



ECOLOGICAL RESTORATION, SPECIES RECOVERY AND LIVELIHOOD SUPPORT PROGRAMS UNDER NATIONAL FUND



**NATIONAL AUTHORITY, COMPENSATORY AFFORESTATION FUND
MANAGEMENT AND PLANNING AUTHORITY (CAMPA)**

**MINISTRY OF ENVIRONMENT, FOREST AND CLIMATE CHANGE
Government of India**



Ecological Restoration, Species Recovery and Livelihood Support

Programs under National Fund

**National Authority, Compensatory Afforestation Fund
Management and Planning Authority (CAMPA)**
Ministry of Environment, Forest and Climate Change
Government of India





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मंत्री
पर्यावरण, वन एवं जलवायु परिवर्तन
और
श्रम एवं रोजगार
भारत सरकार



सत्यमेव जयते

भूपेन्द्र यादव
BHUPENDER YADAV

MINISTER
ENVIRONMENT, FOREST AND CLIMATE CHANGE
AND
LABOUR AND EMPLOYMENT
GOVERNMENT OF INDIA



संदेश

प्रतिपूरक वनीकरण निधि प्रबंधन एवं योजना प्राधिकरण (कैम्पा) प्रतिपूरक वनीकरण, पुनः वनीकरण और पुनरुद्धार के माध्यम से उन्नत जीवन सहायक पारिस्थितिकी प्रणालियों और उनकी सेवाओं को मजबूत करके वनों और जैव विविधता के पुनरोद्धार और संवर्धन करने के लिए समर्पित है। विभिन्न भारतीय राज्य एवं संघ शासित राज्य अपने क्षेत्रों में कैम्पा गतिविधियों में सहयोग करने के उद्देश्य से उत्तम गतिविधियों को जोड़ने की दिशा में प्रयास कर रहे हैं।

राष्ट्रीय कैम्पा निधि देश में वन, वन्यजीवों एवं जैवविविधता संरक्षण से सम्बन्धित अनुसंधान, विकास योजनाओं एवं नई तकनीकों के प्रोत्साहन में सहायक सिद्ध हुई है। यह प्रकाशन राष्ट्रीय कैम्पा निधि के अंतर्गत स्वीकृत विभिन्न योजनाओं एवं परियोजनाओं को समर्पित है। अत्यधिक शिकार के कारण वर्ष 1952 से भारत में चीता विलुप्त हो गया था। अतः कैम्पा निधि द्वारा वित्त पोषित विश्व का अंतरमहाद्वीपीय चीता स्थानांतरण का एक अनुठा प्रयास भारत द्वारा किया गया है जिसका औपचारिक शुभारम्भ मध्य प्रदेश के कुनो राष्ट्रीय उद्यान में माननीय प्रधानमंत्री द्वारा किया गया। इस अवसर पर इस राष्ट्रीय उद्यान को नामीबिया से लाये गये 8 चीतो (5 नर और 3 मादा) को समर्पित किया गया है। इसी क्रम में सरकार अफ्रीका से 12 चीते शीघ्र ही भारत पहुंचाने हेतु कार्यरत है।

कैम्पा निधि पोषित कई अन्य योजनाएं जैसे वन आनुवंशिक संसाधनों पर उत्कृष्टता केंद्रों की स्थापना, पारिस्थितिक स्थिरता और उत्पादकता वृद्धि के लिए वानिकी शोध अनुसंधान का सदृढीकरण, भारत में ग्रेट इण्डियन बस्टर्ड का संरक्षण एवं गंगा डॉल्फिन के लिए संरक्षण एवं कार्य योजना विकसित करना अत्यधिक प्रशंसनीय कार्य है जिसका विस्तृत विवरण दिया गया है।

मुझे राष्ट्रीय कैम्पा निधि द्वारा वित्त पोषित चयनित प्रभावशाली योजनाओं पर प्रकाशित संकलन को आपके समक्ष प्रस्तुत करते हुए अत्यंत प्रसन्नता हो रही है तथा मैं भारतीय वानिकी अनुसंधान एवं शिक्षा परिषद, प्रकृति के संरक्षण के लिए अंतर्राष्ट्रीय संघ, उत्तराखंड विज्ञान एवं प्रौद्योगिकी परिषद, बॉम्बे नेचुरल हिस्ट्री सोसाइटी, भारतीय वन्यजीव संस्थान एवं भारतीय वन सर्वेक्षण को राष्ट्रीय हित में इन क्षेत्रों को आगे बढ़ाने एवं सतत विकास हेतु सहयोग करने के लिए बधाई देता हूँ।

(भूपेन्द्र यादव)





आज़ादी का
अमृत महोत्सव



अश्विनी कुमार चौबे
Ashwini Kumar Choubey



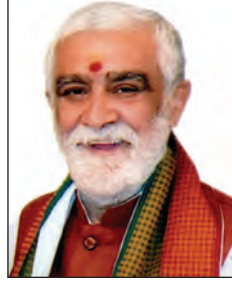
सत्यमेव जयते
आहारशुद्धौ सत्त्वशुद्धिः



एक कदम स्वच्छता की ओर

राज्य मंत्री
पर्यावरण, वन एवं जलवायु परिवर्तन
उपभोक्ता मामले, खाद्य और सार्वजनिक वितरण
भारत सरकार

MINISTER OF STATE
ENVIRONMENT, FOREST AND CLIMATE CHANGE
CONSUMER AFFAIRS, FOOD & PUBLIC DISTRIBUTION
GOVERNMENT OF INDIA



संदेश

वन (संरक्षण) अधिनियम, 1980 के अंतर्गत वन भूमि हस्तांतरण प्रकरणों की स्वीकृतियों के व्यवस्थीकरण, वन क्षेत्रों के बाहर वृक्षों को विकसित करने तथा वृक्ष उत्पादकों की आय में वृद्धि करने हेतु राष्ट्रीय प्रतिपूरक वनीकरण प्रबंधन एवं योजना प्राधिकरण, कैम्पा के कार्य अत्यधिक सराहनीय है।

हर बार जब वन भूमि को गैर वानिकी कार्यों जैसे खनन या उद्योगों के लिए हस्तांतरित किया जाता है, तो प्रयोक्ता संस्था उतनी ही गैर-वन भूमि के समान क्षेत्र में वन लगाने के लिए अथवा इस प्रकार की भूमि उपलब्ध न रहने की दशा में अवनित वन भूमि के क्षेत्र से दोगुनी से अधिक भूमि के लिए भुगतान करने के लिए बाध्य होती है।

राष्ट्रीय कैम्पा राज्यों एवं केंद्रशासित प्रदेशों में कैम्पा कार्यों के प्रबंधन तथा कैम्पा द्वारा आवंटित धनराशि की प्रतिपूरक वनीकरण, दण्डात्मक प्रतिपूरक वनीकरण, जलागम क्षेत्रों का उपचार कार्य तथा एकीकृत वन्यजीव प्रबंधन के सुधार हेतु अत्यंत महत्वपूर्ण एवं प्रमुख संस्था है।

कैम्पा निधि का उपयोग प्रतिपूरक वृक्षारोपण अधिनियम, 2016 तथा प्रतिपूरक वृक्षारोपण नियमवाली, 2018 के अनुरूप क्षतिग्रस्त वनों के रख-रखाव एवं स्थायी प्रबंधन हेतु किया जाता है। इस प्रकाशन का उद्देश्य राष्ट्रीय निधि द्वारा वित्तपोषित विभिन्न प्रभावशाली योजनाओं को प्रस्तुत करना है। मुझे अत्यंत प्रसन्नता हो रही है कि इस प्रकाशन में भारतीय सोन चिरैया, गंगा डॉल्फिन, चीता व अन्य जीवों के प्राकृतिक आवासों तथा प्रजातियों के संरक्षण हेतु राष्ट्रीय महत्व की परियोजनाओं को मुख्य रूप से दर्शाया गया है। यह प्रकाशन देश में प्रदूषण तथा जल संकट जैसी समस्याओं से निपटने के लिए पर्यावरण की रक्षा में विज्ञान तथा प्रौद्योगिकी की भूमिका को प्रतिपादित करता है।

विज्ञान एवं प्रौद्योगिकी की सहायता से समस्याओं को निपटाने में राष्ट्रीय प्रतिपूरक वनीकरण प्रबंधन एवं योजना प्राधिकरण तथा इसके द्वारा समर्थित राज्यों एवं केंद्रशासित प्रदेशों का विशेष सहयोग रहा है जिसे इस प्रकाशन में सफलतापूर्वक चित्रित किया गया है।

(अश्विनी कुमार चौबे)



लीना नन्दन
LEENA NANDAN



सचिव
भारत सरकार
पर्यावरण, वन एवं जलवायु परिवर्तन मंत्रालय
SECRETARY
GOVERNMENT OF INDIA
MINISTRY OF ENVIRONMENT, FOREST AND
CLIMATE CHANGE



MESSAGE

The National Compensatory Afforestation Fund Management and Planning Authority, NCAMPA has played a pivotal role in managing and conducting the CAMPA activities in States/UTs. These States/UTs are highly appreciated for successfully conducted time bound CAMPA works in their districts and villages.

The CAMPA works are carried in full fervour in the various States/UTs for carrying out assisted natural regeneration, artificial regeneration, silvicultural operations in forests, protection of plants and forest, pests and disease control in forests, forest fire prevention and control operations, soil and moisture conservation works in forests, voluntary relocation of villages from protected area, improvement of wildlife habitat as provided in the approved wildlife management plan or working plan, planting and rejuvenation of forest cover on non-forest land falling in wildlife corridors, establishment, operation and maintenance of animal rescue centre and veterinary treatment facilities for wild animals, supply of wood saving cooking appliances and other forest produce saving devices in forest fringe villages as specifies by the National Authority from time to time and management of biological diversity and biological resource.

I congratulate the National Authority CAMPA for bringing out "Ecological Restoration, Species Recovery and Livelihood Support Programs under National Fund" for improvement of wildlife habitat, conservation and rehabilitation of species, intercontinental translocation of cheetahs, management of biological diversity and capacity building programs for enhanced human resource.

(Leena Nandan)



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चन्द्र प्रकाश गोयल
CHANDRA PRAKASH GOYAL



वन महानिदेशक एवं विशेष सचिव
भारत सरकार
पर्यावरण, वन एवं जलवायु परिवर्तन मंत्रालय
DIRECTOR GENERAL OF FOREST & SPL. SECY.
GOVERNMENT OF INDIA
MINISTRY OF ENVIRONMENT, FOREST AND
CLIMATE CHANGE



MESSAGE

The Compensatory Afforestation Fund Management and Planning Authority, CAMPA is a tool for achieving climate resilient growth and it is achieved through the collaborative efforts of the States/UTs. CAMPA has been successful in generating employment through afforestation and plantation works promoting the Green India Mission and Atma Nirbhar Bharat objectives.

CAMPA aims to promote afforestation and regeneration activities as a means of compensating for forest lands that has been taken over for non-forest use due to the development needs of an area and covers a wide range of activities including compensatory afforestation, catchment area treatment, assisted natural regeneration, forest fire prevention, establishment, upgradation and maintenance of modern nurseries and other planting stock production facilities for production of quality planting materials. Various organisations like FSI, UCOST, ICFRE, WII and IUCN have contributed towards various schemes/pilot projects that are strengthened by the funds allocated by the National Authority.

I felicitate this publication as an attempt to highlight the impressive schemes supported by the National Authority that contribute towards sustainable ecological development in the country. Strengthening of Forestry Research for Ecological Sustainability and Productivity enhancement, Estimation of economic losses due to forest fire in Uttarakhand and Madhya Pradesh, Rejuvenation of Damodar and Subarnrekha rivers through forestry interventions, world natural heritage management and training for Asia and Pacific Region, Conservation Action Plan for Manipur's Brow antlered Deer or Sangai, Bustard Recovery Program, Developing conservation action plan for Ganges river Dolphin and implementing the Central Asian Flyway National Action Plan with special focus on preparation of site-specific activity plan, capacity building, developing bird sensitivity map for setting up of wind energy and species action plans acclaim my heartfelt appreciations. My vision for diversified wildlife supported by Indian forests is becoming realistic with one more addition to the cat family in the forest by translocation of Cheetahs from South Africa supported by National CAMPA fund.

Date: 14th Sept, 2022


(Chandra Prakash Goyal)

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सुभाष चन्द्र
SUBHASH CHANDRA



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CHIEF EXECUTIVE OFFICER
NATIONAL AUTHORITY CAMPA,
MINISTRY OF ENVIRONMENT, FOREST AND
CLIMATE CHANGE
GOVERNMENT OF INDIA

PREFACE

The Compensatory Afforestation Fund Act, 2016 (CAF Act) was enacted on 3rd August 2016 and the CAF Rules were notified on 10th August 2018. The National CAMPA came into existence on 30th September 2018 enabling the creation of the compensatory afforestation fund as a special fund under the Public Account of India.

The monies deposited in the National Fund are non-lapsable and interest bearing fund. The CAF Act, 2016 provides for State Compensatory Afforestation Fund under the Public Account of the respective State/UT. The 90% of the monies realised by the user agencies are transferred to the respective State/UT CAMPA fund and the remaining 10% of the realised amount is deposited in the National CAMPA Fund.

The CAMPA Funds are utilized as per provision of the CAF Act, 2016 and CAF Rules, 2018 for carrying out afforestation, forest protection and conservation related activities including control of forest fire, soil and moisture conservation activities and improvement of forests and wildlife habitat.

National Authority under the National Fund supports schemes/ projects and research programmes of national and regional importance pertaining to conservation of forest, wildlife, biodiversity and enhancement of ecosystem services. National Fund is promoting massive urban greening programme under Nagar Van/ Vatika Yojana in various cities across the country. The Ministry aims to create 1000 Nagar Van and Vatikas in the Country in next 3 years with public participation. Its purpose is to make the cities green, liveable, climate resilient, enrich urban biodiversity, improve quality of life of citizens and contribute to the National Clean Air Action Plan (NCAP) by bringing trees in the city.

The monitoring and evaluation of CAMPA activities throughout India ensures accountability and is one of the pivotal tasks by National Authority. It supports upgradation of technologies used for assessment of green cover through e-Greenwatch, Digital Web Portals namely PARIVESH.

The publication titled "Ecological Restoration, Species Recovery and Livelihood Support Programs" funded under National Funds highlights efforts of various Agencies and Institutions viz. Indian Council of Forestry Research and Education, Wildlife Institute of India, Uttarakhand State council for Science and Technology, International Union for Conservation of Nature on special schemes on conservation of Ganges Dolphins, Dugongs, Great Indian Bustard, Brow-Antlered Deer (Sangai) along with enhanced capacity building for stakeholders and State Government employees. National CAMPA also contributed in reintroduction of Cheetahs on Indian sub-continent after their extinction since 1952 by their translocation from Africa.

This publication is an attempt to showcase some of the important activities supported by National Fund for balancing conservation and development and strengthen our joint efforts to combat climatic change.

(Subhash Chandra)

Date: 14th Sept, 2022



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75
आज़ादी का
अमृत महोत्सव



Vision

*Rebuilding and enriching forests and biodiversity
through compensatory afforestation,
re-afforestation and restoration for enhancing life
sustaining ecosystem services*



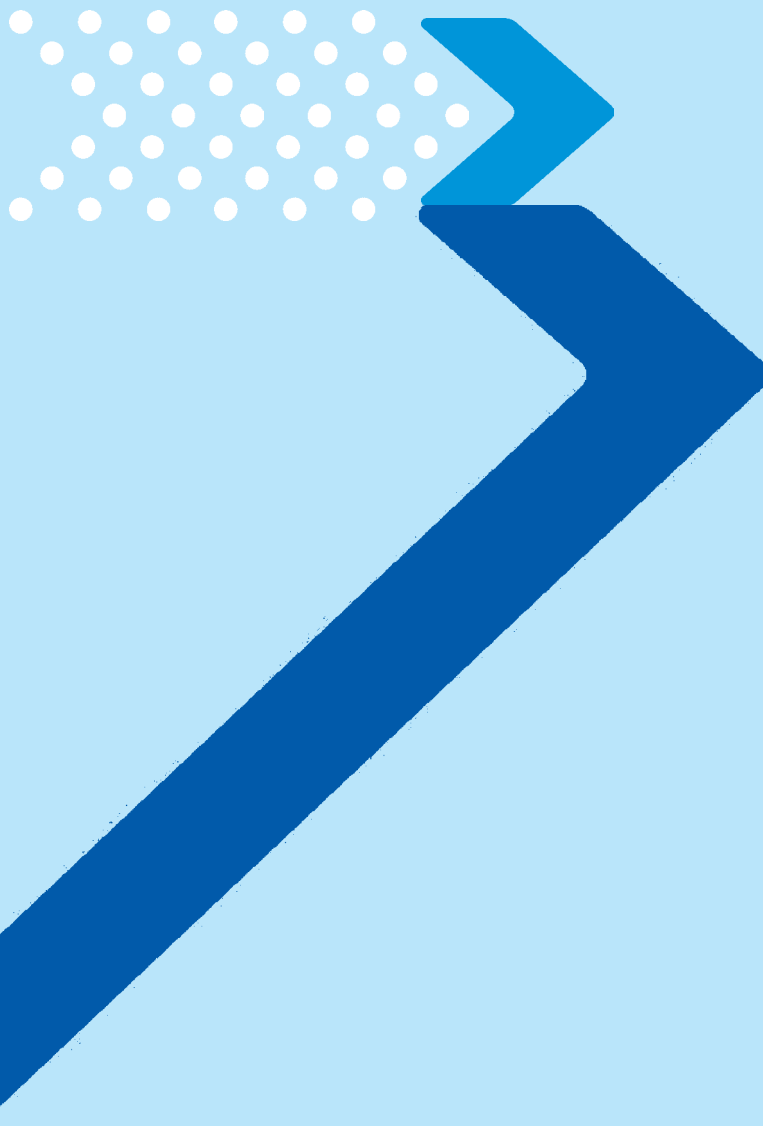


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CONSERVATION OF LANDSCAPE





NATIONAL PROGRAM FOR CONSERVATION AND DEVELOPMENT OF FOREST GENETIC RESOURCES: PILOT PROJECT ON 'CREATION OF CENTRE OF EXCELLENCE ON FOREST GENETIC RESOURCES (COE FGR)'

FOREST RESEARCH INSTITUTE

Key Outputs

1. The Dehra Dun herbarium (DD herbarium) renovated and upgraded for the better access and long-term safeguard of specimens.
2. A herbarium Forest Genetic Resources (FGR) database developed.
3. FRI herbarium digitized. The herbarium database hosted through a web portal and the online access provided to the users.
4. Documented the Forest Genetic Resources (FGR) diversity, population structure, threat and regeneration status of 250 FGR species of Uttarakhand.
5. Identified Rare Endangered and Threatened (RET) species of Uttarakhand with their GPS locations.
6. Eco-distribution maps of 50 priority FGR species developed using Geographic Information System (GIS) and remote sensing tools.
7. Forest Research Institute, Dehradun and National Bureau of Plant Genetic Resources (NBPGR), New Delhi signed Memorandum of Agreement (MoA) for long-term conservation of Forest seed germplasm in their Seed Bank.
8. The processed, viability determined, well desiccated seeds up to safe moisture level of 100 forestry species deposited in the Gene bank of NBPGR at -18°C along with passport details for *ex-situ* conservation.
9. *In vitro* regeneration protocols developed for ten FGR species of high conservation concern in order to achieve whole plant regeneration as well as medium term storage.
10. Protocols for storage of FGR germplasm in the form of 'pollens' for the species of high conservation concern of ten targeted species developed.
11. Analysis and spatial distribution of genetic diversity, identification of genetic diversity hotspots of five FGR species completed for conservation and development of *in-situ* forest field gene banks.
12. Diseased survey in selected forest species and their populations completed in Uttarakhand region.
13. Biochemical characterization of five species in various population lines has been carried out with respect to the Total Flavonoid Contents (TFCs), Total Phenolics Content (TPCs), Tri-Terpenoid Content (TTCs).
14. Propagation techniques standardized for five economically important species having high conservation concern and starting material developed for ten FGR species.
15. The *ex-situ* field gene banks of six prioritized species established and *in-situ* Gene banks designated in five species.
16. Proposal for the notification of Centre of Excellence on Forest Genetic Resources at FRI submitted to the Ministry of Environment, Forest and Climate Change (MoEF&CC.) Govt. of India.
17. The outcome of the project shared with the Uttarakhand Forest Department through experience sharing workshop.

Brief Summary

1. Forest Genetic Resources

Forest Genetic Resources (FGR) form an important subset of biodiversity, defined as 'the heritable material contained within and among tree and other woody plant species that are of actual and potential economic, environmental, societal, and scientific value.' FGR are unique and irreplaceable resources, vital for resilience, productivity, diversity, adaptation and evolutionary processes of forests and trees, and essential for humanity and forest-based other life forms. In short, FGR and genetic diversity within them are essential for ecosystem stability, persistence of species and maintaining fitness, resistance to biotic and abiotic stresses, potential for adaptation to climate change, artificial selection and tree improvement, insurance for

future, and foundation for evolution. In India alone, more than 340 million people are estimated to be dependent on FGR for their livelihoods.

2. Factors Influencing FGR

Across globe, most forests are home to a range of native, non-native, and naturalized tree and shrub species that have adapted in various ways to their growing environments owing to natural processes and human induced activities. Much of the genetic diversity in FGR has evolved over generations as species have adapted at a fine scale to local conditions while influenced by natural processes *viz.*, natural colonization and selection, gene flow, and mutation, and enhanced anthropogenic activities *viz.*, change in land use, forest management practices, agriculture expansion and intensification, forest fire, unsustainable harvest,



introduction of invasive exotics, developmental activities, etc. Most of these factors, particularly forest management practices modify forest composition, tree density, age class structure at different stages during a forest stand rotation besides strong effects on genetic diversity, connectivity, and effective population size. Further, human aggravated climate change is having wider implications in form of population bottle neck, fragmentation and isolation, reduced regeneration, and population size, altered distribution range of FGR species and phenology, asynchrony of pollinating and seed dispersing agent, modified seed biology and germination behaviour, and introduction of pathogens and pest infestations. Since trees and FGR species are long lived and occur in dynamic complex environment, detecting which environmental factors affect most of their genetic diversity is not straight forward.

3. Global Developments and Initiatives for Conservation of FGR

In past seven decades or so, international priorities in genetic resources have gradually moved from initial focus on plants, agricultural crops to domesticated animals, fisheries, human genomics, microorganisms and finally to forest trees and woody plants as these different sectors form a part of wider biodiversity, have strong cross-sectoral interconnections and evident sharing of common technological tools.

The global synthesis on The State of World's Forest Genetic Resources (SOW-FGR) by FAO in 2014 based on information provided by 86 countries highlighted that effective management of FGR requires the availability of accurate knowledge and information on ecosystem and species. Presently, the most widely used estimates for number of tree species range from 80,000 to 1,00,000, but the range of published estimates is much wider indicating the need for further efforts in botanical assessments.

The findings and recommendations incorporated in the SOW-FGR formed the basis for the development of *The Global Plan of Action for the Conservation, Sustainable Use, and Development of Forest Genetic Resources* which was released by FAO in 2014. This comprehensive global plan of work on FGR identified four priority areas, and altogether 27 strategic priorities. Four priority areas included were: (i) improving the availability of, and access to information on FGR; (ii) conservation of FGR (*in situ* and *ex situ*); (iii) sustainable use, development, and management of FGR; and (iv) policy, institutions, and capacity building. Implementation of the Global Plan of Action was expected to strengthen the management and sustainability of FGR while assisting countries in integrating FGR conservation and management needs into wider policies, programs and frameworks of action at different hierarchical governance systems besides developing sound technical and scientific programs for the successful management of FGR and significantly contributing towards the global goals of biodiversity conservation, climate change and sustainable development.

In the long process of development of SOW-FGR and the Global Plan of Action by FAO Commission on Genetic Resources (FAO-CGR), many regional, sub-regional and

ecoregional programs, networks, and initiatives on FGR came into existence and they meaningfully contributed towards creation of awareness, knowledge generation and sharing, capacity development, and even formulation of region/ country specific strategies and programs.

4. Indian Initiatives for Conservation of FGR

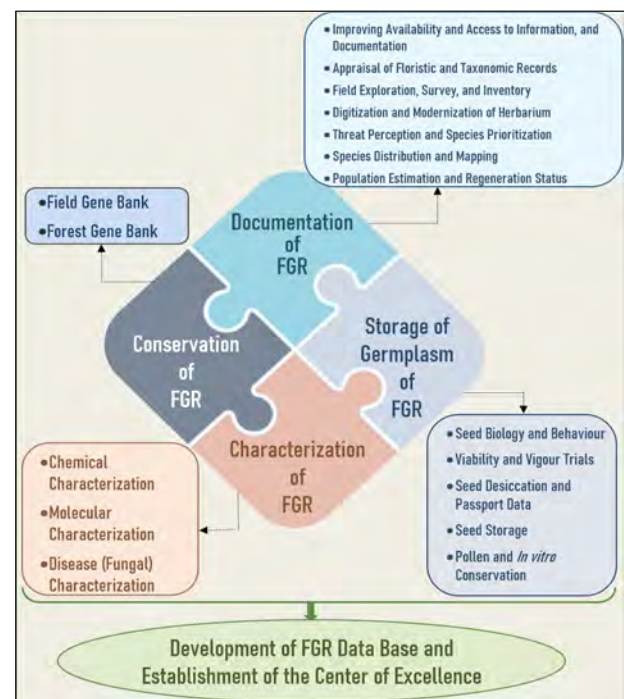
4.1. National Program for Conservation and Development of FGR

In accordance with the Global Plan of Action for FGR, ICFRE and FRI prepared a 20-year perspective plan titled 'National Program for Conservation and Development of Forest Genetic Resources (2016-2035)' incorporating an implementation strategy for execution of Pilot Project - 'Center of Excellence on Forest Genetic Resources (CoE-FGR) of India (2016-21)' and details on the subsequent three phases with an overall outlay of Rs. 622.10 million. After considerable deliberations on the proposed comprehensive perspective plan, the MoEFCC decided to initially establish CoE-FGR at FRI and implement the 5-year Pilot Project on FGR in the State of Uttarakhand with a budgetary allocation of Rs 8.61 crore under the Ad.hoc CAMPA Fund.

4.2. Establishment of CoE-FGR

The CoE-FGR was established and made functional in 2016 utilizing the available expertise across Forest Botany, Silviculture, Chemistry, Pathology, and Genetics Divisions of FRI and varied facilities (DD Herbarium, Botanical Garden, Arboretum, National Forest Library and Information Center-NFLIC, IT and GIS, and analytical/ research laboratories) besides involving experts, professionals, and practicing foresters from time to time as per the need.

4.3. Pilot Project



Four Components and Broad Activities of the Pilot Project on Conservation of FGR



The Pilot Project primarily included four thrust areas viz., (a) FGR Documentation, (b) FGR Seed and Germplasm Storage, (c) FGR Characterization, and (d) FGR Conservation, referred as 'Components'. Each of these four components included three to four sub-components and allied tasks. In addition, the project envisaged an important task on the creation of FGR database.

4.3.1. Demonstration State

The MoEFCC selected the Himalayan State of Uttarakhand for the purpose of implementation and demonstration of the Pilot Project in view of the fact that the State is uniquely placed and represents nearly one-fourth diversity of forest sub-types described for the entire country besides it is geographically, ecologically, socioeconomically and culturally diverse owing to varied landforms, extremities in the altitudinal gradient and climatic conditions, affinity of local communities with forests, and long history of forest management. Uttarakhand is exceptionally rich as 71.05 per cent area of the State is Recorded Forest Area (RFA) and represented by diverse forests along the altitudinal gradient covering total forest cover to the extent of 24,305.13 km² or 45.44 per cent of the State's geographical area. These forests are known repository of forest biodiversity including FGR.

4.3.2. The Approach

The conservation of FGR seeks a comprehensive multidiscipline, multiscale, multisector, and multistakeholder approach as the Pilot Project incorporated four Components besides creation of database and the establishment of CoE-FGR. Thus, the project adopted a holistic, hierarchical, participatory, and multipronged approach including: (a) review of existing information; (b) wider and extensive consultative process; (c) field exploration, surveys, assessments, and documentation; (d) modernization and digitization of DD Herbarium; (e) collection of seeds, processing, viability, and vigour trials, and storage of priority FGR species; (f) medium to long term storage of pollen and tissues; (g) characterization based on biochemical, genetic and pathological attributes; and (h) *in situ*, *ex situ* and *circa situm* conservation measures. The consultative process immensely helped in prioritization of 250 FGR species from the perspective of documentation of their distribution, population structure, regeneration status, threat perception and uses. In addition, 50 FGR species were prioritized for potential ecogeographic mapping based on predictive modeling using bioclimatic attributes. Ten tree species each for pollen storage and tissue culture were selected. Further, five tree species were evaluated for biochemical, genetic, and pathological characteristics. The task on nursery and propagation techniques was integral to *in situ* and *ex situ* conservation measures by way of establishment of Forest Gene Conservation Units (FGCUs), and Field Gene Banks (FGBs), respectively. Concurrently, the process of developing FGR database was initiated. As a part of the consultative process, the inception and experience sharing and dissemination workshops were organized involving stakeholders,

mainly focusing on forest policy and decision makers, field practitioners, and subject matter specialists.

4.4. Outputs, Achievements, and Key Recommendations

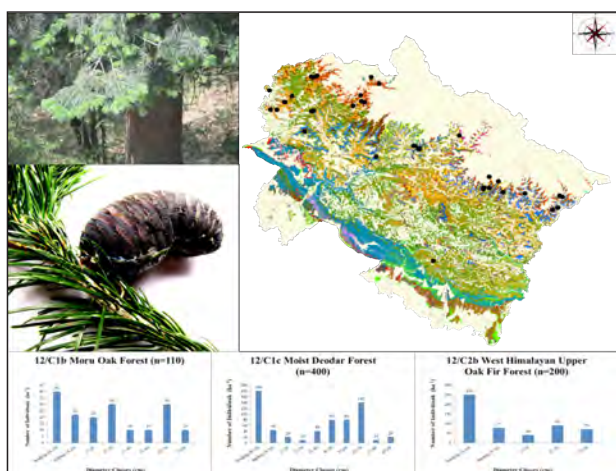
Component-wise outputs, achievements and key recommendations are summarized and highlighted below one by one:

4.4.1. FGR Documentation

The foremost priority of the Pilot Project was to improve the availability of, and access to, information on FGR by way of prioritization, documentation, digitization of herbarium, ecogeographic mapping, and the establishment of Documentation Cell as a part of Center of Excellence. The project outputs of the Component on Documentation of FGR have been broadly described in the following three sub-components:

4.4.1.1. Species Profile, Distribution and Status

Total 5,290 nested quadrats were laid across 37 forest sub-types and 39 forest divisions/ PAs/ wildlife divisions covering an extent of 0.529 km² representing 0.002 per cent of cumulative forest cover of 37 forest sub-types for the purpose of varied assessments on prioritized FGR species. The target of documenting 250 prioritized FGR species representing 88 plant families and comprising 180 tree, 47 shrub, and 23 woody climber species including 62 RET species by describing the species profile with an updated nomenclature, synonyms, local names, uses, threats, distribution within Uttarakhand and across different forest sub-types and forest divisions, population structure, and regeneration status was fully achieved and has been presented in a featured template customized for the purpose. Plant families viz., Fabaceae, Lauraceae, Moraceae, Berberidaceae, Rosaceae, Euphorbiaceae, and Betulaceae collectively covered almost 28 per cent prioritized FGR species.



Species Profile, Distribution and Regeneration Status of *Abies pindrow*

Priority Forest Sub-Types: Four prominent forest sub-types viz., Ban Oak Forest, Upper or Himalayan Chir Pine Forest, Northern Dry Mixed Deciduous Forest, and Moist Shiwalik



Sal Forest out of 37 forest sub-types assessed for diversity of prioritized FGR species emerged as the most important forest sub-types from the perspective of conservation as they harboured disproportionately higher number of diverse FGR species. Among 146 prioritized FGR tree species, six species viz., *Quercus leucotrichophora*, *Q. semecarpifolia*, *Pinus roxburghii*, *Ficus semicordata*, and *Grewia optiva* were widely distributed as their presence was recorded in as many as 13 forest sub-types in each case.

Important Forest Divisions: The highest number of 114 FGR species were recorded in Pithoragarh Forest Division (FD), because it is the largest division and represents extremes of altitudinal gradient besides high extent of forest cover under three different forest canopy classes. Pithoragarh FD was followed by Mussoorie FD, Ramnagar FD, Dehra Dun FD, Champawat FD, Bageshwar FD, Rudraprayag FD and Nainital FD registering distribution of 94, 82, 76, 75, 73, 72, and 63 prioritized FGR species, respectively.

Regeneration Status: The project significantly contributed towards the current status and baseline information on the regeneration status of 250 FGR species and also offered deep insight towards the performance of individual species as well as 37 forest sub-types wherein regeneration studies were carried out. The cumulative 644 assessments in case of prioritized FGR species revealed good, fair, poor, no and new regeneration in 65.5 per cent, 13.81 per cent, 16.92 per cent, 2.95 per cent, and 0.77 per cent, respectively. In case of 146 FGR tree species, good, fair, poor, no, and new regeneration was observed in 80.64 per cent, 12.40 per cent, 4.71 per cent, 1.98 per cent and 0.24 per cent of overall assessments, respectively. All 62 RET exhibited poor regeneration and this situation demands high management attention and interventions.

Use of FGR Species: Nearly 28 per cent prioritized FGR species revealed multiple uses. Almost 18 per cent species were found to have medicinal importance. Fruits of thirty-one species are being used for direct consumption or in production of squash/ juice. About 12 per cent studied species have importance as timber or are being used for making turnery articles and furniture. Six species are in use for fuelwood while five species are being used in charcoal making.

Threats to FGR Species: A larger proportion (58 percent) of prioritized FGR species face threat on the account of varied developmental activities, particularly expansion of road and railway network and widening of existing highways, execution of hydropower projects, and increasing infrastructure related to tourism. As many as 51 species or about one-fifth of prioritized FGR suffer on the account of genetic erosion caused by change in land use, over harvest, recurrent forest fires, livestock grazing, habitat loss and fragmentation, scattered small populations, and disruption in gene flow. At least ten species were at risk on account of overexploitation for medicinal purposes.

4.4.1.2. Modernization and Digitization of DD Herbarium

Well known herbaria across the globe have been recognized as important repositories of plant specimens, having notable contribution towards the documentation of FGR species. The forest-based herbarium with ca. 3,30,000 plant specimens housed in the campus of FRI, Dehra Dun is one of the oldest herbaria, known as the DD Herbarium. It is a repository of valuable wealth of phanerogams (angiosperms and gymnosperms), and vascular cryptogams mounted on herbarium sheets. The DD herbarium also includes a carpological (dry fruits and seeds) collection of ca. 1000 specimens besides it holds an estimated 1,300 Type Specimens and historically important collections from various expeditions.

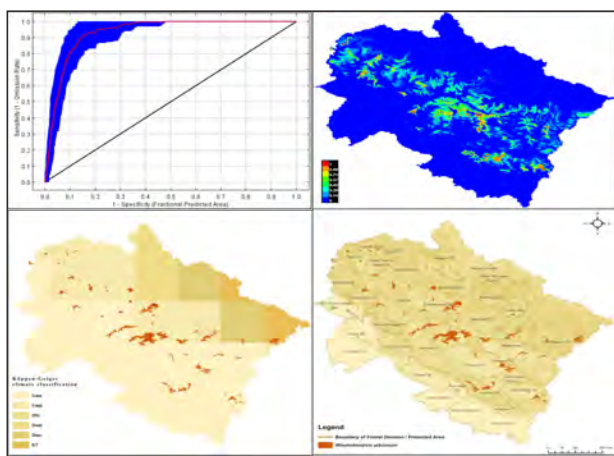
The Pilot Project made notable contribution towards renovation of DD Herbarium by way of transforming the old building and its infrastructure as a modern facility with provisioning of multiple units of compactors replacing old wooden/ steel almirahs besides new air conditioners and equipment for digitization (scanner and image processors, computers, etc.). This activity has contributed towards the creation of additional storage space and offering new lease of life to old plant specimens/ herbarium sheets. The digitization process of DD Herbarium financed under the CAMPA sponsored Pilot Project has facilitated the successful completion of the digitization process of nearly one-third overall specimens. The digitization process has not only allowed easy access of the huge collection, but also wider global dissemination and enhanced visibility through worldwide web besides creating an archive of DD Herbarium.



Modernization and Digitization of DD Herbarium

4.4.1.3. Ecogeographic Mapping of Prioritized FGR Species

In the Pilot Project, the MaxEnt Modeling protocol, a free software and user-friendly operational interface based on the presence data of a species and environmental data (both continuous and categorical) used as input variables immensely helped in generating GIS based ecogeographic maps of range and population distribution of 37 prioritized FGR species.



Ecodistribution of *Rhododendron arboreum*- ROC Curve, Habitat Suitability, KGCC map and Current Distribution

Out of 50 prioritized FGR species, 37 species were mapped through MaxEnt prediction-based modeling, whereas rest 13 species as per locations recorded during the field surveys owing to their smaller number of geo-coordinates. Ecogeographic maps provided valuable statistics on estimated area, distribution in different forest canopy classes, altitudinal range, prominent environmental variables, maximum occurrence of species in different districts, and other specific information for each species generated through modeling. The ecogeographic maps with the precise location and distribution range of these species in the varied forest sub-types and administrative units i.e., districts of the Himalayan State of Uttarakhand offered valuable information for use by concerned DCFs/ DFOs/ PA Managers of respective FDs/ PAs and other stakeholders, particularly in the process of revision of Working Plans/ Management Plans or even formulation of conservation strategy for the RET species.

The area of estimated range in case of 37 prioritized FGR species ranged from as low as 15.54 km² (*Tsuga dumosa*) to 832.4 km² (*Q. semecarpifolia*), representing 0.03 per cent to 1.56 per cent of geographical area of the State, and 0.06 per cent to 3.43 per cent of forest cover. Species viz., *Bombax ceiba*, *Rhododendron arboreum*, *Taxus wallichiana*, *Myrica esculenta*, *Ougeinia oojeinensis*, *Betula utilis*, *Oroxylum indicum*, and *Terminalia chebula* had relatively higher extent of distribution range (> 250 km²). In contrast, species viz., *Albizia julibrisin*, *Hovenia dulcis*, *Corylus jacquemontii*, *Olea europaea*, and *Ulmus wallichiana* had lower extent of their distribution range varying from 33.49 km² to 78.98 km². In case of remaining 13 species having localized eco-distribution, the total occurrence area ranged from as low as 3.14 km² (*Cochlospermum religiosum*) to 32.13 km² (*Trema orientalis*). Districts viz., Pithoragarh, Uttarkashi, Nainital, Bageshwar, Champawat, Dehra Dun and Pauri recorded relatively higher number of species. Species with patchy and limited distribution range <150 km² require utmost attention from the conservation perspective. The concerned DCF/ DFO needs to appreciate the risk faced by species having patchy or scattered distribution that too with small extent and incorporate appropriate

management strategies in the respective Forest Working Plan. Further, 13 species having highly restricted and localized distribution with very small extent will need extra care for their management.

4.4.2. FGR Seed and Germplasm Storage

Germplasm provides the essential hereditary material to natural resource managers dealing with varied aspects of forest management, particularly raising nurseries, and plantations besides tree improvement. Seeds, pollens, plants, plant parts, or cultures are germplasm useful in plant breeding, research, and conservation efforts or accessing the genetic information they possess for biotechnological applications. Seeds are the most common and convenient materials specially for conservation of long lived FGR species those produce a wide range of seeds varying in size, shape, nature of fruit, moisture content etc. besides having some limitations due to their either seasonal availability or longer time gaps in seed production, small quantities or even issues of viability.

Very little information on the seed biology (storage and germination) of tree and other FGR species in the context of Indian forests is available due to the vastness, high diversity, and limited resources (field collection, seed testing and viability, desiccation trials, storage, and manpower) for such purposes. Thus, the Pilot Project envisaged to demonstrate that seeds of FGR species can be stored for periods well in excess of the time to reach reproductive age and preferably the tree's lifespan. Seed storage under control conditions is the most commonly used strategy for short (3-5 years) to medium (30 years or more) term *ex situ* conservation of forest trees.

Plant Tissue Culture (PTC) or *in vitro* culture has emerged as an appropriate alternative method for conservation of germplasm. Similarly pollen conservation is an important tool for the maintenance of plant genetic resources and can promote improved efficiency in breeding programs and germplasm conservation and exchange.

In view of the above, the Pilot Project envisaged the development of protocols for medium to long term storage of seeds, and other germplasm material.

4.4.2.1. Protocols for Seed Storage of Prioritized FGR Species

The task specific to seed storage of prioritized FGR species included development of protocols for seed extraction, processing, quality testing methods for medium- and long-term storage for prioritized FGR species. Twenty-five FGR species in the demonstration state were selected for the purpose of development of medium-term seed storage protocols. In addition, 100 FGR species were prioritized for the development of protocols for long term seed storage of seed samples in the seedbank by availing the facility of National Bureau of Plant Genetic Resources (NBPGR), New Delhi. Accordingly, FRI and NBPGR have signed a Memorandum of Agreement (MoA) in 2016 for the purpose of collaboration and seed storage of prioritized FGR species in the facility of the latter.

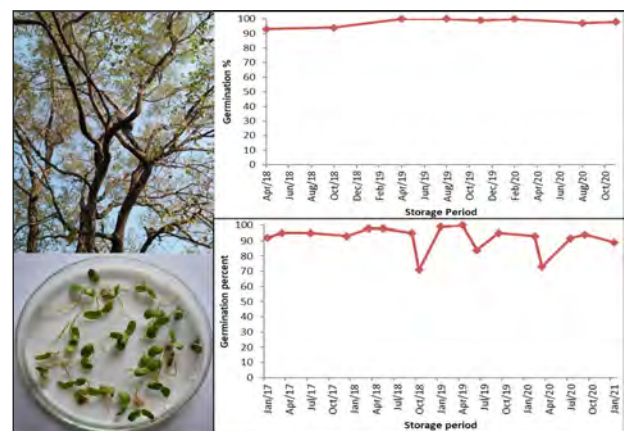


Seed production has a major role in the dynamics of a forest ecosystem. Seed germination, sapling and seedling stages are crucial processes in the development of natural forest communities. Knowledge of the natural regeneration associated with seed quality and seed production are important for developing scientific models, techniques, and new management guidelines to conserve the dwindling natural forest areas. The field observations and laboratory investigations on seed collection, and germination revealed the following major concerns regarding tree species in their natural forests which have potential impact on regeneration, forest structure, composition, functions, and succession.

- (a) **Seed Biology:** Emptiness in seeds was one of the major issues observed in several species. It is associated with pollination – fertilization failures. Early and immature seed fall was also observed in many species. Incomplete development and partially filled seeds were also observed in species that may be associated with environmental factors e.g., *Acer caesium*, *Premna mollissima*, *Pittosporum napaulense*, *Kydia calycina*, *Anogeissus latifolia*, and *Buxus wallichiana*.
- (b) **Seed Dormancy:** Deep dormancy in seeds causes regeneration delay, at times failure in nature due to long time requirement for breaking dormancy in the soil seed banks e.g., *Cinnamomum tamala*, *Corylus jacquemontii* and *Betula utilis*.
- (c) **Fungal and Insect Pest Infestation:** Seed borne pathogens, especially fungi are associated with seeds of several species. Insect injuries were also observed in several species. Seed-borne fungi and insect-pests reduced the quality of seeds. Pathogens infested during seed development, storage, or germination resulted into seed damage by way of loss of seed viability or from seedling infection following germination e.g., *Albizia odoratissima*, *Dalbergia lanceolaria*, *Albizia julibrissin* and *Cordia dichotoma*.
- (d) **Anthropogenic Pressure:** Immense anthropogenic pressure was observed on species having socio-economic utility and multiple values. Lopping associated with fodder collection for livestock, fuelwood collection, timber value of species, medicinal uses, edible parts, etc. determined the biotic pressure on the species e.g., *Cinnamomum tamala*, *Piliostigma malabaricum*, *Sterculia villosa*, *Stereospermum*, *Flacourtia indica*, *Schleichera oleosa*, etc.
- (e) **Population Status of Species:** Isolated populations, scattered populations, and population decline were observed in several species which are socio-economically and ecologically important, RET categories, and Lesser-Known Tree Species (LKTS) e.g., *Bauhinia malabarica*, *Corylus jacquemontii*, *Premna mollissima*, *Acronychia*, *Boswellia serrata*, *Toona serrata*, *Celastrus paniculatus*, *Buchanania cochinchinensis*, etc.

Studies on the development of seed storage protocols for *ex situ* conservation of seed germplasm under medium- and long-term storage conditions revealed that seeds of FGR species under medium term storage condition may be grouped into the following three categories based on their initial viability:

- (a) **Initial Seed Viability >60 Per Cent:** Several tropical and sub-tropical species such as *Acacia catechu*, *Aegle marmelos*, *Albizia julibrissin*, *Aristolochia elegans*, *Berberis lycium*, *Bischofia javanica*, *Dalbergia sissoo*, *Ougeinia oojeinensis*, *Fraxinus micrantha*, *Hippophae salicifolia*, *Holoptelea integrifolia*, *Oroxylum indicum*, *Picea smithiana*, etc. had initial viability greater than 60 per cent. All these species maintained their initial viability at hermetic storage condition at 5 °C storage temperature and reduced seed moisture content, except *Ougeinia oojeinensis* which lost its viability in two years in the given storage conditions.
- (b) **Initial Seed Viability between 30 to 60 Per Cent:** FGR species such as *Carpinus viminea*, *Juglans regia*, *Kydia calycina*, *Myrica esculenta*, *Rhamnus triquetra* and *Pyrus pashia* exhibited initial viability between 30 to 60 per cent. However, these species were successfully conserved without losing initial viability for more than a year in hermetic condition at 5 °C storage temperature.
- (c) **Initial Seed Viability <30 Per Cent:** *Celtis tetrandra* and *Punica granatum* had less than 30 per cent germination percent after pre-treatments and could be successfully stored at hermetic condition at 5°C storage temperature for medium term.



Seed collection and germination behaviour of *Dalbergia sissoo* in medium term storage condition

Pinus wallichiana, *Oroxylum indicum*, *Dalbergia sissoo*, *Acacia catechu* and *Hippophae salicifolia* exhibited high storage possibility under medium storage conditions by retaining viability at almost initial levels for more than 3 years. Hence, present study recommended to conserve those species which maintain initial viability for long durations into the long-term conservation unit after preliminary viability test and minimum required moisture level to maintain the metabolic activity of seed.



The present study also divided seeds into four categories based on initial viability, germinative capacity and storage potential under medium term storage conditions at 5°C viz., (a) seeds having high initial viability and good storage potential e.g., *Oroxylum indicum* and *Hippophae salicifolia*; (b) seeds having high initial viability and less storage potential e.g., *Ougeinia oojeinensis*; (c) seeds having low initial viability and good storage potential like *Carpinus viminea*; and (d) seeds having low initial viability and low storage potential e.g., *Juglans regia*. The study recommended that the present categorization can be correlated with the natural regeneration status of species associated with seed quality and seed production status which may help to devise some valuable strategies for future conservation of such species. The major challenges where species requires special attention in the field like biotic pressure, fungal and insect infestation, population status, seed dormancy and seed biology need to be appropriately addressed along with laboratory-based research activities.

As envisaged, seeds of 100 targeted FGR species from different sources in Uttarakhand have been conserved in the Seed Bank of ICAR-NBPGR. The leads and knowledge generated through the Pilot Project has opened enormous avenues for similar efforts and programs for implementation in other States/ UTs of the country.



Seeds stored in the Seed Bank of ICAR-NBPGR

4.4.2.2. Tissue Culture Protocols for Important FGR Species

Biotechnological strategies such as *in vitro* growth or tissue culture as stated above has emerged as one of the best alternatives to address issues associated with germplasm conservation in field conditions, particularly in case of problematic seeds. Pilot study on *in vitro* storage in the form of slow growing and/or cryopreserved cultures is one of the ways of conserving valuable germplasm in medium and long term, respectively. This objective can be fulfilled once the protocols for whole plant regeneration from these stored cultures i.e. callus, shoot tips, slow growing shoot cultures etc is developed. With an aim to conserve Forest Genetic Resources (FGR) of very high conservation concern or those having recalcitrant seeds or



In vitro Seed Germination, Shoot Initiation, Multiplication of Shoots and Rooting in *Hymenodictyon orixens*

both, *in vitro* regeneration protocols have been developed for eight species including three RET species viz., Trees - *Albizia julibrissin*, *Dysoxylum gotadhora*, *Ougeinia oojeinensis*, *Oroxylum indicum*, and *Hymenodictyon orixense*; and Shrubs - *Aristolochia punjabensis*, *Catamixis baccharoides*, and *Hippophae salicifolia*. In addition, *Meizotropis pellita* shrub and *Diploknemma butyracea* tree species were used for the development of callus regeneration pathways.

The study amply highlighted that *in vitro* storage methods are an effective tool to store propagules of RET and recalcitrant species for medium term.

4.4.2.3. In Vitro Pollen Germination and Storage of Selected FGR

The sub-component of the project on pollen storage focused on several lesser studied forest tree species which have conservation as well as economic significance for study on pollen germination ability under *in vitro* conditions along with their storage under cryogenic conditions. The experimental material included flower buds of varied FGR species viz., *Rauvolfia serpentina* and *Alstonia scholaris* (Apocynaceae); *Meizotropis pellita* and *Sophora mollis* (Fabaceae); *Heteropanax fragrans* (Araliaceae); *Oroxylum indicum* (Bignoniaceae); *Diploknema butyracea* (Sapotaceae); *Sterculia colorata* (Malvaceae); *Crateva adansonii* (Capparaceae); *Mahonia jaunsarensis*



In Vitro Pollen Germination of *Heteropanax fragrans* and Storage in Liquid Nitrogen



(Berberidaceae); *Falconeria insignis* (Euphorbiaceae); and *Buxus wallichiana* (Buxaceae). The study generated important information about the *in vitro* growth requirements of pollen grains in these species and imparts leads towards long term storage of forest germplasm in the form of pollens.

Knowledge of pollen germination ability and their longevity under storage conditions can help frame methods for controlled pollination and related studies. The study has provided information on several species with protocols to understand behaviour of different pollens under *in vitro* conditions.

4.4.3. FGR Characterization

Evaluation process of a species for identifying and describing features or traits of individuals and populations *viz.*, morphology, phenology, chemical content, resistance or susceptibility to pathogens, genetic constitution, etc. is referred as characterization, as it seeks to provide essential and prerequisite information for the conservation of a species. Characterization at the population level helps in identification of ecologically/economically superior populations over the entire distribution range of the species

Under this Component of the project, the biochemical characterization focused on secondary metabolites, specifically phenolic compounds including flavonoids besides terpenoids, particularly triterpenoids, and 10-deacetylbaaccatin III (10DBA-III), a tetracyclic diterpenoid and a secondary alpha-hydroxy ketone.

Molecular Characterization is a broad term that refers to using molecular markers, including DNA, RNA, and proteins, to determine the genetic characteristics of cells or tissues. Generally, genetic variability is being characterized for two primary purposes: (a) conservation planning and sustainable forest management based on identification of 'genetic diversity hotspots' rich in unique alleles; and (b) breeding and improvement of a species based on identification of superior genotypes.

Fungi cause seed rots, seedling damping-off, root rots, foliage diseases, cankers, vascular wilts, die-backs, galls and tumors, trunk-rots, and decay of ageing trees, and they may result into catastrophic losses in the event of an outbreak of a disease. Thus, pathological characterization of ecologically and socioeconomically valuable tree species by recording fungal species associated with them is of utmost importance.

As a part of the Pilot Project, biochemical, molecular, and pathological characterization of five prioritized tree species *viz.*, *Betula utilis*, *Myrica esculenta*, *Quercus semecarpifolia*, *Rhododendron arboreum*, and *Taxus wallichiana* was undertaken. Major revelations based on characterization of the target species are as follows:

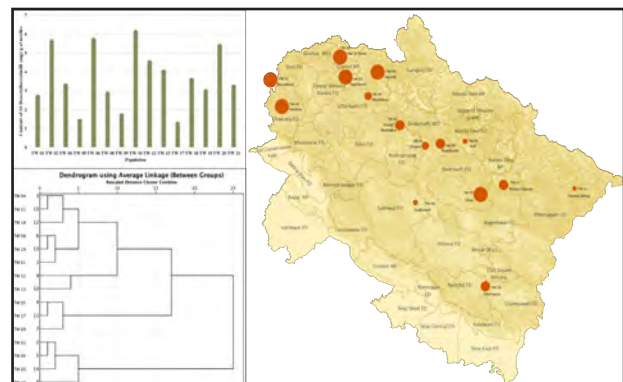
4.4.3.1. Biochemical Characterization

In search of chemically superior populations for *ex situ* conservation and mass multiplication, chemical characterization of above stated five medicinally valued tree species growing across diverse forests of Uttarakhand

based on assessment of stem bark of 11 populations of *B. utilis*, and 11 populations of *M. esculenta*; leaves of 14 populations of *Q. semecarpifolia*; flowers of 09 populations of *R. arboreum*; and needles of 15 populations of *T. wallichiana* for their total triterpenoid contents (TTCs), total phenolic contents (TPCs), total flavonoid contents (TFCs) and 10-Deacetylbaaccatin III (10-DAB III) contents was undertaken because of their medicinal/ biological/ pharmacological effects. Analysis showed significant variability in contents of TTCs, TPCs, TFCs and 10-DAB III across sampled populations. Further, analysis led to grouping of the populations of *B. utilis*, *M. esculenta*, *Q. semecarpifolia*, *R. arboretum* and *T. wallichiana* in 6, 4, 3, 4 and 4 clusters, respectively, indicating a close relationship between populations within the same cluster. The study helped in identifying populations of *B. utilis* located in Niti, Himkhola, Dharchula, Har ki Doon, and Darma Valley; *M. esculenta* found in Kausani and Takula; *Q. semecarpifolia* grown in Yamunotri and Radi Top; *R. arboreum* located in Budher and Chaurangi Khal; and *T. wallichiana* found in Deoban, Harshil, Ghes, and Har Ki Doon as chemically superior populations based on their respective highest biochemical contents, and they have been recommended for conservation and mass multiplication.

4.4.3.2. Molecular Characterization

Maintenance of genetic diversity is one of the main objectives of conservation programs which aims at maximizing either expected heterozygosity or allelic diversity. Maximization of allelic diversity has been



10-Deacetylbaaccatin Content in *T. wallichiana* Populations, Dendrogram and Spatial Distribution Showing Variation Among Sampled Populations

reported to be more efficient in maintaining the genetic diversity of subdivided populations than maximization of expected heterozygosity because the former maintains a larger number of alleles and better control of inbreeding. Hence, the populations with higher allelic diversity and private alleles deserve higher priority for conservation programs.

All the five studied Himalayan tree species showed high genetic diversity indicating their high adaptive and evolutionary potential. Following 28 genetic diversity hotspots identified in case of five targeted species based on their molecular characterization, particularly allelic



richness and presence of unique alleles will serve as the guiding principles for the future conservation programs and these genetic hotspots have been recommended for the establishment of prioritized *in situ* conservation sites among sampled populations as the Forest Gene Conservation Units (FGCUs):

- (i) ***Q. semecarpifolia*** – QS09 (Radi Top, Upper Yamuna Barkot FD), QS11 (Bhukkitop, Uttarkashi FD), QS15 (Munsiyari, Pithoragarh FD), QS19 (Mundhola, Chakrata FD), QS21 (Pinswar, Rudraprayag FD), QS23 (Narayan Ashram, Pithoragarh FD), and QS24 (Himkhola, Pithoragarh FD)
- (ii) ***M. esculenta*** – ME08 (Sandev, Pithoragarh FD), ME15 (Takula, Almora FD), ME16 (Shitla Khet, Almora FD), ME17 (Bhowali, Nainital FD), and ME18 (Mayali, Rudraprayag FD)
- (iii) ***T. wallichiana*** – TW12 (Mundhola, Chakrata FD), TW15 (Himkhola, Pithoragarh FD), TW18 (Mornaula, Nainital FD), TW19 (Har ki Dun, Govind WLS and NP), and TW21 (Baling, Pithoragarh FD)
- (iv) ***B. utilis*** – (BU01 (Rudranath, Kedarnath WD), BU06 (Himkhola, Pithoragarh FD), BU10 (Triyuginarayan, Rudraprayag FD), and BU11 (Darma Valley, Pithoragarh FD)
- (v) ***R. arboreum*** – (RA11 (Chaurangi Khal, Uttarkashi FD), RA16 (Dunagiri, Almora FD), RA18 (Chirbatiya, Tehri FD), RA19 (Badhanital, Rudraprayag FD), RA22 (Dhanaulti, Narendranagar FD), RA23 (Ghes, Badrinath FD), and RA24 (Gwaldam, Badrinath FD)

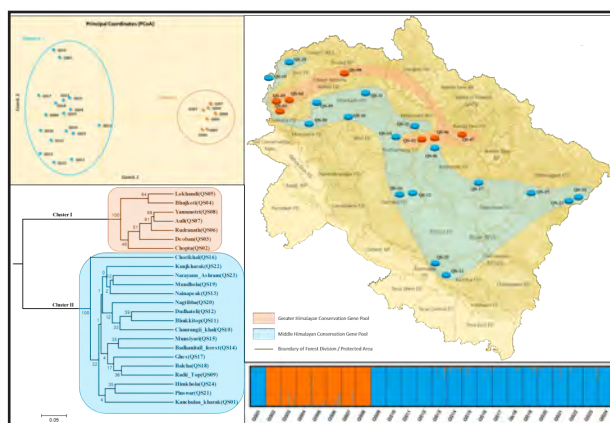
Above recommended 28 FGCUs will ensure the maintenance of high genetic diversity among five targeted species, and the genetic diversity on these hotspots need to be taken into consideration for any type of *ex situ* conservation measure including germplasm storage, rescue of inbred populations or even the production of starting material for propagation.

In each of the five studied FGR species, some populations with unique set of private alleles have been identified. If such populations continue to deteriorate, the rare alleles contained in them would gradually be lost. Thus, such identified populations with unique alleles need utmost conservation attention by way of: (a) effective protection and *in situ* conservation of such populations; and (b) augmentation of small populations in such cases by reforestation and enrichment planting using their own germplasm to maintain their unique characteristics based on private alleles.

Two important genetic processes of natural populations viz., genetic differentiation and gene flow have been recognized, and these processes are inversely related but controlled by multitude of factors related to the species and geographical distribution range. Among five targeted species, moderate level of genetic differentiation and structuring were recorded in *Q. semecarpifolia* due to strong physical barriers imposed by the mountain ranges and river systems of western Himalayas leading to the emergence of two distinct gene pools (GHC- Greater

Himalayan Conservation, and MHC- Middle Himalayan Conservation gene pools) which need to be maintained as independent reservoirs of alleles to conserve the genetic diversity captured within them in the long run. In the remaining four investigated species, sufficient gene flow has been maintained to counter the effect of genetic differentiation due to outcrossing and contiguous distribution range over large geographical span.

Study detected significant genetic structuring in the populations of *Q. semecarpifolia*, *B. utilis*, and *R. arboreum*, and therefore, conserving any random population of these species within the State will not serve the conservation purpose. Thus, seed or planting material must be collected



Dendrogram, PCoA Plot, IDW Interpolation of Membership Coefficient Values of sampled populations and Corresponding Bar Diagram in *Quercus semecarpifolia*

from diverse populations identified in each genetic cluster for the establishment of *in situ* FGCUs, as well as *ex situ* Field Gene Banks (FGBs). Further, in case of three high altitude species (*B. utilis*, *Q. semecarpifolia*, and *T. wallichiana*), the populations present in Pithoragarh FD, particularly Darma Valley and Narayan Ashram in Dharchula forest range emerged as the most important reservoirs of allelic diversity and need to be considered at top priority in conservation programs.

4.4.3.3. Pathological Characterization

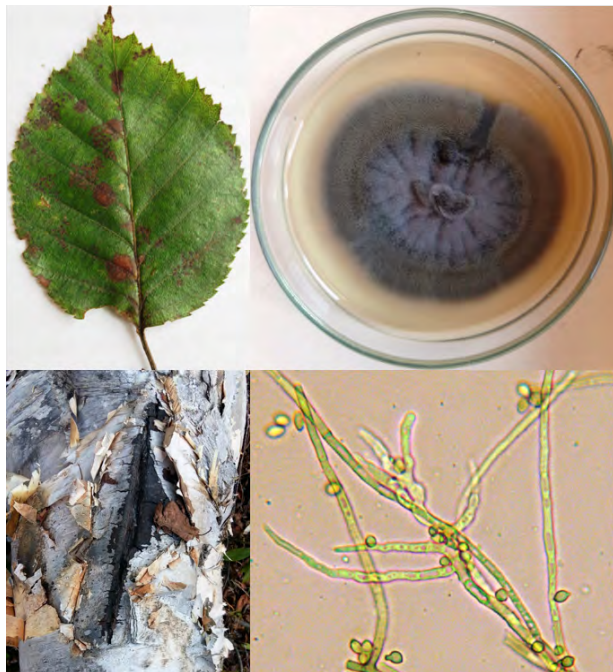
Study on pathological characterization yielded valuable baseline information on the association of different fungal species with respect to five targeted FGR species. Amongst sampled populations, eleven populations for *R. arboreum*; ten populations for *Q. semecarpifolia*; nine populations for *T. wallichiana*; twelve populations for *M. esculenta*; and five populations for *B. utilis* were found healthy and superior for *in situ* conservation.

Alternaria spp., *Fusarium* sp., and *Nigrospora sphaerica* were recorded for maximum number of times causing foliar diseases with disease intensity of upto 45 per cent, followed by *Phomopsis* sp., *Pestalotiopsis* and *Curvularia* spp. on the tree species. These foliar pathogens tend to be deeply influenced by weather, and their sporulation and infection are affected by change in climatic conditions as they often occur within a narrow range of temperature and their spore release usually coincide with periods of



precipitation and regions of wet winters. *Ganoderma* spp. (*G. applanatum* and *G. lucidum*) were also found frequently causing heart and root rot, thus leading to death of the trees.

The future disease surveys and a comparison with the baseline information generated through the present study will help in providing a valuable insight regarding the spread of the existing diseases or incidences of newer health problems of five studied tree species.



Foliar Problems and Mechanical Injury in *Betula utilis*, Morphological and Microscopic Characteristics of Isolated Fungal Species *Cladosporium fusiforme*

4.4.4. FGR Conservation

Forests harbour a wide range of native, non-native, and naturalized forms of tree species, which have adapted in different ways to their growing environments. Forests and associated biodiversity are under intense stress, and due to this, several FGR species persist as small, semi-natural, and fragmented populations. Efforts are underway to reverse the effect of forest degradation through reforestation, afforestation, and even plantations outside forests, and to cater the growing demand for wood, fuelwood, and a wide array of Non-Timber Forest Products (NTFPs). Broadly, dynamic *in situ* and static *ex situ* approaches are in practice for the conservation of biodiversity including FGR. Most governments and local communities have launched a variety of programs for the conservation of natural and semi-natural forests. In addition, forest remnants/ planted forests in the human modified rural landscapes dominated by agricultural crops have been recognized as an important element of *circa situm* conservation as these remnants/ planted trees are not only repository of biodiversity but also offer enormous values (as habitats, pollination, seed dispersal and germination, subsistence, livelihood, and environmental amelioration) besides vital connectivity for PAs/ MFs, and

even FGR species. Varied forestry conservation practices, often require production of genetically improved starting material and propagation methods and thus, they are largely derived from high quality superior identified seed and plant sources.

The Component on FGR conservation specifically envisaged production of starting material of important tree species, standardization of propagation techniques of five prioritized tree species, establishment of FGCUs based on identification of genetic diversity hot spots, FGBs, development of an understanding on *circa situm* repositories and the role played by protected areas towards conservation of FGR.

4.4.4.1. Production of Starting Material and Standardization of Propagation Techniques

The forest tree species may be multiplied in the nursery using seeds, branch cuttings, root cuttings, or air layering. The plants thus raised may be planted in the field for carrying out afforestation, reforestation, enrichment planting, and for establishing gene banks or conservation areas. Private or community plantations may also be established using the plants. Differences in propagation success of a given species may vary with population being propagated, however, the variation is expected to be within a range of 10 to 15 per cent only. As a part of the Pilot Project, study on the standardization of propagation techniques through seed, branch cutting, and air layering in five priority tree species viz., *T. wallichiana*, *R. arboreum*, *M. esculenta*, *Cinnamomum tamala*, and *Diploknema butyracea* revealed varied levels of difficulty in propagation of the studied species.

The study recognized branch cutting as the best method for propagation of *T. wallichiana*, followed by air layering with success rate of 70-77 per cent and 35-40 per cent of plants, respectively. In case of *R. arboreum*, the best recommended method recognized was of air layering with 38-60 percent survival, while propagation through seeds and root cuttings resulted in 9-25 per cent and 7-27 per cent survival, respectively. Propagation by seeds in case of *M. esculenta* yielded relatively better performance than the branch cutting with corresponding values of 26-30 per cent and 10-13 per cent success rate, respectively. In case of *C. tamala*, propagation by seeds revealed 67-69 per cent survival, while the air layering method could ensure only 45-57 per cent success. Propagation by seeds as well as branch cuttings in case of *D. butyracea* emerged as the most preferred propagation methods as they showed 85-90 per cent and 55-60 per cent survival, respectively. In general, seeds can be easily employed in case of four targeted species except *T. wallichiana* besides above recommended vegetative propagation methods. Planting material from seeds is likely to have greater genetic diversity than that from vegetative propagation. Thus, as far as possible seeds may be preferred for establishing FGCUs and FGBs. The Pilot Project recommended that non-mist propagation chambers are cheaper than mist chambers, and they can be installed in places where it is not possible to install the conventional mist chambers due



to concerns of high cost. They are also effective in providing suitable environment for vegetative multiplication of tree species through cuttings, especially in case of dioecious trees of *T. wallichiana* as seeds of this species are not easily available.



Cuttings and rooting in *Taxus wallichiana*

4.4.4.2. Establishment of FGCU and FGBs

The characterization of five targeted tree species, particularly at the molecular level distinctly provided valuable insight on genetic diversity hotspots in each case based on their allelic richness and presence of rare alleles. Earlier, it has already been discussed the details on 28 genetic diversity hotspots and recommendations for the establishment of corresponding FGCU. The study has aptly highlighted that the concept of identification of hotspots based on genetic characteristics in the context of FGR species and their *in situ* conservation is new for India. However, for past decade or so, the European countries and EUFORGEN have been advocating for *in situ* conservation of genetic diversity hotspots and have been successful in implementing the establishment of a network of *in situ* gene conservation units. The UK Forestry Commission has not only provided the criteria for the establishment of field level gene conservation units but have also elaborated on the prescriptions to be followed for their management. Availing the benefit of this rich experience, the Pilot Project has recommended for the establishment of 28 FGCU and provided their broad-based management prescriptions. Similar details of six



Field Gene Bank of *Diploknema butyracea*

FGBs established in case of *R. arboreum*, *M. esculenta*, *T. wallichiana*, *D. butyracea*, *C. tamala*, and *Toona ciliata* in the State besides sources of seeds/ germplasm, type of design (RBD or ABD), spacing, and number of plants have also been provided in the concerned Chapter.

4.4.4.3. Circa Situm Conservation

The role of *circa situm* conservation, especially in human dominated forest and rural landscapes in India when such areas are experiencing varied challenges on account of enhanced biotic and developmental pressures is vital in conservation of threatened FGR. The preliminary pilot study in select 20 villages in Garhwal and Kumaon regions has amply revealed that as many as 19 FGR species are being conserved in *circa situm* repositories by local communities, and efforts are needed not only to develop a database on such forest remnants but awareness about the need of their conservation is required to be created besides replicating similar studies in much more representative villages/ landscapes across the altitudinal gradient.

4.4.4.4. Role of PAs in FGR Conservation

The State has a network of seventeen PAs including six National Parks, seven Wildlife Sanctuaries, and four Conservation Reserves besides a vast extent of Managed Forests across the altitudinal gradient and other conservation management areas set aside for conservation of biodiversity, especially charismatic, flagship, and RET species helping in the continuance of ecosystem services; maintenance of ecosystem; species and genetic diversity; and contribution to the sustainable development goals.

The concerned Chapter has provided an insight on phytosociological assessment in three PAs (Rajaji Tiger Reserve, Nandhaur WLS, and Mussoorie WLS) and how different forest type groups in these reserves are able to retain the diversity of FGR species. Three PAs were represented by five Forest Type Groups. Amongst them, the Tropical Moist Deciduous Forests and Tropical Dry Deciduous Forests were important in harbouring the wider diversity of FGR.

In addition, the potential ecogeographic mapping in the context of 50 prioritized FGR species also offered valuable information and insight with respect to the extent coverage of their distribution range within the PA network. Out of 50 FGR species, ecogeographic mapping based on the MaxEnt Modeling using long-term database on bioclimatic variables besides presence data on the species was carried out, while in case of remaining thirteen species, localized ecogeographic mapping was possible due to their scant distribution and small population size. Out of 37 species, only 35 FGR species showed potential ecogeographic distribution in PAs. The values of estimated ecogeographic distribution area in case of 35 species ranged from as low as 2.10 km² to 283.59 km² in case of *Diploknema butyracea* and *Betula utilis*, respectively. Two species viz., *Olea europaea* and *Premna mollissima* have shown no



predictive distribution within PAs. Amongst five prioritized FGR species selected for characterization, *M. esculenta* with 0.75 per cent representation within PAs registered the lowest value, while *B. utilis* obtained the highest value of 92.93 per cent. Remaining three species viz., *Q. semecarpifolia*, *T. wallichiana*, and *R. arboreum* obtained values of ecogeographic distribution within PAs viz., 21.99%, 27.67%, and 14.9%, respectively. In case of 13 FGR species, the estimated localized ecogeographic distribution revealed that as many as six species have not shown any estimated distribution within PAs. Species like *Boswellia serrata* has bulk (99.75 per cent) of its ecogeographic distribution within PAs, while species like *Madhuca longifolia* having enormous socioeconomic importance registered a lower extent of just 29.75 per cent.

The predictive ecogeographic mapping in case of prioritized FGR species amply reflected that several FGR species have their substantial distribution outside PAs, mainly in managed forests or even *circa situm* conservation repositories in rural/ agricultural landscapes. Hence, it is essential that PAs, MFs and other conservation areas are considered together as interdependent entities in a wider landscape. The Ecosystem Based Forest Management (EBFM) or landscape approach to conservation is more relevant in the case of Himalayan State.

4.4.5. Creation of FGR Database

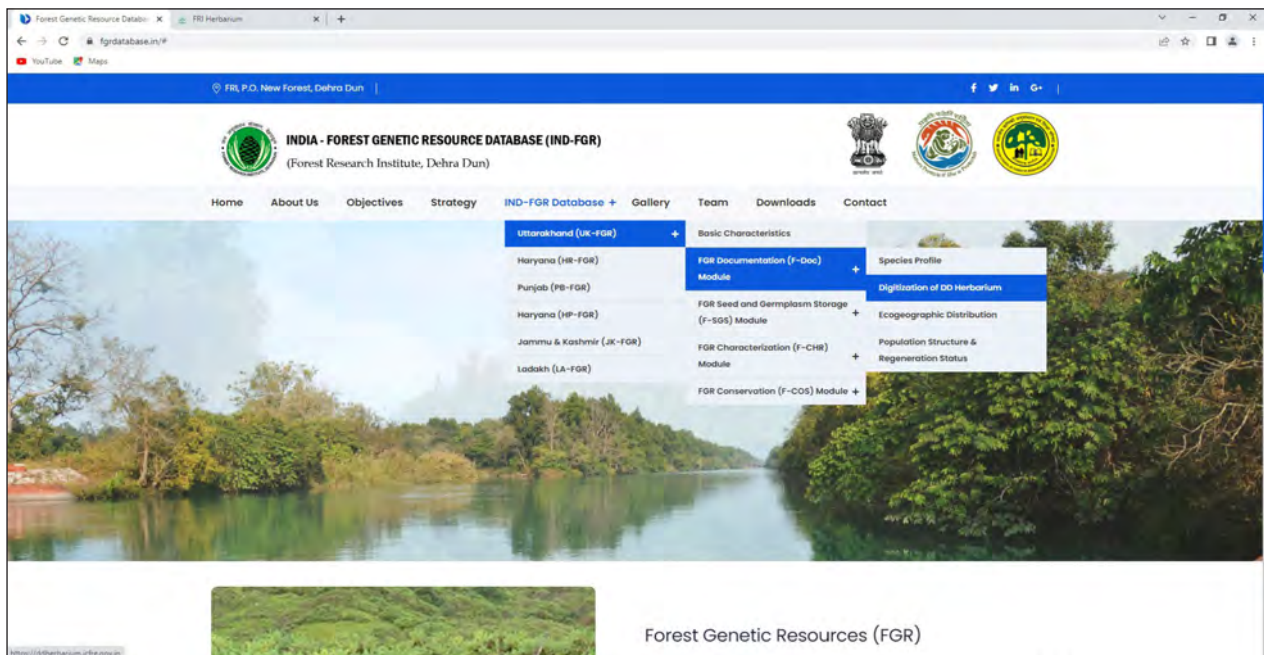
In addition to the above described four Components, their sub-components and specific tasks, the Pilot Project also envisaged the creation of FGR database incorporating varied baseline information generated through the present efforts on different aspects of conservation of FGR. The project has been successful in accomplishing this important task specific to Uttarakhand, as a pioneer effort, ultimately giving the shape for the development of

FGR database in the context of country (IND-FGR) by incorporating similar information on FGR species from other States/ UTs in time to come. The present efforts towards the development of UK-FGR database would certainly provide the direction to other States and serve as comprehensive platform for wider dissemination of much desired information on FGR. The structure of UK-FGR database includes four Project Components as Modules (FGR-DOC, FGR-SGS, FGR-CHR, and FGR-COS) and respective sub-components as sub-modules besides specific activities. The UK-FGR is also linked to digitized DD Herbarium. Like any other advanced web portal-based database, UK-FGR is simple and user friendly, and offers a wide range of opportunities for different clients - policy and decision makers, field practitioners, scientists, etc. by way of species-specific query and report generation. Presently, the newly created State specific database is in testing and validation phase, and as much as possible information generated through the Pilot Project is being incorporated to make it more effective and efficient. This database is expected to play a vital role in facilitating the varied functions of the CoE-FGR.

4.5. Experiences and Future Prospects

The project was first of its own kind in the long standing of FRI or even in the context of Indian forestry wherein a comprehensive multidiscipline, multiscale, multitechnique, and multistakeholder approach was adopted on FGR in the vast Himalayan State of Uttarakhand. Some of the important learnings and emerging newer requirements are highlighted below:

Knowledge of the Species and Value of a Systematic Approach: The project has successfully made a beginning to explore the diversity of FGR species, and generation of wider field knowledge through documentation of information on their distribution,



UK-FGR Database Report Generation



population structure, regeneration status, seed biology and storage behaviour, propagation techniques, characterization specific to biochemical, molecular, and pathological attributes, and conservation strategies. Present contribution is minuscule, considering the overall plant diversity including FGR species. This vital information remains unknown or poorly understood for majority of the FGR species. This situation demands resolute support for attending lesser-known species as well as threatened species on a priority and generation of much desired information on them. Waiting for elusive research information generated through protracted and cumbersome process may not be helpful in view of the unprecedented loss of forest biodiversity at a faster pace. Instead, a concurrent systematic approach to conservation based on robust principles also needs to be considered. A systematic approach requires an initial phase where priorities are discussed based on the known and anticipated threats on the FGR including climate change. It would be worth to consider the 'Forest Tree Genetic Risk Assessment System', a tool for conservation decision making in changing times and apply for robust, objective and evidence-based criteria for prioritization of FGR species. It also involves evaluating the different existing options to develop an effective conservation and use strategy. Potential conservation populations will have to be identified, surveyed, and conservation efforts implemented in a systematic approach in the field. Such an approach may need some adjustments in institutional structures and even necessary involvement of local people to facilitate effective conservation. The National Program on FGR has already envisaged concurrent research on across different States/ UTs involving nine leading forestry research institutes under the umbrella of ICFRE besides development of FGR database and CoE-FGR. Surely, these ongoing activities would provide desired momentum and strengthen efforts for conservation of FGR.

Strengthening Systematic Forest Botany and Adequacy of Field Sampling: The Pilot Project in the context of Uttarakhand was in an advantageous situation as it could avail optimum benefit of experienced and well-known forest botanists, taxonomists, DD Herbarium, arboretum, the National Forest Library, and Forest/Wildlife Plans. The role of forest botany, taxonomy and experts having field information on distribution, threats, and uses of FGR cannot be undermined while considering any action towards their conservation. There is an urgency to appreciate that this valuable science (forest botany, taxonomy) is on decline, it needs strengthening and to promote the concept of para taxonomists for wider coverage and to facilitate adequate field level assessments, especially on abundance and distribution. The project enabled digitization of nearly one-third specimens of the DD Herbarium. Continued efforts and support are needed to complete the task of digitization of remaining two-third specimens. Presently, the herbarium has distributed specimens across broad ten geographic regions spelt out during the British regime, much prior to the independence of the country. There is a felt need

to appropriately incorporate names of State/ UTs in digitized database so distribution of plant specimens collected from the territory of independent India could be digitally segregated at ease. Stratification and adequate field sampling are must, specifically in the case of assessments on population structure and regeneration status. Future efforts on documentation need to carefully look into aspects of appropriate stratification and adequate sampling so as to generate precise information on distribution and regeneration status in different forest sub-types.

Development of Guidelines and Protocols: In the process of execution of Pilot Project, different scientific Divisions and multidisciplinary teams developed protocols relevant to field methods, laboratory investigations, and procedures for integrating them. There is a felt need to document these protocols and relevant guidelines for wider use among nine ICFRE institutions involved in similar efforts on FGR in other States to ensure uniformity in datasets to be ultimately incorporated in the National Database on FGR.

Collaboration and Partnership: Contributions towards the Pilot Project were predominantly made by the varied scientific teams of FRI. The State Forest Department through Working Plans and Management Plans generate enormous information on forest species especially on the distribution, uses, and regeneration status. There is an urgent need to optimally utilize such information generated by State Forest Departments (SFDs) to strengthen and augment current efforts towards FGR conservation and develop State specific databases. Active involvement and partnership of SFDs and other stakeholders in improving the availability of, and access to information on FGR, and their documentation and conservation is of utmost importance and cannot be overemphasized. In addition, collaboration and networking with other national and international organizations would also be desirable to establish linkages with other databases and mutual sharing.

Integrated Approach and *In Situ* Conservation of Multiple Species: Efforts need to be made to identify genetic diversity hotspots for multiple species at a given field site as in the present case some specific sites/ FDs have emerged as the concentration zones harbouring genetic diversity hot spots of multiple species. Moreover, there is a need to identify superior populations in each case based on comprehensive characterization involving biochemical, molecular, and pathological aspects in lieu of isolated efforts.

Complementarity of Conservation Methods: Existing approaches primarily focus on the conservation of genetic resources in their natural habitats. *In situ* conservation is only a technical option in a broader approach to conservation of the diversity between and within species. Moreover, conserving forest trees *in situ* may be the only method that is ecologically, socially, and economically possible. Hence, a combination of approaches including Protected Areas, Managed Forests, *circa situm* repositories, agro-wood



lots, clone banks, plantations and breeding programs may be better suited in a framework of landscape approach to conservation and multiple objectives of forestry. The landscape approach to conservation would facilitate dynamic multispecies conservation besides ecological and evolutionary processes.

Long Term Monitoring: The Pilot Project has generated enormous valuable baseline information relevant to field level parameters as well as analytical attributes based on multifarious laboratory investigations. Since similar

efforts are being made in other States as a part of the National Program, voluminous information on varied aspects of FGR is likely to be generated which need to be incorporated and integrated in the national level FGR database. However, there is an urgent need to plan for periodic monitoring of prioritized FGR species for comparison with the baseline information generated through the Pilot project. Such monitoring effort would timely provide an insight on changes in FGR, especially on account of developmental activities and climate change.



ENHANCED CAPACITY BUILDING OF STAKEHOLDERS AND STATE GOVERNMENTS ON FOREST LANDSCAPE RESTORATION AND REPORTING MECHANISM ON BONN CHALLENGE

International Union for Conservation of Nature (IUCN)

Background

In 2017, the Government of India and IUCN organised a South Asia regional consultation on forest landscape restoration (FLR) in New Delhi, which was attended by eighty-five delegates from India, Nepal, Bhutan, Sri Lanka and Bangladesh. The need for a holistic country-level focus on forest landscape restoration was one of the recommendations from the regional consultation.

To take this recommendation forward, MoEFCC in collaboration with IUCN launched a project. On 17 June 2019 Shri Prakash Javadekar, the Hon'ble Minister for Environment, Forest and Climate Change, India launched a flagship project on World Day to Combat Desertification at Vigyan Bhawan, New Delhi, to build capacity on forest landscape restoration (FLR) and Bonn Challenge in partnership with IUCN.

At the UNFCCC Conference of the Parties (COP) 2015 in Paris, India joined the voluntary Bonn Challenge pledge, to bring into restoration 13 million hectares of degraded and deforested land by the year 2020, and an additional 8 million hectares by 2030. India's pledge is one of the largest pledges from Asia. In the COP 14 of United Nations Convention to Combat Desertification (UNCCD) held in India, Hon'ble Prime Minister has

announced that India will raise its ambition of total degraded areas that will be restored from 21 mha to 26 mha by 2030.

Overview of the Project

A project on “**Enhanced Capacity Building of Stakeholders and State Governments on Forest Landscape Restoration and Reporting Mechanism on Bonn Challenge**” was been awarded to IUCN by MoEFCC; NAEB is the nodal division for the project, supported by National CAMPA.

The objectives of the project are:

- Collation of data from all the States and UTs of India to aid in the reporting of India's achievement towards Bonn Challenge commitment.
- To provide support and develop capacities in the identification, prioritization and monitoring of landscapes for forest landscape restoration (FLR) using the ROAM methodology and building capacities on the same, in five identified pilot states (Haryana, Madhya Pradesh, Maharashtra, Nagaland and Karnataka). These would be scaled up across the country through subsequent phases of the project.
- Capacity building of all the Indian States on FLR and Bonn Challenge and in their reporting requirements.





- Jointly work with MoEFCC in the preparation of India's second progress report on Bonn Challenge.
- With the Government of India, organize the second chapter of the South Asia regional consultation on FLR and Bonn Challenge in India and create a platform for best practices on FLR from the region.

The total budget of 5.9 Crore INR has been sanctioned

Progress in the Project

Objective 1: Collation of data from all the States and UTs of India to aid in the reporting of India's achievement towards Bonn Challenge commitment

First Round of Data Collation

All the states and Union territories nominated their nodal officers. Various meetings were held with the nodal officials from State Forest departments to apprise the nodal officers about IUCN-MoEFCC project on Bonn Challenge and also to build their understanding and capacities on the methodologies and reporting mechanism related to the project.

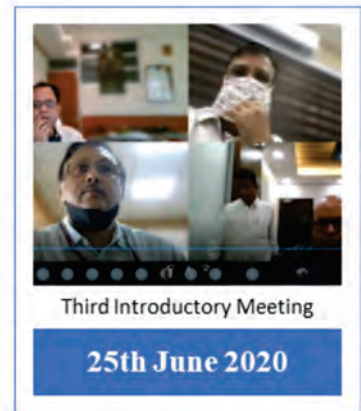
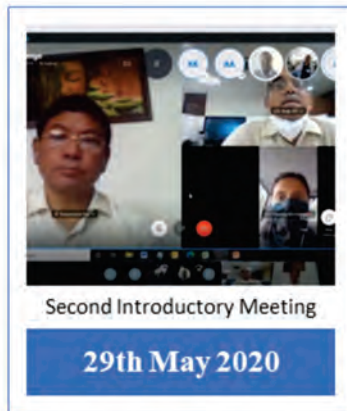
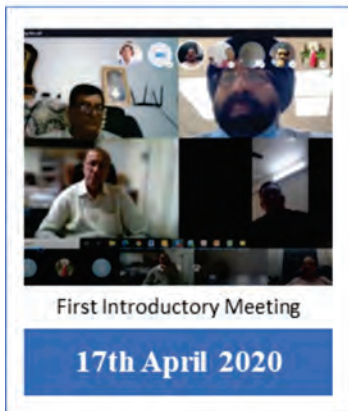
Post these Introductory meetings, the google drive link was prepared for all States and UT's that enabled us to collaborate effectively in real time. The barometer template (excel sheet) were uploaded in all drives and links were shared with respective states and UT's.

Multiple meetings were then held (and are being held currently also) with all the Individual state nodal officers and their team members to explain them about the barometer, excel sheet requirements and assisted in filling the excel sheet.

Second Round of Data Collation

IUCN team is carrying out the Second Round of data collation by visiting every State & Union territory. This is being carried out to capture the following:

- To acquire the restoration related data for the year 2020
- The data that was collated from the State Forest department was a cumulative data. As suggested by IGF NAEB, second round of visit was also carried out to segregate the data for the years 2011-2020 under the FLR types – Planted forest and woodlots, Natural



Meetings with Nodal officers on sensitization of different components of implementing, monitoring and reporting country-specific Bonn Challenge pledges



Meghalaya Forest Department



Chandigarh Forest Department



Gujarat Forest Department



Andhra Pradesh Forest Department



Madhya Pradesh Forest Department



Assam Forest Department



Rajasthan Forest Department



Uttarakhand Forest Department



regeneration, Silviculture, Agroforestry, Improved fallow, Mangrove restoration, Watershed protection and erosion Control.

- To integrate additional data on village relocation from Protected Areas and the resultant restoration in that area, silvi-pastoral, village greening, invasive species removal, grassland management, fire management practices, felling coupe restoration, reclamation of mined land.

To finalize the data sheet and get the sign off from the forest department on the same.

Objective 2- To provide support and develop capacities in the identification, prioritization and monitoring of landscapes for forest landscape restoration (FLR) using the Restoration Opportunities Assessment Methodology (ROAM) methodology and building capacities on the same, in five identified pilot states (Haryana, Madhya Pradesh, Maharashtra, Nagaland and Karnataka).

The Restoration Opportunities Assessment Methodology (ROAM) - an approach that was developed by IUCN and the World Resources Institute (WRI) represents a good first step on the path to restoring degraded and deforested lands. ROAM provides a flexible and affordable framework to rapidly identify and analyze forest landscape restoration (FLR) potential and locate specific areas of opportunity at a national or sub-national level. It provides vital support to move forward with developing restoration programmes and landscape-level strategies. As an iterative and stakeholder-driven approach, ROAM defines how FLR can contribute to social, economic, and ecological goals, providing vital support to countries seeking to implement or accelerate landscape restoration programmes and strategies. ROAM supports decision-making on the relevance and feasibility of potential interventions across the assessment area, identifying priority areas for these interventions, quantifying cost and benefits, analysing finance and investment options, and provides guidance on assessing restoration readiness and addressing major policy and institutional bottlenecks.

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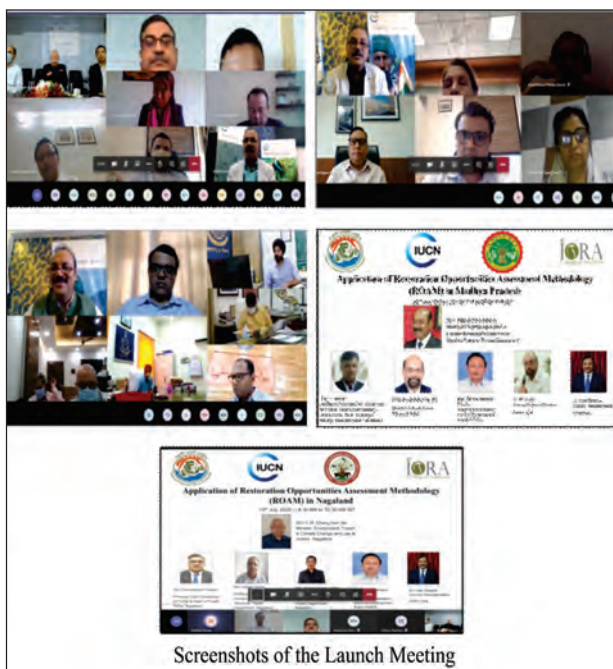
16.1.2 Phases of ROAM Project

The entire project is divided in three phases, the first phase being the Planning and Preparation Phase includes (i) Desk Review - to understand the circumstances of the state (ii) Stakeholder Mapping – to identify the relevant players, their influence and interests in the project, along with their responsibilities and the roles they will play for its successful implementation (iii) Inception Workshops – to introduce the project to relevant stakeholders of the State Departments, and build their interest and involvement from the initial stages of the project (iv) Mapping Drivers of Degradation understand extent and possible drivers

of desertification and land degradation across the five states, through land use land cover mapping and expert knowledge (v) Identify Potential FLR Options to comprehend global best practices and their adaptability to the local context and (vi) Defining Assessment Criteria and Indicators – to help in outlining the need for FLR interventions and the availability of land for them, along with the type and potential of different FLR interventions and their cost-benefit analysis.

The second phase of the project – Data Collection & Analysis, includes collation of appropriate datasets from relevant stakeholders through questionnaires, workshops and one-to-one interactions, ensuring that local knowledge is included in the assessment. FLR Intervention Analysis is carried out at this stage to identify the feasibility of implementing the potential FLR interventions in the landscapes thorough the cost benefit analysis for each intervention scheme and also to run diagnostic for the presence of key success factors. This state also involves identifying the sources of finance for a smooth implementation of interventions, and also to identify the disbursement channel and weigh different investment options.

The last and the final stage of the project is Results to Recommendations that includes Validation Workshops to present the recommendations and allow for a discussion with key high-level stakeholders and experts to critically assess the feasibility of the recommendations.



ROAM Launch workshops	State	Date
	Haryana	7 th July, 2020
	Nagaland	10 th July, 2020
	Maharashtra	20 th July, 2020
	Madhya Pradesh	23 th July, 2020
	Karnataka	12 th August, 2020

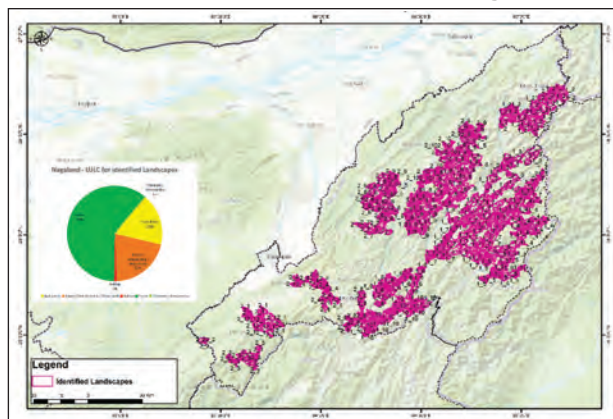


Table 2: Status Update on the ROAM Project

Milestones	Maharashtra	Madhya Pradesh	Karnataka	Nagaland	Haryana
Desk Review	Completed	Completed	Completed	Completed	Completed
Stakeholder Mapping	Completed	Completed	Completed	Completed	Completed
Inception Workshop	Completed	Completed	Completed	Completed	Completed
Questionnaire for Stakeholder	Completed	Completed	Completed	Completed	Completed
Drivers of Degradation Report	Completed	Completed	Completed	Completed	Completed
FLR Intervention Report	Completed	Completed	Completed	Completed	Completed
Stakeholder Mapping Report	Completed	Completed	Completed	Completed	Completed
Criteria and Indicator Report	Completed	Completed	Completed	Completed	Completed
Spatial Data Analysis	Completed	Completed	Completed	Completed	Completed
Stakeholder Workshop	Completed	Completed	Completed	Completed	Completed
Feasible Restoration Opportunity Mapping	Completed	Completed	Completed	Completed	Completed
Cost Benefit Analysis	Completed	Completed	Completed	Completed	Completed
Carbon Sequestration Analysis	Completed	Completed	Completed	Completed	Completed
Technical Reports of Spatial Analysis	Completed	Completed	Completed	Completed	Completed
Final Validation Workshop	Completed	Completed	Completed	Completed	Completed

Prioritized Landscape

Nagaland Prioritized Landscape



Total degraded area 8,28,943 ha, - 50% of total geographic area

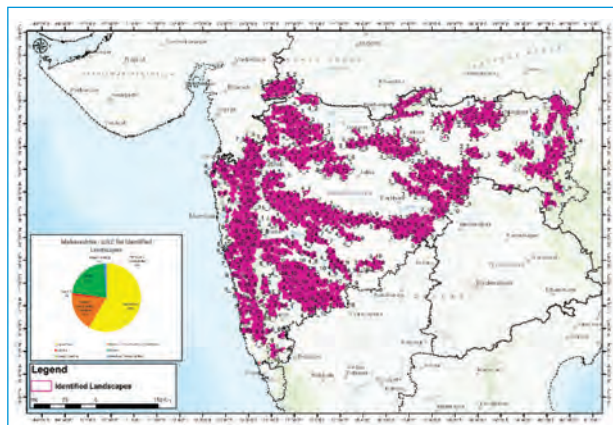
Total area prioritised : 3,65,080 ha - 44% of total degraded area

District with highest area prioritised:

Tuensang

- Major dod: Vegetation Degradation (49.45%), & human settlements (0.55%)
- Landslides a major concern, particularly in southern districts
- Jhum: 6-7 year in south and 8-10 year in north
- Community forest conservation efforts ongoing across northern villages

Maharashtra Prioritized Landscape



Total degraded area 1,43,00,000 ha - 46.49 % of total geographic area

Total area prioritised 74,08,973.34 ha - 51.8% of total degraded area

District with highest area prioritised: **Nashik**

- Major dod: Water Erosion (11%), Vegetation Degradation (9.1%) & Wind Erosion (5.5%)
- Detailed study of mining areas needed
- Other major degradation drivers identified: industrialisation/urbanization, fly ash waste and monoculture of oranges & sugarcane
- ongoing across northern villages



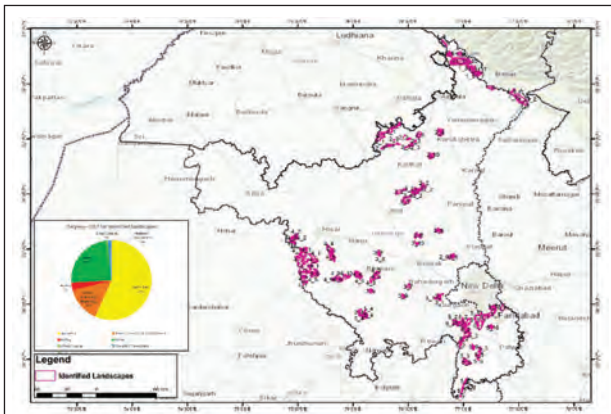
16.1.3 ROAM Launch /Inception Meetings

IUCN organized web Launch Workshop on Restoration Opportunity Assessment Methodology (ROAM) with Five State Forest Department. The goal of the Launch meeting is to sensitize key stakeholders from the forest department and other line departments on the objective of the project, identify nodal officers from various departments, discuss institutional arrangements to facilitate smoother information sharing and consultations and identify high level priority restoration opportunities in the state.

Designing Pilots on FLR

- i. Development of Detailed Project Reports (DPR) and initiating entry point activities on the implementation of FLR in one selected site in each of the five states
- ii. Sites to be selected based on recommendations made in the state-wise ROAM reports in consultation with the SFDs
- iii. Work to be undertaken from Sept 2022 - Jan 2023

Haryana- Prioritized Landscapes

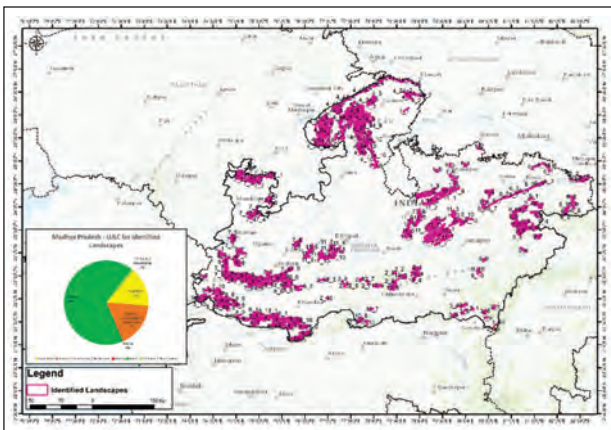


Total degraded area 3,64,154 ha - 8.24% of total geographic area
 Total area prioritised 1,44,724.27 ha - 40% of total degraded area

District with highest area prioritised: Bhiwani

- Major drivers of degradation: Wind Erosion (3.42%) & Vegetation Degradation (1.00%)
- Unsustainable agriculture practices a major concern
- State agriculture schemes could be leveraged to promote land restoration
- ongoing across northern villages

Madhya Pradesh - Prioritized Landscapes



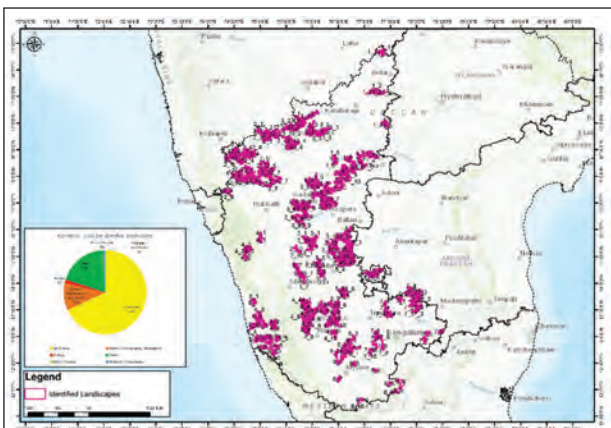
Total degraded area 38,50,000 ha - 12.52% of total geographic area
 Total area prioritised 23,20,301.80 ha - 60% of total degraded area

District with highest area prioritised: Sheopur

- Major dod: Vegetation Degradation (8.23%), & Water Erosion (3.66%)
- Soil severely degraded
- Change in cropping pattern one of the major reasons for loss of soil fertility
- Previous schemes for restoration of gully ravines have been unsuccessful

Karnataka - Prioritized Landscapes

Designing Pilots on FLR



Total degraded area 69,60,000 ha - 36% of total geographic area
 Total area prioritised 17,75,664.23 ha - 19% of total |degraded area

District with highest area prioritised: Belgavi

- Major dod: Water Erosion (26.13%), & Vegetation Degradation (8.85%)
- Need identification of invasive species currently classified as green cover
- Other major degradation drivers identified: surface water contamination, decrease in GW levels, fuelwood extraction and over grazing
- Overuse of irrigation and lack of watershed management also becoming a concern



Objective 3- Capacity building of all the Indian States on FLR and Bonn Challenge and in their reporting requirements.

- i. Capacity building workshops are being planned in each of the 5 States
 - a. 2 days interactive training
 - b. 1 day field visit to the FLR site suggested by the respective State Forest Department
- ii. Participants to include from the State Forest Department, Agriculture Department, Watershed department, other line departments (In consultation with SFD)
- iii. Resource persons from IUCN Global FLR team, National Experts, State level Experts, Practitioners
- iv. Training handbook under preparation
- v. Modules on Fundamentals of FLR, ROAM, Spatial Analysis, Identifying and prioritizing FLR opportunities, Stakeholder engagement including private sector, Cost-Benefit Analysis & Financing, Monitoring and evaluation and Governance mechanism for implementation
- vi. Resource persons being identified
- vii. In process of seeking suitable dates from respective PCCFs of the five states on conducting the training workshops
- viii. Exposure visit for senior officials from the 5 states
- ix. Work to be undertaken from Aug-Dec 2022

Objective 4- Jointly work with MoEFCC in the preparation of India's second progress report on Bonn Challenge.

- i. Drafted - Table of content and introduction part of the report
- ii. Drafted - mapping of policies programmes and schemes at the national and sub-national level

- ii. Drafted - potential risk mapping of India - major land conflicts in India affecting FLR prepared
- iv. Drafted - the first part of calculation - to analyse the climate impact by the FLR

Objective 5- With the Government of India, organize the second chapter of the South Asia regional consultation on FLR and Bonn Challenge in India and create a platform for best practices on FLR from the region.

- i. Second Regional consultation will be org in hybrid mode, IUCN will work with ministry to work on agenda. As part of proceeding, best practices and case studies on FLR from different countries in the region will be brought together.
- ii. IUCN has collected around 28 case studies from India and will be now collecting it from different countries. We are now deciding on the structure of the regional consultation.
- iii. Second Regional consultation to be organized in the year 2023
- iv. Dates to be finalised in consultation with the MoEFCC
- v. Participants to include govt. representatives, CSOs, academia, private sector
- vi. Countries to be invited- India, Bhutan, Nepal, Sri Lanka and Bangladesh
- vii. Host Country: India

Financial overview as on 31th August, 2022:

S. No.	Particular	Amount (in INR)
A	Total project budget	5,90,00,000.00
B	Fund released	2,95,00,000.00
C	Expenditure	2,23,40,958.00
D	Balance	71,59,042.00



WILDLIFE INSTITUTE OF INDIA – CATEGORY 2 CENTRE (WII-C2C) FOR WORLD NATURAL HERITAGE MANAGEMENT AND TRAINING FOR ASIA AND THE PACIFIC REGION, UNDER THE AUSPICES OF UNESCO

Executing Agency: Wildlife Institute of India, Dehradun

Background

The Government of India first submitted to UNESCO in September, 2012, a “Request for Action” proposal for the establishment a Centre specializing in the field of Natural World Heritage at the Wildlife Institute of India, Dehradun, as a Category 2 Centre under the auspices of UNESCO. Based on a feasibility study and examination by the UNESCO Executive Board, the UNESCO General Conference accepted the recommendations on the proposal and decided vide 37C/Resolution 47 dated 19 November, 2013 for establishment of such a Centre in recognition of the significant role played by WII in natural heritage conservation.

The Agreement between Government of India and UNESCO for the establishment in Dehradun of a ‘Centre for World Natural Heritage Management and Training for Asia and the Pacific Region’ as a Category 2 Centre under the auspices of UNESCO, was formally signed on 02 September, 2015 by the Director General of Forests, Ministry of Environment, Forest and Climate Change, Government of India as counterpart to the signature by the Director General, UNESCO, Paris. The signing followed the approval of this Agreement by the Government of India’s Cabinet of Ministers, chaired by Hon’ble Prime Minister, Mr. Narendra Modi on 05 August, 2015.

The WII-C2C was made operational based on financial sanction by the Ad hoc CAMPA of an amount of Rs.18.66 crores for the period 2014-15 to 2018-19, followed by No-Cost Extension from 2019 to 2022 and 2022 to 2024.

Governance

The Centre is an integral part of the Wildlife Institute of India (WII) based in Dehradun. The WII is an autonomous institution of the Ministry of Environment & Forests (MoEFCC), Government of India under which functional autonomy is granted to the C2C. The Director, WII is *ex-officio* Head of the WII-C2C. The Centre is guided and supervised by the Governing Body of Wildlife Institute of India whose composition is amended to deal with all matters related to the functioning of the C2C and is composed of Members of the WII-Governing Body and other individual and institutional members related to World Heritage as per Agreement between UNESCO and Government of India. The Director General, UNESCO has designated the Director, World Heritage Centre, or nominee thereof, as representative on the Governing Body of WII-C2C. The primary resources of the Centre are derived from funds allocated by the National Compensatory Afforestation Fund Management and Planning Authority (National CAMPA) of the MoEFCC, Government of India.

Goals and Objectives

The WII-C2C’s mission is to strengthen implementation of the World Heritage Convention in Asia and the Pacific Region by building the capacity of all those professionals and bodies involved with Natural Heritage site inscription, protection, conservation and management in Asia and the Pacific region, through training, research, dissemination of information and network building. The overall objective is to focus on Natural Heritage conservation issues with the aim to:

- contribute to the strengthening of capacities in the management of Natural World Heritage in the region;
- contribute to achieving a more balanced representation of properties from Asia and the Pacific on the World Heritage List;
- raise awareness among the general public and the youth in particular of the importance of Natural World Heritage and the need to protect it; and
- foster international cooperation on Natural World Heritage initiatives

SUMMARY ACHIEVEMENTS (2014-2022)

Detailed annual progress reports are submitted to the National Authority and MoEFCC regularly. Summary of achievements of the project are given is provided as follows;

Capacity-building workshops and trainings

WII-C2C has organised 25 international capacity-building programmes with a cumulative participation of nearly 1440 participants from India and 33 countries on various World Heritage-related themes ranging from Disaster Risk Reduction to Open Standards for the Practice of Conservation, Ecosystem Services Partnership (ESP), Culture-Nature Journey, Enhancing Management Capacity of Coastal and Marine World Heritage Sites, World Heritage & Pandemics, Dialogues on Cultural Landscapes/Mixed/Transboundary World Heritage Sites, Application of Spatial Technology, World Heritage Global Strategy, Periodic Reporting for Asia-Pacific Region.

The Centre has organised 27 national workshops with 550 participants on World Heritage-related themes of conservation management, Rights-based Approach, World Heritage categories, Intangible Cultural Heritage, community awareness, Periodic Reporting of Natural/Mixed World Heritage Sites of India, etc. It has further conducted 15 training programmes with 435 participants on monitoring OUVs of natural sites, Open Standards for the Practice of Conservation, Management Effectiveness framework, Geospatial techniques, Teacher’s Training, etc.



Advisory Services

Based on its specialization in the field of Natural World Heritage, WII-C2C has offered advisory services to Central and State Governments of India on matters of practice and policy related to conservation and management of natural World Heritage Sites, State of Conservation Reporting, Periodic Reporting, Reactive Monitoring, response to World Heritage Committee decisions, State Party interventions at World Heritage Committee Sessions, World Heritage Conservation Outlook Assessments, response to Parliamentary Questions, etc.

World Heritage Nominations

WII-C2C has provided technical support to Government agencies through orientation on nomination process and procedures, inventorisation and prioritisation of potential sites, review and facilitation of Tentative List and Nomination Format documentation and submissions. The Centre was closely involved with the nomination and inscription of Khangchendzonga National Park as India's first Mixed World Heritage Site in 2016 and has facilitated Tentative List submissions of four sites during 2016 (KeibulLamjao National Park, Manipur), 2018 (Garo Hills Conservation Area, Meghalaya) and 2021 (Bhedaghat-Lametaghat Landscape and Satpura Tiger Reserve, Madhya Pradesh). Currently, WII-C2C has provided technical support for preparation of the nomination dossier of Garo Hills Conservation Area, Meghalaya.

Outreach and Awareness

WII-C2C has conducted a variety of outreach activities to raise awareness among the key stakeholders, of the importance of natural World Heritage and the need to protect it. This includes organisation of site-level awareness programmes, World Heritage Day celebrations and biodiversity-related commemorative events, photo-video documentation of sites, publication of Natural Heritage Bulletin and Anthology of Natural Heritage Sites, initiating a Visiting Fellow Programme, networking, collaborations and participating in World Heritage-related meetings and conferences.

Ongoing/Planned Activities during 2022-24

Key activities during the current phase for maintaining continuity and implementation of the WII-C2C mandate include the following:

Advisory Services

Advisory Support to Government of India as elected member to the UNESCO World Heritage Committee (Thematic Working Group Meetings, Nomination dossiers, State of Conservation reports Sites in World Heritage List 'in Danger'); Technical backstopping to State Governments for World Heritage Committee Decisions and Reporting on natural World Heritage Sites (Great Himalayan National Park Conservation Area, Keoladeo National Park, Manas Wildlife Sanctuary, Sundarbans National Park, Nanda Devi & Valley of Flowers, Khangchendzonga National Park, Kaziranga national

Park and Western Ghats); Responding to Parliamentary queries on Natural World Heritage Sites (Indian Sites - current, proposed and Tentative List); Coordination with Archaeological Survey of India (ASI), Ministry of Culture on World Heritage matters

Nomination Dossiers

Technical assistance for nomination dossier preparation of Garo Hills Conservation Area (Meghalaya), Bhedaghat-Lametaghat in Narmada Valley (Madhya Pradesh), Satpura Tiger Reserve (Madhya Pradesh), and other potential sites in Tentative List of World Heritage Sites in India.

Capacity Building Programmes

Consultative Workshop on raising the profile of World Heritage and role of WII-C2C; International Seminar on Natural World Heritage Sites: case studies and best practices; Regional Report and Action Plan for Periodic Reporting of World Heritage Sites in the Asia-Pacific Region; Training on Outstanding Universal Value (OUV) Analysis of World Heritage Sites in India; Orientation Programme on World Heritage Convention; Dialogue on Culture-Nature Journey in World Heritage Sites; Training Workshop on Climate Change and Geospatial Tools in Natural Heritage Conservation; Natural Heritage Site Managers Forum; Natural Heritage Compendium of Asia-Pacific; Multi-media documentation of natural heritage sites; Courses in Heritage Conservation and management

Outreach

WII-C2C will conduct activities to raise awareness among the general public, youth and relevant stakeholders, of the importance of natural World Heritage and the need to protect it. This will include awareness and orientation programmes on the occasion of the 50th Anniversary celebration of the World Heritage Convention in 2022; UN Calendar Days - World Heritage Day, Biological Diversity Day, Environment Day; Participation in Meetings/Side-events at Annual Session of the World Heritage Committee and UNESCO C2C Coordination Meetings; development of web portal and networking for the Asia-Pacific Region.

Way Ahead

WII-C2C is poised to play a significant role in the World Heritage domain in the forthcoming years both at the national as well as regional/international levels. India's election as member to the UNESCO World Heritage Committee, State Party interventions at World Heritage annual sessions, the World Heritage Convention's 50-years anniversary, World Heritage Periodic Reporting for the Asia and Pacific Region, World Heritage nomination, reporting, monitoring and conservation obligations for several current and potential World Heritage Sites of India, information repository on World Heritage, synergy between World heritage and other Biodiversity-related Conventions, networking and partnerships within India and the wider region will call



upon WII-C2C's core competence and specialisation in natural heritage matters for necessary advice, inputs and capacity-building.

WII-C2C envisages long-term sustainability as a regular scheme through Government of India core funding and additional resource mobilisation to enhance the quality and range of its activities and strive to emerge as a 'Centre of Excellence' and 'Policy Think-tank', with demonstrated competence in the field of Natural Heritage Conservation, and a scope of functioning that has a global footprint.

Financial Overview

Sl.No.	Particulars	Amount (Rs.)	Period
A	Total Project Budget	18,66,00,000.00	2013-14
B	Grant received	15,01,37,000.00	Till 31 March, 2022
C	Expenditure	11,86,62,864.00	Till 31 March, 2022
D	Balance (available with WII)	3,14,74,136.00	2022-23
E	Balance (due from National CAMPA)	3,64,63,000.00	2023-24

* No-Cost Extension approved by National Authority (CAMPA) for 2022-2024

Select Photographs of Activities



International Workshop on DRR



International Training on Geospatial Technology



Annual C2C Coordination Meeting



Celebrating World Heritage Site Inscription



Workshop on Coastal & Marine WHS



Ecosystem Services Partnership - Asia Conference



Culture-Nature Journey, ICOMOS General Assembly



Culture-Nature Symposium, Dehradun



UNESCO Sub-Regional Conference



World Heritage Day celebration

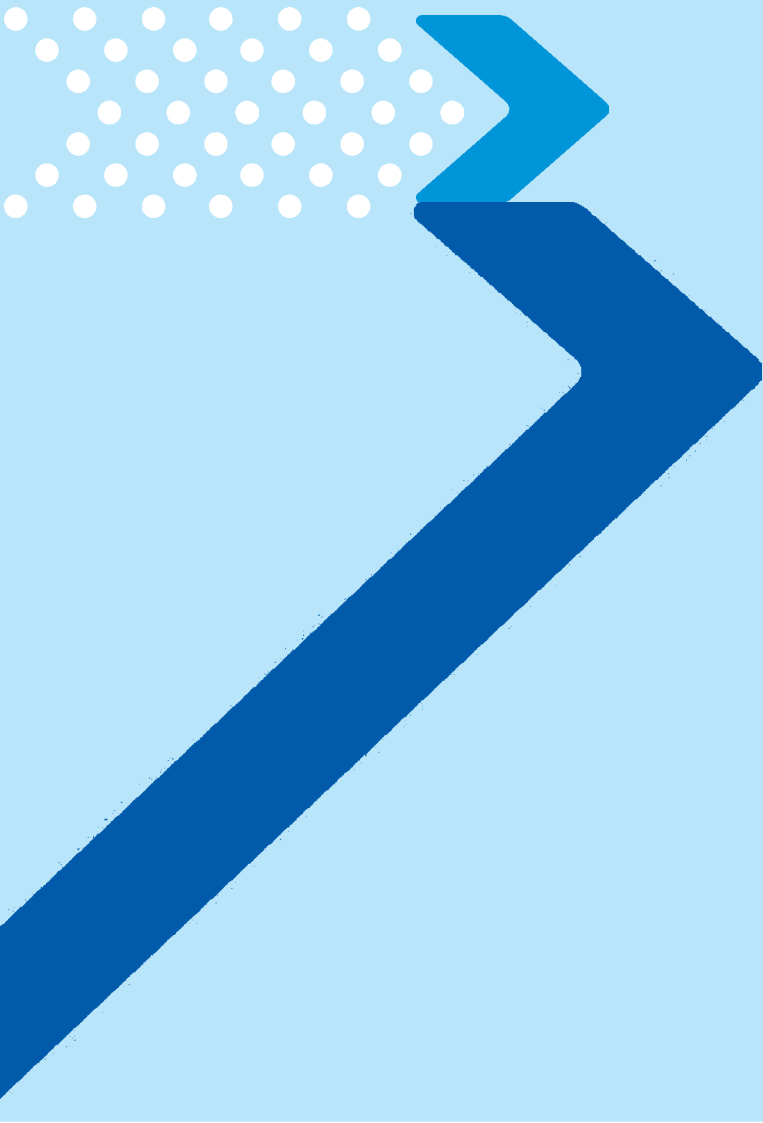


Training on Monitoring of OUVs



State Party India Delegation at World Heritage Committee Session

SPECIES
RECOVERY





ENDANGERED SPECIES RECOVERY PROGRAM (ESRP) CONSERVATION ACTION PLAN FOR MANIPUR'S BROW-ANTLERED DEER OR SANGAI: AN INTEGRATED APPROACH

Wildlife Institute of India, Dehradun

A. Background

The Manipur's brow-antlered deer (*Rucervus eldii eldii*) or Sangai is an endemic and endangered subspecies of Eld's deer. It was first described from the Manipur Valley in India in 1839 by Captain Guthrie, who termed it *Cervus frontalis*. This old-world deer was later discovered in fragmented populations across Southeast Asia in Myanmar, Thailand, Cambodia, China, Lao PDR, Viet Nam, and southern China. Traditional taxonomy divides Eld's deer into three subspecies, viz. Sangai or Manipur's brow-antlered deer (*Rucervus e. eldii*); Thamin or Myanmar brow-antlered deer (*R. e. thamin*); and Siamese brow-antlered deer (*R. e. siamensis*). A fourth subspecies (*R. e. hainanus*) is also proposed, which is endemic to Hainan's Island in south China (Decoux, 1993). Although *R. e. eldii* is closely related to *R. e. thamin*, it has significantly different ecology from other subspecies and is more divergent in morphology (Balakrishnan et al., 2003).

Once believed to be extinct, a small population of around 14 animals was rediscovered in the southeastern fringes of Loktak Lake in 1975. The southern part of Loktak Lake, a Ramsar site, harbours a unique congregation of thick floating meadows, locally called *Phumdis*, which constitutes the only floating National Park in the world, Keibul Lamjao National Park (KLNP). The Park holds the last remaining population of the globally endangered Manipur's brow-antlered deer (*Rucervus eldii eldii*, M'Clelland, 1842), locally known as 'Sangai'. To protect the dwindling number of Sangai, the area was notified as protected in 1965; reserved Forest in 1974, and finally as a National Park vide Notification No. 60/20/75- for dated 28-3-1977 under the Wild Life (Protection) Act, 1972 and marked the beginning of intensive conservation efforts (Ranjitsinh, 1975; Hussain et al., 2004). Since the establishment of KLNP, the Sangai population has started increasing, indicating a positive trend (Angom, 2012; Hussain and Badola, 2013).

The commissioning of the Loktak hydroelectric power project and construction of the Ithai barrage in 1983 has converted this largest freshwater lake in northeast India with fluctuating water levels into a man-manipulated reservoir with a more or less constant water level. The prime ecological alterations due to the Ithai Barrage include the change in the natural hydrological regime of the KLNP, severely affecting the whole ecosystem's health and compromising the survival of biodiversity. The inundation of peripheral land and consequential changes in land use and land cover patterns is modifying the catchment area and resulting in rapid conversion of viable habitats. Alteration in the natural hydrological regime of the Lake and KLNP has resulted in rapid thinning and disintegration of the *phumdis*. These floating

meadows used to settle down during the lean season and get replenished, now continuously floating and getting thinner and consequently becoming defunct in supporting the weight of the deer. The overall thickness of *phumdi* is decreasing at a rate of 9% per annum inside the Park, affecting the survival of Sangai in the imminent future (Tuboi et al., 2015). Another major issue further jeopardising the situation is increased inflow of nutrients and pollutants draining into Loktak Lake and deteriorating the water quality (Tuboi et al., 2016). The current status of Sangai in the wild and its deteriorating habitat, along with the cultural importance of this species, calls for an immediate conservation intervention taking into account both local livelihood and the endangered status of the species.

The Wildlife Institute of India conducted comprehensive scientific research on Sangai and its habitat under the project titled "*Conservation of Sangai and its wetland habitat*" and organised consultation workshops with different stakeholders of KLNP, collection of baseline scientific data on the population structure, genetic status, habitat conditions, socio-economic profile and dependence of the local communities on the Park through systematic surveys. A recovery plan for Sangai was prepared based on the identified factors affecting the long-term survival of Sangai in KLNP. Realising the need for immediate conservation efforts to reverse the declining trend of this endangered cervid, the Ministry of Environment, Forest and Climate Change (MoEFCC), Government of India, under its 'Endangered Species Recovery Plan' assigned WII to implement the project "*Conservation Action Plan for Manipur's Brow-antlered Deer or Sangai: An Integrated Approach*" with funding support from the Compensatory Afforestation Fund Management and Planning Authority (CAMPA) in association with the Manipur Forest Department (MFD) in the year 2016.

The project envisages strengthening the existing population of Sangai in KLNP by improving the habitat conditions and protection measures in collaboration with concerned stakeholders and minimising the impact of anthropogenic threats on the ecological diversity of KLNP. The project aims to actively involve the local communities in the conservation of Sangai through education and awareness programmes. Given the small, single and isolated nature of the Sangai population in KLNP, the project also aims to establish a 'second home' of Sangai in the wild within Manipur by implementing a conservation breeding programme. The project's outcomes will assist in securing a demographically and genetically sound population of Sangai in KLNP, a viable second population in its second home, and developing long-term community partners for species conservation.



B. Progress on conservation action for recovery of the Sangai population

The project was launched at WII, Dehradun, during the National launch workshop "Endangered Species Recovery Projects" on 16th May 2016. A memorandum of understanding (MoU) was signed with Manipur Forest Department in July 2016 for the implementation of the project, and field conservation activities were initiated to secure the existing population in KLNP. To strengthen the existing population of Sangai, WII started training for capacity building for the frontline staff of KLNP and local volunteers for effective implementation of the project. Subsequently, in collaboration with MFD, WII prepared an Integrated Management Plan of KLNP through a series of consultative meetings and workshops with the concerned stakeholders. The plan outlines the management strategies on various aspects of management inside the Park and sustainable management of its surrounding landscape to mitigate the existing conservation issues and maintain its ecological integrity to ensure the long-term survival of Sangai and associated species in the wild.

Owing to its single and isolated nature and the island-like geography of the Park, the existing population of Sangai in KLNP is highly susceptible to demographic and stochastic events. Establishing a second population in the wild is crucial to ensure the long-term survival of Sangai in the wild. Following this, five potential sites identified for establishing the second home were surveyed and Pumlen Pat and Thongam Mondum Reserve Forest were selected as the best sites in terms of ecological factors that share similar characteristic features with the KLNP. The State Board for Wildlife, in its 6th and 7th meetings, agreed to reintroduce Sangai through conservation breeding and declare the Pumlen Pat and Thongam Mondum Reserve Forest as Conservation Reserve. The board advised conducting stakeholder consultation at the proposed reintroduction site and forming a Conservation Reserve Committee involving the local people. Following these recommendations, MFD, in collaboration with WII, started a series of consultative meetings and trust-building activities at the proposed reintroduction site. Further state-level consultations were conducted involving concerned stakeholders.

Another major objective of the recovery programme is to initiate conservation breeding of Sangai to facilitate the establishment of a second population and secure this endangered species for further translocation programmes. For developing the founder population for reintroduction at the proposed site, WII prepared an 'Action Plan for Conservation Breeding of Sangai' in consultation with MFD and expert agencies, including the Smithsonian Conservation Biology Institute, USA and the National Institute of Animal Health, India. Following the standardised translocation methods, four Sangai individuals were successfully translocated to Manipur Zoological Garden, Iroisemba, from Conservation Breeding Centre at Langolin 2019 as a trial for translocation. WII has initiated the development of the Conservation Breeding Centre at KLNP in collaboration with the Manipur

Forest Department. Moreover, a Rescue-cum-rehabilitation centre has also been established adjacent to the Park for handling emergent situations and disease surveillance.

A larger constituency of support for Sangai conservation has been built through the engagement of local communities, NGOs, CSOs, and other concerned stakeholders, including Assam Rifles and Manipur Police, via different activities viz., conservation education and community outreach programs, consultative workshops, trust-building, and capacity development activities in KLNP and the reintroduction site. Continuous training of local women is being carried out on institution building, micro-financing, market linkages, and different livelihood options in the surrounding villages of KLNP. Currently, 12 active Self Help Groups (SHGs) comprising 150 women who earlier depended on the Park resources for their livelihoods. A souvenir shop has also been established at KLNP for marketing products of these SHGs and other local products.

Research and monitoring activities to gain an ecological understanding of the species and its habitat have continued since the Project's inception. Population estimation methods of Sangai and associated species in KLNP using advanced techniques, including drone surveys and thermal imaging, are being standardised to obtain reliable population estimates. In view of this, population estimation of Sangai and associated species have been standardised by WII using the point count method. The estimates derived by WII during 2006-2008 are being used as baseline data for deriving the Sangai population trend in the Park. Unmanned Aerial Vehicles (UAV) or drones equipped with multi-spectral imagery and thermal imaging systems are being standardised to serve as an alternative population estimation method.

Ecological surveys to assess the habitat conditions, including *phumdi* thickness, water levels, plant community structure and habitat use patterns of Sangai and associated species, have been conducted periodically since the inception of the project. As part of the animal health monitoring, regular vaccination camps, animal health check-up camps and awareness workshops on livestock diseases are being conducted in the surrounding villages of the Park. Genetic assessment of Sangai conducted by the WII showed low levels of genetic diversity in both the wild and captive populations (Angom et al., 2017; Ghazi et al., 2021). Assessment of physiological stress in captive and wild populations of Sangai is also being done using quantifying the Faecal Glucocorticoid Metabolites (FGM) concentrations. The preliminary evaluation revealed high levels of FGM in the wild compared to the captive populations. Information on genetics and stress physiology will aid in selecting suitable founder individuals for conservation breeding.

The socio-economic status and dependency of local communities on Park resources are being examined through household-level questionnaire surveys and regular monitoring of resource extraction at selected entry points in the surrounding villages of KLNP and the proposed



reintroduction site at Pumlen Pat. The results indicate that the overall socio-economic status of the communities is economically poor, and most households depend on these wetlands for their livelihood. The preliminary results showed an increasing trend in resource use over the last decade.

C. Limitations and challenges

The conservation of the unique ecosystem of KLNPN and its diverse biodiversity is a challenging and long-term process. The current rise in developmental activities is likely to conflict with other societal objectives. The compounding effects of the alteration of the natural hydrological cycle of



Loktak. Lake and accelerated change in the land-use land-cover patterns in the surrounding landscapes of Loktak Lake are imposing serious conservation apprehensions, with particular impacts on the Keibul Lamjao National Park. The existing conservation measures are largely directed at providing security to the species within the KLNP. A synergistic relationship between National Hydroelectric Power Corporation (NHPC) and other stakeholders, including MFD and Loktak Development Authority (LDA), to maintain appropriate water levels in KLNP is crucial for the ecological restoration of the Loktak Lake. Apprehensions among the local communities for their livelihoods and other societal concerns are hindering the establishment of the second home at the proposed reintroduction site in Pumlen. Moreover, the illegal encroachments and high dependency of local communities are adjourning the land acquisition process for developing the reintroduction site. Addressing these challenges requires a strong political will and active association among relevant stakeholders to find an amicable solution for maintaining this unique ecosystem's ecological integrity and conserving Manipur's pride.

Acknowledgements

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BUSTARD RECOVERY PROGRAM: *IN-SITU* AND *EX-SITU* CONSERVATION OF BUSTARDS IN INDIA

The Great Indian Bustard *Ardeotis nigriceps* (GIB) and the Lesser Florican *Sypheotides indicus* (LF) are two of the three resident species of bustards which are found in India. Populations of these iconic grassland species is undergoing a perilous decline. With an estimated global population of about 100-150 GIB and 1000 LF, these species are Critically Endangered (IUCN). A similar quandary is being experienced by their preferred habitat, grasslands. These ecosystems have dominated much of the country's geographical area and sustained its pastoral economy while supporting a unique set of wildlife adapted to arid conditions. However, they are yet to receive adequate conservation attention, as popular views hold them as 'human-created degraded forests' that resulted in colonial-era policies of managing them as wastelands despite scientific evidence demonstrating their provenance dating back more than a million year. The Ministry of Environment, Forest & Climate Change (MoEFCC), in consultation with experts and managers, developed the National Bustard Recovery Guidelines in 2013, to conserve these species as the flagship for grasslands. The guideline recommended:

- establishing and protecting enclosures to improve breeding success,
- mitigating threats in intensively used areas that are identified through research,
- factoring livelihood concerns into conservation plans by incentivizing compatible land-uses,
- conservation breeding for insurance and restocking of birds in future restored habitats.

The Wildlife Institute of India was mandated by the MoEFCC with the task of implementing conservation breeding and

guiding agencies on science-based *in-situ* measures, with funding support from the National CAMPA Authority. The Bustard Recovery Project commenced for an initial period of five years (2016-21) and an extension of two years (2021-23). The project activities are being implemented by WII in collaboration with the MoEFCC, bustard range state Forest Departments and NGO partners.

A. Objectives

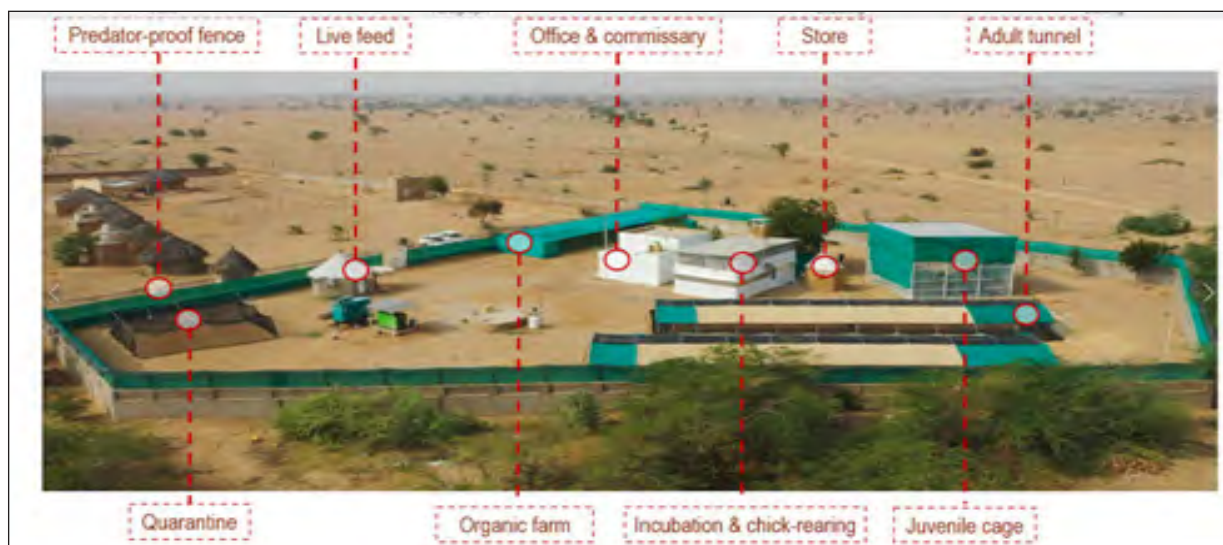
The objectives of the Bustard Recovery Program are:

- Conservation Breeding, to secure *ex situ* populations of GIB and (if needed) Lesser Florican
- Applied research, to a) prioritize areas for conservation, b) characterize threats, c) monitor populations and habitats for assessing management effectiveness, d) understand livelihood issues, and e) understand population genetics to inform conservation management
- Capacity building, awareness and advocacy, to a) improve protection, b) sensitize stakeholders and decision-makers on bustard conservation, c) raise public awareness, and d) incentivize bustard-friendly land uses
- Pilot habitat management, to demonstrate good practices through experimental interventions that can be replicated by State Forest Department and other conservation agencies

B. Activities

Conservation Breeding

The conservation breeding program is a joint initiative of the MoEFCC, Rajasthan Forest Department (RFD) and the WII. Optimal sites for conservation breeding centres (CBC) were selected based on multiple criteria, in consultation





with international experts, MoEFCC, CZA and RFD (July 2018). The selected sites were a) 2 km² enclosure in Ramdevra, Jaisalmer, and b) 6.8 km² area in Sorsan, Kota. A small pilot facility at Sam Forest Chowki near DNP was built for immediately commencing the conservation breeding activity. The conservation breeding program aims at securing an effective founder population of at least 20 birds (15 females) from wild collected, artificially hatched eggs and hand reared chicks. These birds will be bred in captivity, and captive-bred individuals from a later generation will be released into the wild after habitats are restored. Bustards are difficult to rear and breed in captivity due to their sensitive nature and specialized mating system. Hence, WII sought technical collaboration from the International Fund for Houbara Conservation (IFHC)- the world's leading experts on bustard conservation breeding. The IFHC has trained the project husbandry team at UAE and in India during 2017-2021.

During breeding season, GIB eggs are located by observing females from remote vantages and through telemetry. Once a nest is spotted, a team of technicians visits it and collects the egg in a disinfected, shock insulated, isothermal box, which is transported to the CBC in a very slow, soft-suspension vehicle. At the CBC, it is artificially incubated in incubators, where the ambient temperature and relative humidity can be controlled to mimic natural incubation conditions. The development of the egg is examined daily using IR thermometer, candler, ECG and weighing machines, and incubator parameters are dynamically regulated to facilitate egg development. Once the egg pips (breaks the shell), it is shifted to a hatcher for hatching. The freshly hatched chick is shifted to a brooder for the first 24 hours. These units are housed in a disinfected, air-conditioned intensive care room, to avoid infections.

A day later, chicks are shifted to the chick-rearing unit - a clean, air-conditioned room, where they are housed in transparent containers of about one square meter dimension. They are attended closely and hand-fed on a balanced diet of pellets, invertebrates, plant matter and *ad-libitum* water. They get imprinted on technicians, who will become their human mothers or 'keepers'. They are carried to a bigger cage daily, where they can run and fly, for skeletal and muscular growth. After 3-4 weeks, they are transferred to the juvenile unit - a well shaded outdoor predator-proof cage. Here, they acclimatize to the external environment, and continue to be hand-reared with efforts towards making them independent. After 3-5 months in the juvenile cage, birds are moved to the adult unit, a tunnel shaped predator-proof aviary with more space, moderate shade and vegetation for enrichment, where they grow into independent adults. The facility has stringent biosecurity protocol and is not accessible to general visitors, to avoid the risk of infection and stress to birds. Food for birds (insects and crops) are produced under hygienic conditions in the facility. Meticulous logs of individual birds are kept for documentation and research. Technicians monitor their growth, health and physiological parameters regularly, and provide routine husbandry and veterinary interventions. Through this process, the husbandry

protocol is being developed for these endangered birds. A wild GIB becomes sexually mature at 4 years. Since these founder birds have to be kept and bred in captivity, they are imprinted and habituated to keepers. Once the stock is large, viable, and reproducing, their offspring will be released in the wild. The release stock will be reared in a less imprinted approach.

This activity is ongoing since 2019 and has resulted in a captive founder stock of **25 birds** (16 individuals of 1-3 yrs age, 8 individuals of <6 months and 1 wild-rescued) from 31 wild-collected eggs between 2019-22 from DNP, Salkha and Pokhran regions of Jaisalmer, Rajasthan. These birds are housed in Sam facility (fully functional) and Ramdevra facility (partially operational), and are composed of 13 females, 5 males and 7 unsexed chicks. The impact of egg collection on the wild population was low, since majority of tagged birds re-laid after eggs were collected for conservation breeding and recruited chicks within the same season. Telemetry based research has shown that females can lay about four clutches in a year if eggs are predated/removed, and in years with abundant rains, double egg clutches are also common.

Lesser Florican

We collected eight LF eggs from Shokaliya and Bhinai in Ajmer, Rajasthan (2020-22) that were artificially incubated, hatched and chicks are being reared in a rental facility at Bijainagar following a similar approach as the GIB.

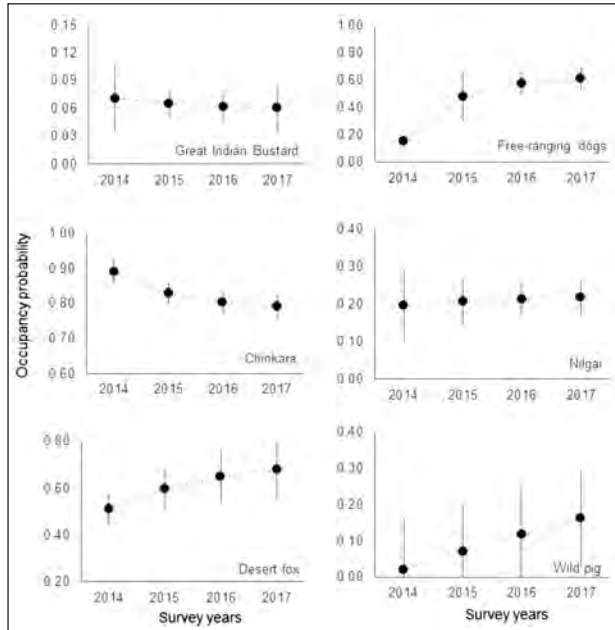
C. Applied Research

1. Population Status surveys

Conservation efforts require baseline information on the species and habitat status and to assess management effectiveness. We carried out large-scale status surveys for bustards to assess their distribution, numbers and the extant and quality of their habitats. We assessed the last remaining viable population of the GIB, found in Thar, Rajasthan that constitutes ~90% of its global population. A population monitoring protocol was developed using statistically robust techniques that was jointly implemented by the WII and RFD during March 2014-18. A small-scale repeat survey of the western Thar region was conducted in April, 2022. We assessed the global population of LF across its breeding range in Rajasthan, Gujarat, Madhya Pradesh, Maharashtra and Andhra Pradesh. A population monitoring protocol was developed and jointly implemented with NGO partners (BNHS, TCF, HYTICOS) and State Forest Departments during the breeding season (Jul - Sep 2017-18). In these surveys, bustard landscapes were systematically sampled from slow-moving vehicles to identify areas occupied by the species. Bird numbers in occupied areas were subsequently assessed through vehicle (GIB) or foot (LF) transects. Surveys were carried out by teams of field biologists, Forest guards and volunteers trained on the survey methods. Information on GIB or LF, associated fauna, habitat characteristics and anthropogenic pressures was recorded. Secondary information on species' occurrences were collected using rapid questionnaires. Data were analysed in Occupancy



(MacKenzie et al., 2006) and Distance Sampling framework (Thomas et al., 2010) to estimate the proportion of area occupied and population size.

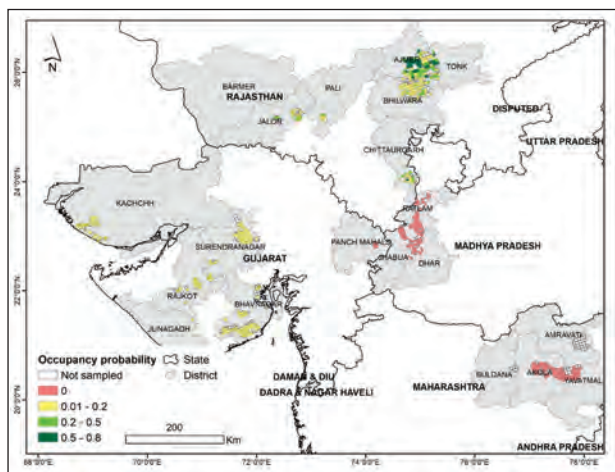


1. Great Indian Bustard

We sighted 37 individuals of GIB in Thar (2016 & 2017). The species occupied 7 (3 SE) % of sampled sites. Estimated population size was 128 (19 SE), distributed in two fragmented pockets - a) in/around DNP and b) Pokhran Field Firing Range (PFFR) and Ramdevra with intervening movements. Threat surveys showed expansion of human footprint (power-lines, water sources etc.) and a remarkable population expansion of free ranging dogs (4 to 23 per 100 km) over the survey years.

Lesser Florican

We sighted 70 individuals (2017). The species occupied 13 (3 SE) % of sampled sites. The estimated population size was 340 (162–597, 95% CI) territorial males that indicates an ~80% decline in their population since 2000. Assuming 2 females per male, the global population would be about 1000 individuals. The breeding population was



largely found in: Velavadar (Bhavnagar, Gujarat) and Shokaliya-Bhinai (Ajmer, Rajasthan), having about 100 territorial males each. Birds were dispersed over a large agricultural expanse at low density in Ajmer (~800 km²) and clustered at high density in a small grassland reserve in Bhavnagar (~100 km²). Thus, a contiguous grassland would achieve the same conservation outcome as a much larger agricultural area.

Telemetry

Telemetry based research was used to gather dynamic and high-resolution information regarding the species' utilisation of space and time in response to habitat, food and its environment. We captured birds on noose traps and fitted them with backpack solar GPRS PTTs using elastic harness. Tags transmitted GPS fixes and other information through cellular networks. Researchers additionally tracked them on ground to collect data on behaviour and habitat use. Bird locations were analysed against season and land-uses, to understand seasonal movements, habitat use and critical requirements of the species.

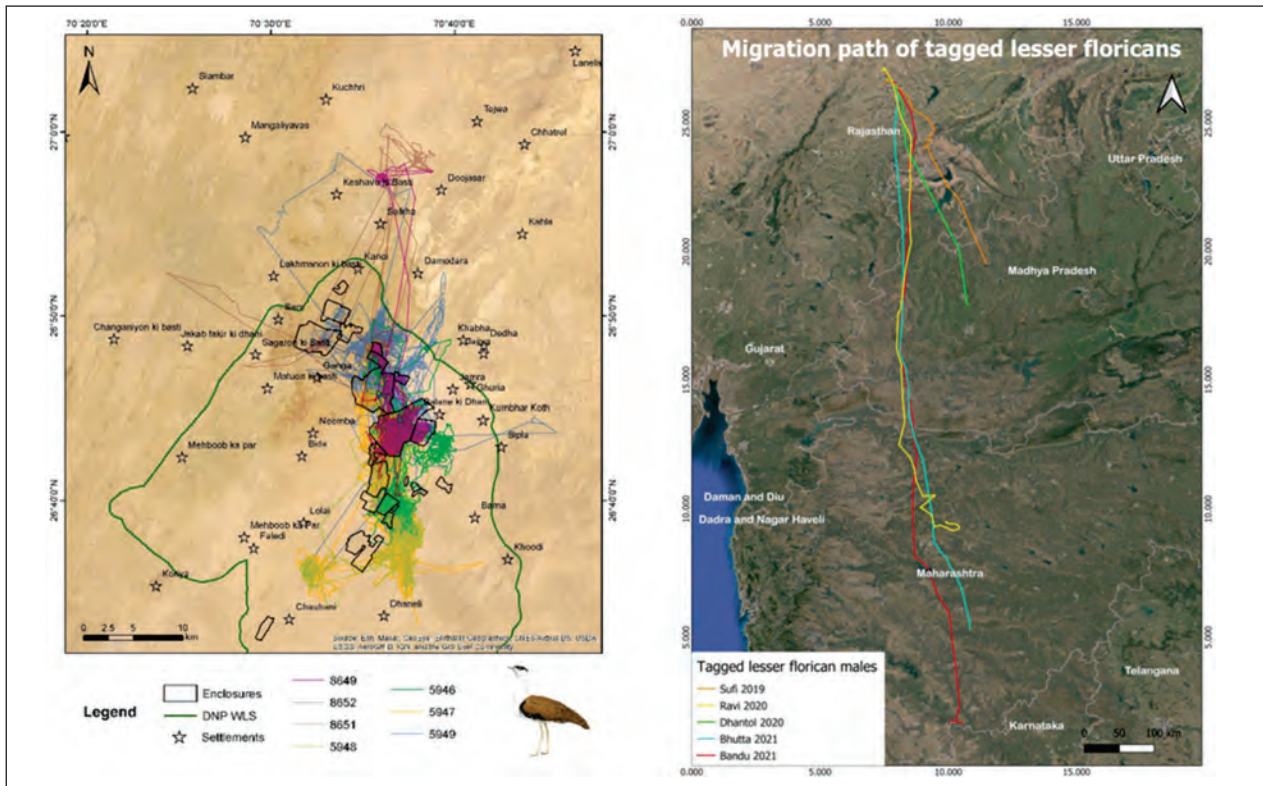


Great Indian Bustard

Ten female GIB (8 in Thar, 2 in Kutch) were tagged with E-obs and Microwave transmitters that weighed <1% of the bird's weight. Tagged females ranged over around 100 to 1000 km² area. Noteworthy results are: a) GIB prefers protected grassland enclosures during breeding season for nesting and rearing of chicks, because of good vegetation cover and high insect resources; b) Interdunal areas, both inside and outside enclosures, are intensively used by them; c) Females do not undertake long-distance migration but can range widely within the landscape in non-breeding season; d) GIB breeding is not limited by fecundity, as females can re-nest if a nest fails, but by nest and chick survival.

Lesser Florican

We tagged 8 males and 1 female at their display/ nesting sites in Ajmer with Milsar and Ornitela transmitters that weighed <3% of the bird. Tagged birds moved out of the breeding ground in mid-October, coinciding with the harvest of crops, and migrated towards Madhya Pradesh,



Maharashtra and Karnataka. This exercise is revealing hitherto unknown migratory routes and wintering sites of the species.

2. Threat characterization

Bustard habitats have changed drastically over the last decade. Besides existing threats (poaching, intensive agriculture, exotic plantations), new threats such as power-lines and pesticides have emerged. Effective conservation requires mapping, quantification and mitigation of the impacts caused by prevalent threats. We thus monitor and characterise the effect of known and potential threats for bustards - energy infrastructure, dogs, and pesticides

i. Energy infrastructure

Power-lines are a critical threat to bustards due to their narrow frontal vision and poor manoeuvrability. We



mapped power-lines, wind and solar power projects in GIB habitats of Thar and Kutch by digitizing these installations in Google Earth and through ground-truthing. Bird carcass surveys and bird crossing surveys at a sample of power-lines and wind-turbines in Thar and Kutch was carried out. Bird mortality was estimated by correcting for biases related to decomposition and non-detection of carcasses.

Carcass surveys at power-lines revealed high avian mortality involving around 40 species including GIB. The study estimated deaths of 3.2 (low-tension line) - 6.2 (high-tension line) birds per km per month that amount to around 20,000 bird mortality per year per 1000 km² landscape in Thar and Kutch. Two tagged GIB died from power-line collisions in Gujarat and Maharashtra, while seven deaths were recorded in Thar during 2017-2022.

ii. Free-ranging dogs

Thar desert holds a large population of free-ranging dogs that partially depend on human provisioned food and additionally predate on wildlife. The population status of dogs in/around DNP was estimated using count surveys and Capture Mark Recapture technique in villages and surrounding habitats (2017-18). Nine dogs were radio-tracked to study ranging, activity and predation patterns using focal sampling. We estimated 1,804 (462 SE) free-ranging dogs in ~1,000 km² area in/around DNP. Individuals ranged over ~20 km² area, and preferred areas at the intersection between hamlets and enclosures. Their diet comprised 54% of livestock carcasses. Dogs hunted ~10 chinkara per individual per year, amounting to an unsustainable annual off-take of 25% of the population of this species.



iii. Pesticide prevalence

We assessed pesticide prevalence in GIB food by collecting insect and fruit samples from Rollapadu, Andhra Pradesh and Kutch (in collaboration with TCF). We assessed pesticide prevalence in LF food by systematically sampling insect, soil and vegetation samples from ~20000 km² area across Rajasthan, Gujarat, Madhya Pradesh and Andhra Pradesh. Samples were analysed using the latest QuEChERS method. Pesticide surveys across the LF range indicated the prevalence of organophosphates, pyrethroids, imidazolinone, triazine & neonicotinoids. The GIB food and soil samples from Rollapadu tested positive for six pesticides namely Dichlorovos, Mocap, Disulfoton, Methyl parathion, Ronnel, Chlorpyrifos.

3. Conservation Prioritisation

We identified important GIB habitats to prioritize areas for conservation actions, using current and recent past locations from surveys, telemetry and habitat suitability modelling. We delineated the prime GIB distribution areas and the intervening movement space as the Priority Area, and areas which are still relatively suitable and can support the species in future if proper habitat management is done, as the Potential Area. The Priority Area for GIB covers 19,727 km² in Rajasthan, and 477 km² in Gujarat (see maps in wii.gov.in/gib_powerline_maps).

4. Social surveys

Questionnaires on 158 households in 20 villages and 10 Dhanis in/around DNP examined socioeconomic profile, human-animal conflict, pastoral institutional arrangements, and conservation attitudes. These surveys will facilitate community-based conservation initiatives in the landscape.

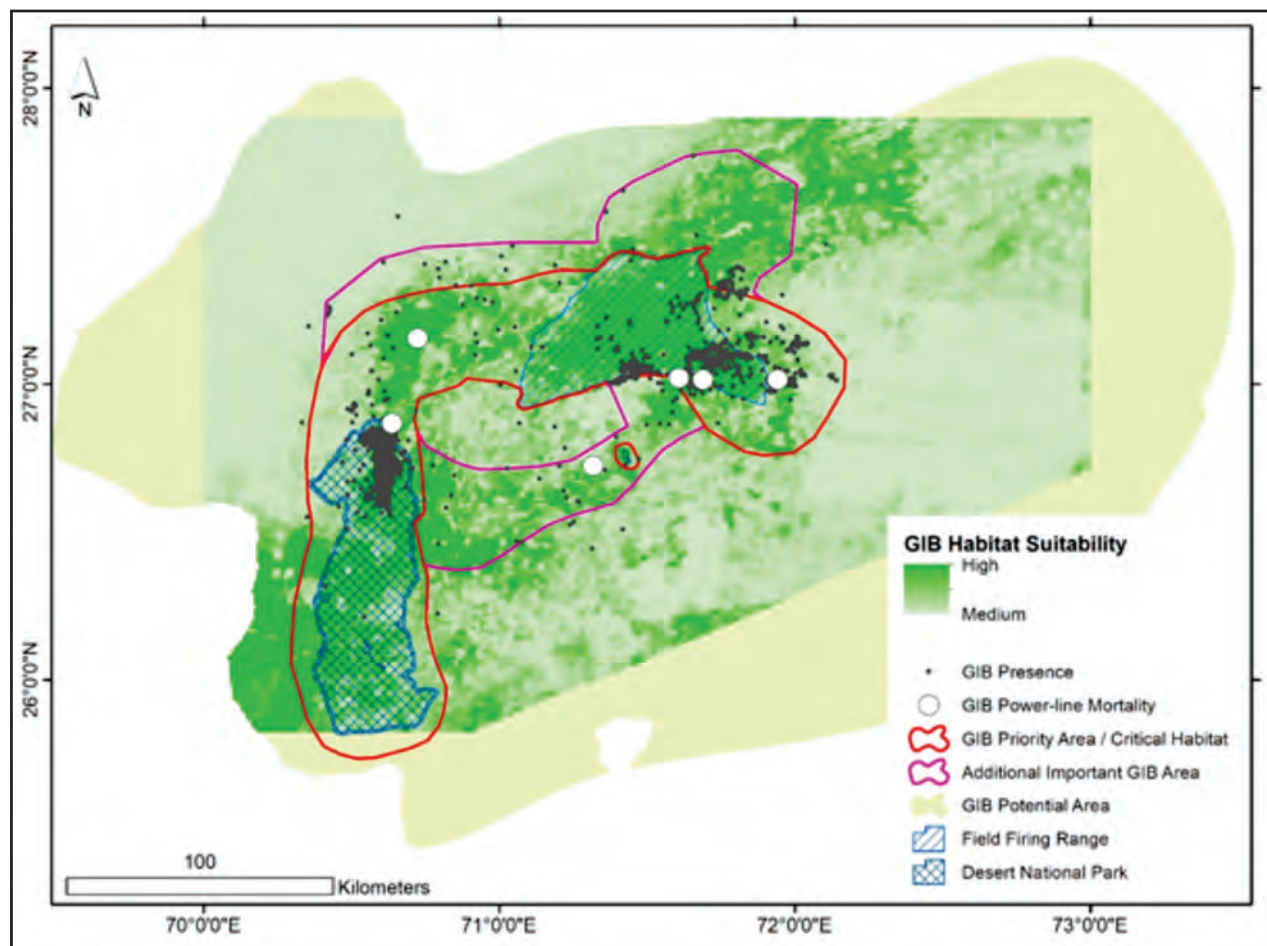
5. Conservation genetics

Genetic analysis of GIB DNA samples indicated low mitochondrial-DNA and microsatellite allelic diversity, three genetically distinct populations (Rajasthan- Madhya Pradesh-Maharashtra, Gujarat and Andhra Pradesh), and evidence of recent migration between Rajasthan, Madhya Pradesh and Maharashtra. These inferences along with a recently completed full genome mapping will inform future *ex-situ* & *in-situ* management strategies.

D. Capacity building, awareness and advocacy

Outreach targeting direct and indirect stakeholders is an important component of bustard conservation. We conducted the following activities to sensitize frontline staff, armed forces and local people.

Technical training of frontline staff: a) We trained >200 frontline staff from State Forest Departments of Rajasthan, Gujarat, Maharashtra, Madhya Pradesh, Andhra Pradesh through field workshops on grassland/





desert biodiversity and wildlife assessment techniques (2016-18). b) Advanced capacity building workshops were conducted for the RFD frontline staff focusing on desert biodiversity, conservation, and wildlife veterinary techniques (2020-21). c) Additionally, our teams regularly interact and coordinate activities with the Forest Department of Jaisalmer division. d) Indian Armed Forces are major stakeholders of bustard habitats, particularly in PFFR and Naliya Air Force base. Thus, meetings and workshops on GIB conservation were conducted in collaboration with State Forest Departments and NGOs, to sensitize Indian Armed Forces at Jodhpur (2016), Naliya (2017) and Pokhran (2018-20).

Capacity building for alternative livelihood: We conducted a green skill development workshop in Jaisalmer (2019) to train upcoming nature guides in eco-tourism activities. The workshop was attended by around 60 locals from DNP and neighbouring areas.

Nature education for students: Conservation education programs were conducted in 22 schools of 18 villages of Jaisalmer, and were attended by > 2000 students.

Mass awareness: a) Conservation awareness stalls were set up at the Desert Festival in Jaisalmer and were visited by >10,000 tourists (2018-20). Outreach materials (posters, t-shirts, caps, books, bags & brochures) were prepared and distributed. b) A documentary film on GIB conservation breeding was developed (youtu.be/XR5Z_rA7xd0). c) The Hon'ble Chief Justice of India, Hon'ble Justice of Rajasthan, Cabinet Ministers, Advocates, Civil Service officers and other public figures were sensitized on bustard conservation at the Conservation Breeding Facility.

Technical inputs in legal matters: The Project shared evidence-based recommendations on GIB conservation with MoEFCC, State Forest Departments of Rajasthan, Karnataka and Gujarat, power agencies, and Courts on matters pertaining to legal issues in the Hon'ble Supreme Court, Jodhpur High Court, Karnataka High Court and NGT Delhi and Bhopal.





Advocacy for power-line mitigation: a) We conducted extensive advocacy to mitigate the threat of powerlines, jointly with MoEFCC and RFD. This includes sensitisation meetings with RFD targeting power agencies and regulatory bodies at Jaipur, Jodhpur, Kutch, New Delhi and Dehradun (2016-21). b) Development of priority and potential area maps for Rajasthan and Gujarat for recommending undergrounding lines in the former and diverter installation in the latter areas. c) Technical inputs on power-line mitigation to several power agencies, funders, regulatory bodies (MoEFCC, Ministry of Power, Central Electricity Authority, Ministry of New Renewable Energy (MNRE), Rajasthan Energy Dept.) and diverter developers.

E. Pilot habitat management

We carried out following pilot interventions for demonstration, and testing of the conservation effectiveness of these measures:

Dog management: Dogs (454 males and 347 females) were sterilized in/around DNP in collaboration with Humane Society International (HSI)-India and RFD (Oct 2018 – Jan 2019). Follow-up surveys were carried out to assess the proportion of unsterilized dogs and lactating females (Feb - Mar 2019 and 2021) that indicated a considerable proportion of unsterilized dogs.

Maintenance of enclosures: We helped the RFD in repairing fences around key GIB breeding enclosures of DNP, to prevent the access of livestock and nest predators. Sudasiri ACD and Chauhani PPC enclosures were

regularly monitored for fence breakages and were repaired wherever needed in the breeding season of 2020-21.

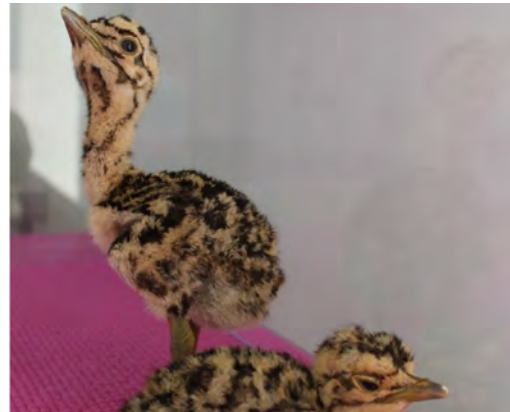
Nest predator management: We captured and translocated five monitor lizards and two Indian fox from key breeding enclosures of DNP, for pilot demonstration (2020, 2022). About 300 problem dogs were captured from key GIB breeding habitats around Pokhran and were relocated to nearby animal shelters.

Pilot installation of bird flight diverters: We procured and distributed ~500 bird diverters to JDVNL, RVPNL and SUZLON for installation on transmission lines in the Priority Area. Marked lines were monitored, to examine the durability of various products in the harsh field conditions.

Monitoring and removal of pesticide contaminated locusts: The Thar desert received large swarms of locusts in 2019 and 2020, and the local administration sprayed Malathion 96%, a contraceptive insecticide, to prevent crop damage in affected areas. Areas with high locust numbers (>200 per ha) and GIB presence were flagged to the Forest Department who cordoned off these areas to prevent contamination to GIB (2019). We collected thousands of dead, pesticide contaminated locusts from Ramdevra enclosure, and disposed them off, to avoid consumption of pesticide-sprayed locusts by the GIB (2020).

Conservation implications

Thus, the National CAMPA funds granted to this Program has helped in establishing captive populations of GIB and





LF for future rewilding, and in guiding scientific aspects of habitat management, that have marked a major milestone in the recent conservation history of these Critically Endangered species, and needs to be sustained in future for their full recovery from extinction.

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DUGONG RECOVERY PROGRAM: PROJECT UPDATES

Major Objectives:

With substantial funding, under the aegis of the National-CAMPA Authority the CAMPA-Dugong Recovery Program has implemented following major objectives, since 2016 as:

- Identify critical dugong habitats and classify threats to develop a site-specific monitoring plan,
- Fine scale mapping and characterization of seagrass habitats, the only foraging grounds of dugongs,
- Raise awareness on the species and encourage the participation of the local communities; and
- Enhance the capacity of the State Forest Department staff and develop/implement smart patrolling tools to improve protection enforcement; train forest staff and local communities in underwater surveys for long-term habitat monitoring.

In the last five years of its implementation, an integrated participatory approach was adopted to ensure recovery of dugong populations and conservation of seagrass habitat in India. Some key achievements of this program have been listed below:

RESEARCH

I) Dugong foraging grounds: Seagrasses Seagrass habitat assessment, associated fauna, socio-ecological aspect and nutrient quality

a) Seagrass habitat assessment

Gujarat:

- Seagrass habitat surveys were conducted at Paga (Hadkiwala and Betiwala reefs), Chusna (Chepri reef) Nakya reef, Bhaidar, and Noru (Tam reef).
- Seagrass species recorded *Halophila ovalis*, *Halophila decipiens*, *Halophila beccarii*, *Halodule uninervis*.
- New dugong foraging trails were recorded in the Pashu islands reef and Chepri reef.

Tamil Nadu:

- Seagrass meadow assessment was done in South Palk Bay and off the Gulf of Mannar coast of Rameswaram.
- Marine mammal assessment surveys were conducted off Thanjavur coast in North Palk Bay.
- Meadows were dominant of *Cymodocea* spp. and *Halophila* spp.

Andaman and Nicobar Islands

- In the Andaman, the survey was carried out across 16 sites from South, North, and Middle Andaman namely; Channel (Between Landfall and East), Landfall, Craggy, Shibpur, Kalipur, Smith Island, Temple, Excelsior, Delgarno, Radha Nagar channel, Paget, Point, Reef, North Reef, Pokkadera, Haddo.

- A total of 7 species belonging to 5 genera were recorded from 16 sampled sites across the Andaman Islands in the present study viz; *Halophila ovalis*, *Halophila decipiens*, *Halodule uninervis*, *Halodule pinifolia*, *Thalassia hemprichii*, *Enhalus acoroides*, and *Cymodocea rotundata*.

Underwater survey for the assessment of seagrass associated fauna, Gujarat

Intertidal surveys for Seagrass meadow characterization

Andaman

b) Ecological surveys for seagrass-associated faunal groups

Primary objective of this study was to evaluate the habitat value of seagrass meadows in terms of associated macrofaunal diversity

i) Seagrass associated macrobenthic macrofauna (Gujarat and Andaman & Nicobar Islands)

- Studies were carried out in Gulf of Kutch in Gujarat and Andaman and Nicobar Islands.
- A total of 16 groups viz Gastropods, Pelecypod, Crustaceans such as Tanaidceans, Cumaceans, Amphipods, Isopods, Oligochaetes, Polychaetes, Foraminiferans, Holothuroidea, Echinoids, Ophiuroidea, Crinoids, Scaphopoda, Polyplacophora, Marine insects were recorded from the seagrass meadows in the Gulf of Kutch.
- Comparatively, 11 different macrofaunal groups were reported from the Andaman Islands.



ii) Surveys for seagrass-associated fish (Tamil Nadu)

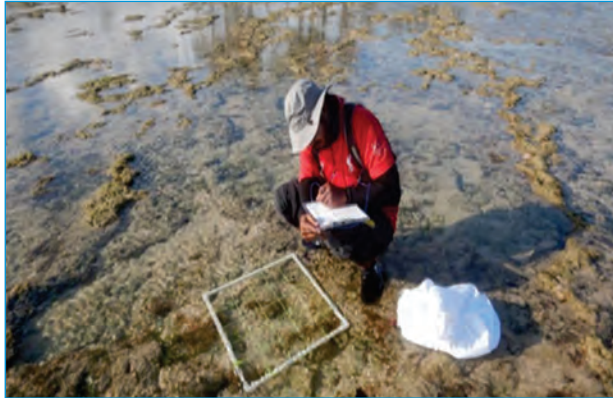
- This study was undertaken to understand ecological and economic importance of seagrass habitats.
- In underwater point-counts conducted in the seagrass meadows of the Gulf of Mannar, fishes belonging to 16 genera and 12 families were observed.



- In fish market surveys of Palk Bay, half of the total fish caught were sourced from seagrass meadows in the area, highlighting their importance in the fishery. Thirty fish species belonging to nineteen families were observed, with costs ranging from Rs. 20 to Rs. 400 per kilogram.

c) Nutrients in the sediments and seagrasses

Nitrogen, Phosphorus, Potassium, Sodium, and ash contents were analysed in the seagrass and sediments of Gulf of Kutch, Tamil Nadu, and Andaman & Nicobar Islands



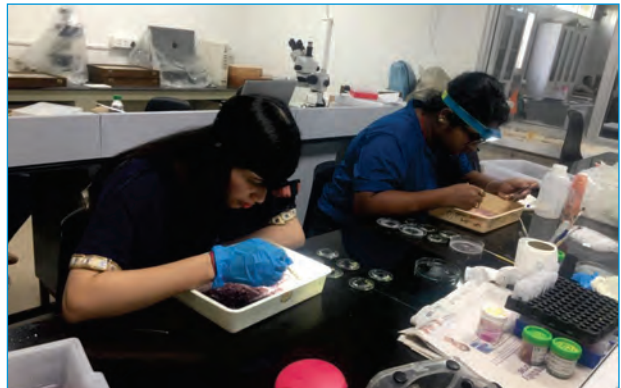
Seagrass Habitat



Fish market surveys, Tamil Nadu



Seagrass associated faunal assessment, Tamil Nadu



Lab team analysing macrofaunal samples associated with seagrass beds

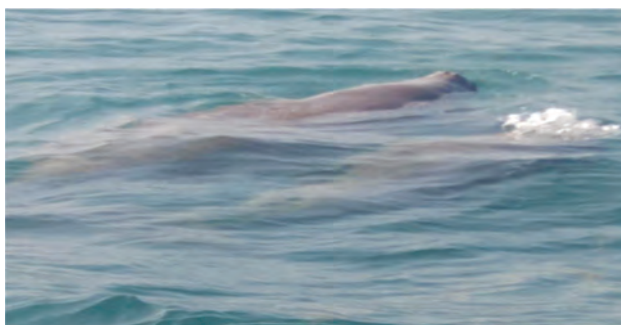
II) DUGONGS

Citizen science approach

- i. We adopted a citizen science program called the 'Dugong Monitoring Program' in the Andaman and Nicobar Islands targeting stakeholders like fisherfolk, forest department frontline staff, Indian Coast Guard and Indian Navy, school children of fisherfolk, and tourism sector viz; SCUBA divers, Lifeguards, and informants from other local NGOs.

- ii. The primary objective was to understand the distribution of dugongs in the Islands
- iii. From February 2017 to May 2021, eight different stakeholder groups were engaged in the Dugong Monitoring Network including fishers, tourism-allied operators, patrolling agencies, and school children.
- iv. In the last year, >10 mother-calf sightings were received which highlights the importance of habitats in India for dugong conservation as it supports a breeding population.

Dugong herd sighted at off coast near Adhipattinam, Tamil Nadu



First photographic documentation of dugong from Little Andaman, where the population was thought to be locally extinct



Threat mapping of Critical Dugong Habitats

- i. We carried out threat mapping surveys in the south-western Gulf of Kutch, Palk Bay, Mayabunder and Diglipur – the North and Middle Andaman district.
- ii. Threats in form of boat traffic and plastic litter were documented in the present study from critical dugong habitats.
- iii. This data is along with dugong occurrence records, is being currently used to generate dugong occupancy models across the three distribution sites.

Aerial surveys for dugong population monitoring

- i. Unmanned Aerial surveys using drone serve as an extremely useful tool for Marine mammal distribution and population studies, especially for species thriving in shallow coastal waters like dugongs.
- ii. Aerial surveys for dugong population monitoring were undertaken from Bet Dwarka, Ajad Island, Paga Reef, Bhaidar Island, and Chusna Pir in the Gulf of Kutch, and South Andaman.
- iii. A total of 134 flights were undertaken through which regions with presence of seagrasses and dugongs were confirmed.
- iv. Marine megafauna like Bottlenose Dolphins (*Tursiops* sps), Manta Rays (*Mobula* sps), Spotted eagle rays (*Aetobatus* sps), marine turtles were observed during the surveys.
- v. Fishing boats, mainly trawlers, fishing nets, and ghost nets were also observed during the survey.

Assessing environmental contaminants in dead stranded Dugongs

- i. This study paves the way for future research to understand how trace elements infiltrate the marine ecosystem.
- ii. We conducted in the tissue samples collected from 19 dugong strandings from Palk Bay and the Gulf of Mannar, Tamil Nadu during 2018-2021.



Boat survey for sightings of marine megafauna and threat mapping to assess the critical dugong habitat

- iii. A first of its kind study from India, we determined the trace metal concentrations in dugongs and elucidate the status of essential and toxic metal accumulations in the tissue samples.
- iv. 12 Trace metals Magnesium (316.617 ppb), Aluminium (21.150 ppb), Chromium (1.541 ppb), Manganese (1.959 ppb), Iron (245.682 ppb), Cobalt (230.308 ppb), Nickel (7.253 ppb), Copper (30.371 ppb), Zinc (294.379 ppb), Arsenic (0.073 ppb), Cadmium (9.632 ppb), and Mercury (0.221 ppb) were detected in the samples.

Comprehensive assessment of the genetic status of Indian dugongs

- i. Genetic studies (mitochondrial and satellite DNA analysis) were carried out from samples retained from dead stranded dugongs, to study connectivity amongst Indian dugongs and between global populations.
- ii. Both mitochondrial and microsatellite analysis points towards populations mixing and being connected.
- iii. This is first study on dugong genetics in India, which points towards the importance of conserving sea-grass patches between these sampling sites since



Demo of Drone operation to Marine Police Thondi, Tamil Nadu



Threat mapping of critical dugong habitats, Tamil Nadu team



they play a major role in sustaining the dugong habitat.

Spatial analysis tools for seagrasses

- i. Spatial analysis was carried out to map seagrass distribution using machine learning algorithms on Google Earth Engine (GEE) from high-resolution satellite images at the Gulf of Kutch, Palk Bay, and the Andaman Islands.
- ii. Geospatial analysis of seagrass meadows at Ritchie's archipelago was done using satellite imageries to attempt the detection of submerged seagrass meadows along the coast of islands of Ritchie's archipelago.

Awareness and outreach

We have conducted a total of 3500 awareness and outreach program, targeting locals (n=1629), college students (n=991), School children (n=447), Indian Navy (n=54), Indian Coast Guard (n=116), fisherman (n=72), Forest officials (n=72), and NGO's, Diver's and Fisheries department (n=13).

Some of the major initiatives are presented below:

Dugong Scholarship Programme

- i. Under the Project's 'Outreach and Awareness Components,' a participatory program, "The Dugong Scholarship Programme," was started to engage the local fisherfolk community at are grass-root level.
- ii. This program targets school-going children of local communities (most of
- iii. them are fisherfolk) and provides them with a scholarship of Rs. 500 / month for two years to support their education.
- iv. Through this program, we have identified a total of 73 school students in Tamil Nadu, Gujarat, and Andaman & Nicobar Islands through a competitive written examination followed by several participatory programs conducted at schools to raise awareness about Dugong and seagrass conservation.
- v. The students selected through the process have been identified as Dugong Ambassadors and have become part of an extensive Dugong Volunteer Network, alternatively known as Friends of Dugong network
- vi. This network provides us with information on dugong sightings/stranding and participates in outreach events to generate awareness in the areas of Dugong occurrence.
- vii. A student from the 6-12th standard of age group 11-18 was selected for the program.
- viii. So far, a total of 586 students across all three sites, Tamil Nadu, Gujarat, Andaman and Nicobar Islands, have been awarded the scholarship.

World Dugong Day Celebration

- i. 'World Dugong Day' is an initiative started by the Wildlife Institute of India to spread awareness about



Necropsy on Dugong carcass was performed by Wildlife Institute of India team, Dugong team- Tamil Nadu along with state forest officials

the importance and status of species throughout the country, which received recognition from the global community, and 28th May was officially declared as the World Dugong Day.

- ii. A month-long social media campaign was organized May 2021 and 2022, to commemorate 'Dugong Day.'
- iii. The event aimed to educate the general public about Dugongs, their habitat, life cycle, distribution, and the current status of the species in the country.
- iv. A total of 284 people for the Quiz, 210 people for the Slogan, and 84 for the Photography competition participated. Winners of the competition were awarded with dugong souvenirs and certificates.
- v. The total reach of this month-long campaign was around 34,355 over Facebook, 629 people over Twitter, and 1416 people over Instagram from people across Florida, Costa Rica, Indonesia, and Japan across the globe.
- vi. A live talk show was showcased on Facebook and Youtube live of the official account of Wildlife Institute of India.
- vii. Apart from these presentations at national and global forums, talks were given at various meetings and consultations conducted under the outreach and capacity building initiatives. These talks targeted stakeholders ranging from the scientific community as well locals.

Webinar series on Marine Mammal Conservation in India: Status, challenges, and opportunities

- i. This webinar aimed to address marine mammal conservation issues and scope of the research opportunities
- ii. And to create awareness among the young researchers, provide a platform for spreading knowledge on current research conducted on marine mammals



Awareness program with the fishing community of Surajkaradi, Gujarat

The participants got the opportunity to interact with eminent scientists working for marine mammal conservation on the national and international levels.

CAPACITY BUILDING

Key stakeholders: State Forest Departments of Andaman & Nicobar Islands, Gujarat, and Tamil Nādu for dugong conservation, Indian Navy, Indian Coast Guard, Marine Police, Coastal Security Group, State Fisheries Departments, and State Education Departments

Major outcomes:

- So far, over 2000 personnel from these departments have been trained and sensitized for dugong conservation in the country
- These trainings have helped us get aerial footages of dugongs from the Indian Navy and Indian Coast Guard, helped us to identify priority sites for dugongs, reduce mortalities due to poaching by increased in active patrolling and enhance the capacity of these frontline stakeholders in the conservation of marine biodiversity in the country.



Awareness program with the fishing community of Surajkaradi, Gujarat



Felicitation of local fishers who rescued net entangled dugongs from Palk Bay. Program was organised by the CAMPA_Dugong team, Tamil Nadu along with Forest department and marked presence of district collector, Ramnathapuram, Sh. Johny Varghese (IAS)

MAJOR OUTCOMES

- As per MoEFCC and WII's CAMPA-Dugong Project's work and recommendations, India's first dugong conservation reserve was proposed in Gulf of Mannar, Palk Bay. At present, the State Forest department is working towards declaring the region as a marine protected area.
- First genetic study on dugongs from India
- First study on gut content in dugong carried out to understand dugong's dietary preferences
- First drone sighting from Gulf of Kutch confirming dugong presence from gulf waters
- Involvement of Indian Navy and Indian Coastguard in the Dugong Monitoring program in the Andaman and Nicobar Islands, which has yielded more than 20 aerial sightings of dugongs from the Islands.
- Fishers turned into dugong rescuers in Tamil Nadu. So far, more than 10 dugongs entangled in fishing nets have been rescued by locals in Tamil Nadu.



Sensitization cum Capacity building program conducted with the Indian Coastguard unit DHQ-10, in the Great Nicobar



Awareness program with the fishing community of Surajkaradi, Gujarat



Sensitization cum Capacity building program conducted with the Indian Coastguard unit DHQ-10, in the Great Nicobar



Beach Clean-up at Shastri Nagar, Great Nicobar. A total of 10 bags of solid waste was hauled from the 35km beach, with the support of the local administration, and the forest department



Dugong awareness cum capacity building program with the Tribal Protection Police Force unit, Tirur, South Andaman



Collaborative 'Community Interaction Program' with the Indian Coastguard with fisher community, Farm Tekri- Little Andaman



Diploma IFS training course: Field work in Gulf of Mannar



Publications:

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- Bayyana, et al.,(2020). "Detection and mapping of seagrass meadows at Ritchie's archipelago using Sentinel 2A satellite imagery." *Current Science* 118.8 1275-1282.
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ALL INDIA SYNCHRONISED ELEPHANT AND TIGER ESTIMATION: A NOVEL APPROACH TO ELEPHANT CENSUS

Elephants are an integral component of ecosystems playing a crucial role in maintaining forest ecosystem and biodiversity. Ecological role of elephants greatly influences ecosystem, which includes changes in plant communities, ecosystem processes, geomorphology and trophic structure of a community. Elephants are referred as “keystone species” as it’s disperse seeds and supports large assemblages of invertebrates, such as dung beetles, and lower plants such as algae and fungi apart from enriching soil nutrients through dung piles. Elephants can identify the subsoil water and natural salt licks through strong sense which is also shared by the other animals especially the herbivores for which intake of minerals from the natural soil is most important for many physiological activities.

India has 60% of the global population of Asian elephants. In fierce competition for food and resources between humans and elephants, human and elephant interface has increased over the years. Conservation of wild Asian elephants *Elephas maximus* depends on resolving human elephant conflict. The Task Forces defines human-elephant conflict (HEC) as the adverse impact people and elephants have on each other. Conflict of this nature entails suffering for both humans and elephants that are rich in such situations. The intensity and scope of the conflict is a major challenge for conservation as much as for humane governance.

The Asian elephant is distributed discontinuously across the Asian continent. The current distribution of elephants in India is a fraction (about 3.5%) of its historical range that stretched from south of Himalayas to entire subcontinent with the exception of the most arid tracts. In India Asian elephants distributed majorly in southern and north-eastern India, east-central and north western regions. The number of wild elephants in historical times is not known, a record of the French navigator Pyrrard de Laval from the period of the emperor Jahangir (early 17th century) indicates a total of about 40,000 elephants within the territories of the Mughal empire and Bengal.

The elephant population of India has been estimated since the late 1970s by elephant range states using various methods. While there is no single or ideal method for counting elephants, each method has its advantages and disadvantages under different conditions. Methods for establishing elephant numbers fall into two broad categories: estimates from total counts, estimates from sample counts.

Total Counts aim to see and record all the elephants in a defined area, either from the air or from the ground. Total counts of a limited area can also be conducted at

ground level by teams in vehicles or on foot. Total ground counts have been accomplished by attempting to identify every individual in the population. This is only possible for intensively studied populations where animals can be observed readily.

The **Total Counts** involves two essential steps: (a) searching and counting all the elephants in a given area, and eliminating double counts through suitable precautions and scrutiny of data. Total Direct Count is usually carried out during the dry season when elephants are easy to locate around the limited water sources. In some Protected Areas, grasses are burnt during winter, which increases the visibility, and thus provides an opportunity for enumeration of wild elephants. Such total counts can provide information on the structure and composition of the population.

Sample Counts, in which only a sample of the area is counted (usually between 3% and 20%), are generally conducted along transects which may be randomly distributed or systematically placed across the study area. The resulting data are used to calculate a population estimate with confidence limits. In contrast with total counts, which tend to produce underestimates of the true population, sample counts have in principle an equal chance of underestimating or overestimating the true population, provided that sampling error is the main source of error.

Nationwide population estimation exercise for wild elephants is conducted every 5 years and elephant data has been compiled since 1993. Till 2012, elephant census was conducted in ad hoc manner with the State Forest Departments conducting the census operation using population estimation methods of their choice and reporting the elephant numbers enumerated to the Ministry. In 2017 an all India synchronized elephant census was carried out to avoid errors in estimation arising from significant movement of elephants between different states. The Ministry has decided that converge the elephant census with that of the Tiger census 2022. The Hon’ble Minister EF & CC had released the All India synchronized census methodology for Elephant and Tiger 2022 during World Elephant day celebration 2021.

As part of the National Tiger Status assessment, data is being recorded on elephant occupancy and relative abundance through the MSTriPES Ecological application. These include a) elephant sigh survey in each beat with three replicate walks of 5 km each in an occupancy framework, b) dung plots to estimate elephant dung density. Fresh dung samples of elephant encountered during the survey will be sampled for genetic analysis.



After individual identification from genetic analyses, information on individuals and their distribution in space will be obtained. This data on captures and recaptures of elephant individuals across space will be used in a spatially explicit capture re-capture framework to estimate densities.

The synchronized elephant and Tiger census 2022 is being conducted in collaboration of Project Elephant Division, Wildlife Institute of India and National Tiger Conservation Authority with funding support by the National CAMPA. In

Tiger Reserves where tiger and elephants' distribution are overlapping, will be covered by the NTCA, whereas other elephant habitats where tiger is not distributed will be covered by the State Forest Departments with the funding support from the Project Elephant Division. The Ministry has entrusted the task of conducting the nationwide elephant population estimation to Wildlife Institute of India. This is an important step towards scientific conservation management of our national heritage animal which will help States to understand the population dynamics and other ecological aspects of elephants, which in turn leads to better habitat management and protection of species in the elephant landscapes.



DEVELOPING CONSERVATION ACTION PLAN FOR GANGES RIVER DOLPHINS

Dolphins are charismatic species that have always evoked human curiosity, along with being an integral part of our cultural milieu. Dolphin was mentioned to have descended with Goddess Ganga, “The Ganga, when it landed on earth, brought with it turtles, crocodiles and dolphins” (Balkhand, Valmiki Ramayan). Dolphin was accorded protection during Mauryan emperor Ashoka’s time, the protection is mentioned on VIth rock edict. Moghul Chroniclers have recorded its presence in Indus, Yamuna and Ganga.

Ganges dolphin (*Platanista gangetica*), India’s national aquatic animal is found in the Ganges-Brahmaputra-Meghna and Karnaphuli river systems of India, Nepal and Bangladesh. The species is listed as Endangered by IUCN and is protected under Schedule-I of Wildlife Protection Act-1972. **No reliable Population estimates exists, though populations may be between < 2000 on the lower side (IUCN) to optimistic estimates of >3000 of all age classes.**

The CAMPA-Dolphin project thus has the following aims:

- 1) To develop a recovery plan for Gangetic dolphins and their habitats in India, and
- 2) Engage stakeholders in conservation of Gangetic dolphins and River Ecosystems in India.

With these aims following consolidated objective are defined for the project in two broad, synergistic themes;

A: Ecological monitoring

1. To develop a monitoring protocol for Ganges River dolphins and associated riverine fauna.
- ii) Quality assessment of river habitat in terms of water quality, anthropogenic pressure and landscape surrounding river scape.

B: Participatory conservation planning and action

- iii) Involve stake holders to develop a network which will assist in Ganges River dolphin conservation.

It was suggested that these river dolphins have evolved from marine platinated ancestors which inhabited the sea, and when sea penetrated low lying areas during Miocene, they entered the continent. As sea-levels receded, dolphins continued to persist in the fresh water river system (Hamilton et al., 2001). Over time, as the connection between Ganga-Brahmaputra River systems and the Indus River system became contentious, the populations started diverging from each other, and have evolved into the two species we know today, Ganges and Indus River dolphins (Braulik et al., 2021).

The species is distributed throughout the length of the Ganga and Brahmaputra, and all their tributaries from the delta at the Bay of Bengal till the Himalayan foothills, their

distribution was only limited by insufficiency of water and by rocky barriers (Anderson, 1878). The Gangetic Dolphin ranges into most of the large tributaries in the Ganga Basin: the Chambal, Ramganga, Yamuna, Gomti, Ghaghara, Rapti, Son, Gandak and Kosi, besides the main channel of the Ganga. In the Brahmaputra valley, it ranges into the major tributaries such as the Tista, Adadhar, Champamat, Manas, Bhareli, Subhansiri, Dihang, Dibang, Lohit, Disang, Dikho and Kulsu rivers. Dolphins in the main channel of the Ganga were split into two subpopulations in 1975, when the Farakka Barrage was commissioned. Today they occur in 5 subpopulations within India, the Brahmaputra, Bijnor–Narora, Narora–Kanpur Barrage, Kanpur Barrage – Farakka, and Farakka to Ganga Sagar. While earlier Anderson also confirmed the presence of the species from Gangetic delta and the Sundarbans, currently we find no recent evidence for dolphin presence in Sunderbans.

In the past 50 years, a 30% decline in the population of these dolphins has been estimated, and substantial range reduction, with many local extirpations. Though reports from 1878 suggest that the abundance of the species was around tens of thousands, a population decline was recognized. Due to continued decline in its population, the IUCN upscaled the status from ‘Vulnerable’ to ‘Endangered’ in 1996. The species is given legal protection in all its range countries - Schedule I under the Wildlife Protection Act (1972) in India, Schedule I in Nepal and Schedule in Bangladesh Wildlife (Conservation) Security Act 2012. The Ganges River dolphins is also declared as the National Aquatic Mammal of India. Currently, less than ~3100 individuals of the Ganges River dolphins are estimated to be in the wild. The population of Ganges River dolphin is declining mainly due to threats like bycatch of the dolphins in fishing nets, poaching of river dolphins for their oil and meat, habitat fragmentation due to construction of dams/



River Dolphins Survives in the Ganga and Brahmaputra River Basins

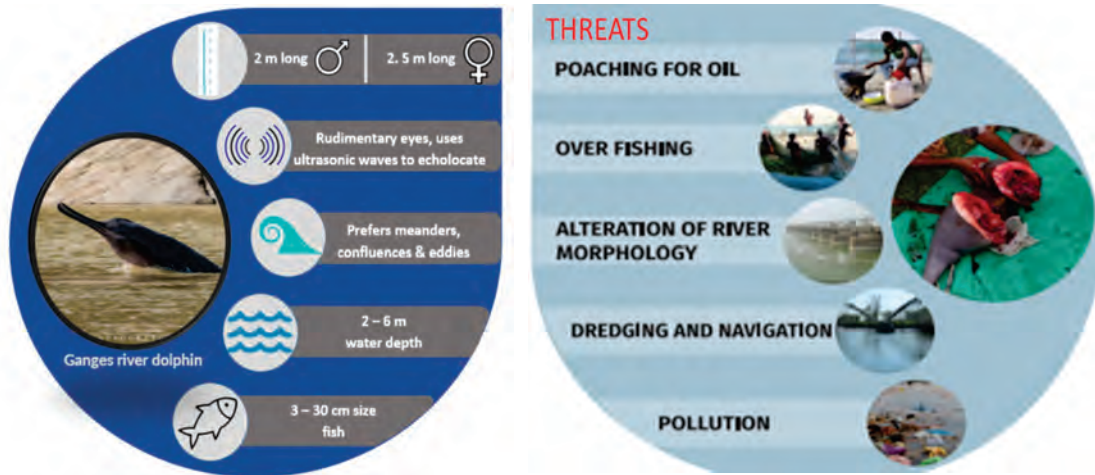


	Global	Nepal	Bangladesh	India
Conservation Status	Endangered	Facing local extinction	Schedule I	Schedule I
Population Status	~3300	52	125	~3000
Distribution	30% range reduction	Karnali, Sapta Koshi, and Narayani Rivers	Meghna	Ganga and Brahmaputra

Global status and distribution of Ganges River Dolphins in its range

irrigation canals, increase in the underwater noise by boat navigation and dredging, collision with motorboats, and pollution caused by human activities like agricultural runoff and industrial wastewaters. It is also important to

understand its surrounding environment, capturing prey, navigation, communication etc. They have the longest inner ear canals of any extant cetacean, and hence can hear a wide frequency range (Thewissen &



Current understanding regarding Ganga River Dolphins and the Threats affecting them

note that the Yangtse river dolphin, distributed in China, was declared to be extinct recently (Turvey, 2008), due to anthropogenic pressures, and only serves as a reminder of the precarious state these species are surviving under.

River dolphins are characterised by a long rostrum, almost non-existent dorsal fin, and side-swimming behaviour (Herald et al, 1969; Sinha et al., 2003). Males are smaller than females in both the sub species (2.5m vs 2m; Kasuya, 1972). Ganges river dolphins have evolved from their platinistid marine ancestors to survive in the murky turbid waters of the Ganga and Brahmaputra river systems. During their evolutionary journey, the structure of their eyes regressed to becoming partially blind (detect only light and dark). This led to their dependency on echolocation as their primary sense receptor to

Nummela 2008). It is because of this, that the underwater soundscape, and any anthropogenic disturbance might have a profound impact on dolphins.

The dolphins feed on fishes, prawns and other crustaceans and are known to prefer fishes of a particular size class. River dolphins are mammals and breathe air by coming up to the surface once in a while, but they surface for a very short time ~1.26 seconds and spend ~107 seconds under water, making it very difficult to observe (Wakid & Braulik, 2009). Given the very low surfacing time, traditional monitoring and abundance estimation methods difficult are difficult to implement. Hardly anything is known regarding their habitat preference in detail, or their breeding habitat, movement ranges and prey preference.



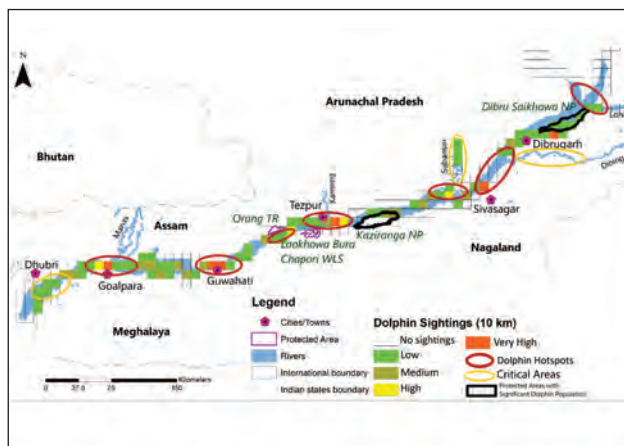
How the project has added to the knowledge on species, and conservation actions:

Population Monitoring, Status and Distribution:

As mentioned above, since river dolphins surface for a very short time, it becomes difficult to observe them, let alone count them. Also, traditional population estimation methods are largely geared at land based fauna, or marine fauna, which cannot be translated to river ecosystems. The first task was to develop a method that will work for our river systems. **Taking advantage of the echolocation property used by river dolphins, a scientifically robust method for counting dolphins was developed.** This method included independent observer teams to account for observer variability, and using hydrophones (devices that record underwater sound), to account for dolphins either missed by observers or those that did not surface during the time the boat passed for counting.

Following river surveys in the past four years, **population status and hotspots were mapped** across the Brahmaputra and Ganga range for river dolphins. The Brahmaputra river system remains one of the major population strongholds of the Ganges river dolphin today, harbouring 30% of the world's population.

Although tributaries like Kulsi and Subansiri also harbours dolphin population, these populations experience a seasonal rise-and-fall which coincides with the flood cycle. The dolphin hotspots in Brahmaputra are at Sivasagar, Kaziranga-Tezpur, Guwahati, and Goalpara, where the population is high and also calf encounters are



Dolphin hotspots in Brahmaputra, based on population encounters at every 10km and critical habitats (in yellow).

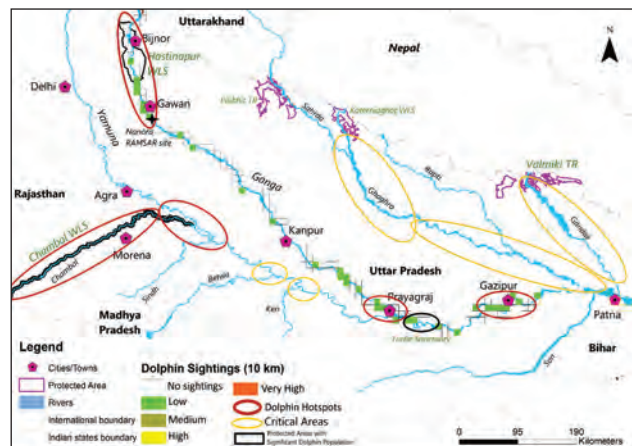
high. There are other areas like the confluence of Lohit and Brahmaputra, confluence of Manas, confluence of Subansiri, amongst others.. Tributaries of Dihing, Subansiri and Kulsi are most important for long term conservation efforts. Unless these populations are secure, the mainstem population of Brahmaputra will be in jeopardy. The current **population estimation established through the project is at 992±19 dolphins in Brahmaputra and its tributaries.**

survey –“Double observer mark recapture method”



A standardised methodology for estimating the number of river dolphins in the country was developed as part of the project, with the help of acoustic technology (hydrophone in inset)

A survey in December 1996 recorded no dolphins between the 100-km stretch of the Ganges River from Bhimgoda Barrage at Haridwar and Bijnor, this stretch was considered the upstream limit of their historical range (Sinha et al. 2000). The total estimated population in the **Uttar Pradesh part of Ganga is around ~400 dolphins** (Qureshi et al., 2021). On the basis of occurrence and distribution of priority species such as Gangetic dolphin, two main river stretches along the mainstem Ganga River were identified (1) Bijnor to Narora (152 km) which is protected as Hastinapur WLS and Upper Ganga Ramsar



Dolphin hotspots in Uttar Pradesh stretch of Ganga, based on population encounters at every 10km and critical habitats (in yellow)

Site, and (2) Prayagraj to Ballia (395 km) of which a 30 km stretch between Maija in Prayagraj and Gyanpur in Bhadohi is protected as newly created Kachhua Sanctuary.

In contrast to the declining range in the tributaries, dolphin range in mainstem Ganga of Bihar, seems fairly stable with high population densities across the stretch. Here Vikramshila Dolphin sanctuary at the confluence of River Koshi and the Ganges forms an important habitat. for the species and may be acting as a source population



of the river stretch. The stretch between Chausa and Maniharighat in Bihar seems to be the strongest hold for this species in the **Bihar region with a best estimate of about 1200 individuals**. While the dolphin sanctuary in Bihar itself serves as a good habitat, where dolphins thrive in the region, the stretch surrounding Katihar (Near Maniharighat) seems to be another major hotspot. Similarly other stretches which include Ghaghara and Gandak confluences also have a good population of Ganges Dolphin. They are also critical links to maintain a viable dolphin population, as they connect the rivers of Nepal with Ganga. Begusarai, Barh, and Naugachhia form other critical hotspots that require regular monitoring and infrastructure, to ensure the survival of dolphins in the future. Kos(h)i and Gandak are the most important tributaries for dolphin, gharial and other aquatic fauna.

In West Bengal, the Farakka Barrage located on the Ganges River 400 km downstream of Patna, close to India–Bangladesh border, acts as a barrier (Sinha & Kannan, 2014). Although a sizeable population (~ 250 individuals) exists in the Hooghly river (Qureshi et al., 2018), studies and surveys conducted in recent past are of the opinion that the range of the dolphin in West Bengal is severely fragmented (Mitra et al. 2015). The stretch between Farakka feeder canal and Kakdwip in West Bengal sustains a population of about 358 dolphins (Qureshi et al., 2018). The **population in West Bengal (around 520)** is understood to be stable, however, there

are increasing incidences of poaching of dolphins for oil, and death due to net entanglement reported in the area. With increase in navigation, and motorized boats, there is further stress to the dolphins which rely on acoustic clues for survival. There is a huge disturbance to the dolphin habitat underwater with increased movement of ship traffic.

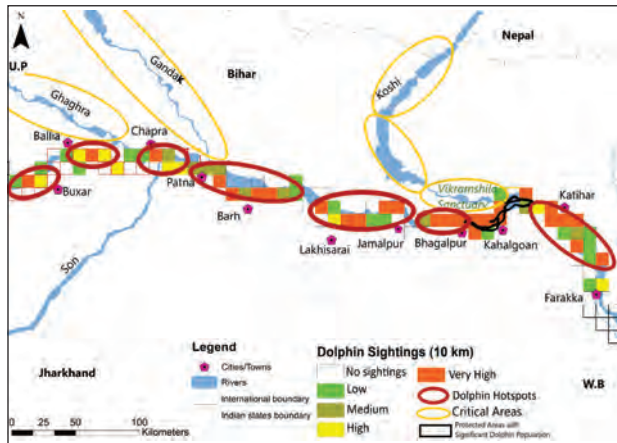
Habitat preference:

To prioritise areas for conservation, it is important to first identify the critical habitats preferred by dolphins. Intensive site monitoring carried out as part of the project were able to identify several river morphologies that were crucial for dolphin survival. Based on studies carried out using acoustic data (hydrophones), it was identified that **confluences, meanders and mid-channel islands were the most preferred dolphin habitats**.

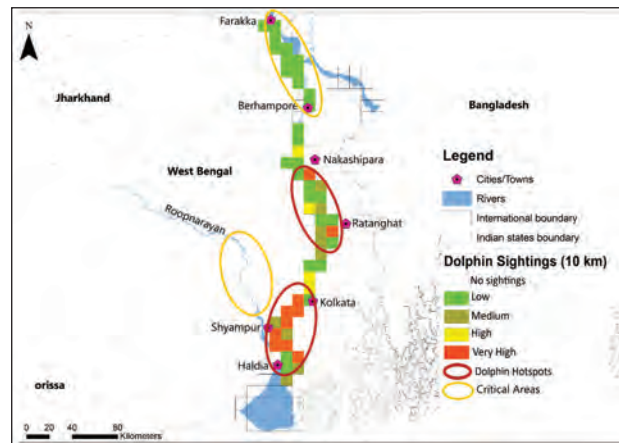
These habitats also provide a diverse micro-habitat for fishes, which is possibly one of the reasons why dolphins prefer these habitats.

Activity pattern and influence of ship traffic:

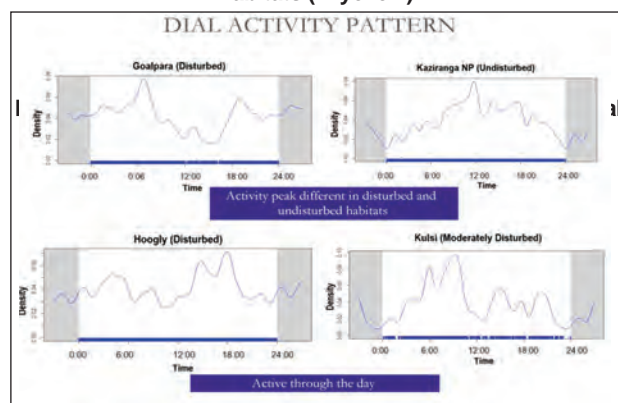
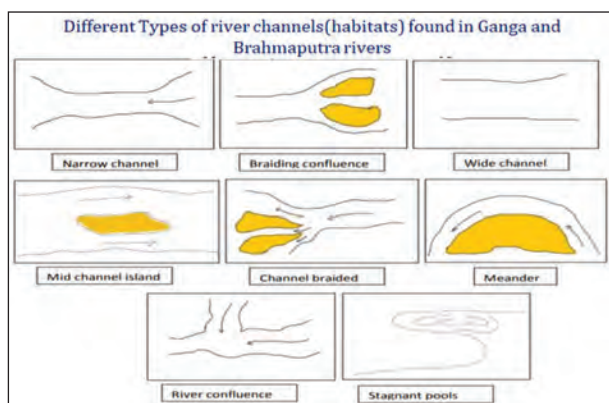
We deployed hydrophones underwater to understand the activity pattern of the Ganges river dolphins. Dolphins continuously emit sonars to understand their underwater environment and these are in the form of clicks - short noises of 14 - 2000 ms. These sonars are recorded by the hydrophones and give us insights to the biology of



Dolphin hotspots in Bihar stretch of Ganga...in Yellow



Dolphin hotspots in West Bengal stretch of Ganga, based on population encounters at every 10km and critical habitats (in yellow)





the Ganges river dolphins. We used a passive acoustic monitoring device (PAM) called C-POD in different study habitats in Brahmaputra and Ganga River. We found that dolphins are active throughout the day. However, in case of disturbed sites with high ship and boat traffic a bimodal activity was found where dolphins showed activity peak during early morning and evening period unlike the undisturbed areas where a diurnal activity pattern was observed. Similarly in tidal areas of Hooghly, the dolphin diel activity was found to coincide with the tidal moment of the sea.

Status of the Associated Riverine Fauna

Ongoing work is going on to understand the status of associated fauna like Gharial, Otter, Turtle and Fishes. We have developed a Protocols for the associated fauna monitoring and will be implemented in the coming surveys

Aquatic birds were surveyed was 884 km stretch of Brahmaputra River in Assam and 625 km of Ganga in Bihar. Total 46 species of birds were recorded in Brahmaputra, whereas 60 species of birds were recorded from Ganga. For understanding the prey base fr the dolphins Extensive fish sampling was carried out in the 92.5 km stretch in Kaziranga National Park ,83.9 km stretches in Goalpara to Dhubri and 60 km of Guwahatti in Brahmaputra in Assam with a cumulative effort of 256 hours of sampling resulting into record of 59 species. Fish landing sites were also survey in Kahalgaon (Bihar) and different parts of Assam which result in the identification of 55 species in Ganga and 62 species in Brahmaputra.



Indian Skimmer and a softshell turtle on the banks of the River Ganges and Brahmaputra (respectively)

Along with this **the Plankton sampling** were conducted in 58 km stretch in Kaziranga National Park and 30 km stretch of Goalpara- Dhubri stretch and 60 km of Guwahatti stretch of Brahmaputra River. In Hooghly River 40km river stretch of the Farakka Feeder Canal (Farakka to Jangipur) and 40km river stretch of Bhagirathi-Hooghly (Patuli to Mayapur) were also surveyed. **Turtle survey** were conducted in 65 km stretch of Brahmaputra, resulting into 3 species of turtles.

Addressing the threats

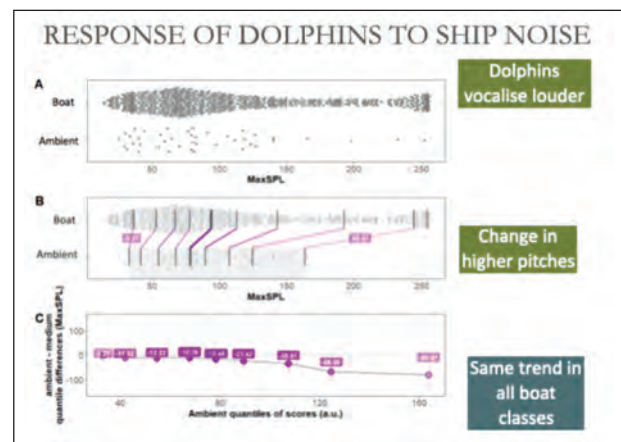
1. Effect of boat noise on Ganges River Dolphin

It is seen in marine dolphins that the dolphins show responses like avoidance, change in the social structure, change in the diving pattern, reduced foraging activity and change in vocalization in the presence of boats. To understand the effect on boat noise on Ganges River dolphin, we carried out hydrophone recording in the presence of boat and their absence in Hooghly in West Bengal. **The result showed that dolphins vocalize louder when a ship passes and that they tend to use higher frequency while communicating in the presence of boats.**

2. Net Entanglement and poaching

Poaching for oil:

One of the major threats to the Ganges river dolphins is their poaching. **Close to 50 dolphins are poached for oil every year in Brahmaputra alone.** The dolphins that are accidentally caught in the fishing nets are poached for their oil instead of releasing them back into the water. This oil is then used as a bait to catch largely two commercially important cat fishes - *Clupisomagarua* and *Eutropiichthysvacha*. To control the increasing threat to dolphin populations in India, various alternatives to dolphin oil have been proposed and promoted. However, it is still not known whether dolphins are being poached for oil, despite the presence of alternatives. **A molecular protocol was developed to monitor the presence of Dolphin DNA in the bait oils obtained from fishermen.** Additionally, information was collected through social surveys to understand the current status of the use of dolphin oil. Results indicate that molecular tools provide an accurate technique for the detection of the presence and absence of dolphin DNA. Enforcement agencies can use this information to further monitor and identify points of threat to dolphins. Social survey **results indicate that despite knowing the legal implications, the fisherman continues to use the dolphin oil for bait. It is found that alternate oils do not provide an effective solution to curb dolphin oil use, and only shift the threats of endangerment from one species to another.** The ban of bait fishing, effective enforcement combined with monitoring through molecular tools, continued community



Response of dolphins to boat traffic – quantified by using hydrophones under water. It is shown here that, when boat passes, dolphins vocalise louder and change to higher pitches.



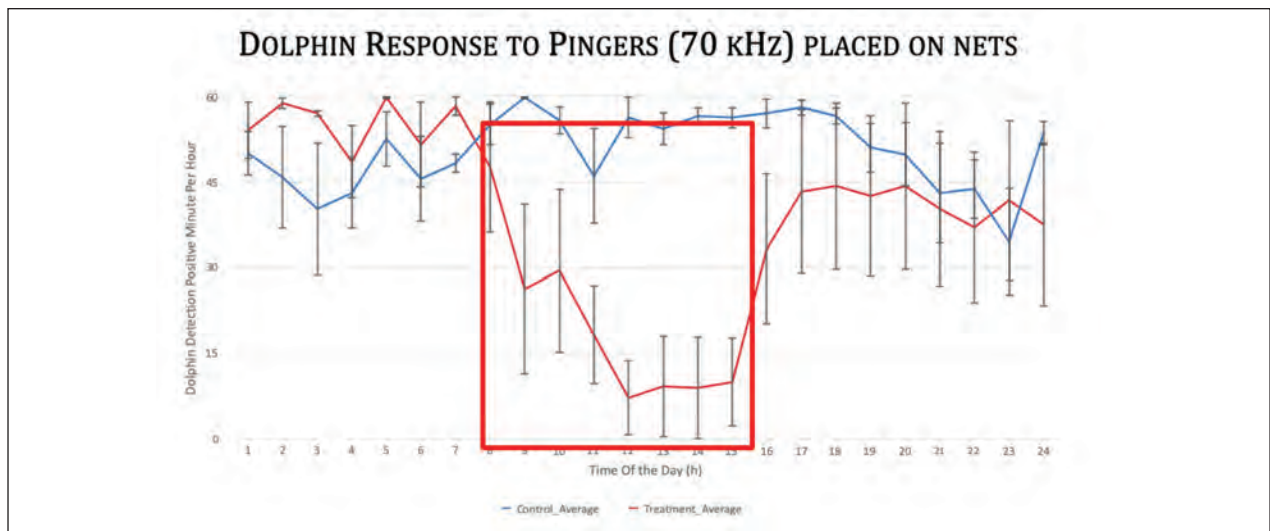
engagement, and life skill development are the most viable solutions for a holistic conservation approach.

Net entanglement:

Dolphins use echolocation as the primary sense organ. However, these are not effective in identifying the mono-filament fishing gill nets. Due to which, the net entanglement and related mortalities are high for this species. **We tested if using an acoustic alarm on the fishing net can successfully deter the dolphins from the fishing nets.** These acoustic alarms are called pingers. The pingers tied to fishing nets emit sounds that are in the audible range

of the Ganges River dolphins which aids in helping them perceive the presence of nets, which are otherwise difficult for them to echolocate. The pingers emit fourteen (14) sonic pings every minute. **The study showed a positive response, i.e., in the presence of pingers the dolphins get deterred from the pingered fishing nets and can potentially help in preventing the net entanglement rate of dolphins.**

Another aspect of using these pingers are that they can be locally manufactured as a cottage industry for local employment of the community, and for sustainability of the model.



Dolphin detections near the nets are plotted here against the time of the day. To reduce entanglements in nets, through the project, we have tested the effect of using acoustic deterrents like pingers. Here, it is visible that in the same nets, when pingers are switched on (treatment, red line), dolphins keep away from the net.



Pingers are small acoustic deterrents that emit sonic pings to help dolphins detect the presence of the net, and thereby reduce their chances of entanglement. Their deployment is depicted here.

Stakeholder engagement, awareness and participation for Ganges River dolphin conservation

Apart from vigilant law enforcement efforts from the authorities, active community participation can ensure

fruitful results. The first and foremost step is to identify and develop a stakeholder platform for dialogue and sustenance of conservation actions. Developing a stakeholder platform requires a patient iterative process



of identifying stakeholders, their interests, building trust, empowering weak stakeholders and, for powerful stakeholders, to accept new rights and roles for other stakeholders. Local community networks are built which engage with different stakeholders, enable a platform for dialogue and awareness, as well as for information gathering.

Such community initiatives are absolutely essential, and will play a pivotal role for any conservation program. There is also a need to identify target groups which are heavily dependent on the river system, and have no alternative sources of livelihood.

We applied mixed methods of social inquiry comprising of qualitative and quantitative techniques for exploring the community narrative, use of common pool resources like the river and fishery practices. Individual verbatim and group discussions are used to tap the subjective responses of community members, whereas rating scales and structured interviews provide a comparable assessment.

Dolphin Conservation Network

The Dolphin Conservation Network (DCN) was established for long term monitoring of dolphins and their habitat. It is more like a citizen science effort to obtain information on dolphin occurrence as well as mortalities in the Brahmaputra River and create a **Network of invested communities for Dolphin conservation**. It started with the aim to conserve Ganges River Dolphin through community participation covering 30 important dolphin habitats in Assam, headed by Dr. Abdul Wakid. This has had a tremendous impact on the awareness and conservation dolphins. Out of the 22-carcass rescued for post mortem in 2008-20, 77% carcasses were secured from local communities and handed over to the Forest Department by DCN members only. Out of the ~68 dolphin mortalities in Brahmaputra in 2008-20, DCN members reported 86.7% of the mortality.

Awareness workshops with targeted audience: To conserve dolphins, it is especially crucial to engage and sensitise fisherfolk, who are one of the main stakeholders of the river systems. During the course of the survey, we realised that it was lack of knowledge of fish ban season, dolphin ecology and legal implications of the kinds of nets used that caused majority of the dolphin deaths. So, fisherfolk awareness campaigns were organised, focussing on improving their knowledge of **dolphin friendly fishing practices, in local languages**.

Target group-oriented awareness programs were conducted among school students near Ganges dolphin hotspots across Brahmaputra river in Assam. The objective of the programme was to generate awareness among the community residing dolphin hotspots on the ecological importance of the species and their role in the conservation with a holistic approach. Overfishing, deaths due net entanglement, poaching for dolphin oil extraction to use as fish bait and as a cure for rheumatoid; and water pollution caused by household chores by the communities residing on river banks are among the major

anthropogenic threats. So, targeting the students from fishing communities, a dolphin conservation **awareness workshop was conducted in 400 schools, and more than 10000 students, residing on those hotspots of Ganges dolphin since the inception of the project across Ganga and Brahmaputra**.

Figure 17 Dolphin yatra to encourage investment in dolphin conservation by future generation, and to inform stakeholders, especially in river side villagers, regarding dolphin, ecology and what can be done to conserve them. The pictures also depict engagement with school children and other stakeholders.

Dolphin yatra was organised for riverside villages along the Brahmaputra to sensitise local school children and villagers. This opportunity was also taken to get feedback regarding the problems faced by villagers, and what can be done to facilitate dolphin friendly practices. **This helped engage the future generation of stakeholders in dolphin conservation. It is also important to inculcate a sense of ownership in communities to embrace dolphin conservation.**

Important Milestones

1. Developed scientifically robust methodology to estimate Ganges river dolphin population
2. Established status, distribution, and identified areas for conservation priority
3. Contributed to understanding of dolphin habitat needs, and habitat use
4. Identification of prevalent threats to dolphin populations
5. Establishing bycatch mitigation measures that will help prevent dolphin entanglement
6. Developed understanding of associated species
7. Investigated and established river quality status across dolphin range
8. Contributed to assessing impact of Baghjan oil disaster, Assam – with knowledge developed in the project
9. Contributed to understanding the effect of sandmining on river dolphins in Kulsi – due to which a committee was developed to secure this population
10. Generating awareness amongst relevant stakeholders on dolphin conservation, and threats
11. Establishing stakeholder participation to ensure long-term dolphin conservation
12. Developing a dolphin conservation network in a citizen science based approach that will ensure long term conservation of dolphins, associated species and rivers

Budget

A total of 23 crore INR was sanctioned for the project. Till date, a total of 13.8 crore INR has been released. The project is currently under a two year no-cost extension, with a budget outlay of the 9.2 crore INR that is yet to be released.



Way Forward

The river and marine ecosystem is the lifeline for the most marginal people in the country, apart from several threatened and endangered fauna.

Conservation of river dolphins and associated fauna and habitat is to not only ensure the conservation of aquatic biodiversity, but the livelihoods of people dependent on natural resources. Dolphin acts as an umbrella species, whose conservation will result in the wellbeing of associated habitat and biodiversity, including humans. This effort is truly in line with our conservation philosophy of '*VasudhaivaKutumbikam*'.

Based on the information stemming from the current project, the Hon'ble Prime Minister Shri Narendra Modi, has initiated a very timely and important step towards ensuring a future for dolphins in the country, by announcing the idea of 'Project Dolphin' on 15th August, 2020. This only goes on to show the importance of conserving the species and habitat, and how committed the government is in taking this forward. As part of this initiative, the Range-wide monitoring of river dolphins, associated fauna and aquatic habitats was initiated. This is a big win for conservation, as this will be the **first of its kind in the country**.

Dolphins (both Ganges River Dolphin and Indus River Dolphin) are impacted by anthropogenic and natural threats, which includes habitat loss, habitat degradation, reduction in flow, pollution, poaching, net entanglement, river navigation, unsustainable fishery practices and sand mining, to name some. There has been local extirpations (eg. Barak river and Son river are recent examples) and this is especially worrying. Efforts have progressed on several fronts to evaluate and develop mitigation strategies for many of these aforementioned threats. However, these threats still pose a significant challenge to counteract. The issue was tackling the problem at small scales. The current protected part of river only impart protection to about 25% of dolphin population and situation is similar for most of the aquatic fauna. **There is a need to look beyond Protected Area system and look for alternatives which conserve integrity of aquatic system and sustain needs of local people.** A concerted effort at a large range wide scale is needed to make significant strides in addressing these issues, and to make any headway in conservation.

One of the main problems to formulate an effective conservation strategy is knowledge gaps that exist in our understanding of Dolphin ecology and behavior. For mitigating threats relating to dolphin entanglement with nets, the effectiveness of acoustic deterrents like pingers need to be understood. However, not enough research exists to quantify the effectiveness of such a strategy for widespread implementation. Initial results look promising (Qureshi et al., 2020), however whether they are effective on a longer term needs to be looked at, before widespread implementation. Other aquatic fauna like fishes, Gharial, otters, water birds are poorly researched, and there is an urgent need to study their basic ecology, and effect of anthropogenic pressures. This will enable a holistic

approach to conservation of aquatic ecosystem in the country.

No conservation action can be successful or sustainable without the involvement of all stakeholders, including humans, and it is essential that everyone's interests are taken care of. The first and foremost step is to identify and develop a stakeholder platform for dialogue and sustenance of conservation actions. Developing a stakeholder platform requires a patient iterative process of identifying stakeholders, their interests, building trust, empowering weak stakeholders and, for powerful stakeholders, to accept new rights and roles for other stakeholders (CBD 2011). Currently, there are several models in place, like the Dolphin Conservation Network (DCN), as supported by the current project. In all these programs, local community networks are built, which engage with different stake holders, enable a platform for dialogue and awareness, as well as for information gathering. Such community initiatives are absolutely essential, and will play a pivotal role for any conservation program. Continuing support for these networks is needed. There is also a need to identify target groups which are heavily dependent on the river system, and have no alternative sources of livelihood.

One should also provide and explore the possibility of alternative livelihood options, along with promotion of ecotourism. The model will use dolphin as flagship species, with dolphin tourism focussing on other species of conservation concern like gharials, birds, protected areas, along with historical monuments, and places of religious importance. A sustainable model needs to be developed keeping these aspects in mind. Alternate livelihood options will also be enhanced through establishment of fish cooperatives, which will not only ensure sustainable fishing and conservation of native fish fauna, but also safeguard dolphin populations. Through the objective of ensuring multi sectoral policy alignment, resources can be garnered for local communities to explore alternate livelihood and also ensuring that government's existing policies are also well utilised.

The core idea of this intervention is to improve understanding of river side community about river ecology and its biodiversity in order to empower them for protecting and preserve their and river's future. We need to mainstream the river side community which faces much more grave danger than of losing their land and livelihood due to river floods and river bank erosion. To engage and enable a future generation of conservation aware citizens, conservation awareness and environment education programs, including engaging with education departments across dolphin range states is needed. Inclusion of aquatic biodiversity in school curriculums, especially in dolphin range states is needed. There is also a need to create a positive narrative amongst children regarding dolphin and other associated biodiversity. A citizen science model for schools, where students are actively involved in understanding river biodiversity, with practical experience and motivation is needed. Science clubs in dolphin hotspots, with regular interaction amongst



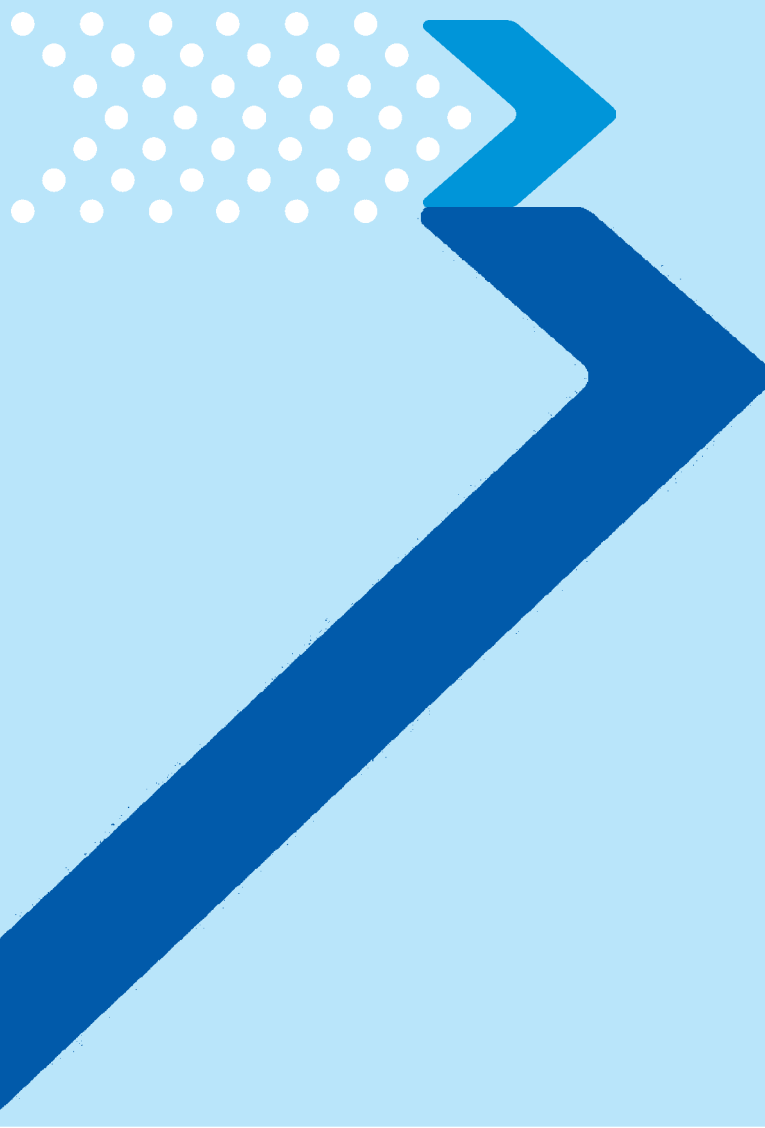
peers and experts from across the country would do well to sensitize students.

We know that the soundscape of riverscape has a tremendous effect on dolphins, as they rely on acoustic communication for not only movement but other life history traits. With plans of largescale navigation in progress, the effect of ship traffic on dolphins and their survival needs to be looked into. Preliminary results suggest behavioural responses that affect the dolphins communication (Qureshi et al., 2019), however more research is needed to confirm the findings. The associated activity with navigation like dredging, river training, embankments, terminals modify the habitat considerably. We understand that certain habitats are critical for dolphins, and any modifications in these habitats might prove detrimental. Therefore, research is needed to understand these effects before proceeding with large scale navigation. To effectively address conservation concerns and inform management about appropriate strategies, there is a need to fill knowledge gaps in the following areas: basic ecology of dolphins, habitat requirement, ranging pattern, health status, population barriers, effect of pollutants, effect of navigation, ecology of species of conservation concern, and effect of dredging on river habitat, fishes and dolphin. It is proposed that appropriate scientific studies be carried out to fill these lacunae so that science based conservation can be implemented.

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ECOLOGICAL
RESTORATION AND
CONSERVATION OF
LANDSCAPE





STRENGTHENING FORESTRY RESEARCH FOR ECOLOGICAL SUSTAINABILITY AND PRODUCTIVITY ENHANCEMENT

Indian Council of Forestry research and Education (ICFRE)

1. Overview of “Strengthening Forestry Research for Ecological Sustainability and Productivity Enhancement”

The Indian Council of Forestry Research and Education is implementing scheme entitled “Strengthening Forestry Research for Ecological Sustainability and Productivity Enhancement” funded by National Authority CAMPA. The

scheme is dedicated towards addressing the requirements of creation and strengthening of ecosystem services and sustainable use of resources through various scientific and technological interventions. The period of the scheme is 5 years from the date of start (February 2020). The scheme has six major components. Each component is output driven and is of 3 to 5 years duration. The cost for the six components is Rs. 313.67 crores.

Components	Objectives
All India Coordinated Research Projects (31 AICRPs) in collaboration with ICFRE and Non-ICFRE Institutes	To undertake research aimed at efficient and sustainable resource use through value addition and development of appropriate technologies.
Programme for Conservation and Development of Forest Genetic Resources (FGR)	To establish a comprehensive national programme for conservation and development of Forest Genetic Resources.
Policy studies under Centre for Forest Policy Research	To undertake policy research in forestry sector to analyze the policy gaps and determine concordant policies.
Capacity Building of State Forest Departments for developing “State REDD+ Action Plans” under National REDD+ strategy	To undertake capacity building programmes for stakeholders, including forestry personnel, communities, tree growers and forest-based industries
Operationalization of Human Resource Development Plan of ICFRE	Operationalization of Human Resource Development Plan of ICFRE through essential trainings
Operationalization of Forestry Extension Strategy and Action Plan of ICFRE	To undertake an exclusive outreach programme taking research and technology to users through a comprehensive extension strategy.

Brief about scheme	
Preparation phase (2017-2018)	Formulation of guidelines for All India Coordinated Research Projects - August/September 2017
Approval phase	Approval of scheme by Research Policy Committee – XVIII RPC 2018 & XIX RPC 2019
	Submission of scheme to National Authority CAMPA – September 2018
	Approval of scheme by Executive Committee of National Authority CAMPA- 8 th March 2019
	Approval of scheme by Governing body of National Authority CAMPA – 15 th November 2019
	Issue of budget of scheme – February 2020

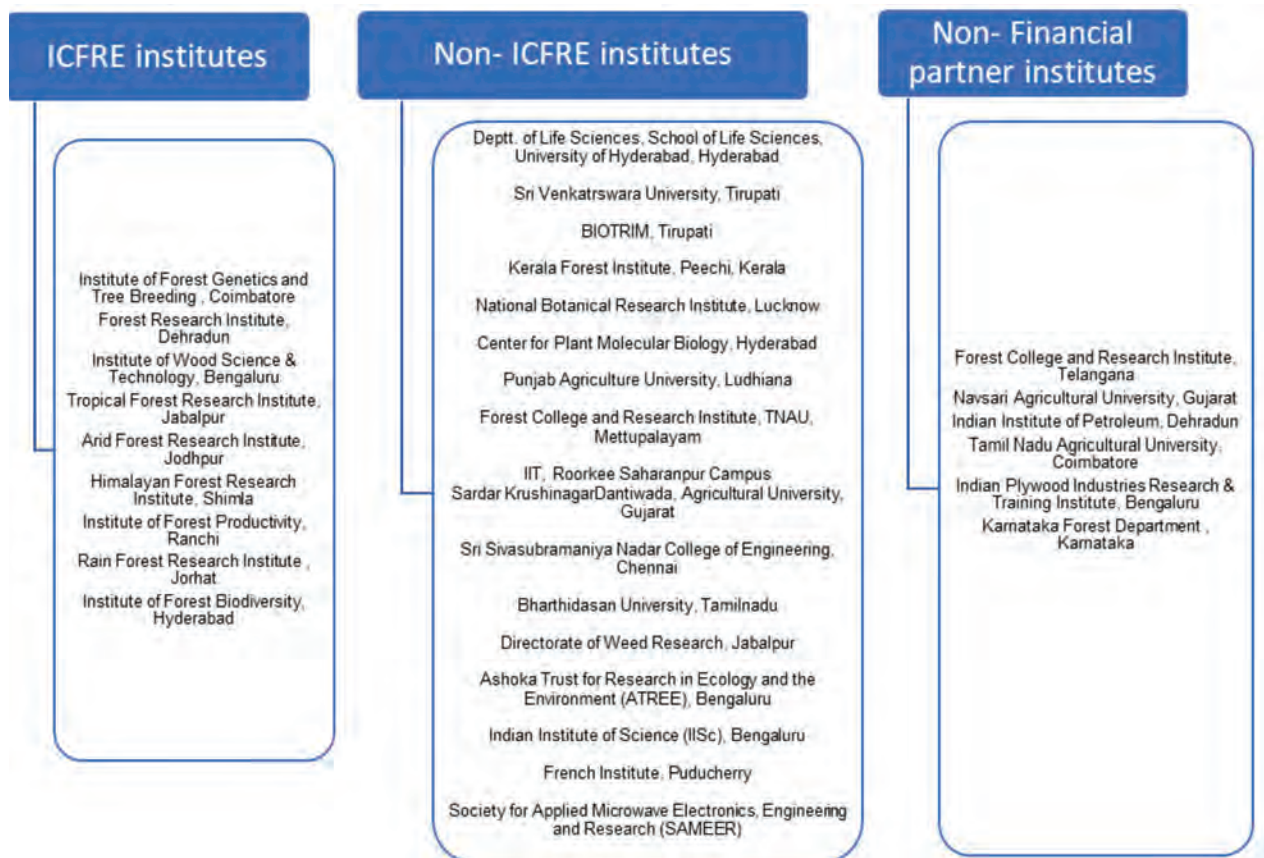
1st PEG Review	For February 2020 to September 2020	November 2020, December 2020, January 2021 & February 2021
2nd PEG Review	For October 2020 to March 2021	July 2021 & August 2021
3rd PEG Review	For April 2021 to September 2021	November 2021, December 2021 & January 2022
4th PEG Review	For October 2021 to March 2022	April 2022, May 2022

Year	Funds Received (in crores)	Expenditure as per audited UCs (in crores)
2019-20	38.59	11.24
2020-21	43.507	34.08
2021-22	NIL	24.71
Total	82.097	70.03

2. Progress of Component -1: All India Coordinated Research Projects (AICRPs)

31 AICRPs are being implemented with the help of nine ICFRE and seventeen Non-ICFRE institutes. There are

13 species-based AICRPs and 18 subject area specific AICRPs. All are inter-institutional and inter-disciplinary. Few Non-financial partner institutes are also providing scientific and technical inputs.



2.1 General Progress of all AICRPs:

- Compilation of existing knowledge/ data for all the projects completed. MOUs with non-ICFRE project partners signed. Recruitment of project staff (JPF, SPF, JRF, SRF, RA, PA, FA) completed. Most of the equipments purchased. Purchase of equipment where supplies were delayed due to COVID or were scheduled for 3rd year will be done shortly.
- Methodologies developed and finalized for each project. Work plan/time line of projects finalized. Coordination meetings of the projects conducted. Four Project Expert Group (PEG) meeting involving internal and external experts for monitoring of project conducted.
- Identified land/sites for trials and field experiments in AICRPs where production of plantations has to be increased by selection of site and end use-specific planting material. Sites were prepared by cleaning of bushes, levelling of field (Through JCB), digging of pits and application of compost in the pits. Need based irrigation, plant protection measure (against termites) and weeding were carried out in the established trial.
- Institute wise work elements of each projects finalized. Priority list of species including bamboo for various components were finalized. The criteria for selecting experimental sites for laying trials either based on potential of species for cultivation or on contrast environments finalized.

2.2 AICRP Wise Progress

AICRP 1: Multilocation Testing of Casuarina Clones and Seed Sources

- Established 15 clonal trials in nine states to select the most suitable clone(s).
- Established six progeny trials in six states to produce genetically improved seeds.
- Established one trial in Karnataka to select most compatible Casuarina clone(s) as nurse plants for Sandal trees.
- Studying water and nutrient use efficiency of different clones for their cultivation with minimum.

AICRP-2: All India Co-ordinated Research Project on Bamboo

- New CPCs of different species maintained in the germplasm bank.
- In vitro shoot multiplication of *B. tulda*, *B. nutans*, *B. balcooa*, *B. polymorpha*, *D. hamiltonii*, *D. asper* and *D. strictus* is continued.
- In vitro rooting of multiplied shoots was performed in *D. strictus* and *D. hamiltonii*. Planted 5200 seedlings of *D. strictus* and Planted 2000 No. of seedlings of *B. Bamboos*. 150 numbers of *B. vulgaris* (yellow) produced through cuttings. 130 No. of *B. tulda* produced through cuttings.
- 45 No. of *B. nutans* produced through cuttings. 3 No. of clumps selected from Angul (Odisha) of *D. strictus*, *B. vulgaris* and *B. bamboos*.

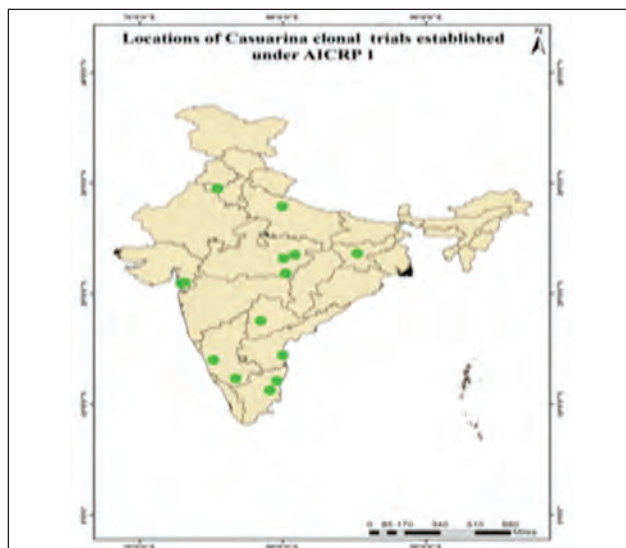


AICRP- 3: Conservation, Improvement, Management and Promotion of Sandalwood (*Santalum album* Linn.) cultivation in India

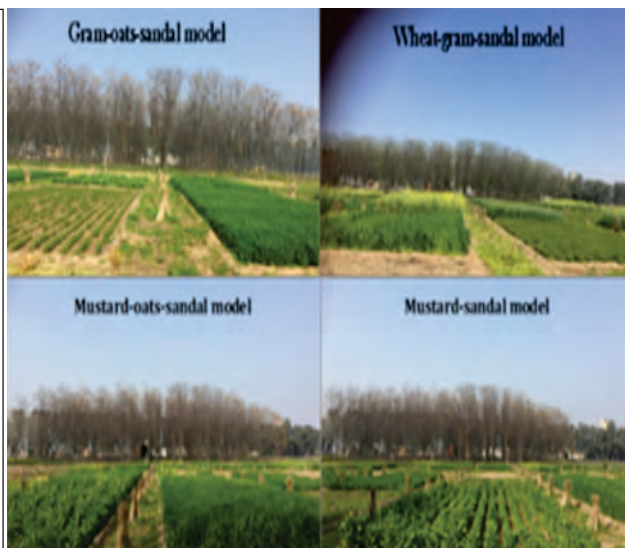
- Surveyed 15 populations in Tamil Nadu, Karnataka and Rajasthan and selected 121 trees for seed collection.
- First methylated cytosine map of *Santalum album* developed.
- Forty polymorphic SSRs identified in five populations from Kerala.
- Documented the incidence of red stem borer and sandal spike disease. Five sandal-based agroforestry trials raised using known seed source.
- Documented existing management practices in 31 plantations in Karnataka.
- Developed method for estimating heartwood diameter from standing trees using Electrical Resistivity Tomography (ERT).
- Carbon isotope composition ($^{13}\text{C}/^{12}\text{C}$) estimated in wood samples using Isotope Ratio Mass Spectrometry (IRMS).

AICRP-4: Eucalyptus Improvement

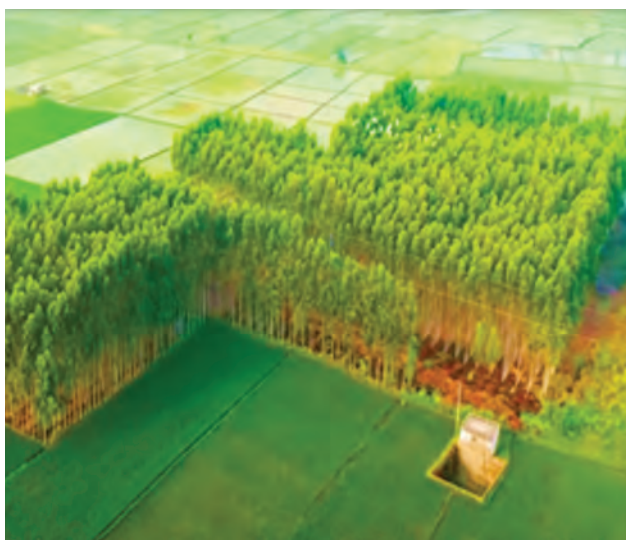
- Established germplasm banks with 285 clones. Established MLTs (Multi Locational Trails) at Marakkanam and Thiyagadurgam (TN) and at Mulugu (Telengana).
- In all ramets of 162 clones have been planted in 6 replications in RBD design. Two adoptive clonal trails at TFRI, Jabalpur and Bargi Forest range, Jabalpur established. Selected about 20 plus trees of *E. tereticornis* from Panampally and Karunya provenance trials.
- About 26 seedlots of 6 species of Eucalyptus (*E. urophylla*, *E. pellita*, *E. cloeziana*, *E. sideroxylon*, *E. moluccana* and *E. longirostrata*) were imported from CSIRO. Establish Progeny tested Clonal Seed Orchard, selected 25 clones of *Eucalyptus camaldulensis*.



Locations of Casuarina clonal trails



Agroforestry models



Released Eucalyptus clone



Microwave Vacuum dryer (bamboo drying)



AICRP-5 : Development of Dielectric Heating based Processing Technologies for Solid-wood, Bamboo, and their Composites

- Lab scale microwave (MW) vacuum dryer was first fabricated for preliminary experiments on drying of small timber samples.
- Final MW dryer has been fabricated and installed at FRI, Dehradun for drying of bamboo and timber of various sizes.
- Radio frequency vacuum dryer has been partially fabricated for drying of bamboo and timber.
- Moisture meter for measuring moisture in timber has been developed. Calibration work of the moisture meter is in progress.

AICRP- 6: Value Addition of Wood and Wood Based Composites Using Nanomaterial

- Stable nanoemulsion of linseed oil containing Zinc oxide and cerium oxide nanoparticles in water was prepared using homogenisation and ultrasonication.
- Significant improvement in resistance to water absorption and dimensional stability was observed in Poplar and *Melia dubia* impregnated with Polyvinyl acetate and nano ZnO blend.
- MDF boards were prepared from *Melia* fibres by using nanoclay (Conc. 1-3%) loaded UF resin. Addition of nanoclay improved mechanical properties of the MDF boards.
- Composite board was prepared using nanocellulose dispersion and sisal fibres and banana fibers and properties evaluated.

AICRP- 7: Assessment and Monitoring of Invasive Alien Plant Species (IAPS) In India and Formulation of Strategies for Management of Key Invasive Alien Plant Species in Different Regions of the Country

- Documented 50 invasive species including trees, shrubs and herbs from Rajasthan. The most important invasive species were *Prosopis juliflora*, *Lantana camara*.
- Insect species collected from the Lantana during the survey, but most prominent species was *Teleonemia scrupulosa*.
- Collected different disease samples of Mikania, Isolated and identified the Bio-control agents under in vitro condition.
- Preparation of input for different models and Multi co-linearity test completed.
- Model validation completed by analysing Jackknife and AUC values.
- Samples of *Prosopis juliflora* collected for processing.
- Isolation of Bio-control agents under in vitro condition infecting *Mikania micrantha* collected from Dibrugarh and Charaideo district.

AICRP-8: Conservation and Productivity Improvement of Redsanders (*Pterocarpus santalinus*)

- Provenance surveys were taken up by component collaborators IFB and BIOTRIM. 22 beats in Kadapa, Nellore and Northern provenances were surveyed. Seed germplasm was collected from 107 trees. Provenance-wise seedlings, from previous year collection, was maintained at BIOTRIM.
- 71 Candidate Plus Trees have been selected so far and collection of seeds is being done for establishment of progeny trails.
- Experiments of vegetative propagation trails, in- vitro protocols for clonal multiplication, identification of superior strains, molecular resource generation is being done.
- Co-relation are being developed for heartwood data and ERT data.

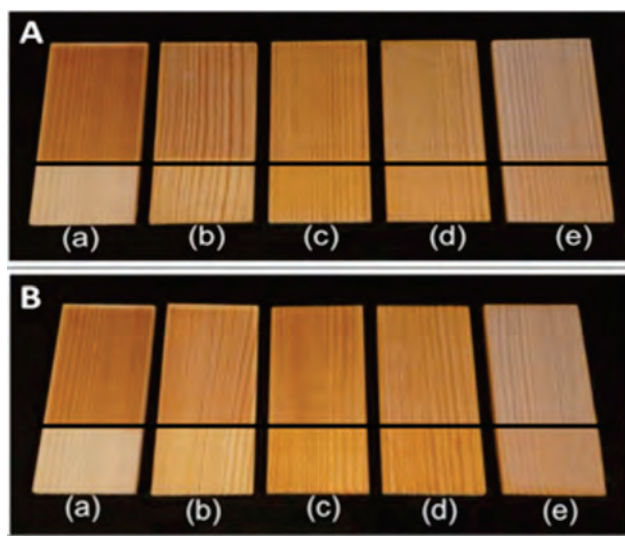


Fig. 5 UV resistance of wood coated with nano ZnO embedded nanoemulsion



Fig 6 Vegetative propagation through air layering of coppice shoots



AICRP-9: Biotechnology Quality Teak Production: Capitalizing on Cloning

- Various aged plantations raised through commercial sources were assessed from states such as Kerala, Tamil Nadu, Chattisgarh, Maharashtra and Andhra Pradesh and found the growth at the age of 5 years was adequate with average height and girth of 9.0m and 35.0cm respectively.
- Memorandum of agreement signed by IFGTB with 3 commercial tissue culture labs for large scale production expected to supply plants from April 2022 onwards. In the project IFGTB provided start up cultures to all participating institutes (TFRI, FRI, IFP) for mass multiplication and plant production. In addition all the institutes initiated multiplication of local clones for mass production. Field demonstration trials in blocks and bunds, were established in Punjab, Gujarat, Tamil Nadu, Kerala and Madhya Pradesh.

AICRP-10: Developing Seed Testing and Seed Storage Protocols of Selected Forestry Species from Diverse Forest Types

- Surveys done for demarcation of populations and fruit maturity assessment of species.
- Seed germination behaviour of identified species is being done for various forest types.
- Seed storage physiology is also being studied. Seed storage category is also correlated with ecological parameters.



Fruits of *Elaeocarpus seratus*



Collection of fruits of *Elaeocarpus seratus*

AICRP-11: All India Coordinated Research Project on *Dalbergia sissoo*

- 32 *Fusarium* isolates, two *G. lucidum* isolates, three *Verticillium*-like fungal isolates and 29 *Trichoderma* isolates were isolated and studied for morphological and microscopic features.
- Shisham populations of 55 sites in Himachal Pradesh were surveyed for disease incidence, and soil samples, diseased plant parts and fruiting bodies of *Ganoderma lucidum* were collected by HFRI. Shisham populations in 28 sites were recorded healthy.
- 35 rhizospheric soil samples have been collected from south-eastern part of Rajasthan by AFRI. 13 CPTs have been marked. Total 15 trichoderma species were isolated and their cultural characters and growth pattern as well as their growth behaviour in different spent material have been studied.
- Prepared all the desired GIS layers for modelling species distribution. The required climate models representing two climate scenarios Climate model NIMR_HADEGM2_AO and IPSL_5A_LR have been downloaded and digitised for the study area.

AICRP-12: Assessment of Demand and Supply of Timber, Fuel-Wood and Fodder in India

- Manual on sampling methodology has been prepared. Data on pulp and paper from CPPRI, Saharanpur has been obtained.
- Among SFDs, data from Jharkhand, Bihar, Telangana have been received. A total of 1,350 households were surveyed.
- 110 industries have been surveyed from different categories of industries. Data entry format of excel sheet for household and SFD data has been prepared and data collected from household surveys and wood-based industries have been entered in provided excel sheets.

AICRP-13: Valuation of forests for GDP, green GDP and Payment of Eco-System Goods and Services

- Socio-economic survey was done in 6 villages in Kangra district and 60 questionnaires were filled.
- Socio-economic survey was done in 10 villages in Udhampur and Doda districts in fringe villages.
- The information were collected on direct and indirect benefits provided by forests to villagers. Total 100 questionnaires were filled.
- Identified 35 Households (VDF-15 Villages, MDF-10 Villages & OF-10 Villages) in Alwar District for survey of Forest Type (FT-5).
- Out of six districts belonging to M.P., Maharashtra and Chhattisgarh i.e. Korea, Mahasamund, Katni, Khargone, Chandrapur and Gadchiroli, conducted socio-economic survey in 100 households from 10 villages each of four districts i.e. Mahasamund, Katni, Chandrapur and Gadchiroli. Socio-economic survey of a total of 400 households has been completed.

**AICRP-14: Forest Fire Research and Knowledge Management**

- The burnt area information till March 2022 has been received from Uttarakhand State Forest Department from time to time and based on the information received field visits are being conducted.
- Sample tool kits (Kit-1 hand tools (15 sets) and Kit-2 safety clothing (06 sets)) has been received from UPES, Dehradun and the same has been sent to Uttarakhand, Odisha and Kerala State Forest Department for testing in actual field conditions.
- The baseline information about burnt and unburnt is being collected with active cooperation from the SFDs.

AICRP-15: Tamarind (*Tamarindus indica* Linn.): Domestication, conservation and deployment of genetic resources for sustenance and livelihood amelioration

- The descriptors were developed as per the guidelines of PPVFRA. Passport data was collected from 55 tamarind clones for developing National Tamarind Registry. Fruit morphometric characterization in 55 clones was done using an image analyzer.
- Assessed gum recovery percentage from 22 different sources of Tamil Nadu to develop tamarind genotypes with high TSG value. Analyzed proximate and ultimate properties of tamarind seed gum. Seed morphometric traits such as seed brightness, roughness, shape and colour were assessed.
- Assessed variations in the clone banks of tamarind in Mulugu in Telangana and based on the calculated data of Mulugu Plantation shortlisted 5 clones. Raised about 3000 tamarind seedlings for rootstock purpose. Optimized grafting season for large scale multiplication of tamarind genetic resources. Shortlisted 10 high productive clones at VMG, Forest Campus; Red and sweet Tamarind germplasm bank. Attempted 3500 grafts in 10 high productive clones.

AICRP-16: Bioprospecting for Industrial Utilization of Lesser known Forest Plants

- Existing knowledge in respect of selected 60 LKFPs by various online and offline databases was documented, and analyzed using a structured format, and 25 LKFPs were prioritized for chemical screening. Reviews of 60 LKFPs conveying the knowledge in respect of Distribution, Ethnobotanical significance, Phytochemistry, Biological activities, Toxicology, Patents and Commercial Products aiming at providing a basis for further studies were compiled.
- Field surveys were conducted and 384 populations of 23 prioritized LKFPs namely *Balanites aegyptiaca*, *Buchanania axillaris*, *Carallia brachiata*, *Careya arborea*, *Cassine glauca*, *Cinnamomum cecidodaphne*, *Citrullus colocynthis*, *Cupressus torulosa*, *Cyperus rotundas*, *Gardenia gummifera*, *Litsea cubeba*, *Mallotus nudiflorus*, *M. philippensis*, *Neolitsea pallens*, *Pithecellobium dulce*, *Prinsepia utilis*, *Punica granatum*, *Schima wallichii*, *Soymida febrifuga*, *Vitex altissima*, *V. negundo*, *Woodfordia fruticosa*, and *Xanthium strumarium* were identified. Chemical screening of these populations to identify the chemically superior genotypes was initiated and continued.
- Populations of *Cupressus torulosa* of Oogla (Uttarakhand) origin and that of *Neolitsea pallens* occurring in Dalhousie, Jahaldevidarh road and Khajjiar of Himachal Pradesh yielding highest quantity of essential oils (0.80%, 0.68%, 0.56% and 0.53%, respectively) were identified. Processes for recovery of natural dyes in yield of 19.63%, 23.5%, 13.74% and 31.7% from *Soymida febrifuga* (Bark), *Buchanania axillaris* (Bark), *Careya arborea* (Bark) and *Punica granatum* (fruit peels). respectively were optimized. A process was also developed for application of *Soymida febrifuga* derived dye as hair colorant gel which was tested and found comparable with the marketed hair colorant samples.

AICRP-17: Enhancement of Fodder Availability and Quality to Reduce Unsustainable Grazing in the Forest

- Maintenance of field trials
- Raised nursery stock for left over field trials. Prepared field trial sites left over field trials
- Planting stock both grasses and tree species have been made ready for plantation in monsoon season.

AICRP-18: Silvicultural Interventions for Productivity Enhancement and Carbon Sequestration in Plantations of Important Tree Species

- Completed assessment on growth in 33 boundary planting and 7 block plantations of Teak in Coimbatore district.
- Surveyed and identified 7 block plantation of *Gmelina* at farmers fields viz. Greenwood Agro plantation, Village- Tewar, Jabalpur, Village-Tinsi, near Bargi, Jabalpur, Phoenix Farm, Dehri-Kalan, Jabalpur, Shri Singh, Village- Chargawa, and recorded growth data on from different block and 5 Boundry plantations of *Gmelina* under different irrigation methods like Flood irrigation (traditional method),
- Established and maintained field trials in 3 ha under mixed block plantation of Teak and *Acacia auriculiformis* in two ratios viz, 1:1 ratio and 1: 8 ratio under rainfed condition at Farmers field in Village- Parasi, Dheemerkheda, Katni.
- Established and maintained field trials of teak in boundary planting at 2 m spacing for establishment in 3 ha *Acacia auriculiformis* on either side of the teak row (1 m away from teak row) under rainfed condition is established at Village- Hinautiya, Barela block, Jabalpur district.
- Assessed and documented growth biometry of 45 Block Plantations of farm grown teak under 3 age class (5-10, 10-15, 15-20 years) in North Eastern, North Western and Cauvery delta, Agroclimatic zones of Tamil Nadu.
- Estimated tree volume of 89 farm grown teak plantations (45 Block Plantations, 44 Boundary Plantations) under 3 age class (5-10, 10-15, 15-20 years) in North Eastern, North Western and Cauvery delta Agro climatic zones of Tamil Nadu.

**AICRP-19: Assessment of Water Requirement of Different Forest Tree Species and its Impact on Subsoil Moisture**

- It aims at identifying the best suitable forest species for plantation under different rainfall conditions in the country with an objective to maximise water yield from a catchment. Total water requirement for transpiration of selected tree species are being measured with the help of sap flow monitoring systems. The cumulative impact of transpiration losses and the infiltration shall be assessed by the continuous measurement of soil moisture around the trees under study. Four ICFRE institutes (TFRI, Jabalpur; IFGTB, Coimbatore; AFRI, Jodhpur and FRI, Dehradun) are involved in the project.
- Protocol for instrumentation and data recording has been finalized. Soil profiling and root zone identification has been done by all the partner Institutes. Installation of sapflow monitoring systems and soil moisture & temperature sensors are in progress. Validation of sap flow and soil moisture data is being done.
- Sapwood thickness of over 200 trees of different species has been studied to facilitate proper installation of sap velocity measuring probe. Core samples were also analysed using tree ring analyzer –wind Dendron software to estimate age of the tree. Weather parameters are being recorded at the experimental sites through automatic weather stations.

Aicrp-20: Development of Biopesticide Products/Formulations from Extracts of Tree Borne Oil Seeds and Different Tissues of Wild Plants for Management of Insect Pests.

- Lab and field testing of the efficacy of the biopesticide formulations Tree PAL^H and Crawl clean at different jurisdiction areas of ICFRE Institutes against various forest pests is nearing completion.
- Survey and Collection of target plant sample with biopesticidal properties, its processing and extraction of plant parts/seed oil/ crude extract is also in progress.
- Evaluation of physicochemical properties of some of the plant parts/seed oil/ crude extract has been completed.
- Promising results have been recorded during Bioassay directed isolation, identification of active compounds of insecticidal properties.
- Bio assay for insecticidal activity of active compounds for determination of LC & LD-50 values has been initiated and is progressing.

AICRP-21: Development of Superior Bio-fertilizers for Enhanced Plant Productivity

- The seedlings of *Santalum album*, *Gmelina arborea*, *Dalbergia sisoo* and *Melia dubia* have been raised in the nursery at ICFRE institutes and inoculated with both commercial and ICFRE developed bio fertilizers such as Nitrogen fixing microbes, Phosphate solubilising microbes and Potassium mobilizing microbes.
- It was found that the ICFRE developed biofertilizers have improved both health and growth when compared to commercial biofertilizers.
- These seedlings were also planted/being planted in various fields for testing the efficacy of biofertilizers. The multiplied biofertilizers were also tested against root pathogens for the bio control activity.

AICRP-22: Preparation of Soil Heath Cards under different Forestry Vegetation in all Forest Divisions of India

- The stratification of sampling points representing 05 forest classes as categorized by FSI i.e., (i) VDF, (ii) MDF, (iii) OF, (iv) SF and (v) NF for 16 Forest Types in different forest divisions of India.
- Finalized geo-referenced soil sampling locations in all forest divisions of India using RS/GIS. Strengthened soil laboratories of ICFRE institutes with latest scientific instruments.
- Institute wise number of soil samples collected/ analyzed.

AICRP-23: Genetic Improvement and Value addition of *Madhuca longifolia*

- All participating institutes selected, a total of 496 Candidate Plus Trees.
- Natural regeneration study was carried out in different locations of Madhya Pradesh, Chhattisgarh, Jharkhand, Bihar, Tamilnadu and Uttar Pradesh.
- Nutritional composition of flowers was analyzed and experiments were conducted to formulate energy bar using dried Mahua flowers. Experiments were conducted for development of herbal handwash from leaves and bark. DNA isolation and its optimization from the leaves of *Madhuca longifolia* is in progress.
- Seeds have been collected from CPTs and seedlings have being raised for plantation as well as root stock for grafting. Scions have been collected from CPTs and cleft grafting has been carried out.

Aicrp-24: Combating Desertification by Enhancing Vegetation Cover and People Livelihoods in Degraded Dry Lands and Deserts of India

- AFRI, Jodhpur carried extensive survey in Bikaner, Jaisalmer and Jodhpur for site selection. Udasar site at Nokha, Bikaner was selected for plantation under sand drift control. Seeds of *Ziziphus nummularia*, *Mytenusemarginata*, *Calligonumpolygonoides* and *Cenchrus ciliaris* were collected and seedling raising is under progress.
- The dominant species found in Himachal Pradesh were *Juniperus polycarpus*, *Salix alba*, *Rosa webbiana*, *Colutea nepalensis*, *Hippophaer hamnoides*, *Populus ciliata*, *Salix fragalis*, *Myricaria squamosa*, *Artemisia sp*, *Lonicera sp*, *Cousiniathomsonii*, *Plantago sp*.
- Tours for the site visit were conducted during August 2021 for Jhansi (UP) and September 2021 for districts of Punjab state. Total of 11 soil samples (6 of the Jhansi and 5 of the Punjab) were collected in different depths

**AICRP-25: Domestication, Genetic Characterization, Improvement and Diversified Utilization of Poplars**

- Field trials of 16 clones of *P. deltoides* have been laid out at following sites: FRI 3 sites, HFRI one site and IFP one site. The same set of clones has been planted as per statistical design
- Cuttings of *P. alba* have been raised in the nursery by HFRI for setting up field trials on spacing, soil working technique and hydrogel dose. Cuttings of *P. gamblei* have been planted in the nursery by RFRI for studies on vegetation propagation. Seedlings of *P. gamblei* have been raised in the nursery by RFRI for supply to FRI and IFP for conducting introduction trials along with five fast-growing species

AICRP-26: Genetic Improvement of *Azadirachta indica* A. Juss. (Neem)

- Survey and selection of 100 Candidate plus trees of Neem from Gujarat and 137 Candidate plus trees from Rajasthan was done.
- Intensive survey was carried out in six different agro climatic zones of Tamil Nadu, parts of Pudhucherry and Andhra Pradesh. Selected 120 CPTs based on superiority in fruit yield, tree form and tolerance to pest and diseases. Collected fruits from the 120 selected CPTs and the seeds were processed as per common methodology in proposal for further estimation. The oil was extracted from 120 seed lots and quantified the physio-chemical properties.
- Surveys were carried out and tours were conducted in different locations of Madhya Pradesh and Uttar Pradesh in Agroclimatic zone 8. Total 110 trees were selected from Jabalpur, Katni, Sohagpur, Guna, Chhattarpur, Gwalior (M.P.) and Jhansi and Lalitpur (U.P.) localities.
- Survey was conducted in three agroclimatic zones 3, 4 and 7. So far 283 phenotypically superior trees were selected. Data on tree height, GBH, crown diameter, number of branches etc were recorded for each selected tree. GPS data of each location were also recorded. Oil estimation has been carried out in 27 seed sources of ACZ 7 only. It varies 33 – 54%.
- Selection of CPTs from different ranges and beats was initiated with the help of SFD officials and 176 trees were selected. Geo-coordinates of the trees have been recorded and morphological data such as height, girth, crown length and canopy length etc., was collected and statistically analysed for seed collection.

AICRP-27: Conservation and Sustainable Management of Wild Edible Fruiting Species

- 81 Forest divisions were surveyed for population survey, species richness, and diversity of target plants.
- 211 superior plants of 10 species were selected for germplasm conservation.
- 98% germination was achieved in *Myrica esculenta* seeds in treated seed which were difficult to germinate in untreated condition. Type of container, sowing depth were also standardized for this species.
- Seed treatments for *Flacourtia indica* and *Semecarpus anacardium* was standardised for better germination.
- Induction of rooting was successful in *Flacourtia indica* with treatment,
- Seedlings of 20 germplasm of *Semecarpus anacardium* were raised for conservation.
- Evaluation of storability of 20 species is continued for ex-situ conservation.
- 6 value-added products: karonda chips and energy drink, karonda Powder, khatmithgoli, karonda candy and cherry karonda were prepared from fruits of *Carissa carandus*.

AICRP-28: Population Status, Collection, Characterization and Evaluation of Genetic Resources of Indian Rosewood, *Dalbergia Latifolia*

- Data on population structure, natural regeneration, phenology, associated species, forest types etc were collected from the Cauvery WLS, Bhadra Tiger Reserve, Haliyal, Yellapur, Dandeli, BR Hill Tiger Reserve, Kudremukh National Park and Anshi-Dandeli Tiger Reserve were collected.
- FRI has carried out survey in a progeny trial established by SFD at Lal Kuan, Haldwani, FRI campus recorded disease incidence and collected samples.
- IWST has collected information on silviculture and management practices were collected from working plans of Karnataka and Kerala Forest Department and from literature; and information pertaining to receipt and sale of rosewood timber collected from Forest Timber Depots of Karnataka and Kerala States.
- IWST has conducted studies on pollinators and recorded information on different pollinators, their frequency of visitation etc.
- DNA isolation protocol was standardized at IFP and IFGTB

AICRP-29: Sustainable Management of NTFP's Through Conservation and Value Addition

- Surveyed and collected germplasm of 27 NTFPs yielding species from different regions and assessed quality.
- Conducted Propagation trials of high altitude species- *Thymus serpyllum*, *Rheum australe* *Aconitum heterophyllum*
- Morphological characters and chemical quality of collected germplasm of targeted species and soil samples of different locations have been assessed for the selection of superior germplasm.
- Documented Indigenous Traditional Knowledge (ITKs) on medicinal formulations used for treatment of different chronic diseases (bronchial, arthritis, cardiovascular and diabetes) in different regions under jurisdiction of different institutes.
- Prioritized NTFPs yielding 10 species (based on role in livelihood generation and economically important) for the standardization of post harvest management techniques by different participating Institutes.
- Formulated edible products with *Curcuma angustifolia* starch and *Moringa olifera* leaves powder.
- Two edible value added product of *Dillenia indica* fruits and dyes as value added product from barks of *Aporosaoctandra* have been prepared.



AICRP-30: Development of Package of Practices on *Gmelina Arborea* Roxb. (Khamer or Gamhar) in Selected Agroclimatic Regions of India.

- Surveyed and selected CPTs in Bihar, Jharkh and Haryana, Punjab, Uttar Pradesh, Uttarakhand, Assam, Madhya Pradesh, and Chhattisgarh.
- The phenotypic data of the identified CPTs i.e. Height, Basal girth, GBH and Crown cover were recorded along with the GPS location and details of area.
- 20 sets of new genome wide microsatellite primers were designed for synthesis and optimized.
- Established *Gmelina* based silvi-horti models - *Gmelina* + Banana at Vadakadu, Pudhukottai and *Gmelina* + Papaya at Kangeyam, Thiruppur and multi-tier agroforestry models- *Gmelina* + Casuarina + Ground nut at Soolakal, Pollachi. (Tamilnadu) *Gmelina* with Chilli and *Gmelina* with Cicer and Brassica.
- The symptoms of defoliator, skletonizer and white grub attack were noted on the seedlings in nurseries. It was also observed that light insect attack of defoliator was visible on green trees and seedlings.
- The eight years old plantation of *G. arborea* at Budhani, Bhopal (MP) was infested by bark eating caterpillar, *Indarbla quadrinotata* and termites. Insect samples were collected, incidence of infestation was recorded and their identification is in progress.

AICRP-31 : Study of Climate Driven Effects on Indian Forests through Long Term Monitoring

- The project encompasses studies on detailed temporal and spatial changes in structure and function, carbon regulating services, nutrient dynamics, biodiversity, phenology, invasive species, pest and disease incidence, soil health etc. in selected forest types. Permanent research plots (Eleven 10 ha plots; one 4ha plot; two 3ha plots; twenty three 1ha plots) for long term monitoring of climate change impacts on Indian forests are being studied in a total of 143 ha area in different forest types.
- Common protocols developed and shared with all partner institutes. Layout and gridding of the experimental plots have been completed by most of the institutes and enumeration is in progress. Biodiversity of the respective area are being studied following belt transect method (30 transects of 250 m length). These transects are used for repeated observations on fungal species, insects, pests, pollinators and regeneration status. Various vegetation parameters and indices are being analysed. Observations on flowering host plants, their pollinators, and frequency of insect pollinators are being recorded.
- Fungal fruit bodies and their abundance, fruiting pattern and host preferences are being recorded along with the geo-tagging. Phenological study is being conducted on 2921 geo-tagged individuals belonging to 264 species in different forest types. Soil samples are being collected for estimation of various physicochemical properties. The weather data are being recorded from the automatic weather stations installed at the experimental sites.



Restocking Tamarind Genetic Resources in Avenues



Stocking and numbering of Tamarind approach grafts at Salem FRS



Fodder species in nursery



Peels from *Punica granatum*



Annual incremental growth recorded in Teak and Cadamba plantations under drip irrigation system



Mass multiplication of Bio-fertilizers from using strains of IFGTB developed Bio-fertilizers



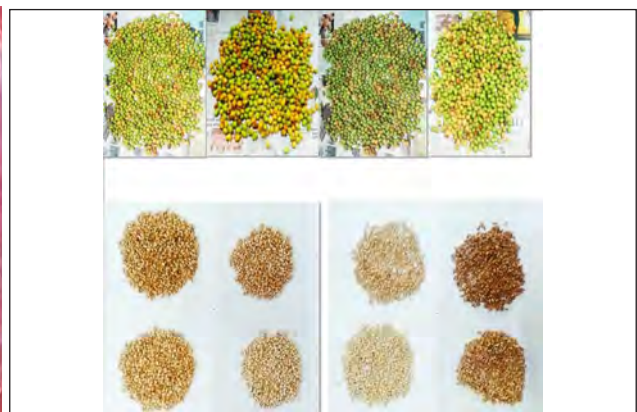
Nursery trails on the seedlings of *C. deodaraat* Jagatsukh (Manali) and Jhungi (Manali)



Collection of Mahua flowers, drying, processing for biochemical estimation and oil estimation from seed samples and extracted oil



Value added product "Khat-Mith" goli & "Karonda Candy"



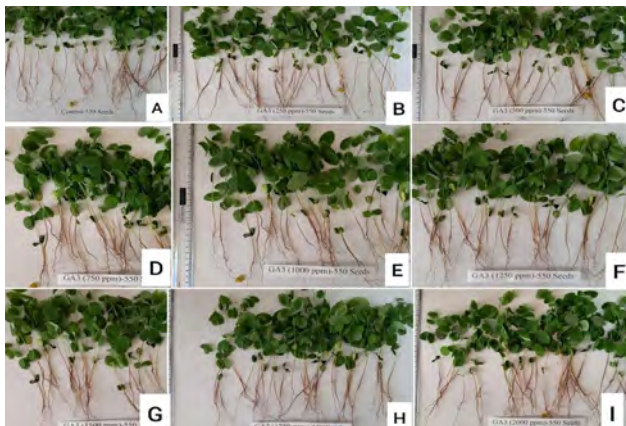
Collection and drying Neem fruits



Value addition of *Arundanalia falacata* in different forest division of Uttarakhand



Traditional practice of processing of Mahua flower



A.I Gibberellic Acid treated seedlings growth measurements



Onsite training at Mudumalai



View of the mangrove plot at Cuddalore

Component 2; National Programme for Conservation and Development of Forest Genetic Resources (FGR)''



Progress of FRI, AFRI, HFRI, IFP, RFRI

- 750 FGR species prioritized based on parameters
- Eco-distribution mapping initiated, **GPS points of 63** priority FGRs have been recorded from different forest areas. Forest type maps of 25 species were generated
- For establishment of Field gene banks, seeds of **8** different FGR species were collected from different forest area of UP, Haryana, Punjab, Rajasthan and Himachal Pradesh

PROGRESS OF FGR (IFGTB, TFRI, IWST & IFB)

- Two hundred tree species have been prioritized for FGR documentation and conservation : 35 for *in-situ*, 35 for field gene bank and 130 for seed gene bank
- Prepared species distribution maps for 40 study species
- Conducted seed storage studies of 12 FGR species for long-term storage



DIVERSITY OF FGRs

18,236 higher plant species in India
(18,159 Angiosperms and 77 Gymnosperms)

More than 80% of this higher plant diversity
in the forest habitats (≈14,500 species).

About half of this forest plant diversity constitutes FGRs
(≈7,250 species).

Remaining being herbaceous flora including soft climbers,
twiners, herbs, and grasses.




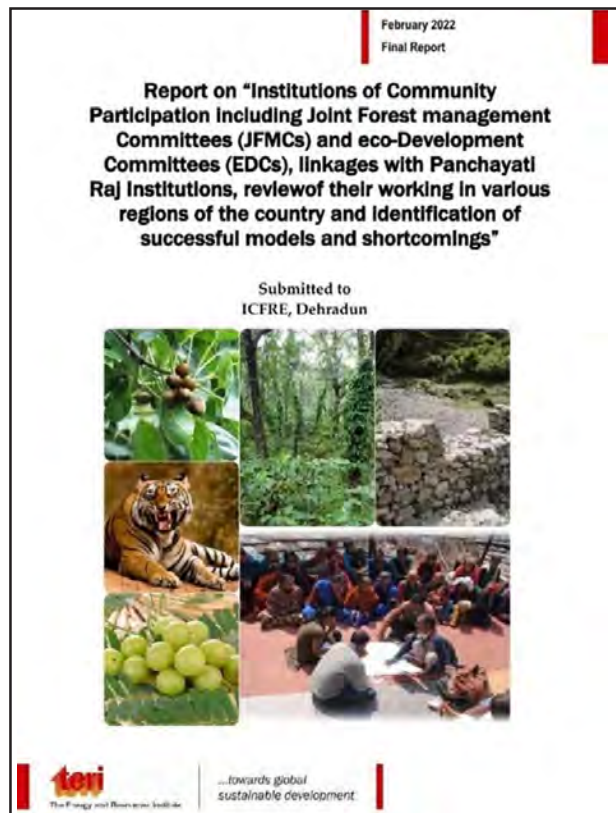
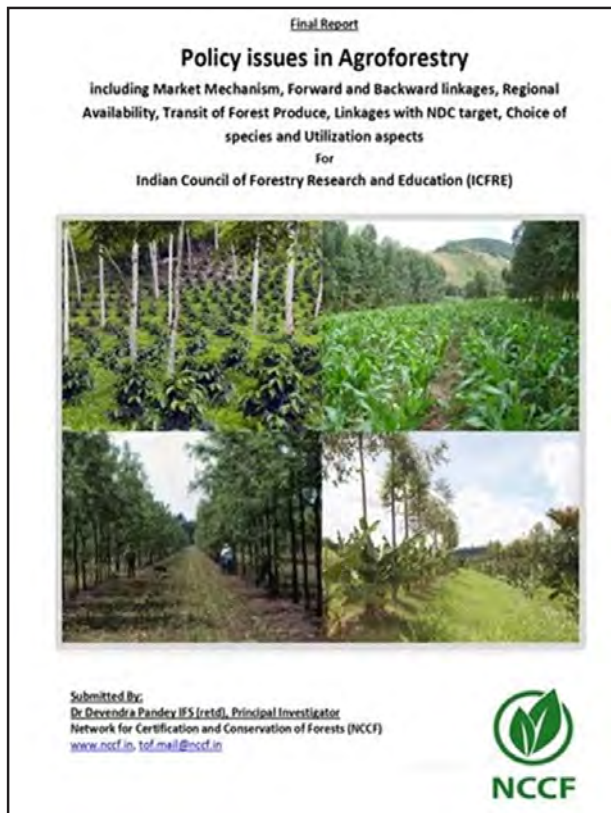
Table 2.3 Number of known floral species (including algae, fungi and lichens), their endemism and threat status

Type	Number Species	Number of Endemic Species	Number of Threatened Species
Gymnosperms	79	12	7
Angiosperms	18159	4303	1750
Bryophytes	2748	629	c. 80
Phanerophytes	1289	88	474
Algae	2327	1824	Not known
Fungi	10115	c. 4130	c. 580
Lichens	2611	c. 520	Not known
Total	46,835	11,554	-

Threat

Component 3: Policy studies under Centre for Forest Policy Research

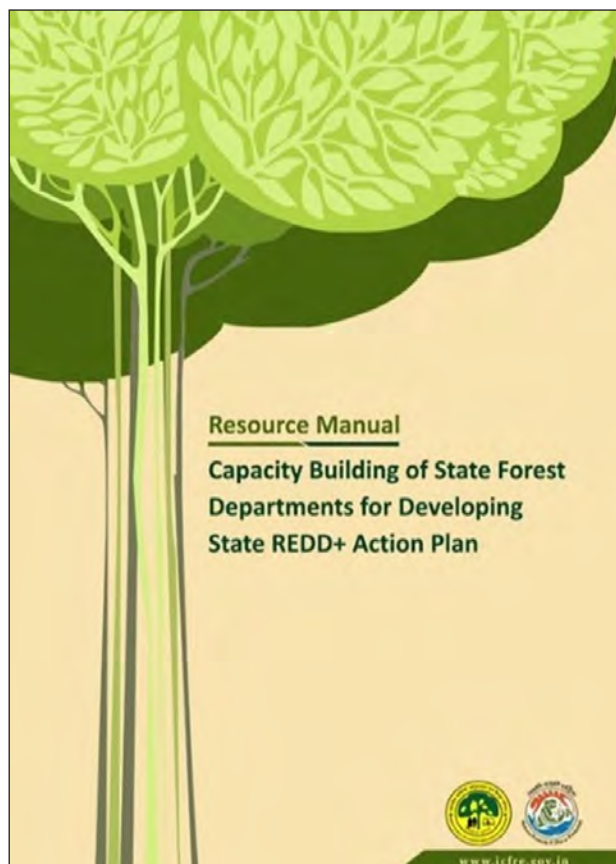
Under CFPR, 6 studies have been allotted			
SN	Name of study	Name of the executing Agency	Present Status
1.	Institutions of community Participation including Joint Forest Management Committees (JFMs) and Eco-Development Committees (EDCs), linkages with Panchayati Raj Institutions, review of their working in various regions of the country and identification of successful models and shortcomings	TERI, New Delhi	Final report submitted to ICFRE & MoEF&CC
2.	Policy issues in agroforestry including market mechanism, forward and backward linkages, regional availability, transit of forest produce, linkages with NDC targets, choice of species and utilization	NCCF, Noida	Final report submitted to ICFRE & MoEF&CC
3.	Popularization of the use of Wood and Wood Substitutes as per the National Forest Policy and Modalities for Facilitating Industries for its Optimum Utilization	NCCF, Noida	Inception report has been accepted.
4.	Functioning of Forest Development Corporations and their role in the present Scenario	IUCN and IORA, New Delhi	Inception report has been accepted.
5.	Issues in forest certification and certifying agency	GICIA, India Pvt. Ltd. Nodia	Inception report has been accepted.
6.	Study of grazing policies in different states and formulation of grazing policy guidelines for states	Society for Resource Planning Development and Research, Bhopal	Inception report has been accepted.



Final Reports submitted to MOEF&CC

Component 4: Capacity Building of State Forest Departments for developing “State REDD+ Action Plans” under National REDD+ strategy”

- A resource manual for capacity building of State Forest Departments for developing State REDD+ prepared and published.
- Organized the 17 capacity building programmes for State Forest Departments of Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Gujarat, Haryana, Jharkhand, Kerala, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Nagaland, Odisha, Punjab, Rajasthan, Tamil Nadu, Tripura, Uttar Pradesh, West Bengal, Andaman & Nicobar Island, Dadra & Nagar Haveli, Jammu & Kashmir and Ladakh for developing State REDD+ Action Plans.
- The methodology and process followed for organizing the training workshops were based on the Resource Manual: Capacity Building of State Forest Departments for Developing State REDD+ Action Plan (2020) developed by ICFRE under the project component. Following the introductory and contextual background on REDD+ mechanism and overview of preparation process of State REDD+ Action Plan, the workshop participants were divided into three working groups (1. Deforestation, 2. Forest Degradation and 3. Forest carbon Enhancement) in order to analyze and prioritize the most important drivers of deforestation and forest degradation, as well as the main barriers forest carbon enhancement activities in the state. The process involved firstly prioritization (e.g., of deforestation drivers) within each Working Group, secondly a plenary presentation of the higher priorities by each Working Group, and thirdly an overall scoring by all workshop participants of all the prioritized by the three Working Groups.



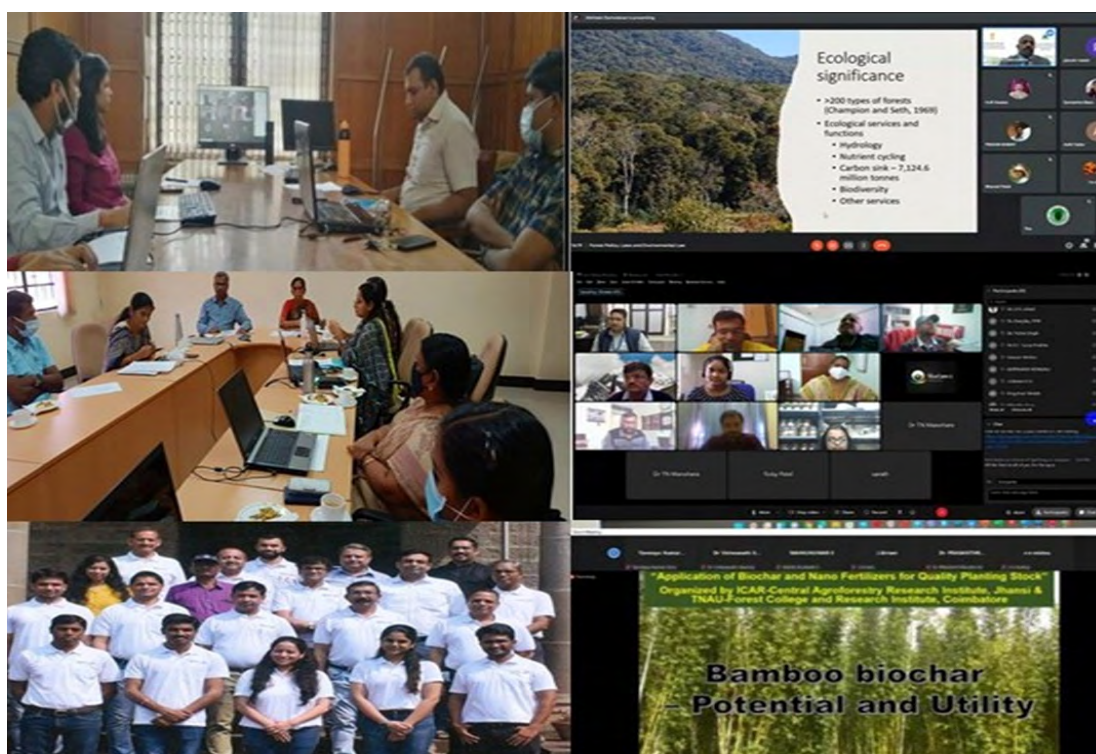


Component 5: Capacity Building of State Forest Departments for developing “State REDD+ Action Plans” under National REDD+ strategy”

Under this component training programmes have been organized through online mode for Technical Staff/ Administrative Staff of ICFRE and Its Institutes under the Human Resource Development Plan. During the

period following trainings have been organized by different ICFRE and non- ICFRE institutes: In total 474 participants have been trained in the trainings listed below.

SN	Name of Training	Target Group
1.	Forest Certification	Scientists
2.	Forest Policy, Laws and Environmental Law	Scientists
3.	Biodiversity Assessment, Conservation and Development	Scientists
4.	Bio-Informatics And Computational Biology	Scientists
5.	Soil and Water Assessment Tool (SWAT)	Scientists
6.	Identification and Characterization of Microorganisms	Scientists
7.	Application of Biochar and Nano Fertilizer for Quality Planting Stock	Scientists
8.	Wood Seasoning Preservation and Composite Wood	Scientists
9.	Advance Training in Molecular Biology Techniques and Its Application	Scientists
10.	Economic Valuation of Forest	Technical Officers
11.	Field Survey Data Collection Compilation and Analysis (Phase-I (online))	Technical Officers
12.	Cultivation Processing Techniques and Management of Non-Wood Forest Products Including Medicinal Plants	Technical Officers
13.	Field Survey Data Collection Compilation and Analysis (Phase-Ii)	Technical Officers
14.	Advanced Training in Computer Networking and Internet Applications (Phase-II)	Technical Officers
15.	Nursery Development and Vegetative Propagation	Technical Officers
16.	Use of Global Positioning System	Technical Officers
17.	Experimentation and Data Management in Tree Improvement	Technical Officers
18.	Sexual Harassment of Women at Workplace (Prevention, Prohibition and Redressal) Act 2013	Scientists, Technical Officers & MTS
19.	Induction Training of Scientist-B (Phase-II)	Scientists



Glimpses of various training programmes conducted under HRD



Component 6: Operationalisation of Forestry Extension Strategy and Action Plan of ICFRE

Heads	Targets achieved
Establishment of new VVK	8 VVKs established at <ul style="list-style-type: none"> • Salem, Tamil Nadu; • Mandi, Himachal Pradesh • Gottipura, Karnataka • Jagadapur, Chhattisgarh; • Sukna, WB; • Udaipur, AFRI; • Mulugu, Telangana; • Hastinapur, UP
Technology Demonstration Centre	08 TDCs being established (IFP, FRI, IWST, HFRI, IFB, TFRI, RFRI & IFGTB).
Demo Village	Established one new DV at Baragaon, Shimla. Establishment of three new DVs at Mohangarh, Rajasthan, Topra, Jharkhand and Attivata, Karnataka are under progress.
Tree Growers Mela	<ul style="list-style-type: none"> • TGM organized at Erode, Tamil Nadu by IFGTB in collaboration with ICAR. • IFP, Ranchi organized Workshop on Bamboo Growers and Bamboo Entrepreneurs under TGM • FRI, Dehradun/FRC-ER, Prayagraj organized Kisan Mela at FRC-ER, Prayagraj. • TFRI, Jabalpur organized “Kisan Mela” for 400 farmers on at KVK-Mandla to strengthen the KVK – ICFRE linkages and dissemination of TFRI Technology among them. • RFRI, Jorhat organized Tree Growers’ Mela for Agarwood Farmers. Along with it, Second National Seminar on Agarwood was also held.
Documentary Films	30 documentaries prepared on research and extension activities like documentary on Cold desert of NW Himalayas, Sandalwood Spike Disease and Agroforestry, Lac Cultivation, Trichocard Technology, Production of improved planting material in Bamboo ,Management of Fly ash in Thermal Power Plants etc have been prepared.
Publication	HFRI- 07 pamphlets on medicinal plants, TFRI -10 Technical bulletins and 02 brochures& IWST- 06 technical bulletins.
Modified Direct to Consumer (MDTC)	<ul style="list-style-type: none"> • Manufacture of ArborEasy DNA isolation kit: A total of 430 reactions were sold. • Improvement of VAM Production unit extended for producing 2000 kg of VAM/year. • Produced 3000 Quality Planting Materials of windbreak clones for supply to farmers to establish demo plots. Established one demo plot with the windbreak clonal plants produced under MDTC-CAMPA in Narasipuram village in Coimbatore District of Tamil Nadu. • Conducted 03 online trainings on seed cake mixture for the staff of SFDs



Training in Collaboration with KVK Rohru



Maintenance of Nurseries at Bichhwal, Bikaner and Mohangarh, Jaisalmer





Research Publications, books, bulletins from the scheme “Strengthening Forestry Research for Ecological sustainability and Productivity Enhancement

Research papers presented in conferences, seminars, symposia etc.

Behera, D., Menon, D., Wilson, V., Das, P., & Ayyappan, N., 2021; “Integration of Sentinel-1 and Sentinel 2 for the estimation of biomass in a tropical wet evergreen forest”. In: 11th International Conference on Ecological Informatics (ICEI 2020+1). pp. Online, Thiruvananthapuram, India, 9-13 November 2021.

Bhasker, T.R., Dev, S.A., Balakrishnan, S. and Modhumita G. 2022; “Development of neutral and adaptive genomic markers for management of *Santalum album* Linn. Paper presented at the Environmental Sciences, Forestry & Wildlife section” presented in 34th Kerala Science Congress, Thiruvananthapuram, Kerala, India, 10-12 February, 2022.

Borpuzari, P.P., Singh, M.K. and Bhuyan, T. (2020); Agroforestry of *Gmelina arborea*: An economically important tree species, presented at International Plant Physiology Virtual Conference “Prospects of Plant Physiology for Climate Proofing Agriculture December, 6-7, 2020; pp182

Kumar, P. Anukriti., Thakur, P. and Sharma, N. 2021; “Importance of Himalayan Plants extracts as a potential biopesticides formulations to control insect pest of forest nursery” presented in International Conference on Indian Culture, Science & Traditions, organized by HFRI, Shimla and Science & Management Society, H.P. in collaboration with 24 degree and PG colleges of H.P. and Haryana at HFRI, Shimla on November.

Mayavel, A., Bagathsingh, C., Chitra, P. and Dharani, M. 2022; ‘Breeding System and Potential Pollinators of *Tamarindus indica*, L.’, ETNVAS 2022: Book of Full research Papers, SVMCH & RC, Puducherry, 12th February, 2022, pp.59-61.

Research papers published in journals

Karthikeyan, A., Kalaiselvi, R. and Sujithra, V., 2021; “Vegetative propagation technique for *Pterocarpus santalinus* L.f.” *Indian Forester*.147(3): 316-317.

Khannam, A., Hamalton, T., Somashekar, P.V., Chandrakala, D., 2021; “Hydroponic acclimatization of micropropagated Bamboo plantlets”. *Indian Journal of Tropical Biodiversity*, 29(1): 54-59.

Buvaneswaran, C., Anurag, R. and Nagarnambi, M. 2021. Modern Silvicultural Practices and Productivity of Teak. In.: Yasodha, R., Galeano, E. and Win, T. T. (Eds.). *The Teak Genome*. Springer Nature, Switzerland. pp 27-44 ISBN: 978-3-030-79310-4

Esakkiammal, S., Sugitha, T., Chitra, P., Nicodemus, A., Nagarajan, B., Mayavel, A. 2021. Evaluation of red tamarind (*Tamarindus indica* var. *rhodocarpa*) pulp extract on phytohistological studies under fluorescent microscope. *Plant. Cell. Biotechnol. Mol. Biol.*22(53&54):37-46.

Kumar, Seema, Jayant, B.V., Khatri, Moolchand and Parmar, V. K. 2020; *Lantana camara* (Raimunia). *AFRI Darpan* (July-Dec) 18(3-4): 3-4.

Maneesh S. Bhandari, Shailesh Pandey, Aman Dabral, Rajendra K. Meena and Rama Kant. 2021. *Global Forestry Perspective: COVID-19 Impact and Assessment*. National Academy Science Letters. ISSN 0250-541X. eISSN 2252–1754. IF: 0.40. <https://doi.org/10.1007/s40009-021-01062-x>

Mayavel, A., Soosai Raj, J., K. Sreenivasan and Nicodimus, A. 2020. Effect of Different Concentration of Indole-3- Butyric Acid and Cutting Size on Rooting in *Gmelina* (*Gmelina arborea* Roxb.). *Journal of Krishi Vigyan*. 9(1): 63-67.

Monika Singh, A. Rajasekaran and Lalit Kumar (2021). Modeling potential hotspots of invasive *Prosopis juliflora* (Swartz) DC. In India, *Ecological Informatics* 64(7):101386.

Muthukumar, A., G. M. Sandhya and Dakshayini, G. 2021. Morphological and Biochemical Characterization – A Comparative Analysis of Non-commercial and Commercial Plant Growth Promoting Microorganisms. *Int. J. Curr. Microbiol. App. Sci.* 10(02): 867-874.

Paper entitled “Screening the Biometabolites of *Pterocarpus santalinus* L.F. - An Endemic, Threatened, Medicinal and Multipurpose Plant Taxon.” is accepted for publication in the *International Journal of Pharmacy and Biological sciences* ISSN: 2230 7605.

Singh, P., Rana, A., Panwar, N. S. and Kumar, A. Review on tree improvement, breeding and biotechnology of *Gmelina arborea* Roxb. *The Indian Forester*.

R. Bansal, S. Nair, K.K. Pandey (2022) UV resistant wood coating based on zinc oxide and cerium oxide dispersed linseed oil nano-emulsion. *Materials Today 30 Communications*, 103177.

Published books/technical bulletins, manuscript, brochures and other publications

Two Technical Bulletins on Propagation and Management of different species of Bamboos were published in English and Hindi language.

Article on “Bamboo based multipurpose windbreak- An effective measure for reduction of wind disaster in Tripura”

Manuscript on Smallholder teak agroforestry in the globalising world: Opportunities and challenges for India. Submitted to *Agriculture and Forestry journal*

A brochure on management of tissue culture teak in plantations in Tamil was prepared, released during the Tree growers Mela during September 2021. Microwave processing of bamboo, *Wood is Good*, 1(2): 73-75, 2021.

Singh Manish K. and Bhuyan T., 2021; A pictorial guide on “Tree Blossoms of northeast India”, RFRI, Jorhat.

Leaflet entitled “*Madhuca longifolia* (Mahua): A Useful NTFP Species of Madhya Pradesh” was published by TFRI, Jabalpur.

Videography

Under AICRP-3 on Sandal, a video was prepared on estimation of heartwood using ERT in standing trees of sandalwood.

Under AICRP-4 on Eucalyptus, a video on Cultivation practices of Eucalyptus clones in dry lands is being prepared for creation on awareness among the farmers of Tamil Nadu.

Under AICRP-23 on *Gmelina*, Indigenous Traditional Knowledge were collected and documented from different locations in Tamil Nadu and Kerala through questionnaire, photos and videos.



Research papers presented in conferences, seminars, symposia etc

- Mayavel, A., Chitra, P., Senthil Kumar, N., Nagarajan, B. 2021; Phytochemical screening of red tamarind clones in Tamil Nadu presented at IHC- NEXT Generation Horticulture Tamil Nadu Agricultural University.
- Mayavel, A., Krishnan, S., Sivarathinavel, R.A., Ajith Kumar, A. and Nagarajan, B. 2020; Effect of grafting season and clone for deploying commercial propagation of tamarind (*Tamarindus indica*). In: Virtual Workshop on Clonal Propagation of Tree Species. Organized by: Institute of Wood Science and Technology, Bengaluru, 7th October 2020, pp. 18.
- Menon, D., Behera, D., Ayyappan, N. & Aravajy, S., 2021; "Understanding tropical phenology of the Western Ghats: Combining citizen science and expert based approach". In: 11th International Conference on Ecological Informatics (ICEI 2020+1) Online, Thiruvananthapuram, India, 9-13 November 2021.
- Pandey Shailesh, 2022; "Molecular taxonomy of fungal pathogens of Poplar" presented in 4th International Conference "Challenges and Opportunities in Agriculture, Horticulture, Environmental and Biotechnology Science in Current Era" on 26-27 February, 2022 organised by Department of Biotechnology & Microbiology, Kalp Laboratories (2nd position for best oral presentation on topic).
- Prakash K Chandra, Singh, P, M Sagar and Sandeep G., 2021; "A Study of Important Medicinal Plants of Kowdipally Forest Area Medak Telangana" presented in National Conference-Value Addition and Marketing Of NTFPS", TFRI, Jabalpur Pp. 87.
- Shukla S.R., 2021; "Extraction of nanocellulose and development of Eco-friendly composites" presented in International Conference on Advances in Smart Materials and Emerging Technologies, ASMET held during December 20-21.
- Shukla S.R., 2022; "Chemi-mechanical processing of cellulose nanofibers from bamboo and development of natural fiber-based nanocomposites" was presented in an International e-Conference on "Nanomaterials & Nanoengineering" held during February 24-26, at National Physical Laboratory, New Delhi (India)
- Shukla S.R., 2022; "Properties of Nano-Wood Composite (NWC) prepared from *Populus deltoides* impregnated with nano Zinc Oxide fortified PVAc resin" presented in an International e-Conference on Nanomaterials and Nanoengineering, APA Nanoforum-2022 held during 22-26 Feb, at National Physical Laboratory, New Delhi (India).
- Sreenivasan, K. Krishnan, S. Soosai Raj, J. and Mayavel, A. Quality Planting Stock Production of *Gmelina arborea* Roxb. Virtual Workshop on "Clonal Propagation of Tree Species" 7th October 2020, organized by Institute of Wood Science and Technology (IWST), Bangalore. Pp.3.
- Warrier Rekha R., 2022; "Smallholder teak agro forestry plantations: scope and prospects in India" presented during the National Webinar on "Augmenting Teak Timber in India: A way forward" held on 21st and 22nd March 2022 (online mode) at IWST, Bengaluru.



ESTIMATION OF ECONOMIC LOSSES IN REAL TERM PER HECTARE BASIS DUE TO FOREST FIRE IN UTTARAKHAND AND MADHYA PRADESH

Indian Council of Forestry Research and Education (ICFRE)

Introduction:

Based on the recommendations of the Parliamentary Standing Committee on Science & Technology, Environment & Forests to Uttarakhand (June 2016) Ministry of Environment, Forest & Climate Change (MoEF&CC), Govt. of India (GoI) vide letter no. F.No.7-2/2016-FPD dated 11th March, 2017 requested Indian Council of Forestry Research and Education (ICFRE), Dehradun to submit a proposal for undertaking the study on Estimation of economic losses in real term per hectare basis due to forest fire. Accordingly, ICFRE proposed a pilot study entitled “**Estimation of economic losses in real term per hectare basis due to Forest Fire in Uttarakhand and Madhya Pradesh**” for funding from National Authority CAMPA towards addressing the requirements of **estimation of total economic loss in real terms of monetary value on per hectare basis for the study states of Uttarakhand and Madhya Pradesh**. Through the study framework / approach / methods / tools and techniques will be provided to estimate tangible and intangible losses due to forest fire on per hectare basis which may be used in other similar situations. **The pilot study being multidisciplinary in nature will be conducted by ICFRE through its institutes at Dehradun (Forest Research Institute) and Jabalpur (Tropical Forest Research Institute) in association with partner institutions mentioned below: -**

- i. Forest Survey of India (FSI), Dehradun
- ii. Wild life Institute (WII), Dehradun
- iii. National Institute of Hydrology (NIH)
- iv. G.B Pant National Institute of Himalayan Environment & Sustainable Development, Kosi-Katarmal, Almora, Uttarakhand (GBPIHESD)

The total outlay of scheme is Rs 378.840 lakhs. The scheme is for 24 months.

Objectives of the Scheme are as under:

- a) To quantify the forest loss in terms of total economic value i.e., monetary value on per hectare basis for the forest types in the States of Uttarakhand and Madhya Pradesh.
- b) Burnt area assessment and severity classification due to forest fire for the respective states.
- c) Economic loss assessment of terrestrial flora due to forest fire on per hectare basis for the respective states
- d) Economic loss assessment of faunal diversity due to forest fire on per hectare basis for the respective states
- e) Economic loss assessment of hydrological changes due to forest fire on per hectare basis for the respective states

- f) Economic loss assessment of provisioning services and cultural value of forest produce loss due to forest fire on per hectare basis for specific forest types and extrapolated for the respective states.

Physical Targets of each institute objective-wise are given below:

- **Forest Survey of India:** Burnt area identification, Verification and finalization of study sites based on severity
- **GB Pant National Institute of Himalayan Environment:** Quantification and valuation of losses of timber, fuelwood, fodder, wild edibles, medicinal and aromatic plants, leaf litter and forest regeneration due to forest fire in Uttarakhand and Madhya Pradesh
- **Wild Life Institute:** Economic Loss Assessment Of Faunal Diversity Due To Forest Fire On Per Hectare Basis For The Respective States
- **National Institute of Hydrology:** To assess the economic losses per hectare basis due to hydrological changes caused by forest fires in different types of forests in Uttarakhand and Madhya Pradesh.
- **Forest Research Institute:** Economic loss assessment of terrestrial flora due to forest fire on per hectare basis for Uttarakhand
- **Tropical Forest Research Institute:** Economic loss assessment of terrestrial flora due to forest fire on per hectare basis for Madhya Pradesh

Progress

Forest Survey of India, Dehradun

- Observations were taken w.r.t. 2019 Fire season, covering 5 Forest Types in Madhya Pradesh and Uttarakhand,
- **In Uttarakhand:** 4897 polygons of Uttarakhand received from FSI. 289 polygons validated by UKSFD and FSI. Finalized 42 polygons for study (moderately burnt =32, low burnt =10).
- **In Madhya Pradesh:** 17288 fire polygons of Madhya Pradesh received from FSI. 228 polygons validated by MP SFD and FSI.
- Finalized 49 polygons for study (severe burnt = 5, moderately burnt =24, low burnt =20)

GB Pant National Institute of Himalayan Environment, Almora

- During the pre and post rainy seasons of 2020 and 2021, total of 2860 study plots for trees, 5720 for shrubs and 8580 for herbs were laid out in burnt and unburnt sites of the identified polygons of U.K. (42) and M.P (49).



- To assess the monetary value of loss due to fire (fodder, fuel wood, NTFPs, MAPs, wild edibles, litterfall, and forest regeneration etc.) standard rates of forest department and other deptts. were used. 35 meetings in U.K. and 31 meetings in M.P. were organized among the villages nearby studied polygons that involved 323 forest officials/field staff and 944 local people including women.
 - Monetary loss of the forest goods for Uttarakhand was found Rs. 130387/ha (range= Rs. 9595-352752) and Rs. 114327/ha for M.P. (range= 15892-249614) across the studied polygons (39 in UK and 47 in M.P.).
 - Monetary loss due to forest fire according to slope in Uttarakhand forest sites was recorded higher for polygons having >18 degree slope (Rs. 138980/ha), than the polygons of 0-18 degree (Rs. 102887/ha).
 - In Madhya Pradesh forest the highest monetary loss was recorded in the polygons having 0-5 degree slope (Rs. 150350/ha), followed by the polygons of 11-36 degree (Rs. 108566/ha), and lowest at 5–11 degree slope (Rs. 101211/ha).
 - In Uttarakhand, according to altitude the highest monetary loss was recorded in polygons having 1800-2200m altitude (Rs. 178473/ha), followed by 900-1800m altitude (Rs. 162963/ha), and minimum at 0-900m altitude (Rs. 53527/ha).
 - In M.P. the highest monetary loss was recorded in polygons having 600-900m altitude (Rs. 118692/ha), followed by 0-300m altitude (Rs. 117982/ha), and minimum at 300-600m altitude (Rs. 113330/ha).
 - In Uttarakhand, according to aspect the highest monetary loss was recorded in the west aspect (Rs. 153285/ha), followed by north aspect (Rs. 136058/ha), south aspect (Rs. 122775/ha), and minimum at east aspect (Rs. 94597/ha).
 - In M.P. the highest monetary loss was recorded in the east aspect (Rs. 123736/ha), followed by north aspect (Rs. 114659/ha), west aspect (Rs. 113745/ha), and minimum at south aspect (Rs. 106339/ha).
 - The highest monetary loss was recorded in the Subtropical Pine Forest (Rs. 170392/ha), followed by Himalayan Moist Temperate Forests (Rs. 150243/ha), TOF/Plantation (Rs. 51671/ha), Tropical Moist Deciduous Forests (Rs. 40250/ha), and minimum in the Tropical Dry Deciduous Forest (Rs. 9595/ha) in Uttarakhand.
 - In Madhya Pradesh the monetary loss value ranged between Rs. 15892 to Rs. 249614 in Tropical Moist Deciduous Forest, and the mean value was computed Rs. 121888/ha; in the Tropical Dry Deciduous Forests Rs. 29768-136006 (mean= Rs. 170392/ha) and in the Tropical Dry Deciduous Forest the mean value was Rs. 92271/ha.
- i. An absolute figure of **Rs 26,592/-** is estimated to be warded off for wildlife losses due to forest fire per ha annually in **Binsar WLS**.
- ii. An absolute amount of **Rs 81,506/-** is estimated to be warded off for wildlife losses due to forest fire per ha annually in **Nandhaur WLS**

Estimated monetary loss of faunal diversity using density approach in per ha basis

- i. It is assumed that 25% of ground dwelling species (reptiles & rodents) were affected
- ii. Being surface fire, it is assumed that 25% of prey species & birds were severely damaged viz. reptiles, rodents, ground dwelling birds; $25\% * 4000 = 1000$ & $25\% \text{ of } 358 = 90$.

National Institute of Hydrology, Roorkee

- Minor decrease in soil infiltration rates is found due to fires. The same may be attributed to the repulsive behavior due to ashes of burnt vegetation getting accumulated over soil surface and soil pores
- Soil moisture retention is found to be decreasing due to fires. This may be due to the reduction in organic matter content caused by burning of upper soil layers. Presence of organic matter in soil is the foremost governing factor for soil moisture retention
- Permeability rates is found to be decreasing due to the accumulation of ashes of burnt vegetation over the soil surface and soil pores.
- Runoff and sediment yields are increasing after fires and the change in sub-surface water storage is decreasing. This is in line with the field and laboratory investigations.
- In Uttarakhand, the economic losses due to hydrological change have been estimated as Rs.178.23 and Rs.1170.97, respectively for low burnt and moderately burnt forest sites.
- In Madhya Pradesh, the economic losses have been estimated as Rs.958.01, Rs.608.12 and Rs.421.35, respectively for severely burnt, moderately burnt and low burnt.

Forest Research Institute, Dehradun/ Tropical Forest Research Institute, Jabalpur

Economic losses in Uttarakhand:

- In Tropical Dry Deciduous overall losses of carbon ha⁻¹ estimated **Rs. 8,026.11**
- In Tropical Moist Deciduous the overall losses of carbon ha⁻¹ estimated **Rs. 10,023.03**
- In ToF and Plantations overall losses of carbon ha⁻¹ estimated **Rs. 16422.28**
- In Subtropical Pine overall losses of carbon ha⁻¹ estimated **Rs. 19,7369.18**
- The maximum carbon losses have been found in Himalayan Moist Temperate Forests estimated **Rs. 26,059.46**

Wild Life Institute, Dehradun

Total loss in per hectare basis = Total loss in INR / Degraded area in hectare



Economic losses in MP:

- In Tropical **Moist** Deciduous overall economical losses is **Rs. 20510** ha⁻¹ with range of Rs 2658-77396 ha⁻¹ due to mean carbon stock loss of **5.40 t/ha** and range of 0.7-20.38 t/ha.
 - In Tropical **Dry** Deciduous overall economical losses is **RsRs. 17540** with range of Rs. 646-77472 ha⁻¹ due to mean carbon stock loss of **4.60 t/ha** and range of 0.17-19.61 t/ha.
 - In MP, overall economical losses is **Rs. 18389.20** with range of Rs. 646-77396 ha⁻¹ due to mean carbon stock loss of 4.80 t/ha and range of 0.17-20.38 t/ha.
- Low slopy (? 5°) area does not show any significant changes in carbon stock loss while higher does (5-11, >11°).
 - Moderate forest density showed significant changes in carbon stock loss while other (VDF, Open) did not.
 - Among 4 surface aspects, only west aspect showed significant changes in carbon stock loss while others did not.



REJUVENATION OF DAMODAR AND SUBARNREKHA RIVERS THROUGH FORESTRY INTERVENTIONS

Indian Council of Forestry Research and Education (ICFRE)

Damodar and Subarnrekha are two major east flowing rivers catering to support various human, biological and industrial needs in the eastern part of the country encompassing Jharkhand, West Bengal and Odisha. Jharkhand being the mineral rich state, most of the industries are established along catchment of these rivers and one of the major causes of depleting river quality. Especially, the Damodar river is considered as the most polluted river of the country.

The Subarnarekha River begins near Piska village (23° 18'02"N and 85° 11'04"E) in Ranchi and runs through Jharkhand, West Bengal, and Odisha until entering the Bay of Bengal near Kirtania port (21° 33'18"N and 87° 23'31"E). The river passes through Ranchi, Seraikela-Kharsawan, and East Singhbhum, West Bengal, and Odisha's Balasore District. The river's maximum length (285km) is in Jharkhand, 83km in WB, and 79km in Odisha. Ruru, Kanchi, Karkari, Kharkai, Garra, and Sankh are its primary tributaries.

Damodar is a rain-fed river that begins near Khamarpat hill in Chhota Nagpur plateau near Chandwa, Jharkhand, and flows for about 545km before merging into the bay of Bengal. The Damodar river, joins the Ganga east of the Sone. Damodar River Basin is a subbasin of Gages Basin and drains 23,370.98 sq. km in Jharkhand and West Bengal. The basin encompasses 11.8% and 8.6% of Jharkhand and West Bengal, respectively. Hazaribag, Ramgarh, Koderma, Giridih, Dhanbad, Bokaro, and Chatra in Jharkhand; Burdwan and Hooghly in West Bengal are in the Damodar River basin. It largely covers Jharkhand's Palamau, Ranchi, Lohardaga, and Dumka, and West Bengal's Howrah, Bankura, and Purulia. State-wise Damodar River Basin constituents are presented below.

Considering the great reserves of minerals and other natural resources its significance in the eastern part, a well-defined rejuvenation plan for the Subarnarekha river and Damodar rivers need to be formulated, addressing the various issues including flood, pollution, river ecosystem, ecological development and natural resource management while providing socio-economic support to rural living in the vicinity of the river. Accordingly, a DPR for the rejuvenation of these rivers have been proposed with following objectives:

1. Review & assess the existing situation of river basin, past river management & implications and lessons learned.
2. Identify and involve stakeholders and build consensus for design and development of strategies and approaches.
3. Assess ongoing forestry activities of the states engaged in the river management programme.
4. Assess potential and possibilities for regeneration, improvement, and restoration of forest catchments.

5. Assess the conditions of riparian forests and potential of biological filters.
6. Examine the possibility of allied and other income generation activities.
7. Assess the potential of cultivation of medicinal plants and restoration of conservation areas and identify appropriate species and suitable sites.
8. Identify and develop a strategy for future research and monitoring, and
9. Formulate strategies, develop approaches, and plan activities for project implementation.

Work progress

1. Recruitment of project staff has been completed.
2. Literature review concerning Damodar and Subarnrekha has been initiated.
3. Codal formalities to hire GIS firm initiated. The tender has already been floated. It is expected to be finalized by 3rd week of September.
4. Letters to concerning states i.e. Jharkhand, WB and Odisha has been sent regarding appointment of State Nodal Officer. Consequently, the names of all the State Nodal Officers have been received.
5. Following appraisal meet with State PCCF & HoFF has been done:

Odisha: A meeting with PCCF & HoFF, Odisha, was held on 26th August. He advised conducting a state inception workshop at Bhubneswar in the first-second week of October. Only one district, Balasore, falls under the DPR for Subarnrekha. In the meanwhile, we will be visiting Balasore to meet DFO and conduct the first preliminary survey of a part of the river in the district in September only.

Jharkhand: A meeting with APCCF CAMPA, Shri Sanjeev Kumar, IFS, CAMPA and was held on the 23rd of August. Another meeting with Shri N K Singh, IFS, APCCF, has been held on September 7th. Based on the discussion a state level kickoff meeting with higher SFD officials and DFOs falling within the riverscape is scheduled between on 19th September. During the meeting various course of actions, data required and stake-holder participation will be discussed and accordingly the date for the State Level Inception workshop will be finalized. The state level inception workshop will involve other stake-holders including representative from agriculture, irrigation, academics and NGOs.



West Bengal: A meeting with PCCF &HoFF, WB was held on September 2nd. Accordingly, he has appointed the State Nodal Officer for WB. A meeting with State Nodal Officer, West Bengal is scheduled on 13th September at Durgapur. This will be followed by another meet with PCCF &HoFF, West Bengal and other state officials on 15th September. During the meeting future course of actions, data required and stake-holder participation will be discussed and accordingly the date for the State Level Inception workshop will be finalized. The state level inception workshop will involve other stake-holders including representative from agriculture, irrigation, academics and NGOs.

6. We have prepared the riverscape buffer for the Subarnrekha, and Damodar Rivers and their major tributaries (Fig. 1). The KML files of these buffers will be demonstrated and given to the concerned state officials

and DFOs during the state kick off meet with state officials scheduled shortly in third week of September only. This will facilitate the identification of riverscape area occurring under their jurisdiction and data collection.

7. An initial survey to observe the source of these rivers has been done (Fig. 2 and Fig. 3).

8. A field survey in the parts of Jharkhand and West Bengal comprising Dhalbhumgarh, Jhargram has been done along tributaries of concerning rivers to have first hand information on landscape type and agriculture practices (Fig 4). Evidence from the field survey in this part show agriculture is the primary source of income in this part and rice is the major agriculture crop. The natural landscape are Sal dominated forests.

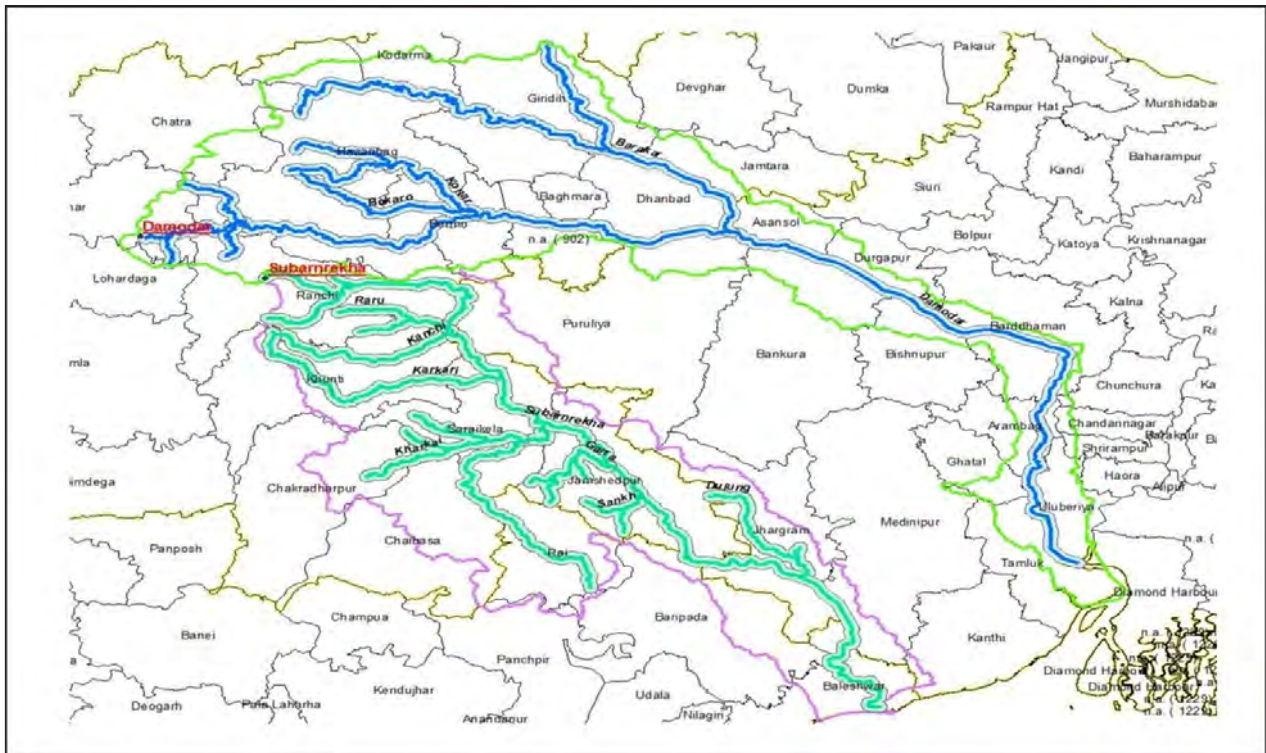


Fig. 1 Riverscape buffer of 5 Km for the Subarnrekha and its major tributaries (green color) and the Damodar river and its major tributaries (Blue Color)



Fig. 2 Source of river Subarnrekha near Piska,



Fig.3 Source of Damodar River near Sithio, Lohardaga, Jharkhand Ranchi



Fig. 4 Field survey along Dhalbhumgarh, Jharkgand and Jhargram, WB, show vast stretches of agriculture landscape.

SI No	Activity	I	II	III	IV	V	VI
1	Review of existing data/information knowledge w.r.t selected rivers	■	■				
2	Identification of knowledge gaps, scoping of forestry activities and developing strategy	■	■				
3	Consultation with subject area experts	■	■				
4	Identification of stakeholders/ academia/ experts/ organizations/ agencies for developing implementation plan on forestry interventions	■	■				
5	Conduction of kick off meeting & brain storming session with state representatives	■	■				
6	Conduction of state level workshop to develop region specific strategies including finalisation of riverscape area		■				
7	Identification, selection & prioritization of forestry intervention sites and type of treatment plans (natural, agriculture and urban land scapes), Preparation of riverscape buffer zone		■	■	■		
8	Interaction with front end staff of SFD for explaining Data collection mechanism and data collection		■	■	■		
9	Field visits and survey of prioritized sites, data collection and analysis for prioritizing actions			■	■		
10	Preparation of Intervention models/Draft DPR				■	■	
11	Conduction of final state level consultation workshop to discuss draft DPR for finalization				■	■	
12	Submission of Final DPR					■	■



NAGAR VAN YOJANA (NVY) State Forest Development Agency (SFDA)

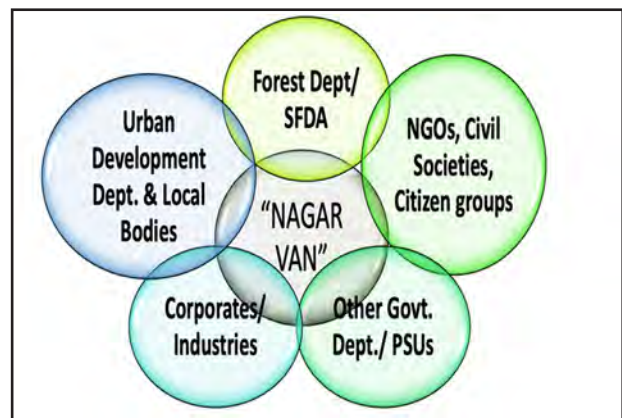
Background

Urban forests are green infrastructure in an urban landscape where trees and associated vegetation provide an assortment of environmental services like cleaning the air, improving local environment, recreational and aesthetic value. A Nagar Van/Nagar Vatikawill be a forested area in the city or in its vicinity which should be accessible to the city dwellers/general public, and will be suitably managed for providing wholesome natural environment for recreation, education, biodiversity conservation and supported services like water and soil conservation, pollution abatement, reduction of heat islands effect of the city with the essential elements for regular use. Nagar Van/Nagar Vatikawill be developed primarily on forest or other land available for greening/tree planting within

the limits of municipalities or in its vicinity. The purpose will be to improve the density of vegetation by planting judicious mix of different locally appropriate species of shrubs and trees as per local site conditions and protection of forest lands within and in the vicinity of cities which are getting affected/ degraded and are facing the threat of encroachment.

Vision

To create *Nagar Van/Nagar Vatikain* each City having Municipal Corporation/Municipal council/Municipality/ Urban Local Bodies (ULBs) for providing wholesome healthy living environment for the residents and thus contributing to growth of clean, green, healthy and sustainable cities.



Fencing in Nagar Van



Objectives

1. Creating green space and aesthetic environment in an urban set up.
2. Creating awareness about plants and biodiversity and developing environment stewardship.
3. Facilitating *in-situ* conservation of important flora of the region.
4. Contributing to environmental improvement of cities by pollution mitigation, providing cleaner air, noise reduction, water harvesting and reduction of heat islands effect.
5. Extending health benefits to residents of the city and
6. Helping cities become climate resilient.

Nagar Van/Vatika

Nagar Van may be developed over a minimum area of 10 ha and a maximum of 50 ha within 5 km limits of Municipal Corporation/Municipal Council/Municipality. Nagar Vatika may be developed in an area of minimum 1 ha and maximum of 10 ha within the city limits.

Components of Nagar Van/Nagar Vatika

Following items of work may be undertaken in a Nagar Van/Nagar Vatika -

1. Fencing of the area.
2. Establishment and maintenance of woodlots/tree cover with emphasis on locally appropriate tree/shrub species.
3. Theme based plantations, like Smriti Van, Rashi (Nakshatra) Van, etc.
4. Plants to include ornamental trees, shrubs and climbers, medicinal plants, flowering plants, fruit trees etc. to represent floral biodiversity.
5. Irrigation/ rain water harvesting facility.
6. Establishment and maintenance of public conveniences, drinking water facilities, benches, walkways/ footpath, jogging and cycle track etc.
7. Establishment and maintenance of Information and extension centre including I&E kiosk, display boards, signage, information brochures etc.

Expected outcomes

Nagar Van/Nagar Vatika is expected to have following outcomes:

1. Improved air quality, pollution abatement, carbon sequestration, reduction in temperature and urban heat island effect, water and soil conservation.
2. Creation of a green space having aesthetic value with cooling and calming effect on the minds of people.
3. Development of green spaces may also make cities climate resilient besides providing ecosystem services.
4. Indirect effects could be promotion of tourism and expansion of business and trade thus improving local economy.
5. Urban forests could offer several positive community physical and mental health benefits.

Implementation

The pilot scheme NVY is proposed to be implemented for a period of five years starting from 2020-21 to 2024-2025. Nagar Van Yojana (NVY) envisages developing 400 Nagar Vans and 200 Nagar Vatikas (total 600 Nagar Van/Vatika) in the country during the period of 2020-21 to 2024-25 with a total cost of Rs.895 Crore. The Central grants from funds under National Authority of CAMPA is provided under the scheme to cover mainly the cost of fencing, soil-moisture conservation measures & related activities, administrative activities, plantation and maintenance.

Till date, 251 Nagar Van/Vatika projects have been sanctioned in 29 States/UTs of the country.

S.No.	State/UT	Number of Nagar Van/Vatika
1	Andhra Pradesh	5
2	Andaman & Nicobar	1
3	Arunachal Pradesh	1
4	Assam	3
5	Bihar	6
6	Chhattisgarh	7
7	Goa	1
8	Gujarat	4
9	Haryana	5
10	Himachal Pradesh	6
11	Jammu & Kashmir	4
12	Jharkhand	6
13	Karnataka	3
14	Kerala	25
15	Madhya Pradesh	12
16	Maharashtra	9
17	Manipur	1
18	Mizoram	2
19	Nagaland	3
20	Odisha	40
21	Punjab	4
22	Rajasthan	6
23	Sikkim	1
24	Tamil Nadu	10
25	Telangana	45
26	Tripura	4
27	Uttar Pradesh	26
28	Uttarakhand	6
29	West Bengal	5
	Total	251

Hariyali Mahotsav

The Ministry of Environment, Forest & Climate Change had organized "Hariyali Mahotsav", the Tree Festival,



Ceremonial Plantation at Kohima, Nagaland



Women Participation in Plantation at Kohima, Nagaland



Ceremonial Plantation at Kohima, Nagaland



Ceremonial Plantation at Rajkot, Gujarat



Foundation Stone at Gandhinagar, Gujarat



Nagar Van Ceremonial Plantation Banner



Ceremonial Plantation at Mandi, Himachal Pradesh



Ceremonial Plantation at Kurnool, Andhra Pradesh



Ceremonial Plantation at Telangana

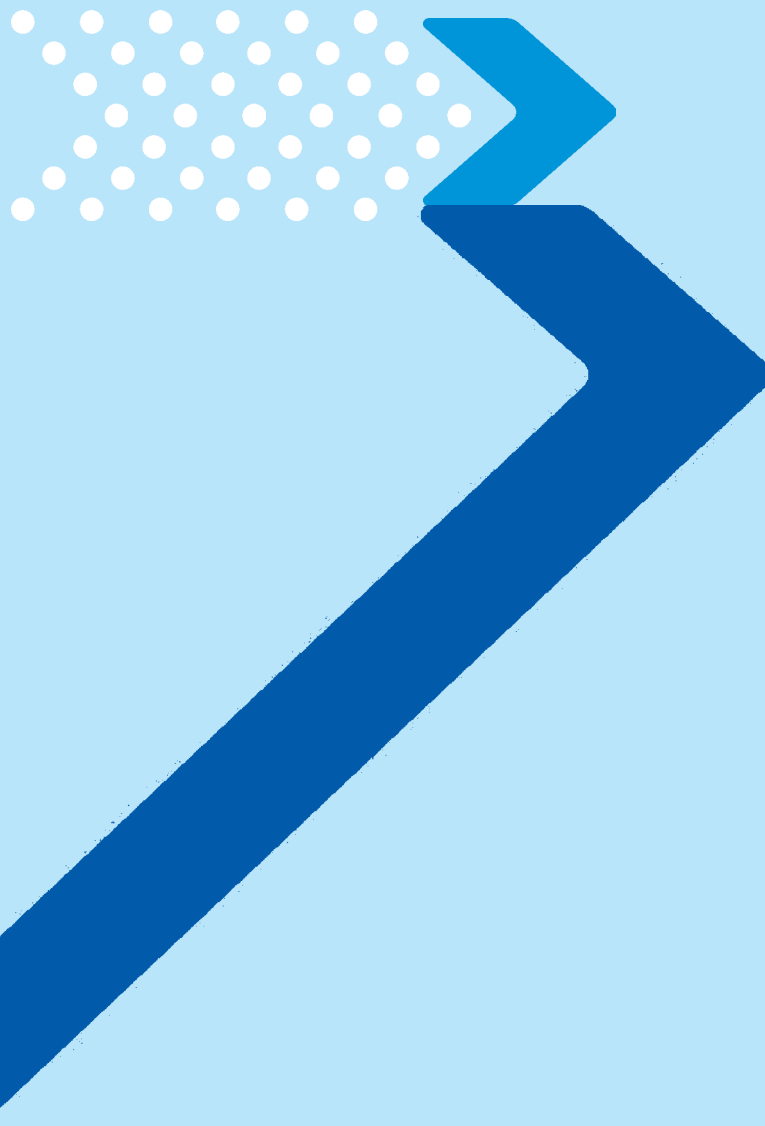


Nagar Van, Yavatmal, Maharashtra



Ceremonial Plantation at Mohammadwadi, Pune, Maharashtra

TECHNOLOGY TRANSFORMATION





E-GOVERNANCE IN GREEN ADMINISTRATION A SINGLE WINDOW PLATFORM - "PARIVESH"

Impact assessment Division, MoEF&CC

Abstract

With accelerated pace of development in various sectors, there has been significant growth in industrial and economic activity during these years. A natural consequence of such development activities is strain on various parameters concerning environment.

In the past about 26 years, the regulatory mechanism on Environment, in India, has come a long way with Wildlife (Protection) Act, 1972, Water (Prevention and Control of Pollution) Act, 1974, Forest (Conservation) Act, 1980, Air (Prevention and Control of Pollution) Act, 1981, Environment (Protection) Act 1986, etc. Extant environmental regulations already in place include mandatory regulatory approvals viz., FC, EC, WL, CRZ, CTE, CTO/Consolidated Consent and Authorization (CCA) etc. Besides this, several other approvals under various rules/regulations are also in place. However, the administration of such regulatory provisions requires to be done in integrated and holistic manner.

These green laws play a pivotal role in the achievement of Sustainable Development Goals (SDGs) while paving a path for industries to establish and grow. The SDGs related to Green Clearances include SDG 9 (Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation), SDG 13 (Take urgent action to combat climate change and its impacts), SDG 14 (Conserve and sustainably use the oceans, seas and marine resources for sustainable development), SDG 15 (Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss).

Ministry of Environment, Forests and Climate Change (MoEF&CC) is in the process of expanding the scope of PARIVESH, which is a single window platform for Green Clearances, intending to build a robust system for transparent, scientific and technical appraisal for granting clearances leveraging on emerging technologies, inter-alia, including Geographical Information System (GIS), Artificial Intelligence (AI) and Internet of Things (IoT). The system will play a key role in ensuring the achievement of SDGs. The system utilizes GIS based Decision Support System to automatically find out the clearances that are applicable for a particular project or activity, proximity analysis for identification of hot spots and vulnerability, biological richness of the area of interest. Similarly, the monitoring devices installed by CPCB, SPCB, IMD, other line ministries across the country would be connected through IoT. This massive data can be analyzed using AI techniques and will be helpful in policy research, management of Natural Resources and formulation of decentralized rules for ensuring Green Governance, leading to the achievement of SDGs.

While expeditious clearances aid in development, monitoring the compliances of conditions of various clearances, viz. FC, WL, WL, compensatory afforestation, etc. is vital. A robust compliance module is also being built in PARIVESH leveraging on technology to address the issue related to effective compliance monitoring. As a result, the country shall have visibility of temporal and spatial information about initiatives taken and compliance pattern from green administration perspective.

Keywords: SDGs, GIS, IoT, Analytics, Green Clearances, EC, FC, WL, CRZ, Sustainability, Green Administration, Green Governance

Background

The Hon'ble Supreme Court, vide its order dated 6th July, 2011 and 6th January, 2014 in W.P.(C) No.202 of 1995, in the case of Lafarge Umiam Mining Private Limited directed that, *inter alia*, **transparent and expeditious disposal of the proposals; creation and regular updating of a GIS based decision support database**; placing the documents like ToRs, minutes of EAC, public hearing proceedings, EIA report, EC letter with conditions, **self-monitoring reports**, Proceedings of FAC, FC letters, etc. **in public domain** (predominantly on the website); etc.

As a first step towards e-governance on environmental issues, the ministry had started receiving online FC and EC applications from 2014 at Central Level followed by at State Level from June 2015. Subsequently, from 2017 onwards applications for Wildlife clearance also started to be received through online mode.

Further, in pursuant to the spirit of 'Digital India' and capturing the essence of Minimum Government and Maximum Governance, a Single-Window Integrated Environmental Management System named **PARIVESH** (Pro-Active and Responsive facilitation by Interactive, Virtuous and Environmental Single window Hub) was launched by Hon'ble Prime Minister of India on 10th August 2018 which was subsequently also rolled out at State level from 10th August, 2019 for automation of process involved in clearances namely Environment, Forest, Wildlife and Coastal Regulation Zone Clearances from Central and State-level authorities.

This web-based application is unique amongst all such portals of regulatory agencies. This initiative brought the Ministry closer to the industry and citizens alike. After the introduction of e-communication in the first phase, this was the second phase of reforms towards e-Governance in its real spirit.

The launch of 'PARIVESH' has proved to be a great propeller and revolutionary step for Ease of Doing Business by bringing in utmost transparency and



A Single window platform launched in 2018 for transparent system for EC, FC, WL and CRZ.

Accommodates processes like User Registration of major clearances EC, FC, WL and CRZ.

Monolithic Workflow System developed for online submission, processing and approval of clearance processes

Developed in phased manner to accept 3000+ applications per month

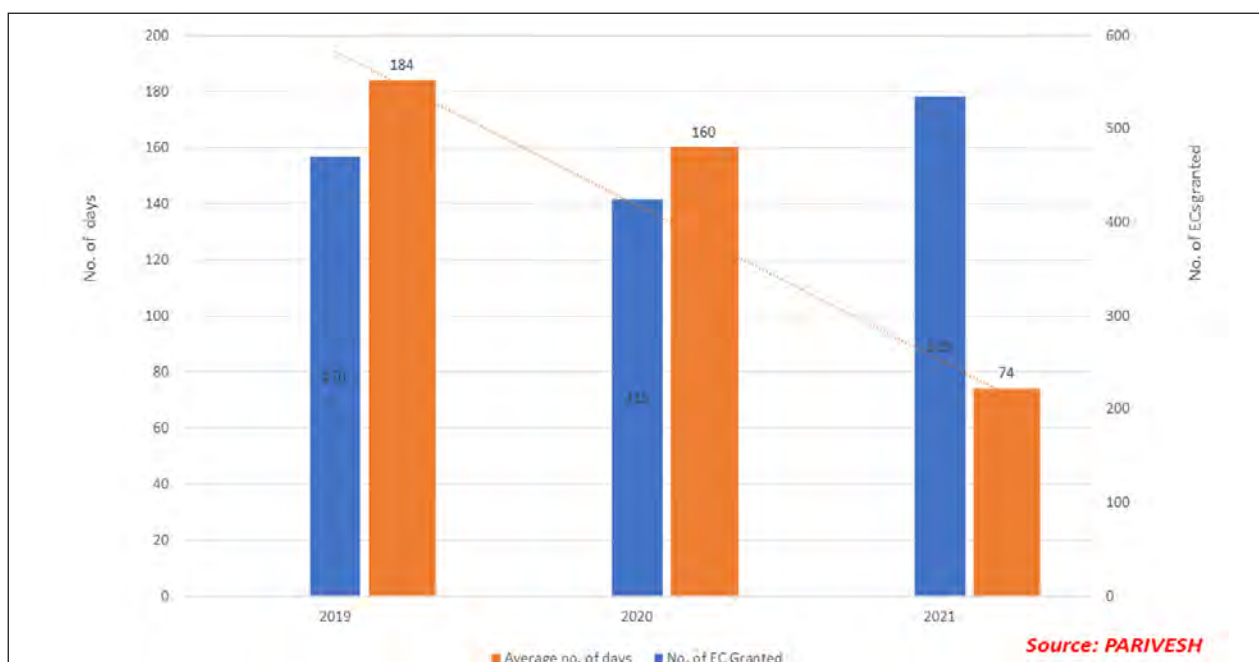
PARIVESH (Existing): Snapshot

accountability. It has also enhanced efficiency, transparency and accountability in the Environment, Forest, Wildlife and CRZ clearance processes. The online portal has helped in enhancing responsiveness through workflows automation and provides real time information about the status of applications with alerts at each of the stages through SMS and emails.

Although the Ministry has been processing all the applications through PARIVESH since it's complete roll out, however, it's real worth came to the fore during the COVID 19 pandemic. Some of the states, who were somewhat reluctant in processing everything online, have been forced to switch to PARIVESH completely for all matters related to various clearances. With more and more transactions happening on PARIVESH, lot of possibilities were automatically thrown at Ministry for improvement in

the existing system to make it more robust and user friendly.

Ministry with the help of NIC, has been continuously improving the existing PARIVESH and many new modules viz. complaint module, review window for senior officials, dedicated dashboard for stakeholder ministries, fact sheet generation, EC generation through PARIVESH with unique identity, etc. have been developed and made operational. In addition to above technological intervention, Ministry has undertaken several systemic reforms through various policy interventions in EC/ FC such as decentralization, rationalization of the project categories; removing of ambiguity; standardization of processes and operating procedures. These steps and implementation of PARIVESH, cumulatively, have resulted in significant reduction in average number of the days for grant of EC and FC.





Next Generation e-Governance – Expanding the scope of PARIVESH

It is beyond doubt that roll out of the PARIVESH has proved to be a game changer in facilitating few most complex approvals viz. EC, FC, WL and CRZ and during the difficult times of pandemic, availability of PARIVESH has helped the Ministry and other authorities in carrying out the works related to various clearances in efficient and transparent manner without any significant technical issues. However, with COVID-19, the new normal is expected to prompt people to seek **more technology based solutions** so that multiple visits to multiple Government offices are minimized. In this regard, when viewed as a first step or say a pilot project, the current version of PARIVESH has successfully served the purpose for which it was conceptualized. However, perhaps it is time that the ‘e-governance on environmental regulations’ graduates to the next level so as to provide comprehensive single window solution that puts in place a robust environment administration featuring:

- Efficient, technology driven state of art workflow that minimizes redundancies in administrative paper work.
- Integrating information flow from different channels.
- Reliable and validated database that encourages accountability on one hand and ease of doing business on the other.
- An effective compliance and monitoring mechanism.
- Robust record keeping and document management.
- Effective data analytics for generating actionable information.
- Raising of appropriate flags to prompt action on stakeholder’s part.
- An effective communication strategy that engages with the stakeholders.
- Backend team to support the governance initiative, along with help desk, etc.

In order to achieve the above “**single window solution**” in truesenserequires acomprehensive setup that has a focused approach towards providing overall solutions. In order to achieve the objectives as explained, Ministry has proposed to expand the scope of **PARIVESH**, to provide a “**single window**” solution and to assist regulatory bodies in administration of various gamut of different notifications including filing of EC/FC/WL/CRZ/Waste Management / Compensatory Afforestation Management and other applications, their processing, issuance and compliance of conditions prescribed therein.

- I. The Objectives of the new PARIVESH to provide an enabling ecosystem for regulatory authority wherein -
 - Repetitive, mechanical and routine work/ validations/clarifications are undertaken by the System (thus saving substantial time and energy of such authorities);
 - Regulatory authorities are assisted by system by providing actionable information (thus making the process fast, effective and manageable);

- Repository of all information related to EC/FC/ WL/CRZ/CTE/CTO/Waste Mngt. and others compliance.
- II. The Objectives of the new PARIVESH, *inter alia*, including,–
 - **Single platform** for all the clearances administered under the Ministry (EC, FC, WL, CRZ, CTE/ CTO, Compensatory Afforestation Management, Authorization under waste management, GMO, etc);
 - **Know Your Approval:** GIS services guide the project proponent on the requirement of different clearances on submission of minimum credentials of the project;
 - **Common Application Form:** Develop e-filing of Forms for EC/FC/ WL/ CRZ/Others /Compliances in xml formats etc.;
 - **End-to-end online processing** of applications: End-to-end e-office approach for processing of applications, query of EAC/SEAC, reply of PP and other correspondence; Complete digitization of the ECs issued till date;
 - **KYC:** Data validations including through web-services, e-signatures/digital signatures;
 - **Decision Support System:** GIS based decision support system to assist EACs/Regulatory authority in taking considered and expeditious decision;
 - **Back-end processing and validations** of the applications and compliance reports
 - Checking for information consistency;
 - Preparation of draft responses/correspondence with stakeholders.;
 - **Servicing EACs/SEACs/FACs/RECs/CAMPA**
 - Backend diligence and submission of information for EAC / SEAC / FAC / RECs/ National CAMPA deliberations;
 - Assist in preparation of minutes and uploading.;
 - **Dashboard** for each level of stakeholder including project proponent, Auditors, CPCB, SPCB, SEIAA, IROs, Nodal officers (PCCF), DFO, CF, etc.;
 - **Compliance module:**
 - Capture compliance reports in monitorable formats & for analytics;
 - Mapping projects with corporate / non-corporate entities for better compliance with complete convergence with monitoring framework and Certified Environmental Auditor Scheme;
 - Giving visibility to corporate/non-corporate through compliance ledgers for monitoring / compliance at Organizational level.
 - **CAMPA Module:**
 - Compensatory Afforestation Monitoring
 - NPV calculation and reporting
 - APO management



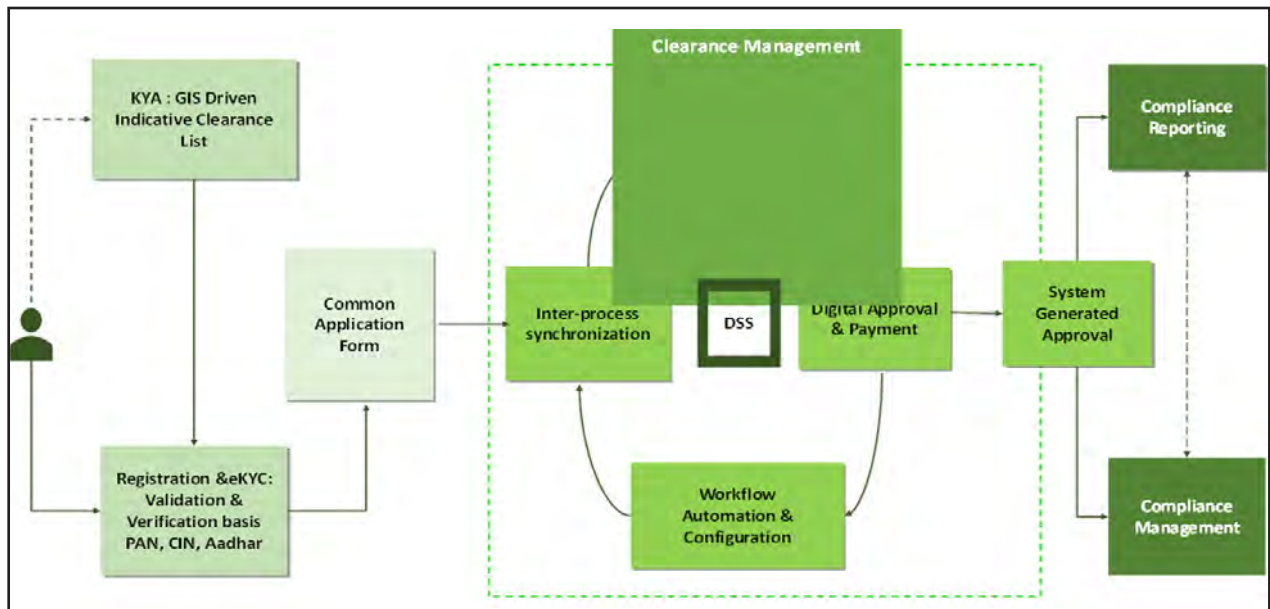
- **Data analytics** using emerging technologies viz. AI/ Data Analytics and leveraging on GIS to reflect trend and patterns as regards compliance; shall help in
 - Profiling of projects/entities across the country including compliance profiling.
 - Assessing compliance level of any individual condition across country to see the magnitude of achievement of the said mitigative measures, eg. Green belt, afforestation, rain water harvesting, etc.
 - Identifying non-compliant industries; Red Flagging of Non- Compliances;
 - Setting up thresholds for monitoring; etc.
- **Help Desk:** Effective Communication for Grievance redressal & other following measures:
 - To stakeholders through emails/sms/call centre, notices etc.
 - From stakeholders – proposing responses thereof
- Attempting linkages between the industries for better environment management eg. Linkage between power plants (source of fly ash) and mines or other sink points where fly ash can be utilized
- Attempting capturing of critical environment parameters from different locations and mapping them with industries in respective locations, thereby flagging potential corrective steps
- Cataloguing and metadata creation of important judicial pronouncements on environmental issues making the judgments searchable

Announcement in Union Budget of FY 2022-23

Union Finance Minister during FY 2022 budget speech also announced that PARIVESH has been able to instrumental in reducing the time required for approval significantly. The scope of the portal will be expanded to provide information

to the applicants based on location of units **information about specific approvals** will be provided. It was also mentioned that it will enable application for **all four approvals through a single form** and **tracking of the process through Centralised Processing Centre (CPC- Green)**.

Thematic depiction of end-to-end process in new PARIVESH:

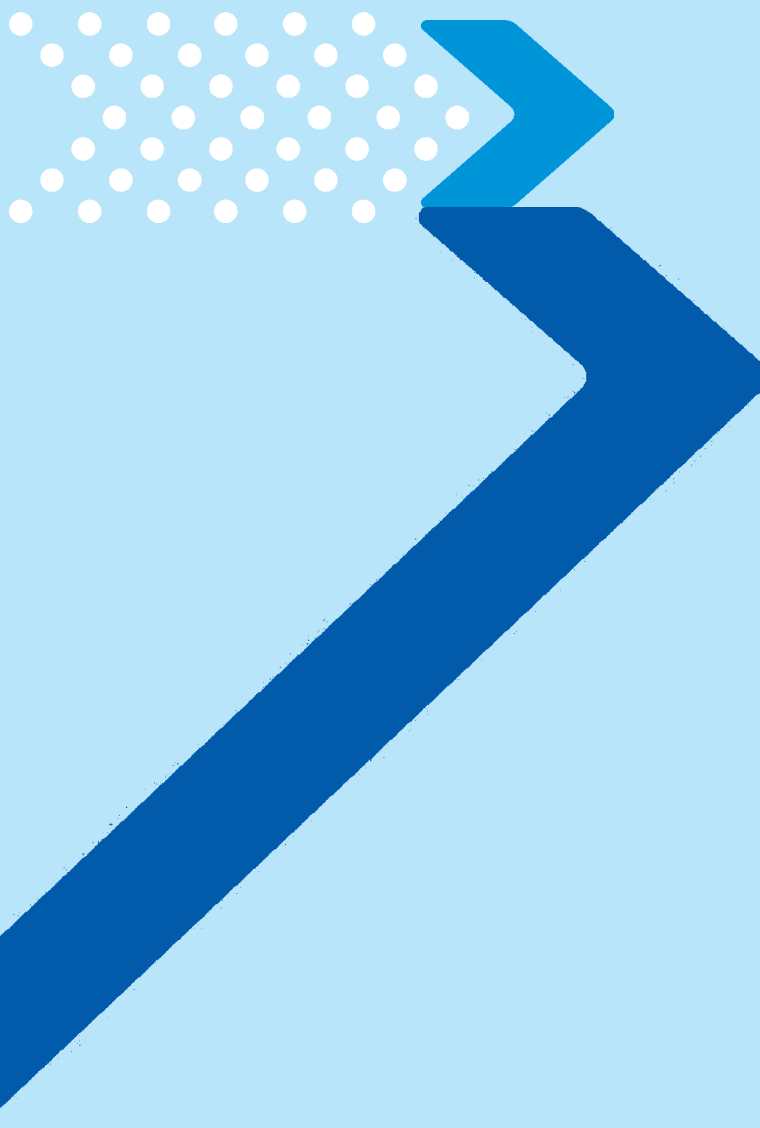


Based on the success of PARIVESH, as big enabler for good governance through e-governance, it is expected that enhanced version of PARIVESH is expected to provide a more robust system. It is expected that the new system would be more user friendly having data driven decision support system for taking an informed decision in effective and expeditious manner. It is also expected that the new system shall have dedicated module for capturing compliance reports in monitorable formats & for data

analytics in order to provide the regulatory authority with actionable information.

As a result of above, the Ministry would eventually have visibility of temporal and spatial information about initiatives taken and compliance pattern from forest, environment and wildlife perspective, helping the Ministry in formulation of robust policy. Ideally, the system should be such that it deters the violators and prompts self-compliance and it is hoped that new PARIVESH will meet all expectations.

CAPACITY
BUILDING AND
LIVELIHOOD
SUPPORT





UTTARAKHAND STATE COUNCIL FOR SCIENCE AND TECHNOLOGY CENTRE OF EXCELLENCE ON FOREST BASED LIVELIHOOD IN UTTARAKHAND A PILOT STUDY

Uttarakhand State Council for Science and Technology (UCOST) Dehradun

Background

Uttarakhand's forests have been an essential part of the state development and nearly 80% people are directly or indirectly dependent on forests either for their sustenance or subsistence. Forests provide fodder, fuelwood, many wild foods, construction material and medicines for humans and cattle. Besides this forests also create microclimate for cultivation of several crops of the hill. Thus forests and their produce provide substantial livelihood for forest fringe areas. Non wood forest products (NWFPs) mainly medicinal plants and bamboos are gaining importance in bringing better livelihood opportunities. A step in this direction was taken by Ministry of Environment, Forest & Climate Change, GOI along with Uttarakhand State Council for Science & Technology (UCOST) Dehradun through establishment of a Centre of Excellence on Forest based Livelihood to carry out the necessary study on the subject. A very first of its kind in the state, the COE delves on issues related to forest based products and livelihood and is going to serve as a knowledge and study centre for forest based resources.

Vision

To become a resource and knowledge centre on forest-based livelihood and contribute towards sustainable livelihood opportunities in the State.

Objective

- To collect all the available data on forest-based produce with focus on non-timber products like medicinal plants and bamboo and to create a clearing house for the same.
- To interact with people through focused group discussion (FGD) and to estimate their dependence on forests for their livelihood.
- To do value and supply chain analysis for different forest products.
- To create a resource directory of various government and non-government organizations, private institutes and experts working in the area of forest livelihood.

To conduct socio-economic analysis and estimate cultural dependence of the forest fringe villages on forestry

SUMMARY ACHIEVEMENTS (2016-2022)

Detailed annual progress reports are submitted to the National Authority and MoEFCC regularly. Summary of achievements of the project are given is provided as follows;

Collection of primary data

i. Survey of forest fringe villages

CoE team visited total 70 villages for primary data

collection through household survey and focus group discussion; out of total 1335 household surveys were conducted till now. The districts covered during this period are Pithoragarh, Almora, Chamoli, and Uttarkashi. The team also interviewed many ringal artisans there. They collect fuel wood, fodder, vegetables and ringal from forest. Major fodder species collected by them were Bhimal, Quaraal, Timla, Banj, Utis, Bedu, Khadik, Kafal etc. Livelihood of this village is majorly dependent on Non timber forest based handcraft.



Photo: Pangot, Chakbhe, Jyoti, and Kadiya village Nainital district

ii. CoE team conducted household surveys in Netri, Sweel, Hudoli and Dhakara villages of Ranwari Ghati of Uttarkashi district

iii. The team conducted village surveys in forest fringe villages viz. Saneh, Farsula, Pataguni and Surari of Pauri Garhwal district.

Household surveys in Reni, Lata, Malari and villages of Chamoli district were carried out. Focused Group Discussion (FGDs) in selected villages were also conducted. Villages viz. Sara Saria in Udham Singh Nagar and Phagpur in





Champawat Districts were also surveyed for forest based livelihood related study.

CoE also conducted survey in villages of Pithoragarh district for the forest-based livelihood assessment and study of cultural dependency on forest. FGDs and household surveys were conducted in Sirdang, Rung, Sirkha, Kureela, Garva, Ghatiyabgarh, Tankul, Himkhola, Sosa, Suwalekh ,salmora, baira, baram , lumti , kanar, kimkhola,dhappa, leelam, bhadeli , basankot , rawalgoan, chitgal, choli , punali , sutar gaon , kamad , kimta and Chalmchilanso villages of Pithoragarh distict.

Collection of secondary data

CoE team collected the herbal auction data of UAFDC mandis located at Rishikesh (Bibiwala), Ramnagar (Aamdanda) and Tanakpur and also from the main office located at Dehradun as a part of value and supply chain analysis.

Other visits

Team also visited Himalayan Action Research Centre (HARC), Dehradun, Uttarakhand Forest Development Corporation (UAFDC) mandi at Aamdanda (Ramnagar), Uttarakhand Forest Development Corporation (UAFDC) mandi at Bibiwala (Rishikesh), Central Himalayan Environment Association (CHEA), Nainital, Forest Training Academy (FTA), Haldwani, Uttarakhand Bamboo and Fibre Development Board (UBFDB), Centre for Ecology Development and Research (CEDAR), Himmothan (NGO) Dehradun and many other government and non-government organisations working on forest related issues.



CoE team visited **Sadiyatal**, Nainital to collect information about drift woodwork and to collect primary data on dependency on NTFPs. Team also visited '**Centre of Excellence on Oak**' at Vinayak in Nainital district to collect information of different Oak species and other medicinal plants growing in high altitude plant nursery there. Data Collected from various NGO's & Organization's in Uttarakhand namely Bhartiya Gramoathan Sanstha Rishikesh, Saraswati Jan Kalyan Evam Swarojgar Sansthan Dehradun , Raebaar Haridwar , CHEA Nainital , AAGAAS Chamoli , HARC Chamoli, STEP Dehradun, CHITKU, Dehradun , Uttaranchal Youth & Rural Development Centre Chamoli , Jandesh Chamoli , AAROHI Nainital ,Avani Pithoragarh those are working in the field of NTFP.





iv. Setting up an NTFP gallery

Non Timber Forest Product (NTFP) gallery was set up at Centre of Excellence (CoE), UCSOT. Different NTFPs, which are found in forests of Uttarakhand like seeds, fibres (hemp, nettle etc.), leaves, ringal items, high altitude medicinal plant parts (choru, faran) etc are displayed in NTFP gallery at Centre of Excellence (CoE).



v. Preparation of News-Bulletins

Information on various activities of CoE were compiled from time to time to prepare News-Bulletin half yearly (March-August and September – February). Some other relevant information was also incorporated into the bulletins. These were distributed among various stakeholders.



vi. Meetings

Project Advisory Committee meeting of Centre was held time to time at UCOST in which expert members of PAC, CoE team and resource persons from UCOST



PAC meeting with CoE Team at UCOST



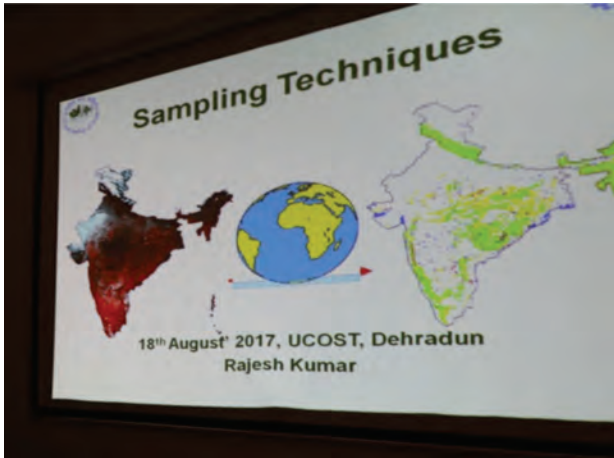
Meeting with experts



participated. Revised proposal of CoE was also approved in PAC meeting which already submitted in ministry. Review Meeting was attended by CoE team at Ministry of Environment, Forest and Climate Change (MoEFCC), New Delhi in which activities of CoE were discussed.

vii. Expert Lecture at CoE

CoE team conducted an expert lecture on 'Statistical Sampling Strategies' which was delivered by Shri Rajesh Kumar, Joint Director, Forest Survey of India and Deputy Director General, NSSO, Regional Office, Dehradun.



Meeting with experts

at Lata village district Chamoli (sub-district Joshimath), Munsiyari region in Pithoragarh and one in house workshop cum capacity building programme in UCOST to gather the available information on forest based produce and to estimate people's dependence on forest resources for their livelihood.



Workshop in Munsiyari Region (Pithoragarh)

viii. Workshops Conducted

A three workshop on "Current Status and Potential of Forest based Livelihood in Uttarakhand" was organized



In-house capacity building workshop in UCOST with stakeholders

Ongoing/Planned Activities during 2022-23

Key activities during the current phase for maintaining continuity and implementation of the CoE mandate include the following:

To conduct surveys at forest fringe villages and to assess forest-based livelihood of people.



Capacity building programmes/Workshops/training will be conducted in different districts of Uttarakhand.

Collection and compilation of secondary data from various sources and review.

Meeting with resource persons and experts in forestry and allied sectors.

To publish news bulletin, research papers and articles.

Outreach

CoE will conduct activities to raise awareness among the general public, youth and relevant stakeholders, of the importance of Non timber forest products and its importance in livelihood generation. This will include newsletter, booklet publication, brochures, awareness and training programmes.

Financial Overview

Sl.No.	Particulars	Amount (Rs.)	Period
A	Total Project Budget	Rs. 69,56,838.00	2022-2023 (Budget for one year)
B	Grant received	Rs. 41,74,103.00	2022-2023
C	Expenditure	Rs. 31,31,394.00	Upto Till 31 July , 2022
D	Balance (available with UCOST)	Rs 10,42,709.00	2022-23
E	Balance (due from National CAMPA)	Rs 2,782,735.00	2022-23

Project budget was received only for 3 years (2016-2018) since then Project activities and field visits were held up due to unavailability of the Project budget and the process was further delayed due to covid -19 Pandemic. Now the project 4th year budget was received in February 2022, from which the remaining project activities will be taken up again.



IMPLEMENTING THE CENTRAL ASIAN FLYWAY NATIONAL ACTION PLAN WITH SPECIAL FOCUS ON PREPARATION OF SITE-SPECIFIC ACTIVITY PLAN, CAPACITY BUILDING, DEVELOPING BIRD SENSITIVITY MAP FOR SETTING UP OF WIND ENERGY AND SPECIES ACTION PLANS

Bombay Natural History Society

OBJECTIVES/COMPONENTS OF THE PROJECT

- 1) Developing site-specific actions and objectives related to conservation of migratory bird species and their habitats in Protected Area Plans (both Management and Working Plans) and details of action to be taken for the non-protected areas;
- 2) Impart training to forest staffs and other stakeholders in various aspects of migratory bird conservation;
- 3) Preparation of Bird sensitivity mapping for setting up of windfarms and energy sector in India; and
- 4) Preparation of Single-Species Action Plan for 20 species prioritised in the National Action Plan.

GOAL OF THE PROJECT: The outcome of the project aimed to support the Ministry of Environment, Forests & Climate Change (MoEF&CC) and the state forest departments in implementing India's National Action for Conservation of Migratory Birds and their Habitats along the Central Asian Flyway (2018-2023) launched in 2018 by the MoEF&CC (hereinafter India's CAF NAP). The activities envisaged under the components no. 1.1, 1.2, 1.3, 1.7, 2.1, 2.2, 5.2, 1.6, 3.1, 3.3, 3.4 and 3.5 of the India's National Action Plan.

BRIEF SUMMARY

COMPONENT 1: SITE SPECIFIC RECOMMENDATIONS

The India's CAF NAP has prioritised 48 wetlands and 31 forest areas across different landscapes of India as important sites for the survival of migratory waterbirds and land birds respectively. The project covers all the sites prioritized in India's CAF NAP. Specific actions are needed for improvement of habitats, actions for flyway perspective and for implementing the activities envisaged in the India's CAF NAP. The protection status of the priority sites are given in Table 1.

The Management Plans of priority sites are being reviewed. Specific actions to be implemented at sites for the improvement of habitats, actions for flyway perspective and for implementing the activities envisaged in the India's CAF NAP are suggested to be included in protected area

management plans. Therefore, the actions envisaged in the India's CAF NAP are being included in the site-specific plans which has have given further scope for managing the priority bird sites mentioned in the India's CAF NAP in better way.

Table 1. Protection Status of the sites prioritized in the India's CAF NAP

Priority Sites Protection Status	Wetlands	Land Birds	Total
Non-protected	19	4	23
Wildlife Sanctuaries	16	16	32
National Parks	4	7	11
Tiger Reserve	1	4	5
Conservation Reserve / Reserve Forest	8	-	8
Total	48	31	79

The recommendations have already been incorporated into the management plans of many protected areas. The brief about the process is explained below.

Review of the site-specific Management Plans and recommended site-specific activities: Information on the status of each site and threats reported from 79 sites were assessed through literature surveys. Field surveys are being carried out to understand the current status of the sites prioritized in India's CAF NAP. Totally 58 sites of 16 states were assessed, so far, since the inception of the project. Land use and land cover changes (LULC) for all the wetlands are being carried out. So far, LULC analysis has been done for 21 wetlands.

GLIMPSE OF THE FIELD SURVEY CONDUCTED IN THE PRIORITY SITES

Based on the literature reviews, field surveys and LULC analysis, site specific recommendations for the management and conservation of migratory birds have been prepared for 15 sites prioritised as important sites in India's CAF NAP (Table 2).



Buxa Tiger Reserve, West Bengal



Idukki Wildlife Sanctuary, Kerala.



Bharatpur, Rajasthan



D'Ering Memorial WLS, Arunchal Pradesh



Satkosia, Odisha



Akshi, Maharashtra



NandurMadhumeshwar, Maharashtra



Field work in Gangapur, Maharashtra



Majuli Island, Assam



Sivasagar Tank, Assam

Table 2. Details of wetlands for activities to be included in the Management Plans have been inventoried.

Sl.No	State	Site type	Site Name
1.	Andhra Pradesh	Major Wetland	Kolleru Wildlife Sanctuary
2.	Andhra Pradesh	Major Wetland	Pulicat Wildlife Sanctuary
3.	Andhra Pradesh	Major Wetland	Coringa Wildlife Sanctuary
4.	Puducherry	Wetland Cluster	Ousteri Lake
5.	Rajasthan	Major Wetland	Sambhar Lake
6.	Rajasthan	Major Wetland	Keoladev National Park
7.	Rajasthan	Wetland Cluster	Bardha Dam
8.	Rajasthan	Wetland Cluster	RamSagar (Hindoli)
9.	Tamil Nadu	Major Wetland	Gulf of Mannar
10.	Uttar Pradesh	Wetland Cluster	KurraJheel
11.	Uttar Pradesh	Wetland Cluster	Saman Bird Sanctuary
12.	Madhya Pradesh	Landbird Site	Madhav National Park
13.	Maharashtra	Major Wetland	Nandur-Madhmeshwar
14.	Maharashtra	Major Wetland	Jayakwadi
15.	Gujarat	Major Wetland	Khijadiya

Successful additions in the Management Plans:

As suggested, out of 15 sites activities have been included in NandurMadhumeshwar Bird Sanctuary in Maharashtra, Kolleru Bird Sanctuary in Andhra Pradesh, Sambhar Lake and Keoladev National Park in Rajasthan, and Gulf of Mannar Marine National Park in Tamil Nadu.

The activities suggested were also considered for inclusion while preparing the Ramasar Site Information Sheet (RIS) for Khijadia Bird Sanctuary in Gujarat and Thane Creek Flamingo Sanctuary in Maharashtra. In addition to this, for the other sites like - Jaikwadi Wildlife Sanctuary and Desert National Park in Rajasthan, BNHS is working closely with state forest departments for incorporating the site-specific activities in accordance with India's CAF NAP in the Management Plans.

Field work is being conducted at remaining sites to prepare site-specific recommendations for the conservation of migratory birds. The same was discussed at a meeting organized by the Additional Director General of Forest (WL), MoEF&CC in August, 2022 to expedite the work. It

has been decided to organize a workshop in this regard with all the site managers of the priority sites.

State Governments: The Implementation of India's CAF NAP and scientific management of wetlands and land bird sites are discussed with the officials of the state forest department including the Chief Wildlife Wardens and the site managers of the sites prioritized in India's CAF NAP. The activities of the project are carried out with due written permissions from the Chief Wildlife Wardens of the respective states. The information gathered through this study has been helpful for the state government to revisit the Management Plans/Working Plans of many priority sites already.

Maharashtra has taken proactive steps to conduct a detailed study on the sites prioritized in India's CAF NAP for filling the gaps in the information and scientific management of the wetlands. Bihar has taken steps to study the key wetlands with respect to flyway perspective (to be included in the India's Action Plan whenever it revises) by following the guidelines given in the India's



CAF NAP. BNHS is supporting the activities being taken by the Government of Bihar.

Tamil Nadu and Bihar have organized a synchronized Asian Waterbird Census with due input from the BNHS for developing standardized database. Therefore, the outcome of the project has helped the bird conservation at state level.

COMPONENT 2 : CAPACITY BUILDING TRAINING PROGRAMME

This is to improve the skills of the frontline staff and to give an orientation to them on bird migration, bird monitoring, flyways, flyway action plans, disease surveillance and roles and responsibilities of the state forest department in implementing India's CAF NAP. Managing wetlands require diverse capacities beyond protected area management to be able to communicate the wide-ranging ecosystem services and biodiversity values to various stakeholders and integrate their views, rights and capacities in management process. India's CAF NAP envisages conducting formal as well as ad-hoc capacity development programmes for site managers, to equip them with necessary skills for integrated wetland management.

BNHS writes to the Office of the Chief Wildlife Warden (O/CWLW) of the respective state to nominate the suitable candidates for the training programme. With due permission and coordination from them, the training programmes are organized. The capacity building programmes conducted in different states have equipped the frontline staff of the priority sites for better implementation of various activities envisaged in the NAP. Frontline staff and local stakeholders have got acquainted with the CAF, NAP and action to be taken for managing the wetlands for CAF Action Plan perspective.

A total of 121 frontline staff from five states viz. Madhya Pradesh, Maharashtra, Rajasthan, Sikkim and Odisha have been trained (Table 3) in bird migration studies and Central Asian Flyway National Action Plan implementation.

In order to make this capacity building more effective, a training manual has been developed in English reviewed by the competent authorities. The training manual has been translated into six Indian languages viz - Hindi, Tamil, Telugu, Marathi, Odiya and Bengali for better understanding of the frontline staff. The training programmes were carried out with due nominations of staff from the Chief Wildlife Wardens of the State Forest Departments. The training programmes relied on a combination of presentations and activity-based sessions to help the participants understand the importance of conservation of migratory birds and their role in well-ordered implementation of India's CAF NAP. All the frontline staff and other stakeholders trained have got acquainted with the CAF, India's CAF NAP and action to be taken for managing the wetlands and land bird sites for CAF perspective. The feedback from the participants is analysed. Training reports are prepared and submitted to the CWLWs of the respective states for the information.

COMPONENT 3 : AVIAN SENSITIVITY MAPPING FOR RENEWABLE ENERGY PLANNING IN INDIA

There are an increasing reports of bird collisions and other negative impacts with wind turbines in India. In order to minimise the conflict between birds and windfarms, a bird sensitive mapping is being designed to provide access to information to enable evidence-based decision making on the safe siting of new wind energy developments.

Highlights of the sensitivity mapping : To construct comprehensive spatial dataset, literature review, assimilating observation records of last two decades from a variety of sources including scientific journals, unpublished reports, environmental impact assessments and e-bird, and archive of bird observation records submitted by ornithologists and birdwatchers have been collected and being processed. The mapping tool procedures and required outline maps are being obtained from the authorised sources. A total of 915 mortalities of at least 61 species, were recorded by various studies were compiled. To account for habitat loss derived of energy infrastructure development, several layers of land cover and land use

Table 3. State-wise details of people trained

Designation	Maharashtra	Rajasthan	Madhya Pradesh	Odisha	Sikkim	Total
Assistant Conservator of Forest (ACF)	-	-	-	-	3	3
Range Forest Officer (RFOs/ FROs)	8	1	5	-	2	16
Forester Section Officers (FSO/FR)	8	8	3	12	3	34
Forest Guard (FG)	11	16	11	8	8	54
Other Govt officials	2	-	3	-	5	10
NGO and others	2	2	-	-	-	4
Total	31	27	22	20	21	121



Nashik, Maharashtra



Bhubaneswar, Odisha



Madhav National park, Madhya pradesh



Gantok, Sikkim



Keoladev National park, Rajasthan

information and area with conservation importance such as Important Bird Areas (IBAs), Protected Areas (PAs), Ramsar sites and other critical habitats are added to the sensitivity assessment. Sensitivity mapping is designed to provide planning authorities, environmental consultants, developers and financial institutions access to information to enable evidence-based decision making on the safe siting of new developments. Once the tool is developed it will help to identify the sites to be avoided for wind energy development for mitigating the impact on birds.

Thar Desert: Bird sensitivity mapping for Dhar Desert area has been prepared which covering the area of 26,100 sq. km. Threats due to energy infrastructure

development to Great Indian Bustard and other Species could be avoided by following sensitivity map. With the support of the BirdLife International, the Beta version of the Avian Sensitivity mapping has been prepared. The Bird Sensitivity mapping tool is under preparation which is the final output of the component.

MoEF&CC: The bird sensitivity mapping tool which is developed under this project will function at a broader level, giving an indication of likely importance of a site for vulnerable birds. As a screening tool, it will be assisting developers of wind energy installations in the advanced planning of required statutory surveys. Importantly, the current tool is specific to wind energy developments

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National Authority,
Compensatory Afforestation Fund
Management and Planning
Authority (CAMPA)

Ministry of Environment,
Forest and Climate Change
Government of India

