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BASELINE INFORMATION OF FLORAL AND FAUNAL DIVERSITY FOR LONG TERM ECOLOGICAL MONITORING OF DHANOLTI ECO PARK - MUSSOORIE FOREST DIVISION, UTTARAKHAND

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ABSTRACT

Long term ecological monitoring of biodiversity is practicable with an inventory of its floral and faunal diversity. With this view, the documentation of biodiversity of the two fenced areas of Dhanolti reserve forest of Mussoorie forest division has been prepared (Site 1 and Site 2). Long term ecological monitoring locations were established for assigning changes in the biodiversity of the fenced area.

Key words **:** Biodiversity, indicators, flora, fauna, fenced area, landscape , Ecological monitoring

Introduction

Biological diversity or biodiversity is not a simple collection of species but a reference to diversity of life (Noss, 1990; Wilson, 1992; McNeely, 1995; Baydack, *et al.,* 1999). Maintaining biodiversity involve dealing with resources at various hierarchical levels, including genetic, species, ecosystem and landscape (The Keystone Center, 1999; Marcot, 1992; Naveh, 1995). To bring about some amount of change in this state of the biodiversity, protected area (PA) system was adopted. However, most PAs are similar to 'islands' as their existing boundaries do not cover the complete range of biodiversity values they seek to protect. There is a need to conduct periodic monitoring to understand the status of a particular ecosystem. Monitoring is an assessment of the spatial and temporal variability in one or more ecosystem properties, and is an essential component of adaptive management. Monitoring can help to determine whether mandated environmental standards are being met and can provide an early-warning system of ecological change (Mathur *et al.*, 2004). Development of a strategy for monitoring biological diversity will likely be most successful when based upon clearly articulated goals and objectives and may be enhanced by including several key steps in the process. Ideally, monitoring of biological diversity will measure not only composition, but also structure and function at the spatial and temporal scales of interest (Beever, 2006). The initial step towards monitoring involves collection and documentation of baseline data. From the current data, determine the extent of distribution, and condition of existing ecosystem types and probable distribution of species concerned. Also map the distribution and intensity of identified stresses (ex. habitat fragmentation, grazing, etc.) (Noss, 1990). This baseline data can be utilized to monitor the impact on biodiversity in future.

Ultimately, however, monitoring results may serve numerous other functions (Noon *et al.*, 1999; Niemi and McDonald, 2004). For example, targeted monitoring can provide information on whether environmental standards are being met and in some cases may identify actions for remediation. Monitoring results can also provide an early-warning system of ecological change, before unacceptable environmental losses occur, and provide data to forecast future changes in the environment. Furthermore, monitoring is essential for facilitating adaptive management (Holling, 1978), in which management actions such as particular timber-harvest strategies or creation of wilderness are viewed as ecological experiments in an iterative process of corrective improvements.

To conserve and monitor any PA it is important to have an inventory of its floral and faunal diversity. A sound ecosystem is an indicator of its stable components (Davis, 1992) like the floral and faunal diversity of that particular area. Keeping in view, the baseline information of recently developed eco-park in Dhanolti reserve forest, Mussoori forest division has been documented at the time of fencing with the objectives: to document the biodiversity of the two fenced areas (Site 1 and Site 2) for establishing long term ecological monitoring locations for assessing future changes in the biodiversity of the area.

Study Area

Dhanolti lies on a ridge at an altitude of 2286 m (N 30° 27' 0" E78° 15' 0") on the Mussoorie-Chamba track. Dhanolti is the launching point for numerous treks in to the snow capped Himalayas, especially to the Tehri region of Garhwal (Fig. 1). The area in the midst of deep forests of deodar, oak, conifer and rhododendron. The

Tree species like *Cedrus deodara* and *Persia odoratissima*, shrubs including *Sarcococea saligna* and herbs *Fragaria* and *Trifolium* sp. dominate the surveyed area of Dhonalti Eco-park.

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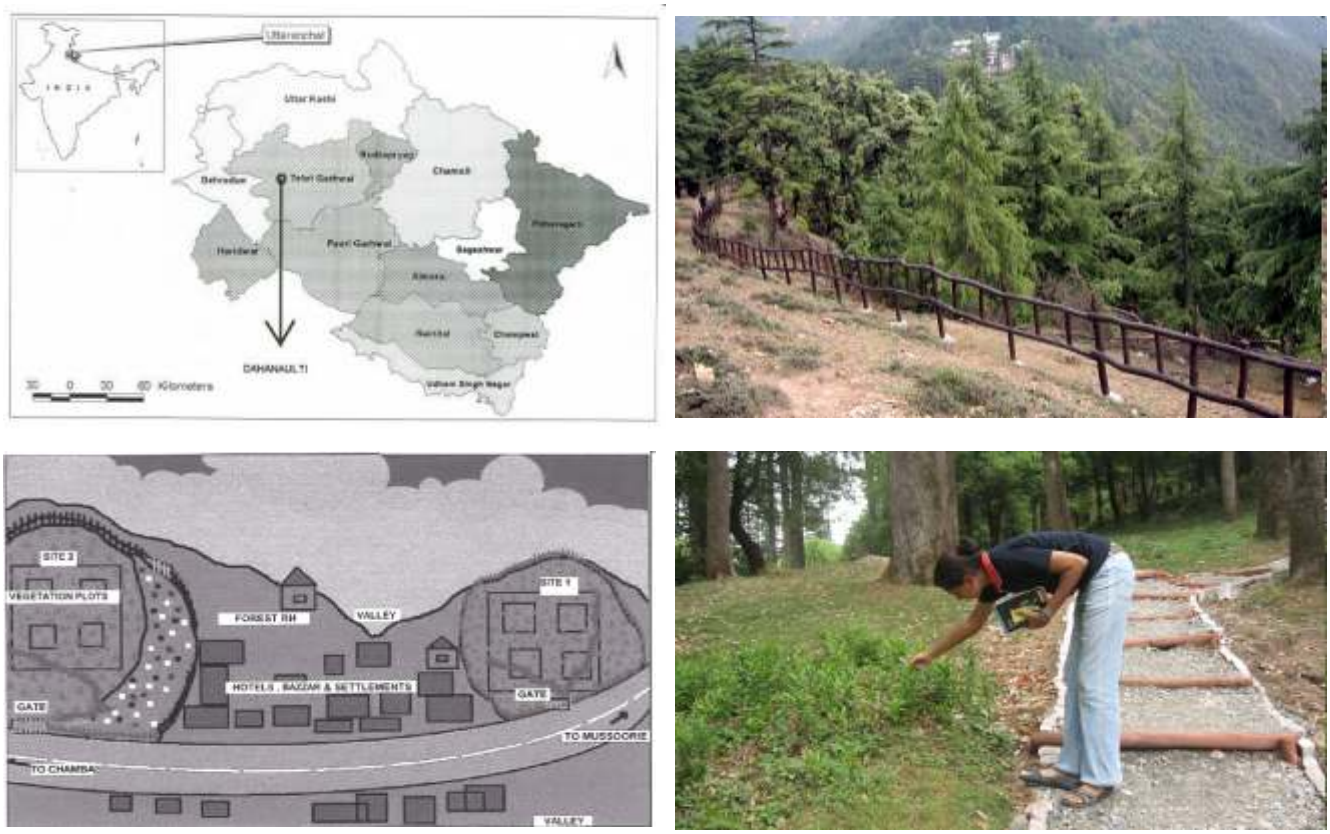

Fig. 1. : Study Area Location and Monitoring Plots

annual rainfall of this area is 1600 mm and temperature ranges from -10°C to 28°C. The relative humidity ranges from 25 to 90%. Due to the various places of visit there are large numbers of tourists visiting this place except in monsoons. Hence the major income of the people living here is from services to the tourists.

The forest department fenced two sites which were earlier open areas of Dhanolti reserve forest. These areas are denoted as Dhanolti Reserve Forest (DRF) close to main road. The area has been developed as eco-park for the tourist's attraction and restricted the entry on payment from June 2008. Earlier there was heavy biotic pressure *viz.* grazing, fuel and fodder collection and direct human interference on it. The study was conducted during May-June 2008 and documentation of biodiversity has been done in two fenced areas with one hectare each as site 1 (2250 m amsl - N 30° 25'41.9" ; E 78° 14'32") site 2 (2300 m amsl - N 30° 25' ; E 78° 15') Fig. 1.

Methodology

Floral Documentation

To document the floral diversity, quadrat sampling method (Mishra,1968) was used for the quantitative study of the vegetation. Two 100 m x 100 m quadrats were established. Trees (individuals with height above 3 m and GBH more than 20 cm), seedlings, saplings and stumps of trees were documented in these two plots. The density, relative density, frequency and relative frequency were estimated in the randomly placed quadrats. Shrubs and herbs were quantified using four 10 m x 10 m and four 1 m x 1 m quadrats respectively.

Identification of plant species was done on the field and herbariums of unidentified plant species were prepared and later identified in the herbaria.

Faunal Documentation

For faunal documentation viz. insects, birds and mammals were recorded. The insects were collected and identified with the help of relevant literature and compared with the museum specimens. Birds were observed with the help of binocular (8 x 40) and identified using Grimmett *et al.,* 1999. Mammals were recorded through direct sightings and indirect evidences such as pellets, marks and also personal interviews with local people using secondary information of presence and absence.

Results

Floral Diversity

A total of 33 plant species was recorded from the two fenced patches (site 1 and site 2). Tree species like *Cedrus deodara* and *Persea odoratissima* dominates the two fenced patches. *Sarcococca saligna* has the largest density among shrubs. *Fragaria* and *Trifolium* sp.

Table 1 : Tree species documented at site 1

Tree species	Trees Density (Ind. ha^{-1})	Saplings (Ind. ha^{-1})	Seedlings (Ind. m^{-2})	# Stumps ha^{-1}	RD (%)
Cedrus deodara	232	0	0	45	53.9
Persea odoratissima	192	4	7	0	44.6
Lyonia ovalifolia	2	0	0	0	0.5
Rhododendron arboreum	2	0	0	0	0.5
Quercus floribunda	1	2	0	0	0.2
Pyrus communis	0	1	0	0	0
Quercus semecarpifolia	1	2	0	0	0.2
Aesculus indica	0	1	0	0	0
Ilex dipyrena	0	0	7	0	0

Table 2 : Tree species documented at site 2

Tree species	Trees Density (Ind. ha^{-1})	Saplings (Ind. ha^{-1})	Seedlings (Ind. m^{-2})	# Stumps ha^{-1}	RD (%)
Cedrus deodara	178	18	2	49	49.3
Persea odoratissima	98	11	7	0	27.2
Aesculus indica	0	0	1	0	0
Quercus semecarpifolia	24	0	0	0	5.6
Quercus floribunda	25	0	0	0	6.9
Rhododendron arboreum	1	0	0	0	0.3
Ilex dipyrena	17	5	1	0	4.7
Cornus macrophylla	2	1	2	0	0.6
Viburnum mullaha	8	0	3	0	2.2
Lonicera sp.	7	3	1	0	1.9
Pyrus pashia	1	0	0	0	0.3

Table 3 : Shrub species documented at site 1

Shrub species	Quadrats				*F %)	*RF (%)	Density (Ind. ha^{-1})	*RD (%)
	1	2	3	4				
Clematis gauriana	4	7	0	0	50	11.77	2.75	1.94
Sarcococca saligna	15	0	0	20	50	11.77	8.75	41.2
Rosa lavigata	1	1	2	0	75	17.65	1	4.71
Cotoneaster microphyllus	0	12	0	1	50	11.77	3.25	15.29
Berberis asiatica	0	9	1	0	50	11.77	2.5	11.77
Prinsepia utilis	0	1	0	0	25	5.9	0.25	1.18
Girardiana diversifolia	0	0	2	2	50	11.77	1	4.71
Cotoneaster bacillaris	0	0	3	0	25	5.9	0.75	3.53

*F=Frequency, RF= Relative Frequency, RD= Relative Density

Table 4 : Shrub species documented at site 2

Shrub species	Quadrats				F (%)	RF (%)	Density (Ind.ha^{-1})	RD (%)
	1	2	3	4				
Sarcococca saligna	28	113	175	58	100	26.67	93.5	47.88
Cotoneaster bacillaris	6	0	0	0	25	6.67	1.5	0.77
Jasminum multiflorum	8	0	0	0	25	6.67	1.6	1.02
Girardiana diversifolia	1	121	28	0	75	20	37.5	19.21

dominate in herbs. The number of species of trees is more in site 2 than site 1, whereas total number of trees in site 1 is higher than site 2 (Table 7-8).

Faunal Diversity

The Mammals sited directly were rhesus macaque (*Macaca radiata*) and common langur (*Presbytis entellus*). Through, the interviews with the local people and the forest officials information of occasional sightings of leopard (*Panthera pardus*), Himalayan black bear (*Ursus thibetanus*) and sambar (*Cervus unicolor*) have been recorded in this area.

Insects of the Order Hemiptera, Coleoptera, Diptera, Lepidoptera and Hymenoptera were recorded.

Table 5 : Herb species documented at site 1

Herb species	Quadrats				F (%)	RF (%)	Density (Ind.ma^{-2})	RD (%)
	1	2	3	4				
Fragaria nubicola	92	47	155	23	100	21.1	79.3	34.5
Viola betonicifolia	19	0	16	0	50	10.5	8.8	3.8
Trifolium repens	30	38	71	0	75	15.8	34.8	15.1
Oxalis corniculata	15	15	23	76	100	21.1	32.3	14.1
Galium aparine	0	49	5	17	75	15.8	17.8	7.7
Strobilanthes atropurpureus	0	40	0	0	25	5.2	10	4.4
Erigeron bellidioides	0	0	52	0	25	5.2	13	5.7
Clinopodium umbrosum	0	0	0	135	25	5.2	33.8	14.7
Rumex nepalensis	0	0	3	1	50	11.77	1	4.71

Table 6 : Herb species documented at site 2

Herb species	Quadrats				F (%)	RF (%)	Density (Ind.ma^{-2})	RD (%)
	1	2	3	4				
Trifolium repens	91	14	61	38	100	22.22	51	50.12
Oxalis corniculata	0	17	20	55	75	16.7	23	22.6
Dracocephalum wallichii	0	5	1	0	50	11.11	1.5	1.5
Strobilanthes atropurpureus	0	14	5	12	75	16.7	7.8	7.6
Galium aprine	0	22	0	0	25	5.6	5.5	5.4
Fragaria nubicola	0	3	0	0	25	5.6	0.8	0.7
Stellaria media	0	39	2	0	50	11.11	10.3	10.1
Geranium wallichianum	0	4	0	0	25	5.6	1	1
Clinopodium umbrosum	0	0	0	4	25	5.6	1	1
Rumex nepalensis	0	10	11	8	75	20	7.25	3.71

The butterflies found in the two sites were cabbage white (*Pieris canidia*), dark clouded yellow (*Colias fieldii*), Indian fritillary (*Argyreus hyperbius*), Indian tortoise shell (*Aglais cashmiriensis*) and painted lady (*Vanessa cardui*) (Table 7). Fifteen bird species were recorded from site 1 and 2 (Table 8).

Discussion

Methods employed for documenting of biological diversity in Site 1 and site 2 gave a baseline data to carry out future monitoring of the fenced area. Present studies shows that the plant diversity of site 2 is higher as compared to site 1. However, site 1 has lesser number of tree species than site 2 but higher number of shrub species. Site 2 has higher number of herb species of plants. Tree species like *Cedrus deodara* and *Persea odoratissima* show high densities in both the sites. Among the shrub species in site 1, *Sarcococca saligna* highest density (8.75 ind.ha^{-1}) followed by *Cotoneaster microphyllus* (3.25 ind.ha^{-1}). *Cotoneaster bacillaris* was least dense shrub species in Site 1 as well as site 2. In site 2 *Sarcococca saligna* showed a high density (93.5 ind.ha^{-1}). In case of herbs present in site 1, *Fragaria nubicola* showed high densities of 79.3 ind.m^{-2}. Whereas, lowest

Table 7 : List of insects at site 1 and site 2

Order	Family	Number of Species
Hemiptera	Reduviidae	1
	Pyrrochoridae	2
	Fulgoridae	1
Coleoptera	Carabidae	1
	Chrysomelidae	1
	Coccinalidae	1
Diptera	Tipulidae	1
	Nymphalidae	
Lepidoptera	Pieridae	5
Hymenoptera	Formicidae	1

Table 8 : List of birds at site 1 and site 2

Sr. No.	Bird species	Common name
1	*Streptopelia oriantilis*	Oriental turtle dove
2	*Garulax regulus*	Striated laughing trush
3	*Regulus regulus*	Gold crest
4	*Turdus boulboul*	Grey-winged blackbird
5	*Ficedula westermanni*	Little flycatcher
6	*Culicapa ceylonesis*	Grey-headed cannery flycatcher
7	*Glaucidium radium*	Jungle owlet
8	*Dendrocopos himalayansis*	Himalayan woodpecker
9	*Picus xanthopygaeus*	Streak-throated woodpecker
10	*Mycerobus icterioides*	Black-and-yellow Grosbeak
11	*Niltava sundara*	Rufous-bellied Niltava
12	*Eumyias thassina*	Verditer flycatcher
13	*Saxicola splendens ferrea*	Grey bushchat
14	*Acridotheres fucus*	Jungle Mayna
15	*Corvus splendens*	Common crow

density (8.8 ind.m^{-2}) was shown by *Viola bentonicifolia*. *Trifolium repens* showed a high density in site 2. Whereas lowest density in site 2 was shown by *Galium aparine* with a density of 5.5 ind.m^{-2}.

The two sites are being developed and a project for a park has been proposed and the work is in full swing. There would be a fare ticket for entry to the park. Various articles with potential to litter (this includes eatables drinks and their packing materials) the area will be prohibited inside the park. To monitor the developments in these sites the baseline information, which has been documented during the study can be used. Also continual improvements of the baseline data are required. It is assumed that local people could be involved in eco-development programs which will create new linkages between the people and the forest and its resources. With some more efforts from the management and scientific groups as well as NGOs it will be possible to involve the local communities in the long term ecological monitoring of the area.

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धनौल्टी इको पार्क-मसूरी वन प्रभाग, उत्तराखण्ड के दीर्घकालीन पारिस्थितिकीय अनुवीक्षण के लिए वनस्पति एवं प्राणिजात विविधता की आधारभूत सूचना

प्रीति एस. बिरकर, वी.पी. उनियाल और ए.के. बनर्जी

सारांश

जैव विविधता का दीर्घकालीन पारिस्थितिकीय अनुवीक्षण इसके वनस्पति एवं प्राणिजात विविधता की एक सूची के साथ व्यवहार्य है। इस दृष्टिकोण से मसूरी वन प्रभाग के धनौल्टी आरक्षित वन के दो क्षेत्रों (स्थल-1 और स्थल-2) को विविधता का प्रलेख पोषण किया गया। तारबाड़ क्षेत्र की जैव विविधता में परिवर्तनों के निर्धारण के लिए दीर्घकालीन पारिस्थितिकीय अनुवीक्षण स्थानों की स्थापना की गई।

References

Baydack, R.K., H., Champa, III, and J. B. Haufler, (1999). *Practical approaches to the conservation of biological diversity*, Island press, Washington, D.C.

Beever, E.A. (2006). *Monitoring Biological Diversity: Strategies, Tools, Limitations, and challenges.* USGS-BRD Forest and Rangeland Ecosystem Science Center, 3200 SW Jefferson Way, Corvallis, Oregon.

Davis, G.E. (1992). Design of Environmental Monitoring Programs, National Research Council Workshop on Long-term Environmental Monitoring in Glen Canyon and the Grand Canyon, National Academy of Sciences, Backman Centre, Irvine, California, 1-7.

Grimmitt, R., C. Inskipp and T. Inskippe (1999). *Birds of India, Pakistan, Nepal, Bangladesh, Bhutan, Sri Lanka and Maldives*. Princeton University press, Princeton, N.J..

Holling, C.S. (1978). *Adaptive environmental assessment and management*. New York, NY: John Wi-ley and Sons. 337 pp.

Marcot, B.G. (1992). *Conservation of Indian Forest*. Conservation Biology International Conservation News. Vol.6 No.1. 12-17.

Mathur, P.K., V.P., Uniyal, B.S.Mehra and S. Pandey (2004). Ecological Monitoring Design for the Conservation of Biodiversity in the Great Himalayan National Park Conservation Area, Western Himalaya, *International Journal of Fieldwork Studies,* **2**(1).

McNeely, J.A. (1995). *Expanding partnerships in conservation*. Island press, Washington, D.C. 1-302.

Mishra, R. (1968). *Ecology Work Book*. Oxfrdand IBH publishing Co. Calcutta. (India). 244pp

Naveh, Z. (1995). *From Biodiversity to Ecodiversity* : New Tools for Holistic Landscape Conservation. *Int. J. Ecol. and Env. Sci*. (21)16.

Niemi, G.J. and M.E. McDonald (2004). Application of eco-logical indicators. Annual Review of Ecological and Evolutionary Systems 35:89-111.

Noon, B.R., A. Spiest and M. G. Raphael (1999). Conceptual basis for designing an effectiveness monitoring program. In: Mulder BS, Noon BR, Spies TA, Ra-phael MG, Palmer CJ, Olsen AR, Reeves GH, Welsh HH, technical coordinators Edt.). *The strategy and design of the effectiveness monitoring program for the Northwest Forest Plan. Portland,* OR: USDA Forest Service, Pacific Northwest Re-search Station. General Technical Report PNW-GTR-437. 49-68.

Noss, R.F. (1990). Indicators for Monitoring Biodiversity: A Hierarchical Approach. Vol.4. No. 4, 355-364. U.S. Environmental Protection Agency Environmental Research Laboratory Corvallis, OR 97333, U.S.A.

The Keystone Centre **(***1999***)**. *Final consensus report of the Keystone Policy Dialogue on the Biological Biodiversity on Federal Lands. The Keystone Centre, Keystones, Co.*

Wilson, E.O. **(**1992**)**. *The Diversity of Life*. Harvard University Press, Belknap, Cambridge, Mass.