

# 7

## RESEARCH

**[Environmental Research, G.B. Pant Institute of Himalayan Environment & Development, Research on Biosphere Reserves, Wetlands, Mangroves and Coral Reefs, Forestry Research, Indian Council of Forestry Research & Education, IPIRTI, IIFM, Wildlife Research, WII, NNRMS]**

Research is basic to any developmental activity. The Ministry supports research in multidisciplinary aspects of environmental protection, conservation and development including forestry and wildlife. The objectives of the Research schemes are to generate information required to develop strategies, technologies, methodologies for better environment. It also aims at attempting solutions to practical problems of resource management, conservation of natural resources and restoration of degraded ecosystems and environmental protection and provides necessary inputs to development and formulation of Action Plans.

### **Environmental Research**

The Environmental Research aims at developing strategies, technologies and methodologies by way of better facilities and infrastructure to facilitate research and training of manpower.

Research projects are funded in multidisciplinary aspects of environment and ecological protection, conservation and management at various universities, research and development institutions and reputed non-governmental organizations of the country. These are supported under the following main schemes :

- Ecosystem Research Scheme (ERS)
- Environment Research Programme (ERP)
- Research Programme for Eastern and Western Ghats.
- Pitambar Pant National Environment Fellowship Award.
- B.P. Pal National Environment Fellowship Award for Bio-diversity.

Ecosystem Research Scheme is an inter-disciplinary programme of research which emphasizes ecological approach for studying the relationship between man and environment. The objective of the programme is to develop a basis within the field of natural and social sciences for rational use and conservation of resources for general improvement of the relationship between man and his environment. The programme seeks to provide a scientific basis to solve the practical problems of resource management. The programme also seeks to

provide scientific knowledge and trained personnel needed to manage the natural resources in a rational and sustainable manner. Ecosystem studies become even more important as the Earth's environmental systems are increasingly being affected at all levels. Ecological understanding and research in this area offer tangible hope for addressing extremely complex and potentially devastating assaults on local, regional and global ecosystems. Under the scheme, emphasis is laid on multi-disciplinary aspects of environmental conservation with emphasis on eco-system approach consistent with the identified thrust areas and orientation.

The Environmental Research Programme specially deals with problems related to air, water and soil pollution and development of suitable cost effective technology for abatement of pollution load in the environment. Emphasis is given on development of eco-friendly biological and other interventions for prevention of pollution, development of strategies/technologies, instruments etc. Projects are also encouraged for development of biodegradable plastics, epidemiological studies, ways and means to reduce impact of mining, chemical pollution of soils, hazardous substances including pesticides, heavy metals, etc. Waste recycling and resource recovery from waste along with development of eco-friendly and cleaner technology are given due priority.

The Eastern and Western Ghats Research Programme addresses itself to location – specific problems of resource management in the Eastern and Western Ghat regions of the country. Under this programme, studies relating to Bio-diversity, land use, impact of developmental activities etc. are taken up.

During the year, under Research and Development Scheme, 35 new projects have been sanctioned and 18 projects were completed.

Annual review meetings were organized to monitor the progress of the ongoing research projects. The lists of projects sanctioned and completed during the current year are given in Annexure-V and VI respectively.

Details of specific research activities under Pitambar Pant Fellowship and B.P. Pal Fellowship are given in Chapter 8.



**Fig 60.** Cultivation of medicinal plants (*Allium* spp.) in the experimental plots

## **Significant results of the completed projects**

### **Economic utilization of hazardous sludge at Lakwa oil field, Assam**

The Regional Research Laboratory, Jorhat has prepared common masonry brick, pazzolona, lightweight aggregate utilizing the hydro-carbon in the sludge of Lakwa oil field effluent in Assam, as fuel to solve disposal problem associated with the sludge. After optimization of raw mix preparation for making bricks, firing temperature, physico-chemical characterization of the product, the product was demonstrated to the brick kiln operators and

entrepreneurs. Contacts were made with organizations like State Pollution Control Board, ONGC Ltd. and brick kiln owners for commercialization of the process.

### **Atmospheric deposition and budgeting of nutrients and trace elements around industrial sites at Singrauli region, U.P.**

A study conducted by the Department of Botany, Banaras Hindu University, Varanasi in the downwind of a number of thermal power plants and opencast coal mines at Singrauli region of Uttar Pradesh concludes that soil, physical, chemical and biological properties are unfavourably altered due to atmospheric depositions at different sites. The trace element build up in soil is a direct consequence of aerial depositions. Plants were found useful as bio-monitors of environmental pollution caused by sulphur dioxide and trace elements. The atmospheric deposition also altered pattern of species composition and structure of herbaceous community.

### **Development of low-cost filtration kit for the treatment of selenium contaminated water in Talcher – Angul Region of Orissa**

The Regional Research Laboratory, Bhubaneswar has reported that selenium released from fly ash being disposed by the thermal power plants into the river water of Nandira and Brahmani affects the animals which feed on the vegetation grown on the river banks. In order to remove selenium from water, ferrihydrite coated sand has been used as an adsorbent. The laboratory has also worked out that overloaded ferrihydrite can be easily regenerated. The life of the kit developed by the laboratory with about 200gm adsorbent is nearly one year for generating 3600 liters of safe drinking water.

### **Studies on anatomical, physiological and biochemical response of trees to coal smoke pollution around thermal power plant.**

The project was undertaken to study the effects of emissions of a thermal power plant, on structural and functional properties of leaves of some tree species and then the influence of alterations in these parameters on the cambial activity and wood production phenomena in some selected trees, namely (a) *Azadirachta indica* A. Juss., (b) *Dalbergia sissoo* Roxb. Ex DC., (c) *Eucalyptus citriodora* Hook, (d) *Prosopis cineraria* Linn., and (e) *Syzygium cumini* (L.). The studies have revealed the following :

- The stomatal index of tree leaves showed a negative as well as a positive relation with the pollution stress.
- Concentration of green pigments in leaves invariably declined under pollution stress. The extent of decline was corresponding to the increases in degree of the pollution. Chlorophyll content was greater during the periods of active growth.
- The stomatal conductance and the net photosynthetic rate were always low under polluted condition. Inhibition of photosynthesis was directly proportional to the degree of pollution and relatively greater during winters.
- Nitrate reductase activity and amount of total nitrogen declined with increasing degree of pollution, whereas the reverse was the case with nitrate content of leaves. The peaks of decline or gain were observed generally in winters.
- Leaf protein content did not vary markedly and consistently with changes in season or distance from pollution source. Mostly, protein content was minimum in winter.

- Concentration of reducing sugars in leaves was greater under pollution stress despite a reduced rate of photosynthesis, thus indicating that process of photosynthate translocation to shoots and roots was hampered.
- Sulphur content of leaves increased in all species with increasing degree of pollution in the air.

### **Impact of Indira Gandhi Canal Irrigation on the Status of Mammals in Western Rajasthan**

The study was undertaken to assess the impact of changes in landuse pattern on relative abundance of mammals in the Indira Gandhi Canal Area. The mammal species namely; wolf, *Canis lupus pallipes*; Jackal, *Canis aureus aureus*; Desert fox, *Vulpes vulpes pusilla*; Bengal fox, *Vulpes bengalensis*; Desert cat, *Felis silvestris*; Wild boar, *Sus scrofa cristatus*; Black buck, *Antelope cervicapra*; Chinkara, *Gazella bennetti*; Blue bull, *Boselaphus tragocamelus*; Desert hare, *Lepus nigricollis dayanus*; and Porcupine, *Hystrix indica*, were studied in Sri Gandhinagar, Hanumangarh, Bikaner and Jaisalmer districts. The study has revealed that one of the causative agent of impact on the biodiversity in this desertic region is sand dune transformation from grassland to irrigated cropland. The availability of green food increases the reproductive potential of most of the animals. The impact of this factor has been observed very carefully through the abundance of Chinkara and Porcupine. Another very important change is that certain mammalian species like wild boar and Blue bull which never occurred in the desert zone have appeared in fairly large numbers.

### **Threats to biodiversity conservation of middle altitude oak forests in Kumaon Himalaya**

The Kumaon division of Uttaranchal constitute a significant conservation unit in Himalaya as the biological diversity in this region is home to a number of extremely threatened faunal and floral elements. The landscape in Kumaon, once dominated by oak forests, has undergone extensive change due to deforestation which has led to fragmentation, reduction and degradation of oak forest and its biological diversity. Study was undertaken to : a) map the extent of oak patches, b) assess major components of biodiversity, c) assess various threats, and d) prepare a conservation strategy. The study was conducted in Almora, Nainital and Pithoragarh districts covering an area of 21,032 Sq.km.



**Fig 61.** *Piper nigrum* (black pepper) grown by tribals in Nilgiri Biosphere Reserve

A total of 63 tree species, 62 shrub species, 88 herb species and 23 grass species were sampled in 23 oak patches of Kumaon Himalaya. Nineteen broad habitat types have been recognized in Kumaon. A total of five homogenous groups in relation to the environmental variables were identified. A total of 18 mammal species were encountered during the surveys

of Kumaon Himalaya. The group size was maximum for Himalayan tahr and minimum for Serow. Over all, 251 bird species were recorded in Kumaon Himalaya. The overall Bird Species Diversity (BSD) was highest for patches in Almora districts. Bird densities were maximum in undisturbed habitats in pre monsoon season while in post monsoon season they were maximum in disturbed habitats.

A total of five pheasant species were recorded. The maximum of (4) pheasant species were encountered from Pindari and Wachham reserve forest. The white crested Kaleej was found at 14 sites out of 23 sites covered during the surveys of Kumaon Himalaya and thought to be most abundant species in the region. Cheer was found to be the most threatened species among all pheasants occurring in the Kumaon found to be the most threatened species among all the pheasants occurring in Kumaon Himalaya. Kaleej was associated with the areas having low percentage of grass cover and abundant herb density at low altitude. Koklass preferred areas are having very low grass cover and abundant herb density at middle altitude. Cheer pheasant was associated with the areas having high percentage of grass cover with limited number of herbs at middle altitude while Satyr tragopan was present in the areas with low percentage of grass cover at higher altitude. Monal was found to be separated from the rest by holding areas having medium percentage of grass cover and medium herb density at the highest altitude. A total of 23 threat factors to biodiversity values were assessed at different sites. The forest fires at different patches caused extensive plant mortality.

### **Protected Area Network & Endangered Species in Kumaon**

There exists two wildlife sanctuaries in Kumaon. These are Askot and Binsar Wildlife Sanctuary. These two Protected Areas (PAs) cover approximately 3.1% of total land area in Kumaon. The biodiversity assessment surveys in Kumaon showed that both PAs are providing protection to species such as kaleej, koklass, sambar barking deer and goral only. These species are commonly distributed throughout Himlayas and are not threatened. Both PAs are badly disturbed and suffer from heavy poaching pressure. Oak patches having the endangered taxa such as cheer pheasant, monal pheasant, satyr tragopan, musk deer, serow, Himalayan tahr and mountain quail (presumably) are currently outside the PA coverage. Creation of two more PAs in Pindari region in Almora and Vinayak region in Nainital district will afford protection to entire range of biodiversity of the Kumaon. The recommended PAs are also less disturbed compared to the existing ones.

### **Mushroom Bio-diversity in the Nilgiri Biosphere region of Western Ghats**

A taxonomic study on members of Agaricales of Nilgiris Biosphere Region in Tamil Nadu state was made. A total number of 130 species in 42 genera belonging to 12 families have been described. Out of the 130 species, 79 species were new addition to the Indian Agaric Flora, 21 new taxa have been proposed and 30 species although already reported from different parts of India but have been reported for the first time from Nilgiri region under this study.



**Fig 62.** Eggs of a rare turtle being artificially hatched at Sunderban National Park

### **Bio-diversity of Coccoids (Coccoidea: Hemiptera) and their natural enemies in the Western Ghats of Tamil Nadu**

This study was undertaken to catalogue Coccids, their natural enemies and their population regulation factors in Western Ghats of Tamil Nadu. During the surveys, more than hundred species of Coccids were collected and more than 700 host plants were recorded.

Three new species viz. *Pulvinaria azadirachtae*, *Aspidiotus vernoniae* and *Anomalococcus rhamnaceus* have been described. Five species of Coccids viz. *Aulacaspis martini* Williams, *Chionopsis broughae* Williams, *Parlatoria citri* McKenzie and *Paralecanium expansum* have been recorded for the first time in India and two species viz. *Drosicha dalbergiae* (Green) and *Perissopneumon phyllanthi* (Green) were reported for the first time in Tamil Nadu.

### **Environmental Research sub-component under Environmental Management Capacity Building (EMCB) Project**

The details about Environmental Research sub-component under Environmental Management Capacity Building (EMCB) Project are given in Chapter 11.

### **G.B. Pant Institute of Himalayan Environment & Development**

G.B. Pant Institute of Himalayan Environment and Development was established in August 1988, at Kosi-Katarmal, Almora, by the Ministry as an autonomous institute. The Institute is identified as a focal agency, to advance scientific knowledge, to evolve integrated management strategies, demonstrate their efficacy for conservation of natural resources and to ensure environmentally sound development in the entire Indian Himalayan Region (IHR). The Institute has made considerable progress in strengthening infrastructural facilities both at the Headquarters and units, presently numbering four and located at Srinagar (Garhwal Unit), Mohal – Kullu (Himachal Unit), Tadong-Gangtok (Sikkim Unit) and Itanagar (NE Unit), so as to promote Science and Technology (S&T) initiatives for overall development in the IHR.

The broad areas of concern include various core programmes, namely Land and Water Resource Management, Sustainable Development of Rural Ecosystems, Conservation of Biological Diversity, Ecological Economics and Environment Impact Assessment, Institutional Networking and Human Resource Development, Environment Physiology and Biotechnology and Indigenous Knowledge Systems.

Land and water are the two prime natural resources and management of these two resources is fundamental to support life in the Himalayan mountains. The rural people make use of water for irrigation through community managed canals. A few representative community managed canals were studied and their application efficiency was found to vary from one canal to another due to fluctuation in demand and poor channel structures. Hydro meteorological data in the selected Himalayan watersheds and in the Gangotri glacier was collected. Increase in suspended sediment load was recorded in Gangotri glacier in comparison to previous years due to higher rate of melting. Global positioning system field campaign was conducted in selected locations of higher Himalaya to understand deformation fields causing earthquakes in this region. Training was imparted to 160 farmers on a number of livelihood support practices and seventy farmers adopted one or other of these practices. Under the replication and adaptability testing of SWEET (Sloping Watershed Environmental Engineering Technology) 44 ha community land belonging to 15 villages was treated in Kumaon Himalaya.

The local communities practice a range of natural resource management strategies. Studies on such practices were carried out in selected localities of Arunachal Pradesh, Almora and Nanda Devi Biosphere Reserve (NDBR) in Uttaranchal. Indigenous methods of making fermented food and beverages have been recorded for Uttaranchal, documentation of various land races of traditional crops and their role in agricultural systems, uses of medicinal plants by *Vaidyas*, biodiversity conservation, livestock management, breeding and health (ethno veterinary), ethnomedicine, food habits, family planning measures were covered. Studies on impact of economic condition and education on the fertility behaviour, family planning measures and role of women in decision making, access to social infrastructure to the mountain people were also conducted. Demonstration of alternatives to shifting cultivation in North-Eastern India and restoration of degraded community lands, medicinal plant cultivation as out reach activities were continued. Training was imparted to farmers and students on biodiversity conservation, medicinal and aromatic plant cultivation and value addition.

Biodiversity studies and conservation of biological resources were other important focus areas in the reporting period. Recruitment patterns of woody components in identified sensitive habitat (i.e. timberline zone) were investigated to find out its relationship with changing climate and anthropogenic disturbances. The extent of available natural stock of some high value medicinal plants was qualified. Germination studies of some of these medicinal plants were conducted and propagation protocols (*in vitro*) developed. Also, genetic variability among different populations of targeted species was assessed. Zone wise prioritization of identified medicinal plants for cultivation was done.



**Fig 63.** Training of local farmers on polyhouse and polythene lined tanks for cost effective resource conservation

Identification of strategies for ameliorating environmental damage and looking at alternative pathways for development are important aspects of Ecological Economics and Environmental Impact Assessment. During the reporting period, studies on air quality monitoring in and around tourist destinations of Kullu valley were conducted. Background levels of air pollutants were monitored during the tourist season. Study of vegetable cultivation in Khairna valley reveals extent and level of vegetable cultivation in the area and their impacts on environment. The study on evaluation of landslide hazards in Sikkim Himalaya has provided RS/GIS framework for geo-environmental assessment and mitigation. Studies on impact assessment and ecological economics of tea cultivation and Oak and Pine forests have been initiated to work out suitable environmental management plan to offset long-term implications.

A variety of microorganisms, like bacteria, actinomycetes and fungi including mycorrhiza (both endo and ecto) are used for improving plant productivity. Three bacterial spp. namely, *Bacillus subtilis*, *B. megaterium* and *Pseudomonas corrugata* were studied in respect of rhizosphere microflora, mycorrhizal infection, phosphorus content, growth and yield parameters for their growth promotion ability under pot as well as field conditions. A local land race of rice was used as a test crop. The inoculations resulted an overall improved plant performance. Large scale propagation of location-specific elite plants using conventional and biotechnological methods is continuing. Crosses and reciprocal crosses were made amongst *Cymbidium alolifolium*, *C. giganteum* and *C. mastersii* and hybrid plants from one of the crosses have been established in the field. *In vitro* multiplication and subsequent rooting and hardening of *Aconitum violaceum* have been achieved. New germplasm of *Picrorhiza kurroa* from Himachal Pradesh, and *A. balfourii* from HP and Garhwal Himalaya was collected.

Under the Integrated Eco-development Research Programme (IERP) scheme funds for a number of research and action projects have been released and follow up action on a number of completed projects and upcoming projects has been taken up. Dissemination of Research & Development efforts in the IHR as well as in other places of India as elsewhere was made through publications and Newsletters to strengthening of the institute library was done.



**Fig 64.** Dissemination of biodiversity conservation education among the school children by G B Pant Institute of Himalayan Environment & Development

Various mountain-specific activities were organized across the Indian Himalayan region through the regional Units of the Institute during the reporting period. These include : training to women, NGOs, Government officials, interested youth on environment-friendly technologies in Arunachal Pradesh and Sikkim; medicinal plant cultivation and solid waste management in Himachal Pradesh; and capacity building of selected farmers (particularly women) on cost-effective technologies and sylvi-pasture management in Uttaranchal. A National Workshop on Integrated Development of Mountain Watersheds: Challenges and Options was organized. On the occasion of International Year of Mountains the Institute organized a National Workshop on Mountain Environment and Development: Potentials and Prospects on December, 2002.



**Fig 65.** A nursery for mangrove trees in Sunderban

## **Research on Biosphere Reserves, Wetlands, Mangroves and Coral Reefs**

Research activities under Biosphere Reserves, Wetlands, Mangroves and Coral Reefs programmes are overseen by specific advisory committees and sub-committee. Under Wetlands, Mangroves and Coral Reefs Programme, Thrust Areas for research have been identified as well as Nodal institute also identified to pursue the same research.

During the year, several projects have been sanctioned under these schemes. The list of such sanctioned and completed research projects are given in Annexure-V & VI respectively.

### **Forestry Research**

#### **Indian Council of Forestry Research and Education (ICFRE), Dehradun**

The Indian Council of Forestry Research and Education (ICFRE), Dehradun is the premier forestry research organization to the country with the mandate to formulate, organize, direct and manage forestry research, transfer the technologies developed to states and other user agencies and impart forestry education. The Council has eight research institution and three advanced centres in various parts of the country to cater to the research needs of different bio-geographical regions of the nation.

### **Achievements of ICFRE during the year are as follows :**

#### **Technique to produce tamarind polysaccharide**

*Tamarindus indica* Linn. A monotypic genus of trees is indigenous to tropical Africa and probably also some parts of South India. It is cultivated throughout the tropics, subtropics and has become naturalized at many places. It is one of the common and most important trees of India. Almost every part of it finds some use, but most useful is the fruit. The fruit is composed of seed, stringy fibrous matter and acidic pulp. Its proximate analysis shows the presence of pulp (55.0%), seed (33.9%), shell and fiber (11.1%). Sweetish, acidic pulp is widely used for souring curries, sauces, chutneys and certain beverages and also employed in medicines. Tamarind seed, which is obtained as a by-product of the tamarind pulp industry (~1 lakh metric tonne), is a valuable raw material for certain industries in India. The seed contains 30% of testa and 70% of kernel. Tamarind Kernel Powder (TKP) obtained by powdering of dehusked seed (~60,000 – 65,000 metric tonnes) of tamarind is a complex mixture containing a galactoxyloglucan polysaccharide (55-65%), proteins (18-21%), Lipids (6-10%) and certain minor constituents e.g. fibers, tannins, ash etc.

Industrial pectin are a specific group of carbohydrates polymers composed largely of galacturonic acid units, parts of the wider class of plant pectin substances. Pectin is the traditional gelling agent for jams and jellies, but its application extends to fruit products for the food industry, dairy products, deserts, soft drinks and pharmaceuticals.

The complex nature of action of pectin produced from other sources under controlled condition of pH can be overcome by using a Tamarind Polysaccharide. Tamarind polysaccharide is capable of forming a gel at sugar content (70-75%) at neutral pH and this is a pectin replacer. The one step reaction has been developed by FRI to remove proteins and lipids from the TKP to produce pure polysaccharide. Pure polysaccharide, which is galactoxyloglucan, has properties of pectin. Adopting this technology ~ 50-55% yield of the polysaccharide can be obtained from TKP.

#### **Breeding populations of hard wood species**

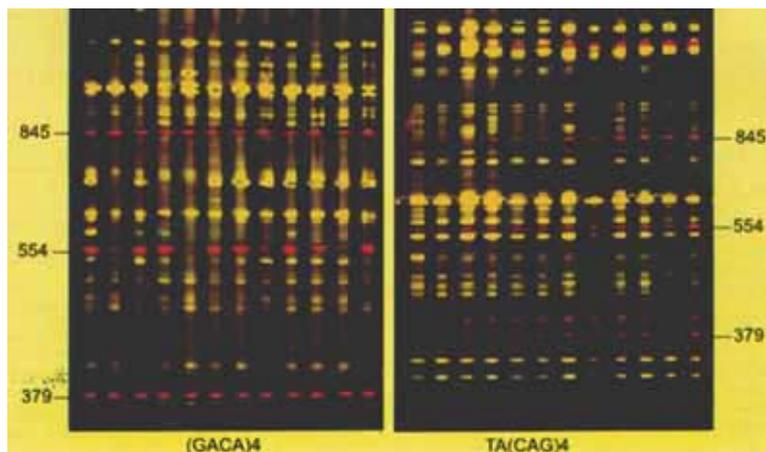
Breeding populations of *Casuarina equisetifolia*, *C. junghuniana*, *Eucalyptus tereticornis*, *E. grandis*, *Acacia mangium* and *A. auriculiformis* have been established, and continuous process of production of quality seeds is in position in collaboration with State Forest Departments of Tamil Nadu and Kerala. Tree Breeding programmes are developed for traits like fast growth, tree form and wood properties. Quality seeds are already being made available to various agencies like Forest Departments, Forest based industries, NGOs and people's nurseries.



**Fig 66.** Tissue culture of teak clones

### Controlled pollination programmes

Controlled pollination programmes at inter-provenance and interspecific levels have been carried out and small quantity of hybrid seeds obtained successfully. The plants raised from the seeds are assessed under field conditions for desirable silvicultural and morphological characters. This programme is a continuous process to develop hybrid varieties that are high yielding.



**Fig 67.** FISSR-PCR DNA fingerprinting pattern for *Casurina equisetifolia* clones

### Categorization of different clones *Eucalyptus*

Different paper industries viz. Andhra Pradesh Paper, Ballarpur, JK Corp., ITC, Hindustan paper produce different types of papers like map litho, kraft, cream wove, bond, duplex board, poster and newsprint. They require different types of fiber characteristics. Therefore, different clones of *Eucalyptus* were analyzed and categorized for tree form, high growth rates, better pulping characteristics, high cellulose content, better fiber characteristics and wood density.

### Clonal technology through macro propagation for teak

The clonal technology through macro propagation approaches have been perfected for juvenile as well as mature teak. The important output of this study is its application in recovery and conservation of high volume teak trees of over 50-60 years that can be multiplied several fold without loss of genetic properties. This is an important approach as mature trees when harvested; the genotype that was lost can now be recovered and conserved.

## **DNA fingerprinting of clonal plants**

Unique DNA profiles were obtained for widely planted clones of *Eucalyptus* and *Casuarinas* using RAPD and FISSR markers. The studies conducted provide information for clonal registration approaches, which is an evolving field in forestry. The fingerprinting studies are used to remove the redundancies in the clonal collections, identify mislabeled clones, and identify somaclonal variants in tissue-cultured plantlets. Strategies for DNA fingerprint database management for clonal germplasm collections have been devised. Inter provenance diversity in *Casuarinas* and *Eucalyptus* provenances are also analyzed for application in tree improvement programmes.

## **Bioactive compounds from *Acacia nilotica***

*Acacia nilotica* has been found to be a promising species capable of providing bioactive compounds. The extracts raised from leaves are showing antifeedancy, ovicidal, pupal and larval mortality characteristics against Teak and Pongamia defoliators. The extracts are being refined that can provide basic material for development of biopesticides.



**Fig 68.** Superior of teak tree identified for clonal propagation

## **Improving soil health in problem soils**

The ongoing programme of improving soil health in problem soils, mine dump and quartz and sand dumps are combined with different strategies for different types of soils. This work has enabled the mine-quarry industries to successfully green the barren lands through introduction of appropriate trees and soil amendments. This is regularly done to improve the environment in mine and quartz dumps.

## **Conservation of medicinal plant diversity**

Conservation of medicinal plant diversity is important to determine resource base and provide materials for traditional system for Indian medicine. In the context of extensive exploitation in the past, threatened species recovery research in Medicinal Plant Conservation Area of silent valley (Kerala) and Kolli hills (Tamil Nadu) are under assessment for the status of population distribution, seed biology and regeneration. Of the 21 species selected for the

purpose, 14 species have been identified to be of low density and recommendations are provided to improve their frequency. To add value to the project additional approaches like seed collection, storage and handling have been developed for these threatened species that can be enhanced for introduction in conservation.

### **Participatory agro forestry for poverty alleviation**

Under the project working with NGO in Perur block in Coimbatore, the Institute of Genetics and Tree Breeding (IFGTB) has catalysed in establishing agroforestry practices in several hundred farmers land, has provided environmental education to various farmers in local language and has also helped in development of farmers' nurseries. Over 80,000 saplings were supplied, village nurseries established and extension material provided. This work enabled the farmers to anchor agroforestry activities, which is developing into a sustainable programme. The project has also provided the village panchayats with soil health map to enable them to adequately improve the soil nutrients through a blend of biofertilizers and inorganic fertilizers. The farmers were given soil health cards indicating nutrient status of soils and trees suited for such areas. The project has helped to develop village land use plans using participatory rural appraisal methods. The inputs on supplementary activities to increase income generation like mushroom cultivation and bee keeping were also provided.

### **Mortality in blue pine and willow plantations**

Large-scale mortality in *Pinus wallichiana* (Blue Pine) in the states of Himachal Pradesh and Jammu & Kashmir was investigated by the scientists of Himalayan Forest Research Institute (HFRI), Shimla. Insect beetle *Pityogenus scitus* had affected the health of Kail forests to greater extent. This beetle has ability to resist the moderate resin exudation and hence board the thin green bark of the stem of the seedlings, saplings and top stem of the growing and mature trees. Field observations have also revealed the combined effect of extensive lopping and the climatic factors due to which the trees showed the physiological stress and ultimately loss in its vigour. The presence of fruiting bodies of fungal pathogen and yellowish to brownish spots on needles also contributed towards the health of the forests of Blue Pine.

The infestation of "BLACK WILLOW APHID", *Tuberolachnus salignus* (Homoptera: Aphidoidea: Lachnidae) was responsible for large-scale mortality in willow plantation in forestland in farmers field in Lauhaul Valley of district Lahaul-Spiti, Himachal Pradesh. The Scientists of Himalayan Forest Research Institute (HFRI), Shimla attributed this problem to the micro-climatic charges and the monoculture of willow plantations in the valley.

### **Tissue culture technology for mass propagation of bamboos**

The conventional methods of propagation in bamboos are slow and time consuming. Seed propagation is unreliable because of long (25-100 years) flowering habit. Seeds have short viability, high-speed sterility and low germinability, resulting in insufficient seedlings for plantation. The offset and rhizome cuttings are bulky and available in less numbers, involving large investment for preparation of planting stock.

Micro propagation offers the potential for rapid and mass multiplication of bamboo for reforestation and conservation. ICFRE micropropagated six species of bamboo viz. *Dendrocalamus membranaceus*, *D. asper*, *D. giganteus*, *D. strictus*, *Bambusa bamboo* and *B. wamin* through enhanced auxiliary bud proliferation.



**Fig 69.** Large scale *in vitro* propagation of bamboo

This technology of micro propagation will solve the problem of availability of planting stock material. The technology is fast, commercially viable and produce year round plants. With this, the bamboo production could be stepped up to not only stem the current rate of depletion but also to eventually increase bamboo's industrial uses. Making use of this technology the institute has already multiplied exotic edible bamboo (*D. asper*) in thousands and established it in India at various places.

### **Project on Himalayan pine**

A first ever wide ranging provenance trial of low level Himalayan pine, the chir pine (*Pinus roxburghii* Sarg.) has been laid out at two sites under the USDA funded project. Seeds have been sampled from 56 sources from the states of Uttaranchal, Himachal Pradesh, Jammu & Kashmir, West Bengal/Sikkim and Arunachal Pradesh covering the entire range of distribution of chir pine in India.

Field planting has been done with 3380 seedlings in a replicated design in about 4 ha area in the FRI campus at 640 m and at Jarmola in Singrur range, Tons Forest Division in Uttaranchal at an elevation of about 1600 m m.s.l. The aim of the study is to explore the nature and extent of variation in wide range if population of chir pine in some prominent characters and relate them to adaptability and growth. In order to achieve this object studies have been carried out to find out source variation in cone, seed and seedling characteristics of chir pine. Different morphological traits, germination behaviour and nursery performances have been recorded. Significant amount of genetic variation has been observed in different characters of cone, seed and seedling. A similar study on Himalayan high-level pine the *Pinus wallichiana* is underway for which seeds from 48 sources have sampled.

### **Mortality of *Prosopis cineraria* (L) Druce (khejri) in northwestern Rajasthan and their management**

The first information on the drying and mortality of Khejri in Nagaur district was communicated by the Joint Director agriculture (Ext.), Government of Rajasthan, to Arid Forest Research Institute (AFRI), Jodhpur during February 1999. A team of Scientists of different disciplines was constituted and the team visited the affected areas during March 1999. It has been closely examined that this devastating problem has primarily been raised with the cumulative effects of indiscriminate and successive lopping followed by a secondary infestation of a shoot borer, *Dorolus discicollis* Gahen. The borer lays its eggs on the freshly lopped top portions of shoots and branches and completes its life-cycle by destroying the

plant tissues of the main branches and stems. The larva excavates long, irregular tunnels in the sap and heartwood. The borer attack is followed by a tertiary infection of fungus disease. The infected samples reveal the presence of three highly infective species of *Fungi imperfectii* viz., *Alternaria* sp; *Phoma* sp. and *Botryodiplodia* sp. which cause the die-back disease in mature trees of Khejri as a result of which the tree starts drying from the top.

Amongst the other probable contributory factors: i) continuous depletion of water tables in western Rajasthan; ii) increasing number of tube wells or over exploitation of ground water; iii) effect of low rain fall and iv) change in soil properties and agricultural practices, are some of the suspected causes which may play an important role in large-scale drying of Kherji in western zone of Rajasthan. The data on the above aspects are being collected from the Kherji dominated areas for further studies. The scientists are making extensive surveys to the effected areas.

### **Recommendation for the management**

- Austere and indiscriminate lopping of Khejri trees by the farmers seems to be the primary cause of pest/disease infestation. Hence, a gap of one year of Khejri lopping is advisable in order to recover from the injuries made by pest and disease.
- The lopped portions/open wounds should be treated with AFRI PASTE\* to check the fungal infection and egg lying by the shoot borer, *D. descicollis*.
- Severely infected and dried trees should be uprooted and the felled trees should be lifted from the vicinity immediately after their exploitation.
- The trees, showing partial dieback symptoms should be dealt for their treatment on priority in order to check further spread of pest/disease.
- \* One part of Copper Carbonate (say ½ Kg) + One part red Lead (say ½ kg) + two part white petroleum jelly (1 Kg) or 1.25 ltr. Linseed oil and 3 ml Monocrotophos 20 EC. (modified Chaubattia paste)

Mix Copper Carbonate and Red Lead homogeneously, then add white petroleum jelly or raw linseed oil (Alsi ka tel) and add insecticide (Monocrotophos) and can be applied by brush or by hand using gloves. The paste has toxic effect hence hand should be thoroughly washed with dettol soap after given treatment.

### **Computerization of Herbarium of Forest Research Institute, Dehradun**

The herbarium of the Forest Research Institute international known as the Dehra Dun Herbarium (DD) was established in 1908 by the amalgamation of the Forest School Herbarium founded by James Sykes Gamble in 1890 and the Saharanpur Herbarium started by John Firminger Duthie in 1876. The oldest collection in the herbarium dates back to 1807. Besides collections from the Indian region, herbarium contains specimens from all over the world. In addition to the phanerogams the herbarium has valuable collections of pteridophytes. The Herbarium contains 3,30,000 specimens and 1200 valuable type materials. Expeditions sent out from this herbarium have explored many unexplored and underexplored parts of India viz. Indo-Nepal and Indo-Tibet border, Great Nicobar Islands, Gir Forests, erstwhile Tehri Garhwal State, Sikkim, Goa, Daman & Diu, Ladakh, and many parts of North-Eastern States. Some of the collections worth mentioning are of J.D. Hooker, D. Brandis, C.B. Clarke, H. Falconer, W. Jameson, D. Brandis, C.B. Clarke, Gamble, A.E. Lowrie, A.E. Osmaston, R. R. Stewart, H. H. Haines, R.S. Hole, R.N. Parker, C.E. Parkinson,

N.L. Bor, U.N. Kanjilal, M.B. Raizada, K.C. Sahni, K.N. Bahadur and several of other present workers of the Discipline.

The system of classification of plant specimens followed is that of George Bentham and Sir Joseph Dalton Hooker. The collections housed in this herbarium have been inestimable value to specialists of different groups/families/genera engaged in revisionary/monographic work all over the world in having a better understanding of the groups they study. Within India, especially for the northern parts this herbarium serves as a centre for correct identification, development of herbarium, taxonomic database and networking on forest biodiversity, global taxonomic initiatives, conservation etc. Further, it is of great significant value to different fields such as ethnobotany, phytogeography, phytochemistry, economic botany, and collecting data on the exact localities of the species for the collection of materials at the appropriate period for various kinds of scientific research and development. The herbarium serves as a ready reference in collection of information on rare and threatened plant diversity and their habitats, it also has many unknown or little known uses of plants recorded on their sheets. Besides, it serves many other educational purposes.

The herbarium has a carpological museum as its adjunct. It has approximately 1000 samples of fruits/seeds, some of which cannot be preserved with the herbarium specimens. It supports in the morphological studies and in identifying fruits and seeds of plants from different parts of the country without recourse to microscopic details. In addition a Botanical Garden and Arboreta are maintained as adjuncts to the herbarium. They have one of the richest live collections of indigenous and exotic species in the country especially of bamboo; gymnosperms and a large number of other species of forestry importance, about 30% of them are exotics from various parts of the world.

With a view to computerizing the Herbarium of Forest Research Institute, Dehradun, 600 type specimens and species diversity of 30 genera and 80 species as represented in herbarium were studied for the development of database. The database would ultimately be used for the development of software for a ready reference to the plant taxonomists and conservationists world over for dissemination of information on floristic inventories, species, characterization and conservation. Enumerative checklist of 10 families and 75 rare and threatened species of forest origin made during the current project period would be used for computerization. Generic entity of 200 taxa nomenclaturally studied would be used for data incorporation.

The outcome of the work would enhance the position of FRI Herbarium from orthodox, time consuming and age old method of gathering information from the specimens to the instant retrieval by harnessing advances in the field of information technology. This would serve appreciably at faster pace the purpose of providing information on the biodiversity and genetic resource covering various aspects. The 150 OTUs (Operational Taxonomic Units) finalized as parameters for automated information mechanism and the herbarium database on the type specimens, species and generic diversity would provide taxonomic, nomenclatural status, conservation aspects and phytogeographic entities. Inter-Institutional linkages at national and international levels for dissemination of information related to the ongoing activities to the herbarium of FRI was developed.

Based on the repositories, R & D activities, Systematic Botany discipline conducted six training courses on herbarium management and biodiversity emphasizing role and integration of recent trends on Herbarium to the participants from universities, research and non-government institutions. UNESCO sponsored one such course.

## **Studies on the diversity of Aleyrodid (Aleyrodidae: Homoptera) of Western Ghats**

The project entitled was sanctioned to Institute of Wood Science and Technology (IWST), Bangalore by Ministry in November, 2000 for a period of two years which was concluded in October, 2002. The salient achievements of the project are given below:

The first intensive study on the *aleyrodid* fauna of Western Ghats of Southern India was conducted and a total of 164 species under 43 genera of the family Aleyrodidae were collected and identified, of which 50 species are found new to the science. The study also necessitated the erection of two new genera namely *Davidiella gen. nov* and *Icfrealeyrodes gen. nov* to accommodate those species which differed in their structural features from the characteristic features of all known genera. Three species of whiteflies viz., *Aleurtocanthus martini*, *Parabemisia myricae*, and *Gigaleurodes abbotabadiensis* have been noticed in India for the first time. Three species of white flies were synonymised and five new combinations were proposed. Intra-specific variation in *Alerodicus dispersus* was observed for the first time. Array of natural enemies were found associated with the aleyrodids. Eight species of Coccinellids (all are new records on aleyrodids); eight species of ants (seven new records on aleyrodids) were found predaceous on aleyrodids. Seven species of parasitoids were also identified (five new records in which the presence of *Encarsia abundantia* is a new record to India). A checklist of Aleyrodidae of Western Ghats is provided with information on host plants and distribution.

## **Indian Plywood Industries Research and Training Insitute (IPIRTI), Bangalore**

From a modest beginning as a cooperative research laboratory under the Council of Scientific and Industrial Research (CSIR) Umbrella with active participation of the plywood industries in 1962, the institute has now established its credentials as the premier research and training organization in the field of panel materials from renewable fibers including plantation timbers, wood and bamboo and forest/agro residues. Since 1990 it is an autonomous institute under the Ministry of Environment and Forests and carry out applied research and training on all aspects of technology for manufacturing plywood, panels and other engineered/reconstituted products from lignocellulosic materials.

Institute's vision is "Conservation of natural forests through development and promotion of efficient technologies for manufacturing wood alternates and panel products from renewable fibers, including plantation timbers & bamboo to meet the vital needs of our developing society.

### **Research Activities**

The Institute continued applied research in one of the five strategic action areas "Reduction in total demand" for wood identified in the National Forestry Action Programme 2000, the twenty-year comprehensive strategy for development of the forestry in the country. R&D activities have already been reoriented to achieve the twin goals of reoriented to achieve the twin goals of rationalizing the utilization of wood produced through plantations through appropriate technological intervention and development of wood alternates from other natural/renewable fibers. The research programme aims at efficient utilisation of plantation timber through development of appropriate technologies for manufacturing wood composites including glu-lam and finger jointed wood, plywood, block board, enhancing service life of wood based composites and other products; development of quality control

techniques and standards. The institute has already made significant contribution towards the development of bamboo sector in the country through development of successful people and environmentally sound technologies for manufacturing bamboo based industrial products.

The research projects are classified in three categories, namely

Wood and wood composites, Composites from non-wood renewable fibers, and Enhancing service life.

Some important projects undertaken during the year are:

- Demonstration of suitability of finger jointed timber from fast growing plantation woods using indigenous machines developed by the Building Materials and Technology Promotion Council of India for making furniture products.
- Development of Marine, Shuttering grade and film faced plywood from *Grevillia robusta* (silver oak) planted as shade tree in coffee and tea plantations.
- Development of window/door frames from *Shorea robusta* (Sal) poles using finger jointing and glu-laminating techniques at the instance of the West Bengal Forest Development Corporation.
- Improvement of Fire Retardancy of Plywood (work in progress).
- Based on the detailed investigations for evolving alternate test methods for plywood (IS 303) and plywood adhesives (IS 848) recommendations were made to the Bureau of Indian Standards for amendment to the relevant standards.
- Development of Laminated Vaneer Lumber (LVL) utilizing veneers from small girth plantation timbers and fabrication of door and window frames, rails and stiles for flush doors and panels to demonstrate usefulness of LVL for furniture and joinery.
- Commissioning of specially designed multi-day-light hydraulic hot press for industrial production of Bamboo Mat Corrugated Sheets as an eco-friendly roofing material at an existing factory in the North-Eastern region under a project sponsored by the Ministry being implemented by the Institute in collaboration with the Building Materials and Technology Promotion Council of the Government of India. It is also proposed to construct demonstration houses in Mizoram under this project in collaboration with BMTPC and the Mizoram State Government. A unique project for Life Cycle Analysis of BMCS has been initiated.
- The two bed room demonstration house constructed at the Institute premises was kept open to professional and public to generate interest in bamboo based housing system evolved by the Institute in collaboration with the TRADA technology of UK. The BMCS manufactured at the pilot scale plant at the Institute were successfully used in demonstration houses constructed during the year at Bangalore, Chennai, Agartala, and in Chhattisgarh. It is also proposed to study the earth quake resistance of the bamboo based housing system and evolve construction techniques for two-storey bamboo house in collaboration with TRADA Tech. of UK under a project funded by DFID UK.
- Development of high strength cross-laminates from bamboo as alternative to structural panels for various end use applications (Work in progress)
- Detailed evaluation of strength properties of “bamboo wood” manufactured from bambos at the experimental production facility established at the Institute under a project funded by the Ministry. The results indicate that the material is comparable to teak wood and is suitable for furniture. The Institute is collaborating with Technology Information

Forecasting Advisory Council (TIFAC), Department of Science & Technology, for evolving a technology package to facilitate industrial adoption of the technology.

- Laboratory technology for making particle board from Chir Pine needles was developed under a project sponsored by the Himachal Pradesh Forest Development Corporation (HPFDC) and suitability of the material for use as table tops, door/window in-fill panels was demonstrated. The Institute is assisting the HPFDC in revival of a closed factory for manufacturing particle boards from Chir pine needles.
- Up-scaling of the laboratory technology developed by CSIR's Regional Research Laboratory, Trivandrum for making panel material from banana sheath has been initiated. The project is funded by the Building Materials and Technology Promotion Council of the Government of India, New Delhi.
- Long term evaluation of efficacy of Dursban initiated earlier was continued. An Addition, holistic evaluation of Bifenthrin against termite and borers for protection of wood and plywood was taken up. The studies are sponsored by the manufacturers of these chemical.
- Standardization activities through participation at various Committees/Sub-committees of the Bureau of Indian Standards were continued during the year.
- The Institute has initiated the process for getting its testing laboratory accredited by the National Accreditation Board for testing and calibration Laboratories. The testing laboratory has also been strengthened and upgraded as a Center for Evaluation and Testing of Composites (CENTEC).
- The Institute is associated with the revision of the National Building Code particularly related to wood and woody products as building materials and use of bamboo and its composites in construction. The Institute has suggested for incorporation of the concept of green rating for various building materials.
- The Institute has entered into an Memorandum of Understanding with the Government of Orissa to prepare and action plan for bamboo sector for Orissa, provide technical support and other assistance in implementation of the above mentioned Action Plan, and provide the necessary linkages to national/international initiatives under the National Mission for Bamboo Applications aiming at ecological security, livelihood and food security through alternate industrial uses of bamboo resources for the benefit of the people of the states.
- Consultancy for establishment of a production facility in Karnataka for woven bamboo mats was funded by BMTPC.
- The Institute is also actively associated in various initiatives of the Planning Commission in connection with the preparation of bamboo development Programme under the National Mission on Bamboo Applications.

### **Indian Institute of Forest Management (IIFM), Bhopal**

IIFM, Bhopal was established as an autonomous organisation under this Ministry in 1982. The main activities of the Institute are :-

- Research
- Forest Management Education
- Training for capacity building

- Consultancy
- Extension

## Research

### Report Submitted

- Problems and prospects in Joint Forest Management working in Bihar and West Bengal of India.
- A study of visitor information system at Keoladeo National Park

### Report expected till March, 2003

- Assessing the impact of micro finance as a tool for adoption of appropriate technology and conserving the environment.
- Contribution of NTFP in the nutrition and the livelihood of tribal communities in Betul.
- Gender participation in rural resource management study of JFM village on Jhabua.
- Water Management strategies at micro level.

### On-going project in 2003-04

- Analyzing factors affecting the implementation of information technology in forest related Government in India.
- Research study on wood craft and carving industry at Bastat in Chattisgarh.
- Sustainable Management of some critically endangered species of medicinal plants in Central India.
- Technical and social evaluation of impact of watershed activities communities forestry and JFM.

## Wildlife Research

### Wildlife Institute of India (WII), Dehradun

Research conducted on ecological, biological, socio-economic and managerial aspects of wildlife conservation in various parts of the country. The research projects generate valuable scientific data, help evolve study techniques relevant to the Indian ground condition, and also create a group of trained field biologists, socio-economists and wildlife managers. The scientific information generated is utilized for management of protected area. Given below is a list of research projects under different categories :

#### WII Grant-in-aid Projects

- Impact of land use pattern changes on habitat and ecology of Sarus crane (*Grus antigone*) in the Indo-Gangetic flood plains.
- Ecology of otters in Corbett Tiger Reserve: Impact of Kalagarh reservoir on the habitat use pattern.
- Impact of forest fragmentation on the hoolock gibbon (*Hylobates hoolock*) in Assam, India
- The ecology of the leopard in Satpura National Park and Bori WLS.

- Characterization of species from bone, tusk, rhino horn and antler to deal with wildlife offence cases.
- Social organisation and dispersal in Asiatic lions.
- Conservation genetics of marine turtles on the mainland and island coasts of India.
- Developing a Spatial Conservation Protocol for Central Indian Highlands through a Biogeographical Analysis of Birds and Existing Protected Area Network. A Geographical Information Systems Approach.
- Diversity and rarity in floral and avifaunal assemblages in the Western Himalaya. A study of patterns and mechanisms to devise viable biodiversity conservation strategies.
- Conservation ecology for an isolated population of gaur (*Bos gaurus*) in Trishna WLS, Tripura
- Ecology of the Dhole (*Cuon alpinus* Pallas) in Central India.

### **WII-US Fish and Wildlife Services (USFWS) Collaborative Projects**

- Conservation of Indian Wolf.
- Planning and development of interpretive facilities in selected Protected Areas in India. Protected Areas : Panna National Park and Corbett National Park
- Conservation of Hoolock Gibbon in northeast India



**Fig 70.** Spotted deer at Ranthambore National Park

### **Other Sponsored Projects**

- Studies on animal-habitat interactions in the Buffer Zone of Nanda Devi Biosphere Reserve.
- All India Co-ordinated research project on ORCHIDS (Sponsored by the Ministry & Tropical Botanical Garden and Research Institute, Kerala)
- Natural resource ecology and management in the Himalaya. (Collaboration between WII & University of Tromso, Norway) - Sponsored by NORAD
- Monitoring of forest conditions and prey base for the tiger conservation in the Terai Arc.
- Acoustic signals in two avian species: their characterisation and importance.
- WII-Himachal Pradesh Forest Department (HPFD) Projects: a) Conservation of flora and fauna in and around the Great Himalayan National Park (Great Himalayan Conservation Landscape) b) Conservation of Endangered Wildlife Species in Himachal Pradesh.

- Studies on animal-habitat interactions in the buffer zones of Nanda Devi Biosphere Reserve.
- Aspects of Ecology of Hangul (*Cervus elaphas hanglue*) in Dachigam National Park, Kashmir.

## Projects completed

### WII Grant-in-aid Projects

- A quantitative analysis of incidental sea turtle captures and mortalities during commercial shrimp trawling in the coastal waters of Orissa.
- Evaluation and refinement of the pugmark technique for individual tiger identification and for tiger census.

### WII-USFWS Collaborative Projects

- The relationships among large herbivores, habitat and humans in Rajaji Corbett National Parks.
- Identify potential areas for conserving biodiversity in the Indian Himalayas.
- Development of an Indian Cooperative Wildlife Health Programme and Technical Assistance in WII's wildlife health programme.
- Management of forests in India for biological diversity and forest productivity - A new perspective.

### Other sponsored Projects

- Ecological, social and hydrological factors affecting the management of wetland systems in UP with special reference to Vijay Sagar and associated water bodies in Mahoba district, Okhla and associated water bodies in Ghaziabad district, Bakhira Bird Sanctuary and Nawabganj Bird Sanctuary.
- Forage relations between ibex *Capra ibex* and livestock in the Indian Tans-Himalaya.
- GOI-UNDP Sea Turtle Project.
- Status and ecology of leopard in Pauri Gahwal. Phase-II: Ranging patterns and reproductive biology of leopard (*Panthera pardus*) in Pauri Garhwal Himalayas.
- Strengthening field conservation through ecological studies, capacity building and conservation awareness in the Ladakh Trans-Himalayas: A collaborative initiative.
- The maintenance and publication of studbooks of five endangered species. CZA Sponsored.

## Institutional Collaborations

**The Collaboration with the United States Fish and Wildlife Service (USFWS)** that was initiated in mid 80s on Capacity building of institute faculty in specialized subject areas such as high altitude ecology, GIS based planning, Wildlife Health, Wildlife Forensic, Corridor management and problematic species will continue till December 2003. Through this collaboration in addition to capacity building, state of art infrastructure has also been developed at the Wildlife Institute of India.

**The Institute signed a Memorandum of Understanding (MoU) with the Himachal Pradesh Forest Department (HPFD).** The institute signed an MoU with HPFD for one-year assignment on March 20, 2002. The Institute will formulate Conservation Projects: (i) Conservation of Flora and Fauna in and around the Great Himalayan National Park and (ii) Conservation of Endangered Wildlife Species in Himachal Pradesh.

**WII has a MoU with the Nature Conservation Foundation (NCF), Mysore.** NCF a non-profit organization dedicated to promote the use of science for wildlife conservation in India and WII signed an MoU. The primary focus of joint work will be in the Indian Trans-Himalaya. Scientists wrote up a proposal on the 'Forage relations between ibex, Capra ibex, and livestock in the Indian Trans-Himalaya'.

**Institutional Cooperation Programme in Natural Resources Ecology and Management between the Wildlife Institute of India and the University of Tromso, Norway.** This programme aims to promote the sustainable use and conservation of pasture resources in rangeland environments, through investigations of livestock-wildlife interaction and biomass production in pastures. Faculty of the co-operating institution will jointly supervise investigations. This cooperation also includes Faculty and Student Exchange Programme between WII and University of Tromso for teaching and research assignments. Planning for three short duration studies and one long-term study in the alpine regions of the Himalaya are underway.

**WII-Ford Foundation Project on "Building Partnerships for Biodiversity Conservation in Rajaji National Park".** The FORD Foundation supported the project entitled "Building Partnerships for Biodiversity Conservation in Rajaji National Park". The overall objective of this project was to build upon the strengths of stakeholders and create an environment where the wildlife-human conflicts could be resolved easily. The project has been able to generate confidence between the local people and the park management.

**UNDP-WII collaborative projects on the marine conservation sector.** WII is implementing the UNDP assisted "Olive Ridley Sea-turtle Conservation Project in which mapping of sea turtle nesting sites, threat analysis, cross sectoral integration in sea turtle management and capacity building of frontline and other managerial staff is the primary focus of this ongoing project.

**GOI-UNDP Sub-Programme on "Wildlife Protected Area Management in Jaldapara".** The Institute is implementing a sub-programme under the Environment Programme Support of the Country Cooperation Framework under the UNDP. The sub-programme aims to assist the Forest Department, Government of West Bengal to update and implement an integrated management and ecodevelopment plan in Jaldapara Wildlife Sanctuary. In November, 2002, a Stakeholder workshop was organized.

**Collaborations with Centre for Cellular and Molecular Biology and Centre for Herpetology.** The Institute signed an MoU with the two institutions on the October 27, 2002 in connection with the execution of the project "An evaluation of the endemism of the amphibian assemblages from the Western Ghats using molecular techniques". The collaboration with CCMB has been earlier sought in connection with the sea turtle genetics project.

### **Important Field Visits**

**Field survey for the creation of Bir Moti Bagh Sanctuary, Punjab.** Based on the request from the Chief Wildlife Warden, Punjab, WII conducted a rapid wildlife survey in the

sanctuary during the month of July 2002. The recommendations for conservation of deer species and their habitats management were made.

**Survey of Champawat (South Pithoragarh) Division during 26-29 November 2002.** This survey took place along Chalti-Chuka-Kaldhunga-Thuligad in Champawat division as part of the Terai Arc Tiger Conservation Landscape project. Some suggestions to improve protection in the Division were made.

## **National Natural Resource Management System (NNRMS)**

The main objective of National Natural Resource Management System (NNRMS) is utilization of remote sensing technology with conventional methods of monitoring of natural resources such as land, water, forests, minerals, oceans etc. for attaining sustainable development by addressing the following aspects :

- Optimal utilization of the country's natural resources by a proper and systematic inventory of the resource availability.
- Reducing regional imbalances by effective planning and in tune with the developmental efforts
- Maintain the ecological balance with a view to evolve and implement the environmental guidelines.

The Standing Committee on Bio-resources and Environment (SC-B) constituted by the Planning Commission advices on the methods of using the remote sensing technology for optimal use and management of natural resources in the country.

The SC-B had identified 49 priority areas for taking up remote sensing based studies in tune with key environment and ecological issues of the country. They encompassed forest, grassland, plant and faunal resources, wastelands, land degradation, water and air pollution etc. for information requirements for the Man and Biosphere Reserve Programme and some typical areas like mining, coastal areas, wildlife habitats, etc. Out of the above 49 priority areas, more than 20 have been covered so far.

So far SC-B has met 17 times and sponsored more than 60 remote sensing application projects addressing key environmental and ecological issues such as management of forests, grassland, faunal resources, wetland, coastal areas, mangroves and coral resources, land degradation, impact of mining and industrialization, river pollution, etc. More than forty projects have so far been completed. The 18<sup>th</sup> meeting of Standing Committee of National Natural Resource Management System (NNRMS) was held on 21-1-2003.

The potential user agencies for utilizing the outcome/information generated in the projects sanctioned by the Ministry under NNRMS programme are the Central Government Departments/agencies, and the Ministry of Environment and Forests itself including the various organizations under its administrative control like FSI, ZSI, BSI etc.

The inter-agency Remote Sensing PEER Review Committee met under the Chairmanship of Secretary (E&F) on 19<sup>th</sup> June 2002 at Indian Space Research Organisation (ISRO), HQ, Bangalore and reviewed the status and future plan of remote sensing and GIS based applications in the field of Forestry and Environment. Based on the discussions and recommendations made by the committee, the specific areas where action/projects need to be taken up by Ministry are listed in Annexure-VII. The Peer Review Committee urged the

Secretary (E&F) to consider actions on this through the NNRMS SC-B so that task-oriented projects get defined and time-bound results can be achieved. These could form a major element of the 10<sup>th</sup> Plan activities of Ministry and State Forest Departments.