Template/Pro forma for Submission

NMHS-Himalayan Institutional Project Grant

NMHS-FINAL TECHNICAL REPORT (FTR)

Demand-Driven Action Research and Demonstrations

NMHS Reference No.:	GBPNI/NMHS-2017/MG-22/566	**Date of Submission:**	1	7	0	1	2	0	2	2
			D	**d**	**m**	**m**	**y**	**y**	**y**	**y**

PROJECT TITLE (IN CAPITAL)

MONITORING AND EVALUATION OF SPECIES COMPOSITION AND RICHNESS IN ENDEMIC PLANTS, BIRDS, MAMMALS, AND REPTILES ALONG SUCCESSIONAL GRADIENT AFTER SHIFTING CULTIVATION AND CREATING EDUCATION AND AWARENESS FOR THEIR CONSERVATION IN DAMPA TIGER RESERVE LANDSCAPE, MIZORAM

Project Duration: *from* (**26.02.2018**) *to* (**30.11. 2021**).

***Submitted to*:**
Er. Kireet Kumar
Scientist 'G' and Nodal Officer, NMHS-PMU
National Mission on Himalayan Studies, GBP NIHE HQs
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Submitted by
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GENERAL INSTRUCTIONS:

1. The Final Technical Report (FTR) has to commence from the date of start of the Project (as per the Sanction Order issued at the start of the project) till its completion. Each detail has to comply with the NMHS Sanction Order.
2. The FTR should be neatly typed (in Arial with font size 11 with 1.5 spacing between the lines) with all details as per the enclosed format for direct reproduction by photo-offset process. Colored Photographs (4-5 good action photographs), tables and graphs should be accommodated within the report or should be annexed with captions. Sketches and diagrammatic illustrations may also be given giving step-by-step details about the methodology followed in technology development/modulation, transfer and training. Any correction or rewriting should be avoided. Please give information under each head in serial order.
3. Training/ Capacity Building Manuals (with details contents of training programme technical details and techniques involved) or any such display material related to project activities along with slides, charts, photographs should be brought at the venue of the Annual Monitoring & Evaluation (M&E) Workshop and sent at the NMHS-PMU, GBP NIHE HQs, Kosi-Katarmal, Almora 263643, Uttarakhand. In all Knowledge Products, the Grant/ Fund support of the NMHS should be duly acknowledged.
4. The FTR Format is in sync with many other essential requirements and norms desired by the Govt. of India time to time, so each section of the NMHS-FTR needs to duly filled by the proponent and verified by the Head of the Lead Implementing Organization/ Institution/ University.
5. Five (5) bound hard copies of the Project Final Technical Report (FTR) and a soft copy should be submitted to the **Nodal Officer, NMHS-PMU, GBP NIHE HQs, Kosi-Katarmal, Almora, Uttarakhand**.

The FTR is to be submitted into following two parts:

Part A – Project Summary Report

Part B – Project Detailed Report

Following Financial and other necessary documents/certificates need to be submitted along with Final Technical Report (FTR):

Annexure I	**Consolidated and Audited Utilization Certificate (UC) & Statement of Expenditure (SE)**, including interest earned for the last Fiscal year including the duly filled GFR-19A (with year-wise break-up)
Annexure II	**Consolidated Interest Earned Certificate**
Annexure III	**Consolidated Assets Certificate** showing the cost of the equipment in Foreign and Indian currency, Date of Purchase, etc. (with break-up as per the NMHS Sanction Order and year wise).
Annexure IV	**List of all the equipment, assets and peripherals** purchased through the NMHS grant with current status of use including location of deployment.
Annexure V	Letter of Head of Institution/Department confirming Transfer of Equipment Purchased under the Project to the Institution/Department
Annexure VI	**Details, Declaration and Refund of any Unspent Balance transferred through Real-Time Gross System (RTGS) in favor of NMHS GIA General**

NMHS-Final Technical Report (FTR) *template*

Demand-Driven Action Research Project

DSL: Date of Sanction Letter

2	6	0	2	**2**	**0**	**1**	**8**

Completion

DPC: Date of Project

3	0	1	1	**2**	**0**	**2**	**1**

Part A: Project Summary Report

1. Project Description

i.	Project Reference No.	GBPNI/NMHS-2017/MG-22/566							
ii.	Type of Project	Small Grant		**Medium Grant**	√	Large Grant			
iii.	Project Title	Monitoring and Evaluation of species composition and richness in endemic plants, birds, mammals, and reptiles along successional gradient after shifting cultivation and creating education and awareness for their conservation in Dampa Tiger Reserve landscape, Mizoram							
vi.	State under which Project is Sanctioned	Mizoram							
v.	Project Sites (IHR States covered) (Maps to be attached)	Dampa Tiger Reserve and its surrounding areas, Mizoram, India							
vi.	Scale of Project Operation	**Local**	√	Regional		Pan-Himalayan			
vii.	Total Budget/ Outlay of the Project	0.909 (in Cr)							
viii.	Lead Agency	Department of Zoology, Mizoram University							
	Principal Investigator (PI)	Prof. H.T Lalremsanga							
	Co-Principal Investigator (Co-PI)	NA							
ix.	Project Implementing Partners	Department of Zoology, Mizoram University, Tanhril, Aizawl, Mizoram-796004 Amity Institute of Forestry and Wildlife, Amity University, Noida-201313, Uttar Pradesh, India							
	Key Persons / Point of Contacts with Contact Details, Ph. No, E-mail	Prof H.T. Lalremsanga Head of the Department, Department of Zoology Mizoram University, Tanhril, Aizawl,Mizoram-796004 Contact No.: + 917005670693 *e-mail: htlrsa@yahoo.co.in*							

2. Project Outcomes

2.1. Abstract (not more than 500 words) [it should include background of the study, aim, objectives, methodology, approach, results, conclusion and recommendations).

Background*:** Biodiversity are crucial part of ecosystem that plays structural and functional roles. It comprises of mammals, avifauna, plants and also the tiny amphibians and reptiles that shares there contribution. Monitoring their pattern through a successional gradient of shifting cultivation provides an insight to the ever-changing dynamic of species recovery and development of various components in that mosaic of ecosystem. ***Objectives: The study emphasis on various aspects of biodiversity recovery pattern upon successional gradient of shifting cultivation. It also addresses the nature and extent of anthropogenic activities in the region and the factors that drives these issues. The role of awareness programs, capacity building and a sustainable livelihood approach for conservation of biodiversity of the region was also tested through the study. ***Methodology:*** The study area was categorized into four forest types namely current jhum field, abandoned jhum fields (1-4 years old), Middle age jhum land (5-10 years old), Long aged Jhum land (10 years and above) and primary mature forest for field surveys. Direct and indirect evidence on distribution, abundance, habitat use, threats etc. of mammals, birds and amphibians were collected. Questionnaires surveys, satellite based data mapping, awareness programs were also adapted. ***Results*:** The study resulted in documentation of over 30 mammals, 169 birds, 35 amphibian, 21 reptiles and numerous plant species. Several of the identified species are Data deficient, Endangered and Vulnerable species. Few winter migratory birds were also recorded from the study sites. The recovery pattern of biodiversity shows that secondary forest (1-4 years old) has the highest recovery rate and is represented by rich population of birds, mammals and plant diversity. They provide refuge and act as connecting corridors for several small carnivores and herbivores species. Amphibian and reptiles were more abundant in mature forest and along natural streams, water patches and in adjacent areas of the road that divides the core and buffer region of DTR. Questionnaire and ground survey indicates that the LULC pattern in buffer areas of DTR is highly altered by shifting cultivation. Practice of monoculture is another reason for decline of forest areas. Forest fire, retaliation killing, lack of alternative livelihood options were identified to be other major threats to biodiversity around the reserve. Although a decrease in numbers of oil palm plantation sites was observed, as locals are adapting mixed farming, sustainability in resource management is far from achieved. Organizing the programs on sustainable development and livelihood improvement filled the gaps between the governmental sector, banks and the local farmer population. **Conclusion:** The study was fruitful with several takeaways. It not only provided with numerous information of the faunal diversity of the region but also the factors that regulates them. ***Recommendations:*** While shifting cultivation is always a debatable topic, our study shows that if

regulated sustainably and there is increase in time period between uses of fallow jhum fields, they can be ideal for species recovery and sometimes even function better than the mature forest. However, more such studies are needed to formulate an implementing measure that promotes biological sustainability and growth for all.

2.2. Objective wise major achievements

S. No.	Objectives	Major achievements (in bullets points)
1	To investigate the pattern of recovery of floral composition and richness with respect of time elapsed since abandonment after shifting cultivation	• Highest diversity of plants was observed in the abundant jhum fields of 5 -10 years old. While climbers and shrubs were abundant in all ages of jhum, we focused mainly on the tree species in the study. • 41 tree species were recorded from the study. Current jhum has no or only burnt tree while the order of tree composition in fallow jhum lands is represented in the order of **5-10 years > 10-15 years > 1-5 years >** that was based on their IVI values.
2	To study the trajectory of faunal (birds, mammals and reptiles) recovery patterns along the successional gradient.	**Birds** – • The study reports 168 bird species from 54 families including 17 winter visitors. • The abundance of species increases with the age of the fallow land. The relationship between the abundance of birds along the age of fallow land tests significant ($r = 0.503$, $df = 5$, $P < 0.05$). • The highest numbers (%) of species were found at altitude between 300 to 400 m. **Mammals** • Over15 mammals were confirmed through camera traps and 36 were identified through indirect evidences • 139 scat samples were also collected during the survey period. • Barking deer (27%) and wild boar (24%) were most

		frequent visitors in crop fields. Among the carnivores highest abundance (3-5 scat samples per jhum field) was recorded for leopard cat and Indian Palm civet. • Grasslands were found to be ideal for small felids, rodents and civets. • 2-5 years old abandoned jhum fields were recorded to be suitable habitat for movement of large herbivores. The frequency of scat decreased with age of the jhum. • Significant ($P < 0.05$, $F = 7.73$) values were obtained between frequency of visits vs different animals visits with species of wild boar, sambar, barking dear, jungle fowl are regular visitors. **Herpetofauna** • 35 amphibians were reported with 26 new records for Dampa Tiger Reserve (DTR). Six new distribution records for the state of Mizoram and two species, *Raorchestes rezakhani* and *Sylvirana lacrima*, are new country records. • 21 reptile species were also recorded in the study. • More than 86 eggs of king cobra were also rescued and hatched under laboratory conditions. The hatchlings were later released to the wild in presence of the concern Forest Department.
3	To examine changes in spatio-temporal utilization of habitat by birds, mammals and reptiles along the successional gradient in comparison to habitat utilization in primary forest.	• Probability of finding a scat sample or other evidence tends to decrease with age of the jhum. • Agricultural plots embedded in a large forest matrix are known to increases spatial heterogeneity and promotes mammalian distribution. • In amphibians there was no significant age determinacy along different gradient of habitat recovery, yet puddles, canals, natural ponds, fish ponds, roadside, primary forest, secondary forest,

		paddy fields, and human settlement serves as excellent microhabitat. • Physiological actors such as soil moisture content, organic matter content, and ground litter cover are positively correlated and crucial for recovery of amphibian and reptiles in the region.
4	To assess the nature and extent of anthropogenic pressures on species diversity.	• LULC map prepared for the eight surveyed period. • 60.1% of respondent practicing slush and burnt (*jhum*) cultivation has more than a hectare of agricultural lands. • Current jhum around DTR has an area of 3119.43 ha^2, abandoned jhum have 3965.1 ha^2 and about 22571.15 ha^2 of area is under secondary forest respectively. • Local's tribes collect about 21.04% of bamboo, 2.8% of timber, 28.01% of fuel wood, and 11.01% of food and medicines requirement from the forest. • The frequency of lopped trees was recorded to varied considerably among villages in Phuldungsei and Teirei forest ranges ($\chi 2 = 89.16$, df = 5, $p < 0.004$. • Ethno-zoological usage consists of animal parts of the snake, bear bile, monitor lizard, porcupine, etc.
5	Capacity building of gender based local communities and stakeholders for sustainable development through training, workshops and creating awareness about alternate livelihood and conservation of natural resources.	• Four awareness and livelihood development were conducted in four villages namely Damparengpui, Teirei, West Phaileng and Lallen. • 70 (38 males and 32 females) from Damparengpui, 40 (30 males and 10 females) from Teirei, 45 (40 males and 5 females) from West Phaileng and 25 (20 Male and 5 female) from Lallen participated in the programs. • Knowledge gaps were addressed and better coordination among forest department, Local NGO's and farmers was achieved.

		• Resource persons including the Project Investigator (PI) Prof. H.T. Lalremsanga, from the Department of Zoology, Mizoram University; Dr Jonathan a Veterinary Doctor and Mr H. Lalruatdika, the Public Relation Officer (PRO) at Mizoram Rural Bank from West-Phaileng, and the Director of the Dampa Tiger Reserve, Pu C. Lalbiaka address several issues raised by the locals and suggest them suitable livelihood development options.

2.3. Outputs in terms of Quantifiable Deliverables*

S. No.	Quantifiable Deliverables*	Monitoring Indicators*	Quantified Output/ Outcome achieved	Deviations made, if any, & Reason thereof:
1	Knowledge on impact of shifting cultivation on floral and faunal composition and richness	Baseline information to be provided in the 1st quarter	• Baseline data on presence of over 15 mammals, 168 birds, 35 amphibians and 17 reptiles have been confirmed along different gradient of shifting cultivation.	No Deviations
2	Document on adaptive strategy adopted by fauna to overcome the effect of shifting cultivation	• No. of new database/datasets generate on the identified dynamics (no.) shifting cultivation, trajectory of fauna recovery patterns, spatio-temporal utilization of habitat, anthropogenic pressure on species diversity etc. • Periodic submission on	• Datasets developed for mammals, avifauna and herpetofauna respectively along successional gradient of shifting cultivation. • LUCL maps developed for the eight surveyed villages in peripheral areas of DTR. • Recovery trajectory of	

		adaptive strategy of selected species (no.) with analytical findings and outcome	faunal diversity identified which states that abandoned agricultural field's serves as better opportunities for feeding and corridors for movement of birds and animal species. • Clearing of forested lands, forest fire, high dependency on NTFP's, over exploitation are the primary form of anthropogenic pressure in the region. • No significant effect was observed along different gradient of habitat recovery. • Best adaptive strategy would be to increase the time period between utilization of fallow lands for agricultural purposes.	
3	Creating awareness and building capacity among stakeholders four villages from the selected district	• No. of capacity building/awareness programs, including no. of stakeholders benefitted (No. of rural youths, No. of women, and total no. of beneficiaries) • Report on anthropogenic pressure on diversity for	• Four capacity building/awareness programs were organized in different villages of DTR. • 180 locals representing different sections of the society participated in programs. • Six youths were selected	Due to spread of Covid-19 pandemic, restriction was imposed on gathering of large group of people leading to the presence of only

		assisting the management and decision-making • Publication and knowledge products (no.), particularly on impact of shifting cultivation, adaptive strategies.	for the Green Hub fellowship program. • An amount of Rs 8, 60, 60,000 was approved as loans under different schemes to 361 local peoples from 14 villages around the DTR. • 97 women's members were also granted loans for various development and self- sustenance activities. • Two papers have been published of the topic of impact of shifting cultivation, adaptive strategies. • Knowledge gaps were addressed and better coordination among forest department, Local NGO's and farmers was achieved. • A total of 31 papers have been published acknowledging the funding agency (NMHS) in peer reviewed and UGC recognised journals.	selected representatives from different section of the society in the 4th awareness program.

(*) As stated in the Sanction Letter issued by the NMHS-PMU.

2.4. Strategic Steps with respect to Outcomes (in bullets)

S. No.	Particulars	Number/ Brief Details	Remarks/ Attachment
1.	New Methodology developed		
2.	New Models/ Process/ Strategy developed	Distinct morphological and genetic traits were identified to differentiate between closely related species such as *Raorchestes rezakhani* and *R. manipurensis* ; *Minnervarya asmati* and *Fejervarya multistriata*; *Euphlyctic kalasgramensis* and its congener species etc.	Details are provided in Supplementary file no 1.
3.	New Species identified	2 (new country reports) 17 (new reports for DTR)	Supplementary file no 2.
4.	New Database established	21 new NCBI database	Supplementary file no 3.
5.	New Patent, if any		
	I. Filed (Indian/ International)	NIL	
	II. Granted (Indian/ International)	NIL	
	III. Technology Transfer(if any)	NIL	
6.	Others (if any)	NIL	

3. Technological Intervention

S. No.	Type of Intervention	Brief Narration on the interventions	Unit Details (No. of villagers benefited / Area Developed)
1.	Development and deployment of indigenous technology	• Different crop production technologies and conflict mitigation measures has been demonstration • Techniques and mode of procurement of bank loans were explained	• 361 villagers were benefitted from 14 villages
2.	Diffusion of High-end Technology in the region		
3.	Induction of New Technology in the region		
4.	Publication of Technological / Process Manuals	Research articles	31 (Published) 04 (Under- review)
	Others (if any)		

4. New Data Generated over the Baseline Data

S. No.	New Data Details	Status of Existing Baseline	Additionality and Utilisation New data
1	Land use and land cover map generated for eight villages	Published in research journals for wider use and circulation	It will be useful for future development activities in the villages
2	Crop management practices	Demonstrated and are practically in use by the local farmers	• Several villagers are not taking up mixed agricultural practised in comparison to the traditional form of shifting cultivation • Betel nuts, pineapple, banana, ginger etc. are now planted along with common vegetables and paddy

3	Animal husbandry and fish rearing	Veterinary doctor, Dr Jonathan is generously offering help the local villagers with the treatment of diseases and vaccination of their domestic animals and other cattle species in the village of West Phaileng.	

5. Demonstrative Skill Development and Capacity Building/ Manpower Trained

S. No.	Type of Activities	Details with number	Activity Intended for	Participants/Trained			
				SC	**ST**	**Woman**	**Total**
1.	Workshops	4	• Bridge the gap between Forest department and local tribals • Aware locals with existing and modern tools for crop management and conflict mitigation with animals • Promote animal husbandry and fish rearing • Encourage locals for biodiversity conservation		128	52	180
2.	On Field Trainings	6			6		6
3.	Skill Development	4	• Better management of biodiversity threats • Encourage mixed farming and adapt to alternative livelihood development activities • Easy bank loans at minimal interest • Trained youth for wildlife film making and documentary		128	52	180
4.	Academic Supports						
	Others (if any) (trained for attending Green Hub training Program)	6			6		6

6. Linkages with Regional & National Priorities (SDGs, INDC, etc)/ Collaborations

S. No.	Linkages /collaborations	Details	No. of Publications/ Events Held	Beneficiaries
1.	Sustainable Development Goal (SDG)	Mizoram Rural Bank (West-Phaileng) has actively collaborated with Self Help Groups (SHG's) and local farmers for providing agricultural and self-sustainability loads	4	361
2.	Climate Change/INDC targets			
3.	International Commitments			
4.	Bilateral engagements			
5.	National Policies			
6.	Others collaborations			

7. Project Stakeholders/ Beneficiaries and Impacts

S. No.	Stakeholders	Support Activities	Impacts
1.	Gram Panchayats		
2.	Govt Departments (Agriculture/ Forest)	Forest Department has activity participated in all of the awareness programs and has tried to engage local communities in conservation implementation drives.	• Many locals has reported illegal hunting in the region to the concern department, resulting in decrease in no. of hunting cases • The village Serhmun has been successfully relocated • Free distribution of gas by the forest departments has led to sustainable resources utilization and decrease in NTFP's collection

			• They have also built houses for all tribal women's and other needy persons
3.	Villagers	Villagers from all surveyed villages has fully cooperated and supported throughout the project	• Easy access to crop fields • Monitored camera traps and provided with information of encounters with animals in crop fields and other valuable information
4.	SC Community	None	
5.	ST Community	All participants of awareness program belongs to the ST community	
6.	Women Group	Women representatives of Self Help Groups participated in all of awareness program	Procured loans for livelihood development and other activities
	Others (if any)		

8. Financial Summary (Cumulative)

S. No.	Financial Position/Budget Head	Funds Received	Expenditure/ Utilized	% of Total cost
I.	Salaries/Manpower cost	1723200.00	1722907.00	99.98
II.	Travel	1859472.00	1859079.00	99.97
III.	Expendables &Consumables	400000.00	400000.00	100
IV.	Contingencies	200000.00	199694.00	99.84
V.	Activities & Other Project cost	1000000.00	1000000.00	100
VI.	Institutional Charges	200000.00	200000.00	100
VII.	Equipments	660000	660000.00	100
	Total	6042672.00	6041680.00	99.98
	Interest earned	143512.00		
	Grand Total	6186184.00		

* Please attach the consolidated and audited Utilization Certificate (UC) and Year wise Statement of Expenditure (SE) separately, *ref.* **Annexure I.**

9. Major Equipment/ Peripherals Procured under the Project** (if any)

S. No.	Name of Equipments	Cost (INR)	Utilisation of the Equipment after project
1.	Camera traps (Cudde back C1)	363490.00	Educational and research purpose in the institute
2.	Nikon D5300 DSLR Camera	43950.00	-do-
3.	Voice recorder (ZOOM H4N Pro)	75127.00	-do-
4.	Compass (SUNNTO A10)	15654.00	-do-
5.	Range finder (Bushnell)	122535.00	-do-
6.	Projector (Nikon)	32544.00	-do-

Details should be provided in details **(*ref* **Annexure III &IV).**

10. Quantification of Overall Project Progress

S. No.	Parameters	Total (Numeric)	Remarks/ Attachments/ Soft copies of documents
1.	IHR States Covered	1	Map of study site attached (Supplementary file 4 & 5
2.	Project Site/ Field Stations Developed	Dampa Tiger Reserve, three field stations developed in the villages of Damparengpui, West Phaileng and Lallen respectively	Pictures of field stations attached (Supplementary file 6)
3.	New Methods/ Modeling Developed		
4.	No. of Trainings arranged	4	
5.	No of beneficiaries attended trainings	180	Pictures attached (Supplementary file 7)
6.	Scientific Manpower Developed (Phd/M.Sc./JRF/SRF/ RA):	1 JRF, 2 SRF	
7.	SC stakeholders benefited		
8.	ST stakeholders benefited	180	
9.	Women Empowered	95	
10.	No of Workshops Arranged along with level of participation	4	
11.	On field Demonstration Models initiated	.... (attach maps about location & photos)	
12.	Livelihood Options promoted		
13.	Technical/ Training Manuals prepared	10	
14.	Processing Units established	.... (attach photos)	NA
15.	No of Species Collected	52	
16.	New Species identified	235 (15 mammals, 168 birds, 35 amphibians and 17 reptiles)	
17.	New Database generated (Types):		
	Others (if any)		

11. Knowledge Products and Publications:

S. No.	Publication/ Knowledge Products	*Number*		*Total Impact Factor*	*Remarks/* Enclosures
		National	International		
1.	Journal Research Articles/ Special Issue:		31	17.99	Publications attached (Supplementary file 8)
2.	Book Chapter(s)/ Books:				
3.	Technical Reports	7 Quarterly reports & 2 Annual reports			
4.	Training Manual (Skill Development/ Capacity Building)	4			
5.	Papers presented in Conferences/Seminars	1	2		
6.	Policy Drafts/Papers		4 articles accepted		
7.	Others:		2 articles under review		

* Please append the list of KPs/ publications (with impact factor and further details) with due Acknowledgement to NMHS.

12. Recommendation on Utility of Project Findings, Replicability and Exit Strategy

Particulars	Recommendations
Utility of the Project Findings	The project has addressed several aspects of biodiversity, its recovery over the course of time and socioeconomic status of locals in the region. The project findings will be crucial to understand the pattern of faunal recovery following shifting cultivation and systematically plan for its conservation. Various livelihood options suggested and some of which have been adapted by locals will help creating better income opportunities for the farmers. Reporting on several new faunal species from the region will further attract researchers to peruse their studies and ultimately conserve them.

Replicability of Project	Since the landscape of Northeast states are quite similar, the project findings can be easily applied to other parts of the region. Value addition products and practised (Mixed farming) that are adapted by locals can be suggested to other farmers too. Research articles published from the project will reach out to the wider audience and can possibly be replicate throughout Southeast Asia.
Exit Strategy (Please describe the Exit Strategy of the project, self-sustaining and benefitting the stakeholders and local community)	• LULC maps prepared will be helpful for future plan and other development activities. • Links created between stakeholders and cooperative banks will help for easy accessibility and other livelihood activities for the locals. • Mixed farming and adaptation for value added products • Better coordination among locals and forest department will support biodiversity and successful implementation of conservation management strategies. • Baseline data obtained for faunal species and the recovery pattern will helpful for their long-term monitoring and conservation.

Prof. H.T. LALREMSANGA

(**PROJECT PROPONENT/ COORDINATOR**)

(Signed and Stamped)

(**HEAD OF THE INSTITUTION**)
(Signed and Stamped)

Place: Mizoram University, Aizawl
Date: 17/01/2021

PART B: PROJECT DETAILED REPORT

The Detailed report should include an Executive Summary and it should have separate chapters on (i) Introduction (ii) Methodologies, Strategy and Approach (iii) Key Findings and Results (iv) Overall Achievements (v) Project's Impacts in IHR (vi) Exit Strategy and Sustainability (vii) References and (viii) Acknowledgement (It should have a mention of financial grant from the NMHS, MoEF&CC)

Further, description of Technical Activities, List of Trainings/ Workshops/ Seminars with details of trained resources, list of New Products developed under the project, Manual of Standard Operating Procedures (SOPs) developed, Technology developed/Transferred etc should be enclosed as Appendix.

1 EXECUTIVE SUMMARY

The Executive Summary of the project should not be more than 3–5 pages, covering all essential features in precise and concise manner as stated in Part A (Project Summary Report) and Part B (Comprehensive Report).

2 INTRODUCTION

2.1 Background of the Project (max. 500 words)
2.2 Overview of the Major Issues to be Addressed (max. 1000 words)
2.3 Baseline Data and Project Scope (max. 1000 words)
2.4 Project Objectives and Target Deliverables (as per the NMHS Sanction Order)

3 METHODOLOGIES, STARTEGY AND APPROACH

3.1 Methodologies used for the study (max. 1000 words)
3.2 Preparatory Actions and Agencies Involved (max. 1000 words)
3.3 Details of Scientific data collected and Equipments Used (max 500 words)
3.4 Primary Data Collected (max 500 words)
3.5 Details of Field Survey arranged (max 500 words)
3.6 Strategic Planning for each Activities (max. 1000 words)
3.7 Activity wise Time frame followed [using Gantt/ PERT Chart (max. 1000 words)]

4 KEY FINDINGS AND RESULTS

4.1 Major Research Findings (max. 1000 words)
4.2 Key Results (max 1000 words in bullets covering all activities)
4.3 Conclusion of the study (maximum 500 words in bullets)

5 OVERALL ACHIEVEMENTS

5.1 Achievement on Project Objectives [Defining contribution of deliverables in overall Mission (max. 1000 words)]
5.2 Establishing New Database/Appending new data over the Baseline Data (max. 1500 words, in bullet points)
5.3 Generating Model Predictions for different variables (if any) (max 1000 words in bullets0
5.4 Technological Intervention (max 1000 words)
5.5 On field Demonstration and Value-addition of Products (max. 1000 words, in bullet points)
5.6 Promoting Entrepreneurship in IHR
5.7 Developing Green Skills in IHR
5.8 Addressing Cross-cutting Issues (max. 500 words, in bullet points)

6 PROJECT'S IMPACTS IN IHR

6.1 Socio-Economic Development (max. 500 words, in bullet points)
6.2 Scientific Management of Natural Resources In IHR (max. 500 words, in bullet points)
6.3 Conservation of Biodiversity in IHR (max. 500 words, in bullet points)
6.4 Protection of Environment (max. 500 words, in bullet points)
6.5 Developing Mountain Infrastructures (max. 500 words, in bullet points)
6.6 Strengthening Networking in IHR (max. 700 words, in bullet points)

7 EXIT STRATEGY AND SUSTAINABILITY

7.1 How effectively the project findings could be utilized for the sustainable development of IHR (max. 1000 words)
7.2 Efficient ways to replicate the outcomes of the project in other parts of IHR (Max 1000 words)
7.3 Identify other important areas not covered under this study needs further attention (max 1000 words)
7.4 Major recommendations for sustaining the outcome of the projects in future (500 words in bullets)

8 REFERENCES/BIBLIOGRAPHY

9 ACKNOWLEDGEMENT

APPENDICES

Appendix 1 – Details of Technical Activities
Appendix 2 – Copies of Publications duly Acknowledging the Grant/ Fund Support of NMHS
Appendix 3 – List of Trainings/ Workshops/ Seminars with details of trained resources and dissemination material and Proceedings
Appendix 4 – List of New Products (utilizing the local produce like NTFPs, wild edibles, bamboo, etc.)
Appendix 5 – Copies of the Manual of Standard Operating Procedures (SOPs) developed
Appendix 6 – Details of Technology Developed/ Patents filled
Appendix 7 – Any other (specify)

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Annexure-I

Consolidated and Audited
Utilization Certificate (UC) and Statement of Expenditure (SE)

For the Period: 2018 - 2021

1.	Title of the project/Scheme/Programme	Monitoring and Evaluation of species composition and richness in endemic plants, birds, mammals, and reptiles along succession gradient after shifting cultivation and creating education and awareness for their conservation in Dampa Tiger Reserve landscape, Mizoram
2.	Name of the Principle Investigator & Organization:	Prof. H.T. Lalremsanga Department of Zoology, Mizoram University, Aizawl, Tanhril-796004, India
3.	NMHS-PMU, G.B. Pant National Institute of Himalayan Environment, Kosi-Katarmal, Almora, Uttarakhand, Letter No. and Sanction Date of the Project:	Letter No. GBPNI/ NMHS-2017/MG-22 Sanction Date: 26-02-2018
4.	Amount received from NMHS-PMU, G.B. Pant National Institute of Himalayan Environment, Kosi-Katarmal, Almora, Uttarakhand during the project period (Please give number and dates of Sanction Letter showing the amount paid):	**Amount Received in 1st Installment** **Rs/- 3321600.00** Letter No. GBPNI/ NMHS-2017/MG-22 Sanction Date: 26-02-2018 **Amount Received in 2nd Installment** **Rs/- 2861600.00** Letter No. GBPNI/ NMHS-2017/MG-22/566/408/96/210 Sanction Date: 18.11.2020 **Extension period** Letter No. GBPNI/ NMHS-2017/MG-22/566/408/96/210/29 Sanction Date: 31.05.2021
5.	Total amount that was available for expenditure (Including commitments)	3321600.00 + 2861600.00

	incurred during the project period:	
6.	Actual expenditure (excluding commitments) incurred during the project period:	3321600.00 +2721072.00
7.	Unspent Balance amount refunded, if any (Please give details of Cheque no. etc.):	992 (Transition No. PUNBH22038208199)
8.	Balance amount available at the end of the project:	992
9.	Balance Amount:	992
10.	Accrued bank Interest:	143512

Certified that the expenditure of Rs. 6041680.00 **(**Rupees Sixty Lakhs Forty One Thousand Six Hundred and Eighty) mentioned against Sr. No. 6 was actually incurred on the project/scheme for the purpose it was sanctioned.

Date: 17/01/2022

(Signature of Principal Investigator)

(Signature of Registrar/ Finance Officer)

(Signature of Head of the Institution)

OUR REF. No.

ACCEPTED AND COUNTERSIGNED

Date:

COMPETENT AUTHORITY
NATIONAL MISSION ON HIMALAYAN STUDIES (GBP NIHE)

Statement of Consolidated Expenditure

[Mizoram University]

Statement showing the expenditure of the period from Sanction No. and Date: Ref. No.: GBPNI/ NMHS-2017/MG-22 Date: 26-02-2018

1. Total outlay of the project : 9096560.00

2. Date of Start of the Project : 26/02/2018

3. Duration : 3 years (Nine months extended)

4. Date of Completion : 31/11/2021
a) Amount received during the project period : 6042672.00
b) Total amount available for Expenditure : 6183200.00

S. No.	Budget head	Amount received	Expenditure	Amount Balance/ excess expenditure
1	Salaries	1723200.00	2686560.00	**(-) 963360.00**
2	Permanent Equipment Purchased (Item-wise	660000.00	660000.00	0.00
3	Camera traps (Cudde back C1)		363490.00	
4	Nikon D5300 DSLR Camera		43950.00	
5	Voice recorder (ZOOM H4N Pro)		75127.00	
6	Compass (SUNNTO A10)		15654.00	
7	Range finder (Bushnell)		122535.00	
8	Sherman's traps (Local made)		6700.00	
9	Nikon Projector		32544.00	
10	Institutional charges	200000.00	200000.00	Nil
11	Accrued bank Interest	143512.00	143512.00	Nil
12	**Total**	**2726712.00**	**4350072.00**	**(-) 963360.00**

Certified that the expenditure of **Rs. 4350072.00 (Rupees: Forty Three Lakhs Fifty Thousand and Seventy Two)** mentioned against Sr. No.12 was actually incurred on the project/ scheme for the purpose it was sanctioned.

Date: 17/01/2022

(Signature of Principal Investigator)	(Signature of Registrar/ Finance Officer)	(Signature of Head of the Institution)

OUR REF. No.

ACCEPTED AND COUNTERSIGNED

Date:

COMPETENT AUTHORITY
NATIONAL MISSION ON HIMALYAN STUDIES (GBP NIHE)

Annexure-II

Consolidated Interest Earned Certificate

Please provide the detailed interest earned certificate on the letterhead of the grantee/ Institution and duly signed.

This is to certify that an amount of Rs 1,40,528 was earned as bank interest in FY 2018-2019 & 2019-2020, and Rs 2984 was earned in the Financial year of 2020-2021 and the same has been incurred in the project schemes and activities during the project period.

Annexure-III

Consolidated Assets Certificate

Assets Acquired wholly/ substantially out of Government Grants

(Register to be maintained by Grantee Institution)

Name of the Sanctioning Authority: Mizoram University

1. Sl. No.: MZMU 11 - MZMU 19
2. Name of Grantee Institution: Mizoram University
3. No. & Date of sanction order: Ref. No.: GBPNI/ NMHS-2017/MG-22, Dated 26/02/2018
4. Amount of the Sanctioned Grant: 660000.00
5. Brief Purpose of the Grant: Required for field survey and data collection
6. Whether any condition regarding the right of ownership of Govt. in the property or other assets acquired out of the grant was incorporated in the grant-in-aid Sanction Order: NA
7. Particulars of assets actually credited or acquired 8 Nos.
8. Value of the assets as on: Rs-/ 660000.00
9. Purpose for which utilized at present Academic/Educational and research demonstrations
10. Encumbered or not : NOT
11. Reasons, if encumbered: NA
12. Disposed of or not : Yes Sherman's traps (Local made)
13. Reasons and authority, if any, for disposal: All the traps have been used and were in no condition for their reuse
14. Amount realized on disposal: NA

Any Other Remarks: Except the batteries that were purchased for the functioning of camera traps and other equipment's all the procured equipment's and fields items are in proper functional mode and will be used for educational and technical demonstration to the students and scholars of the university by the concern departments.

(PROJECT INVESTIGATOR) **(FINANCE OFFICER)**

(Signed and Stamped) **(Signed and Stamped)**

(HEAD OF THE INSTITUTION)

(Signed and Stamped)

Annexure-IV

List or Inventory of Assets/ Equipment/ Peripherals

S. No.	Name of Equipment	Quantity	Sanctioned Cost	Actual Purchased Cost	Purchase Details
1	Camera traps (Cudde back C1)	20	363490.00	363490.00	Purchased from Precision suppliers and dealers
2	Nikon D5300 DSLR Camera	01	43950.00	43950.00	Arem Agencies Aizawl
3	Voice recorder (ZOOM H4N Pro)	02	75127.00	75127.00	Precision suppliers and dealers
4	Compass (SUNNTO A10)	02	15654.00	15654.00	Precision suppliers and dealers
5	Range finder (Bushnell)		122535.00	122535.00	Precision suppliers and dealers
6	Sherman's traps (Local made)	25	6700.00	6700.00	Local market
7	Densitometer	01	5000.00	5000.00	Precision suppliers and dealers
8	Telescopic lens	01	23615.00	23615.00	TANOTIS
9	Projector	01	32544.00	32544.00	Arem Agencies Aizawl

(PROJECT INVESTIGATOR) **(FINANCE OFFICER)**

(Signed and Stamped) **(Signed and Stamped)**

(HEAD OF THE INSTITUTION)

(Signed and Stamped)

Annexure-V

Letter of Head of Institution/Department confirming Transfer of Equipment Purchased under the Project to the Institution/Department

To,

The Convener, Mountain Division
Ministry of Environment, Forest & Climate Change (MoEF&CC)
Indira Paryavaran Bhawan
Jor Bagh, New Delhi-110003

Sub.: Transfer of Permanent Equipment purchased under Research Project titled "*Monitoring and Evaluation of species composition and richness in endemic plants, birds, mammals, and reptiles along successional gradient after shifting cultivation and creating education and awareness for their conservation in Dampa Tiger Reserve landscape, Mizoram*" funded under the NMHS Scheme of MoEF&CC – reg.

Sir/ Madam,

This is hereby certified that the following permanent equipment purchased under the aforesaid project have been transferred to the Implementing Organization/ Nodal Institute after completion of the project:

1. Camera traps (Cudde back C1) (15 Nos.)
2. Nikon D5300 DSLR Camera (1 Nos.)
3. Voice recorder (ZOOM H4N Pro) (1 Nos.)
4. Compass (SUNNTO A10) (1 Nos.)
5. Range finder (Bushnell)
6. Densitometer (1 Nos.)
7. Telescopic lens (Bushnell) (1 Nos.)
8. Nikon Projector (1 Nos.)

Head of Implementing Organization

Name of the Implementing Organization: Mizoram University

Stamp/ Seal:

Date:

Copy to:

1. The Nodal Officer, NMHS-PMU, National Mission on Himalayan Studies (NMHS), G.B. Pant National Institute of Himalayan Environment (NIHE), Kosi-Katarmal, Almora, Uttarakhand-263643

Annexure-VI

Details, Declaration and Refund of Any Unspent Balance

Please provide the details of refund of any unspent balance and transfer the balance amount through RTGS (Real-Time Gross System) in favor of **NMHS GIA General** and declaration on the official letterhead duly signed by the Head of the Institution.

Kindly note the further Bank A/c Details as follows:

Name of NMHS A/c: NMHS GIA General
Bank Name & Branch: Central Bank of India (CBI), Kosi Bazar, Almora, Uttarakhand 263643
IFSC Code: CBIN0281528
Account No.: 3530505520 (Saving A/c)

In case of any queries/ clarifications, please contact the NMHS-PMU at e-mail: nmhspmu2016@gmail.com

PART B: PROJECT DETAILED REPORT

The Detailed report should include an Executive Summary and it should have separate chapters on (i) Introduction (ii) Methodologies, Strategy and Approach (iii) Key Findings and Results (iv) Overall Achievements (v) Project's Impacts in IHR (vi) Exit Strategy and Sustainability (vii) References and (viii) Acknowledgement: It should have a mention of financial grant from the NMHS, MoEF & CC)

Further, description of Technical Activities, List of Trainings/ Workshops/ Seminars with details of trained resources, list of New Products developed under the project, Manual of Standard Operating Procedures (SOPs) developed, Technology developed/Transferred etc. should be enclosed as Appendix.

1 EXECUTIVE SUMMARY

The Executive Summary of the project should not be more than 3–5 pages, covering all essential features in precise and concise manner as stated in Part A (Project Summary Report) and Part B (Comprehensive Report).

Project Summary Report

Biodiversity are crucial part of ecosystem that plays structural and functional roles within the ecosystem. It comprises of mammals, avifauna, plants and also the tiny amphibians and reptiles that shares there contribution for the smooth functioning of the ecosystem. With continuous change in the landscape and habitat alteration, the need of regular monitoring of several aspects of the landscape and its components are of paramount necessity. Monitoring their pattern along the successional gradient in an altered landscape such as shifting cultivation provides an insight to the ever-changing dynamic of species recovery and development of various components in that mosaic of ecosystem. Considering the large scale conservation of forested land into agricultural crop fields in one of India's most forested state *i.e.* Mizoram, the study emphasis on various aspects of biodiversity recovery pattern upon successional gradient of shifting cultivation. It also addresses the nature and extent of anthropogenic activities in the region and the factors that drives these issues. The role of educational awareness programs, capacity building and a sustainable livelihood approach of conservation of biodiversity in the region was also tested through the study. The study area was categorized into four forest types namely current jhum field, abandoned jhum fields (1-4 years old), Middle age jhum land (5-10 years old), Long aged Jhum land (10 years and above) and primary mature forest for necessary field surveys and data collection. Different methods such as questionnaires surveys, direct and indirect evidence on distribution, abundance, habitat use, threats etc. of mammals, birds and amphibians were collected through transect surveys. Along with field surveys, house to house surveys were followed to gather information on the nature and extend of anthropogenic pressure in the surrounding areas of Dampa tiger reserve. Satellite based data mapping was used to determine and understand the change in land use and land cover in the surveyed villages at the vicinity of the reserve. Awareness programs and other livelihood development workshops were also adapted to educate the locals on various possibilities of livelihood betterment and sustainable development.

The study resulted in documentation of over 30 mammals (through camera traps), 169 birds, 35 amphibian, 21 reptiles and numerous species of trees, shrubs, climbers and other floral diversity. Several of the identified species are Data deficient, Endangered and Vulnerable species. Few winter migratory birds were also recorded from the study sites. The recovery pattern of biodiversity shows that secondary forest (1-4 years old) has the highest recovery rate and is represented by rich population of birds, mammals and plant diversity. The relationship between the abundance of birds along the age of fallow land was tested for Pearson's correlation and found significantly correlated ($r = 0.503$, $df = 5$, $P < 0.05$). Among the carnivores highest abundance (3-5 scat samples per jhum field) was recorded for leopard cat and Indian Palm civet. 2-5 years old abandoned jhum fields were recorded to be suitable habitat for movement of large herbivores. The frequency of scat decreased with age of the jhum >5 yrs. They provide refuge and act as connecting corridors for several small carnivores and herbivores species. Amphibian and reptiles were more abundant in mature forest and along natural streams, water patches and in adjacent areas of the road that divides the core and buffer region of DTR.

Survey on nature and extend of anthropogenic activities showed that 60% of respondents practiced slash & burn (jhum) cultivation on more than a hectare of agricultural land, while 33% had less than a hectare and 5.9% of surveyed individuals had no agricultural land and were involved in other activities like small scale business, forest guard, and daily wage labors. Locals in the region collect 21% of their bamboo, 2.8% of timber, 28% of fuel wood, and 11% of food and medicines from the forest. About 37% of respondents were recorded collecting all the above from the buffer region. Apart from the floral diversity, faunal resources also contribute for the daily usage of the local people around Dampa Tiger reserve in the form of bush meat and ethno-medicinal sources. Although a good section of the society, about 29% were listed not to use any form of faunal species, about 25% of the population consumed snakes for their medicinal values. Bear (Asiatic black bear and sun bear) subsidizes for 21% of the village medicine sources followed by pangolin (7%), primates (6%), monitor lizards (4%), ungulates (2%) and others (6%). Different parts of animals like fats of snakes (*Python molurus*), bear bile, pancreas of monitor lizard (*Varanus Indicus*) and porcupine (*Hystrix cristata*), pangolin, primates, ungulates etc. were often used against different health ailments. The hunting records gathered through the range officer (RO) suggest that the hunting trend in and around DTR is to a declining trajectory as the number of major items seized, *i.e.* non-licensed gun (Local made) (n=94) and traps or snares (n=68) from local hunter were relatively low in the past two years

Questionnaire and ground survey indicates that the LULC pattern in buffer areas of DTR is highly altered by shifting cultivation. Information obtained from MIRSAC and its mapping shows that highest number of agricultural land is in villages of West Phaileng (319 ha^2) and Damparengpui (283.8 ha^2). Closed or dense forest was in highest proportion in Phuldungsei and least in Tuipuibari (120 ha^2). Grazing activities was relatively low or absent in most part of DTR. Abandoned jhum fields were in largest number in Damparengpui (939.60 ha^2) followed by Silsuri (881.17 ha^2) and Serhmun (880.99 ha^2). In the past few decades, the fallow period of shifting cultivation has reduced to 2–3 years from 20–25 years, adding more abandoned land to the region. Although a decrease in numbers of oil palm plantation sites was observed which was mainly due to the adaptation of mixed farming by the local farmers; better outcomes are still expected. These changes in land-use patterns may also be due to the adaptation of alternate livelihood options by local villagers around DTR, which has increased by many folds in recent times compared to the negligible numbers in previous studies. Farmers were noted to have followed mixed farming (farms comprising of rubber (*Hevea brasiliensis*), betel (*Piper betel*), papaya (*Carica papaya*), broom plants (*Thysanolaena latifolia*), spiny coriander (*Eryngium foetidum*), banana (*Musa sp.*), *Parkisonia timontonria*, *Schima wallichii*, *Albizzia sp.* etc.) along with shifting cultivation to generate multiple sources of income. Farmers were also observed to cultivate various plant species such chilli (Mizoram's Birds Eye Chilli') (*Capsicum frutescens*), sesame (*Sesemum indicum*), ginger (*Zingiber officinale*), etc. in their crop fields to prevent crop-raiding by wild animals.

Organizing the programs on sustainable development and livelihood improvement filled the gaps between the governmental sector, banks and the local farmer population. The study was fruitful with several takeaways (increased in number of bank loans, obtaining proper permission before entering forest, increased in number of research activities etc.). It not only provided with numerous information of the faunal diversity of the region but also the factors that regulates them. While shifting cultivation is always a debatable topic, our study shows that if regulated sustainably and there is increase in time period between uses of fallow jhum fields, they can be ideal for species recovery and sometimes even function better than the mature forest. However, more such studies are needed to formulate an implimentive measure that promotes biological sustainability and growth for all.

Chapter 1

2 INTRODUCTION

2.1 Background of the Project (max. 500 words)

Land cultivation in India is having various forms in different regions of the country, based on the suitability of local conditions. These cultivation processes are classified into two distinct patterns (a) settled farming on the permanent and developed land in the plains and valley areas and (b) tribal agricultural practices, popularly known as shifting cultivation or '*Jhuming*' on the hill slopes or simply *jhum* lands available in the hill areas of different regions of the country by the tribal people of the country (Panda et al., 2016; Punitha et al., 2018). Shifting cultivation is a primitive method of cultivation. Shifting cultivation refers to the form of cultivation where a large area is cultivated for few years and then abandoned for some time until the fertility of the land is restored naturally. In India, even though this traditional method of cultivation has been discontinued for more advanced forms of farming, it is still practiced in the hill areas of North-Eastern Region, Sikkim, Bihar, Madhya Pradesh, Karnataka, Maharashtra etc. (Sati, 2019).

In the hilly tracts of north-east India, jhuming is linked with the ecological, socio-economical, and cultural lives of the over 86% of local people (Sati and Rinawma 2014; Sati 2019). Many rituals and festivals are closely associated with shifting cultivation. But the negative impacts of shifting cultivation are devastating and far reaching in degrading the environment and ecology of this region. The earlier 15-20 years cycle of shifting cultivation on a particular land has reduced to 2-3 years now. This has resulted in large scale deforestation, soil and nutrient loss and invasion by weeds and other species. The indigenous biodiversity has been affected to a large extend (Dangi 2008; Dasgupta and Gupta 2016; Gouda et al., 2020). The effect is more sever in biodiversity-rich tropical rain forests of north-east India which are undergoing conversion to secondary habitats at a rapid rate. Practices like logging and slash-and-burn cultivation are believed to be responsible for the major loss of biodiversity and forest cover in this region (Raman 2001; Mondal and Raman, 2001; Raman et al., 1998). As per Forest Survey of India 2015 report, there has been a decline of 631 km^2 of forest area, primarily due to shifting cultivation in seven states of north-east India. Mizoram alone has lost 306 km^2 forest areas from 2013 to 2015.

Land use practices like shifting cultivation causes significant changes in habitats and animal communities thus are a major concern in conservation biology. Frequent shifting from one land to the other, has affected the ecology of these regions. The area under natural forest has declined; the fragmentation of habitat, local disappearance of native species and invasion by exotic weeds and other plants are some of the other ecological consequences of shifting agriculture. Therein, the project explores the pattern of floral and faunal recovery along the successional gradient of jhum lands and the role of awareness in management and conservation of biodiversity in the region. It also attempts to work for achieving the long term goals of sustainable development and livelihood betterment in the surrounding areas of Dampa Tiger reserve in Mizoram India.

2.2 Overview of the Major Issues to be Addressed (max. 1000 words)

Through the project several important factors on biodiversity recovery, richness, threats, change in landscape dynamics, role of educational awareness programs and possible mitigation strategies for biodiversity conservation will be achieved. Some of the major issues that will be addressed through the study include knowledge products on impact of shifting cultivation on floral and faunal composition and richness. The distribution pattern of the avifaunal and mammalian diversity in the stratified study areas will also be made available at the end of the study period. The amphibian and the reptilian fauna present in the region will be documented after a gap of almost two decades as the previous data available on the herpetofauna of Dampa was dated back in 2001 by Pawar and Birand. The importance of herpetofauna as biological indicators shall be highlight through publication of research articles in UGC recognized journal. The role of the mosaic of forest patches between the *jhum* crop fields will be evaluated and their add-ons in serving valuable breeding sites, corridors for herbivores etc. will be recorded. Documentation of the adaptive strategy adopted by faunal species to overcome the effects of shifting cultivation along various gradients of forest recovery and will also be address through the study. Lack of information on change in landscape and forest dynamics will be overcome by field survey and satellite mapping of the survey villages and the pattern of land use and land cover in the region will be tried to understand to develop future management plans. Awareness and building capacity programs among stakeholders are crucial for implementation of any conservation strategies (Sahoo et al., 2010; Solanki et al., 2016). Various livelihood development programs will be held in the surrounding villages of Dampa to reduce the dependency of locals on forest resources and

improve their livelihood through various schemes and sustainable development approaches. Knowledge gaps between stakeholders and forest departments or other concern human resource development agencies will be addressed during the course of these programs. Through the study not only the documentation and conservation are on priority, but the adaptation of sustainable development approaches will be addressed and a road map for better understanding and implementation of conservation and development plans in the region.

2.3 Baseline Data and Project Scope (max. 1000 words)

Shifting cultivation is regarded as one of the traditional methods for cultivation in hilly areas of tropical regions in which forest vegetation is cut and burned on site. The site is cultivated for food crops and when the final crop is harvested; the site becomes fallow and is allowed to regain its natural forest cover. Slash and burn considered to be well adapted to tropical climates and soils which accessible to small farmers because of its low cost. It practices the continuous seven sister states (North-East India); Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura and the Himalayan state of Sikkim. Vegetation and land characteristics of North-East India are heavily influenced by jhum activities which have greatly amplified in recent decades with increase with human population (Yadav et al., 2012). But the current practice of shifting cultivation in the region is an extravagant and unscientific form of land use. The negative impacts of shifting cultivation are devastating and far reaching in degrading the environment and ecology of this region. The earlier 15-20 years cycle of shifting cultivation on a particular land has reduced to 2-3 years now. This has resulted in large scale deforestation, soil and nutrient loss and invasion by weeds and other species. The indigenous biodiversity has been affected to a large extend (Dangi 2008). The effect is more sever in biodiversity-rich tropical rain forests of north-east India which are undergoing conversion to secondary habitats at a rapid rate. Practices like logging and slash-and-burn cultivation are believed to be responsible for the major loss of biodiversity and forest cover in this region (Raman et.al., 1998). Multiple land use practices in forests lead to loss of carbon stocks and emissions of carbon dioxide and if the biomass is the burned during the clearing process, additional Green House Gases (GHGs) are emitted. The clearing of vegetation by burning is an aspect of shifting cultivation there is no doubt that carbon dioxide and other GHGs are emitted in the course of a cultivation cycle. Slash and burn land clearing on sloppy land may lead to increased soil run-off following disappearance of the protective vegetation cover. Soil erosion is irreversible phenomena causing land degradation and

deterioration of surface water quality. Soil run off is enhanced by disappearance of vegetative cover and surface litter following the burned. Vegetation is one of the major factors controlling soil erosion, while most soil erosion soil erosion occurrences are removal of vegetation and top soil exposure to the air. Heavy rainfall in the area may lead to sedimentation run-off from higher elevation and steep slopes. In future, this can lead to serve of soil erosion problem in the area. The soil erosion may significantly affect any future revival of the vegetation now; it becomes clear that jhum cultivation plays very big role in degradation of soil, forest and biodiversity fragmentation in that region. This is also upheld as an evidence of how indigenous people have blindly destroyed their environment. As per FSI 2015 report, there has been a decline of 631 km^2 of forest area, primarily due to shifting cultivation in seven states of north-east India. Mizoram alone has lost 306 km^2 forest areas from 2013 to 2015. Land use practices like shifting cultivation causes significant changes in habitats and animal communities thus are a major concern in conservation biology. Frequent shifting from one land to the other, has affected the ecology of these regions. The area under natural forest has declined; the fragmentation of habitat, local disappearance of native species and invasion by exotic weeds and other plants are some of the other ecological consequences solely due to shifting agriculture. An ongoing project sanctioned by GBPIHD, titled: Technology Development, Management and Long-term Monitoring of Shifting Cultivation and Coal Mining in North-eastern India, is mapping the area under shifting cultivation in seven states of north-east India.

The project will directly impact policy decisions on conservation and preservation of biodiversity of Eastern Himalaya by involving all the stakeholders at local, national and international level. This project will also have a dual impact, one on the livelihood of local communities and second on conservation of biodiversity, by reducing the dependency of local people on forest. Alternate livelihood options will provide them better opportunities and will involve them in the process of conservation.

2.4 Project Objectives and Target Deliverables (as per the NMHS Sanction Order)

The following objects were set and approved by the funding agencies (NMHS)

- To investigate the pattern of recovery of floral composition and richness with respect of time elapsed since abandonment after shifting cultivation
- To study the trajectory of faunal (birds, mammals and reptiles) recovery patterns along the successional gradient
- To examine changes in spatio-temporal utilization of habitat by birds, mammals and reptiles along the successional gradient in comparison to habitat utilization in primary forest
- To assess the nature and extent of anthropogenic pressures on species diversity
- Capacity building of gender based local communities and stakeholders for sustainable development through training

Some of the Target Deliverables include

- Knowledge products on impact of shifting cultivation on floral and faunal composition and richness
- Document on adaptive strategy adopted by fauna to overcome the effects of shifting cultivation will be available
- Creating awareness and building capacity among stakeholders 4 villages from each selected district.

Chapter 2

3 METHODOLOGIES, STARTEGY AND APPROACH

3.1 Methodologies used for the study (max. 1000 words)

Intensive study area (ISA) will comprise of buffer area of Dampa Tiger Reserve, where 12 villages are situated. This ISA will then be stratified based on successional cycle into the following categories:

a) Current jhum
b) Abandoned field (2-4 years old jhum)
c) 5 - 10year fallow lands
d) 10-15 year fallow lands
e) > 25 year fallow lands

Vegetation sampling

Transect survey will be under taken for vegetation sampling that will cover all the successional gradients and primary forest. Attributes like species richness will be determined through establishing circular plots (radius – 10m) along the transect belt. For shrubs and herbs, circular plots of radius 5m and 3m respectively will be used. The canopy cover will be scored 0 when there is no overhead cover, 1 when canopies of adjacent trees of bamboo culms barely met, 2 when adjacent canopies overlaps with the sky still visible and 3 when sky is not visible.

Avifauna sampling

Line transects of 500m length across the different successional gradients and primary forest will be used for birds sampling (Raman et.al., 1998). An observer will start sampling between 0.5 and 3hrs after sun rise, when the visibility is the maximum for the birds. Transect will be covered at a slow and uniform pace. All the birds seen, heard and flying under the canopy will be recorded. Distance of birds from the observer will also be recorded. Sound of birds will be recorded in case the bird is difficult to identify, for later verification by an expert. All transects will be covered twice a month in all the seasons.

Mammal sampling

All the established transects will be surveyed for direct sighting and indirect signs for medium to large mammalian species presence. Camera traps will be installed at appropriate places for assessing the diversity of shy, elusive and nocturnal mammals. For small mammals like rodents, live trapping offers an effective way to monitor a wide range of species at one time as many can be found occupying the same habitat. Sherman traps will be deployed at every 10 m on a transect (Sibbald et al., 2006). Traps will be placed in the evening with food material in it and will be checked in the subsequent morning. Animal trapped will be released at the same spot after data collection.

Reptile sampling

For reptilian diversity, we will use quadrate sampling as per (Todd and Andrews, 2008). Square quadrates of 5m x 5m will be established randomly in the intensive study area and also on both the sides of the pre-existing transect, located alternatively 10 m to the left and right of the point regularly spaced 50 m apart on the transect line. For arboreal reptiles transect surveys will be undertaken by two observers simultaneously, one looking on right side and second on left side.

Spatio-temporal utilization of habitat

For every sighted bird, mammal and reptile, micro-habitat parameters such as: terrain, soil type, slope, aspect, elevation, plant species, girth at breast height of occupies plant, height of the occupied plant, elevation of sighted individual from ground, canopy cover, leaf litter depth, proximity of water source, disturbance factor, land use pattern etc. will be recorded. Data from successional forest will be compared with that of primary forest.

Anthropogenic pressures

To assess anthropogenic pressure and its impact on biodiversity, disturbance parameters like: presence or absence of shifting cultivation, bamboo collection, timber collection, fodder collection, NTFP collection, fishing, hunting, manmade forest fire, habitation etc. will be recorded along all the transects uniformly at every 100m and also at all the points where wildlife is sighted (Sahoo et al., 2010; Solanki et al., 2016). Data on land use and land cover will also be developed by collaborating with suitable agencies in the region.

Capacity building and awareness creation

During the initial phase of the study a questionnaire survey will be carried out to understand the requirement of locals, their knowledge of wildlife management and their attitude and perception towards conservation of faunal diversity in the tiger reserve. Throughout the project period, representatives or village heads will be contacted and explained about the study and its purposes. Workshops and meetings will be organized for 2-4 villages at a time and discussion will be held about the importance of biodiversity and animal conservation. Issues related to ways in which biotic pressures can be reduced and their role in protection of the species and its habitats etc.

Generating capacity-building amongst local stake holders is crucial for long-term sustainability of the program. Towards this goal, we propose to conduct a series of training programs and generate resource materials both in print and electronic media for wider dissemination. With the help of forest department, NGOs and government organizations for cottage and small scale industries, workshops and training programs will be carried out to promote alternate livelihood options to the local people engaged in shifting cultivation. Just to demonstrate the training impacts, small groups of women and children will be asked to further propagate the conservation awareness and knowledge among rest of the people & how all these capacity building programs will help in conservation by way of implementation.

3.2 Preparatory Actions and Agencies Involved (max. 1000 words)

The project activities were mostly carried out by the project implementing institute *i.e.* Department of Zoology, Mizoram University. However, essential and necessary inputs were timely acquired from Amity Institute of Forestry and Wildlife, Amity University Noida and from other departments of Mizoram University. Suggestions and issues faced during the course of the study were thoroughly put forward before all the committee member of the project and solutions were developed. Members were also used as Resource persons during educational awareness and livelihood development programs that were organized during the course of the project.

3.3 Details of Scientific data collected and Equipment's used (max 500 words)

Through the study, data on several aspects of biodiversity and livelihood development were collected. Information of recovery pattern and distribution of floral diversity across different habitats or ages of agricultural crop fields were collected through field surveys using Compass (SUNNTO A10) (2 Nos.), GPS (Garmin etrex 10) (2 Nos.) and reference books (Sawmliana, 2013). Data on avifaunal diversity and recovery pattern in agricultural crop fields and different ages of shifting cultivation was collected through manual observation and using voice recorder (ZOOMH4N Pro) (2 Nos.), Digital camera, telescopic lens, Olympus binoculars (10x50) and standard field guides of Ali and Ripley (1983) and Grimmett *et al.*,(1998), Kazmierczak and Perlo (2000) and Grewal et al., (2018). A total of 168 bird's species observed in the study along different forest gradients and 17 species were identified as seasonal winter visitors. Mammalian species distribution in the study sites or stratified plots was determined using active Camera traps (Cudde back) 20 Nos. of which seven camera traps went missing in the process of data collection. Scat samples (186 Nos.) all picked up during transects surveys were identified by locals as well as by refereeing book of 'Mammals of India' by Vivek Menon. The nature and extend of anthropogenic activities were determining through manuals site surveys and with help of Spherical Densiometer (1 Nos.) (For measuring canopy cover), Range finder (Bushnell) (2 Nos.) and later the collected data was digitalization with the help of GIS software. Sherman's Trap (Locally made) (25 Nos.) were put in use for capturing rodents and other small carnivores for estimation of rodent's density and encounter rates. Herpetological data for the study is represented by reporting of 35 amphibian species and 21 reptiles from the study area. All data on herpetofauna was collected through field survey at night using basis instruments. Digital Projector (1 Nos.) and human resources in the form of resource persons were actively engaged in educating locals on various governmental schemes undertaken for the development of the rural population of the country. Experts from the field of fishery, poultry, and horticulture and human-wildlife conflict management took part in the programs to educate the locals on methods of alternative income sources and mitigate Human-wildlife conflict in and around the study sites.

3.4 Primary Data Collected (max 500 words

In the study, 41 tree species were recorded from various study sites. Highest diversity of plant species were in the abundant jhum fields of **5 -10 years** old. Followed by **> 10-15 years > 1-5 years >** based on their IVI values. The study reports 168 bird species from 54 families including 17 winter visitors. The abundance of plants species increases with the age of the fallow land. The relationship between the abundance of birds along the age of fallow land tests significant ($r = 0.503$, $df = 5$, $P < 0.05$). The highest numbers (%) of species were found at altitude between 300 to 400 m. Over15 mammals were confirmed through camera traps. 139 scat samples were also collected. Barking deer (27%) and wild boar (24%) were most frequent visitors in crop fields. Among the carnivores highest abundance (3-5 scat samples per jhum field) was recorded for leopard cat and Indian Palm civet. Grasslands were found to be ideal for small felids, rodents and civets. 2-5 years old abandoned jhum fields were recorded to be suitable habitat for movement of large herbivores. The frequency of scat decreased with age of the jhum. Significant ($P < 0.05$, $F = 7.73$) values were obtained between frequency of visits vs. different animals visits with species of wild boar, sambar, barking dear, jungle fowl are regular visitors. 35 amphibians were also reported with 26 new records for Dampa Tiger Reserve (DTR). Six new distribution records for the state of Mizoram and two species, *Raorchestes rezakhani* and *Sylvirana lacrima*, are new country records. 21 reptile species were also recorded in the study. Probability of finding a scat sample or other evidence tends to decrease with age of the jhum. In amphibians there was no significant age determinacy along different gradient of habitat recovery, yet puddles, canals, natural ponds, fish ponds, roadside, primary forest, secondary forest, paddy fields, and human settlement serves as excellent microhabitat. LULC map prepared for the eight surveyed period. The LULC shows that current jhum around DTR has an area of 3119.43 ha^2, abandoned jhum have 3965.1 ha^2 and about 22571.15 ha^2 of area is under secondary forest respectively. 60.1% of respondent practicing slush and burnt (*jhum*) cultivation has more than a hectare of agricultural lands. Local's tribes collect about 21.04% of bamboo, 2.8% of timber, 28.01% of fuel wood, and 11.01% of food and medicines requirement from the forest. Ethno-zoological usage consists of animal parts of the snake, bear bile, monitor lizard, porcupine, etc. Four awareness and livelihood development were conducted in four villages namely Damparengpui, Teirei, West Phaileng and Lallen. 70 (38 males and 32 females) from Damparengpui, 40 (30 males and 10 females) from Teirei, 45 (40 males and 5 females) from West Phaileng and 25 (20 Male and 5 female) from Lallen participated in the programs.

Knowledge gaps were addressed and better coordination among forest department, Local NGO's and farmers was achieved.

3.5 Details of Field Survey arranged (max 500 words)

For smooth functioning and conducting of field surveys, three base camps were setup *i.e.* one at Damparengpui village, one at West Phaileng village and the other at Lallen village. Three researchers were enrolled for the entire project period. Field assistant were arranged as per the requirements. All project activities were planned, discussed and evaluated from the Department of Zoology, Mizoram University. Field surveys were planned keeping in mind to cover various types of forest habitat across different seasons. The researchers spent most of the time in the field with occasional visit to the head office at Department of Zoology, Mizoram University to submit their data, samples collected and report writing. All necessary items (batteries, field kits etc.) were also purchased and supplied back to the base camp. Transportation for the researchers to carry out field survey and other data collection process was arranged as per the availability of communication means in the respective areas.

3.6 Strategic Planning for each Activities (max. 1000 words)

Detail discussion and planning for the entire study period was carried out as per the timeline proposed in the proposal.

1. **To investigate the pattern of recovery of floral composition and richness with respect of time elapsed since abandonment after shifting cultivation**

- **Field survey/ Data Collection**: Field surveys were carried-out after thorough reconnaissance survey in the surrounding areas of Dampa Tiger Reserve. Upon purchased of field equipment's and survey kits, transects were laid across different forest types and altitude gradient. Transects were sets to cover all types of forest present in the region. Floral species were recorded along different forest types and identified to map their distribution pattern. Distribution and pattern of floral recovery across different gradient for forest and altitude was identified using references book and knowledge of local field guide. Unidentified plants were collected and preserved through a herbarium and with suggestions of collaborative partners in the department of Botany and Forestry in Mizoram

University. Richness of floral species and other parameters were determined through statistic software.

2. **To study the trajectory of faunal (birds, mammals and reptiles) recovery patterns along the successional gradient**

- **Transect survey and Data collection:** Direct and indirect evidences for presence of birds were recorded through visual observation and voice recorders. All surveys were carried out in early morning and late evenings considering the landscape of the area. References books were always carried in the field for easy identification of species. Unidentified species were photographed and identified later in the stationed. Scat samples were searched in areas with most probability such as trail with animal's foot marks and water bodies. Knowledge of local field guides was put into used while looking for indirect evidences of mammals. Burrows were also extensive search along transects paths. Remains of animals, shed-off scales, scratch marks, foot marks etc. were used as presence of animals in the area. Transect survey were mainly planned during winter and summer season to avoid survey difficulties during the rainy seasons.
- **Camera trapping**: 20 camera traps were deployed for trapping any trespassing animal species in the area. Cameras were functional all through the survey period to photo-capture maximum number of species. Areas for placement of camera traps were planned based on previous research experiences and presence of indirect evidences on animals in the region.
- **Night Survey**: Amphibians and reptiles were mainly surveyed at night time. For survey of herpetofauna the following methods were applied; (a) Call survey (b) Hand capturing (c) Visual encounter survey (VES). The VES search lasted approximately for 6:00 hr – 11:00 hr for morning hours and the same trials were repeated on same route. The night hours approximately lasted 7-8 hours are easier due to advertise call and it is done with the help of handy and head torch and calls gradually subside by early dawn. Reptile activity during day was observed and minimal or very less during cold seasons in compared to pre-monsoon seasons; Roadside scan was carried out mostly at early evening through locating by calls and easy prey by hand capturing. When amphibians and reptiles were encountered they are photographed before collecting and then captured, with the marked GPS location.

3. To examine changes in spatio-temporal utilization of habitat by birds, mammals and reptiles along the successional gradient in comparison to habitat utilization in primary forest

Field survey (transect) were carried out in different forest types and altitude gradient. Encounter rate, distribution pattern and other ecological data's were collected for determining the spatio-temporal utilization of habitat by all groups of faunal species *i.e.* birds, mammals, amphibians and reptiles. The relationship between the abundance of birds, mammals and herpetofauna along the age of fallow land was tested for Pearson's correlation and other analysis tools. Project partners from department of social science and other institute were asked to provide with important inputs on analysis tools and techniques.

4. To assess the nature and extent of anthropogenic pressures on species diversity

Upon obtaining necessary data on livelihood dependency, utilization of forest resources, socio-economic status, livestock's, land holding capacity, forest cover, distribution of wildlife etc. through questionnaire survey and field survey from the surrounding villages of DTR; all the information were arranged and discussed with officials from the Mizoram Remote Sensing Application Centre, Directorate of Science and Technology for developing satellite based imaginary maps of all survey villages. Information was also acquired from the Forest department as they share common interest on wildlife conservation and crop damage compensation for the local villagers. GIS department of Mizoram University were also consulted before conduction field survey to get a brief idea on what sources of information are necessary for mapping the LULC data in the surveyed villages.

5. Capacity building of gender based local communities and stakeholders for sustainable development through training

Before organizing the educational workshops discussion were held with village representatives, youth leaders and ground staffs of Forest Department about their availability, their expectations from the program and development needs in their respective villages. Awareness programs were organized with resource persons from various sectors and departments such as forestry, fishery and poultry, experts in human-wildlife conflict mitigation management, forest department etc. Strategic measures were taken to make the programs fruitful and interactive. As suggested by local farmers, addition of experts were

made in subsequent awareness and livelihood development programs in the later phase of the project. Knowledge gaps were also address through the programs. Amid the rise of Covid-19 cases all necessary precaution were taken during the program.

3.7 Activity wise Time frame followed [using Gantt/ PERT Chart (max. 1000 words)]

Year 1

Activity	**Months**											
	1	2	3	4	5	6	7	8	9	10	11	12
Recruitment of JRF/RA/Technical staff												
Field Training of staff												
Procurement of equipment												
Reconnaissance survey of the study area												
Preparation of land cover, land use and habitat maps using satellite imageries												
Field surveys and data collection												
Data compilation												
Submission of Progress Report												
Project Review Meeting												

Year 2

Activity	**Months**											
	1	2	3	4	5	6	7	8	9	10	11	12
Field surveys												
Data compilation												
Local capacity building training												
Submission of Progress Report												
Project Review Meeting												

Year 3

Activity	**Months**											
	1	2	3	4	5	6	7	8	9	10	11	12
Field surveys												
Data compilation												
Local capacity building training												
Publication and dissemination of information												
Compilation and submission of final report												

Extension period (9 months)

Activity	**Months**								
	1	2	3	4	5	6	7	8	9
Educational Awareness program									
Report Writing/ FTR									

Chapter 3

4 KEY FINDINGS AND RESULTS

4.1 Major Research Findings (max. 1000 words)

Some of the major research findings of the study are as follows;

- Floral recovery pattern was determined which show that highest diversity is within the middle aged jhum and long aged jhum. Bamboo forest was also dominant between the ages of 3- 10 years old fallow jhum lands.
- Baseline data on presence of over 15 mammals, 168 birds, 35 amphibians and 21 reptiles have been confirmed along different gradient of shifting cultivation.
- The recovery pattern of the faunal diversity can be shown as 5-10 years > 10-15 years > 1-5 years. Recovery trajectory of faunal diversity identified states that abandoned agricultural field's serves as better opportunities for feeding and corridors for movement of birds and animal species.
- Through the study, two new country reports and 23 new records from Dampa TR and surrounding areas was noted.
- LUCL maps developed for the eight surveyed villages in peripheral areas of DTR showing that Current jhum around DTR has an area of 3119.43 ha^2, abandoned jhum have 3965.1 ha^2 and about 22571.15 ha^2 of area is under secondary forest respectively.
- Clearing of forested lands, forest fire, high dependency on NTFP's, over exploitation are the primary form of anthropogenic pressure in the region.
- Hunting, ethno-zoological usages of wild animals, local consumption are other threats in the region.
- No significant effect on herpetofaunal diversity was observed along different gradient of habitat recovery.
- Best adaptive strategy would be to increase the time period between utilization of fallow lands for agricultural purposes.
- Four capacity building/awareness programs were organized in different villages of DTR.
- More than 10 king cobras were rescued and about 86 king cobra eggs were hatched and later released to the wild.
- 180 locals representing different sections of the society participated in programs and share their concern and queries
- Six youths were selected for the Green Hub fellowship program.

- An amount of Rs 8, 60, 60,000 was approved as loans under different schemes to 361 local peoples from 14 villages around the DTR.
- 97 women's members were also granted loans for various development and self-sustenance activities.
- Two papers have been published of the topic of impact of shifting cultivation and adaptive strategies by mammals.
- Knowledge gaps were addressed and better coordination among forest department, Local NGO's and farmers was achieved.
- Apart from the above outcome, a total of 31 research articles in different 15 journals (all listed in Web of Science and UGC) with total Impact Factor = 17.99, 16 new data sets in NCBI were developed and published.

4.2 Key Results (max 1000 words in bullets covering all activities)

Some of the key findings of the study are:

Floral diversity

- Floral diversity along the ages of shifting cultivation tends to recover if sufficient amount of time gap is there between successional utilization of the same area of growing crop.
- Tree richness is significantly low in current and abandoned jhums compare to the primary forest.
- Shrubs and bamboo density are higher in the middle age jhum fields thereby attracting high number of birds, rodents and carnivores in the region.
- The areas under bamboo forest and shrub are about 10 times more than that of the current agriculture jhum and abandoned jhum lands in all the survey villages.
- *Schima wallichii, Castanopsis spp., Heyotes scandens, Albizia spp. Quercus spp* etc. were dominant species in the secondary forest or middle aged jhums.
- The trajectory of floral recovery can be presented as Long age jhum> Primary forest> Middle age jhum> recently abandoned jhum and Current jhum fields.

Avifauna diversity and distribution

- A total of 168 avifaunal species were recorded from different habitat from surrounding areas of Dampa Tiger Reserve.
- Thirty six species were found to be common in all four types of habitats.
- Granivore (*Chloropsis aurifrons*) and raptors (*Elanus caeruleus*) were diverse in current jhum fields.
- Red-headed trogon (*Harpactes erythrocephalus),* Asian fairy bluebird (*Irena puella),* verditer flycatcher (*Eumyias thalassinus*) and little pied flycatcher (*Ficedula westermanni)* are very rare and visited the landscape as winter visitor.
- The site heterogeneity favoured avifaunal persistence by providing favourable foraging, roosting, and nesting opportunities to birds.
- Bird species recovery rate increases by two fold in recent jhum, three fold in middle age jhum, four fold in long age jhum from current jhum.
- Clearing and burning of all standing trees in a crop fields results in a major loss of avifaunal and other arboreal species.
- Hunting through air guns, traps, snares etc. continue to be other potential threats for the avifaunal diversity in the region.

Mammalian diversity and distribution

- Fifteen camera trap images were obtained for individual species during the survey period, that include bears, golden jackal, sambar, barking deer, wild cats etc. Of the observed specie three were 'Vulnerable' species while the rest were in the Least Concern category as per IUCN Redlist.
- Visual encounters and other indirect animal signs indicate the presence of over 50 mammalian species across various habitat and forest types.
- 139 scat samples were also collected from the surveyed sites and preserved for future identification and research activities.
- Trails to crop fields and other plantation sites were found to be the most preferred sites for finding scat samples with 44.6 % chances (n=62).
- Presence of small carnivores were evident in current and recently abandoned jhum, while signs of large herbivores were high in the middle aged and long aged jhum fields.

- The mosaic of fragmented forest within current jhum fields provided the mammals with refuge and act as corridors for movement and interconnectivity.
- Jhum fields with standing crops are often raided by elephants, wild boar, bear and herbivores such as barking deer and sambar.
- Such continuous raiding and damage to the crop fields leads to development of negative perception towards wild animals by the local farmers.
- Rodents were found to be abundant in recently abandoned crop fields and plantation sites. Bamboo forests were also found to be idea habitat for the rodents.
- Collection of large number of scat samples from the abandoned crop fields and trails of bamboo forest can be attributed to the presence of better feeding opportunities for the carnivores in the form of rodents and other small mammalian species.
- Perennial streams and small water bodies running along the crop fields were also ideal sites for mammals, as several indirect evidence as hoop marks, scratch marks, scat samples were recorded from such areas.
- Crab eating mongooses were recorded in large number from these sites.
- In compare to altered or human modified landscape, primary forest were found to harbor large carnivores like clouded leopard, larger primates, and exotic birds species.
- Only stamped tailed macaques were recorded from recently abandoned crop fields, while Hoolock gibbon was encountered only once during the entire surveyed period.

Herpetofauna diversity

- 35 amphibians and 21 reptiles have been confirmed along different gradient of shifting cultivation. 23 amphibian species were found to be new records for the Dampa reserve and its surrounding areas. Two species of amphibian *i.e. Raorchestes rezakhani* and *Sylvirana lacrima*, are new country records.
- In agricultural crop fields only toads and Pegu rice frog species were recorded.
- Amphibians were found to be abundant in fish ponds, small water patches, small streams and waterfall in the surrounding areas of Dampa TR.
- Amongst the recorded species, Six species are Data Deficient, Five Vulnerable, 16 Least Concern, and eight species are not assessed as per the IUCN Red List.
- Although change in landscape and alteration in habitat were found to have some negative effects on the amphibians diversity in the surveyed sites, it’s the use of

fertilizers, hunting, road kills and human consumption that have a deleterious effect on the population of amphibians and reptiles in surrounding areas of DTR.

- Small perennial streams, fish ponds and microhabitat are necessary for the conservation and management of the species.

Nature and extend of anthropogenic threats

- Land use and Land cover (LULC) pattern in the survey areas showed that there is serious forest alteration in the surveyed villages.
- Survey in eight surrounding villages of DTR shows that the amount of land as abandoned is fairly high that the agricultural crop fields.

- Of the 760 households that were surveyed, 60% of respondents practiced slash & burn (jhum) cultivation on more than a hectare of agricultural land, while 33% had less than a hectare and 5.9% of surveyed individuals had no agricultural land and were involved in other activities like small scale business, forest guard, and daily wage labours.
- Of the 500 km2 of DTR, about 221.3 km2 (33.3%) were found to have high human interference and were less occupied by sun bears. An area of 111.1 km2 (26%) was regarded as moderately affected, while 96.9 km2 (22.5%) was affected to a lower extent. Only 70.7 km2 (18%) of the core region was without any form of biotic pressures with intact vegetation.
- Closed or dense forest was in highest proportion in Phuldungsei and least in Tuipuibari (120sq.ha).
- Grazing activities was relatively low or absent in most part of DTR.
- Abandoned jhum fields were in largest number in Damparengpui (939.60sq.ha) followed by Silsuri (881.17sq.ha) and Serhmun (880.99sq.ha).
- In the study area, it appeared that the locals rely heavily on forest resources for their livelihood as 21% of the respondents collect bamboo, 2.8% of timber, 28% of fuel wood, and 11% of food and medicines from the forest as their daily livelihood needs. About 37% of respondents were recorded collecting all the above from the buffer region.
- Usage of animals or their products as sources of ethno-medicine were also found to be high among the locals. Twenty-five percent of the locals uses snakes as sources of medicines, while 21% use bear bile, 7% are involved in scales of pangolin, 6% in

primates etc. About 29% of the surveyed populations were found to rely of medical drugs for the treatment of health ailments.

Capacity building and sustainable development

- Four educational awareness and livelihood developments were organized for capacity building.
- 70 (38 males and 32 females) from Damparengpui, 40 (30 males and 10 females) from Teirei, 45 (40 males and 5 females) from West Phaileng and 25 (20 Male and 5 female) from Lallen participated in the programs.
- Through the programs, different issues of cultivation, agriculture productivity, alternate livelihood options, human-wildlife conflict mitigation measures etc. were discussed and appropriate measures were suggested.
- Resource persons including the Project Investigator (PI) Prof. H.T. Lalremsanga, from the Department of Zoology, Mizoram University; Dr. Jonathan a Veterinary Doctor and Mr. H. Lalruatdike, the Public Relation Officer (PRO) at Mizoram Rural Bank from West-Phaileng, and the Director of the Dampa Tiger Reserve, Pu C. Lalbiaka address several issues raised by the locals and clarified their doubts.
- Practice of mixed farming instead of traditional shifting cultivation was promoted through the program.
- On request of participants, the Director of Dampa Tiger Reserve and Repreentatives of the Mizoram Rural Bank were also invited to the program.
- About 6 youths and 361 individuals from 14 villages around the DTR were benefited from the programs as an amount of Rs 8, 60, 60,000 was approved for loans under different schemes for various skill developments and livelihood betterment activities.
- 97 women's members were also granted loans for various development and self-sustenance activities.
- Better coordination between locals, Youth groups and Forest department was developed and a decrease in hunting cases was also recorded during 2018-2021.
- More such programs will be a major boost and promote sustainable development and conservation of wildlife around the protected area.

4.3 Conclusion of the study (maximum 500 words in bullets)

Some of the important outcomes of the study are as follows;

- The project was very fruitful with several takeaways. The study not only provided information on the faunal diversity in the region but also the factors that regulate them.
- While shifting cultivation is always a debatable topic, our study shows that if regulated sustainably and there is increase in time period between uses of fallow jhum fields, they can be ideal for species recovery and sometimes even function better than the mature forest.
- However, more such studies are needed to formulate an implimentive measure that promotes biological sustainability and growth for all.
- As land under shifting farming is now reduced, the success of mixed farming in the region in well adaptable. More and more people are now adapting for alternative livelihood options such as small scale business, direct sells of vegetables and cash crops, poultry, fishery, etc.
- Better coordination among locals and forest department has been developed which is evident through the reduced number of hunting cases from 300 to 94 in 2021-2020.
- About 361 families were provided with Rs 8, 60, 60,000 as loans under different livelihood and socio-economic development schemes.
- Several development activities to reduce the dependency of locals on NTFP's such as distribution of LPG gas, house for old age women's, easy distribution of saplings on beetle and other cash crops to the locals etc.
- From the study it was established that more focus on amphibian and reptiles should be given as they are more prone to climate change and many gets extinct even before they are reported.
- Detail study on interactive mammalian biology and the influence of changing landscape dynamics on them are needed in the region.
- Development of integrated techniques to connect forest corridors and patches of fragmented forest are also necessary for better connectivity.
- More such programs will be necessary to boost and promote sustainable development and conservation of wildlife around the protected area.

Chapter 4

5 OVERALL ACHIEVEMENTS

5.1 Achievement on Project Objectives [Defining contribution of deliverables in overall Mission (max. 1000 words)]

Floral diversity: 41 tree species were reported across different forest gradient. Shrubs and herbs were dominated in the recently abundant (1-3 years old) and Middle age jhum land (5-10 years old forest). Tree diversity and distributing tends to increases with the age of the jhum. The currently jhums have completely burned flora without any ground flora or with few burned standing trees. Floral composition in fallow jhum lands can be represented in the order of 5-10 years > 10-15 years > 1-5 years > that was based on their IVI values.

Avifaunal Composition and distribution trajectory: Birds in the surveyed area was determined to be 168 species from 54 families including 17 winter visitors. The family Picidae contributed with highest number of species (12 Nos.) and Muscicapidae, columbidae, Dicaeidae, Motacillidae, and Accipitridae followed to next highest number by 9, 9, 8, 7 and 6 species of birds, respectively. The results revealed that there is a difference in bird richness and diversity between the habitats of successional fallow in the study area. From the long aged fallow land, the highest number of species (126 Nos.) was recorded followed by middle age *jhum* (109 Nos.), recent *jhum* (72 Nos.) and lowest in current *jhum* (36 Nos.). Out of 168 species, 123 species visited in all season of the year in this landscape shows richness of the site. The highest numbers (%) of species were found at altitude between 300 to 400 m. the recovery trajectory in avifaunal diversity across different habitat shows that bird species recovery rate increases by two fold in recent *jhum*, three fold in middle age *jhum*, four fold in long age *jhum* from current *jhum*.

Mammalian distribution: In the study, 15 mammals were confirmed through camera traps and 36 were identified through indirect evidences. Some of the important species include bear, Golden jackal, Leopard cat, large Indian civet, sambar, barking deer, and wild boar. 139 scat samples were also collected during the survey period. The reporting of Golden cat and Golden jackal from the study were the first reports from Dampa Tiger reserve. Collected scat samples comprise of clouded leopard, civets, elephants, Crab eating mongoose and other wild carnivores. It was found that the rate of encountering scat was highest in recently abandoned (2-5 years old jhum) and current crop fields and tends to decrease with the age of the jhum

field. Middle age jhum were abundant with signs of herbivores such as barking deer, sambar and other rodent species. Grasslands were found to be ideal for small felids, rodents and the Indian palm civets. Significant ($P < 0.05$, $F = 7.73$) values were obtained between frequency of visits vs different animals visits with species of wild boar, sambar, barking dear, jungle fowl are regular visitors.

Herpetofauna diversity: Herpetofauna in the region comprises of snakes, lizards, amphibians and turtles. A total of 21 snake species including King cobra, Burmese python, branded krait, monocle cobra, pit viper etc. were collected and examined during the course of the project. More than 86 eggs of king cobra were also rescued and hatched under laboratory conditions. The hatchlings were later released to the wild in presence of the concern Forest Department. 35 amphibian's species were also collected from different habitats of which two species *i.e. Raorchestes rezakhani* and *Sylvirana lacrima*, are new country records. 23 number of the collected amphibian species were new reports for Dampa and its surrounding areas. Few species of soft shell turtles and tortoises were also observed from the study period including the rare Black soft shell turtle. Amphibians were collected from sites with huge human presence and disturbed areas and therefore protection of small fragmented forest patches are crucial for the growth and survival of these species in the region.

Spatio-temporal utilization of habitat

Avifauna

- The results revealed that there is a difference in bird richness and diversity between the habitats of successional fallow in the study area.
- From the long aged fallow land, the highest number of species (126) was recorded followed by middle age *jhum* (109), recent *jhum* (72) and lowest in current *jhum* (36). Bird species recovery rate increases two fold in recent *jhum*, three fold in middle age *jhum*, four fold in long age *jhum* from current *jhum*.

Mammals

- Trails to crop fields and other plantation sites were found to be the most preferred sites for finding scat samples with 44.6 % chances (n=62).
- Recently abandoned jhum fields showed highest numbers of camera trap images followed by middle age jhum and primary forest. Streams running along agricultural crop were utilized most by small carnivores while middle age jhum were used by herbivores.

- Jhum with standing crops harboured mostly rodents, jungle fowl, wild boar, and occasionally bears and elephants.
- Probability of finding a scat sample or other evidence tends to decrease with age of the jhum.
- Agricultural plots embedded in a large forest matrix are known to increases spatial heterogeneity and promotes mammalian distribution.
- In amphibians there was no significant age determinacy along different gradient of habitat recovery, yet puddles, canals, natural ponds, fish ponds, roadside, primary forest, secondary forest, paddy fields, and human settlement serves as excellent microhabitat.
- Physiological actors such as soil moisture content, organic matter content, and ground litter cover are positively correlated and crucial for recovery of amphibian and reptiles in the region.

Nature and extent of anthropogenic pressures

- LULC map prepared for the eight surveyed period. Showed that 60.1% of respondent practicing slush and burnt (*jhum*) cultivation has more than a hectare of agricultural lands.
- Local's tribes collect about 21.04% of bamboo, 2.8% of timber, 28.01% of fuel wood, and 11.01% of food and medicines requirement from the forest.
- Bird's diversity was observed to recover as the fallow lands changes into mature forest. However, with reduced time gap between successional shifting lands, the bird species tend to alter their preference from crop sites to primary forest.
- With ethno-zoological usage of animal parts such as that of the snake, bear bile, monitor lizard, porcupine, etc. mammalian diversity it the region are at constant threats. Several snares, and locally made traps were removed during the survey. Hunting and retaliation killing are also practised in the region.
- Although, no immediate threats for herpetofauna was observed in the study, threats in the form of consumption, hunting, road kills, excessive fishing and release of harmful chemicals such as detergents, fertilizers and other household wastes were recorded from some localities.

Capacity building and sustainable development

- Four awareness and livelihood development were conducted in four villages namely Damparengpui, Teirei, West Phaileng and Lallen.
- 70 (38 males and 32 females) from Damparengpui, 40 (30 males and 10 females) from Teirei, 45 (40 males and 5 females) from West Phaileng and 25 (20 Male and 5 female) from Lallen participated in the programs.
- Knowledge gaps were addressed and better coordination among forest department, Local NGO's and farmers was achieved.
- Resource persons including the Project Investigator (PI) Prof. H.T. Lalremsanga, from the Department of Zoology, Mizoram University; Dr Jonathan a Veterinary Doctor and Mr H. Lalruatdike, the Public Relation Officer (PRO) at Mizoram Rural Bank from West-Phaileng, and the Director of the Dampa Tiger Reserve, Pu C. Lalbiaka address several issues raised by the locals and suggest them suitable livelihood development options.
- Six youths were selected for the Green Hub fellowship program.
- 97 women's members were also granted loans for various development and self-sustenance activities.
- An amount of Rs 8, 60, 60,000 was approved as loans under different schemes to 361 locals from 14 villages around the DTR.

5.2 Establishing New Database/Appending new data over the Baseline Data (max. 1500 words, in bullet points)

Of the several species amphibian species that were collected during the study period, 21 New Database sets in National Center for Biotechnology Information (NCBI). DNA was extracted for the samples which upon sequencing were found to be new distribution records and new country records. The data base established includes the following species with their voucher and Accession number by NCBI.

Species name	**Voucher ID**	**Location**	**NCBI_AccNo.**
Microhyla mymensinghensis	MZMU1747	Dampa	MW165448
Megophrys serchhipii	MZMU1759	Dampa	MW165447
Fejervarya asmati	MZMU1746	Dampa	MW165462
Fejervarya orissaensis	MZMU1749	Dampa	MW165463
Tropidophorus assamensis	MZMU2080	Dampa	MW493234

Bufoides meghalayanus	MZMU2091	Dampa	MW741545
Roarchestes manipurensis	MZMU2331	Dampa	MZ148617
Roarchestes manipurensis	MZMU2329	Dampa	MZ148618
Roarchestes manipurensis	MZMU2328	Dampa	MZ148619
Roarchestes manipurensis	MZMU2327	Dampa	MZ148620
Roarchestes manipurensis	MZMU2326	Dampa	MZ148621
Hoplobatrachus tigerinus	MZMU1383	Dampa	MT808305
Hydrophylax leptoglossa	MZMU1382	Dampa	MT90753
Scorpiops tamdil	MZMU2246	Dampa	MZ144166
Odorrana chloronota	MZMU2280	Dampa	MZ230673
Bufoids kempi	MZMU2332	Dampa	OL457694
Scorpiops longimanus	MZMU2246c	Dampa	MZ144166
Sphenomorphus maculatus	MZMU776a	Dampa	MZ292907
Sphenomorphus indicus	MZMU760	Dampa	MZ292908
Euphlyctis kalasgramensis	MZMU2082	Dampa	OM363226
Euphlyctis kalasgramensis	MZMU2083	Dampa	OM363225

5.3 Generating Model Predictions for different variables (if any) (max 1000 words in bullets

No model Predictions were developed from the study

5.4 Technological Intervention (max 1000 words)

Distinct morphological and genetic traits were identified to differentiate between closely related species such as *Raorchestes rezakhani* and *R. manipurensis* ; *Minnervarya asmati* and *Fejervarya multistriata*; *Euphlyctic kalasgramensis* and its congener species etc. Several new techniques and morphological traits were identified and developed during the course of the study for species identification and differentiation. Many of the closely related that were previously considered to be same or misidentified by Pawar and Birand 2001 were resolved in the project. Some of the important ones are discussed below;

- Development of Bioacoustics analysis for differentiation between cryptic species such as *Raorchestes rezakhani* and *R. manipurensis.*
- Between *Minnervarya asmati* and *Fejervarya multistriata*, the SVL is higher (>3.5mm) in F. *multistriata* and absence of mild dorsal line in most of the population.

- *Euphlyctic kalasgramensis* can be differentiated from its congener species, *E. cyanophlyctis* due to absence of minute dots on the ventral side that were previously overlooked.
- *Microhyla mukhlesuri* vs *M mymensinghensis:*

i. An inverse 'U' shape mark on the anus of *M. mukhlesuri* vs Cresent shaped mark in *M. mymensinghensis.*

ii. SVL (>19mm) larger in *M. mukhlesuri* Vs ≤ 20mm in *M. mymensinghensis.*

iii. Thinner forearm in *M. mukhlesuri* than that of *M. mymensinghensis*

iv. Longer trunk (axilla- groin) in *M. mukhlesuri* (>45% of SVL) while in *M. mymensinghensis* it is <40% of SVL.

v. Inner metacarpal tubercle elongated in *M. mukhlesuri* vs rounded in *M. mymensinghensis.*

vi. Terminal phalange of 4th toe in *M. mukhlesuri* knob-like but in *M. mymensinghensis* it is flattened.

- *Sylvirana lacrima* can be easily differentiated from its congener species due to the presence of tear-drop mark below the tympanum.
- *Polypedates terainensis* can be differentiated from ossified skin in between the orbit from its congener species *P. braueri*.
- *Hydrophylax leptoglossa* can be distinguished by having a rough dorsal skin, presence of rectal gland at the base of forelimbs and semi-fully webbed toes.
- *Pterorana khare* can be identified for the presence of flap on the lateral body and posterior side of the thigh, and elongated toes with fully-webbed.
- *Hoplobatrachus litoralis* can be distinguish from its sympatric species *H. tigerinus* for its smaller SVL (<120mm), presence of dark bands in between eyes and snout tips, and dark spot at the base of forelimb insertion.
- Presence of pectoral, ventrolateral & femoral glands distinguished *Leptobrachella tamdil* from other species under this genus.
- *Ichthyophis moustakius* can be identified for having moustache like stripe from snout tip to tentacle and annular groove in the range between 238 to 268.
- *I. multicolor* can be distinguished for having a lateral yellow striped that divides bromnish dorsum and polar ventral with Annular grooves width 346-386.

5.5 On field Demonstration and Value-addition of Products (max. 1000 words, in bullet points)

- Although no such demonstration or agenda was covered in the study, local villagers were suggested to practice mixed farming. Locals were encourage to plant value added products such as ginger, broom grass, bird eye chilli and other products. Local market and contacts with salesman in Aizawl city were established to easily sell their products directly to the markets in Aizawl. Some of the vegetables and items that were promoted through the awareness include bamboo shoot, charcoal, mustard, lemon, lemon juice, beetle nuts, banana, edible ferns, crabs, snails, prawns, fermented soya beans, Parkia sp., orange, corn, cucumber, pumpkin, pineapple, green pea, cabbage, beans, topica, yam etc.
- Through the livelihood development programs several areas and sections of the society were brought together for sustenance forest resources and socio-economic development. Some of the issues that were addressed include easy accessibility to the market, plantation of cash crops (beetle nuts, ginger, broom grass, pineapple etc.), small scale retailers and skill development for the locals.

5.6 Promoting Entrepreneurship in IHR

- Entrepreneurship in the region was promoted by providing easy loans and other development schemes to 97 rural women under various skill development programs.
- Loans were provided to Self- help groups, and other women NGO's organization to undertake self-reliant activities tailoring, small scale business, handlooms, carpentry etc.
- Six youths were trained under the Green hub photography fellowship program.
- Resource persons and veterinary doctors also explained techniques of integrated fish farming, poultry, piggery etc. to develop entrepreneurship and socio-economic development in the surrounding areas of DTR.

5.7 Developing Green Skills in IHR

- Special emphasis was given on sustenance development and conservation of biodiversity in the region.
- Resource persons and veterinary doctors encourage techniques of integrated fish farming, poultry, piggery etc. to develop entrepreneurship and socio-economic development in the surrounding areas of DTR. Such activities could also help reduce

the dependency of locals on forest resource and make them self-sustainable in their own field of work.

- Through the livelihood development programs several areas and sections of the society were brought together for sustenance forest resources and socio-economic development.
- Some of the issues that were addressed include easy accessibility to the market, plantation of cash crops (beetle nuts, ginger, broom grass, pineapple etc.), small scale retailers and skill development for the locals.
- Farmers were encouraged to cultivate mixed crop farming and minimize shifting cultivation and allow the forest to recover from jhum.
- Youths were trained to acquire bank loans under various developmental schemes for the rural development provided by government of India based on their capabilities and interest.
- Eco-tourism activities such as bird watching, jungle trail walk and nature camps were organized and income courses were developed though them.

5.8 Addressing Cross-cutting Issues (max. 500 words, in bullet points)

- Clearing of forested lands and burning it down for shifting cultivation is one of the major issues that was addressed during the course of the study.
- It was understood that until and unless local farmers were provided with alternatives to increase and maximize their agricultural outputs proper implementation of any development schemes will remain unsuccessful. Thereby considering the above mention points, perceptions, availability of resources and needs of locals were examined and follow up measures were suggested to the local farmers and youths.
- Promoting of mixed farming and resulted in a decrease of jhum lands in the region in the past few years. Local now not only cultivate cash crop but also and sells their products apart to the city market directly, that results in good income.
- Many of the local women and youths are now procuring bank loans to start their own small business and improve their livelihood status.
- Meeting with Forest department has resulted in better coordination among them and a decrease in number of hunting cases in the past two years.
- Assistance from the Forest department in the form of free LPG to under developed families has decreased the dependency of locals of fuel wood which was primarily collected from the buffer areas of the Dampa Tiger Reserve.

- Through the project awareness program, issues of crop raiding by wild animals were discussed and the crop damage compensation was provided to the farmers that helped in developing a positive perception of locals towards wild animals.
- Incidences of Forest fire that were very common in the surrounding areas of Dampa has been put to checked with continuous monitoring by forest guards and informing the locals about their consequence during the study period.
- The development of eco-tourism activities has seen a raised in visitors from different parts of India and abroad. Locals could easily assist them to the forest trails and demonstrate their cultural items, which helped in generating income through sell of handloom products.
- Rescue of several venomous snakes and their eggs (86 Nos.) from surrounding areas of DTR can also be a cross-cut issue which was addressed as previously locals used to kill snakes upon encountering them.
- People from various part of Mizoram are now member of a social group that reports sighting and rescue of wild animals all over the state.

Chapter 5

6 PROJECT'S IMPACTS IN IHR

6.1 Socio-Economic Development (max. 500 words, in bullet points)

- Many of the local women and youths are now procuring bank loans to start their own small business which will improve their livelihood status in the study areas.
- An amount of Rs 8, 60, 60,000 was approved as loans under different schemes to 361 local peoples from 14 villages around the DTR.
- 97 women's members were granted loans for various development and self-sustenance activities and it encourage other local women to do the same.
- Knowledge gaps were addressed and better coordination among forest department, Local NGO's and farmers were achieved thereby creating a sense of understand among different stakeholders.
- 180 locals representing different sections of the society participated in programs.
- Six youths were trained under the Green hub photography fellowship program and are now managing their own photography shops and some have even pursues their career in wildlife photography.
- More than 50% of the local farmers are now practicing mixed farming and are generating alternate sources of livelihood.
- Several animal repellant plant species are cultivated along the edges of crop fields to mitigate human-wildlife conflict and encounters with wild animals.
- Number of cash crops planted in crop fields has increased by 10 folds after the awareness program.

- The development of eco-tourism activities has seen a raised in visitors from different parts of India and abroad. Locals could easily assist them to the forest trails and demonstrate their cultural items, which helped in generating income through sell of handloom products.

6.2 Scientific Management of Natural Resources In IHR (max. 500 words, in bullet points)

- Development of grassland within the core areas of DTR to mitigate crop raiding in agriculture crop fields by wild boar, sambar, barking deer etc.
- Proper demarcation and fencing between the core and buffer areas to avoid road kills and mitigate human-wildlife conflict.
- Scientific documentation of faunal resources and pattern of recovery will help in better planning of forest resource management and promote afforestation.
- Providing free LPG has regulated the use of fuel wood in the surrounding areas of the study site and has decrease the dependency of locals of forest.
- Awareness and scientific knowledge among locals on role of different faunal diversity in various ecosystem functions has helped better management of forest resources and reduction in usage of NTFP's.
- Promoting more research activities has led to documentation and reporting of several new floral and faunal species from Dampa and its surrounding areas.

6.3 Conservation of Biodiversity in IHR (max. 500 words, in bullet points)

- Checklist developed for the faunal diversity and their pattern along successional gradient of shifting cultivation will be helpful for planning and management of conservation related plans in the IHR.
- The study on the ecology of mammalian species will help mitigate human-wildlife conflict across protected areas of IHR.
- Reporting of new species of amphibian and mammals from the study region will encourage further research activities in the region and explore the untamed biodiversity of the Indian Himalayan belt.
- Awareness in the study has helped reducing hunting frequency reduced in the study site.
- New data-base generated for amphibian species form their genetic materials in the study will help in solving misidentify of closely related species and resolve taxonomic queries.
- Several new species were reported for the first time in the region that further adds –up to the biodiversity of the region and the country.

- Collaborative approach observed between local people and the Forest department that can be used as a template for more conservation activities in other parts of the IHR.
- Knowledge acquired on the LULC pattern will be useful for mitigating deforestation and better understand the change in landscape across other similar areas of IHR.
- Positive outcomes from the study will be a boost for research team and other conservationist working on similar grounds.
- The publications from the research data will be useful for wider circulation of information and scientific knowledge of young scholars and researchers.

6.4 Protection of Environment (max. 500 words, in bullet points)

- Ecological role defined for several species through the study will be helpful in conservation of species and their habitat in the surrounding areas of DTR.
- New data-base generated for amphibian species form their genetic materials in the study will help in accessing important species that were previously overlooked or misidentified.
- Information shared on the negative impact of shifting cultivation and monoculture in the region will help in prevention of forest loss.
- Awareness conducted during the course of the study has decrease in areas under shifting cultivation and promote mixed farming.
- Forest fires that were quite prevalent in the region were also checked through the awareness programs.
- Checklist developed for the faunal diversity and their pattern along successional gradient of shifting cultivation will be helpful for planning and management of conservation related plans in the IHR.
- Motivating the locals for sustainable use of forest resources and NTFP's will help in sustaining a balance among resource portioning.

6.5 Developing Mountain Infrastructures (max. 500 words, in bullet points)

None, as it was not in scope of the project

6.6 Strengthening Networking in IHR (max. 700 words, in bullet points)

During the project period, several people came forward and participate in the program. It includes retired resource persons from the Department of Horticulture, Fishery, Veterinary, Forest, Banks, Educational department (Teachers), Media house local NGO's, Youth Organizations (YMA) and more importantly peoples from the local communities. All of the above mentioned groups has contributed significantly for the success of the project and are even providing us with necessary information and helping in rescue of herpetofauna and other mammalian diversity rescue from the surrounding areas of DTR after the completion of the project.

Chapter 6

7 EXIT STRATEGY AND SUSTAINABILITY

7.1 How effectively the project findings could be utilized for the sustainable development of IHR (max. 1000 words)

- Scientific documentation of faunal resources and pattern of recovery will help in better planning of forest resource management and promote afforestation in the entire Himalayan region.
- New data-base generated for amphibian species form their genetic materials in the study will help in accessing important species that were previously overlooked or misidentified.
- Motivating the locals for sustainable use of forest resources and NTFP's will help in sustaining a balance among resource portioning.
- Awareness conducted during the course of the study has decrease in areas under shifting cultivation and promote mixed farming, which has increases the forest cover in the study sites.
- Forest fires that were quite prevalent in the region were also checked through the awareness programs and can be used as possible template for future references.
- Information shared on the negative impact of shifting cultivation and monoculture in the region will help in prevention of forest loss.
- Awareness and scientific knowledge among locals on role of different faunal diversity in various ecosystem functions has helped better management of forest resources and reduction in usage of NTFP's.

- An amount of Rs 8, 60, 60,000 was approved as loans under different schemes to 361 local peoples from 14 villages around the DTR which will help locals for socio-economic development.
- 97 women's members were granted loans for various development and self-sustenance activities that will help in improving the socio-economic conditions of the locals.

7.2 Efficient ways to replicate the outcomes of the project in other parts of IHR (Max 1000 words)

- Different outcome of the project can be replicate in other parts of IHR. Some of the information data include the LULC map developed for the landscape, success of awareness program, documentation of faunal diversity etc.
- As carried-out in the study, necessary ground survey and information of the availability of resources, requirements of the locals etc. are needed to be synchronized for the proper implement of conservation plans.
- During the project it was observed that, although there are several developmental schemes for rural population that are layout by the government agencies; lack of awareness and proper information about the same has limited its reach to the needy locals. Therefore, just as our study deed, creating awareness about such schemes will be crucial to achieve any set goals for development in the rural part of the IHR.
- Although monoculture and shifting cultivation are deemed to have a negative impact on the biodiversity of any region, understanding the factors that regulate them and providing alternatives will be important for conservation and development.
- As highlighted in the study, a collaborative approach is needed to address the sensitive issues of forest ownership and creating community forest for the use and reduce the dependency on NTFP's of the protected areas.
- Rules and laws are needed to be set with active participation of locals on hunting and collection of forest usages.
- Clearing misconceptions on use of animals and their products as sources of ethno-fauna medicines will be helpful to protect the exploitation of wildlife in any part of IHR
- The publications from the study will also be important to be used as reference for future research in similar landscape across the IHR regions.

7.3 Identify other important areas not covered under this study needs further attention (max 1000 words)

- More focus on amphibian and reptilian should be given as they are highly prone to climate change and many of the species gets extinct even before they are reported.
- Detail study on interactive mammalian biology and the influence of changing landscape dynamics on wildlife are needed in the region.
- Development of integrated techniques to connect forest corridors and patches of fragmented forest in the surrounding areas with the primary forest will be useful to insure better connectivity.
- Capacity building and creating better livelihood opportunities for the locals through multiple approaches will not only improve the livelihood and socio-economic condition of locals but will also ensure biodiversity conservation through sustainable resource utilization.
- Promoting mixed farming in the region will be important to minimize the impact of shifting cultivation and provide a continuous source of income for the farmers.
- It was observed that, in many of the survey villages, villager's uses fertilizers that need to be checked to protect the amphibian diversity since the water bodies are all interconnected in the region.

7.4 Major recommendations for sustaining the outcome of the projects in future (500 words in bullets)

- Although the project have been able to achieved almost all of their set targets in the surrounding areas of Dampa Tiger reserve, yet many villages in the extreme corners of the reserve could not be covered. Hence, more of such research activities will be needed to monitor the biodiversity and development of the local population.
- Regular motivation of the local youth will be important to deter them from practice of hunting.
- Promoting eco-tourism and other activities such as bird watching, organizing eco-trail walks, photography, hosting visitors etc. will be important for generating income for the local youths.

- Providing more funds to undertake research activities will be useful to further explore the untamed forest resources and biodiversity of the protected forest and its surrounding areas.
- Timely interaction between various stakeholders be going to be crucial for maintaining the cooperation and sharing similar thoughts on biodiversity and conservation of wild species.

Chapter 7

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Chapter 8

8 ACKNOWLEDGEMENT

The successful completion of the project despite several roadblocks in the form of Covid-19, lockdown, medical concern etc. was a coordinated effort of several individuals and stakeholders. First of all, the research team will like to thank the Chief Wildlife Warden, Ministry of Forest and Environment, Mizoram, for granting us the permission to undertake the study. We are also thankful to the Director, Dampa Tiger Reserve, Mammit, Mizoram for supporting us with necessary manpower and logistic during the entire course of the study. Our sincere obliged to the Range Officer of the Teirei and Phuldungsui forest division for all their support. We express our gratitude to the Beat Officers of Damparengpui, Teirei forest, Tuipuibari, Rajiv Nagar, Khawhnai, West-Phaileng, Lallen, Saithah and Phuldungsui for their essential inputs, logistic and guidance during the entire study period. We are in debt of all the members of the Village council and local villagers for accepting us even during the times of Covid-19 pandemic and for their unconditional love and support. The fruitful outcome of the awareness program won't be possible without the efforts of our research partners namely Dr. N.P.S Chauhan (Human-wildlife conflict and resource management), Prof G.S. Solanki (Livelihood and socio-economic development), Dr. S.P. Singh (Fishery), Dr. Zohlimphui (Piggery and poultry), Dr. Jonathan (Veterinary Doctor), Pu. C Lalbiaka (Director, Dampa Tiger Reserve) and Mr. H. Lalruatdika (Public Relationship Officer, Mizoram Rural Bank). Last but not the least we are ever grateful to the funding agency, National Mission on Himalayan Studies for providing us with the funds to carry-out the research work.

Chapter 9

APPENDICES

Appendix 1 – Details of Technical Activities

Appendix 2 – Copies of Publications duly Acknowledging the Grant/ Fund Support of NMHS

Appendix 3 – List of Trainings/ Workshops/ Seminars with details of trained resources and dissemination material and Proceedings

Appendix 4 – List of New Products (utilizing the local produce like NTFPs, wild edibles, bamboo, etc.)

Appendix 5 – Copies of the Manual of Standard Operating Procedures (SOPs) developed

Appendix 6 – Details of Technology Developed/ Patents filled

Appendix 7 – Any other (specify)

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