

Comparison of Prey Availability and Altitudinal Distribution of Breeding Leaf Warblers in the East and West Himalayas

- Mousumi Ghosh, Senior Research Fellow

Sixteen species of breeding *Phylloscopus* and *Seicercus* warblers are being investigated in this study to evaluate the causes of variation in species richness of passerines from the west to the east Himalayas. Previously, we found significant differences in foraging behavior of species breeding in the east and the west which were indicative of differences in available niche. To compare available niche in the east and the west, we examined (a) breeding ranges of species and (b) abundance of arthropod prey across sites. Field sampling was carried out at nine and seven sites in the east and the west, respectively. Bird populations were surveyed using 25 m point count stations placed along altitudinal gradients. Arthropods were sampled using branch clipping method at multiple elevations. The leaf warbler species occupied a narrower altitudinal range in the west (1000-4000 m) as compared to the east (100-4900 m). Common species had significantly narrower altitudinal ranges in the west (paired t-test, $t=7.53$, $df=9$, $p<0.05$). There was a negative relationship between mean breeding elevation and altitudinal range for western species ($r=-0.91$, $n=12$, $p<0.05$), while no such correlation was evident among eastern species ($r=0.07$, $n=14$, $p>0.05$). Abundance of arthropod prey differed significantly across altitudinal zones in eastern (ANOVA, $F_{8,409}=8.37$, $p<0.05$) and western sites (ANOVA, $F_{6,319}=9.76$, $p<0.05$). Arthropod abundance was highest in the broadleaved forests at 1260 m a.s.l. in the east (67.44 ± 5.56 SE) and in the mixed-conifer forests at 2550 m a.s.l. in the west (46.82 ± 2.8 SE), with overall arthropod abundance being higher in the east. These observations support the ecological hypothesis. The major findings of the overall project are: (a) species are older in the Himalayas than in the Andes; (b) lower species richness in the west is associated with the west being drier; and (c) in both east and west, intermediate altitude (1000-2500 m) are most species rich.

Project Title	: Study of bird species numbers and densities in the east and west Himalayas
Principal Investigator(s)	: Dr. Dhananjai Mohan and Mr. Pratap Singh
Researcher(s)	: Ms. Mousumi Ghosh (SRF)
Funding Agency	: WII Grant-in-Aid and National Science Foundation, USA
Project Duration	: January 2007 to January 2012

Population Monitoring, Habitat Relationships and Conservation of Endangered Bustards

-Sutirtha Dutta, Junior Research Fellow

All resident bustards of the Indian subcontinent are endangered. Conservation practices for this group must transcend anecdotal inputs and adopt country-wide systematic monitoring linked with management interventions. The traditional bustard surveys lack scientific robustness that can mislead inferences. We present systematic survey designs to estimate population status and habitat relationships of Lesser Florican (LF, *Sypheotides indica*) and Great Indian Bustard (GIB, *Ardeotis nigriceps*). While LF is represented by a small breeding population (~2,200 birds) in western India, the GIB population (~250 birds) is fragmented into eight pockets and rapidly declining. We used distance sampling to estimate and monitor LF density during 2009–2010 in Kachchh, and investigated its habitat relationships using occupancy based generalized linear models. Grassland cover, human related disturbances, vegetation heterogeneity and grass height influenced LF site selection. We used distance sampling (vehicle transects) to monitor GIB population during 2008–2010 in Kachchh, after correcting for imperfect bird detection by intensive sampling in a smaller representative habitat. We investigated GIB habitat requirements at two scales: (a) country level, from rapid sign surveys across the range; and (b) site level, from presence/random site-comparisons in a relatively high-use patch (Abdasa). Within less disturbed grassland dominated landscape, vegetation structure and food influenced the GIB occurrence. Population Viability Analysis shows that GIB populations of ≤ 25 birds can persist only under unrealistic conditions of first year mortality $< 40\%$ with no human caused mortality of adult birds. Given the current levels of hunting of this species in Pakistan and Rajasthan, extinction is a real threat. This calls for immediate commencement of *ex-situ* conservation breeding programs for Great Indian Bustard.

Project Title	: Research and conservation of endangered and threatened fauna of Kutch: an integrated approach
Principal Investigator(s)	: Dr. Y.V. Jhala, Dr. A.R. Rahmani and Late Dr. Ravi Sankaran
Researcher(s)	: Mr. Sutirtha Dutta (JRF), Mr. Bopanna, I.P. (JRF) and Mr. Kamesh Maurya (JRF)
Funding Agency	: WII Grant-in-Aid
Project Duration	: December 2004 to March 2011

Ecology of Endemic Species of Turtles of India

-V. Deepak, Senior Research Fellow

The Travancore tortoise (*Indotestudo travancorica*), cane turtle (*Vijayachelys silvatica*) and Leith's softshell turtle (*Nilssononia lethii*) are poorly known endemic turtles of India. This study focussed on Travancore tortoise and cane turtle. Five Travancore tortoises (two males and three females) and six cane turtles (three males and three females) were fitted with radio transmitters and were tracked periodically. Temperature loggers were installed to collect temperature data on an hourly basis. Home range, microhabitat association and diet of the species were studied from February 2006 to May 2010. The intensive study area for Travancore tortoise was 110 ha and for cane turtle, it was 42 ha in Anamalai and Parambikulam Tiger Reservers in the southern Western Ghats. Home ranges were estimated using Minimum Convex Polygon (MCP) and Local Convex Hull (LCH) methods. Diet of the species was studied by direct *ad libitum* observations and by examination of faecal matter. MCP home ranges of four individuals of Travancore tortoise varied between 5.2 and 34.7 ha. In 1541 tracking days, the tortoises were found in *Lantana* dominated scrub near stream (39%), evergreen forests (25%), bamboo thickets (24%) and in edge habitats (12%). They also spent majority of their time buried in leaf litter. Ninety two percent of the faecal samples had grass/bamboo blades. The density of cane turtles in the study area was 0.6 individual ha⁻¹. Home range of four individuals ranged from 3.5 to 14.2 ha using MCP and 0.8 to 5.2 ha using LCH methods. They also had extensive overlaps in their home ranges (MCP: 15.4 to 92.1%; LCH: 0 to 64.5%). Cane turtle activity was influenced by temperature range, mean temperature and individual specific behaviour. Movement by turtles was influenced by mean temperature, range of temperature and behavioural differences among individuals.

Project Title	: Ecology of two endemic turtles
Principal Investigator(s)	: Dr. Karthikeyan Vasudevan and Dr. Bivash Pandav
Researcher(s)	: Mr. V. Deepak (SRF)
Funding Agency	: WII Grant-in-Aid
Project Duration	: January 2006 to October 2010

Determining the Offshore Distribution, Migration and Movement of Olive Ridley Sea Turtle along the East-coast of India

-B.C. Choudhury, Scientist – G

Study on satellite telemetry of sea turtles along the east coast of India confirmed post-nesting migration of olive ridley turtles at least up to the northern Indian Ocean and the eastern Sri Lankan coast. All 63 tagged turtles off Orissa coast moved all over Bay of Bengal and most of them moved towards Sri Lanka. Return migration to Orissa coast from their foraging ground began by the first week of November and were arriving the offshore coast of Orissa from Sri Lanka for breeding by the end of November. The post-nesting outward migration starts by the first week of May every year. Five more satellite transmitters were fitted on olive ridley and green sea turtles on the south east coast of Sri Lanka. These five turtles moved towards western side of the Sri Lanka, but not towards off-coast of Orissa, revealing that there are at least two different migratory pathways of sea turtles in the Indian ocean. Both male and female ridleys were found moving together. The analysis shows that the migration routes and foraging habitat of olive ridley turtles are possibly more generalized in nature. Multiple congregation patches of ridleys were always observed along Gahirmatha, Devi and Rushikulya within 20km from the coast, the highest concentrations being within 5km. Highly dynamic parts of the beaches due to wave actions were selected for mass nesting. More number of dead turtles were stranded on the shore when the intensity of fishing was high in the off-shore waters during the breeding season ($r^2=0.6$). Though mass nesting took place in Gahirmatha, their success was low due to erosion. This study could identify the spatial and temporal distribution pattern of olive ridley and their breeding congregation sites in the Bay of Bengal.

Project Title	: Determining the offshore distribution, migration and movement of olive ridley sea turtle (<i>Lepidochelys olivacea</i>) along the east-coast of India
Principal Investigator(s)	: Mr. B.C. Choudhury, Dr. K. Sivakumar and Dr. C.S.Kar
Researcher(s)	: Mr. Suresh Kumar, Dr. Basudev Tripathy, Mr. Subrata Kumar Behera, Mr. Satyaranjan Behera, Mr. Sajan John, Mr. Ved Prakash Ola and Mr. Sandeep Ranjan Mishra
Funding Agency	: Directorate General of Hydrocarbon, Ministry of Petroleum & Natural Gas, Government of India
Project Duration	: October 2006 to December 2010

Population Viability of Tiger in their North-Western Range Limit, Terai-Arc Landscape

-Abishek Harihar, Senior Research Fellow

The Terai-arc Landscape (TAL) spanning 49,000 km² from the River Bhagmati in the east to the River Yamuna in the west is one of the global priority landscapes for the conservation of tiger. The north-western portion of this landscape, Tiger Habitat Block I (THB1), comprises of west Rajaji National Park (RNP) and reserve forests between the River Ganga in the east to the River Yamuna in the west. Recent studies have shown that tigers in THB1 are genetically isolated from the rest of the TAL and that this population has declined sharply in abundance. Therefore in our study, we construct a spatially-explicit tiger habitat model by employing occupancy modelling techniques and then estimate the population size of tigers using photographic capture-recapture sampling within identified tiger-use areas. Finally, we assess the viability of the subpopulation within THB1 under various management scenarios and assess the potential for translocation and restoration of habitat connectivity for ensuring the long-term persistence of tigers.

Based on occupancy surveys conducted across THB1, we recorded evidence of tigers only within west RNP and photographic evidence suggested that the area is being used by two females. Population Viability Analysis (PVA) modelling of various scenarios suggested that translocation of tigers following the plans executed in Sariska and Panna could help revive the existing population in THB1. Given that populations are extremely vulnerable to poaching pressures, if translocations will be carried out in the first 10 years, along with restoration of Chilla-Motichur corridor, the survival probabilities of tigers could be raised significantly. Therefore, we recommend that restoring connectivity to east RNP should remain the foremost priority towards securing the future of tigers in THB1. In the meantime, translocation may be initiated to prevent imminent local extinction of tiger, while maintaining stringent anti-poaching/protection measures.

Project Title	: Population and habitat viability assessment of tiger subpopulations in the north-western Terai-arc landscape
Principal Investigator(s)	: Dr. S. P. Goyal and Dr. Bivash Pandav
Researcher(s)	: Abishek Harihar (SRF)
Funding Agency	: WWF-International
Project Duration	: August 2006 to June 2010

A Study on Sympatric Small Carnivores in Mudumalai Tiger Reserve, Tamil Nadu

-Riddhika Kalle, Junior Research Fellow

Occupancy and diet composition of small carnivores were assessed in Mudumalai Tiger Reserve from October 2009 to May 2010. Camera traps were placed systematically in 1.25 km x 1.25 km grids in dry thorn forest (25 km²), deciduous forest (35 km²) and semi-evergreen forest (25 km²) to estimate occupancy of small cats, civets and mongooses. Highest occupancy estimate was obtained for small Indian civet (0.19), followed by jungle cat (0.14), ruddy mongoose (0.12), grey mongoose (0.11), stripe-necked mongoose (0.09), common palm civet (0.08), brown palm civet (0.08) and leopard cat (0.05). The percent occurrence of prey items in scats of small cats (n = 86) revealed that small mammals were the dominant prey (42.5), followed by reptiles (15.9), invertebrates (13.6), birds (9.8), fishes (5.6), fruits (3.7), grasses (7) and others (1.9). Civet scats (n = 32) largely comprised of fruits (37.8), followed by small mammals (21.9), invertebrates (18.3), fishes (9.7), reptiles (7.3), birds (1.2) and grasses (3.6). Mongoose scats (n = 234) largely comprised of invertebrates (38.8), followed by small mammals (25.8), reptiles (13.4), fruits (9.1), fishes (4.5), birds (3.3), grasses (2.7) and carrion (2.4). The estimated dietary overlap between small cats and mongooses was 68%, and it was 68% for civets and mongooses and 52% for small cats and civets.

Project Title	: A study on sympatric carnivores (tiger, leopard and dhole) in Mudumalai Tiger Reserve, Tamil Nadu.
Principal Investigator(s)	: Dr. K. Sankar and Mr. Qamar Qureshi
Researcher(s)	: Ms. Riddhika Kalle (JRF) and Mr. T. Ramesh (TA)
Funding Agency	: WII Grant-in-Aid
Project Duration	: January 2008 to January 2011

Food Habit of Sloth Bear in Mount Abu Wildlife Sanctuary, Rajasthan

- Prakash Chandra Mardaraj, Junior Research Fellow

We studied the food habits of sloth bear (*Melursus ursinus*) in Mount Abu Wildlife Sanctuary, Rajasthan. A total of 469 scats were collected during 2007-2010 and analysed for the food remains to determine the percentage frequency of food items in the diet of sloth bear. The analysis of 469 scats, comprising of 147 scats in summer, 197 in monsoon and 125 in winter revealed 21 distinct plant species and five insects in the diet of sloth bear. The plant and animal matters constituted 58.8% and 41.2% respectively of the diet of sloth bear throughout the year. Among the plant matter, the frequency of occurrence of *Ficus* species was the highest (48.2%), followed by *Lantana camera* (34.9%), *Phoneix sylvestris* (4.9%), *Carissa karonda* (4.3%) and *Mangifera indica* (4.1%). Among the animal matter, the frequency of occurrence of red ants was the highest (23%), followed by black ants (20.9%), termites (14.9%) and other insects. *Ficus* species were consumed maximum during summer (40.8%) and monsoon (35%), whereas *Lantana camera* was consumed maximum during winter (68.8%), followed by monsoon (23.9%) and summer (21.1%). The frequency of red ants and black ants was highest during monsoon (49.8%). The frequency occurrence of the plant and animal matters showed marked variation in different months. The percent dry weight of food items during summer (55.5%), monsoon (56.5%) and winter (57.3%) in scat samples was almost the same. Across the seasons, the percent weight of plant material was more than the animal matter. Sloth bear were also found to consume *Psidium guajava*, *Zea mays*, *Triticum aestivum*, *Sorghum bicolor* and vegetables. The feeding habit of sloth bear was found to be largely dependent on the availability of food resources in different seasons.

Project Title	: Ecology, behaviour and interaction of highly dense populations of sloth bear (<i>Melursus ursinus</i>) and human-sloth bear conflict in Jessore Wildlife Sanctuary, Gujarat and Mount Abu Wildlife Sanctuary, Rajasthan.
Principal Investigator(s)	: Dr. N.P.S. Chauhan
Researcher(s)	: Mr. Prakash Chandra Mardaraj (JRF) and Mr. Bharat Bhushan Sharma (JRF)
Funding Agency	: WII Grant-in-Aid
Project Duration	: April 2007 to April 2011

Habitat Use by Asiatic Black Bear in Dachigam National Park, Kashmir with Reference to Food Availability

-Lalit Kumar Sharma, Senior Research Fellow

Investigation on the habitat use by Asiatic Black bear (*Ursus thibetanus*) with reference to food availability in six habitats of Dachigam National Park, Kashmir was carried out from April 2007 to July 2010. Major food plants were identified based on scat analysis (n = 376) and feeding observations (n=162). These plants were quantified in permanent plots (n = 109) that were placed along 13 transects in all the habitats. To estimate fruit production, 20-25 individuals of each food plant (n= 12) were selected in all habitats and their phenology were monitored. Food availability was estimated as abundance per metre square for the three seasons (spring, summer, autumn). For fruits in trees, it was estimated as mean number per cubic metre, for fruits in shrubs, it was mean number per square metre, and for ground cover, it was mean percentage per square metre. Within each habitat, food abundance index was calculated by summing the mean density and mean frequency of occurrence of food plant species, mean number of fruits, and mean percentage palatable ground layer vegetation. Of the total black bear sightings and their evidences recorded (n = 809), about 31.6% were in riverine habitat, 23.1% in oak plantation, 15.2% in lower temperate pine mixed, 13.8% in lower temperate, 12.7% in mid-temperate, and the remaining in grassland and scrubland habitats. There was a significant difference in the food abundance in different habitat types during different seasons (F= 5.5, p<0.01). The overall mean fruit abundance was 102.4 (30.4 SE) in riverine habitat, 99.1 (12.1 SE) in lower temperate forest, 98.0 (29.3 SE) in lower temperate pine mixed forest, 69.7 (21.2 SE) in mid temperate forest, 33.7 (7.3 SE) in oak forest and 1.9 (0.3 SE) in temperate grasslands. The overall food abundance index of riverine habitat was the highest (3.5 to 4.9). The food abundance index and habitat use were significantly correlated in summer (r = 0.94, p < 0.01), autumn (r = 0.86, p < 0.05) and spring (r = 0.89, p < 0.05). Habitat use by the three radio-collared bears is also presented and discussed.

Project Title	: Ecology of Asiatic black bear (<i>Ursus thibetanus</i>) at Dachigam National Park, Kashmir
Principal Investigator(s)	: Dr. S.Sathyakumar
Researcher(s)	: Mr. Lalit Kumar Sharma (SRF) and Ms. Samina Amin Charoo (SRF)
Funding Agency	: WII Grants-in- Aid
Project Duration	: March 2007 to February 2011

Seasonal Pattern of Biomass Production and Forage Availability for Wild Ungulates in Keibul Lamjao National Park, Manipur

-Chongpi Tuboi, Junior Research Fellow

The floating meadows of Keibul Lamjao National Park are the last refuge of endangered Sangai (*Rucervus eldii eldii*). Studying the ecology of the meadows and the role it plays is therefore important for the conservation of this species. A study on the vegetation composition and productivity of the meadows in the Park was carried out from October 2007 to August 2010. Eighteen transects of 500 m length were laid in nine blocks during winter and 53 transects in 25 blocks during summer. Vegetation sampling was done in 0.5 m x 0.5 m plots on these transects. In each plot, species composition, height and total number of individuals were recorded. To estimate the plant productivity, 16 enclosures of 10 m x 10 m were constructed in four different regions of the Park having varying thickness of floating meadows and water depth. Proportion of biomass consumed was estimated by measuring the foraged part of the species from field observation. In the Park, 83 plant species belonging to 21 families were recorded. Poaceae and Cyperaceae formed the dominant families. Species diversity and richness were higher in the winter, than in the summer. During winter and summer, eight plant communities were identified. The mean annual above ground biomass was 2075.70 (\pm 462.9) g m⁻². It was highest in monsoon, 1037.31 (\pm 224.1) g m⁻² and lowest in summer 450.60 (\pm 139.4) g m⁻². Biomass was highest for *Zizania latifolia* in summer 832.72 (\pm 188.1) g m⁻², followed by monsoon 707.94 (\pm 53.9) g m⁻² and winter 289.81 (\pm 55.3) g m⁻², compared to other species found in the enclosures. Out of the total forage biomass produced, only 30% was available to the wild ungulates.

Project Title	:	Conservation ecology of Sangai and its wetland habitat
Principal Investigator(s)	:	Dr. S. A. Hussain
Researcher(s)	:	Ms. Chongpi Tuboi (JRF)
Funding Agency	:	WII Grant-in-Aid
Project Duration	:	December 2004 to November 2009

Assessment of Carbon Stock and Soil Moisture Content in Different Land Use/Land Cover of Nanda Devi Biosphere Reserve, Uttarakhand

-Ashi Qureshi, Junior Research Fellow

Our study aims to quantify carbon sequestration, nutrient retention, volumetric water content and yield, prevention of landslide and soil erosion by different Land Use/ Land Cover (LU/LC) categories of Nanda Devi Biosphere Reserve. In this presentation, an assessment of carbon stock and volumetric soil moisture content in 12 LU/LC types is provided. The carbon stock was highest in oak forest (33,563.45 ton ha⁻¹), followed by conifer mixed forest (14,978.56 ton ha⁻¹), oak-pine mixed forest (9,182.37 ton ha⁻¹), blue pine (5,131.84 ton ha⁻¹), deodar forest (2,869.26 ton ha⁻¹) and mountain scrubland (18.62 ton ha⁻¹). Carbon stock was lowest in alpine and low altitude grasslands at 18.48 ton ha⁻¹ and 8.91 ton ha⁻¹ respectively. Among the human modified vegetative covers, carbon stock was highest in plantations (829.07 ton ha⁻¹), followed by orchards (224.41 ton ha⁻¹) and agriculture areas (201.85 ton ha⁻¹). Mean volumetric soil moisture content was highest in oak forest (39.4% vol. \pm 1.61 S.E), followed by oak pine forest (34.0% vol. \pm 1.97), conifer mixed forest (29.2% vol. \pm 1.47), blue pine forest (22.4% vol. \pm 1.00), deodar forest (17.5% vol. \pm 0.77) and chir pine forest (2.5% vol. \pm 0.34). Alpine grasslands had 38.8% (\pm 2.0), while low altitude grasslands had 12.3% (\pm 1.16). Soil moisture content in human modified landscape was 19.1% (\pm 5.13). The results of present study are relevant for national inventories of carbon stock and can be used to derive green house gas emissions, once the land cover change dynamics are known. The study will provide a basis for predicting water requirements in the Himalayas for effective planning and management of water allocation.

Project Title	:	An integrated approach to reduce the vulnerability of local community to environmental degradation in the Western Himalayas, India
Principal Investigator(s)	:	Dr. Ruchi Badola and Dr. S.A. Hussain
Researcher(s)	:	Ms. Ashi Qureshi (JRF) and Ms. Pariva Dobriyal (JRF)
Funding Agency	:	WII Grant- in-Aid
Project Duration	:	January 2007 to January 2011

Distribution and Abundance of *Berberis* Species in Uttarakhand

-Umeshkumar L. Tiwari, Senior Research Fellow

Extensive surveys were conducted in various Forest Divisions of Uttarakhand to ascertain the distribution and abundance of *Berberis* species (Family Berberidaceae). Of the 55 species of *Berberis* recorded in India, 22 have been reported from Uttarakhand. Stratified, random transects of 1 km length were laid across major vegetation types covering different forest ranges and altitudinal gradient. In all, 205 transects were walked and on either side of these transects, 4100 circular plots of 10 m and 5 m radius were laid to count trees and shrubs along with their number. Around each circular plot, four square plots (1x1 m) in cardinal directions were laid to estimate the number of seedlings of *Berberis* species to ascertain the regeneration status. Habitat parameters such as vegetation type, terrain, altitude, aspect and degree of slope were recorded at each plot. *Berberis asiatica* and *Berberis lycium* were found in 14 different forest types between 700 and 2500 m asl. *Berberis lambertii* and *Berberis concinna* were confined to only one type of vegetation *i.e.*, temperate grassy slope at one locality in eastern Uttarakhand (2700-2900 m). Abundance/Frequency (A/F) ratio indicates that 14 species have patchy distribution, while two show random distribution. Influence of environmental factors on the distribution and abundance of various species have been analyzed and discussed.

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

Influence of Climatic Variations on the Phenology of Timberline Tree Species in the Western Himalaya

- Ishwari Datt Rai, Senior Research Fellow

Major objective of the study was to understand the influence of climatic variations on the phenology of timberline tree species. Phenology of five tree species (*Betula utilis*, *Quercus semecarpifolia*, *Abies spectabilis*, *Rhododendron arboreum* and *R. campanulatum*) was monitored along extended timberline ecotone in a part of the western Himalaya during 2007-2010. Twenty five terminal buds for each species were marked at five sites located at an interval of 150 m along the altitudinal gradient of 3000-3600 m. Observations on various phenophases (winter dormancy, start of bud swelling, bud bursting, leaf emergence, leaf fall initiation and completion, and flowering initiation and completion) were made and growth of bud, shoot and leaves were measured every fortnight. The climate data *i.e.*, minimum and maximum temperatures (using HOBO[®] Data Loggers), relative humidity, rainfall and snow fall were recorded at five stations. The intensive study area was under snow cover for 95, 65 and 67 days during winter months in 2007-08, '08-09 and '09-'10 respectively. It was observed that low amount of snowfall and the resultant early snow-melt led to early start of shoot growth but rate of growth, was reduced due to low soil temperature in 2009. *Betula utilis* (a deciduous species) was found to be the most sensitive to climatic fluctuations. In this species, duration of leaves on the shoots, number of leaves per shoot and leaf expansion rates were lower in the low snowfall year compared to other years. The phenological responses to fluctuations in climatic conditions were compared across deciduous, coniferous and evergreen species. Results are discussed in the light of their adaptability and life-history strategies.

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)	:	Ishwari Datt Rai (SRF), Rupesh Ranjan Bharati (JRF) and Sabuj Bhattacharyya (SRF)
Funding Agency	:	WII Grant-in-Aid
Project Duration	:	May 2007 to May 2011

Impacts of National Highway-7 on Habitat Use and Movement of Wild Animals in Pench Tiger Reserve, Madhya Pradesh

-A.Pragatheesh, Junior Research Fellow

This study aims to evaluate the impacts of National Highway-7 on habitat quality and movement of wild animals in Pench Tiger Reserve, Madhya Pradesh. During this study, habitat features (vegetation type and structure, slope, water availability and anthropogenic disturbance) and presence of animal species along the road corridor were recorded using 26 line transects in three seasons for two years. Data on road kills was collected based on 430 days of observations. Use of underpasses was assessed using pugmark impression pad method (n = 270) and camera traps (n = 135).

Use of road side habitats by wild ungulates varied seasonally. The encounter rate of ungulate was low within 600 m of the road verge in winter and high within 1 km in summer. During monsoon, animals were found to be randomly distributed. Water availability appeared to influence the use of habitat by the animals along the road. Biotic pressure extend up to 600m beyond the road verge. The traffic intensity based on 24 hour cycle varied between 2620 and 3382 vehicle/day. A total of 1035 road kills were recorded in the 9.2 km stretch of the road passing through Pench Tiger Reserve. The frequency of road kills was the highest for reptiles (47%), followed by mammals (21%), amphibians (18%) and birds (14%). Among the seasons, 52% of animals were killed during monsoon, 34% during summer and 14% during winter. Of the 36 underpasses located in the 9.2 km stretch, nine underpasses were used by mammals such as jungle cat, wild pig, porcupine, palm civet, hanuman langur and rhesus macaque. Topography, location and size influenced the use of underpasses. The study has both site specific and general implications for addressing road related impact on wildlife species.

Project Title	:	Ecological effects of road through sensitive habitats: implications for wildlife conservation
Principal Investigator(s)	:	Dr. Asha Rajvanshi and Dr.V.B. Mathur
Researcher(s)	:	Mr. A.Pragatheesh (JRF)
Funding Agency	:	WII Grant-in-Aid
Project Duration	:	April 2008 to March 2011

Conservation Status of Malayan Sun Bear in the North-Eastern States of India

-Janmejy Sethy, Junior Research Fellow

We carried out field surveys during 2007-2010 to understand the conservation status of sun bear and potential threats faced by them in the state of Mizoram, Nagaland and Arunachal Pradesh. Informal interviews of people living in villages located in and around Protected Areas (PA) were conducted and information on direct and indirect evidences were recorded. Random transect were walked two to three times in PAs to establish the status of sun bears, through direct and indirect evidences.

According to 579 respondents, sun bear is found in nine PAs. Out of 1915 respondents, 265 from Arunachal Pradesh, 245 from Mizoram and 69 from Nagaland confirmed the presence of sun bear based on direct sighting and indirect evidences. Correspondingly 3.9%, 7.3% and 8.5% respondents reported the probable occurrence. High percentage of respondents from Arunachal Pradesh (66%), Mizoram (61%) and Nagaland (63%) were non-responsive. We sighted sun bear three times; once in Mizoram and twice in Arunachal Pradesh. We recorded 695, 307 and 183 indirect evidences of sun bear along transects in Arunachal Pradesh, Mizoram and Nagaland respectively. Overall status of sun bear occurrence ranged from low to medium in and around PAs in these states, except Dampa and Namdapha Tiger Reserves, where its occurrence was relatively high. Protection efforts for wild animals including sun bear and black bear were minimal. Potential threats for sun bear include severe habitat destruction, fragmentation and poaching. Poaching of sun bear for illegal trade of gall bladder and their body parts was high. We recorded 23 sun bear poaching cases in three states. Recommendations for minimizing threats and conservation of bear species are discussed.

Project Title	: Status and distribution of Malayan sun bear (<i>Helarctos malayanus</i>) in north-eastern states, India.
Principal Investigator(s)	: Dr. N.P.S. Chauhan
Researcher(s)	: Janmejy Sethy, (JRF)
Funding Agency	: WII Grant –in-Aid and International Bear Association
Project Duration	: April 2007 to November 2010

Prioritization of Important Coastal and Marine Biodiversity Areas (ICMBAs) along the Coastline of India

-K. R. Saravanan, Senior Research Fellow

The coastal and marine environments of Indian mainland were studied in detail to identify and prioritize potential sites for conservation as Important Coastal and Marine Biodiversity Areas (ICMBA), in addition to the existing Marine Protected Areas. Detailed surveys were carried out all along the coastline between 2006 and 2010. This study followed the standardized global, national and regional level approaches to develop a criteria with several indicators which were used to identify ICMBA sites in India. A state-wise site matrix was prepared and prioritized based on identified indicators considering the ecological, cultural and socio-economic values of respective sites. A total of 350 sites were visited along the east and west coasts of Indian mainland and, of these, 106 sites were identified as ICMBA and 22 sites were prioritized. Along the west coast of India, a total of 62 ICMBAs were identified and 44 were identified along the east coast. These sites are proposed for consideration of Protected Areas under various categories largely as Conservation or Communities Reserves.

Project Title	: Preparation of status report on the Indian coastal and marine environment and developing a network of Marine Protected Areas
Principal Investigator(s)	: Mr. B.C. Choudhury and Dr. K.Sivakumar
Researcher(s)	: Dr. K.R.Saravanan (SRF)
Funding Agency	: WII Grant-in-Aid
Project Duration	: November 2006 to April 2010

Development and Application of Barcodes for Frogs

-K. Vasudevan, Scientist D

Barcoding is DNA fingerprinting that specifically aims to characterize species using short sequences of DNA as robust and reproducible signatures. This technology is touted to speed up the rate of species discovery and also reduce the burden on taxonomists. In an attempt to develop barcodes for anurans (frogs) of India, we accessed 368 specimens comprising of about 30 species. Anurans collected from 72 locations were used for this study. In addition to this, we used 21 frog larvae. Barcodes of different genes (12S, 16S rDNA, ND1, Co1, CoII CoIII, Tyrosinae and Rhodopsin) from the collection were sequenced, with emphasis on designing universal primers for barcoding anurans. Over 90 primer pairs were designed targeting number of informative domains. These were tested using a panel of 35 frog species. We achieved 90 to 100% recovery of barcodes. At least two to six primers were required for the genes targetted to retrieve barcodes. This was primarily due to nucleotide variation at the priming sites of 12S, 16S and ND1. Minimum intra-/inter-specific variation was seen in 16S and the variation in 12S was comparable. All other domains showed high inter-specific variation. Based on 0.03 pairwise distance as cutoff for species demarcation in 16S variation, nine new species were identified. Feasibility of developing universal primers is low, severely constraining barcode recovery. Overall, both rRNA genes (12S and 16S) provide stable and informative variability that enable demarcate species boundaries. Conversely, all protein coding genes *i.e.*, ND1, Co-1, Co-II, Co-III and Cyt-b showed inconsistent variability and therefore, unsuitable for barcoding. An “universal DNA barcode” for frogs from this region still eludes us. However, this study emphasizes the need for multiple sets of primers to generate reasonably informative DNA barcodes even from the closely related taxa and revealed many cryptic species.

Project Title	: Barcoding anurans of India
Principal Investigator(s)	: Dr. Karthikeyan Vasudevan, Dr. Ramesh Aggarwal and Dr. S.K. Dutta
Researcher(s)	: Mr. Prudhvi Raj (SRF)
Funding Agency	: Department of Biotechnology, New Delhi
Project Duration	: January 2008 to January 2011

Counting Seabirds and Seals during the XXIX Indian Scientific Expedition to Antarctica

-R. Suresh Kumar & J.A. Johnson, Scientist-C

During the 29th Indian Scientific Expedition to Antarctica from November 2009 to March 2010, regular observations for seabirds were made when the expedition vessel was at sea. A total of 34 species of sea birds that included three species of penguins were recorded during the expedition. Bird species assemblage varied across the latitudes with the highest diversity of species between 40° and 50° S latitude. In Antarctica, counts for seals and penguins were made through aerial surveys along the Larsemann Hills Coast (around Bharthi Station) and Princess Astrid Coast (Maitri Station). A total of seven aerial surveys each spanning around two hours and each covering over 200 km were made at both the sites. Weddel seal, *Leptonychotes weddellii* was the most commonly recorded species and was encountered more at the Larsemann site (ER = 4.1 seals/km) than along the Princess Astrid Coast (ER = 0.7 seals/km). The encounter rate of weddel seal in the 28th Antarctic expedition was also the highest at Larsemann hills (ER = 21.2 seals/km). Further, seal abundance at the Larsemann site alone varied between the surveys with 1350 seals counted during December 2009 as compared to 1900 seals during January 2010. This relates to the melting of fast ice over much of the region during January resulting in the seals crowding around the available fast ice in the area. It is therefore, suggested that any future survey and/or comparisons of seal count data across the years need to consider the timing or the spread of fast ice during the survey so as to correctly determine the population trend. Similar is the case with sea bird counts, which is being carried out at a time when most birds are at their breeding sites.

Project Title	:	Long-term monitoring of wildlife and their habitats in Antarctica
Principal Investigator(s)	:	Dr. S. Sathyakumar, Dr. K. Sivakumar, Dr. J.A. Johnson and Mr. R. Suresh Kumar
Researcher(s)	:	
Funding Agency	:	National Centre for Antarctic and Ocean Research (NCAOR), Ministry of Earth Sciences, Government of India, and Wildlife Institute of India
Project Duration	:	November 2009 to March 2010

Estimation of Tiger Population by Different Methods to Determine Accuracy, Precision and Cost in Ranthambhore Tiger Reserve, Rajasthan.

- Randeep Singh, Senior Research Seminar

Population estimation and monitoring have been central focus during the last two decades for management of tiger. Pugmark, camera trap and DNA based methods are commonly used for determining occupancy, distribution and abundance of carnivores, but these estimates have rarely been compared for accuracy and precision. We compare the efficacy of different non-invasive techniques for population estimation of tiger with reference to accuracy, precision and cost in Ranthambhore Tiger Reserve. Intensive study area of 233 km² was monitored for tiger population using track plots, camera trap and fecal DNA in different seasons from 2007 to 2009. Individuals identified from pugmark, camera trap and fecal DNA were used to estimate tiger population in capture-recapture framework, using mean maximum distance moved (MMDM) method. The estimated tiger density using pugmark during winter, summer and post-monsoon were 7.01 (SE 1.13) tigers/100 km², 3.42 (SE 0.26) tigers/100 km² and 2.16 (SE 0.61) tiger km² respectively, while densities determined using camera trap were 7.40 (SE 1.40) tigers/100 km², 5.96 (SE 0.70) tigers/100 km² and 5.03 (SE 1.40) tigers/km² respectively. Observed differences in estimates between pugmark and camera trap based methods could be due to relative high number of transit animals which were captured though camera traps, but probably not in pugmarks. Coefficient of Variance (CV) in estimates increased from 2.31 % to 5.36% with decrease in camera trap density from 100 camera trap/100 km² to 50 camera trap/100 km², where as density ranged between 7.40 to 6.61 tigers/100 km². These estimates were also compared with the population estimation determined using fecal DNA. We compare sampling cost for the 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 and Mr. Qamar Qureshi
Researcher(s)	: Mr. Randeep Singh (SRF) and Mr. Puneet Pandey (JRF)
Funding Agency	: WII Grant-in-Aid
Project Duration	: May 2007 to March 2011

Tracking the Life of Tricarinate Hill-turtle

-R. Suresh Kumar, Scientist - C

Tricarinate hill-turtle *Melanochelys tricarinata* is a poorly known terrestrial South Asian geoemydid, with a distribution range restricted to the northern parts of the Indian subcontinent. The species has been commonly recorded within the campus of Wildlife Institute of India. An intensive study of the turtles using thread-trailing technique is being carried out under the Campus Biodiversity Monitoring Program since 2008. Turtles were captured mainly during the rainy months (94%) and captures were significantly correlated with periods of high rainfall in the area. A total of 22 (11 males and 11 females) were fitted with thread spools and were tracked for a minimum of 14 h to 333 days. Males were found to have larger home ranges than females estimated based on Kernel method. The activity of the turtles during the period was interspersed with active as well as inactive phases, and especially during the winter months, they appeared to go through torpor. During such period, most turtles remained beneath leaf litter while few moved into burrows. Two female turtles tracked showed an increase in body mass during post monsoon and when x-rayed showed presence of fully developed eggs. Subsequently, nine other female turtles captured during the winter months, were found to be gravid with fully developed eggs. Interestingly, nesting occurred only in the middle of April suggesting egg retention in the species for up to a minimum of 200 days. Hatchling emergence occurred after a period of 90 to 110 days and coincided with peak rainfall in the area. This is the first record of nesting of the species in the wild and the egg retention is interesting finding for the species.

Project Title	: Long term monitoring of vegetation and biodiversity in WII Campus, Chandrabani.
Principal Investigator(s)	: Dr. G.S. Rawat
Researcher(s)	:
Funding Agency	: WII Grant-in-Aid
Project Duration	: Ongoing

Population Status, Habitat use and Monitoring of Wild Ungulates in Changchenmo Valley, Eastern Ladakh

-Ashwini Kumar Upadhyay, Senior Research Fellow

Five species of endangered mountain ungulates *viz.*, tibetan antelope, tibetan argali, kiang, wild yak and blue sheep were studied from August, 2007 to July 2009 in the northern parts of Changthang Wildlife Sanctuary, Ladakh looking into their population status and patterns of habitat use. Wild ungulate species were surveyed using a combination of trail (modified line transects; $n = 58$; mean length 6 km) walked once at least every year (ranging from 1.5 km to 11.7 km) and vantage points (4 observation posts; 75 minutes approximately time spent per post in winter and summer). Five replicates of $1 \times 1 \text{ m}^2$ quadrates were laid within 10 m radius of animal sighting for vegetation characteristics and habitat parameter evaluation. The estimated populations of wild ungulates in the study area were: 23 for Tibetan antelope, 112 for wild yak 130 for kiang, 122 for blue sheep and 38 for argali. Tibetan argali ($n = 27$) had the highest adult male: female ratio (1.48:1), followed by wild yak ($n = 22$, 0.99:1), kiang ($n = 97$, 0.45:1), and blue sheep ($n = 12$, 0.11:1). The female: fawn ratio was 5.9:1 for tibetan argali, 1.7:1 for wild yak, 6.7:1 for blue sheep and 3.8:1 for kiang. The patterns of altitude, degree of slope, vegetation type and distance to escape terrain use were compared between the species. Tibetan argali and blue sheep shared 10% of habitat in close proximity of escape terrain. However, they differed in the use of degree of slope and altitude. Most of the wild yaks were sighted on steep and rugged terrain ($>5000 \text{ m a.s.l.}$). Tibetan antelope occupied flat valley bottoms, with high plant species diversity, while wild yak occupied higher terrain. Monitoring protocols for these species to be used by the wildlife staff in collaboration with security personnel are suggested.

Project Title	: Habitat ecology and conservation status of wild ungulates in northern parts of Changthang Wildlife Sancturay, Ladakh.
Principal Investigator(s)	: Dr. G.S. Rawat and Dr. K. Sankar
Researcher(s)	: Mr. Ashwini Kumar Upadhyay (SRF)
Funding Agency	: WII Grant –in-Aid
Project Duration	: February 2007 to February 2011

Distribution and Genetic Diversity of Red Junglefowl in India

-Merwyn Fernandes, Senior Research Fellow

Red Junglefowl *Gallus gallus* (RJF) is believed to be the wild ancestor of all domestic fowls in the world. Recently concerns have been expressed regarding the genetic endangerment of this species in terms of purity due to hybridisation and introgression of domestic genes into wild populations. Through this project, the current distribution of RJF in India along with information on status, genetic diversity and admixture with domestic chicken were assessed during 2008-2010. Species distribution was defined based on literature review, questionnaire surveys and field surveys. Genetic diversity and admixture with domestic chicken in India were analysed from over 300 samples collected throughout the distribution range using a panel of 30 microsatellite loci markers. PCR cycling conditions for all 30 loci were standardised and 12 microsatellite loci were successfully genotyped with all DNA extracts. Predicted habitat distribution was mapped using Maximum Entropy Model using Maxent 3.2. software, with 19 bioclimatic variables as predictors. Of these variables, precipitation in the driest and wettest month, and mean temperatures of the warmest quarter were the predictors. This model was further refined using existing forest cover and topography feature. Nei's Genetic distance is discussed with reference to the distribution modelling.

Project Title	: Conservation of red junglefowl <i>Gallus gallus</i> in India (Phase-II)
Principal Investigator(s)	: Dr. S.Sathyakumar, Dr. Rahul Kaul and Dr. Rajiv S. Kalsi
Researcher(s)	: Mr. Merwyn Fernandes (SRF) and Mr. Mukesh (SRF)
Funding Agency	: WII Grant-In Aid
Project Duration	: March 2008 to February 2011

Genetic Structure of Tiger and its Implications in Forensics

-Sudhanshu Mishra, Senior Research Fellow

Illegal poaching is a major challenge for wildlife conservation globally and require special attention for species such as tiger which is in high demand in international market for use in traditional Chinese medicines and others. Recent developments in DNA technology and bioinformatics made it possible to identify the traded species to its geographic origin, using mitochondrial and nuclear markers. Tiger has been a major issue of conservation in India due to heavy illegal poaching for trade. The present study aimed to establish standardized data on population genetics of tiger across its range and to assign tiger poaching to its geographic origin using mtDNA and nuclear (highly polymorphic microsatellite loci) markers. The source of DNA was from tissue, blood and scat samples of tiger collected from different populations. There are limitations in using fecal DNA, due to lack of high throughput capabilities and time consuming tasks. Therefore, we designed and optimized five multiplex PCR panels (*viz.*, TigPlex1, TigPlex2, TigPlex3, TigPlex4 and TigPlex5) using 23 microsatellite loci. Success rate of these panels was 98% with tissue and blood DNA ($n = 37$); where as, 13 loci showed a success of >50% with scat samples ($n = 376$). Genotyping success was higher (>60%) with fecal DNA diluted to 50x and 100x than original template. We examined genetic diversity in tiger population of Corbett Tiger Reserve, Dudhwa Tiger Reserve, Rajaji National Park, Ranthambore Tiger Reserve, Sunderban Tiger Reserve and other tiger populations using tissue, blood and scat samples. The mean observed heterozygosity ranged from 0.31 to 0.60. The mean effective alleles per locus (N_e) ranged from 2.08 to 3.52. We discuss feasibility of using mtDNA haplotypes, private alleles, PCA and Bayesian based “assignment test” to classify individuals to respective population.

Project Title	: Panthera tigris genome: implication in wildlife forensics
Principal Investigator(s)	: Dr. S. P. Goyal
Researcher(s)	: Mr. Sudhanshu Mishra (SRF) and Mr. Sujeet Kumar Singh (JRF)
Funding Agency	: WII Grant-in-Aid
Project Duration	: October 2005 to March 2011

Managing Captive Populations Using Pedigree Data: A Case Study of One-horned Rhinoceros

-Anupam Srivastav, Research Associate

Ex-situ populations of wild fauna are insurance for species survival and provide surpluses for reintroduction programmes. The major constraints of loss of genetic diversity and demographic stochasticity in such populations can be managed through analysis of pedigree data. A project to develop and update studbooks for 14 threatened species in Indian zoos was initiated. The studbook of One-horned Rhinoceros (*Rhinoceros unicornis*) is discussed here. One-horned Rhinoceros inhabits riverine grasslands of the Terai and Brahmaputra basins with major population in Kaziranga National Park, India and Chitwan National Park, Nepal. The species is currently listed as Vulnerable in the IUCN Red List, Schedule 1 of the Wildlife Protection Act (1972) and in Appendix I of CITES. Current captive population of this highly threatened species in India is 33 across 12 zoos requiring intensive management.

Data received from the 12 zoos was analyzed using SPARKS 1.5 and PM2000. The total number of specimens across time was 135 (76.59.0), with 32 specimens of wild origin of which 18 have contributed to the gene pool. The present population has high values for various measures of genetic variability *viz.* the founder genome surviving, gene diversity retained, population mean kinship, mean inbreeding and percent of pedigree known. The observed age distribution of known age individuals showed an equitable distribution across various age classes. This was in agreement with the modeled age distribution. However, the projected growth rate as determined by analysis of the life table suggested a declining population size. Population modeling carried out using PM 2000 suggests that a population of 100 individuals to be achieved over a span of 10 years would allow for the maintenance of a genetically viable and demographically stable captive population. This study demonstrates that pedigree analysis is an essential tool for scientific management of captive populations.

Project Title	:	Maintenance and update of studbooks of selected faunal types in Indian zoos
Principal Investigator (s)	:	Dr. Parag Nigam
Researcher (s)	:	Dr. Anupam Srivastav (RA)
Funding agency	:	Central Zoo Authority
Project Duration	:	November 2006 to November 2011