

## Status of *Banj* Oak Forests in Garhwal Region, Uttarakhand

- Gajendra Singh, Senior Research Fellow

*Banj* Oak (*Quercus leucotrichophora*) forms a major component of temperate broadleaf forest in the mid elevation zone (1500-2500m asl) of Uttarakhand. This species is highly preferred by the local inhabitants for their livelihood and also serves vital ecosystem services in the region. Owing to increasing anthropogenic pressures, these forests are degrading and intermixing with other forest types in several places. In order to assess the status of *banj* oak forests, a baseline study is being conducted in the state of Uttarakhand with the following objectives: 1) mapping of *banj* oak forests distribution, 2) identification of transition zone between oak and pine forests, and 3) evolving conservation and management strategies.

This presentation deals with the status of *banj* oak forests in Garhwal region. Prior to field survey, a baseline vegetation and land use/land cover map was generated using AWiFS data. Satellite data of *banj* oak zone (1000-2500m) was segregated in four altitudinal zones and hybrid image classification was performed to classify different vegetation classes. The results were evaluated based on field data (>105 forested areas surveyed). The species status and human interferences were ascertained through field observations and site specific interviews. The study revealed that 655.57 km<sup>2</sup> area is under *banj* oak forests (~14100 patches) in Garhwal region with mean patch area of 4.5 ha. Maximum area under *banj* oak (225.60 km<sup>2</sup>) with high fragmentation (PD 1.6/km<sup>2</sup>) was in Mussoorie/Chamba region, while maximum intact *banj* oak forests were recorded in Kedarnath WLS (PD 0.95/km<sup>2</sup>). High IJI value (61.1%) for the Kedarnath WLS region shows high intermixing with other forest types, while the intermixing in the Mussoorie region is low (IJI 56.8%). Human interference in the *banj* oak forests supports excessive growth of alien species e.g., *Eupatorium adenophorum* in the understory. Based on the finding of the study, conservation strategies are discussed.

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Project Title	: Assessment of <i>banj</i> oak forests and their conservation status in Uttarakhand
Principal Investigator(s)	: Dr. G.S. Rawat
Researcher(s)	: Dr. Gajendra Singh (SRF)
Funding Agency	: Uttarakhand State Council for Science and Technology, Government of Uttarakhand
Project Duration	: July 2009 to July 2011

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## Response of Tree Seedlings to Resource and Competition: An Ecological Perspective

- Priyanka Bhatt, Technical Assistant

The objectives of the project are to study the response of tree seedlings in savannas to resources, their ability to compete with grasses for different resources and to tolerate defoliation, and to find out whether the species' seedlings show convergent traits for environmental conditions. The study was conducted from July 2009 to March 2010 in Sariska Tiger Reserve, Rajasthan. The experiment included enclosing a 50 m X 50 m permanent enclosure in the study area within which 120 sub-plots of 2.5 m X 2.5 m were laid in a factorial type design. These subplots were subjected to differential treatments of water, light, nutrient, competition with grass and defoliation on tree seedlings and were monitored every month.

*Acacia leucophloea*, *Anogeissus pendula*, *Balanites aegyptiaca*, *Butea monosperma*, *Lannea coromandelica*, *Zizyphus mauritiana*, *Chloris dolychostachya* and *Heteropogon contortus* were chosen as the target species for the experiment and various growth parameters of these species were recorded during the first year of seedling development. Four seedlings of each target species were planted in the subplots and their growths were monitored. Three fourths of the plots were watered with calculated amounts in accordance with Köppen-Geiger system and the rest with natural rain water. One fourth of the plots within the Köppen- Geiger system were provided 20% shade and another one fourth with defoliation treatment where all the seedlings under observations were clipped twice to 0.02 m above ground at an interval of 90 and 60 days respectively. Within each plot, one third of the subplots were treated with presence of *Chloris dolychostachya*, one third with *Heteropogon contortus* and the rest were left devoid of any grass. Half of the above mentioned subplots were supplemented with nutrients. The seedlings showed significant response to various resources (light, nutrient and water) and disturbance (defoliation and competition from grasses).

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Project Title	: Global experiments on savanna tree seedlings in Sariska Tiger Reserve, Rajasthan
Principal Investigator(s)	: Dr. K. Sankar and Dr. G. S. Rawat
Researcher(s)	: Ms. Priyanka Bhatt (TA)
Funding Agency	: Wageningen University, The Netherlands
Project Duration	: April 2009 to March 2011

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## Recent Changes in Forest Cover around Timberline Ecotone in Uttarakhand

- Rupesh Ranjan Bharti, Junior Research Fellow

Forest cover change in the last three decades around the timberline ecotone was assessed using image based change detection methods, which included Normalized Difference Vegetation Index (NDVI), Tasseled Cap derived Disturbance Index (DI) and Normalized Difference Moisture Index (NDMI) differencing techniques. NDMI and DI detects any change in brightness and moisture content resulting from natural or human disturbances, while NDVI gives the best result for change in canopy cover. A major forest type map of the study area was prepared from hybrid classification method for class wise change interpretation. Heterogeneity of change (above and below 3400 m) was assessed by simple correlation as well as by comparing the mean and standard deviation of different indices from consecutive dates. The forest cover value of 62 plots showed a linear trend with NDVI in 2009 ( $r = 0.91$ ), while a little deviation from linearity in 1980 ( $r = 0.62$ ) indicates that the change might be a recent phenomena. A comparison of extent of change showed that the increase in canopy cover within protected areas is more than that of the other areas; however no significant difference for decrease in canopy cover between these two areas was noticed. Most of the change is associated with oak forest, while birch forest is the least affected class. Heterogeneity of change was found more at higher elevations indicating diverse nature of growth either through community structure or regeneration patterns.

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Project Title	:	Ecological assessment of timberline ecotone in the western Himalaya with special reference to climate change and anthropogenic pressures
Principal Investigator(s)	:	Dr. B.S. AdhiKari and Dr. G.S. Rawat
Researcher(s)	:	Mr. Rupesh Ranjan Bharti (JRF), Mr. Ishwari Dutt Rai(SRF) and Mr. Sabuj Bhattacharyya (SRF)
Funding Agency	:	WII Grand-in-Aid
Project Duration	:	May 2007 to May 2011

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## Survey of Herpetofaunal Diversity in the Andaman and Nicobar Islands

- S. Harikrishnan, Senior Research Fellow

The Andaman and Nicobar Islands are the largest group of Islands within Indian territory. Remoteness, inaccessibility and supposedly hostile natives kept these islands away from biologists for a very long time. Ever since the first European naturalists made collections in these islands, many new species have been discovered there, and a majority of them are endemic to these islands. The herpetofauna of these islands is still incompletely explored, and every new survey has added new species to the islands. Despite this, literature suggests that among the biodiversity hotspots in Asia, these islands have the second highest species richness per 100 km<sup>2</sup> in the case of reptiles (9.5 species/100km<sup>2</sup>) and fourth highest in the case of amphibians (2.4 species/100km<sup>2</sup>). In March 2010, we initiated a study to document patterns in diversity and geographic distribution of herpetofauna in these islands. We used quadrats, Visual Encounter Surveys (VES) and pitfall traps with drift fences to record reptile and amphibian species. During the three months of field work in Long Island (Middle Andaman) and Mt. Harriet National Park (South Andaman), we recorded 24 species of reptiles (23 from Long Island and 11 from Mt. Harriet) and 10 species of frogs (6 from Long Island and 7 from Mt. Harriet). This included three undescribed species, including one arboreal toad and two arboreal agamid lizards. This brings the total number of species known to exist in Andaman and Nicobar Islands to 77 species of reptiles (not including the salt water crocodile and 5 species of turtles) and 18 species of frogs. This total number also includes at least two undescribed agamid lizards, two unnamed gekkonid lizards, one unidentified colubrid snake and one undescribed arboreal toad. Our short study further highlights the need for long term, intensive studies on the biodiversity of Andaman and Nicobar Islands.

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Project Title	:	Macroecology of terrestrial herpetofauna of Andaman and Nicobar Archipelago
Principal Investigator(s)	:	Dr. Karthikeyan Vasudevan, Mr. B.C. Choudhury, Dr. S.K. Dutta and Dr. Indraneil Das
Researcher(s)	:	Mr. S.Harikrishnan (SRF) and Mr. S.R. Chandramouli (JRF)
Funding Agency	:	Department of Science and Technology
Project Duration	:	January 2010 to January 2014

## Patterns of Spider Assemblages along Altitudinal Gradient in Nanda Devi Biosphere Reserve, Uttarakhand

- Shazia Quasin, Senior Research Fellow

We documented spider families of Nanda Devi Biosphere Reserve (NDBR) investigating the role of altitude in structuring spider community. Three altitudinal gradients (2000 m - 4100 m, Lata Kharak; 1800 m - 4100 m, Bhyundar Valley and 3000 m - 4000 m, Malari) were sampled using systematic plots. Spiders from all possible niches were collected using pitfall trapping, sweep netting, ground hand collection, aerial hand collection and litter sampling. We selected four different climatic-vegetation zones along the altitude viz., warm temperate (1800 m - 2000 m); cool temperate (2000 m-3000 m); sub-alpine (3000 m-3500 m) and alpine meadows (3500 m - 4000 m) to study the composition and structure of spider community across these zones. Overall 30 families (5101 individuals) were recorded from NDBR (Lata: 26, Bhyundar: 24, Malari: 16 and others: 4). Family richness ( $S = 5.8$ ) and diversity ( $H = 1.49$ ) in Malari were lower when compared to Bhyundar ( $S = 15$ ,  $H = 2.40$ ) and Lata Kharak ( $S = 13.6$ ,  $H = 2.18$ ). Spider family diversity and richness were highest in cool temperate ( $H = 2.63$ ;  $S = 18.3$ ) and lowest in alpine meadows ( $H = 1.45$ ;  $E = 0.84$ ). Topographic and climatologic variation, influencing vegetation composition and structure, between Malari and the other two gradients possibly explain the stark difference in richness and diversity between these sites. The underlining factor is the low prey availability with respect to vegetation composition and structure, but further investigation is required to draw any definitive conclusion.

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Project Title	: Diversity of spiders in Nanda Devi Biosphere Reserve
Principal Investigator(s)	: Dr. V.P.Uniyal and Dr. K.Sivakumar
Researcher(s)	: Ms. Shazia Quasin (SRF)
Funding Agency	: Department of Science and Technology (DST), New Delhi
Project Duration	: January 2008 to December 2010

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## Potential of Lepidoteran Assemblages as Indicator of Habitat Quality in Gangotri Landscape

- Abesh Kumar Sanyal, Senior Research Fellow

Lepidoptera (butterflies and moths) provide an ideal opportunity to detect changes in entire community and habitat quality as they are closely associated with vegetation structure and composition. We test the potential of Order Lepidoptera as indicator of species richness and habitat disturbance by analyzing the general habitat associations of different families and subfamilies in Gangotri and Govind National Parks and Wildlife Sanctuary during 2009-2010. The study area shows large variation in altitude from 1200m to 6000m asl. During our sampling, we recorded 130 butterfly species representing five families and 435 moth species (morphospecies) representing 16 families. We screened different Lepidopteran families and subfamilies to identify assemblages that have high ecological fidelity and primarily comprised of species that can be identified by non-experts. At family level, three moth families, Geometridae (Subfamily Ennominae), Arctiidae and Noctuidae showed highest habitat breadth. Species assemblage changed significantly with the degree of forest disturbance and different disturbance categories were characterized by particular set of species composition. We performed Indicator Species Analysis to select indicator butterfly and moth species for different habitat types. Species associated with intermediate levels of disturbance showed larger habitat breadth than those located at the extreme of the spectrum. The results provide evidence that supports the use of Lepidoptera as indicator for rapid monitoring of habitat quality to prioritize areas requiring management interventions. Additional research will be required, before species within these families having practical significance for assessing forest condition and disturbance level can be identified.

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Project Title	:	An assessment of entomofauna for management and conservation of biodiversity in the Gangotri landscape
Principal Investigator(s)	:	Dr. V. P. Uniyal
Researcher(s)	:	Mr. Manish Bhardwaj (SRF) and Mr. Abesh Kumar Sanyal (SRF)
Funding Agency	:	WII Grant-in-Aid
Project Duration	:	January 2008 to January 2012

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## Response of Habitat and Avifaunal Communities to Anthropogenic Disturbances in the Shiwalik Landscape

- Monica Kaushik, Junior Research Fellow

Frequent compounded perturbations in terms of lopping, grazing, biological invasions and collection of firewood and NTFP gradually alter the habitat and ecological communities. However, it is challenging to quantify these disturbances due to their high frequency, low intensity and interaction among themselves. In order to quantify and investigate the impact of such disturbances on habitat of bird communities, we carried out this study in the Shiwalik landscape. A total of 19 grids of 1 km x 1 km area encompassing 171 points were marked and used for collecting data on disturbance, habitat and target taxa in three major forest types namely dry Sal, moist Sal and *Anogeissus latifolia* tract. Around each point, we delineated an area of 10 m radius for vegetation sampling and 20 m radius for disturbance sampling. Birds were sampled three times in each season utilizing variable radius point count method. Vegetation structure (e.g. canopy cover, basal area, average tree height and tree density) and composition (tree and shrub species diversity and richness) were quantified for each point. Various indicators for disturbance (e.g. grazing, fodder collection, firewood and fire) were recorded in all points. Summarization of all disturbance variables was done using Principal Component Analysis (PCA) and a disturbance gradient for all three forest strata was established. In *Anogeissus latifolia* and moist Sal forest, first two components accounted for 90% of the total variance. However, an additional component was required to explain the variance in dry Sal strata that accounted for 10% variance. Largest loading across all three strata corresponded to grazing pressure followed by firewood extraction. Lopping pressure was the third component in dry Sal strata that explains the residual variance. Segregation of sites using PCA and cluster analysis corresponded closely with that made *a priori*. Impact of disturbance on habitat and bird community is presented and discussed.

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Project Title	: Study of impacts of biotic disturbances on birds in the western Himalayan foothills and development of bird-habitat monitoring protocol
Principal Investigator(s)	: Dr. Dhananjai Mohan and Mr. Pratap Singh
Researcher(s)	: Ms. Monica Kaushik (JRF)
Funding Agency	: WII Grant-in-Aid
Project Duration	: April 2009 to September 2011

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## Distribution, Abundance and Habitat Use of Galliformes in *Prek Chu* Catchment, Khangchendzonga Biosphere Reserve, Sikkim

- Kamal Poudyal, SRF

Distribution, abundance and habitat use patterns of galliformes in *Prek Chu* catchment (182 km<sup>2</sup>) in Khangchendzonga Biosphere Reserve were assessed during February 2008 - July 2010. Trail sampling (n=22, 629.43 km walks) and camera trapping (n=71 locations) were carried out. A total of 365 plots (10m×10m) on trails and camera trap locations were laid to quantify habitat parameters. Based on visual encounters and photo captures, presence of blood pheasant (*Ithaganis creuntus*), satyr tragopan (*Tragopan satyra*), Himalayan monal (*Lophophorus impejanus*), kalij pheasant (*Lophura leucomelanos*), snow partridge (*Lerwa lerwa*), hill partridge (*Arborophila torqueola*) and chestnut-breasted partridge (*Arborophila mandellii*) was confirmed. Himalayan monal occupied the highest proportion of the sites (0.73, 0.06 SE) and blood pheasant had the highest detection probability (0.52, 0.05 SE). Density (#/km<sup>2</sup>, SE) and encounter rates (#/km, SE) of blood pheasant (13.64±2.79; 6.99±0.91) was highest in *Prek Chu* followed by Himalayan monal (1.39, 0.45; 2.82, 0.22), satyr tragopan (1.02, 0.44; 2.72, 0.62) and kalij pheasant (0.74, 0.59; 0.07, 0.03). Bonferroni confidence intervals (p<0.05) revealed that monal and blood pheasant preferred 3,000 - 4,000 m elevation zones (subalpine forests and alpine scrub) and above. Satyr tragopan occupied wide range of elevation categories from 2,000 to 4,000 m (wet temperate forests to subalpine scrub), while kalij and hill partridge were restricted to 2,000 - 3,000m and snow partridge above 4,000m asl. Galliformes used all the available aspects and slope categories in proportion to availability. Satyr tragopan used wet-temperate, fir-birch-rhododendron and rhododendron-scrub habitats in proportion to availability. Blood pheasant preferred fir-birch-rhododendron dominated subalpine habitat, whereas monal preferred *Juniper* and rhododendron dwarf scrub habitat. Occupancy based model showed that elevation, vegetation cover and distance to water source were the most important factors for change in site occupancy of blood pheasant (p = 0.32). Threats to galliformes in *Prek Chu* catchment are presented and discussed.

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Project Title	: Developing spatial database on the mammal distributions and monitoring programme for large carnivores, prey populations and their habitats in Khangchendzonga Biosphere Reserve, Sikkim
Principal Investigator(s)	: Dr. S.Sathyakumar
Researcher(s)	: Mr. Tapajit Bhattacharya (SRF), Mr. Tawqir Bashi (SRF) and Mr. Kamal Poudyal (SRF)
Funding Agency	: WII Grant-in-Aid
Project Duration	: January 2008 to January 2012

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## **Ranging Pattern and Survivorship of Leopard in Semi-Arid Landscape of Sariska Tiger Reserve, Rajasthan**

**- Krishnendu Mondal, SRF**

The study on ranging pattern and survivorship of leopard was carried out in Sariska Tiger Reserve from December 2006 to August 2010. Data on ranging pattern was collected from two relocated collared individuals (L1 and L2) between March 2009 and August 2010. Survivorship of leopard in the study area was determined from mark-recapture data obtained from camera traps during December 2006-May 2010.

The radio-collared animals were monitored regularly through VHF tracking. In total, 123 and 268 radio-locations were recorded for L1 and L2 respectively, which yielded the home range estimate (100% MCP) of 95.3 km<sup>2</sup> and 337.5 km<sup>2</sup> respectively. These larger home ranges of leopards may be attributed to habitat exploration in the initial two months. Subsequently, after removing exploration period, the home ranges (90% Kernel) of L1 and L2 were reduced to 72.4 km<sup>2</sup> and 54.6 km<sup>2</sup> respectively. The highly utilized area (50% Kernel) by L1 and L2 were 12.2 km<sup>2</sup> and 7.9 km<sup>2</sup> respectively.

In total, 32 individual leopards were identified in the study area. Survivorship of leopard was examined using capture-recapture data in program MARK. The survivorship of leopard during 2007 - 2008, 2008 - 2009 and 2009 - 2010 were  $0.65 \pm 0.11$ ,  $0.56 \pm 0.12$  and  $0.49 \pm 0.13$  respectively (Robust Design model). The overall survivorship of leopard in the study area was  $0.55 \pm 0.06$  (Pradel model including robust design). The survival success was calculated to be  $0.76 \pm 0.08$ . The survivorship of leopard declined after 2008, and this may be attributed to the presence of trans-located tigers in the study area.

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Project Title	: Ecology of leopard in Sariska Tiger Reserve, Rajasthan
Principal Investigator(s)	: Dr. K. Sankar and Mr. Qamar Qureshi
Researcher(s)	: Mr. Krishnendu Mondal (SRF)
Funding Agency	: WII Grant-in-Aid
Project Duration	: September 2007 to September 2012

## **Ranging Pattern and Food Habit of Reintroduced Tiger in Sariska Tiger Reserve, Rajasthan**

- Subhadeep Bhattacharjee, Junior Research Fellow

Ranging pattern and food habit of three translocated tigers (ST1-male, ST2 and ST3 - female) were studied from July 2008 to June 2010. The radio-collared tigers were monitored periodically through ground tracking using 'triangulation' and 'homing in' techniques. A total of 1022, 1004 and 869 locations were obtained for ST1, ST2 and ST3 respectively. Minimum Convex Polygon and Fixed Kernel methods were used to analyze seasonal and annual ranging patterns. The estimated annual home ranges of ST1 and ST2 were 168.6 km<sup>2</sup> and 181.4 km<sup>2</sup> respectively in 2008-09 with an overlapped area of 99.04 km<sup>2</sup>. During 2009-10, the annual home ranges of ST1, ST2 and ST3 were estimated as 185.6 km<sup>2</sup>, 123.5 km<sup>2</sup> and 112.2 km<sup>2</sup> respectively with overlapped areas of 117 km<sup>2</sup> between ST1 and ST2, 97.5 km<sup>2</sup> between ST1 and ST3 and 53.9 km<sup>2</sup> between ST2 and ST3. Food habit and prey selection by the tigers were studied through scat analysis and kill data. In all, 248 kills and 216 scats of tigers were collected. Tigers fed on nine prey species as shown by kill data, whereas scat analysis revealed 10 prey species. Sambar was the most utilized prey species as revealed from scat analysis and kill data. Line transect method was used to estimate the prey availability. In all, 20 line transects were walked thrice during three seasons for two years. The density ( $\pm$  SE) of peafowl was found to be the highest ( $91.7 \pm 13.4$  km<sup>-2</sup>) in Sariska followed by livestock ( $65.7 \pm 9.0$  km<sup>-2</sup>), chital ( $14.5 \pm 1.9$  km<sup>-2</sup>), sambar ( $9.7 \pm 1.0$  km<sup>-2</sup>), common langur ( $9.5 \pm 2.1$  km<sup>-2</sup>), nilgai ( $7.4 \pm 0.8$  km<sup>-2</sup>) and wild pig ( $4.4 \pm 0.9$  km<sup>-2</sup>). Prey preference by tigers was in the following order: sambar> chital> common langur> wild pig> nilgai> livestock.

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Project Title	: Monitoring of reintroduced tiger in Sariska Tiger Reserve, Rajasthan.
Principal Investigator(s)	: Dr. K. Sankar and Mr. Qamar Qureshi
Researcher(s)	: Mr. Subhadeep Bhattacharjee (JRF)
Funding Agency	: Rajasthan Forest Department and National Tiger Conservation Authority
Project Duration	: February 2009 to February 2012

## **Monitoring of Reintroduced Tiger in Panna Tiger Reserve, Madhya Pradesh: Coarse Scale Findings on Ranging Pattern and Breeding Success**

- K. Ramesh, Scientist - C

Three tigers (two females and one male) were translocated to Panna Tiger Reserve, Madhya Pradesh to re-establish the population, after it became extinct here in February 2009. Post release monitoring of introduced tigers was a key strategy under the Species Recovery Plan and was taken up since the release of first individual of the founder population in March 2009. The females were fitted with VHF/GPS-UHF collars and the male was fitted with VHF/GPS-Argos satellite collar. The collared animals were monitored continuously by trained teams of forest staff and researchers based on VHF radio signal, onboard GPS technology, and by actively searching for pugmark, where the radio signal could not be obtained. During the initial months, the introduced animals ranged extensively for exploring the new habitat. The male in particular (which was released in November 2009), traversed about 250 km from the release site, invoking the 'homing instinct' assumption, and it had to be brought back after recapture. Subsequently, all the three animals were found to be settled in the new habitat, with only occasional ranging beyond the reserve limit. Home ranges of females overlapped marginally, while the home range of male encompassed the home ranges of both the females. The male was observed to be in association with the females on different temporal scales through the period, and consequently, one of the females yielded a litter of four cubs in April 2010, marking the beginning of successful reintroduction efforts in Panna Tiger Reserve.

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Project Title	: Ecological monitoring of tiger population in Panna landscape, Madhya Pradesh
Principal Investigator(s)	: Dr. K. Ramesh, Mr. S. Sen, Dr. J.A. Johnson and Field Director, Panna TR
Researcher(s)	: Mr. Ravi N. Parmar (JRF) and Ms. Devi Priyadarshini (JRF)
Funding Agency	: Madhya Pradesh Forest Department
Project Duration	: February 2010 to January 2014

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## Planning for Conservation Corridors Connecting Two Asiatic Lion Populations

- Parabita Basu, Junior Research Fellow

Corridors mitigate the adverse effects of habitat fragmentation by maintaining connectivity between disjoint populations. For long term persistence of Girnar lion population, its connectivity with the source Gir Wildlife Sanctuary is vital. We used data of movement pattern, dispersal and habitat use by radio collared lions from January to June 2010, recent lion sighting records, land use patterns, prey availability and infrastructural developments to evaluate the potential of delineating a habitat corridor between Gir and Girnar using GIS. Lions were observed to use dry river channels and forest dirt tracks as passage ways and mango orchards as day refugia. The collared animals roamed through the community lands of over 30 villages out of 100 villages under the study. These villages are distributed in an area of approximately 1500 km<sup>2</sup>, surrounding Girnar Wildlife Sanctuary (180 km<sup>2</sup>), covering revenue and private lands between Gir and Girnar and at the periphery of western part of Gir Wildlife Sanctuary. Major land-use patterns observed in this corridor habitat include croplands (35%), broken terrains characterized by dry river systems (20%), road network (15%), water-body (13%), scrublands (10%) and dense forested patches (7%). Telemetry data (>1500 GPS fixes) from one of the radio-collared males in Girnar confirmed our speculation as the male made a to and fro movement from the Girnar to Gir within 6 days across the landscape passing through revenue lands of villages delineated in the corridor. Specific areas of these villages were used by lions to move between Gir and Girnar. We evaluate these lion movement routes in relation to the overall habitat matrix to understand and propose an eco – sensitive zone for maintaining the demographic and genetic connectivity between the Girnar and Gir lion populations.

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Project Title	: Ecology of lions with emphasis on the agro-pastoral landscape of Greater Gir Ecosystem
Principal Investigator(s)	: Dr. Y.V. Jhala and CCF(WL), Junagadh, Gujarat
Researcher(s)	: Mr. Kausik Banerjee (SRF) and Ms. Parabita Basu (JRF)
Funding Agency	: WII Grant-in-Aid
Project Duration	: April 2009 to March 2012

## Population and Occupancy Estimation of Tiger in Pench Tiger Reserve, Madhya Pradesh

- Aniruddha Majumder, Senior Research Fellow

Population and occupancy estimation of tiger in Pench Tiger Reserve, Madhya Pradesh was carried out from June 2006 to June 2010. Tiger population size and survivorship were determined from mark-recapture data obtained from camera trap sampling. The effective trapping area was 146 km<sup>2</sup> in 2006, 179 km<sup>2</sup> in 2008, 171 km<sup>2</sup> in 2009 and 223 km<sup>2</sup> in 2010. Population size of tiger in the study area was estimated to be 14.0 (SE 0.3; capture probability or  $\hat{p}$  0.39) in 2006, 15.0 (SE 0.9;  $\hat{p}$  0.12) in 2008, 17 (SE 2.7;  $\hat{p}$  0.09) in 2009 and 11.4 (SE 2.9;  $\hat{p}$  0.11) in 2010. The estimated density (using 1/2 MMDM model) of tiger was 9.6 (SE 1.2) 100 km<sup>-2</sup> in 2006, 7.6 (SE 0.9) 100 km<sup>-2</sup> in 2008, 9.8 (SE 2.5) 100 km<sup>-2</sup> in 2009 and 5.1 (SE 1.5) 100 km<sup>-2</sup> in 2010. Annual survival rate was 0.58 (SE 0.16) between 2006 and 2008, 0.66 (SE 0.16) between 2008 and 2009 and 0.49 (SE 0.15) between 2009 and 2010. Results showed that there are no significant changes in survival rate of tiger during this period. Site occupancy (a measure of intensity of beat usage) by tiger was assessed based on sign survey in 43 beats of the study area. Three different trails in each beat were walked with a total effort of 734.6 km in 2006, 728.5 km in 2009 and 710.6 km in 2010. Correspondingly, the site occupancy by tiger was 0.97 (SE 0.02;  $p$  0.91, SE 0.02) in 2006, 1.0 (SE 0.0;  $p$  0.89, SE 0.02) in 2009 and 1.0 (SE 0.0;  $p$  0.91, SE 0.02) in 2010. Result showed that high site occupancy and detection probabilities of tiger in the study area.

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Project Title	: Ecology of tiger in Pench Tiger Reserve, Madhya Pradesh and Maharastra
Principal Investigator(s)	: Dr. K. Sankar, Dr. Y.V. Jhala, Mr. Qamar Qureshi and Dr. Rajesh Gopal
Researcher(s)	: Mr. Aniruddha Majumder (SRF) and Mr. Santanu Basu (JRF)
Funding Agency	: WII Grant-in-Aid
Project Duration	: October 2005 to March 2010

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## Monitoring the Status of Tiger in Corbett Tiger Reserve, Uttarakhand

- Shikha Bisht, Junior Research Fellow

We evaluated the density of tiger and its prey species in a part (six ranges) of Corbett Tiger Reserve during February-July 2010. The Phase IV protocols evolved for the assessment and monitoring of tigers, co-predators, prey and their habitat were followed. We sampled the area through sign surveys ( $n = 93$ , km walked = 453.6) for estimating carnivore presence. Line transects ( $n = 31$ , km walked = 177.6) were carried out for estimating wild ungulate presence and abundance, and habitat parameters including anthropogenic pressures. Camera trap based capture-recapture (Pollock's robust design) was done between 23 May 2010 and 2 July 2010 in an area of 215 km<sup>2</sup> (MCP) to estimate population size, density and survival of tiger. A total of 57 camera locations were sampled in the area identified based on our reconnaissance survey and local knowledge of the forest staff. An effort of 41 trap nights yielded 237 photographs of 52 individual tigers. Closed population estimators selected *Mth* as the best-fit model, thereby accounting for time-induced heterogeneity. Population estimate (# (S.E)) computed using the *Mth* Chao estimator was 68(7.93) (11.66% C.V). The 1/2 MMDM density estimate (# (S.E)) per 100 km<sup>2</sup> was 20.76 (2.73). Under the spatial likelihood model, the density was 15.41(2.30). Present results were compared with the estimates obtained in 2006-2007, using the same MCP. *Mth* Chao estimator based population estimate of 65(5.15) (7.9% C.V) and density estimates (1/2 MMDM and spatial likelihood models) of 22.73(2.39) and 15.1(2.26) were similar (95% C.I,  $p > 0.1$ ).

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Project Title	: Monitoring source population of tiger in Corbett Tiger Reserve
Principal Investigator(s)	: Dr. Y.V Jhala and Mr. Qamar Qureshi
Researcher(s)	: Ms. Shikha Bisht (JRF)
Funding Agency	: National Tiger Conservation Authority and Uttarakhand Forest Department
Project Duration	: October 2009 to October 2012

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## Abundance Estimation and Monitoring of Tiger in Kanha Tiger Reserve, Madhya Pradesh

- Ujjwal Kumar, Junior Research Fellow

The objective of the project is to implement the Phase IV protocols in Kanha Tiger Reserve to intensively monitor this source population. We estimated tiger abundance through camera trap based mark-recapture method using Pollock's robust design. Reconnaissance survey was carried out and an area of 256 km<sup>2</sup> (MCP) was identified for camera trapping. In this area, 56 camera trap stations were installed. Each station was in a 5 km<sup>2</sup> grid. The total effort of 1736 trap nights was expended across 31 occasions and 28 unique individuals of tigers (8 males and 20 females) were captured. Capture histories were developed for each adult tiger identified in the camera-trapping session and we used program MARK 5 and DENSITY 4.2 for abundance estimation. The best fit model was  $M_h$  and Chao estimator was used for population estimate. The population estimate was 28 (SE 0.9). The tiger density was 6.9 (SE 0.47) /100 Km<sup>2</sup> in an effective trapping area of 408 Km<sup>2</sup> (1/2 MMDM model). The spatial model of IP density was estimated through Program Density 4.2 and it was 4.7 (SE 1.5) /100 Km<sup>2</sup>. We compared population and density estimates obtained in 2006 with the current estimates. The effective sampling area was estimated pooling all mean maximum distance moved by tigers from both sampling periods. The density estimate was 9.45 (SE 1.4) /100 km<sup>2</sup> in 2006, while it was 5.78 (SE 0.6) /100km<sup>2</sup> in 2010. We compared the two estimates using paired design Monte Carlo simulation for  $t$  test at  $\alpha$  level of 0.05 and found that density had significantly declined.

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Project Title	: Monitoring source population of tiger in Kanha Tiger Reserve, Madhya Pradesh
Principal Investigator(s)	: Dr. Y. V. Jhala and Mr. Qamar Qureshi
Researcher(s)	: Mr. Ujjwal Kumar (JRF)
Funding Agency	: National Tiger Conservation Authority, New Delhi
Project Duration	: June 2009 to June 2012

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## Population Estimation and Ranging Pattern of Tiger in Sunderban Tiger Reserve, West Bengal

- Dipanjan Naha & Manjari Roy, Junior Research Fellows

The general methods for estimation of population size of tiger and prey densities are not applicable in the Sunderbans, because of its unique mangrove habitat as well as the ever-present threat from tigers. Sign deposition, decay rate of signs and sign density are used to estimate tiger abundance. During the study period the channel banks were searched for recording tiger pugmark due to the unique nature of the tidal washing of the mangrove. Sign deposition was calculated using the daily movement rates and the number of channel crossings in a day by radio-collared tigers. Quantification of decay rate was carried out during field surveys along with the various factors influencing the obliteration of the pugmarks, such as type of tide (high/low tide), lunar phase (spring/neap tide), slope of the bank, proximity to primary or secondary channels and soil type. Four tigers were radio-collared using Vectronics IRIDIUM collars. The mean home range of the radio-collared tigers using 100% MCP method was 140.2 km<sup>2</sup> (SE 34.4), whereas using 95% and 50% Fixed Kernel, it was 115.88 km<sup>2</sup>(SE 23.4) and 32.2 km<sup>2</sup> (SE 17.9) (n=3) respectively. For estimating prey density, we carried out boat transects (of 10-15 km length) using distance sampling methods. The bias corrected occupancy estimate for tiger was 100% and the probability of detecting a tiger sign was 0.76 (SE 0.03) across the entire Sunderbans. Mean encounter rates for tiger, chital and wild pig along 221 km of sign surveys conducted from February-May 2010 in Sajnekhali Wildlife Sanctuary and West Range of Sunderban Tiger Reserve were 0.52 (SE 0.003), 3.8 (SE 0.02) and 0.15 (SE 0.003) respectively. Based on the above information, an effective monitoring system for the conservation of this unique ecosystem will be developed.

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Project Title	: Population estimation and ecology of tiger in Sunderbans
Principal Investigator(s)	: Dr. Y.V.Jhala and Mr. Qamar Qureshi
Researcher(s)	: Mr. Dipanjan Naha (JRF) and Mr. Manjari Roy (JRF)
Funding Agency	: National Tiger Conservation Authority, New Delhi
Project Duration	: October 2009 to October 2012

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## Monitoring of Tiger in Ranthambore Tiger Reserve, Rajasthan

- Y.V. Jhala, Scientist – G

Intensive monitoring of tiger population in Ranthambore Tiger Reserve was proposed to be achieved by implementing Phase IV protocols recommended by the Tiger Task Force. The other objectives of the project were to gain an understanding of the land tenure system and dispersal patterns of tigers in Ranthambore. This project was initiated in April 2009 for an initial duration of three years and funded by the National Tiger Conservation Authority. Camera trap based mark-recapture population and density estimation using the Pollock's robust design was done in an effective trapping area of 450 km<sup>2</sup> with a trapping effort of 1,392 trap nights. From 97 photo-captures of 28 individual tigers, the tiger population using closed population estimators was 32 (SE 3, Model  $M_{th}$ ) and density was estimated at 7 (6.1-8, 95%CI) tigers per 100 km<sup>2</sup> using the  $\frac{1}{2}$  MMDM. Annual CTMR in the same area is proposed for estimating tiger survival and recruitment along with population and density estimates. The research project personnel assisted the Park management in monitoring radio-collared and dispersing tigers so as to ensure their protection.

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Project Title	:	Monitoring and dispersal of tigers in Ranthambore Tiger Reserve : Phase IV
Principal Investigator(s)	:	Dr. Y.V. Jhala and Mr. Qamar Qureshi
Researcher(s)	:	Mr. Peter P. Chakroborthy (JRF)
Funding Agency	:	National Tiger Conservation Authority, New Delhi
Project Duration	:	January 2008 to March 2010

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## Prey Availability and Prey Selection by Asiatic Wild Dog in Pakke Tiger Reserve, Arunachal Pradesh: Preliminary Findings

- K. Muthamizh Selvan, Junior Research Fellow

Prey availability and prey selection by wild dog or dhole (*Cuon alpinus*) were investigated in Pakke Tiger Reserve, Arunachal Pradesh between November 2009 and March 2010. Densities of large herbivores were estimated using line transects (n = 20) and data were analyzed using software DISTANCE 6.0. Prey selection of dhole was determined by scat analysis (n = 95). Selectivity for each prey species was inferred from likelihood ratio tests comparing observed counts of scats to hypothesized scat frequencies generated from prey density estimates using parametric bootstrap (SCATMAN) replication. Sign encounter rate of dhole was 0.27 signs km<sup>-1</sup>. Among prey species, wild pig *Sus scrofa* (5.4 ± 1.5 km<sup>-2</sup>) was abundant throughout the study area, followed by barking deer *Muntiacus muntjac* (4.4 ± 1.1 km<sup>-2</sup>), sambar *Rusa unicolor*, (3.1 ± 0.9 km<sup>-2</sup>), capped langur *Trachypithecus pileatus* (1.9 ± 0.9 km<sup>-2</sup>) and gaur *Bos gaurus* (1.6 ± 0.8 km<sup>-2</sup>). The study area supports a wild herbivore biomass of 1510.8 kg km<sup>-2</sup>. Among individual biomass, gaur was found to be the highest (761.9 kg km<sup>-2</sup>). Scat analysis showed no significant (p > 0.05) selectivity among prey species. Wild pig (47.6%) and sambar (19.1%) were represented in considerable amount in dhole diet. The total prey biomass consumed by dhole was 244.07 kg/100 scats and in terms of biomass contribution in dhole diet, gaur was the highest (44.16%), while hare was the lowest (1.27%). Preliminary results are discussed and it is proposed to continue the investigations on food habits of dhole.

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Project Title	: Conservation of the endangered Asiatic wild dog <i>Cuon alpinus</i> in western Arunachal Pradesh: linking ecology, ethnics and economics to foster better coexistence
Principal Investigator(s)	: Mr. Gopi.G.V and Dr. Bilal Habib
Researcher(s)	: Mr. K. Muthamizh Selvan (JRF) and Mr. Salvador Lyngdoh (JRF)
Funding Agency	: Department of Science and Technology, New Delhi
Project Duration	: May 2009 to May 2012

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## Socio-economic and Wildlife Conflict Status in Western Arunachal Pradesh with Special Reference to Asiatic Wild Dog: Preliminary Findings

- Salvador Lyngdoh, Junior Research Fellow

Arunachal Pradesh holds a fraction of the historical range of the Asiatic wild dog. A major threat to wild dog population in the state is retaliatory killing by local people due to livestock depredation. This study was conducted between November 2009 and February 2010 in three districts viz. East Kameng, Papumpare and Lower Subansiri. A total of 371 households from 48 villages surrounding three major Protected Areas in the western Arunachal Pradesh viz. Pakke Tiger Reserve (PTR), Itanagar Wildlife Sanctuary (ITWLS) and Talle Valley Wildlife Sanctuary (TVWS) were sampled through a set of open and closed ended questions in a questionnaire survey targeting the indigenous communities of the *Nishi* and *Apatani*. Wild dog was the prime livestock predator across various clusters of villages (69.2%). Proportion of *Mithun* depredated by a large predator was reported as highest (27.1%) and wild dog accounted for the major proportion (79.5%) of this depredation. Depredation by wild dog was high near north-eastern PTR (32.2%), medium in Apatani valley (10.6%) and low in ITWLS (4.5%), eastern (8.8%) and northern PTR (4.4%) and negligible in Naumura (0.8%) areas. Out of 44 killings of carnivores, 15 wild dogs were killed in retaliation. More than half of the respondents hunted for wild meat at some point or the other (62.3%). Motive for hunting was for sustenance (54.9%). Monetary losses due to *Mithun* depredation by wild dog, perceptions and attitudes among respondents were analysed and discussed.

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<b>Project Title</b>	: Conservation of the endangered Asiatic wild dog <i>Cuon alpinus</i> in western Arunachal Pradesh: linking ecology, ethnics and economics to foster better coexistence
<b>Principal Investigator(s)</b>	: Mr. Gopi.G.V and Dr. Bilal Habib
<b>Researcher(s)</b>	: Mr. Salvador Lyngdoh (JRF) and Mr. K. Muthamizh Selvan (JRF)
<b>Funding Agency</b>	: Department of Science and Technology, New Delhi
<b>Project Duration</b>	: May 2009 to May 2012

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## Do Interpretive Facilities Contribute to Tourism Readiness of Tiger Reserves in the Country?

- Madhumita Panigrahi, Technical Assistant

Growing need for awareness amongst the tourists visiting Protected Areas for wildlife conservation has necessitated the need to develop programs that increase understanding and appreciation of their experience and their commitment to natural resource conservation. The way forward is developing a well planned interpretative facility. Tiger Reserves have gained popularity amongst visitors and the visitation is ever increasing. This presentation focuses on visitation and interpretive facilities in 20 Tiger Reserves across India. Results show that there is a strong correlation between presence of diverse interpretive facilities and tourism readiness of the reserve ( $r=0.67$ ,  $p<0.05$ ). Presence of good interpretive facilities does not relate to the duration of reserve existence ( $r=0.24$ ,  $p>0.05$ ). Many newly established reserves also have good interpretive facilities. Contrary to the general assumption that the interpretive facilities attract higher visitation, there is no significant correlation between visitation to the reserve and the interpretive facilities ( $r=0.16$ ,  $p>0.05$ ). A strong correlation is found between cost of the interpretive facility and its quality ( $r=0.69$ ,  $p<0.001$ ). We conclude that interpretive facilities in Tiger Reserves are not developed in a planned manner in line with the management plans, requirements of the visitors and research background. These are rather developed opportunistically depending on the inclination of the park management and the fund availability.

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Project Title	:	Evaluating effectiveness of interpretive facilities in enhancing conservation awareness in select tiger reserves in India
Principal Investigator(s)	:	Ms. Bitapi C. Sinha and Dr. V.B. Mathur
Researcher(s)	:	Ms. Madhumita Panigrahi (TA)
Funding Agency	:	WII Grant-in-Aid
Project Duration	:	January 2007 to March 2011

## Impact Evaluation of Narmada Canal on the Floral and Faunal Species in the Command Area in Rajasthan: Preliminary Findings

- Roshni Arora, Junior Research Fellow

According to Narmada Water Dispute Tribunal (NWDT) award in 1979, the utilizable flow of Narmada water is to be shared by four co-basin states. The Narmada Canal originating from the Sardar Sarovar dam in Gujarat will enter Rajasthan at Silu Village in District Jalore. In response to the requirements of preparation of the Environmental Impact Assessment (EIA) report, the Government of Rajasthan (GoR) engaged Wildlife Institute of India to conduct the EIA of the proposed canal on wildlife values of the command area. The study aims to (i) assess key floral and faunal attributes in the command area; (ii) identify impacts of construction/operation of canals and resulting changes in agriculture on select wildlife and their habitats; (iii) inventorize floral resources of medicinal/forage values; and (iv) suggest measures to mitigate adverse impacts.

Based on the intensity of irrigation, the study area was divided into five land categories. Line transects (n=33) were walked in different land categories during winter season to assess floral and faunal attributes. Of these transects, 13 were repeated during summer. Efforts were made to inventorise plant species and record animal presence/absence, diversity and encounter rate through direct/indirect observations.

A checklist of plants (50 species), mammals (12 species) and birds (54 species) was prepared. The frequency of chinkara encounter varied in different land categories. It was the highest in non-irrigable land followed by grazing areas. Nilgai encounter was the highest in grazing land followed by that in moderately irrigable land in both summer and winter. Largest group size of chinkara was observed in grazing lands in winter and in moderately irrigable land in summer. Largest group size of nilgai was observed in grazing lands in both summer and winter. Analysis of data is in progress to determine the impacts of intensified irrigation on cropland habitats of chinkara and nilgai.

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Project Title	: Study of flora and fauna in the context of Environmental Impact Assessment (EIA) and Environment Management Plan (EMP) for command area of Narmada Canal Project in Rajasthan
Principal Investigator(s)	: Dr. Asha Rajvanshi, Dr. S.P Goyal and Dr. V.B. Mathur
Researcher(s)	: Ms. Roshni Arora (JRF)
Funding Agency	: Government of Rajasthan
Project Duration	: August 2009 to November 2010

## Status of Traditional Knowledge on the Uses of Medicinal Plants in Uttarkashi District, Uttarakhand

- Ninad B. Raut, Senior Research Fellow

An ethnobotanical survey was carried out in Uttarkashi district to assess the status of Traditional Knowledge (TK) on the uses of Medicinal Plants (MPs). Semi-structured interviews were conducted in villages located in three major river valleys, viz. Bhagirathi, Yamuna and Tons. The area was stratified on the basis of altitudinal gradients into three categories (800 – 1500m; 1501 – 2000m; 2001m - above) in each valley. Of the total of 669 villages in the district, 134 (20%) were sampled during the present study. Individual interview of respondents (n = 861) representing various age group and gender were carried out in each sampled village. Study revealed that only 30% respondents possess TK related to use of medicinal plant species. Of these, only 3% respondents use this knowledge for the treatment of various ailments, though it is not their primary income source. Interviews revealed that respondents had knowledge of 118 species of medicinal plants belonging to 56 families. Maximum respondents (80%) were found to have TK on medicinal properties of *Aconitum heterophyllum* and *Picrorhiza kurrooa* commonly known as *Atis* and *Kutki* respectively. Based on multiple factors, the Use Value (UV) of each species was determined. The species which have high UV were then compared with available literature on the potential of species to cure other diseases. Information from Forest Department and other relevant literatures are being procured to understand the underlying intricacies of prevalent trade of various MPs. With the development of new medical facilities, the study was immensely helpful in identifying the declining trend of Traditional Knowledge of Medicinal Plants in Uttarkashi District, Uttarakhand.

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Project Title	:	Survey and mapping of commercially important medicinal plants in Uttarakhand
Principle Investigator(s)	:	Dr. G. S. Rawat and Dr. B. S. Adhikari
Researcher(s)	:	Mr. Ninad B. Raut (SRF) and Mr. Umeshkumar L. Tiwari (SRF)
Funding Agency	:	Uttarakhand Forest Department
Project Duration	:	February 2008 to January 2011