high species richness. Therefore, demands for methods which enable the species richness of the area to be predicted, and several surrogates have been proposed to achieve this (Beccaloni & Gaston 1994). Most studies have attempted to use indicator to identify areas of overall high biodiversity, by seeking positive correlation between the species richness of the chosen groups and the richness of other groups. Of necessity, however, comparisons are usually made at coarse spatial scale, often across widely divergent habitats or ecosystem, and between groups of organisms, which do not

necessarily share the same, or even similar, ecological requirements (Lawton *et al.* 1998).

Indicator species can be a valuable tool for conservation research. Their use has been divided in two categories: - a) inventory studies and b) monitoring studies (Kremen 1992, Rodriguez *et al.* 1998). The former deals with evaluation of changes in habitats or ecosystem over time and the latter records distribution patterns of taxa or ecological units over geographical space (Rodriguez *et al.*1998). The present study tried to cover both the aspects with more emphasis in the latter.

Criteria for selecting potential study groups

Debinski and Brussard (1994) suggested following criteria for the selection of the potential indicator groups:

(a) Groups of taxa are chosen to be appropriate for the study area. For example, mammals would have been inappropriate since the sighting frequency is very negligible. Thus bird and butterfly have been chosen, as it is much easier to establish clear-cut levels of commonness and rarity for the area.

(b) As vast field has been already developed in these taxa, the groups are ameable to sampling and identification to the species level by non-specialists.

(c) The groups were chosen, taking in mind, that they are not directly exploited by humans, to avoid influence on their distribution and abundance.

(d) Both the groups are fairly found throughout the study area.

(e) Saleable species were chosen for the species (e.g. butterflies are more appealing to the public than spiders).

(f) The groups represent varied trophic levels and guilds, and also response to environmental changes.

(g) The life history and ecology of the groups are relatively well known.

Bird and butterfly satisfy most of these criteria for using as potential indicator species (Debinski & Brussard 1992). Birds are suitable, because they respond to habitat structure (MacArthur 1964) and represent several trophic groups or guilds (Steele *et al.* 1984). Moreover, butterflies show the potential as they are host specific herbivores whose diversity may correlate with plant diversity (Ehrlich 1983), and are well known for their taxonomy, broad distribution, and represent varied ecological guilds (Debinski & Humphrey 1997).

1.5. Hypothesis

Two broad hypotheses each for forest structure and bird and butterfly communities have been recognised for the study. These are:

Hypothesis 1: Intensive firewood and fodder extraction will modify tree species composition and age structure of temperate and sub-alpine forests in the following respects:

(a) Human interference in terms of firewood, fodder and timber are species and area specific.

(b) Woody tree diversity (H') and species richness (d) values decreases with elevation and also vary in harvested forest stands.

(c) Density and standing biomass of species, which are preferred by local residents for firewood and timber, reduce in relation to harvested (open) or un-harvested (closed) canopy forest stands.

(d) Open canopy forests subject to human interference will be dominated by trees of larger DBH classes, compared to closed canopy forests and causes change in size and canopy structure.

(e) Net primary production will be higher in open forest due to less competition.

Hypothesis 2: Due to the above factors, forest bird and butterfly communities of the two ecological zones (lower forest and upper forest) will differ between open and closed canopy forest stands in terms of:

(a) Species composition, relative abundance and richness.

(b) Bird and butterfly community structure strongly related to forest types as per distinctiveness of their distribution.

(c) Birds and butterfly community structure differs altitudinally, irrespective of habitat differences, until a specific niche or guild is considered.

Key predictions to be tested are:

(a) The relative abundance of those species most adapted to human activity and disturbance will be greater in open canopy condition rather than closed canopy forest stands.

(b) Open canopy forest areas will contain higher species richness than closed canopy/dense forest area.

(c) Bird species dependent upon closed canopy coverage and tree layering will be absent or sparser in open canopy stand compared to old-growth closed canopy stand.

(d) Bird species richness will be higher in well-stratified forest than in the completely degraded one.

1.6. Aims and objectives

The primary aims of this study are to:

(a) Characterize forest stand structure under human disturbed (open) and relatively undisturbed (closed) canopy conditions along the Yuksam-Dzongri corridor.

(b) Estimate vegetation structure and productivity of two major forest types, warm-temperate forest (lower forest) dominated by *Quercus* spp. and *Castanopsis* spp., and cool temperate-subalpine (upper forest) forest typified by *Abies densa* and *Rhododendron* spp.

(c) Investigate bird and butterfly communities and guild structure in relation to habitat condition and forest types.

(d) Develop bird and butterfly species lists indicating seasonal and altitudinal occurrence along this trekking route.

1.7. Limitations

The present study has tried to cover wide subject areas with pertinent issues as socio-cultural set-up, dependency on forest for natural resources, species preference for firewood, fodder and

timber, impact on forest vegetation, investigation of bird and butterfly communities living therein and their association with the vegetation. Most of the data have been collected as primary from the field. Sensitive issues like firewood extraction area and consumption rate, fodder demand, number of livestock and landholding size were difficult to achieve. People's perception was not hostile as the investigation was made for the reserve area utilisation. They were reluctant to provide actual information on many vital issues associated with resource extraction. In some issues, which were not clear to my understanding was crosschecked with available secondary data as well. But, some of the secondary data considered were old and many records were either incomplete or completely different from the present scenario.

Another constraint was inaccessibility of the areas due to steep slopes in many parts of the corridor and adjoining areas. Unpredicted weather conditions and natural hazards like landslide, continuous rain and extreme cold weather disrupted the work plan and many times the schedule was missed or covered later. Collection of data for butterfly became difficult due to wide variation in weather and elevation. Distributions of butterfly species were sparse to very sparse with the gain in elevation. This led me to drop the sampling schedule for the second year.

Similarly, sampling for birds was also not easy. Point Count Method, which was initially thought to carry out simultaneously with Line Transect, was not recommendable. The values of species richness and diversity were much less and fluctuating and many common species were missed in the Point Counts. Thus, after one year of trial and error, Line Transect Method was found to be more reliable for further study. Sampling schedule for bird and butterfly, which was initially thought to cover for three seasons viz. winter, summer and monsoon, was followed only in winter and summer. This was considered due to the fact that in monsoon, a constant rain and fog have disrupted the bird visibility and butterfly activity. As a result, data consideration for the monsoon seemed to obscure the trend with biases.

1.8. Thesis organise

This thesis emphasises on three broad aspects of the study area, namely a) human interference on the natural resources, b) impact of human interference on vegetation structure and biomass productivity and c) assessment of consequences of human disturbances on bird and butterfly communities. The thesis starts with introduction as chapter I with an overview of study, hypothesis and background of the present study along with limitations faced therein. Chapter II and III provide review of literature and description of study area, respectively. Human

interferences such as firewood, fodder and timber extractions are elaborately discussed in chapter IV with an overall idea of resources use pattern by communities and tourism enterprises. Species preferences and quantification of their annual consumption by the communities and the tourism enterprises were further added in this chapter. Bird and butterfly communities were considered to assess their indicator quality for biodiversity assessment; in order to do this, knowledge of habitat quality was important. Therefore, vegetation structure and woody biomass productivity are dealt first to understand the habitat type in chapter V. The vitally important chapter, i.e. chapter VI gives the accounts on bird community structure along the prescribed habitat conditions in the trekking corridor. Bird-habitat relationships, along with migratory groups, feeding guilds and selective species are dealt in chapter VII. Butterfly community as well as their habitat association is dealt in chapter VIII. This chapter also provides the indicator properties of bird and butterfly as one of the main objectives of the entire study. The concluding chapter IX adds on management and conservation implications for the area with recommendations. Finally, appendices on list of birds, butterflies and the NTFPs are also presented.