Final Evaluation Report

Your Details	
Full Name	Divya Bhattarai
Project Title	Impacts of Invasive Species on Plant Diversity, Dietary Overlap with Livestock and Conflict with Human: Asian Wild Buffalo (Bubalus arnee) Conservation
Application ID	32553-1
Date of this Report	16th July 2022

1. Indicate the level of achievement of the project's original objectives and include any relevant comments on factors affecting this.

Objective	Not achieved	Partially achieved	Fully achieved	Comments
Assessment of the impact of the invasive species				Five IAPS with the highest cover were identified in the study area. Ten pairs of adjacent plots were measured for each species covering different vegetation types. One plot of the pair named invaded plots was placed where the invader is dominant with high cover (> 50%) and second pair of uninvaded plots was placed in an adjacent area with similar site conditions, where invader had no cover. Each of the allocated plot sized 4 x 4m was sampled similar to Hejda et al., (2009). In each plot, all species of vascular plants was recorded, and their covers percent were estimated. Similarly, height (cm) and cover (%) of the invader as well as that of dominant native species (grasses and herbs) was measured. Species richness 'S', Shannon diversity index 'H' and evenness 'J' and Sørensen similarity index was calculated. The data were statistically analysed in SPSS.
Assessment of the dietary overlap between wild water buffalo, buffalo and cow				The sample of 116 grasses from the study area was collected in a zip lock bag. Fifty samples each of cow, feral buffalo and wild water buffalo was also collected in zip lock bag and labelled properly. The plant and dung samples were first air dried and then dried in an oven. An herbarium was maintained for collected plants to facilitate the identification. The diet was analysed using standard micro-histological technique (Norbury, 1988). The reference plant samples were dried in an oven at 60 ^{0}C. The dried samples were separately ground with an electric blender and sieved in a

				mesh of size 1–0.3 mm. The powder retained on the 0.3 mm sieve was chosen as the final sample for slide preparation. The final sample was placed in petri dishes and bleached with 4% sodium hypochlorite for 7 hours at room temperature to remove mesophyll tissue and to make the epidermis identifiable. The bleached contents were rinsed well in a sieve. Then they were treated with a few drops of gentian violet solution for 10 seconds and again rinsed. The stained fragments were mounted on microscope slides in a glycerine medium and covered with a cover slip. A similar process was followed for the faecal samples. Both reference slides and faecal slides were observed at different magnifications; 100x, 200x and 400x with a compound microscope and each fragment was photographed using a digital camera for microscope (DCM510) in a laptop using software- ScopeTek Scope Photo. The epidermal features of plants in the dung were identified with the help of reference slides prepared from plant species collected. Finally, after identification of plant samples for each cow, buffalo and wild water buffalo. The diet overlap was assessed.
Questionnaire surveys for the assessment of the conflict				Human and wild water buffalo conflict records from past 10 years (2012-2021) were collected from the department. Based on the data collected structured questionnaire surveys was conducted with the affected households (n = 116) in the study area. The data was analysed in the R statistical package. In the GLMM, fatalities on wild water buffalo attack were used as dependent variable by coding the human fatality—1 and injury—0. Twenty explanatory variables representing wild water buffalo characteristics, human characteristics, and site characteristics were defined.

Community mobilization and sensitization regarding wild water buffalo conservation				Students from selected four schools from the study area were sensitised and raised conservation awareness on wild water buffalo and motivated to raise awareness among their families. Interactive quizzes were held with the students and an essay writing competition was organised. Eight varied groups of local people were provided with the conservation awareness on wild water buffalo. 1000 posters and leaflets were prepared. The posters were pasted in public places and leaflets were distributed to the participants of the conservation awareness.

2. Describe the three most important outcomes of your project.

The three most important outcomes of this project are:

a). Conservation awareness:
The conservation awareness was raised to local schools and the local community. The sessions in the schools included interactive conservation-based questions to make the awareness sessions more interesting and livelier. In addition, essay writing competition was held in a school and Community Learning and Information Center (CLIC) was also created. The awareness materials such as posters and leaflets on wild water buffalo conservation were prepared in Nepali language prior to the fieldwork. The posters were pasted in public places where everyone could view and read the conservational content on wild water buffalo. Few samples of the posters and leaflets were provided to the reserve authority as well.

Bishwanath Singh Adharvuth School, Sunsari Star English boarding School, Shree Rastriya Madhyamik School Sohanpur and Koshi Janta Secondary School. Around 500 students were provided with the conservation awareness and the desired target was met in numeric terms. As the schools were geographically far and amidst ongoing Covid situation inter-school quiz competition could not be held. Therefore, during the presentation, interactive quiz related to wild water buffalo, Koshi Tappu Wildlife Reserve and wildlife were asked to the students to make the session more interactive and interesting. After the completion of the conservation awareness programme, the leaflets on wild water buffalo were distributed to the students and the posters were pasted in the classrooms and premises of the school. Few samples of the posters and leaflets were also distributed to the school administration. An essay competition was held in the Sunsari Star English boarding School. The students who secured first, second and third position; and consolation position were provided with cash prize and stationeries. A community learning and information centre (CLIC) was set up in Sunsari Star English Boarding School with the students of grade 6 and 7 under the supervision of the class teacher. They were provided with ample stationery material such as chart paper, marker etc. along with conservational

materials such as poster and leaflets. They were encouraged to conduct the awareness campaign at local level on a regular basis. My team believes that this initiation of CLIC is crucial to enhance the long-term understanding of the young school children towards conservation in a sustainable basis.


Figure 1: Pasting awareness related poster in a local place. Figure 2: Sharing the leaflet and posters with the reserve personnel.

There was enthusiastic participation from the local residents as well in the conservation awareness session. The community awareness was held for the local residents in various buffer zone area of the wildlife reserve. Total eight groups of local residents were provided with the conservation awareness. The conservation awareness to local residents consisted of two groups each in Kusaha, Prakashpur and Kamalpur along with one group each in Pathari and Haripur. Around 500 local residents were provided with the conservation awareness and the desired target was met quantitatively.


Figure 3: Awareness at Shree Bishwanath Singh Adharvuth School. Figure 4: Awareness at Shree Rastriya Madhyamik School Sohanpur.


Figure 5: Awareness at Sunsari Star English boarding School. Figure 6: Awareness at Koshi Janta Secondary School.

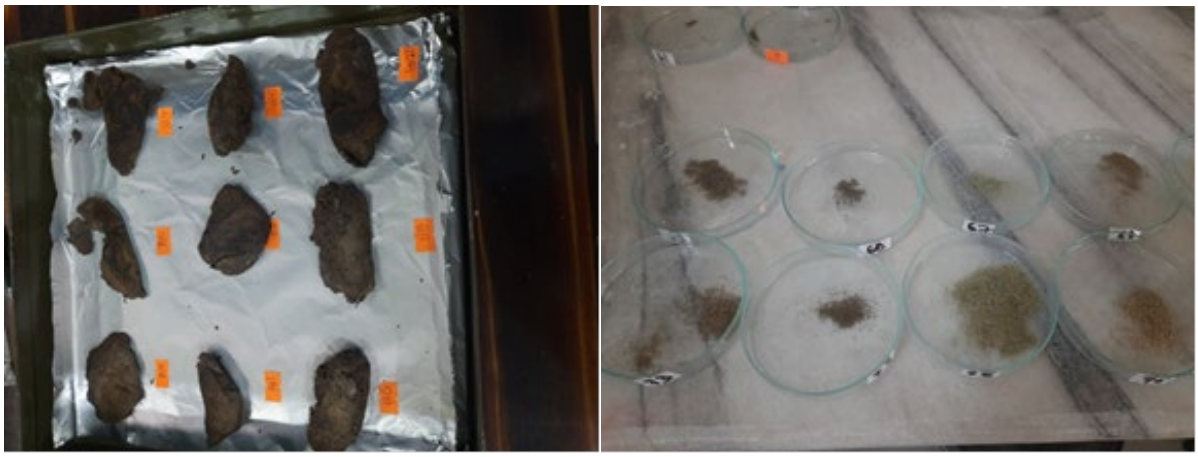

Figure 7: Prize distribution to the winners of the essay competition. Figure 8: Conservation awareness on wild water buffalo conservation.

b). Increased ecological data crucial for wild water buffalo conservation:
The ecological data on the impact of invasive species and dietary overlap cow, buffalo and wild water buffalo was assessed in the study area. These data are highly crucial for the long-term survival of the species in the study area.

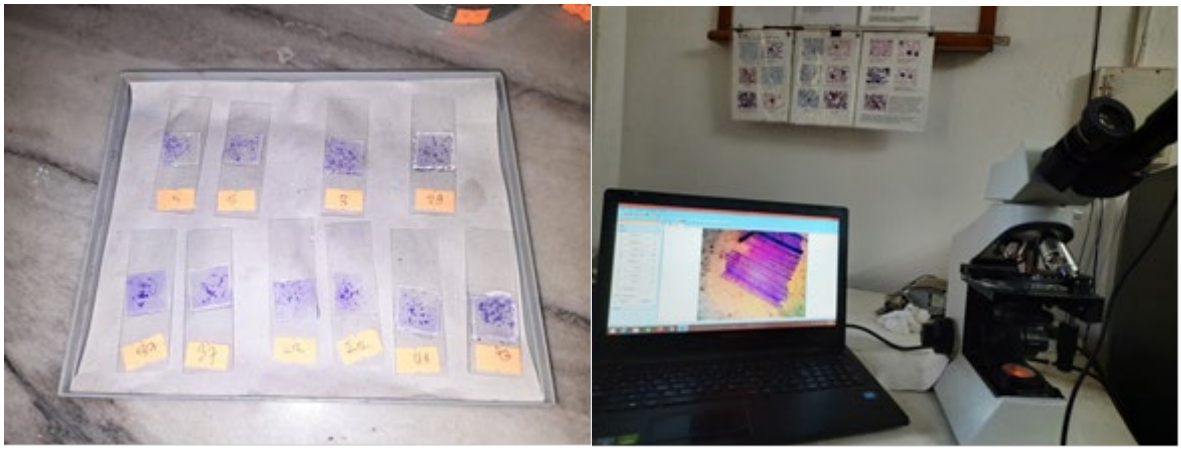
Out of the 25 alien invasive plant species (IAPS) mentioned by Shrestha (2016); 19 IAPS were documented in the KTWR, during the preliminary field survey. A significant difference was found between the species richness of the invaded and un-invaded plots. The correlation was run for the Sørensen similarity index and difference in species richness and was found to be negatively correlated. The impact of invasion on the invaded communities markedly differed among the five invading species; significant differences in species richness between invaded and uninvaded plots were found for three species (*Chromolaena odorata*, *Mikenia micrantha* and *Hyptis suaveolensis)*. Sorenson similarity index between invaded and uninvaded plots ranged from 38% to 53%, and *Ipomea carnea* exhibited the smallest effect on the species composition and highest impact was exerted by the *Chromolaena odorata*. Also, significant difference was observed for S, H and J in the invaded plots for the species *Chromolaena odorata*, *Mikenia micrantha* and *Hyptis suaveolensis*. The diet analysis reveals significant diet overlap between buffalo and wild water buffalo and

cow and wild water buffalo. This stresses the urgency of the management of the feral cattle (cow and buffalo) wildly roaming in the reserve by the reserve authority.

Left: Collection of dung samples from the reserve. Right: Collection of plant samples from the reserve.



Left: Dung samples laid out for drying. Right: Plant remains retrieved from the dung samples.



Left: Temporary slides prepared for viewing. Right: Viewing and photographing images of the fragments from the microscopic camera in the laptop.

c). **Enhanced information on human-wild water buffalo conflict:**
At first, records of the victims (injured and dead) from the reserve, from past 10 years (2012- 2021) was collected in March 2022. Structured questionnaire surveys of all affected households (n = 116) were conducted in the study area. Either the head of the household or another adult member was interviewed with consent. GPS location of each household was recorded. Before an interview, for a verbal consent was requested with the respondents. The questionnaire included the demographic background of the interviewee and the victim (age, sex, ethnicity), socioeconomic status (education, source of income, occupation etc.), victim behaviour/activity during attack (place of attack, activities while being attacked, characteristics of attacking wild water buffalo (adult/sub-adult bull), type of attack (injury/ death), habitat characteristics (land use type) and location (either inside or outside the reserve).

The data analysis was performed in the R statistical package v. 4.0.2 (R Development Core Team, 2020). We carried out binomial logistic regression by constructing a generalised linear mixed model (GLMM) to determine the factors associated with fatalities in wild water buffalo attacks. In the GLMM, fatalities on wild water buffalo attack were used as dependent variable by coding the human fatality—1 and injury—0. Twenty explanatory variables representing wild water buffalo characteristics, human characteristics, and site characteristics were defined. Mostly, the people who were associated with agricultural activities were found to be more vulnerable to the attacks of wild water buffalo. In the land use type, forest areas were found to be more vulnerable to the fatalities. Similarly, education-wise illiterate people were found to be more inflicted with the fatalities.


Figure: Questionnaire survey with the wild water buffalo victims.

Finally, the findings and the achievements of the project was shared with the reserve authority at the completion of the project.

3. Explain any unforeseen difficulties that arose during the project and how these were tackled.

The first unforeseen difficulties that arose during the ecological survey of the project was encounter with wild male elephant Makuna, who had killed some local residents. There were few other male elephants that were ranging in the study area.

To tackle this problem, we constantly coordinated with the reserve authority and the staffs from the elephant breeding centre to know about the locations of the elephants. The reserve personnel requested the staffs from the breeding centre to join our team to ease our ecological survey and data collection. We incorporated security issue of the team during field survey with utmost importance.

During the questionnaire survey, the team was not welcomed warmly in all the households. The questions at times triggered unpleasant memories of the victims associated with the attack. In such cases the data was collected with help of family, close relative, friends or neighbours. At times, the victims were expecting monetary relief from the team which was not the case. Victims were not able to get the relief amount on time due to administrative hurdles. Thirdly, there was no drying machine in KTWR to dry the dung and plant samples. Therefore, the samples in the field were air dried under sun. Fourthly, COVID lockdown happened for the second time while the lab analysis was going on. Due to this the remaining field work and conservation related activities could not be held on time and the project was delayed. Besides this, due to the project leader's knowledge of working in Terai areas, no other unforeseen difficulties were faced. Also, there was constant support from the reserve authority and NTNC.

4. Describe the involvement of local communities and how they have benefitted from the project.

The project followed a participatory approach so that the local residents could be included in each and every stage of the project. The opinions and suggestions of the local residents were taken seriously during the key informant interview and preliminary survey which helped to design and implement the project efficiently. The project provided the local guides, auto rickshaw driver and managers of home stay with direct employment and financially supported them in difficult time of COVID crisis.

One of the main objectives of this project was to create awareness among local communities and school children and to create a Community Learning and Information Center (CLIC) in a school. The school students and the local community were directly benefitted with enhanced knowledge on wild water buffalo conservation and things to do encountering the species. It is expected that the conservation education reached to a larger audience as the school children shared their learning with their parents and family members. It is also expected that the CLIC formed will work sustainably on increasing conservation awareness on the study area. The significant involvement of local communities was observed during the questionnaire survey apart from the conservation awareness. Their views, opinions and correct data regarding the conflict was crucial for the success of the project.

5. Are there any plans to continue this work?

Of course, I have planned to continue study regarding genetics of wild water buffalo along with conservation awareness. There is widespread illiteracy and poverty in the area which increases the dependency of the local residents in the

reserve for the forest products such as fuelwood, fodder, wild spinach, fish, etc., and mass grazing of cattle still persists. This has in turn created pressure in the reserve and degraded its condition.

The analysis of conflict data reveals that people who were associated with agricultural activities were found to be more vulnerable to the attacks of wild water buffalo. Regarding the land use type, forest areas were found to be more vulnerable to the fatalities. Similarly, education-wise illiterate people were more inflicted with the fatalities. So, I would like to conduct conservation project focusing on the local entrepreneurship, which requires skills such as weaving mats from local plant *Typha elephantina* and plantation of fodder varieties in alleys of agricultural field. I believe this type of income generating activities and training are highly needed to uplift their economic status and reduce the dependency on the forest resources, hence minimising cases of conflict.

6. How do you plan to share the results of your work with others?

A final presentation was conducted with the reserve authority at the end of the project to impart and share the data generated from the project. As the project team has now successfully completed the project and the data has been completely analysed using advanced software. We would further like to publish the findings, by preparing manuscript for publication in a peer reviewed journal. This will impart the knowledge to the entire scientific community.

7. Looking ahead, what do you feel are the important next steps?

It is good news that in the recent census conducted by the government the number of wild water buffalo has increased. The local residents are highly dependent on the reserve for forest-based products. Moreover, enhancing the capacity of local residents through different income generating activities and training them will help to reduce their dependency on the reserve.

So, the important next steps are as follows:

1. Preparation of the manuscript and submitting it to the peer reviewed journal.

2. Planning and developing project proposal to further study on wild water buffalo focusing on the income generating training and conservation awareness to the local residents in the study area.

3. Discussion with the reserve authority towards development and implementation of regional wild water buffalo management strategy. That too including proper solutions to reduce the feral cattle in the reserve.

8. Did you use The Rufford Foundation logo in any materials produced in relation to this project? Did the Foundation receive any publicity during the course of your work?

Yes, the logo of The Rufford Foundation was used in all the materials produced during this project. In the educational materials mainly posters and leaflets; presentation to the KTWR authority RF logo was used, and the organisation was acknowledged for its support. The pictures from field were also shared actively in the social media mentioning the organisation. This indeed helped the organisation to gain publicity in study area and in social media too.

9. Provide a full list of all the members of your team and their role in the project.

Below are the details of the people who directly involved in my project:

Pratik Pandeya: M.Sc. in General Forestry from Agriculture and Forestry University. Major role includes field survey for impact invasive species and sampling collection for the diet analysis, data analysis and support with instruments such as binoculars.

Bikal Dahal: M.Sc. in Environmental Science from Pokhara University. Major role includes project coordination with the park staffs, support in procuring permission letter for carrying out the ecological section of the project and designing questionnaires and conservation awareness materials.

The constant support and guidance from the referees were highly crucial for the successful completion of this project. Apart from our core team, the people who helped us throughout this project to make it successful are:

Saurav Lamichhane: MSc. in General Forestry from Agriculture and Forestry University. He helped us in questionnaire preparation, school education, and field surveys and data analysis.

Birendra Gautam: Program officer at National Trust for Nature Conservation (NTNC). He helped with accommodation choices, coordinating with the community and during conduction of the conservation awareness.

Jayaram Neupane: Ranger at Koshi Tappu Wildlife Reserve (KTWR). He helped in mobilising citizen scientist to assist the team for the ecological survey and procurement of conflict data from the department.

Ankit Poudyal: Ranger at KTWR. He helped the team with contact details and the annual reports which included data of human and wild water buffalo conflict.

The analysis of the diet was conducted in the National Trust for Nature Conservation. The support from Dr. Babu Ram Lamichhane, Dr. Rama Mishra, Santosh Bhattarai was crucial for conduction of diet analysis smoothly in the lab. Plant identification expert and prior NTNC staff Bal Bahadur Lama helped with the plant identification from the herbarium of the study area. The guidance from diet expert Dr. Amar Kunwar was very helpful to conduct the analysis with advanced methods and

procedures. The support from lab personnel, Janardan Dev Joshi and vet Dr. Amir Sadaula was crucial.

NTNC staff Dev Kumar Biswas, helped us during questionnaire survey to identify the house of the victims. The support from citizen scientist and NTNC staff Koshi from elephant breeding centre Mr. Pawan Chaudhary and Mr. Baldev Ram during the field survey was really helpful for data collection during the ecological survey. Gamescout Binda Sardar helped the team during ecological survey in the Western side of the reserve. The support from the administration of schools Bishwanath Singh Adharvuth School, Shree Rastriya Madhyamik School, Sunsari Star English boarding School and Koshi Janta Secondary School was highly commendable while conducting community awareness at the respective schools. Local resident Om Prakash Shah coordinated the team for local transport during fieldwork throughout the project period.

Last but not the least our team would like to thank Sudip Homestay and Maleth homestay for supporting our team with lodging and accommodation during the field work.

10. Any other comments?

This project is the first project in the area that researched on the ecological aspects of the critically endangered wild water buffalo and simultaneously generated conservation awareness to the local community. There is immediate need to give continuity to the initiations of this project. The team is very hopeful that The Rufford Foundation will support our future research work that will be aimed towards creating baseline data on ecology of wild water buffalo in Eastern Nepal. This is also crucial for the long-term survival of the species.