

Conservation Leadership Programme: Final Report

Project title: Conservation of Critically Endangered Toad-skinned Frog in India



CLP ID: 03234915

Host country: India

Site Location: Southern Western Ghats, India

Dates in the field: 1st July 2015 to 30th October 2016

Participating Institutions: Conservation Research Group, St. Albert's College, Banerji Road, Kochi, Kerala, India

Overall Aim: The project initiates habitat-scale conservation of the Critically Endangered Toad skinned frog with multiple stakeholders

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Date when report was completed: 31st March 2017

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Project Partners & Collaborators

We would like to thank Benjamin Tapley (ZSL) and Rajeev Raghavan (KUFOS) who were the main project advisors. They supported the team throughout the project and helped undertake it during the time-period. We would also like to thank Carly Waterman (ZSL), Jack Tordoff (CEPF) and K.V. Gururaja (Gubbi Labs) for helping us initiate the project; Sandeep Das (KFRI, Kerala) helped us design the amphibian identification workshop material and conducted the first workshop along with the project team; Vijaya Lakshmi for helping us undertake the project components, the Mankulam Forest Division, Munnar Forest Division and Munnar Wildlife Division for actively participating and supporting the project activities and the team with research permissions from the Kerala Forest Department (WL10-15417/15); TIDE (Bengaluru) for supporting the energy-efficient stove component of the study, PHCC (Kodaikanal) for providing native, evergreen tree saplings and Suprabha Seshan and Aline Horwath (Gurukula Botanical Sanctuary) for training and supporting the team with the habitat restoration component of the project.

Section 1

Summary

The project aims to improve the on-ground conservation of threatened and endemic amphibians of the Western Ghats in India and focuses on the Critically Endangered Toad skinned frog (*Indirana phrynoderma*). By restoring degraded habitats, reducing firewood utilization through the installation of efficient stoves, improving the knowledge of local Forest Departments and reducing pesticide spill-over to forests, this project focuses on securing the future of this non-charismatic frog. The project was successful in restoring 10 acres of degraded habitat and improving the knowledge of local Forest Departments in identifying and monitoring key amphibians in Munnar including initiating an annual Toad skinned frog monitoring program. The installation of energy-efficient stoves was not undertaken after the pilot phase since the local communities were not satisfied. The pesticide spillover activities could not be initiated past the discussions with tea plantation managers as they were not interested and claimed that their land use practices were as per the Rainforest Alliance certification standards.

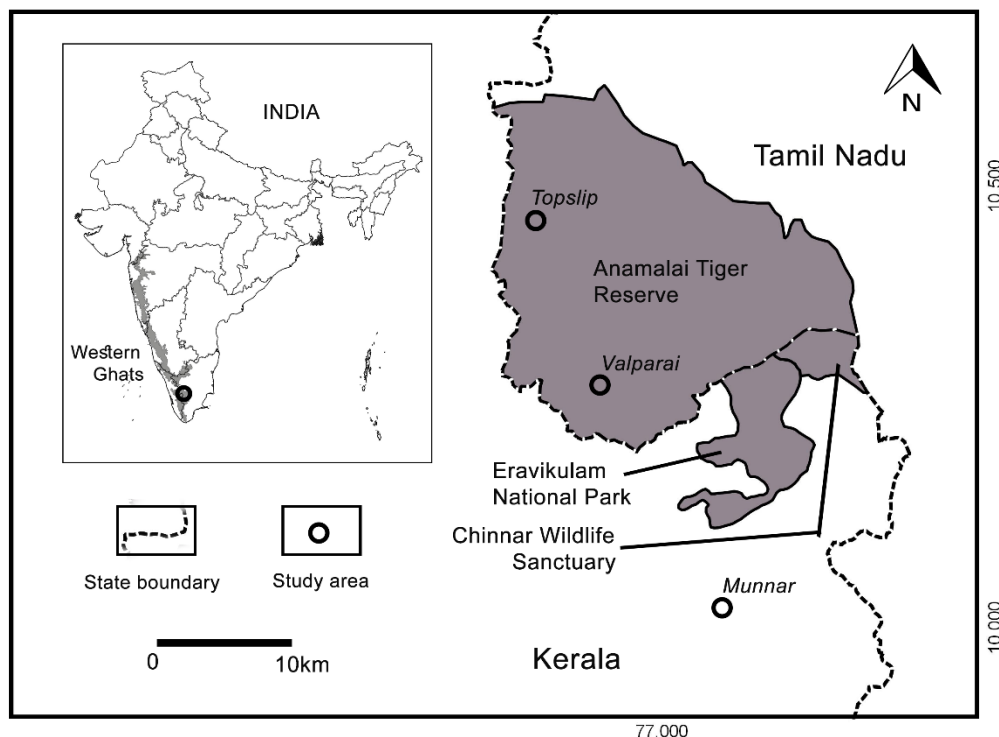
Introduction

Globally, amphibians as a group exhibit the highest endemism among vertebrates and are consequentially also the most threatened. This is largely due to severe population declines and species extinctions from habitat loss, diseases and climate change. In the Western Ghats of India, conservation of amphibians continues to focus on taxonomical and evolutionary aspects and has neglected their real-time and on-ground conservation including towards threatened and range-restricted amphibians. This is the conservation value of our project that it initiates focus towards on-ground conservation of amphibians and to inspire others to initiate similar action.

The project focuses on the Toad skinned frog (*Indirana phrynoderma*), an evolutionarily distinct and Critically Endangered amphibian, endemic to the Anamalai Hills of the southern Western Ghats in India. The species faces numerous threats including habitat degradation as a result of firewood collection and pesticide spillover from the surrounding plantations. Additionally, formal conservation measures from the Forest Department are severely lacking as they largely focus on large, charismatic mammals like the Bengal tiger and Asian elephant. This project aims to secure the Toad skinned frog population by reversing these threats and using integrative approaches to improve its conservation.

The project site is the plantation town of Munnar, Kerala in the Cardamom Hills of Western Ghats, India, which is a part of the Western Ghats-Sri Lanka Biodiversity Hotspot (Figure 1). This biodiversity hotspot is the 'hottest hotspot' in the world due to the extensive anthropogenic pressures on the endemic and threatened biodiversity and, is also a UNESCO World Heritage site. The Cardamom Hills are named after the extensive cardamom cultivation in the region, which supply the largest volume of small cardamom (*Elettaria cardamomum*) in south India. Munnar is surrounded by numerous protected areas, which hold the largest population of Nilgiri Tahr (*Nilgiritragus hylocrius*). These protected areas only cover a small extent of of the town as the rest of the land is dominated by tea, teak, cardamom, and coffee plantations. These plantations are interspersed with evergreen forests and grassland, which are utilised by numerous charismatic and endangered mammalian mega-fauna, like the Asian elephant and Indian gaur.

Figure 1. Map of the Study Area



The key partners of the project are local Forest Departments, plantation owners and local communities. The Forest Departments are official Government authorities in charge of protecting and managing the protected areas. Munnar is largely comprised of tea and cardamom plantations. There are numerous forest fragments within these plantations that harbour threatened and endemic amphibians including the Toad-skinned frog. The plantation owners control and manage most of the land holdings in Munnar and largely influence land-use strategies including the use of natural resources. Local communities are largely composed of individuals employed by these plantations. These communities depend on the forest fragments for firewood and other NTFPs, which could influence amphibian populations.

Project members

Arun Kanagavel: Arun Kanagavel is currently a Research Associate with the Conservation Research Group, Kochi. He received an M.S in Conservation Biology from the Durrell Institute of Conservation and Ecology, University of Kent (2010). He has worked extensively (biological and social work) in the study area for five years, has extensive knowledge of the focal species, has undertaken population abundance surveys, disease screening and social surveys, has undertaken stakeholder appraisal and has initiated conservation and livelihood initiatives with multiple stakeholders. Arun was the team leader for the project and was involved in organizing the amphibian identification workshops, initiating the annual amphibian monitoring program and pilot energy-efficient stove program, undertaking habitat restoration and initiating dialogue with the plantation owners.

Sethu Parvathy: Sethu Parvathy is currently a Research Associate with the Conservation Research Group, Kochi. She received an M.S. in Ecology and Environmental Sciences from Pondicherry University (2013). She has worked extensively at the project site for three years, conducted social surveys with multiple stakeholders including towards understanding stakeholder perceptions of biodiversity and initiating programs that integrate local livelihoods and conservation, has knowledge about the focal species and has undertaken habitat and population surveys for amphibians. Sethu conducted the amphibian identification workshops, initiated the annual amphibian monitoring program and pilot energy-efficient stove program, undertook habitat restoration and initiated dialogue with the plantation owners.

Nithin Divakar: Nithin Divakar is currently a Research Fellow with the MES Mampad College, Malappuram, Kerala. He received an M.S. in Wildlife Studies from Kerala Veterinary and Animal Sciences University (2015). He has previously undertaken amphibian surveys to understand their diversity and abundance, participated in a herpetology field course in the study area, undertook disease screening of amphibians and has conducted nature awareness programs. Nithin conducted the amphibian identification workshops, undertook the pilot energy-efficient stove program and habitat restoration.

Section 2

Aim and Objectives

Aim: Improving on-ground conservation action for the endemic and threatened amphibians of the Western Ghats, and securing a future for the non-charismatic, yet Critically Endangered Toad Skinned frog in its range.

- Objective 1: *Restore 20 hectares at two degraded sites occupied by the species in 2 months*
- Objective 2: *Reduce fuelwood collection by 40% at 60% of local households within the locations of species occurrence in 6 months*
- Objective 3: *Improve knowledge on the species among 75% of the front-line staff of Munnar and Valparai Forest Departments through the initiation of an amphibian monitoring program in 4 months*
- Objective 4: *Improve the quality of the species habitat in 50% of Rainforest Alliance-certified tea plantations through reduced pesticide spillover within 11 months of project initiation*

Changes to original project plan

1. The project was originally aimed to be undertaken at Valparai (Tamil Nadu) and Munnar (Kerala). However repeated permit requests from the Tamil Nadu Forest Department were rejected. Therefore, the project was focused only at Munnar including Mankulam where the Forest Departments were interested and keen for us to pursue the project. The permissions from the Kerala Forest Department were received later than expected due to which, habitat restoration had to be postponed to May-June 2016.
2. Initially, local communities expressed exceptional interest in the energy-efficient stoves and on a pilot-basis, these were installed at five households. However, the communities were not satisfied post installation. This initiative was then discontinued and a greater effort was focussed on habitat restoration.
3. The per acre costs that were estimated for the habitat restoration were under-estimated and 10 acres were effectively restored instead of the proposed 20 hectares. We had also not estimated the costs for transporting the saplings and other related material to the restoration site. An additional 800 saplings were planted above the proposed 700 saplings.
4. The component towards reducing pesticide spillover to species habitats from the tea plantations was unsuccessful and could not be continued post the discussion phase.

Methodology

1. Habitat restoration

Transects were setup in the Toad-skinned frog habitats at Munnar to understand the species abundance. Two transects measuring 150m were divided into 10 segments and time-constrained searches were conducted in each segment by actively searching the habitat up to a height of three feet for six minutes. The surveys were repeated five times each from 18:00 to 19:30 hrs by two observers. The number of individuals of each amphibian species encountered were recorded at each segment while weather parameters were recorded at the start and end of each survey.

The vegetation was categorized based on the diameter of the plant's trunk at breast height (DBH) and height. Vegetation was classified as a tree if the DBH was 15cm or greater and, as saplings if the DBH was between 5 cm and 15 cm. Shrubs were classified as woody-stemmed short plants not taller than 50 cm while seedlings were green herbaceous stems less than 50cm. The total number of trees were enumerated in a 5m x 5m plot while the number of saplings, shrubs and seedlings were calculated in a 2m x 2m random sub-plot within the tree plot. Canopy cover was calculated using a graduated glass plate (100 - 1 cm x 1cm squares) attached to a cardboard cylinder. Litter density (g) was calculated from weighing the soil litter of a 10cm x 10cm sub-plot using an electronic weighing scale (Weiheng®, 0-10kg, $\pm 0.01g$).

Ten acres of degraded habitat were divided into grids (20*20m) and 1500 native evergreen tree saplings were planted in a horizontal manner uphill. A gap of one meter was left around and between each sapling or existing vegetation. Since the area was prone to erosion, bunds were created around each sapling so that they would be able to resist erosion. Each sapling was tagged post planting and assigned a unique species code and number so that the growth of each plant can be monitored annually. Maintenance was undertaken at the restoration plots after four months by providing fertilisers and restoring bunds around saplings. The total height of the plant and diameter of the stem at 10 cm from the ground was recorded for each sapling as a part of the monitoring protocol during planting and the maintenance activity to monitor the growth and survival rate of saplings.

2. Installation of energy-efficient stoves

Discussions were undertaken with local communities and landowners at three settlements within the species range to understand their dependence on firewood and interest in the energy-efficient stoves. On the basis of individual interest, in-depth surveys at six households from two settlements were initiated to understand the actual household dependence on firewood prior to installing energy-efficient stoves. TIDE, Bangalore supported the technical aspects of this initiative and provided the metal frame for stove construction and supplied the metal inserts. Red mud bricks were purchased from the closest market while red mud and tiles were gathered from around the settlements where the stoves were installed. An employee

of TIDE, Bangalore installed five energy-efficient stoves at two settlements towards the pilot program.

3. Amphibian monitoring program

Two day-long amphibian identification workshops were conducted with 26 participants from three Forest Departments in Munnar, Kerala (1st Workshop: 16 November, 14 participants, Munnar Forest Division, Munnar Wildlife Division; 2nd Workshop: 8 December 2015, 12 participants, Mankulam Forest Division). The workshop consisted of classroom and field sessions. The ‘classroom’ session consisted of visual presentations detailing the importance of amphibians and their diversity in the Western Ghats, specifically focusing on five amphibians in Munnar; *Indirana phrynoderma* (CR), *Rhacophorus pseudomalabaricus* (CR), *Micrixalus adonis* (NE), *Ghatixalus asterops* (DD) and *Raorchestes beddomii* (NT). These species were chosen as they were distinct, easier to identify and occupied different habitats within the rainforest ecosystem. Five species information cards in the local language (Malayalam), each with an illustration of the amphibian along with identification characteristics, common name and habitat occupied were provided to each participant. The field session involved showing the participants the five species in the field, the specific habitats they occupied, monitoring and amphibian handling protocols and filling up data sheets. A questionnaire survey was conducted with the participants before the workshop to record their knowledge of the five amphibians. Information on species identity, its local name and habitat were requested after showing them photographs of the species. An identical survey was repeated four months later with 14 respondents to understand whether the workshop had improved their skills in identifying the five species. The number of participants who had had previous knowledge or who either gained knowledge or had not was calculated.

Following the amphibian identification and monitoring workshops, the annual toad-skinned frog monitoring program was launched in collaboration with the Mankulam Forest Division. Two forest officials joined the survey team to conduct the transect surveys that were similar to the amphibian abundance surveys undertaken

4. Reducing pesticide spillover

Informal and formal discussions were initiated with the various plantation managers of tea plantation divisions in Munnar with regard to reducing the pesticide spillover from tea plantations to toad-skinned frog habitats.

Outputs and Results

1. Habitat restoration

The most abundant amphibian species/genus were *I. leptodactyla*, *Micrixalus sp* and *Rhacophorus sp* (Table 1). *Indirana phrynoderma* was the most abundant after these species/genus, which suggests that the species is not locally abundant within its range but is rather uncommon.

Table 1. Relative abundance of amphibians encountered at two transects in the Cardamom Hills

Species	Transect 1	Transect 2
<i>Indirana phrynoderma</i>	6.3±0.7	7±1.4
<i>Indirana leptodactyla</i>	22.5±3.9	18.6±2.7
<i>Micrixalus sp</i>	16.6±3.2	1.6±0.3
<i>Duttaphrynus sp</i>	2.8±0.8	3.2±0.7
<i>Rhacophorus sp</i>	20.5±5.2	5.3±1.2
<i>Uperodon sp. montanus</i>	1.8±0.5	0.1±0.1
<i>Nyctibatrachus anamalaiensis</i>	0.4±0.3	0.6±0.3
Other <i>Nyctibatrachus sp</i>	0.7±0.3	0.2±0.1
Unidentified species	2.3±0.6	1.7±0.5
Total	73.9±8.2	38.3±5.4

The canopy cover at the locations were 93±4%. The vegetation comprised of 5.5±1.5 trees (Table 2), 44±19 saplings, 28±10 shrubs and 76±28 seedlings. The litter weight was 0.18±0.02g.

Table 2. Checklist of dominant tree species at restoration sites in Munnar, Kerala

	Scientific Name	Family
1	<i>Syzygium densiflorum</i>	Myrtaceae
2	<i>Rapanea thwaitesii</i>	Myrsinaceae
3	<i>Vernonia arborea</i>	Asteraceae
4	<i>Schefflera spp</i>	Araliaceae
5	<i>Litsea ghatica</i>	Lauraceae
6	<i>Eucalyptus spp</i>	Myrtaceae
7	<i>Neolitsea scrobiculata</i>	Lauraceae
8	<i>Eurya spp</i>	Theaceae
9	<i>Symplocos spp</i>	Symplocaceae
10	<i>Actinodaphne spp</i>	Lauraceae
11	<i>Clerodendrum infortunatum</i>	Verbenaceae
12	<i>Neolitsea spp</i>	Lauraceae
13	<i>Melicope spp</i>	Rutaceae
14	<i>Prunus ceylanica</i>	Rosaceae
15	<i>Actinodaphne spp</i>	Lauraceae
16	<i>Maesa indica</i>	Myrsinaceae

A total of 1500 native, evergreen tree saplings were planted across 10 acres of degraded toad-skinned frog habitat (Image 1) in a systematic manner (Image 2) and tagged to monitor their growth and survival rates (Image 3). Seventy-four percent of the saplings survived four months post restoration. The saplings that did not survive had either been completely damaged by the activity of Indian gaur in the restoration plots or had dried up. Numerous saplings, which had survived had also been partially damaged or its leaves had been consumed by wild herbivores (Table 3). The species which had the best survival and growth rates were *Ligustrum* sp, *Syzygium densiflorum* and *Symplocos* sp (Table 3).

Image 1. A restoration site at Munnar to improve the Toad skinned frog population in Kerala



Image 2. Systematic planting of saplings at a restoration site in Munnar, Kerala



Table 3. The survival and growth rate of saplings planted to restore degraded *Indirana phrynoderma* habitats in the Cardamom Hills

Species	Survival rate	Original height*	Change in height*	Original diameter^	Change in diameter^
<i>Ligustrum sp</i>	81%	57.71	-1.07	7.12	0.33
<i>Litsea glabrata</i>	77%	73.17	-9.61	5.36	0.33
<i>Symplocos sp</i>	73%	38.08	4.37	4.55	0.32
<i>Syzygium densiflorum</i>	83%	37.89	7.83	6.46	0.24
<i>Celtis sp</i>	74%	53.87	-5.63	5.64	0.14
<i>Elaeocarpus sp</i>	63%	50.76	0.67	5.06	0.29
<i>Alstonia sp</i>	66%	65.90	-2.26	5.81	0.22
<i>Cinnamomum sp</i>	64%	30.07	-1.25	4.89	0.27
Unknown 1	100%	35	3.00	4	0
Unknown 2	64%	30.82	2.57	3.57	0.50
Unknown 3	60%	46.57	-9.08	3.29	0.21
Unknown 4	100%	49	-1.00	4.50	0.20
Unknown 5	50%	32.4	3.20	4.54	0.66
Unknown 6	90%	56.40	2.99	6.90	1.45
Unknown 7	63%	17.93	3.32	3.29	0.52
Unknown 8	0%	31	-	3.6	-
Unknown 9	0%	27	-	4.9	-
Unknown 10	50%	39.00	-1	4.55	0.5
Unknown 11	100%	39.25	3.25	4.86	7.5
Unknown 12	0	54	-	5.9	-
Unknown 13	100%	60	-8.50	7.80	0.65

Image 3. Tagging saplings at a restoration site in Munnar to monitor annual growth and survival



2. Installation of energy-efficient stoves

An average of 8.34 kg of firewood was used across five households during a 30 day time period. Post-installation the average firewood utilization per household was 6.58 kg. The energy-efficient stoves resulted in a 21% decrease in firewood utilization across local households in the species habitat.

Image 4. Installation of the energy-efficient stove by Sustaintech/TIDE, Bangalore at Munnar, Kerala



Image 5. The energy-efficient stove installed by Sustaintech/TIDE, Bangalore at Munnar, Kerala



3. Amphibian monitoring program

Indirana phrynoderma (100%, 79%), *R. pseudomalabaricus* (67%, 71%) and *M. adonis* (63%, 82%) were the species that the Forest Departments had substantially improved their skills in with respect to identifying species and the habitats they occurred in respectively (Table 4). These species are therefore relatively easier to distinguish for the Forest Department and should feature as focal species during official monitoring of amphibian populations. The participants also had substantial previous knowledge towards *R. pseudomalabaricus* and *M. adonis*. Information regarding the common names of the species were not retained by most of the respondents (Table 4). This could have arisen from the common names being difficult to memorize. This could be improved through a greater impetus from the higher officials of the Forest Department towards their staff to equip themselves with such knowledge. Overall, the workshops have improved the knowledge of the Forest Department and if undertaken annually could consistently improve their skills in identifying amphibians and eventually conserving them.

Image 6. Amphibian guide books featuring the flagship endemic and threatened amphibians of Munnar provided to participants of the amphibian identification and monitoring workshops



Image 7. Classroom session of the amphibian identification and monitoring workshop at Munnar



Image 8. Field session of the amphibian identification and monitoring workshop



Table 4. The success of education workshops conducted at Munnar in improving the ability of Forest Department officials (n=14) to identify amphibians and related information

Species	Species identity	Common name	Habitat
<i>Indirana phrynoderma</i>	Yes = 14	Yes = 2; No = 12	Yes = 11; No = 3
<i>Rhacophorus pseudomalabaricus</i>	Yes = 2; No = 1	Yes = 2; No = 12	Yes = 10; No = 4
<i>Micrixalus adonis</i>	Prior knowledge = 11		
	Yes = 5; No = 3	Yes = 3; No = 11	Yes = 9; No = 2
	Prior knowledge = 6		Prior knowledge = 3
<i>Ghatixalus asterops</i>	Yes = 3; No = 8	No = 14	Yes = 6; No = 8
	Prior knowledge = 3		
<i>Raorchestes beddomii</i>	Yes = 5; No = 7	Yes = 2; No = 12	Yes = 6; No = 8
	Prior knowledge = 2		

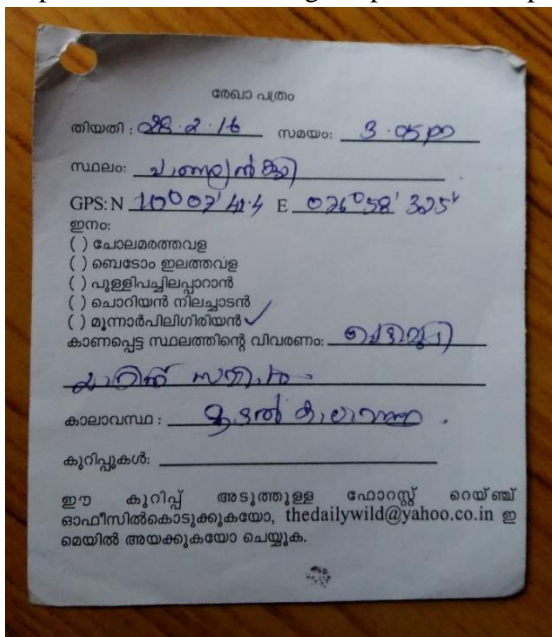
Image 9. A forest department official learning to handle a frog carefully to minimize stress during the amphibian identification and monitoring workshop at Munnar, Kerala



Image 10. The amphibian monitoring program team composed of project team and forest department officials at a transect location in Munnar, Kerala



Image 11. A completed amphibian monitoring sheet shared with the project team by a Forest Department official during the post workshop survey at Munnar, Kerala



Communication & Application of results

The project results have been communicated through a press release to local newspapers (English, Malayalam). The amphibian guide books were not only provided to the amphibian identification workshop participants but also to the participating Forest Departments and local communities for greater dissemination. The results of the amphibian identification workshop, field and social surveys have been prepared for scientific journals and are at various stages of publication. We have also assessed *I. phrynoderma* and *I. leptodactyla* for the Conservation Needs Assessment based on the information generated from this project. Due to these project results, the profile of amphibians has increased among Forest Department officials.

Monitoring and Evaluation

1. Habitat characterization surveys before and after restoration were conducted to monitor the habitat restoration initiative. The surveys confirm that 74% of planted saplings have survived in the 10 acre plots.
2. A survey at five local households where energy efficient stoves were setup, before and after installation that involved measuring the weight of the firewood were conducted to monitor the initiative to reduce firewood utilization among local communities. The surveys confirm that firewood utilization reduced by an average of 21% at the local households.
3. A questionnaire survey with the Kerala State Forest Departments before, and after the amphibian identification workshop was conducted to understand whether the participants in actuality improved their skills in identifying amphibians. The surveys confirm that on an average 77% of the front-line staff can identify 3 out of 5 key amphibian species and associate them with their habitats after 4 months of the workshop.

Achievements and Impacts

1. Ten acres of degraded habitat were restored to support the sustained and long-term habitat improvement of the Critically Endangered Toad skinned frog *Indirana phrynoderma*. This is the first initiative in the country to improve the habitat of a threatened amphibian. The habitat restoration helps secure the population of Toad skinned frog and will improve the population of the entire amphibian community in the region including other endemic and threatened species.
2. An annual amphibian monitoring program in collaboration with the Forest Department was initiated in 2015 to collect long-term data on amphibian populations in Munnar. This program initiates partnerships between multiple stakeholders towards the common cause of amphibian conservation that help secure its future. Moreover, the availability of transparent information on the species population will allow for undertaking sound conservation measures whenever necessary in the future. The Forest Departments increased focus towards amphibians would improve amphibian conservation and safe-guard future populations.
3. The local Forest Departments in Munnar now have improved knowledge in identifying and monitoring amphibians especially the Toad skinned frog. The forest department is the

managing authority for the forests and biodiversity. Building their capacity in amphibians will not only improve their appreciation and attention towards the conservation of these species but also in directly monitoring their populations.

Capacity Development and Leadership capabilities

The entire team trained at the Gurukula Botanical Sanctuary, Wayanad to implement the habitat restoration component, which led to an improved overall capacity in initiating and implementing habitat restoration. Additionally, Sethu Parvathy and Arun Kanagavel also completed an intensive three month long online course “Tropical Forest Restoration in Mosaic Landscapes of Southeast Asia” conducted by ELTI (Environmental Leadership and Training Initiative), Yale School of Forestry and Environmental Studies, which helped the team substantially in formulating the different aspects of the restoration initiative for this project. The team also has the knowledge to build energy-efficient stoves. Additionally, Sethu’s skills in project management and communication improved due to the CLP Conservation Management and Leadership Training Course at Barrier Lake Field Station, Canada in 2015. Sethu then trained the other two members, which not only improved the team’s capacity but also improved their working relationship. Sethu’s leadership skills improved as she led the amphibian identification workshop component with the Forest Departments. Her skills in scientific writing improved from her training at the Writing for Conservation Workshop organized by CLP & FFI at Bengaluru, India in 2017. She is currently leading the preparation of a scientific paper for the first time as the lead author. Nithin improved his capacity in designing questionnaires, undertaking social surveys and habitat characterization surveys, interacting with multiple stakeholders, project management (especially finances) and scientific writing. At the end of the project, Nithin felt he had gained the perspective of a conservation researcher as he perceived that he was more of a wildlife ecologist before the project.

The team’s improved skill base enabled them to undertake a research essential course (project planning, scientific writing, fund raising and social science survey techniques) for the MSc Wildlife Sciences students of the Centre for Wildlife Studies – Kerala Veterinary and Animal Sciences University (CWS-KVASU), Pookode, Wayanad during 4-10 July, 2016.

Section 3

Conclusion

Our project has initiated on-ground conservation towards the Critically Endangered Toad-skinned frog. The project has been able to initiate habitat restoration at degraded species habitats and thereby helping to secure the Toad skinned frog population. It has improved the capacity of the local Forest Department officials in identifying and monitoring amphibians that would not only increase their focus towards amphibian conservation but also improve the profile of amphibians.

Problems encountered and lessons learnt

- *Which project activities and outcomes went well and why?*
 The habitat restoration, amphibian identification and monitoring workshops and the amphibian monitoring program went really well as they were readily accepted for implementation by the local Forest Departments. Moreover, these stakeholders were flexible with their approach, which made working with them easier.
- *Which project activities and outcomes have been problematic and in what way, and how has this been overcome?*
 The most problematic activities were the energy-efficient stove installation and the pesticide spillover reduction components. Sourcing the stove parts was quite strenuous as they were not easily available in the mountainous regions where the team was based. Working with the local communities was also quite strenuous as they initially expressed exceptional interest in the energy-efficient stoves. Post installation however, the communities were not satisfied since these stoves required a greater maintenance effort, they perceived that their cooking pans were getting burnt and they also wanted the stoves to be tiled and painted. This initiative was therefore discontinued after the pilot exercise and the balance funds were focussed on the restoration initiative. The component towards reducing pesticide spill over to species habitats from the tea plantations was unsuccessful and could not be continued post the discussion phase. The tea plantations approached stated that their strategies, as per the Rainforest Alliance certification standards were up to the mark and that no pesticide spilled over to the forested habitats. However, this is definitely not the case as we have observed otherwise locally. While pursuing further discussions with one plantation division, the entire plantation company was faced with a social protest by its workers towards salaries. The protest continued for a month and led to a reduced interest from plantation managers in conservation initiatives. The support from adjoining tea plantations towards habitat restoration was not received as the restoration site was not owned by them, which led to further increase in restoration costs as daily-wage labourers had to be employed to assist in restoration. Initially, one of the sites considered for restoration was owned by the plantations and discussions were ensued with the managers. After numerous discussions, presentations and provision of site restoration plans and site visits, the managers decided against this initiative as they stated that the proposed site was set aside for timber production. Due to this they stated that the land use of the proposed site could not be changed, especially as the company paid taxes towards it. We then

approached the Forest Department to restore degraded species habitats on land owned by them, which was successful.

- *Briefly assess the specific project methodologies and conservation tools used.*
The habitat characterization, amphibian abundance and social questionnaire surveys were simple to undertake especially since team members have been working with similar tools in their previous projects. The habitat restoration methodology and sapling tagging were formulated and perfected only after the training at Gurukula Botanical Sanctuary and the online tropical forest restoration course by ELTI as the team had little experience in this methodology.
- *Please state important lessons which have been learnt through the course of the project and provide recommendations for future enhancement or modification to the project activities and outcomes.*
The lessons learnt from the project is that stakeholders are in a fluidic state of mind which directly affects the project activities. The project can be well undertaken when team members of different strengths take on individual as well as joint activities that further improves their relationships and the project's success.

In the future

The annual amphibian monitoring and the habitat restoration programs will continue beyond the grant period as they will be undertaken by the local Forest Departments. Annual maintenance activities at the restoration plots will be undertaken by the local Forest Department with support from the project team. In the future, greater effort needs to be focussed towards engaging local communities directly in conserving amphibians including building their interest and appreciation towards this vertebrate group. The habitat restoration component can also be scaled up and more degraded species habitats could be restored to improve the population of the focal species and the amphibian community. Small-scale, local nurseries can be setup close to the species habitats to supply low-cost, native saplings for the restoration initiative. Moreover, if the amphibian identification workshop can be repeated or refreshed every year, it would improve the Forest Department's ability in monitoring and conserving amphibians.

Financial Report

Itemized expenses	Total CLP Requested (\$)	Total CLP Spent (\$)	% Difference	Details & Justification (Justification must be provided if figure in column D is +/- 25%)
PHASE I - PROJECT PREPARATION				
Communications (telephone/internet/postage)	300.00	521.81	74%	The internet costs at the remote field site were much higher than estimated
Field guide books, maps, journal articles and other printed materials	100.00	41.46	-59%	Field guide books were received free of cost from project collaborators
Insurance	250.00	24.12	-90%	The insurance for the team was paid for by Conservation Research Group
Visas and permits	100.00		-100%	Since research components did not include specimen collection, the Forest Department did not charge costs towards permits
Team training	300.00	280.88	-6%	
Reconnaissance	250.00	372.84	49%	Additional visits needed to be made to Trivandrum and Chennai towards resolving research permit issues
EQUIPMENT				
Scientific/field equipment and supplies	300.00	359.51	20%	
Boat/engine/truck (including car hire)	1,000.00	1162.62	16%	
Other (Equipment)	2,400.00	2063.41	-14%	
PHASE II - IMPLEMENTATION				
Accommodation for team members and local guides	2,000.00	2298.24	15%	
Food for team members and local guides	2,000.00	1419.14	-29%	The food expenses were much lesser than expected
Travel and local transportation (including fuel)	1,500.00	1958.57	31%	Local travel was increased due to the various project activities that required consistent meetings with project advisers and collaborators. Moreover, the transportation expenses for the restoration component were not added to the original budget
Workshops	200	381.12	91%	The participants needed to be transported to the field sites which increased the cost substantially, especially since Forest Department Jeeps were unavailable
Outreach/Education activities and materials (brochures, posters, video, t-shirts, etc.)	400.00	274.27	-31%	Designing and printing booklets of protocols to avoid pesticide spillover to forests were not undertaken since the component was unsuccessful.
Other (Phase 2)	1,100.00	1284.71	17%	
PHASE III - POST-PROJECT EXPENSES				
Other (Phase 3)	300.00	301.63	1%	
Total	12,500.00	12,744.33		

Section 4: Appendices

CLP M&E measures table

<i>Output</i>	<i>Number</i>	<i>Additional Information</i>
Number of CLP Partner Staff involved in mentoring the Project	10	Stuart Patterson, Julie Lewis, Kiragu Mwangi, Christina Imrich, Laura Owens, Iain Dickson, Nalini Mohan, Martin Fowlie, Martin Davies, Robyn Dalzen
Number of species assessments contributed to (E.g. IUCN assessments)	2	Conservation Needs Assessment for <i>Indirana phrynoderma</i> & <i>Indirana leptodactyla</i>
Number of site assessments contributed to (E.g. IBA assessments)	0	-
Number of NGOs established	0	-
Amount of extra funding leveraged (\$)	\$6748	Rufford Small Grants Foundation (\$6248); Idea Wild (\$500 worth equipment)
Number of species discovered/rediscovered	0	-
Number of sites designated as important for biodiversity (e.g. IBA/Ramsar designation)	0	-
Number of species/sites legally protected for biodiversity	0	-
Number of stakeholders actively engaged in species/site conservation management	1	Kerala State Forest Department
Number of species/site management plans/strategies developed	0	-
Number of stakeholders reached	3	Forest Department officials, local communities, plantation owners and managers
Examples of stakeholder behaviour change brought about by the project.	1	The capacity of Forest Department officials in identifying amphibians was improved by 77% towards three species including <i>Indirana phrynoderma</i>
Examples of policy change brought about by the project	0	-
Number of jobs created	0	-
Number of academic papers published	2	Two papers have been accepted for publication (Conservation Evidence; ENVIS Bulletin)
Number of conferences where project results have been presented	1	BIAZA Reptile and Amphibian Working Group Meeting, May 2016

Raw field data

Table 1. Checklist of amphibians recorded at plantations outside the protected area in Munnar

	Common name	Scientific name	Status [^]	PA ⁺	Plantation [#]
I. ORDER ANURA					
Family Bufonidae (Toads)					
1	Common Indian Toad	<i>Duttaphrynus melanostictus</i>	LC	C	T, C
2	Small-eared Toad*	<i>Duttaphrynus microtymphanum</i>	VU	C	T
3	Ridged Toad*	<i>Duttaphrynus parietalis</i>	NT	UC	T
Family Dicroglossidae (Fork-tongued frogs)					
4	Kerala Warty Frog	<i>Fejervarya keralensis</i>	LC	UC	T
5	-	<i>Fejervarya sp</i>	NA	C	T, C
Family Micrixalidae (Dancing frogs)					
6	Munnar Torrent Frog*	<i>Micrixalus adonis</i>	NE	C	T, C
7	Cold Stream Torrent Frog*	<i>Micrixalus frigidus</i>	NE	C	T
8	Forest Torrent Frog*	<i>Micrixalus silvaticus</i>	DD	UC	T
Family Microhylidae (Narrow-mouthed frogs)					
9	Jerdon's Balloon Frog*	<i>Uperodon cf montanus</i>	NT	UC	T, C
Family Nyctibatrachidae (Night frogs)					
10	Meowing Night Frog*	<i>Nyctibatrachus poocha</i>	NE	C	T, C
11	Spinular Night Frog*	<i>Nyctibatrachus acanthodermis</i>	NE	R	T
12	Anamallai Night Frog*	<i>Nyctibatrachus anamallaiensis</i>	NE	UC	T
13	Deccan Night Frog*	<i>Nyctibatrachus deccanensis</i>	VU	UC	T, C
Family Ranixalidae (Leaping frogs)					
14	-	<i>Indirana sp</i>	NA	UC	T, C
15	Sreeni's Golden-backed Frog*	<i>Indosylvirana sreeni</i>	NE	UC	T, C
Family Rhacophoridae (Tree frogs)					
16	Kadalar Swamp Frog*	<i>Beddomixalus bijui</i>	NE	UC	T
17		<i>Polypedates occidentalis</i>		UC	C
18	Star eyed Ghat Frog*	<i>Ghatixalus asterops</i>	DD	C	T
19	Great Ghat Frog*	<i>Ghatixalus magnus</i>	NA	R	T
20	Yellow Bellied Bush Frog*	<i>Raorchestes flaviventris</i>	DD	R	T
21	Beddome's Bush Frog*	<i>Raorchestes beddomii</i>	NT	C	T
22		<i>Raorchestes ponmudi</i>			C
23		<i>Raorchestes glandus</i>			C
24		<i>Raorchestes anili</i>			C
25	Green Eyed Bush Frog*	<i>Raorchestes chlorosomma</i>	CR	UC	T, C
26	Kodaikanal Bush Frog*	<i>Raorchestes dubois</i>	VU	C	T
27	Griet Bush Frog*	<i>Raorchestes griet</i>	CR	C	T
28	Jayaram's Bush Frog*	<i>Raorchestes jayarami</i>	NE	C	T, C
29	Kadalar Bush Frog*	<i>Raorchestes kadalarensis</i>	NE	C	T
30	Munnar Bush Frog*	<i>Raorchestes munnarensis</i>	CR	C	T
31	Uthaman's Bush Frog*	<i>Raorchestes uthamani</i>	NE	R	T
32	Theuerkauf's Bush Frog*	<i>Raorchestes theuerkaufi</i>	NE	R	T
33	Sushil's Bush Frog*	<i>Raorchestes sushili</i>	CR	R	T, C
34	Water Drop Frog*	<i>Rarchestes nerostagona</i>	EN	R	T
35		<i>Pseudophilatus kani</i>			C
36	Kalakad Tree Frog*	<i>Rhacophorus calcadensis</i>	EN	UC	T
37	Malabar Gliding Frog*	<i>Rhacophorus malabaricus</i>	LC	UC	C
38	Malabar False Tree Frog*	<i>Rhacophorus pseudomalabaricus</i>	CR	C	T, C

Table 2. Checklist of reptiles recorded at plantations outside the protected area in Munnar

	Common name	Scientific name	Status [^]	PA ⁺	Plantation [#]
ORDER SQUAMATA					
Family Agamidae (Lizards)					
1	Roux's Forest Lizard	<i>Calotes rouxii</i>	LC	R	T
2	Large-scaled Forest Lizard*	<i>Calotes grandisquamis</i>	LC	UC	T, C
3	Anamalai Spiny Lizard*	<i>Salea anamallayana</i>	LC	C	T
4	Blanford's Rock Agama	<i>Psammodromus blanfordianus</i>	LC	UC	T
Family Gekkonidae (Geckoes)					
5	Indian Day Gecko*	<i>Cnemaspis indica</i>	VU	UC	T, C
6	Anaimalai Gecko*	<i>Dravidogecko anamallensis</i>	NT	C	T, C
Family Scincidae (Skinks)					
7	Skink	<i>Eutropis sp</i>		C	T, C
8	Side-spotted Ground Skink*	<i>Kaestlea laterimaculata</i>	VU	C	T, C
Family Uropeltidae (Shieldtails)					
9	Red-spotted Shieldtail*	<i>Uropeltis rubromaculatus</i>	LC	C	T
10	Red-sided Shieldtail*	<i>Uropeltis maculata</i>	DD	UC	T
11	Kerala Shieldtail	<i>Uropeltis ceylanica</i>	LC	C	T, C
12	Palni Shieldtail*	<i>Uropeltis pulneyensis</i>	LC		T
13	Three-lined Shieldtail*	<i>Platyplectrurus trilineatus</i>	LC	R	T
14	Western Shieldtail*	<i>Teretrurus sanguineus</i>	LC	R	T
15	Yellow-striped Shieldtail*	<i>Melanophidium bilineatum</i>	VU	R	T
16	Pied-belly Shieldtail*	<i>Melanophidium punctatum</i>	LC	R	T
Family Natricidae (Keelbacks)					
17	Green Keelback	<i>Macropisthodon plumbicolor</i>	NE	C	T
18	Checkered Keelback	<i>Xenochrophis piscator</i>	NE	C	T
Family Colubridae (Colubrid snakes)					
19	Travancore Wolf Snake	<i>Lycodon travancoricus</i>	LC	C	T, C
20	Travancore Kukri Snake*	<i>Oligodon travancoricus</i>	DD		T
21	Montane Trinket Snake	<i>Coelognathus helena monticollaris</i>	NE		T
22	Gunther's Vine Snake*	<i>Ahaetulla dispar</i>	NT	UC	T
23	Indian Rat Snake	<i>Ptyas mucosa</i>	NE	C	T
Family Xenodermatidae (Narrow-headed snakes)					
24	-	<i>Xylophis cf captoni</i>	NE	R	T
Family Elapidae (Elapid snakes)					
25	Striped Coral Snake*	<i>Calliophis nigrescens</i>	LC	UC	T
26	Spectacled Cobra	<i>Naja naja</i>	NE		T
Family Viperidae (Vipers)					
27	Large Scaled Green Pit Viper*	<i>Peltopelorus macrolepis</i>	NT	C	T

*Endemic to the Western Ghats of India


[^]Threat status as per IUCN Redlist (CR=Critically Endangered, EN=Endangered, VU=Vulnerable, NT=Near Threatened, LC=Least Concern, DD=Data Deficient, NE=Not Evaluated)

⁺Perceived Abundance, C=Common, UC=Uncommon, R=Rare

[#]Plantation Type, T = Tea, C = Cardamom

Copies of newspaper articles relating to the project

DECCAN CHRONICLE SATURDAY



Indirana phrynoderma.

A CENSUS IN SEARCH OF ENDANGERED FROG SPECIES

SMITHA N | DC
KOCHI, JAN. 1

It is the first of its kind in the country to focus on a single amphibian species.

In a first of its kind, the Munnar forest division in collaboration with researchers at St. Albert's College here has conducted a frog census to monitor the population of the critically endangered toad-skinned frog *Indirana phrynoderma*. The species is more threatened than the tiger on the International Union for Conservation of Nature (IUCN) red list.

"This particular species of frog is very habitat specialised," said Sethu Parvathy of the Conservation Research Group of St. Albert's. "Even small changes in the habitat and climate patterns will affect the animal. Through the survey, we also want to get an idea of the status of the shola-grassland ecosystems of Munnar in the future as the amphibians are excellent indicators of habitat quality."

The frogs seen in vast areas has now restricted to small pockets of 100 sq

km tropical rainforests in the Anamalai Hills specifically at Munnar due to the change in land use pattern and deforestation.

The frog resembles a toad (locally known as *choryan paaratavala*) and can be easily differentiated from its black, speckled underbelly and elongated finger and toe tips.

"We have plans to conduct an extensive amphibian census programme annually in collaboration with other stakeholder institutions," the research fellow added.

The four-member survey team includes Arun Kanagavel of Conservation Research Group and forest officials Rajendran K. and Rajan S.

Alarm bells ring as frogs disappear in Munnar

Times News Network



Disappearing forest cover and pressures of mass tourism are posing a threat to frog species endemic to the region.

Kochi: Disappearing forest cover and pressures of mass tourism are posing a threat to frog species endemic to the Munnar forest region, according to researchers.

On Wednesday a group of researchers under the Conservation Research Group (CRG) of St. Albert's College Kochi, conducted a frog census in the Munnar Forest Division to monitor the population of the toad-skinned frog *Indirana phrynoderma*. The 4.5 cm long species, which resembles a toad locally known as 'choryan paaratavala' can be easily identified by its black, speckled underbelly and elongated finger and toe tips.

During their one-day census expedition, the group members Arun Kanagavel and Sethu Parvathy of CRG and Sandeep Das of Kerala Forest Research Institute identified 137 frogs belonging to 12 different species. Of the 137 frogs, only eight were identified as the *Indirana phrynoderma*.

"This is a bad sign as they are very rare in their endemic environment," Arun said.

Found in evergreen forests at an elevation of 1,300-1,700m above sea level, these little creatures are dwindling in numbers and have now been listed as critically endangered species under the International Union for Conservation of Nature's Red List. They are found only in small fragments of tropical rainforests of Anamalai Hills in Munnar within a 100 sq km radius.

According to the researchers, the greatest threat to frogs and other species in the area is the destruction of forests for commercial tea plantations. "In order to create vast tea plantations a great deal of natural vegetation and forests were felled down. Also, the sudden spurt in infrastructure development and tourism venturing into the forests could also be a reason," said Sethu Parvathy.

This census is the first of its kind in India to focus on a single amphibian species. Currently only larger mammals like elephants and tigers are annually monitored. "Amphibians are excellent indicators of habitat quality as they are very sensitive to slight environmental changes like pollution and deforestation. Monitoring the population of the frog will not only help us keep a track and study the species but also give us an indication of the status of the ecosystem," said Arun Kanagavel.

The Conservation Research Group had previously conducted workshops with the front-line staff of the forest department at Munnar to build their capacity in identifying threatened amphibians like the toad-skinned frog and the purple frog.

വംശഭിക്ഷണി നേരിടുന്ന പോക്കാന്തവളകളുടെ സെൻസസ് തുടങ്ങി



കൊച്ചി: മൂന്നാർ ഹോറസ്റ്റ് ഡിവിഷനും സെന്റ് ആൽ ബെർട്ട്സ് കോളേജ് കൺസർവേഷൻ റിസേർച്ച് ഗ്രൂപ്പും സംയുക്തമായി ചേർന്ന് വംശഭിക്ഷണി നേരിടുന്ന പോക്കാന്തവളകളുടെ/ചൊരിതവളകളുടെ സെൻസസ് തുടങ്ങി. ഇന്ത്യയുടെ ഹെൽത്ത് നാമമുഖ്യനായ ചൊരിതവളകളുടെ ഇന്ത്യയിൽ ആദ്യമായി നടക്കുന്ന സെൻസസ് ആണിത്.

മൂന്നാറിനെ ആസ്പദമാക്കി വളരെ അപൂർവ്വമായി കാണപ്പെടുന്ന ഇവയെ കുറിച്ചുള്ള പഠനം ഉയർന്നുവരുന്ന പഠനങ്ങളിൽ ആദ്യമായിട്ടാണ്. ആവാസ വ്യവസ്ഥയിൽ മുഖ്യപങ്കു വഹിക്കുന്ന ഇത്തരം ഉയർന്നുവരുന്ന കളിപ്പാമ്പുകളുടെ പഠനം വരും വർഷങ്ങളിൽ മൂന്നാർ ഉദ്യോഗസ്ഥർക്ക് വേണ്ടി ഇത്തരം ഉയർന്നുവരുന്ന തിരിച്ചറിയുന്നതിനു വേണ്ടിയും അന്വേഷണ സംരക്ഷണ പ്രക്രിയകളെ കുറിച്ചുള്ള പഠനം കൂടി നടത്തിയിരുന്നു. തുടർന്നും വിവിധ സമാഹരണങ്ങളുമായി ചേർന്ന് ഉയർന്നുവരുന്ന കളിപ്പാമ്പുകളുടെ ആവാസ വ്യവസ്ഥയെ കുറിച്ചും കൂടുതൽ പഠനങ്ങൾ നടത്താൻ കൺസർവേഷൻ ഗ്രൂപ്പിലേക്കുവന്നുണ്ട്.

ഘോല വനമേഖലയിൽ ഉണ്ടാവുന്ന മാറ്റങ്ങളെ കുറിച്ച് പഠിക്കാൻ സഹായിക്കും. സെൻസസ് ഒരു വർഷത്തിനുള്ളിൽ പൂർത്തിയാക്കും.

അറ്റൻ കനകവേൽ, സേതുപാർവതി എന്നിവർ ഉൾപ്പെട്ട കൺസർവേഷൻ ഗ്രൂപ്പും കേരള ഹോറസ്റ്റ് റിസേർച്ച് ഇൻസ്റ്റിറ്റ്യൂട്ടിലെ സിപിദാനും ചേർന്ന് കേരള ഹോറസ്റ്റ് ഡിപ്പാർട്ട്മെന്റിലെ ഉദ്യോഗസ്ഥർക്ക് വേണ്ടി ഇത്തരം ഉയർന്നുവരുന്ന തിരിച്ചറിയുന്നതിനു വേണ്ടിയും അന്വേഷണ സംരക്ഷണ പ്രക്രിയകളെ കുറിച്ചുള്ള പഠനം കൂടി നടത്തിയിരുന്നു. തുടർന്നും വിവിധ സമാഹരണങ്ങളുമായി ചേർന്ന് ഉയർന്നുവരുന്ന കളിപ്പാമ്പുകളുടെ ആവാസ വ്യവസ്ഥയെ കുറിച്ചും കൂടുതൽ പഠനങ്ങൾ നടത്താൻ കൺസർവേഷൻ ഗ്രൂപ്പിലേക്കുവന്നുണ്ട്.

Papers published or manuscripts proposed based on project data

In press

1. Education workshops improve the ability of Forest Departments to identify amphibians in Western Ghats, India (Conservation Evidence)
2. Potential flagship species for improving support and garnering attention towards amphibian conservation in the Western Ghats, India (ENVIS Bulletin, Wildlife Institute of India, Dehradun)

Under Review

3. Local and traditional ecological knowledge of threatened and cryptic amphibians in a biodiversity hotspot (Animal Conservation, second round)
4. Herpetofaunal diversity of the plantation landscape of Munnar, Kerala, India (Amphibian and Reptile Conservation, first round)

Under Preparation

5. Is the Edge Species Restricted to a Single Location? Determining Base-line Information for the Critically Endangered Point-endemic Toad-skinned Frog *Indirana phrynoderma* (Journal of Herpetology)
6. The role of plantations in amphibian conservation in the Western Ghats of India: Pertinent issues and the way forward (Current Science)

Bibliography

- Anadón, J.D., Giménez, A., Ballestar, R. & Pérez, I. (2009) Evaluation of local ecological knowledge as a method for collecting extensive data on animal abundance. *Conservation Biology*, 23, 617-625.
- Atran, S. (1998) Folk biology and the anthropology of science: Cognitive universals and cultural particulars. *Behavioral and Brain Sciences*, 21, 547-609.
- Balcar, T. (2003). Realising community-based forest conservation in the Palni Hills of the Western Ghats. *Social Change* 33 (2-3): 115-128
- Biju S.D., Vijayakumar S.P. & Dutta S. (2004) *Indirana phrynoderma*. The IUCN Red List of Threatened Species v. 2015.2. <http://www.iucnredlist.org/details/58314/0> (accessed 22 March 2017).
- Bunyan, M., Bardhan, S., & Jose, S. (2012). The shola (tropical montane forest)-grassland ecosystem mosaic of peninsular India: a review. *American Journal of Plant Sciences*, 3(11), 1632.
- Das S. (2015) A checklist of amphibians of Kerala, India. *Journal of Threatened Taxa*, 7, 8023-8035.
- Gururaja, K.V. (2012) *Pictorial Guide to Frogs and Toads of the Western Ghats*. Gubbi Labs LLP, Bengaluru, India.
- Harpalani, M., Parvathy, S., Kanagavel, A., Euvathingal, L. & Tapley, B. (2015) Note on range extension, local knowledge and conservation status of the Critically Endangered Anamalai gliding frog *Rhacophorus pseudomalabaricus* in the Cardamom Hills of Western Ghats, India. *Herpetological Bulletin*, 133, 1-6.
- Isaac, N.J.B., Redding, D.W., Meredith H.M. & Safi, K. (2012) Phylogenetically-Informed Priorities for Amphibian Conservation. *PLoS ONE*, 7, e43912.
- Kanagavel, A., Parvathy, S., Nirmal, N., Divakar, N. & Raghavan, R. (2017) Do frogs really eat cardamom? Understanding the myth of crop damage by amphibians in Western Ghats, India. *Ambio*, 1-13. <http://dx.doi.org/10.1007/s13280-017-0908-8> [accessed 27 February 2017].
- Muthuramkumar, S., Ayyappan, N., Parthasarathy, N., Mudappa, D., Raman, T. R., Selwyn, M. A., & Pragasan, L. A. (2006). Plant Community Structure in Tropical Rain Forest Fragments of the Western Ghats, India1. *Biotropica*, 38(2), 143-160.
- Newing, H. (2011) *Conducting Research in Conservation: A Social Science Perspective*. Routledge, London, UK.
- Raman, T. R., Mudappa, D., & Kapoor, V. (2009). Restoring Rainforest Fragments: Survival of Mixed-Native Species Seedlings under Contrasting Site Conditions in the Western Ghats, India. *Restoration Ecology*, 17(1), 137-147.
- Shankar, T. R., & Mudappa, D. (2003). Bridging the gap: Sharing responsibility for ecological restoration and wildlife conservation on private lands in the Western Ghats. *Social Change*, 33(2-3), 129-141.
- Srimathi, A, Schmerbeck, J & S Gärtner. (2012). Regeneration of Shola tree species under Eucalyptus plantations in Upper Palni Hills, pp. 8-11. In - Land-use Related Biodiversity in India (eds. N Naudiyal, J Schmerbeck and N. Kumar), Seminar Proceedings, TERI University, Delhi.
- Stuart, S. N., Chanson, J. S., Cox, N. A, Young, B. E., Rodrigues, A. S. L. and Fischman, Waller, R. W. (2004). Status and trends of amphibian declines and extinctions worldwide. *Science* 306, 1783-1786
- Verissimo, D., Macmillan, D.C. & Smith, R.J. (2011). Toward a systematic approach for identifying conservation flagships. *Conservation Letters* 4(1), 1-8.
- Wangchuk, S, Siebert, S & J Belsky. (2014). Fuelwood use and availability in Bhutan: implications for national policy and local forest management. *Human Ecology*, 42: 127-135.