

Evaluating the errors associated with population estimation of tiger (*Panthera tigris*) using different non-invasive techniques: A case study from Ranthambhore Tiger Reserve

- Randeep Singh, Senior Research Fellow

Successful conservation and management of rare and elusive species such as tiger (*Panthera tigris*) requires reliable estimates of population size. The commonly used approaches for felids are pugmark technique, camera trapping and recently used non invasive genetic sampling based on genotyping of faecal DNA. We used the above three methods for assessing the abundance of tiger in a 233 km² area of Ranthambhore Tiger Reserve (RTR), Rajasthan during winter of 2010. We monitored 90 track plots and collected 27 set of pugmarks for further analysis. Using 23 variables and discriminate function analysis we could identify 16 individual tigers. The estimated population size was 19 ± 4.5 with a detection probability of 0.07. A total of 345 photo captures of tigers were obtained by intensive monitoring of 186 camera trapping station for 21 days. Only 44 % of photo-captures were used for the analysis. Twenty two individual tigers were captured within 5 days of sampling. The estimated population size was 25 ± 1.5 for the area and detection probability was 0.31. Male tigers had 8% higher detection probability than females. A total 220 scats were collected by 6 replicates of 27 road segments, of which 150 scat samples were used for DNA extraction. Only 59 scats gave amplification at more than 5 loci and were used for individual identification. Twenty unique genotypes were identified and used for population estimation. We discuss and compare optimal strategies for obtaining precise estimates of tiger population using these three methods.

Project Title	: Comparison of tiger (<i>Panthera tigris</i>) population estimated using non-invasive techniques of pugmark, camera trap, and DNA based analysis of hair and scat in Ranthambhore Tiger Reserve, Phase II: Estimation of tiger population.
Principal Investigator(s)	: Dr. S. P. Goyal, Dr. K. Sankar & Qamar Qureshi
Researcher(s)	: Randeep Singh, SRF & Puneet Pandey, JRF
Funding Agency	: WII Grant-in-Aid
Project Duration	: May 2007 to September 2011

Food habits of leopard (*Panthera pardus*) in Dachigam National Park : Preliminary findings

-Athar Noor, Junior Research Fellow

Ecological study on the common leopard (*Panthera pardus*) was initiated in the Dachigam National Park of the Kashmir valley in March 2011. Feeding ecology was studied by analysing 198 leopard scats collected from the study area. Standardised scat analysis protocol was used to obtain preliminary outputs about the feeding habits of the leopards. A total of 15 items were identified in the dietary spectrum of the leopard which was represented by eight wild mammalian taxa, three domestic and one taxon each from aves, arthropods and an unknown type and other vegetative and non-biodegradable matters. About 68.7% (n=136) of the scats analysed contained single type of item which successively decreased to 26.8% for two and 4.5% for three types of items consumed. The percent frequency of occurrence (%F), of the items ingested, puts small rodents at the highest (56.1%) order of the leopard diet followed by Himalayan grey langur (*Semnopithecus ajax*) (12.1%), domestic sheep (9.7%) and Hangul (*Cervus elaphus hanglu*) (5.2%). There is a seasonal shift in dietary spectrum which was studied by comparing the scat samples across the two seasons viz spring (March - May; n=166) and early summer (June – July; n=32). Diet dependency of leopard on small rodents increases from spring (%F=49.6) to summer (%F=71.8). Further ecological components of the study on the leopard abundance estimation, ranging pattern and human-leopard conflict are underway.

Project Title	:	Ecology of Leopard (<i>Panthera pardus</i>) in Relation to Prey Abundance and Land Use Pattern in Kashmir Valley
Principal Investigator(s)	:	Dr. Bilal Habib & Shri. Gopi G. V.
Researcher(s)	:	Athar Noor, JRF & Zaffar Rais Mir, JRF
Funding Agency	:	Department of Science & Technology (DST), New Delhi
Project Duration	:	December 2010 to December 2013

Multi-scale resource selection by leopard (*Panthera pardus*) in Sariska Tiger Reserve, Rajasthan

-Krishnendu Mondal, Senior Research Fellow

A study on multi-scale resource selection of leopard was carried out in Sariska Tiger Reserve from January 2007 to May 2011, through camera trapping technique under mark-recapture framework. Camera trapping was done in the intensive study area (ETA- 230 km²) covering 85 to 130 occasions each year with 180 to 200 camera locations. In total, 40 individual leopards were identified in study area, of which seven leopards were selected for resource selection analysis; those were captured in more than 30 locations. The resource selection was categorized into two scales: Level one and Level two.

Level one habitat selection (~2nd order) was studied through compositional analysis comparing the habitat availability in geographic range of all seven leopards and utilization by each leopard within it. The result showed that habitat selection was non-random ($p < 0.001$) and *Boswellia* dominated forest and *Anogeissus* dominated forest were preferred than other habitat types.

Level two resource selection (~3rd order) was studied through generalized linear mixed-effect model (GLMM) comparing the resource availability and utilization in each individual leopard's range. The result showed that leopard preferred *Anogeissus* dominated forest followed by *Zizyphus* mixed forest and scrubland. In addition, leopard preferred the habitat with higher encounter rate of sambar and chital and less used habitat with higher encounter rate of livestock.

Habitat suitability model for leopard was developed using MaxEnt prediction in Sariska and adjoining 5 km areas. The predicted distribution model of leopard was positively dependent on distribution of peafowl, chital, sambar and wild pig. *Zizyphus* mixed forest, *Boswellia* dominated forest, *Anogeissus* dominated forest, scrubland, NDVI in summer and water sources were positively correlated to the distribution of leopard. In the present study, leopard showed some degree of preference to moderate to thick vegetation cover and wild prey species rather than open forest types and domestic prey species.

Project Title	:	Ecology of leopard in Sariska Tiger Reserve, Rajasthan
Principal Investigator(s)	:	Dr. K. Sankar, Sh. Qamar Qureshi & Dr. Y.V. Jhala
Researcher(s)	:	Krishnendu Mondal, SRF & Pooja Chourasia, JRF
Funding Agency	:	Grant-in-Aid
Project Duration	:	September 2007 to September 2012

Survival rate, habitat use and home range of tiger (*Panthera tigris*) in Pench Tiger Reserve, Madhya Pradesh

-Aniruddha Majumder, Senior Research Fellow

Survival rate, habitat use and home range of tiger were studied in Pench Tiger Reserve, Madhya Pradesh between June 2006 and July 2011. Survival rate of tiger in the intensive study area (>200 km²) was estimated by camera trapping (n=36) using Pollock's robust design. The estimated annual survival rate for tiger population was 0.63 ±0.19; 0.56 ±0.13 for male and 0.67 ±0.08 for female. To study the habitat use by tiger, direct and indirect signs were collected from major habitat types in the study area and compared with the available habitat types. Bonferroni's confidence interval technique was used to determine which habitat types were preferred. The expected use of each vegetation types (submergence, riverine, miscellaneous, agriculture, barren land and teak-mixed) differed significantly from the available vegetation types in winter ($\chi^2=18.3$, df=5, $p<0.01$) and in summer ($\chi^2=24.6$, df=5, $p<0.01$) followed by canopy types (non forest, open forest, moderately dense forest and very dense forest) in winter ($\chi^2=38.5$, df=3, $p<0.01$) and in summer ($\chi^2=39.9$, df=3, $p<0.01$). Of the total kills located, maximum were in teak-mixed forests. One adult female-AF (n=539), one adult male-AM (n=118) and one sub adult male tiger-SAM (n=734) were radio-collared and GPS locations were plotted on the map to estimate home ranges. The estimated home ranges at 95% Adaptive Kernel was 32.8 km², 69.2 km² and 19.4 km² for the AF, AM and SAM, respectively.

Project Title	:	Ecology of tiger in Pench Tiger Reserve, Madhya Pradesh and Maharashtra
Principal Investigator(s)	:	Dr. K. Sankar, Dr. Y.V. Jhala, Qamar Qureshi & Dr. Rajesh Gopal
Researcher(s)	:	Aniruddha Majumder, SRF
Funding Agency	:	WII Grant-in-aid
Project Duration	:	October 2005 to March 2013

Ecology and conservation of Himalayan wolf: Phase 1

-Shivam Shrotriya, Junior Research Fellow

Molecular studies on wolves in India reveal the presence of three different lineages. The Himalayan lineage, from Spiti to Sikkim, including Nepal, and the peninsular lineage are the most ancient lineages of the world. Population estimation of wolves in Ladakh and Spiti by earlier workers revealed the presence of around 350 individuals left in the wild. Nevertheless, aspects of their biology and ecology were never investigated. The current project was initiated to fill this gap. A baseline survey is currently in progress across the Himalayan and Trans-Himalayan landscapes to identify key areas for wolf conservation. Since October 2010, 90 villages and groups of nomadic herders were visited and 244 interviews were conducted using semi-structured questionnaires for obtaining records of wolf sighting by the local people and livestock predation, in the states of Jammu & Kashmir and Himachal Pradesh. Indices were developed to compare the level of wolf-human conflict and wolf presence across the Protected Areas.

Wolves accounted for 11.2% cases of livestock predation as compared to leopard (30.8%) and snow leopard (17.5%) in Himachal Pradesh and 57% cases compared to leopard (17.6%) in Jammu & Kashmir. In Himachal Pradesh, Conflict index was found to be higher in Kibber Wildlife Sanctuary (9.12) followed by Pin Valley National Park (1.56). In Jammu & Kashmir, the Conflict index was higher in Thajwas-Baltal Wildlife Sanctuary (13.89) followed by Hirpora Wildlife Sanctuary (9.43) and Changthang Cold Desert Sanctuary (4.08). Wolf Presence index was higher in Kibber (0.76) followed by Pin Valley (0.34) and Hirpora (1.00) followed by Changthang (0.88) and Thajwas-Baltal (0.80). Considering if the livestock predation cases and the sightings by the people are relative to the abundance of wolves, Kibber and Thajwas-Baltal with adjoining Overa-Aru Wildlife Sanctuaries and Changthang Cold Desert Sanctuary are seen as potential sites of higher abundance.

Project Title	: Ecology and conservation of Himalayan Wolf
Principal Investigator(s)	: Dr. Bilal Habib & Dr. Y.V. Jhala
Researcher(s)	: Shivam Shrotriya, JRF
Funding Agency	: MBZ Species Conservation Fund & WII Grant-in-aid
Project Duration	: August 2010 to February 2012

Management of captive populations using studbooks: Lessons learnt and the way forward

-Manjari Malviya, Technical Assistant

Ex-situ conservation with its primary aim of complementing *in-situ* conservation enhances the chance of survival of many species. Success of captive breeding programs depends largely on the genetic and demographic health of the population. Studbook analysis provides a basic foundation for conservation as it forms a tool capable of suggesting the genetic and demographic status of the captive population. A study was initiated to update and develop National Studbook of 14 faunal species maintained in Indian zoos. The data for the studbooks was collected from the holding institutions and analyzed using SPARKS 1.5 and PM2000 software. The results of demographic parameters *viz.* population size and growth rates, age distribution, mortality and fecundity; and genetic parameters *viz.* genetic diversity, founder statistics, mean inbreeding coefficient and mean kinship were derived as they provide an insight into the long term viability of the populations. The study revealed that, for certain species, *e.g.* Tibetan Wolf (*Canis lupus chanco*), Asiatic Wild Dog (*Cuon alpinus*), the captive population was small and the number of individuals with known parentage was low, making it difficult to undertake genetic or demographic analysis. For all other species, *e.g.* Red Panda (*Ailurus fulgens fulgens*), Snow Leopard (*Uncia uncia*), Hoolock Gibbon (*Hoolock hoolock*), the status of captive populations are presented and appropriate population planning and breeding recommendations discussed. From this study, it is concluded that captive population of certain species reflect a positive growth, some are stable while others are declining. Thus, effective management of captive populations requires robust data, adequate number of founder animals and equalizing founder representation.

Project Title	:	Development and maintenance of studbooks of selected endangered faunal types in Indian zoos
Principal Investigator(s)	:	Dr. Parag Nigam & Sh. P.C. Tyagi
Researcher(s)	:	Manjari Malviya, TA & Dr. Anupam Srivastav, RA
Funding Agency	:	Central Zoo Authority
Project Duration	:	November 2006 to November 2011

Evaluation of housing and enclosure enrichment practices in the sloth bear (*Ursus ursinus*) enclosures of three zoos

-Sitendu Goswami, Junior Research Fellow

Animals in wilderness depict a range of activity patterns and spend considerable time in foraging, territorial defense and other instinctive behaviours. In captivity, space limitations and supplemental feeding greatly alter their activity patterns. A study to evaluate the available housing and enclosure enrichment practices and their effectiveness for select species in Indian zoos was initiated. For this purpose; enclosure complexity (including vegetation and other natural features present), enrichment devices, available space, feeding practices, and behavioural attributes of welfare viz. space utilization, utilization of enrichment devices, social interactions, resting and aberrant behaviour were studied using focal sampling.

This study conducted at three zoos focuses on 8 (6.1.1) sloth bears (*Ursus ursinus*) of which 7 were adults and 1 cub. Focal sampling was carried out for 17 hrs for each animal. The enclosure at Chennai Zoo had the highest enclosure complexity with the presence of both enrichment devices and natural features such as rocks and trees suitable for climbing, whereas the one at Tirupati was the least complex. The space available per animal was maximum at Tirupati Zoo (1157 m²), followed by Chennai (280 m²) and the least at Mysore (268 m²). Supplemental feeding of several items including fruits, vegetables and cereals was provided to the animals in the individual retiring cubicles twice a day at each zoo.

The results of the behavioural study suggest that space utilization pattern fluctuates spatio-temporally. Aberrant behaviour also forms an integral part of the behavioural repertoire of bears at all three zoos, though their intensity varies from animal to animal, their location and the time of the day. Our findings also suggest that enclosure complexity and feeding regimen rather than available space play a major role in determining the welfare of the animals housed as perceived by behavioural attributes.

Project Title	:	Studies on Housing and Enclosure Enrichment of Some Species in Selected Indian Zoos
Principal Investigator(s)	:	Sh. P.C. Tyagi & Dr. Parag Nigam
Researcher(s)	:	Dr. Anupam Srivastav, Project Consultant, Sitendu Goswami, JRF & Tamma Ajay Kumar, JRF
Funding Agency	:	Central Zoo Authority of India (CZA)
Project Duration	:	January 2011 to January 2013

Conservation breeding of Western Tragopan (*Tragopan melanocephalus*) in Himachal Pradesh: Current status and proposed interventions for scientific management of captive populations

-Lakshminarasimha R., Junior Research Fellow

Western Tragopan (*Tragopan melanocephalus*) is a threatened pheasant species endemic to the north-west Himalaya. In order to support conservation of this species, an *ex-situ* breeding program was initiated by the Himachal Pradesh Forest Department, with establishment of Conservation Breeding Centre at Sarahan, Shimla district in 1987. There are 19 individuals of Western Tragopan (10 males and 9 females) currently housed in the Sarahan Pheasantry. After the initial success in 1993 which marked first ever breeding of this species in captivity, further breeding success was achieved only in 2005, with most productive year being 2007. The techniques that have been considered and employed in the scientific management of this species in captivity are presented. An ideal keeping system derived from the limited information available on the wild populations of Western Tragopan and related species is taken to represent improvised options. The breeding history, behavioral observations and current management practices provide insights on the reproductive output of the population over the years, growth of the population and husbandry deficiencies. Science-based interventions with reference to housing, dietary regimes and reproductive management of the birds have been proposed. The new management protocols which will be adaptive in nature will be based on the results of the planned studies on proximate aspects of behaviors and reproductive biology of these birds. This study has implications for captive breeding and management of the species and will also potentially provide perspectives for *ex-situ* management of other pheasant species.

Project Title	:	Reproductive biology and behavior of captive and wild populations of Western Tragopan in Himachal Pradesh
Principal Investigator(s)	:	Dr. K. Ramesh & Dr. Parag Nigam
Researcher(s)	:	Lakshminarasimha R., JRF & Samhita Bose, JRF
Funding Agency	:	Wildlife Wing, Himachal Pradesh Forest Department
Project Duration	:	June 2011 to May 2014

Twenty years of change in the Lower Ganga Basin: A remote sensing and GIS approach

-Indranil Mondal, Junior Research Fellow

The Lower Ganga Basin is one of the highly populated areas of India, home to about 300 million people. The current study aims at finding out the change in landuse and landcover (LULC) over a span of 20 years, identifying the factors driving this change and predicting land use scenarios for 2015. Within the basin, the area of interest consisted of the states of West Bengal and Bihar, and parts of Uttar Pradesh, Madhya Pradesh, Chhattisgarh and Jharkhand, covering 287,774 km² area. It includes 49 protected areas, among which 4 are Tiger Reserves. LULC maps for the years 1985, 1995 and 2005 were generated using satellite images and visual interpretation. Data for drivers of change were categorized into bio-physical and socio-economic, and were acquired from various sources and compiled into geo-databases. Change matrices were generated from the LULC maps and multiple regression analysis is being done to identify the most important drivers of change. Models like CA_MARKOV, GEOMOD and Multi-layer Perception (MLP) neural network are being employed for predicting future LULC scenarios. Preliminary results for the states of Bihar and West Bengal covering 60% of the study area were obtained. Cross tabulation of the LULC maps for Bihar show that the most prominent land use change was between wetlands and water bodies to agricultural land, with agricultural land being most stable. Land use fluctuations between different classes in Bihar show an overall ϕ_c (Cramer's V) of 0.884. In case of West Bengal most prominent changes are from agricultural land to wetlands and water bodies, followed by agriculture to scrub and wastelands. Changes in West Bengal show an overall ϕ_c of 0.9223.

Project Title	: Landuse Landcover Dynamics and Impact of Human Dimensions in Indian River Basins: Lower Ganga Basin
Principal Investigator(s)	: Dr. Gautam Talukdar
Researcher(s)	: Indranil Mondal, JRF
Funding Agency	: Indian Space Research Organization (ISRO)
Project Duration	: August 2010 to August 2012

Assessment of provisional and recreational services of Nanda Devi Biosphere Reserve, Uttarakhand

- Pariva, Junior Research Fellow

The present study assesses the provisioning and recreational services of the Western Himalayan landscape in the Nanda Devi Biosphere Reserve (NDBR). Data for assessment of socioeconomic status of the local communities as well as provisioning services was collected using ethnographic questionnaire-based interviews, participant observation method (POM) and entry point surveys. Households were selected on the basis of forest types and distance from forest and divided into distance categories (500-2000 m & >2250 m). This was subsequently analyzed using standard correlation analyses (N=690) to derive the relationship between socioeconomic variables and human wellbeing which was based on Millennium Development Goals. Water dependency was estimated using POM and timed volumetric method in six streams, selected on the basis of forest types. Recreational value was estimated by travel cost method through multisite model-based questionnaire surveys and subsequently analyzed using regression model (N=570). Socioeconomic assessment revealed that the dependency on forests for fuelwood, fodder, thatch, leaf litter and other NTFPs was more for household located near forests (40.84 mt/year) than distant ones (18.9 mt/year). Forest products contribute 15.4% of the total household income for those located near forests and 10.05% for households located away from forests. The correlation between education level and human wellbeing was positive ($R=0.608$; $p<0.01$), while between degraded forests and wellbeing it was negative ($R=-0.693$; $p<0.01$). Further, wellbeing was highest in households located near conifer mixed forests and lowest for the households that are away from forests (>4 km) while there was no correlation between wellbeing and distance from road. Average water flow for the selected streams was estimated 2.85 m³/year and dependency on it was estimated as 41.3 m³/year/household. Water-use value was estimated as Rs. 1,36,300.7/ household/annum. Recreational value of NDBR was estimated as Rs. 16.2 million/annum.

Project Title	: An integrated approach to reduce the vulnerability of local communities to environmental degradation in Western Himalaya
Principal Investigator(s)	: Dr. Ruchi Badola & Dr. S.A. Hussain
Researcher(s)	: Pariva, JRF & Ashi Qureshi, JRF
Funding Agency	: Grant-in-Aid
Project Duration	: January 2008 to January 2012

Assessment of Banj oak (*Quercus leucotrichophora*) forests and their conservation status in Uttarakhand

-Gajendra Singh, Research Personnel

Banj oak forms a major component of temperate broadleaf forest in mid elevation zone (1000-2500 m asl) of Uttarakhand. It is highly preferred by the local inhabitants for their livelihoods and ecosystem services. Owing to increasing anthropogenic pressures, this forest type is degrading and intermixing with other forest types in several places. In order to assess the status of Banj oak forest, a baseline study was conducted in Uttarakhand with the objectives to (i) map the Banj oak forest distributions (ii) assess the status, structure and composition, and (iii) develop Banj oak conservation and management strategies. Baseline distribution map of Banj oak forest was generated using AW data. Satellite data of Banj oak zone (1000-2500 m asl) was segregated in to four altitudinal zones and hybrid image classification was performed to differentiate vegetation classes. Around 515 sampling plots in ~150 Banj oak patches were laid to assess the structure and regeneration pattern of Banj oak.

About 1284.60 km² area was recorded under Banj oak forests in Uttarakhand, of which 774.93 km² area falls within reserve forests (RF) and 509.66 km² lies outside. The highest Banj oak area was recorded in Uttarkashi (209.08 km²) followed by Tehri (206.68 km²) and Pithoragarh districts (148.49 km²), while, minimum was in Champawat (53.92 km²), Bageshwar (66.25 km²) and Almora (66.74 km²) districts. Fragmentation analysis reveals that Champawat district has the most fragmented Banj oak forest with high patch density (0.57/100 ha), while Banj oak forests of Pithoragarh district are least fragmented with low patch density (0.19/100 ha). This can be attributed to availability of other fodder species and relatively low human pressure around Banj oak forests in Pithoragarh district, and vice-versa for Champawat district. Based on the study, conservation strategies are discussed.

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

Patterns in species richness and diversity of butterflies along an elevational gradient in Tons valley, Western Himalaya

-Manish Bhardwaj, Senior Research Fellow

The current study documents differences in species richness and diversity of butterflies (Lepidoptera: Rhopalocera) along an elevational gradient in the Tons valley (Western Himalaya), Uttarakhand, India. We tested a number of hypothesis that were proposed as ‘general explanations’ for these patterns namely (i) the mid-domain effect (ii) overlap between butterfly faunal compositions (ii) water and energy availability (iv) area of elevational bands and (v) determination by floral diversity and disturbance. Line transects and direct search approaches were used to quantify the local species richness and diversity (Fisher’s α) at 130 sites during 2009 - 2010. Lists of occurrence of butterflies were compiled for each 100 m elevational band, starting from an elevation of 900 m - 3500 m. For each of the 26 elevational band sites, climate and NDVI data was acquired and plot level microclimatic, vegetation and disturbance parameters were quantified. A total of 174 butterfly species were recorded (Expected species richness=182, SE \pm 161-233 (Chao1) during the entire sampling period. A decreasing pattern in species richness, abundance and diversity (Peak species richness and diversity was observed between 1200-1500 m) with an increase in elevations, while evenness was high at higher altitudes. At plot level, the predictors of butterfly richness were plant species richness ($r^2=0.87$), herb ($r^2=0.74$) and shrub density ($r^2=0.69$). The species richness and abundance were highly correlated with altitude, temperature, relative humidity, fire-signs and livestock abundance. Butterfly composition (Species richness; ANOVA: $F_{4, 173}=3.38$, $P=0.009$) (Family abundance; ANOVA: $F_{4, 4}=3.91$, $P=0.009$) varied significantly across three protection regimes (NP, WLS and Reserve forest). We identified the sites that held most conservation value for endangered and unique butterfly species.

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)	: Manish Bhardwaj, SRF & Abesh K. Sanyal, SRF
Funding Agency	: WII Grant-in-aid
Project Duration	: January 2008 to January 2012

Survey and Mapping of Commercially Important Medicinal and Aromatic Plants in Uttarakhand – An overview

-Ninad B. Raut, Senior Research Fellow

Globally, the growing demand for herbal products has led to a quantum jump in volume of plant material traded. In India, over 90% of the traded medicinal and aromatic plants (MAPs) are harvested from wild, most of them in an unsustainable manner. This has caused tremendous pressure on the wild population of MAPs. To conserve and to ensure sustainable use of MAPs, it becomes imperative to know their status in the wild. The study was undertaken in Uttarakhand to ascertain the distribution and abundance of commercially important MAPs. Reserve forests of Garhwal region covering an area of *ca* 11,528 km², were surveyed. Total 582 transects each of 1 km length were laid following Rapid Mapping Exercise (RME) in different forest blocks to collect data on abundance of MAPs. One of the study objectives was to generate spatial database on the distribution and abundance of MAPs for future monitoring. Distribution map was prepared for each MAP using SOI topo map (1:50,000), GPS points and population-distribution. Potential forest blocks, rich in diversity and density of MAPs were identified and Conservation, Development and Harvest (CDH) plan was recommended for such blocks. In order to identify areas for the CDH plan, density, frequency and diversity of MAPs species were calculated.

Total 181 blocks were identified and recommended for CDH plan. Seventy three MAPs (9 trees, 14 shrubs and 50 herbs) were recorded which can be included in CDH plan. Forest blocks such as Gangi (29 MAPs), Suki (16) and Harshil (10) need more protection as they harbour rare and important MAPs and hence are suggested as priority areas for conservation. Species like *Adhatoda zeylanica* and *Vallaris solanacea* are widely distributed in various blocks and are recommended for sustainable harvest on rotational basis after reassessment.

Project Title	: Survey and Mapping of Commercially Important Medicinal and Aromatic Plants in Uttarakhand
Principal Investigator(s)	: Dr. G. S. Rawat, Dr. B. S. Adhikari, WII and Dr. S. Chandola (UKFD)
Researcher(s)	: Ninad B. Raut, SRF & Umeshkumar L. Tiwari, SRF
Funding Agency	: Uttarakhand Forest Department
Project Duration	: February 2008 to December 2011

**Fish assemblage structure in relation to habitat variables in streams of Kalakad
Mundanthurai Tiger Reserve, Tamil Nadu**

-Kannan, K., Junior Research Fellow

Fish diversity and assemblage in relation to habitat variables were examined in 24 streams of Kalakad Mundadurai Tiger Reserve (KMTR), Tamil Nadu. The sampling was carried out between January-February 2011. In each stream (100 m reach) fish sampling and the major habitat variables (depth, width, substrate, riparian cover, water temperature, percentage of pool-riffle and habitat volume) were assessed. Fish sampling was carried out using monofilament gill nets, drag and scoop nets. Forty species of freshwater fishes, including a new species of cat fish belonging to the genus *Silurus* were recorded from the study area. Four species (*Garra kalakadensis*, *Horalabiosa joshuai*, *Puntius tambraparniei* and *Puntius kannikattiensis*) were strictly endemic to the KMTR and 18 species (45%) were endemic to Western Ghats. A rare Deccan Mahseer *Tor malabaricus* was also recorded from the study area. Cyprinids were the most dominant assemblage in all the study stream. The cyprinids, *Daverio aequipinnatus*, *Garra kalakadensis*, *Garra mullya* and *Horalabiosa joshuai* had highest local dominance (64 to 75%) and they were widely distributed in KMTR stream. Maximum number of species and high species diversity were recorded in Karayar stream (18 species, $H' = 2.65$). Similarly, high species equality (0.98) was observed in Kakachi stream. Low species richness and diversity value were recorded in Valayar stream (3 species, $H' = 0.69$). Canonical correlation analysis between fish diversity and habitat variables revealed that fish diversity was associated with habitat volume, high % of riparian cover, warm water and greater percentage of Pool-riffle habitats.

Project Title	:	Diversity and conservation of endangered fish genetic resources of Kalakad Mundanthurai Tiger Reserve, Tamil Nadu.
Principal Investigator(s)	:	Dr. J.A. Johnson
Researcher(s)	:	K. Kannan, JRF
Funding Agency	:	Department of Science & Technology, New Delhi
Project Duration	:	December 2010 to December 2012.

Amphibian diversity in the Andaman and Nicobar Islands

-S.R. Chandramouli, Junior Research Fellow

The Andaman and Nicobar islands span across two global biodiversity hotspots. Though exploration of its herpetofaunal diversity began way back in the 19th century, knowledge today is still inadequate for conservation planning. Since March 2010, four islands namely Neil, Long Island, Rutland, and South Andaman were sampled for documenting herpetofauna under this project. Three sites namely Wandoor (lowland evergreen forest), Mt. Harriet (mid elevation hills) and Chidiyatapu (secondary forest) were selected for sampling in the large island of South Andaman to cover its heterogeneous nature. Species richness was assessed using visual encounter surveys, quadrat sampling and pitfall traps, which varied from four to nine across the smallest to the largest island. Of the nine amphibian species recorded, 55% were endemic. Species richness was strongly influenced by the island area $[s=2.121 \times \log(\text{area}) + 0.479]$ ($r^2=0.615$). Smaller islands show greater similarity in species composition (measured using Morisita's index) to each other (75%) while the relatively large islands were less similar to the smaller ones (60%). The three different sites surveyed on the large island of South Andaman were less similar to each other due to habitat heterogeneity with a higher proportion of endemic species from the hill forests of Mt. Harriet. These surveys uncovered an enigmatic, diminutive toad which is new to science and revealed further information on one of India's 'lost' frogs. *Ingerana charlesdarwini*, a species known till date from three adult specimens, was recorded for the first time after its description more than a decade ago. This species was observed to be colour polymorphic. Morphometric data from representatives of different morphotypes were analyzed using PCA and hierarchical cluster analysis, which did not group them into different categories. The ongoing molecular study would throw more light on their taxonomic status.

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