



Entry	9 Ecology & Env.
M.Sc. Zoo Dept.
Signature
Date:	2081-12-20

2025-4-2

**Distribution, Habitat Use and Threats of Elongated Tortoise
(*Indotestudo elongata*) in Bahundagi Forest, Jhapa, Nepal**

Binu Rai

T.U. Registration No.: 5-2-2-264-2016

T.U. Examination Roll No.: 7930016

Batch: 2079

**Central Department of Zoology
Institute of Science and Technology
Tribhuvan University
Kirtipur, Kathmandu
Nepal**

**A dissertation submitted
in partial fulfilment of the requirements for the award of the degree
of Master of Science in Zoology with special paper Ecology and Environment**

March 2025



**Distribution, Habitat Use and Threats of Elongated Tortoise
(*Indotestudo elongata*) in Bahundagi Forest, Jhapa, Nepal**

Binu Rai

TU Registration No.: 5-2-2-264-2016

M.Sc. Zoology (Ecology and Environment)

T.U. Examination Roll No.: 7930016

Supervisor

Dr. Laxman Khanal

Associate Professor

Central Department of Zoology

Institute of Science and Technology

Tribhuvan University

Kirtipur, Kathmandu

**Dissertation submitted in partial fulfilment of the requirements for the degree
of Master of Science in Zoology with special paper Ecology and Environment**

March 2025

©Binu Rai

March 2025

E-mail: binu09rai1756@gmail.com

Central Department of Zoology

Institute of Science and Technology

Tribhuvan University

Kirtipur, Kathmandu, Nepal

Website: <https://www.cdz.tu.edu.np/>

Citation: Rai, B. (2025). *Distribution, habitat use and threats of elongated tortoise (Indotestudo elongata) in Bahundagi Forest, Jhapa, Nepal*. Central Department of Zoology, Institute of Science and Technology, Tribhuvan University, Kathmandu, Nepal.

Declaration

I hereby declare that the work presented in this dissertation “**Distribution, habitat use and threats of elongated tortoise (*Indotestudo elongata*) in Bahundagi Forest, Jhapa, Nepal**” has been done by myself and has not been submitted elsewhere for the award of any degree. All sources of information have been specifically acknowledged by reference to the author(s) or institution(s).


Binu Rai

Exam Roll No.: 7930016

Email: binu09rai1756@gmail.com

Date: 28 March 2025



TRIBHUVAN UNIVERSITY
INSTITUTE OF SCIENCE AND TECHNOLOGY
CENTRAL DEPARTMENT OF ZOOLOGY
Kirtipur, Kathmandu, Nepal

Recommendation

This is to recommend that the dissertation entitled “**Distribution, habitat use and threats of elongated tortoise (*Indotestudo elongata*) in Bahundagi Forest, Jhapa, Nepal**” has been carried out by Binu Rai for the partial fulfilment of Master’s Degree of Science in Zoology with a special paper Ecology and Environment. This is her original work and has been carried out under my supervision. To the best of my knowledge, this dissertation work has not been submitted for any other degree in any institution.

Laxman Khanal, PhD

Associate Professor

Central Department of Zoology

Tribhuvan University

Kirtipur, Kathmandu, Nepal

Date: 28 March 2025



TRIBHUVAN UNIVERSITY
INSTITUTE OF SCIENCE AND TECHNOLOGY
CENTRAL DEPARTMENT OF ZOOLOGY
Kirtipur, Kathmandu, Nepal

Letter of approval

On the recommendation of supervisor Dr. Laxman Khanal this dissertation submitted by Binu Rai entitled “**Distribution, habitat use and threats of elongated tortoise (*Indotestudo elongata*) in Bahundagi Forest, Jhapa, Nepal**” is approved for the examination in partial fulfilment of the requirements for Master’s Degree of Science in Zoology with special paper “Ecology and Environment.”

Head of Department
Kumar Sapkota, PhD
Professor
Central Department of Zoology
Tribhuvan University
Kirtipur, Kathmandu, Nepal

Date: 28 March 2025



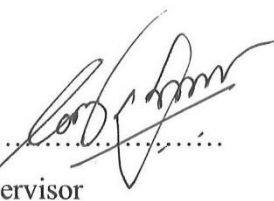
TRIBHUVAN UNIVERSITY
INSTITUTE OF SCIENCE AND TECHNOLOGY
CENTRAL DEPARTMENT OF ZOOLOGY
Kirtipur, Kathmandu, Nepal



Certificate of acceptance

This dissertation work submitted by Binu Rai entitled “**Distribution, habitat use and threats of elongated tortoise (*Indotestudo elongata*) in Bahundagi Forest, Jhapa, Nepal**” has been accepted as a partial fulfilment for the requirements of Master’s Degree of Science in Zoology with a special paper "Ecology and Environment."

Evaluation committee:


.....

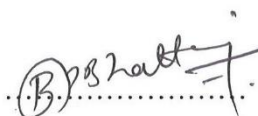
Supervisor
Laxman Khanal, PhD
Associate Professor


.....

External Examiner
Mukesh Kumar Chalise, PhD
Professor


.....

Head of Department
Kumar Sapkota, PhD
Professor


.....

Internal Examiner
Bishnu Prasad Bhattarai, PhD
Assistant Professor

Date of examination: 09 April 2025

Acknowledgements

I am thankful to my supervisor Associate Professor Dr. Laxman Khanal for his enduring guidance and support during this study. My deepest admiration to the Head of the Department Professor Dr. Kumar Sapkota for his genuine support and courage. I am very thankful to my department for assisting me to get the field equipment and gears. This thesis has not originated for itself, the motivation which I get from various stakeholders and Community Forest User Group members who encourage me to this study I must admire their interest and genuine interest to support my research. All those community peoples who showers me a respect and good working environment during the field work melts my heart with pleasure.

I would like to express gratitude to all our guide who assist us during the field survey, individuals who assisted during my field work has long list of names so, I express my sincere gratitude to all those wonderful people who guides me thorough extensive field work for my study.

I thank the Department of Forest and Soil Conservation and District Forest Office, Jhapa, Bahundagi Sub-division for granting research permission. Also, I want to acknowledge my brother, Mr. Bijay Rai, and my husband, Mr. Kiranj Deep Younghang, for their invaluable support and time in assisting me during my fieldwork. I respectfully acknowledge, Mr. Asmit Limbu, senior student, Central Department of Zoology for encouragement me in writing section, and my friend, Mr. Nishan Limbu for providing me valuable ideas for the survey. I also want to acknowledge my friend, Mr. Niten Bharati for his valuable time to support me in technical work and data management for this thesis. Most importantly, I am here because of my family, to whom I owe my infinite love and respect for shaping me into who I am today.

I am grateful to everyone, both known and unknown, for their direct and indirect support during my thesis. A special thanks to those who provided additional information about the Elongated Tortoise. I truly appreciate your kindness.

Abstract

Turtles of Nepal are grouped into three families: Geomydidae, Testudinidae, and Trionychidae. Among them, the elongated tortoise (*Indotestudo elongata*) under the Testudinidae family is a medium sized terrestrial tortoise native to South and Southeast Asia, including Nepal. It is listed as Critically Endangered in the IUCN Red List of Threatened Species and is included in CITES Appendix II. The specific distribution patterns and ranges of the elongated tortoise in Nepal are poorly known. Bahundagi Forest at eastern part of Jhapa District, bordering India to the east, is one of the optimal habitats for elongated tortoise, however, detailed ecological records that are vital for adequate conservation and management strategies are still lacking. This study aimed to understand the factors influencing the distribution and habitat uses of elongated tortoise in Bahundagi Forest and their conservation threats and understand the people's knowledge on the elongated tortoise of Bahundagi Forest. The Bahundagi Forest was split into 500 m × 500 m grids, and 50 % forest coverage was statistically chosen using QGIS 3.38.0. A total of 60 grids were surveyed to collect data on the presence and absence of the species, using both direct and indirect evidence. Ecological variables, along with direct and indirect evidence, were recorded every 100 m within each grid. Spearman's rank correlation was applied to detect multicollinearity among continuous variables, with those showing high correlation ($\rho > |0.7|$) were excluded. The Generalized Linear Model (GLM) was employed from the MuMIn package in R Studio (version 4.2.3) to identify the most significant factors influencing tortoise presence. The findings revealed a significant positive relationship between tortoise occurrence and three key factors: canopy cover (CI = 4.73398–0.13866, $p < 0.03$), food availability (CI = 3.89–4.03, $p < 0.04$), and proximity to rivers (CI = 1.656559–0.00082, $p < 0.001$). From the questionnaire survey, hunting for meat and medicine, habitat destruction, and wildfire were the major threats in decline of elongated tortoises in Bahundagi Forest. To safeguard this species, conservation initiatives such as reforestation programs, forest fire prevention strategies, and wildlife protection measures should be implemented.

शोध सारांश

नेपालमा पाइने कछुवारु ३ वटा families मा grouped गरिएको छन: Geomydidae, Testudinidae, र Trionychidae। ती मध्येमा Testudinidae family मा पर्ने सानो आकारका जमिनमा बस्ने पहेलो खबटे कछुवा (*Indotestudo elongata*) नेपाल लगायत दक्षिण एसिया र दक्षिणपूर्वी एसियामा पाइन्छन्। यो प्रजातिलाई IUCN Red List of Threatened Species मा Critically Endangered रुपमा सूचिबद्ध गरिनुका साथ CITES Appendix II मा पनि समावेश गरिएको छ। नेपालमा यस कछुवाको निश्चित वितरण ढाँचा र क्षेत्रहरूको बारेमा पूर्ण ज्ञान छैन। भारतको सिमानासँग जोडिएको पूर्वि भाषाको बाहुनडाँगी वनक्षेत्र यो कछुवाको उपयुक्त बासस्थान मानिन्छ, यद्यपि, यसको संरक्षण तथा व्यवस्थापन गर्न पर्याप्त तथ्यांकहरू भने उपलब्ध नन्। यस अध्ययनको उद्देश्य बाहुनडाँगी वनमा पहेलो खबटे कछुवाको वितरण, बासस्थानको प्रयोग र तिनीहरूको संरक्षणमा पर्ने खतराहरूलाई प्रभाव पार्ने कारकहरू बुझ्नु र बाहुनडाँगी क्षेत्रका बासिन्दहरूको यो कछुवा बारेमा ज्ञान बुझ्नु थियो। कछुवाको उपस्थिति तथा अनुपस्थिति जाँच गर्नका लागि ६० वटा grids बाट तथ्याङ्कहरू सर्वेक्षण गरी प्रत्यक्ष तथा अप्रत्यक्ष प्रमाणहरू जुटाइएको थियो। QGIS 3.38.0 प्रयोग गरी ५०० × ५०० वर्ग मिटरको ग्रिडहरूद्वारा बाहुनडाँगी वनको ५०% क्षेत्रलाई तथ्याङ्कीय रुपमा विभाजन गरिएको थियो। प्रत्येक grid भित्र प्रत्येक १०० मिटरमा प्रत्यक्ष र अप्रत्यक्ष प्रमाणहरू सहित Ecological variables रेकर्ड गरियो। ती variables बीच multicollinearity पत्ता लगाउन Spearman's rank correlation लागू गरिएको थियो जसमध्ये, high correlation देखाउनेहरूलाई समावेश गरिएन। कछुवाको उपस्थितिलाई प्रभाव पार्ने सबैभन्दा महत्त्वपूर्ण variables पहिचान गर्न R Studio (version 4.2.3) मा MuMIn प्याकेजबाट Generalized Linear Model (GLM) प्रयोग गरिएको थियो। सर्वेक्षण गरिएका जम्मा ६० grids मध्ये १३ वटा grids मा पहेलो खबटे कछुवाहरूको उपस्थिति रेकर्ड भएको थियो। नतिजाहरूले कछुवाको उपस्थिति र तीन प्रमुख variables बीचको महत्त्वपूर्ण सकारात्मक सम्बन्ध प्रकट गर्‍यो। Canopy cover (CI = 4.73398–0.13866, $p < 0.03$), food availability (CI = 3.89–4.03, $p < 0.04$) र proximity to rivers (CI = 1.656559– 0.00082, $p < 0.001$) कारकहरू हुन्। Questionnaire survey अनुसार बाहुनडाँगी वनमा मासु र औषधिको लागि हुने शिकार, बासस्थानको विनाश, र डढेलो जस्ता खतराहरूले गर्दा यस कछुवाको संख्या घट्दो क्रममा रहेको पाइयो। यस प्रजातिको संरक्षण गर्न पुनःवृक्षरोपन कार्यक्रम, वन डढेलो रोकथाम रणनीति र वन्यजन्तु संरक्षण पहलहरू कार्यान्वयन गरिनुपर्छ।

Contents

Declaration	Error! Bookmark not defined.
Recommendation	Error! Bookmark not defined.
Letter of approval.....	Error! Bookmark not defined.
Certificate of acceptance.....	Error! Bookmark not defined.
Acknowledgements.....	v
Abstract.....	vi
Contents	viii
List of tables.....	xi
List of figures.....	xii
List of photographs	xiii
List of abbreviations	xiv
1. Introduction.....	1
1.1 Background.....	1
1.2 Statement of the problem.....	2
1.3 Research objectives.....	3
1.3.1 General objective	3
1.3.2 Specific objectives	3
1.3.3 Research questions.....	4
1.3.4 Significance of the study.....	4
2. Literature review.....	5
2.1 Distribution and habitat use of elongated tortoise	5
2.2 Conservation threats of elongated tortoise.....	9

2.3 Research gap	12
3. Materials and methods	14
3.1 Study area.....	14
3.2 Field survey.....	15
3.3 Covariates recorded during field survey	16
3.4 Questionnaire survey	17
3.5 Data analysis	18
4. Results.....	19
4.1. Distribution and habitat use of elongated tortoise in Bahundagi Forest	19
4.1.1 Distribution of elongated tortoise in Bahundagi Forest.....	19
4.2. Conservation threats and local people’s perception towards elongated tortoise	23
4.2.1 People’s knowledge and perception on elongated tortoise	24
4.2.2. Factors affecting people’s support for tortoise conservation.....	27
5. Discussion.....	28
5.1. Factor affecting the distribution and habitat use of elongated tortoise	28
5.2. Threats and people’s knowledge towards elongated tortoise	30
6. Conclusion and recommendations	34
6.1. Conclusion	34
6.2. Recommendations.....	34
7. References.....	35
Appendices.....	41
Appendix 1. Questionnaire survey form for elongated tortoise and their conservation threats. ..	41
Appendix 2. Demographic composition of surveyed people.....	45
Appendix 3. Spearman’s rank correlation	46
Appendix 4. GLM analysis.....	47

Appendix 5. Local people's perception and knowledge on elongated tortoise	48
Appendix 6. Relation between demographic profile and conservation perception of tortoise in Bahundagi Forest.	49
Appendix 7. Photographs of elongated tortoise recorded during the field survey.	50
Appendix 8. Research Approval Letter	57

List of tables

Table No	Title of tables	Pages
Table 1.	Model averaging ($\Delta AICc < 2$) was used to calculate confidence intervals (conf.low and conf.high) and identify the factors influencing the habitat use of the elongated tortoise.	21
Table 2.	Generalized linear models with $\Delta AICc$ values < 2 describe the presence of the elongated tortoise. These models are arranged in descending order of Akaike information criteria (AICc).	47

List of figures

Figure No.	Title of figures	Pages
Figure 1.	Map showing the survey grids in Bahundagi Forest.	15
Figure 2.	Survey design of a grid with six points aligned along a transect passing through the centroid.	17
Figure 3.	Map showing the surveyed grids and the observation points of the elongated tortoise within Bahundagi Forest.	20
Figure 4.	Canopy cover and prediction probability of elongated tortoise in Bahundagi Forest. .	21
Figure 5.	Food presence and mean predicted probability \pm standard error (SE) of elongated tortoise in Bahundagi Forest.	22
Figure 6.	Distance to river and prediction probability of elongated tortoise in Bahundagi Forest.	23
Figure 7.	Conservation threats of elongated tortoise in Bahundagi Forest.	24
Figure 8.	Local people's perception on elongated tortoise importance	25
Figure 9.	Likert chart showing the local people's perception and knowledge on elongated tortoise	26

List of photographs

Photograph	Title of photograph	Pages
Photo 1.	Elongated tortoise found in Sal Forest in Bahuban Community Forest during field study.	50
Photo 2.	Scale of rat snake (<i>Ptyas mucosa</i>) found under bushes in Bahuban Community Forest during field work.....	50
Photo 3.	A termite mound found in Bahuban Community Forest during field work.	50
Photo 4.	A piece of carapace found in Meeche Community from Telpani Community Forest during questionnaire survey.	50
Photo 5.	Carapace of elongated tortoise was found in Magar Community during questionnaire survey from Bahuban Community Forest.....	51
Photo 6.	Three carapaces (male, female and small female carapace) of elongated tortoise found during questionnaire survey.....	51
Photo 7.	Measuring carapace length of male elongated tortoise during questionnaire survey. ...	51
Photo 8.	Recording the carapace data during questionnaire survey.....	51
Photo 9.	Goats grazing in the Bahuban Community Forest during field work.....	52
Photo 10.	Cutting down of tree in Telpani Community Forest during field work.....	52
Photo 11.	Invasive species (IS) <i>Lantana camara</i> in Bahuban Community Forest during field work.	52
Photo 12.	Freshly chopped tree in Telpani Community Forest during survey.	53
Photo 13.	Field guide showing Kalunge cheu (<i>Termitomyces eurrhizus</i>) found in Bahuban Community Forest during field work.	53
Photo 14.	Habitat preference “Chapgairree” of the elongated tortoise in Telpani Community Forest.	53
Photo 15.	Burnt tree due to forest fire in Telpani Community Forest.	54
Photo 16.	Soil disturbance along forest edge near river in Telpani Bahundagi Community Forest	54
Photo 17.	During questionnaire survey, an elongated tortoise was kept in a well while rearing.	55
Photo 18.	Questionnaire survey with local people around the periphery of Bahundagi Forest..	55
Photo 19.	Kalikhola Simsar in Bahuban Community Forest.	56

List of abbreviations

Abbreviated form	Details of abbreviations
AIC	Akaike Information Criterion
CFUGs	Community Forest User Groups
CITES	Convention on International Trade in Endangered Species of wild flora and fauna
IS	Invasive species
GLM	Generalized Linear Model
IUCN	International Union for Conservation of Nature
SD	Distance nearest to human settlement
R ₁ D	Distance nearest to river
CC	Canopy cover
R ₀ D	Distance nearest to road
HDI	Human disturbance index
FP	Food presence point
HP	Human presence
VD	Vegetative disturbance
FF	Forest Fire

1. Introduction

1.1 Background

The elongated tortoise was originally described as *Testudo elongata* by Blyth in 1854. This species is also known as the yellow-headed tortoise (Ihlow et al., 2016). The genus *Indotestudo* consists of three distinct species: *Indotestudo elongata*, *Indotestudo travancorica*, and *Indotestudo forstenii* (Rhodin et al., 2017). In Nepal, there are grouped three families, 11 genera, and 18 species of Testudines. These include 13 species from the Geoclemmydidae family, one species from the Testudinidae family, and four species from the Triocychidae family (Shrestha et al., 2021). The medium-sized tortoise *Indotestudo elongata* (Family Testudinidae) has a straight carapace that can reach a length of 360 mm. The carapace and plastron of *Indotestudo elongata* are yellowish-brown or olive in color, with distinct black blotches in the center of each scute. Males and females of the species have different face colors during the breeding season, which is one of the physical distinctions between the sexes in this sexually dimorphic species (Buhlmann et al., 2009; Dubois & Bour, 2010). Females mature at seven years with a SCL of 178–203 mm, while males mature at six years with a straight carapace length (SCL) of 175 mm by McCormick in 1992. They are morphologically distinguished from their congeners by the presence of a well-developed, narrow nuchal scute. Mature individuals have noticeable reddish tints around their eyes and nose during the breeding season. With longer tails and thicker, more curled tubercles at the terminal end, males tend to be larger than females.

In Southeast Asia, *Indotestudo elongata* can be found in low- to mid-elevation environments such as grasslands, secondary forests, open deciduous dipterocarp forests, and hilly evergreen forests (Ihlow et al., 2016). Covering Bangladesh, Bhutan, Cambodia, India, Lao People's Democratic Republic, Malaysia, Myanmar, Nepal, Thailand, Vietnam, and China, it is extensively distributed throughout South and Southeast Asia (Drukpa et al., 2020; Ihlow et al., 2016; Rai, 2021).

Its home range is of 0.038 km² to 0.415 km² (average 0.168 km²) and it requires a variety of habitats and plenty of space for its natural behavior (Ihlow et al., 2016). They are omnivorous generalist species has a diet which is influenced by habitat and seasonal variations, typically consuming a broad range of food items, including fruits, mushrooms, grasses, vegetables,

earthworms, slugs, thin-shelled terrestrial snails, insects, crabs, eggshells, carrion, detritus, and the excreta of other animals (Ihlow et al., 2016; Rai, 2020).

In Nepal, tortoise primarily distributed in the Tarai region and rarely in the midlands (Subba & Khanal, 2023). They exhibit their peak activity during the rainy season, with a decline in movement during the dry season. To avoid extreme temperatures, their activity is primarily concentrated in the early morning and late evening hours (Drukpa et al., 2020). In the lowland Tarai and mid-hills of Nepal, primarily below 1000 m, elongated tortoise inhabits Sal (*Shorea robusta*) forests (Schleich & Kästle, 2004). It has been discovered between Shuklaphanta National Park in the west and Jhapa District in the east (Subba & Khanal, 2023). This species has declined by 80% over the last 90 years and is listed as Critically Endangered on the IUCN Red List under criterion A2cd (Drukpa et al., 2020).

Hunting, pet trade, forest fires, habitat degradation, and collecting for food and medicine are among the major threats for the elongated tortoise (Ihlow et al., 2016; Rahman et al., 2019; Schleich & Kästle, 2004). However, we have very little information on factors affecting the elongated tortoise and localized threats affecting their distribution so further investigation is required to preserve the elongated tortoise for extinction.

1.2 Statement of the problem

Herpetofauna in Nepal have received little conservation priority, and their survival largely depends on protected areas (PAs) established for other purposes (Schleich & Kästle, 2004). Without proper conservation measures, among vertebrates, herpetofauna are at the greatest risk of reduction and face rapid loss. The elongated tortoise is the only species of the Testudinidae family found in Nepal (Rhodin et al., 2017). It is listed as Critically Endangered species in IUCN Red List of Threatened Species. Despite its rapid population decline, it receives little conservation attention (Ihlow et al., 2016). There is a lack of information on tortoise records, habitat use, and environmental conditions influencing their occurrence (Schleich & Kästle, 2004). Recent studies have begun to shed light on the conservation status and ecological behaviors of elongated tortoise in eastern Nepal, providing critical insights into local threats and habitat dynamics. According to (Subba & Khanal, 2023) reported a low population density of just 0.35 individuals per square kilometre in Jalthal Forest of Jhapa District through field surveys and community-based assessments. Their study

identified hunting and habitat degradation caused by invasive plant species, particularly *Mikania micrantha*, as the most pressing threats to the species. Furthermore, it revealed that members of the Meche and Sathar indigenous communities engage in tortoise hunting, primarily for consumption and ethnomedicinal purposes, emphasizing the need for culturally sensitive conservation strategies in the region. Complementing these findings, (Rai, 2020) recorded an unusual instance of an elongated tortoise attempting to prey on a buff-striped keelback snake (*Amphiesma stolatum*) at the Turtle Rescue and Conservation Centre in Jhapa. This behavior unexpected for a species typically regarded as herbivorous or omnivorous suggests a broader dietary flexibility than previously understood. Such localized observations are crucial, as they challenge existing ecological assumptions and underscore the need for region-specific studies. These findings collectively highlight both the ecological vulnerability and behavioral complexity of elongated tortoise, reinforcing the urgency of focused research and conservation in eastern Nepal. Bahundagi Forest, located in easternmost Nepal, is considered a suitable habitat for the elongated tortoise and other threatened species. This forest remains scientifically unexplored, with very few studies on its faunal diversity. Biodiversity in Bahundagi Forest is under threat due to invasive alien plants, timber-focused management, and high demand for biomass extraction by Community Forests, leading to habitat loss. There is limited information on status and ecological dynamics of the elongated tortoise in this region. Therefore, a scientific study is essential to understand the habitat range, resource use, and biodiversity threats of the elongated tortoise in Bahundagi Forest and to support its conservation.

1.3 Research objectives

1.3.1 General objective

The general objective of this study was to understand the distribution of elongated tortoise and the conservation threats in Bahundagi Forest of Jhapa District.

1.3.2 Specific objectives

- i. To determine the environmental variables that impact the distribution of elongated tortoise in the Bahundagi Forest.
- ii. To identify the conservation threats and local people's knowledge about elongated tortoise in the study area.

1.3.3 Research questions

- i. How do ecological factors, including habitat characteristics, human disturbances, and vegetation cover, influence the occurrence and distribution of the elongated tortoise (*Indotestudo elongata*) in the Bahundagi Forest?
- ii. What are the main threats and local perception towards the status of the elongated tortoise in the study area?

1.3.4 Significance of the study

Over the past 90 years, the elongated tortoise population has declined by 80%, resulting in its classification as Critically Endangered on the IUCN Red List and its listing in CITES Appendix II. The species faces significant threats, including habitat loss, hunting, the pet trade, forest fires, and illegal trafficking. Despite its wide distribution, very few studies have been conducted on its ecology. Elongated tortoises have been recorded in the Sal-dominated forests of Nepal's lowland Terai, at elevations under 1000 m. While much of the research in Nepal has concentrated on the presence, absence, or diversity of turtles, there is a lack of studies focused on the status and ecology of specific species, creating a gap in understanding the factors that influence their distribution. Additionally, threats such as climate change, invasive species, and habitat alteration may lead this isolated, restricted-ranging species to extinction.

Bahundagi Forest is suitable habitat for the elongated tortoise, but very little is known about its population. This study ensures further surveys to determine if a stable population exists in the area and help to fill this gap. The results support better protection and conservation efforts for the species.

2. Literature review

The elongated tortoise (*Indotestudo elongata*) is commonly known as yellow-headed tortoise distributed across Southeast Asia, including Nepal. It is classified as a Critically Endangered species by the (Rhodin et al., 2017). Habitat loss, fires, overexploitation, climate change, and human activities are threatening elongated tortoise, especially small, isolated populations (Drukpa et al., 2020; Ihlow et al., 2016; Subba & Khanal, 2023).

2.1 Distribution and habitat use of elongated tortoise

The elongated tortoise is found in South and Southeast Asia. Its range extends to Kaleshar Wildlife Sanctuary in the west Its range extends west to Kaleshar Wildlife Sanctuary (Rahman et al., 2019), and covers Vietnam, Cambodia, Bangladesh, Myanmar, northern and eastern India, Nepal, Bhutan, Thailand, Laos, and Malaysia (Ihlow et al., 2016). There is no exact numerical data, but earlier reports say the species was once common in many those areas (Ihlow et al., 2016). It also extends north to Guangxi Province in China and south to Peninsular Malaysia. A separate population exists on the Chota Nagpur Plateau in eastern India. This population was likely present before the formation of the Indo-Gangetic Plain and later became isolated due to changes in the environment and landscape (Ihlow et al., 2016). It lives in low to mid-elevation areas, mainly in hills, secondary forests, hills, high plateaus, and deciduous forests and lastly human-dominated landscapes with minimal tree cover remaining, located adjacent to farmland (Ihlow et al., 2016; Phuntsho et al., 2022; Schleich & Kästle, 2004; Subba & Khanal, 2023).

Studies indicated that the elongated tortoise is distributed across elevations ranging from 50 m to 1,910 m above sea level. The highest recorded elevation for this species has been recorded in Bhutan at 1,910 m asl (Drukpa et al., 2020). Followingly, in Cambodia at 50–60 m (Hartmann et al., 2013), in Vietnam at 100–300 m (Ihlow et al., 2016), in Thailand at 225–560 m asl (Van Dijk, 1998), in Myanmar at 795 m asl. In Nepal, it occurs below 1,000 m asl (Kästle et al., 2013). According to the previous data, most of the threatened turtle species were reported to be extremely abundant in Myeik area in Tanintharyi Region in Myanmar (Khaing & War, 2018). In the north eastern part of India, it inhabits bamboo-mixed deciduous forests in both lowland and hilly areas (Khan et al., 2020). In the northwestern part of India and Nepal, the elongated tortoise is found in

forests dominated by Sal trees. In Nepal, it is found in the midlands and Sal forests of the lowland Terai (Kästle et al., 2013; Schleich & Kästle, 2004).

Females are generally larger than males and possess longer, thicker tails with a more pronounced, curved horny tubercle at the tip. The plastron in males is concave, whereas in females, it remains flat (Ihlow et al., 2016). Additionally, the anal notch in males is narrower and V-shaped, while in females, it is broader. Females exhibit a more rounded body shape and have longer, more curved posterior claws. The age and size at maturity were estimated by counting the growth rings on the shell scutes (Sriprateep et al., 2013). Males have a concave plastron and a much longer tail than females. Tortoises that could not be sexed were considered juveniles. The size of a species' distribution range can impact its likelihood of extinction. Smaller-ranging species tend to have lower genetic diversity and less ability to adapt compared to those with broader ranges (Subba & Khanal, 2023).

A dense canopy provides shelter from direct sunlight, reducing exposure to high temperatures and offering humidity regulation (Subba et al., 2024). It also protects the tortoise from predators and harsh weather conditions, making it crucial for survival in tropical and subtropical forests (Ihlow et al., 2016). Without adequate canopy cover, the habitat becomes less suitable for the tortoise. The elongated tortoise helps spread fruit seeds by eating the fruits and later excreting the seeds in different locations (Ihlow et al., 2016). In areas with insufficient shade, the tortoise could experience temperature stress or face increased exposure to predators. Former burrows create a stable and humid microenvironment, shielding tortoises from intense heat and dehydration. In habitats with limited ground cover, these burrows serve as essential refuges when vegetation is scarce. Compared to dense vegetation, burrows offer greater protection from potential predators. Additionally, relying on burrows reduces the need to search for shaded areas, helping tortoises conserve energy (Ihlow et al., 2016). Elongated tortoises look for shelter during periods of rest. In Thailand, they were found resting in vegetation, near fallen tree trunks, in boulder caves, inside porcupine burrows, and within hollow *Lagerstroemia* tree trunks. However, they preferred dense grasses and fallen tree trunks as resting spots. In Laos, within evergreen forests, these tortoises were seen resting under streambeds or piles of leaves in ravines during the dry season. Even though there is no surface water at that time, these places stay cool and moist (Ihlow et al., 2016). The

presence of vegetation near streambeds offers both food resources and shelter, reducing the risk of desiccation and heat stress (Ihlow et al., 2016).

However, the invasive species shows negative effect in which a thick growth of *Mikania micrantha* could reduce the foraging and basking of elongated tortoise; the *M. micrantha* invasive plant commonly known as the mile-a-minute vine or bitter vine; the ground is mostly covered (average $74 \pm \text{SD } 12\%$) by the invasive plant *Mikania micrantha* (Subba & Khanal, 2023).

The tortoise is primarily an herbivore, relying on a variety of plant species for nourishment, with its diet varying based on habitat and season (Rai, 2020). It is also a frugivore, typically consuming different types of fruits (Ihlow et al., 2016). The tortoise depends on other food sources such as mushrooms, vegetables, grasses, earthworms, snails, insects, crabs, eggshells, detritus, and animal droppings (Ihlow et al., 2012; Kästle et al., 2013; Schleich & Kästle, 2004). The tortoise consumes rice, white ants (*Isoptera*), Colocasia plants, and mushrooms such as Kalunge (*Termitomyces eurhizus*), Salle chyau (*Russula cyanoxantha*), Kanye chyau (*Pleurotus* spp.), (Ihlow et al., 2016; Schleich & Kästle, 2002). These wild edible mushrooms (WEMs) support rural livelihoods and provide essential nutrients, including proteins, vitamins, minerals, and immune-boosting properties (Rai, 2022). They are low in calories, fat, and sugar, with no starch or cholesterol (Prasad & Pokhrel, 2017). Researchers have found dirt and sand in its feces, indicating that these materials are intentionally ingested to obtain necessary nutrients (Van Dijk, 1998). While termites dominate tropical and subtropical regions, *Termitomyces* species, including *T. eurhizus* are also found in Japan. *Termitomyces* fungi, belonging to the *Lyophyllaceae* family, form a mutualistic relationship with termites by decomposing plant material, aiding termite digestion, and serving as a protein source. Their evident of symbiosis with termites likely originated in Africa (Ono et al., 2016). These mushrooms, which grow abundantly in termite nests, have been identified as wild edible mushrooms with high nutritive value (Zhang et al., 2015) and are commercially valuable as well as nutritious for the nourishment of the elongated tortoise. However, According to (Ihlow et al., 2012), the elongated tortoise eats fruiting bodies of two unidentified mushroom species, likely from the *Lepiotaceae* and *Pluteaceae* families in monsoon season. While the mycelium of *T. eurhizus* is perennial, remaining within the termite nest year-round, the fruiting bodies (mushrooms) are annual, emerging once a year, usually after the first heavy rains (Ono et al., 2016). A juvenile in Myanmar was discovered sheltering near a termite mound during midday

(Ihlow et al., 2016). Areas with abundant, diverse vegetation will support larger, healthier populations of the tortoise. If the food supply in a habitat is limited, the tortoise may not be able to sustain itself, leading to poor health, reduced reproduction rates, and eventual population decline (Ihlow et al., 2016). Changes in vegetation caused by human activity, climate change, or invasive plants can limit food availability (Khan et al., 2020).

Climate change indicates potential shifts in the species' distribution, possibly in response to environmental changes or habitat pressures (Khan et al., 2023). Extremely high temperatures can be harmful and may limit their ability to reproduce (Subba et al., 2024). The habitat of the elongated tortoise is being destroyed, likely due to climate change. As a result, the species may have moved to cooler region at higher elevations or because it needs a larger home range (Drukpa et al., 2020). The species is more likely to be found in areas where isothermality (temperature stability) is high, particularly within a 40–50% range, indicating a preference for environments where temperatures fluctuate between 15–30°C (Khan et al., 2020). Since temperature directly affects the tortoise's thermal physiology, it plays a crucial role in determining its distribution. Extremely high temperatures can exceed the limits necessary for survival and reproduction, restricting the species' range (Brattstrom, 1965).

The elongated tortoise possesses a nomadic movement pattern. Their average home range is 0.168 km² (Ihlow et al., 2012). This means they need a large and diverse habitat to meet their ecological and behavioural needs. Home range size and location help explain animal movement decisions, which are influenced by resources, topography, and habitat, shaping their spatial niche (Montano et al., 2022). In addition, several studies (Ihlow et al., 2016; Spencer, 1987; Van Dijk, 1998) reported that the tortoises develop a vivid pink coloration around their nose and eyes, which helps with scent detection and recognition. Breeding occurs throughout the rainy season, which runs from May to August. Because the females' ability to lay eggs is influenced by temperature, they prefer to sunbathe in cooler temperatures. So, rainfall plays a key role in their reproduction, affecting egg development and hatchling survival (Ihlow et al., 2016). Eggs are laid by *Indotestudo elongata* in nests shaped like flasks, typically during the early morning or at night (McCormick, 1992). Females produce clutches with an average size of 4.5 ± 2.3 eggs, laying them at the end of the rainy season from October to March (Ihlow et al., 2016; Sriprateep et al., 2013; Van Dijk, 1998). Males reach sexual maturity at six years of age with a straight carapace length (SCL) of 175 mm, while females mature at eight years with an SCL of 240 mm (Sriprateep et al., 2013).

Human disturbance, canopy cover, and food availability determines whether a habitat is suitable for the *Indotestudo elongata*. These variables not only affect the species' immediate survival but also influence its ability to reproduce, find shelter, and remain healthy (Ihlow et al., 2016). As these factors change over time due to human activities or environmental shifts, the tortoise's distribution can shift as well, leading to population declines or local extinctions (Subba & Khanal, 2023).

2.2 Conservation threats of elongated tortoise

The primary threats to tortoise conservation across its range include habitat destruction, excessive hunting for human consumption, and commercial trade (Rhodin et al., 2017). According to (Ihlow et al., 2016), the elongated tortoise has been a food source for humans for centuries, with evidence of its consumption found in ancient human settlements. Poaching pressure has intensified because of higher demand for food and traditional medicine (Ginal et al., 2023; Rhodin et al., 2017) due to such reason these species' population had seen dropped sharply in the last 15 years ago in Thailand in 1970, and it has not yet recovered in Thailand after that (Ihlow et al., 2016; Sriprateep et al., 2013). A similar decline has been observed in Myanmar, where tortoises are hunted for food (Ihlow et al., 2016). This was also practiced in the studies (Duc & Broad, 1995; Mudar & Anderson, 2007), which highlighted that humans have been using tortoises as a food source since the Pleistocene era, and was the most commonly traded chelonian species in Vietnam's wildlife market, with over 500 kg sold daily in Ho Chi Minh City about two decades ago. Whereas China has been the main consumer of turtles and tortoises for food and medicine (Ihlow et al., 2016; Sriprateep et al., 2013). Tortoises are often captured opportunistically during farming and forest resource collection, while deliberate hunting, including the use of dogs, remains widespread (Drukpa et al., 2020; Ihlow et al., 2016). Similarly, the annual average number of *Indotestudo elongata* individuals hunted between 2017 and 2021 is 6.8 individuals per year for food and medicinal purpose (Subba & Khanal, 2023). The tortoise was heavily impacted by illegal ritualistic hunts in West Bengal, India. These hunts, linked to cultural festivals, result in the killing of thousands of wild animals annually. However, the tortoise was hunted mainly for its meat and shell, believed to have medicinal properties by ethnic community (D'Cruze et al., 2024; Drukpa et al., 2020; Khaing & War, 2018; Sriprateep et al., 2013). Isolated, small-ranging species can be

driven to extinction by climate change, introduced species, pathogens, disasters, and habitat changes (Subba & Khanal, 2023).

Due to human settlements and disturbances, the species was relocated to a more suitable habitat (Drukpa et al., 2020) (Khaing & War, 2018). Fodder and firewood collection and grazing lead to loss of feeding habitat of elongated tortoise (Rhodin et al., 2017). A dense growth of invasive species; *Mikania micrantha* hinders the foraging and basking of elongated tortoise (Subba & Khanal, 2023). Comparably, Southeast Asia had experienced significant deforestation, particularly in lowland dipterocarp forests, which have been cleared predominantly for agricultural purposes, including rice paddies, cassava fields, and banana plantations (Ihlow et al., 2016). As a result, the species is now largely absent from densely populated and intensively cultivated regions, such as the Indo-Gangetic Plain in India, the Chao Phraya Basin in central Thailand, and the Khorat Plateau in northeastern Thailand.

Natural fires occur from February to May due to wind (Ensafi et al., 2015). Fire makes it easier for hunters and natural predators to find and catch surviving tortoises (Ihlow et al., 2016). Similarly, Open dipterocarp forests are naturally adapted to fire, and *Indotestudo elongata* populations can likely withstand occasional fires (Ihlow et al., 2016). Observations have recorded tortoises with fire scars covering up to two-thirds of their carapace (Khan et al., 2020). Some researchers have reported that fires have become more frequent and intense in recent decades (Khan et al., 2020; Sodhi et al., 2004), possibly reaching a level that tortoise populations cannot tolerate (Khan et al., 2020). In northeast India, the widespread practice of Jhum cultivation (shifting agriculture), which involves burning vegetation, had already destroyed over 44,000 km² of forest (Khan et al., 2020) from February to May. In the lowland forests of Thailand and Cambodia, elongated tortoises frequently perish in these fires (Ihlow et al., 2016). Moreover, fires expose surviving tortoises, making them more vulnerable to hunters (Ihlow et al., 2016; Khaing & War, 2018).

Increment of trade can cause exploitation of tortoise number and its habitat type and export in the global wildlife trade (Ginal et al., 2023; Khan et al., 2020; Rhodin et al., 2017). The shells of elongated tortoises were sold in markets in West Bengal, India (D'Cruze et al., 2024) and in Tanintharyi Township in Myeik area by local fishers (Khaing & War, 2018) to Rs. 700 for 500 gm

(Khaing & War, 2018). The turtle parts along with carapace were exported by dealers in China market, and in India illegally (Khaing & War, 2018). The elongated tortoise is traded internationally as a pet, though its impact is minimal compared to its trade for food and traditional medicine (Drukpa et al., 2020; Ihlow et al., 2016). Although official records are lacking, the species has been documented in the pet trade in the Philippines and Taiwan (Ihlow et al., 2016). Currently, most of the demand for pets in the United States and Europe is met through captive breeding, though occasional imports of wild-caught tortoises still occur (Ihlow et al., 2016). From 1975 to 1985, approximately 3,800 tortoises were exported from Thailand to the United States and Europe, and between 1985 and 1998 (Ihlow et al., 2016). Over 500 kg of elongated tortoises were sold daily in Vietnam and Cambodia. The carapace and tortoise are mainly traded for decorative purpose and their religious beliefs (Ihlow et al., 2016). People hunt the tortoises with dogs, and traded as pet in temple and home (Subba & Khanal, 2023). However, Tortoise species were protected as pets with the help of local monks in some monasteries in the Myeik area (Khaing & War, 2018).

A study in Ban Kok Village, Northeastern Thailand, recorded high hatchling mortality may result from factors such as maternal and environmental influences, nest site selection, and energy investment in egg production. The tortoises were killed by off-road vehicles, and trampled by cattle. About 81% hatching success rate in undisturbed nests, dropping to 60.3% in disturbed nests (Sriprateep et al., 2013). Additionally, low incubation temperatures can weaken hatchlings, and dehydration further contributes to mortality. The concentration of hazardous chemicals is raised when excessive amounts of agrochemicals are applied to agricultural land and infiltrate aquatic environments (Aryal et al., 2010) destroy food sources and plants, which results in the mortality of terrestrial tortoises and young turtles being particularly vulnerable (Khan et al., 2020).

Due to this, almost 80% of the elongated tortoise population has decreased over the past 90 years, and during the 2018 species red list assessment, it was determined that the species is Critically Endangered under IUCN Red List of Threatened Species under criterion A2cd (Rhodin et al., 2017). Over the past 20 years, the population of elongated tortoise in India and Bangladesh has by about 50- 70% (Ward et al., 2021). Similarly, in Thailand, the population is still abundant in protected areas, but outside these areas, they are collected for food and habitat destruction (Ward et al., 2018). Similarly, in northeast Thailand, the population is reduced due to its habitat

destruction (Rahman et al., 2019). However, Although quantitative historical data on elongated tortoises is scarce, early records indicate that they were once abundant throughout their range (Ihlow et al., 2016). But, according to Wangyal (2012), there is no record of turtle trade or consumption within Bhutan (Ihlow et al., 2016).

In Nepal's Tarai region, exploitation and trade of land turtles were observed in local communities, markets, and through interactions with locals. Turtles were harvested from all natural areas surveyed outside protected areas (PAs) (Aryal et al., 2010). Turtles were harvested indiscriminately, regardless of age, sex, or size, mainly for food and medicinal purposes. Their eggs were also collected for consumption, but their current population status and distribution remain poorly understood (Shrestha, 2001). It was also reported that some authors mentioned decorative masks made from the carapaces of elongated tortoise were sold to tourists in curio shops in Kathmandu, Nepal (Ihlow et al., 2016). However, environmental degradation and consumption of the elongated tortoise have been reducing its population across its distribution range (Rhodin et al., 2017). This study offers insights that aid in the conservation of the Critically Endangered species, elongated tortoise in Bahundagi Forest.

2.3 Research gap

Although several studies have explored the distribution, habitat preferences, and ecological behavior of elongated tortoise across South and Southeast Asia (Drukpa et al., 2020; Hartmann et al., 2013; Ihlow et al., 2016; Van Dijk, 1998), there remains a critical lack of site-specific ecological and threat assessments, particularly in eastern Nepal. Despite confirmed records of the species in Nepal's Sal-dominated forests (Kästle et al., 2013; Schleich & Kästle, 2004), fine-scale information on its habitat use, microhabitat selection, foraging ecology, and species-specific threats in localized areas like Bahundagi Forest is still missing.

Previous studies from countries such as India, Myanmar, and Thailand have highlighted key ecological factors influencing the species such as vegetation structure, availability of food resources, temperature sensitivity, and reproductive conditions (Ihlow et al., 2016; Rai, 2022), yet these variables remain uninvestigated in Bahundagi. The forest's subtropical climate, diverse vegetation, and proximity to human settlements may represent a unique ecological scenario, warranting targeted research (Drukpa et al., 2020; Ihlow et al., 2016).

Furthermore, while broader regional studies have identified threats like habitat loss, poaching, illegal trade, invasive species (*Mikania micrantha*), climate change, and agrochemical use as major drivers of population decline (Khan et al., 2020; Rhodin et al., 2017; Subba & Khanal, 2023), their specific impacts and severity within Bahundagi Forest remain undocumented. Local accounts suggest harvesting of tortoises for consumption, medicine, and decoration is ongoing in Nepal's Terai region (Aryal et al., 2010) but no scientific assessment has validated or quantified this pressure in Bahundagi.

Additionally, critical ecological aspects such as nesting success, hatchling mortality, exposure to fire, and habitat degradation from firewood collection or grazing- well-studied in other regions (Khan et al., 2020; Sriprateep et al., 2013) have not been explored locally. These knowledge gaps hinder conservation efforts and limit the ability to develop effective, context-specific strategies for the long-term survival of elongated tortoise in eastern Nepal. Besides, human-elephant conflict and their mitigation measures were studied in Bahundagi and in Jhapa of eastern Nepal (Khatiwoda et al., 2018; Shrestha & Koirala, 2013).

The elongated tortoise is classified as Critically Endangered by the IUCN, with over 80% population decline observed across its range (Rhodin et al., 2017), a lack of ecological and threat-based data from regions like Bahundagi represents a significant conservation blind spot. This study seeks to address this gap by providing the first comprehensive assessment of the distribution, habitat use, and anthropogenic threats to elongated tortoise in Bahundagi Forest, thereby contributing valuable insights for regional conservation planning and management.

3. Materials and methods

3.1 Study area

The study area consists approximately 57.5 km² located in the easternmost part of Jhapa. Five community forests (CFUGs) of Bahundagi are Bahuban Community Forest, Telpani Community Forest, Mahila Sirjanshil Community Forest, Shree Krishnathumki Community Forest, and Dudhepattapur Community Forest. It borders India to the east, Mechinagar Municipality to the south, Shantinagar to the west, and Erautar and Jirmale to the north (Shrestha & Koirala, 2013). The average temperature is 33°C in the summer and 6°C in the winter and, rainfall temperature (average annual precipitation) is 378.16 mm. Its range extends between 26°43'11"N to 26°48'16"N and 88°07'10"E to 88°10'09"E of Bahundagi.

This study area consists of dominant tall Sal trees (*Shorea robusta*) and Teak tree (*Tectona grandis*) The threatened wildlife habitat; Asian elephant (*Elephas maximus*), Chinese pangolin (*Manis pentadactyla*), king cobra (*Ophiophagus hannah*) (Jnawali et al., 2011; Schleich & Kästle, 2004). Others flora are like Katus (*Castanopsis indica*), giant bamboo (*Dendrocalamus giganteus*), and Khirra (*Falconeria insignis*) found in Bahundagi forest. The invasive species are *Mikania micrantha*, *Mimosa diplotricha*, *Chromolaena odorata*, and *Lantana camara* found in this forest. The herpetofauna found in Bahundagi Forest are rat snake (*Ptyas mucosa*), monitor lizards (*Varanus* spp.), elongated tortoise (*Indotestudo elongata*), and Indian flap-shell turtle (*Lissemys punctata*).

Habitat destruction, hunting, forest fires, and illegal trade are the main threats which cause low in number of tortoise population. Moreover, elephant (*Elephas maximus*) and monkey (*Macaca mulatta*) with their conflict to human is contemporary in Bahundagi Forest.

From 2001 to 2023, Mechi lost 259 ha of tree cover from fires and 2.49 kha from all other drivers of loss. The year with the most tree cover loss due to fires during this period was 2009 with 71 ha lost to fires- 31% of all tree cover loss for that year (GFW 2022).

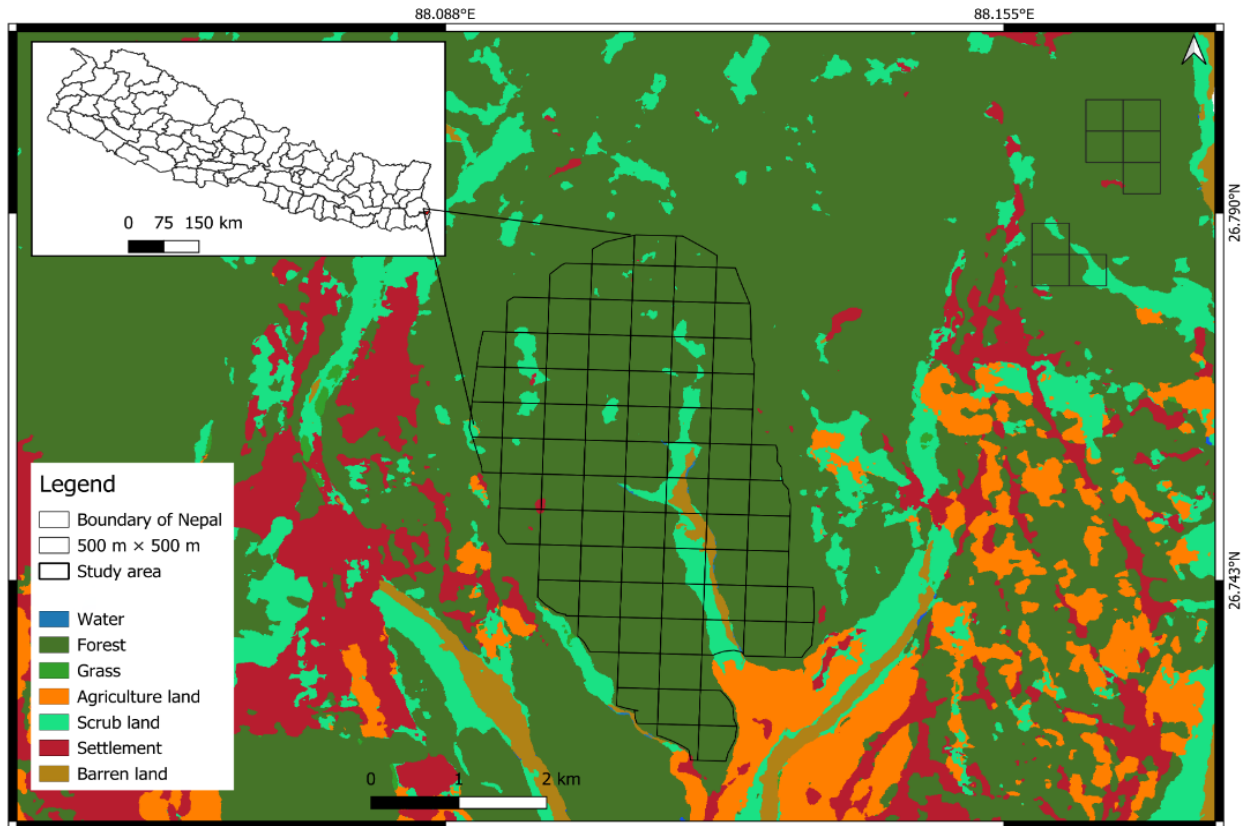


Figure 1. Map showing the survey grids in Bahundagi Forest.

3.2 Field survey

The study area was first divided into 500 m × 500 m grids, and 50% of the total area was statistically selected using QGIS 3.38.0. In each selected grid, a 500 m transect line was placed through the center. Data collection points were set at 100 m intervals along a 500 m transect, where nine variables- canopy cover, ground cover, food presence, human disturbance, presence/absence of invasive plants, soil type, habitat type, coordinate point, and weather type were recorded, and a 10 m area on both sides of each point was examined for the species (Dhamala et al., 2012) (Figure 2).

The field survey was conducted during post monsoon season in Bahundagi Forest with the help of Field guide during daytime between 10:00–4:00 for 30 days during (October–December) 2024 to record elongated tortoise presence and habitat variables. A total 60 grids covering an area of 12.47 km² was surveyed for this study. During survey, the data was collected based on direct evidence

and indirect evidence, and previous sighting points on occurrence of presence and absence. Indirect evidence of the elongated tortoise includes footprints, triangular bite marks on vegetation, and shells of dead tortoises, while direct evidence includes live sightings in the wild (Deepak & Vasudevan, 2014). Survey grids were assigned a value of 1 if any evidence was detected and 0 if no evidence was found (Deepak & Vasudevan, 2014).

3.3 Covariates recorded during field survey

The covariates are recorded to understand the distribution, habitat selection and threats of elongated tortoise in Bahundagi Forest. For data collection, GPS was used to record the presence point. Additionally, canopy and ground cover were assessed using the GLAMA and Canopeo apps (Landert, 2019). Weather, habitat type and invasive species were identified by visual observation. Herbaceous leaves, mushrooms, leftover vegetables, earthworms, snails, insects, crabs, eggshells, detritus, and animal droppings were the significant food presence (FP) identified for the elongated tortoise (Ihlow et al., 2012; Rai, 2020), detected through visual observation. Soil was recorded by using feel method and time was recorded by watch. Using the Euclidean distance tool in QGIS 3.38.0, the distance from the center of each grid cell to the nearest river, road distance and settlement distance were measured (Pokharel et al., 2022; Subba et al., 2024). Rivers were marked using Google Earth images.

To evaluate the effect of human-induced risks on elongated tortoise which impact their presence/absence, a method from earlier existed research; (Pokharel et al., 2022; Subba et al., 2024) were adopted to study threats on elongated tortoise. Due to limited research, four major threats: Human presence (HP), Vegetative disturbance (VD), Forest fire (FF) and Road/Paths (R) were identified for integrating the effect on elongated tortoise. There, signs of livestock, human presence, vehicle disturbance, and vegetation damage were recorded at each 100 m segment conducted surveys in October– December 2024. Same weight (0.25) was allocated to each factor when calculated the Human Disturbance Index (HDI) for every 100 m segment. This was done to ensure a balanced assessment and prevent over- or underestimating the impact of specific variables, The Human Disturbance Index (HDI) was determined using the formula: $HDI = (HP \times 0.25) + (FF \times 0.25) + (VD \times 0.25) + (R \times 0.25)$. The HDI values were then averaged for each study grid (Subba et al., 2024).

Disturbance levels were categorized as follows: values up to 0.40 indicated low disturbance, 0.41 to 0.60 represented moderate disturbance, and 0.61 to 1.0 signified high disturbance (Subba et al., 2024). Possible anthropogenic variables to elongated tortoise were learnt in the area by help of local people and forest officers and field guide. The charred remains from forest fires from five years were confirmed by field guide that is helpful to detect signs of forest fire (Rein & Huang, 2021; Subba et al., 2024).

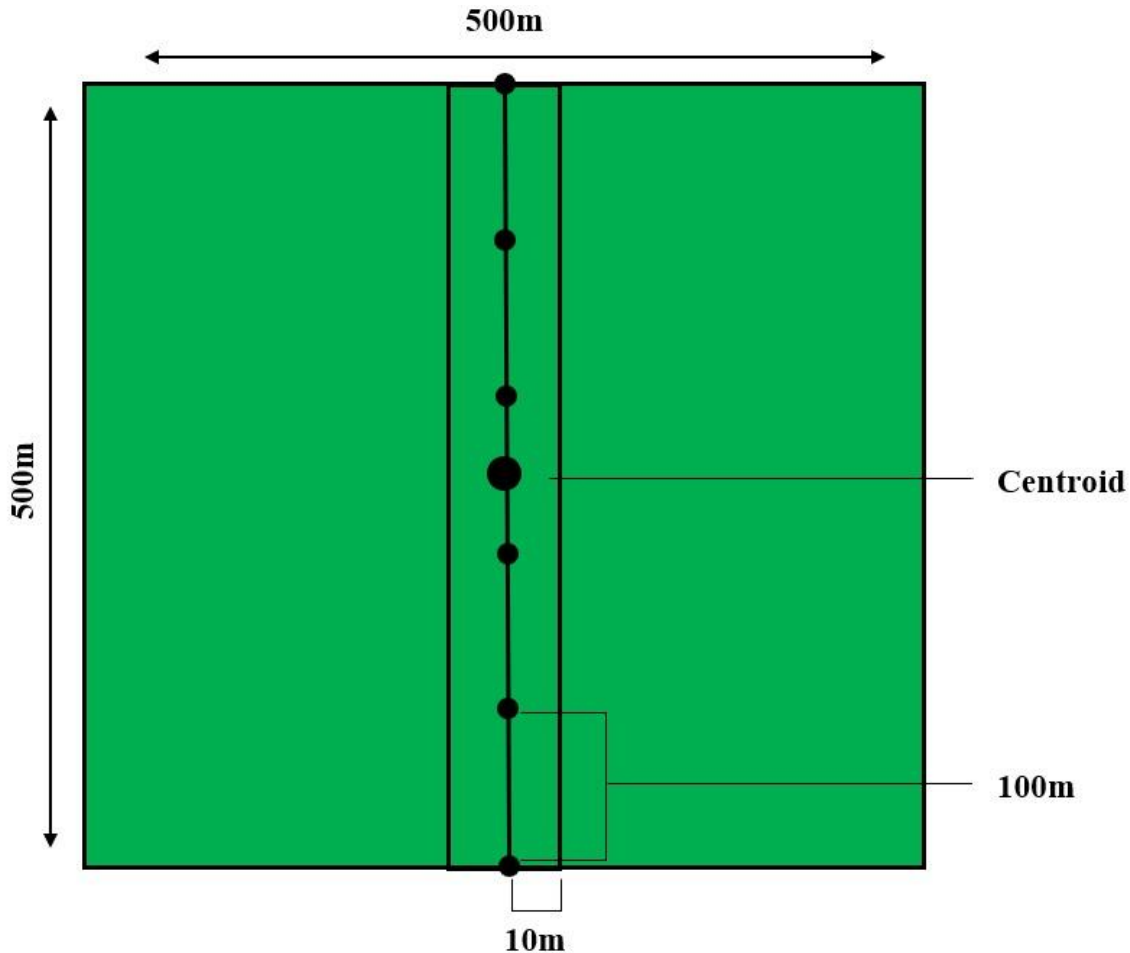


Figure 2. Survey design of a grid with six points aligned along a transect passing through the centroid.

3.4 Questionnaire survey

A semi-structured questionnaire survey was conducted with local people living within 1 km distance from the periphery of Bahundagi Forest. The survey lasted for 18 days in Month of June during monsoon season. For each question 20 seconds time was considered, overall, for 60

question maximum 20 minutes was required. While questionnaire, photograph was used to identify the elongated tortoise. The questionnaire was focused mainly on factor affecting people's knowledge and conservation attitudes of elongated tortoise those who depend on forest resources. Forest officials and CFUG units were also interviewed to identify conservation threats to *Indotestudo elongata* and suggest management strategies for its protection. The demographic information of respondents is included in appendix 2.

3.5 Data analysis

To study the presence of elongated tortoises and the impact of environmental and human-related factors, field data was analyzed using GLM models. The dependent variable was tortoise presence or absence, while the explanatory variables included habitat characteristics, human disturbances, and environmental conditions, with both categorical and continuous data. Spearman's rank correlation was used to check for multicollinearity among continuous variables, and those with high correlation ($\rho > 0.7$) were removed. Categorical variables were tested with a chi-square test, and those with $p > 0.05$ were excluded.

The distance to human settlement was excluded because the distance to human settlements had highly correlation only among the variables on spearman's rank correlation test. To find the best factors influencing tortoise presence, Generalized Linear Model (GLM) with the binomial distribution employed from the MuMIn package in R Studio (version 4.2.3) was used. Logit link function in a binomial generalized linear model was applied to get the average model (Monti, 2011). Three models ($\Delta AICc < 2$) were found. The variables of the models are canopy cover (CC), distance to the nearest road (R_oD), distance to the nearest river (R_rD), food presence point (FP), and human disturbance index (HDI) (Table 1).

For threat analysis and people's perception, descriptive statistics was used. Likert charts, bar-diagram, and pie charts were used to represent the perceptions of people and knowledge of elongated tortoise in Bahundagi. Survey responses were compiled in Microsoft Excel 2019, and all statistical analyses were performed in R Studio (R Core Team, 2023).

4. Results

4.1. Distribution and habitat use of elongated tortoise in Bahundagi Forest

4.1.1 Distribution of elongated tortoise in Bahundagi Forest

Out of 19.38 km² total grid area, a total survey effort of 12.47 km² was conducted by sampling 60 grids in the study area (Figure 3). Observed points of elongated tortoise from 13 grids were recorded in Bahundagi Forest of which two direct evidence, five indirect evidence and six previously sighted evidence in Bahundagi Community Forest. During the field survey, one male and one female elongated tortoise were recorded. The male had a carapace length and breadth of 15.8 × 13.9 cm, while the female measured 14.5 × 13.6 cm. Similarly, the plastron length and breadth were 12.7 × 6.9 cm for the male and 11.6 × 6.8 cm for the female. The female weighed 345 gm, whereas the male weighed 296 gm. In the questionnaire survey, one male and two female tortoise carapaces were found. The male carapace measured 26.1 × 20.8 cm, with a plastron measuring 25.4 × 16.5 cm, and the male weighed 424 gm. The two female carapaces measured 28.4 × 24.1 cm and 28.4 × 24.6 cm, with plastrons measuring 29.2 × 18.2 cm and 29.4 × 18.5 cm, respectively. The females weighed 569 gm and 494 gm respectively.

The elongated tortoise primarily inhabited moist Sal-dominant forests (30.76%) and mixed deciduous forests (27.27%). It was also found in wetlands (16.66%) and scrublands (11.11%), though in smaller proportions. This distribution highlighted the species' preference for Sal-dominant and mixed deciduous forests while utilizing other habitats to a lesser extent. In fact, invasive plants were the main ground vegetation in 65% of the surveyed grids, where 20.51% of tortoise occurrences were recorded within an area covering 1.84 km².

The elongated tortoise tends to prefer habitats with high food availability, canopy cover (42.78 ± 14.84), and a greater distance from rivers (4583.25 ± 2774.97 m). These variables are strongly associated with the tortoise's habitat use. However, human disturbance index (0.70 ± 0.23), ground cover (62.83 ± 13.39), distance to human settlements (279.92 ± 236.39), and distance to roads (1094.64 ± 991.66) do not significantly affect habitat use.

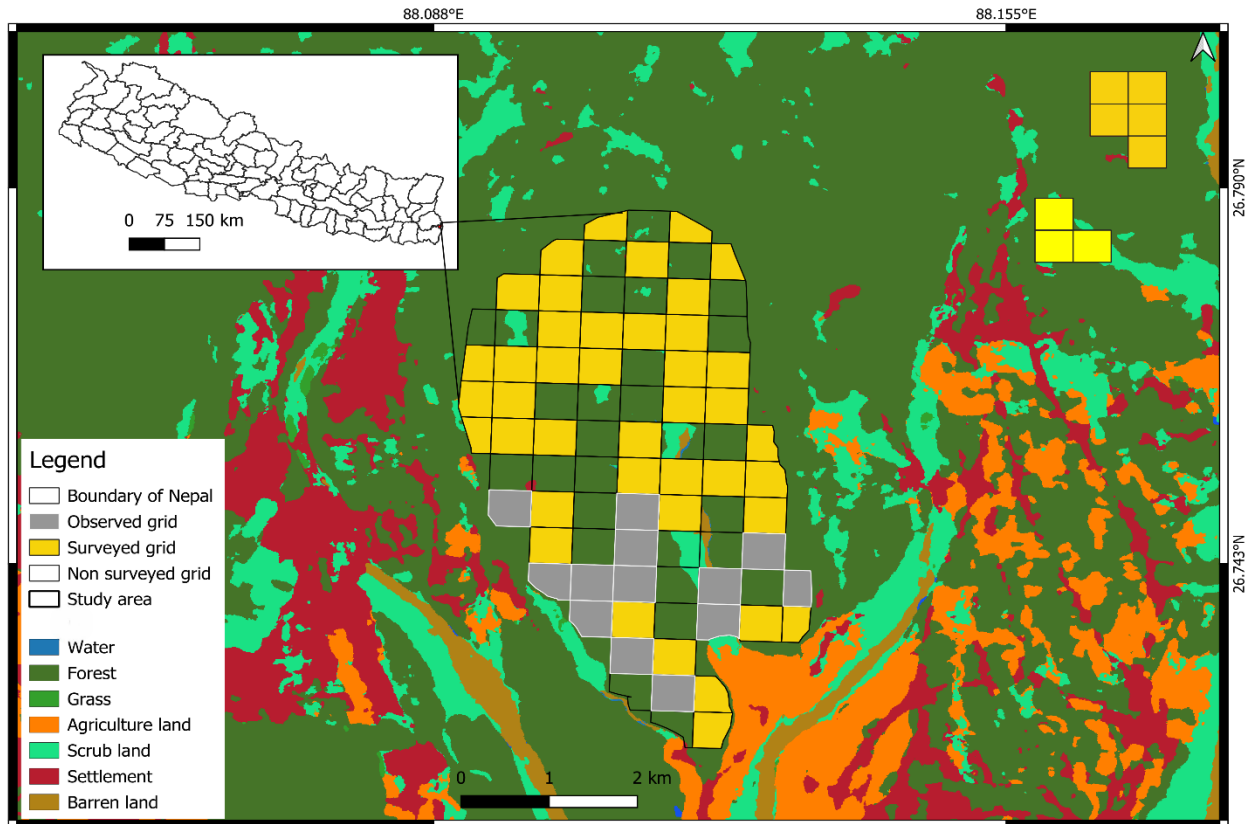


Figure 3. Map showing the surveyed grids and the observation points of the elongated tortoise within Bahundagi Forest.

Canopy cover, food presence and distance to river had significant positive effects on the occurrence of elongated tortoise. Canopy cover had a significant positive relation on the occurrence of elongated tortoise (CI= 0.1387-0.0047, $p < 0.03$) (Table 1). This interval does not include zero, reinforcing the idea that the effect is statistically significant (Figure 4). Similarly, Food presence (FP) also showed a strong positive effect on the elongated tortoise's presence (Table 1). This interval does not include zero, confirming the effect is statistically significant (Figure 5). When food is absent (0), the mean predicted probability is very low, with a small standard error. When food is present (1), the mean predicted probability increases significantly, indicating that the presence of food strongly influences the probability of the event occurring. The larger error bar at food presence (1) suggests greater variability in predictions when food is available. Likewise, the distance to river (R_{iD}) confirmed a significant positive impact on the elongated tortoise presence (Table 1). This interval does not include zero, reinforcing the idea that the effect is statistically significant (Figure 6).

Table 1. Model averaging ($\Delta AICc < 2$) was used to calculate confidence intervals (conf.low and conf.high) and identify the factors influencing the habitat use of the elongated tortoise.

Parameters	Estimates (β)	Std. error	conf.low	conf.high	z-value	Pr(> z)
(Intercept)	-10.2200	3.3950	3.3950	-3.4499	2.9580	0.0031**
CC	0.0717	0.0334	0.0047	0.1387	2.0990	0.0359 *
R ₁ D	0.0005	0.0002	0.0002	0.0008	2.9490	0.0032**
FP	2.0340	0.9961	0.0389	4.0289	1.9980	0.0457*
HDI	2.2690	2.5340	-1.0427	8.2572	0.8850	0.3760
R ₀ D	0.0001	0.0002	-0.0005	0.0013	0.3060	0.7600

Note: Elongated tortoise presence acting as the response variable and canopy cover (CC), distance to closest road (R₀D), distance to closest river (R₁D), food presence point (FP) and human disturbance index (HDI), as predictor variables.

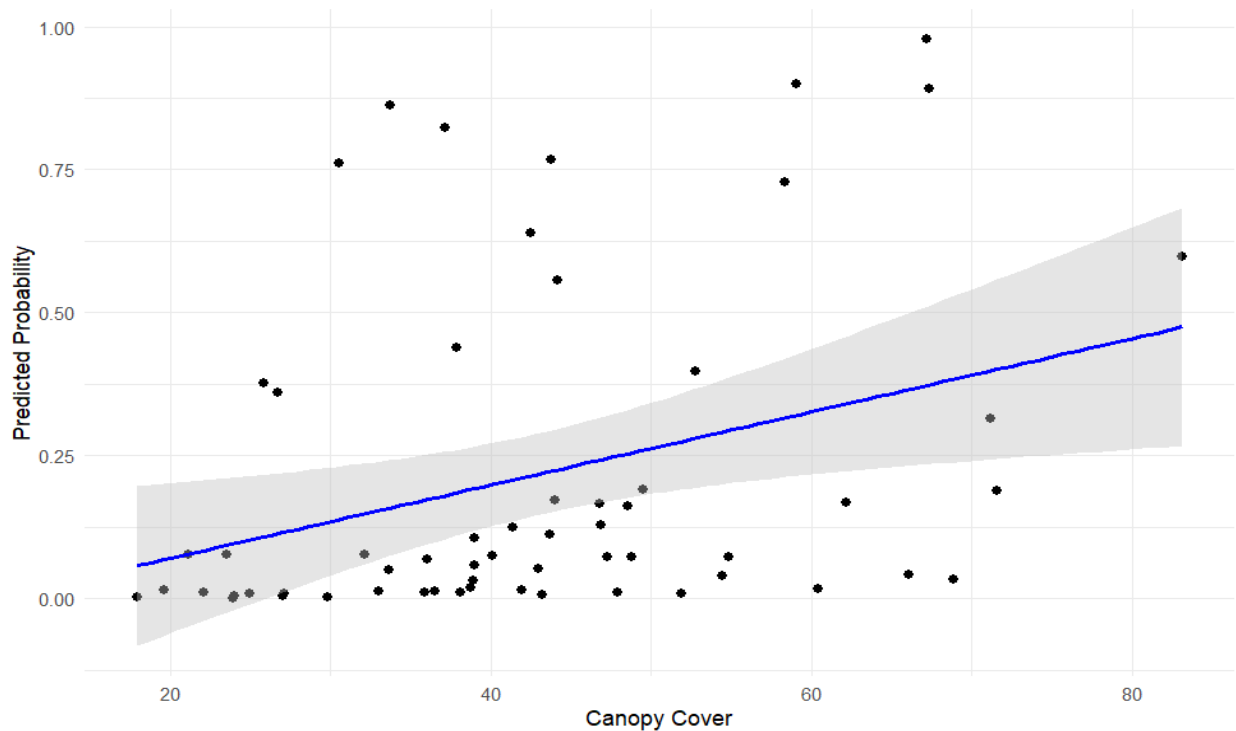


Figure 4. Canopy cover and prediction probability of elongated tortoise in Bahundagi Forest.

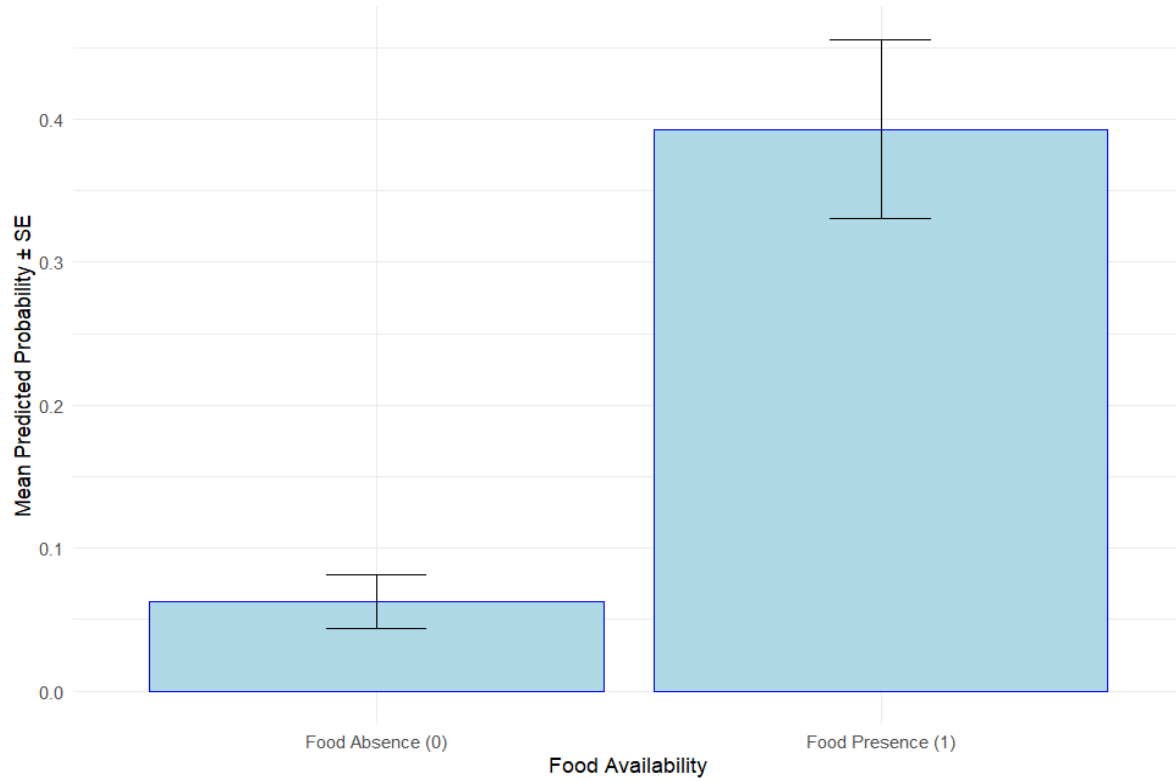


Figure 5. Food presence and mean predicted probability \pm standard error (SE) of elongated tortoise in Bahundagi Forest.

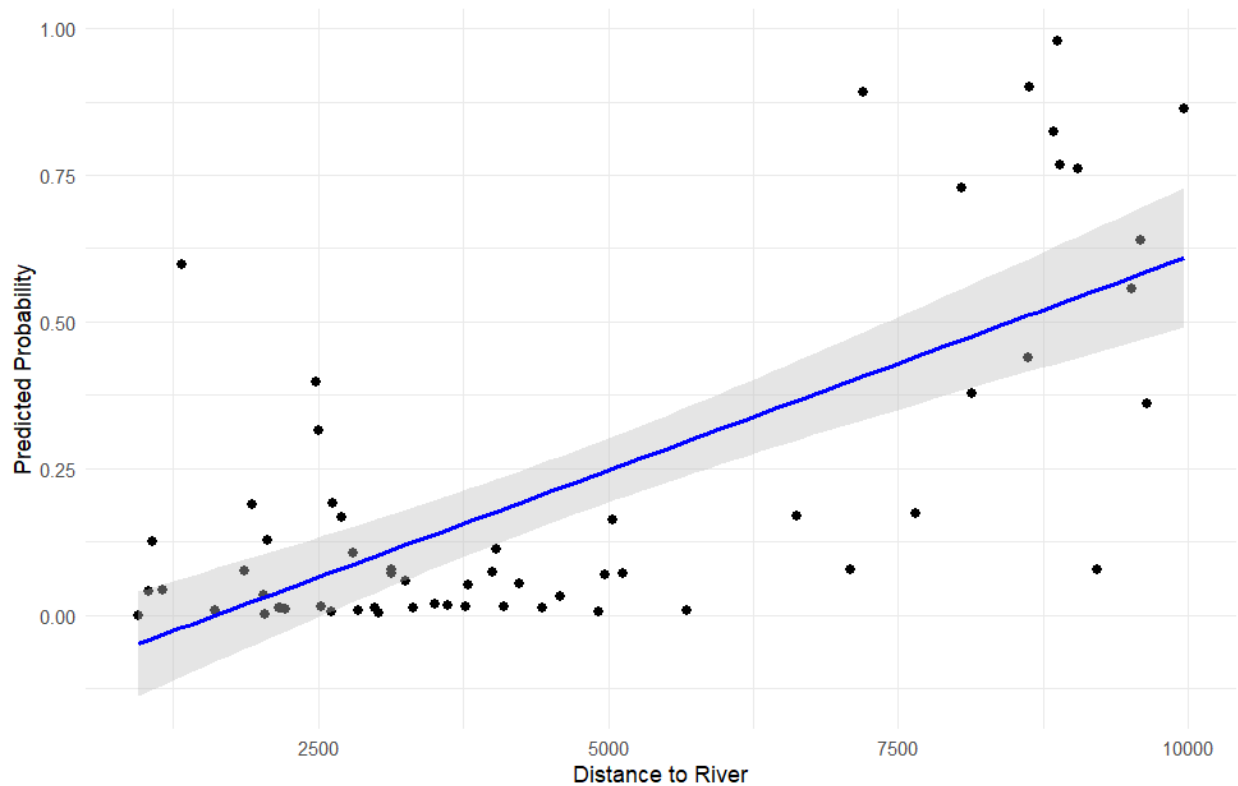


Figure 6. Distance to river and prediction probability of elongated tortoise in Bahundagi Forest.

4.2. Conservation threats and local people’s perception towards elongated tortoise

The questionnaire survey indicated that the population of elongated tortoises in Bahundagi Forest is declining. The main reason, cited by 33% (n=36) of respondents, was hunting for meat and ethnomedicine. Other factors included habitat destruction (20%, n=22), wildland fires (14%, n=15), low reproductive rates (9%, n=10), illegal trade (6%, n=6), clutch predation (5%, n=5). Additionally, 13% (n=14) of respondents had no knowledge about the decline in tortoise numbers (Figure 7). However, the difference was not statistically significant ($\chi^2= 45.093$, $P= 4.486$) indicates that the observed variation in perceived threats among respondents may have occurred by chance and does not provide strong statistical evidence that one threat is significantly more dominant than the others.

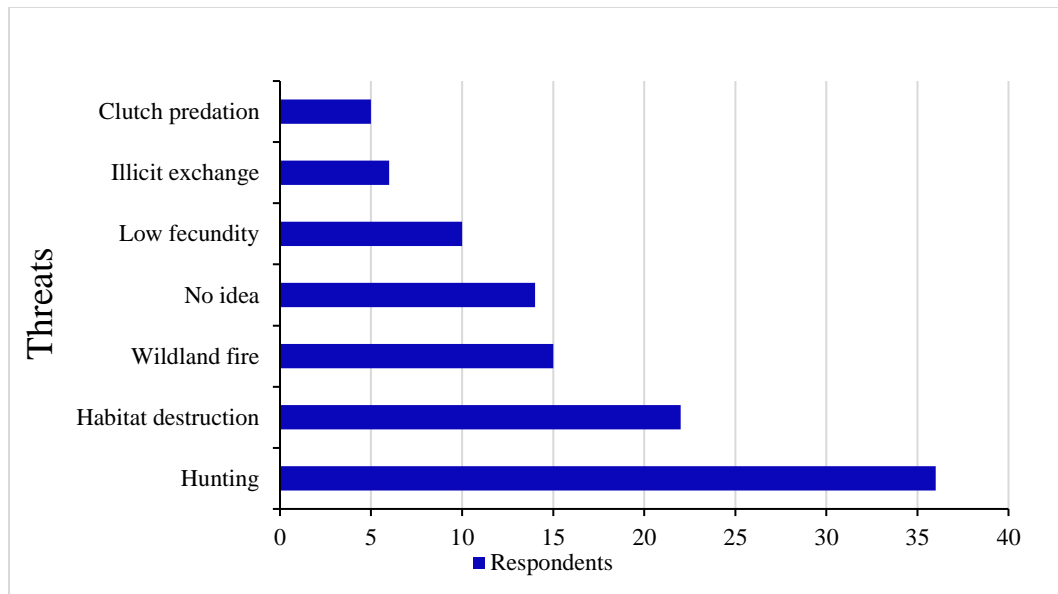


Figure 7. Conservation threats of elongated tortoise in Bahundagi Forest.

4.2.1 People’s knowledge and perception on elongated tortoise

From the survey, 20% of respondents stated that the ecological role of the elongated tortoise is its most important significance, while 47% agreed that the species helps maintain environmental balance (Figure 9). Additionally, 26% believed that breeding and rearing tortoises could contribute to their conservation. About 22% of local respondents expressed interest in keeping tortoises as pets, whereas 18% supported efforts to protect and conserve the species (Figure 9). Cultural beliefs also played a role in people's perceptions of tortoises. Around 40% of respondents believed that tortoises bring prosperity to a household, while 36% regarded them as a symbol of Lord Vishnu (Figure 9). Additionally, 27% mentioned that tortoises are used for decorative purposes, and 50% agreed that they are used in ethnomedicine (Figure 9). When asked about threats to the species, 24% of respondents identified hunting as the main cause of population decline, and 23% were aware that invasive plants negatively impact tortoises (Figure 9). Nearly half (49%) of the respondents believed that the tortoise population is decreasing in Bahundagi Forest. Furthermore, 27% recognized the elongated tortoise as an important species, and an equal percentage agreed that it is endangered (Figure 9). Among the tested attitude categories significant difference was represented in appendix 5. These results indicate that the majority of local respondents in Bahundangi Forest are aware of the ecological and cultural importance of elongated tortoises and recognize key threats to their survival, such as hunting and invasive plants. However, there is less consensus

or awareness about their endangered status and keeping tortoises as pets, suggesting the need for more targeted awareness programs.

Therefore, the local people's perception of elongated tortoise was considered structured question where the participants were freely giving their opinion for the structured question than for the threat chart (open-ended question) in which they felt discomfort and uneasy to give answers.

Additionally, 61% (n=67) of respondents said they would release the tortoise in Kalikhola Simsar if they found it, while 26% (n=29) would keep it as a pet, 8% (n=9) would release it immediately, and 5% (n=5) were unsure what to do. Meanwhile, 92% (n=79) of respondents know about the organization or law for protecting tortoises, while 8% (n=7) are unaware of it.

Furthermore, 67% (n=74) of respondents were aware of the ecological importance of the elongated tortoise (Figure 8). Meanwhile, 16% (n=18) believed its importance was for education, 11% (n=12) believed it as valuable for recreation, and only 5% (n=6) considered it important for religious reasons (Figure 8). However, the difference was significant ($\chi^2= 38.6838$, $P<0.0001$) indicates that respondents' perceptions of the elongated tortoise's importance varied significantly, with a clear majority recognizing its ecological role over educational, recreational, or religious values.

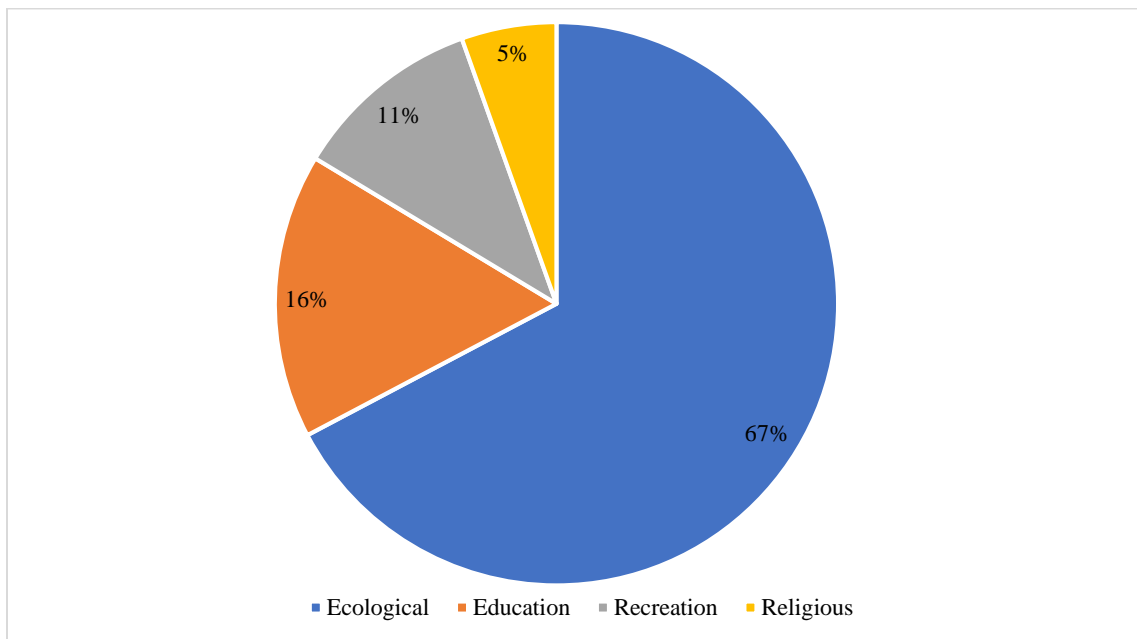


Figure 8. Local people's perception on elongated tortoise importance

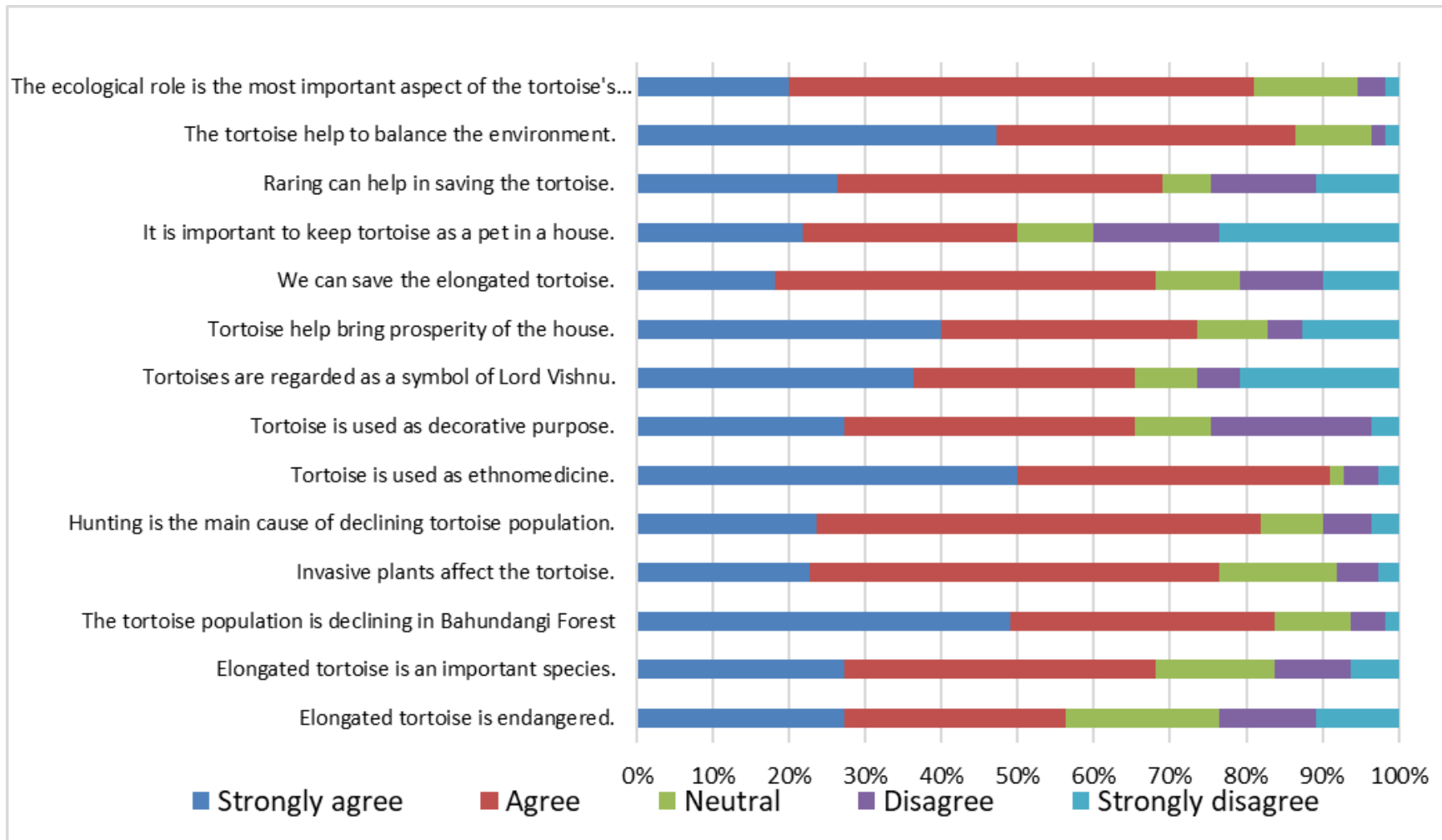


Figure 9. Likert chart showing the local people’s perception and knowledge on elongated tortoise

4.2.2. Factors affecting people's support for tortoise conservation

The conservation agreement by demographic analysis examines the percentage of respondents who agree or disagree with tortoise conservation across different demographic groups. The significance of each factor is measured using a p-value from Fisher's Exact Test except gender factor in which chi-square test was done.

Among the 110 respondents, those engaged in agriculture (80.65%, n=75) and employees (80%, n=4) showed the highest agree on tortoise conservation. In contrast, students (40%, n=2) and business professionals (42.86%, n=3) had the lowest agreed rates. Majority of the respondents, 80.65%, strongly agreed that the tortoise should be conserved (P=0.02). However, the difference was statistically significant (P=0.02) indicates that occupation strongly influences conservation support. The relation between demographic profile and conservation perception of tortoise in Bahundagi Forest is included in appendix 6.

Both males and females show high support for conservation. Females (76.19%, n=32) have a slightly higher agreement percentage than males (70.59%, n=48). However, the difference was not statistically significant (P=0.674) indicates that gender does not significantly affect conservation attitudes (Appendix 5). Mid-adults (40-59) have the highest agreement (79.41%, n=27), suggesting that they are more inclined to support conservation. Young adults (61.54%, n=16) and older adults (62.50%, n=5) show lower support. Therefore, the difference was not statistically significant (P=0.2445) shows that age is not a significant factor influencing conservation attitudes (Appendix 6). Illiterate respondents (76.92%, n=20) support conservation the most, followed by those with primary education (75.00%, n=36). College-educated respondents show the least support (50%, n=4), indicating a possible difference in conservation perception among higher-educated individuals. Moreover, the difference was not statistically significant (P=0.4912) suggests that education level does not significantly impact conservation attitudes (Appendix 6). Since 92%(n=79) respondents were aware about organization/law to save tortoise. Dalit (85%, n=17) and Brahmin (81.25%, n=13) groups show the highest support, while w (60%, n=9) and Janajati (62.96%, n=17) groups show lower support. Furthermore, the difference was not statistically significant (P=0.4724) suggests that ethnicity is not a statistically significant factor in conservation agreement (Appendix 6).

5. Discussion

5.1. Factor affecting the distribution and habitat use of elongated tortoise

This study highlights the elements influencing the distribution of elongated tortoise in Bahundagi Forest. The elusive nature of the elongated tortoise required careful surveying in both open and dense vegetation, as well as in fallen logs, deadwood, and burrows of porcupines and pangolins (Subba & Khanal, 2023). The search focused on detecting direct signs, such as live tortoises, and indirect signs, including carapaces, footprints, bite marks on vegetation, and previously recorded sighting locations. Additionally, various ecological factors were documented. The collected data were analyzed using a Generalized Linear Model (GLM) with a binomial distribution to identify the key factors influencing the distribution of the elongated tortoise in Bahundagi Forest.

The determining factor indicating that the tortoise's habitat in Bahundagi Forest is influenced by canopy cover. During the field survey, a total of thirteen occurrence points were recorded for the elongated tortoise. Among these, ten occurrence points were in mixed forests and Sal-dominated forests, characterized by dense tree cover. The remaining three occurrence points were recorded in scrubland and wetland habitats. The likelihood of finding the turtle increases with the amount of tree cover. According to some residents, new plants emerge from dried twigs and leaves following a forest fire, increasing canopy cover and producing lush foliage. This shows a lot of dense trees with high canopy cover. Basking and egg production were typically observed under shaded, deciduous trees on cold mornings between September and January in Bahundagi Forest. This behavior helps the tortoises avoid high temperatures through their daily activity pattern (Drukpa et al., 2020; Ihlow et al., 2016). During the questionnaire survey, about 47% (n=45) respondent seen tortoise in mixed and Sal dominant forest area and scrubland 11% (n=10). One individual kept three tortoise shells in their house, which were found in the Mixed and Sal-dominated Forest zones.

Apart from canopy cover, food presence also influences the distribution of elongated tortoise in Bahundagi Forest. Out of 60 survey grids, 28 had food presence for the tortoise. According to (Drukpa et al., 2020), this indicates that the tortoise is an omnivore. The food presence (FP) had a significant positive impact on the elongated tortoise presence, as food presence increases, the presence of elongated tortoise increases. Most respondents said whether mushrooms are edible

depends on the type of trees, as mushrooms are food items for them. According to field guide, there are designated days for managing the gathering of timber and feed, typically on Wednesdays and Thursdays. Commonly, the elongated tortoise inhabits in mud and eat muddy soil, and many mushroom types (Ihlow et al., 2016) as mentioned above but the most loved mushroom type of the elongated tortoise is Kalunge chyau (*Termitomyces eurrhizus*) in Bahundagi Forest. Consequently, various poisonous mushroom and edible oyster mushrooms from family *Pleurotus* grow in Bahundagi Forest, but the tortoises do not eat them according to respondent. Unregard, in Bahundagi Forest, *T. eurrhizus* mushroom is part of the tortoise's diet, which could help in understanding the foraging behavior of elongated tortoise. The high collection of edible mushrooms by local communities due to their high market value (Rs. 1500 for 1kg) has led to a decline in their abundance. This reduction negatively impacts the population of elongated tortoise, as mushrooms are an important food source for the species. The decreased availability of this dietary component may contribute to nutritional stress, ultimately affecting the health and survival of tortoise populations.

The distance to river had a significant positive impact on the elongated tortoise presence, as the distance of river increase, the finding of elongated tortoise increases. The proximity to rivers plays a crucial role in increasing the abundance of the elongated tortoise. These areas provide essential moisture, even during the dry season, ensuring a more stable microhabitat with higher humidity and cooler temperatures. Vegetation near streambeds provides essential food and cover, helping to minimize the chances of dehydration and heat-related stress. Additionally, riverbanks and ravines accumulate organic matter, including leaf litter, which enhances foraging opportunities. It is believed that predators near river resources such as monitor lizards (*Varanus* spp.) and eagle may prey on the tortoises' eggs and young ones. The decline of elongated tortoise is mainly due to the destruction of Bahundagi forests as this case increase the poaching, hunting and trade of elongated tortoise. Harmful pesticides and chemicals from nearby farms contaminate the river. Sand mining sometimes trapped tortoises, causing injury or death. Generally, while on surveyed 13 tortoise sighting were found far from river on the dense vegetation. The occurrence point was distance is about 9,511 meters away far river. As a result, tortoises are more likely to be found in these areas, where the environmental conditions support their survival and activity throughout the

year, thus, the river distances increase the abundance of tortoise. Street dogs, crow are the predators found in Bahundagi forest.

Most respondents said Kalekhola Simsaar found on edge of Bahundagi Forest; is a shaded area, and tortoises were seen there during sunny times to drink water, relax, and search for food like earthworms, insects and others (Ihlow et al., 2016). The "Chapgairee" named is given by the local people as it is the habitat preferred by the tortoise due to the favorable climatic conditions and available resources.

5.2. Threats and people's knowledge towards elongated tortoise

Bahundagi Forest is partially fragmented, with some continuous patches in the northwest and smaller isolated patches in northeastern part located at the easternmost part near the Indian border in Jhapa District. The forest is experiencing a significant loss of biodiversity due to human activities. Hunting, habitat destruction, wildfires, and illicit exchange were the biggest risks to Bahundagi Forest's elongated tortoises.

Hunting is the major threat of elongated tortoise in Bahundagi Forest. The elongated tortoises were heavily hunted for food and medicine in Bahundagi. Local people hunt them while gathering fodder and firewood in Bahundagi. According to respondents, the meat tastes like chicken or mutton, while some said it has no distinct taste. In Bahundagi, "Dhami" and "Jhakri" used live tortoises for healing sick people. Most of the believers are from the Meeche, Magar and Bahun communities. It is believed that the blood of a living tortoise can cure severe diseases like heart disease and asthma, while its shell is used as a bangle to protect babies from evil spirits. During the questionnaire survey, one of the respondents was an indigenous hunter from the Meeche community who had been hunting tortoises and various turtles for sustenance throughout his 60-year lifetime. Not only the Indigenous hunters, but local people also hunt this tortoise for mainly food and medicinal purposes. People use it as a traditional medicines because modern medicines were not available, due to superstitions, and they were a cheaper treatment option (Kharel & Chhetry, 2012). According to one male respondent aged 60 years old said about 17 years ago in Naxalbar, India, many medicines were not being sold, and hospital treatments were losing money due to similar reason. Later, it was banned. About 15 years ago, the tortoises were abundantly found but due to heavy hunting practices the number of tortoise availability is low in

Bahundagi Forest according to local people. This was also mentioned in (Ihlow et al., 2016) study that recent decades, the consumption of elongated tortoises for food and traditional medicine has significantly increased across their range. During questionnaire, 90% (n=98) of respondents had heard about the killing of the elongated tortoise, while 6% (n=7) said they did not know about it, and 4% (n=4) were unaware of it. So, there is a lack of awareness among the locals about the conservation of the elongated tortoise, as observed during the survey in Bahundagi. Therefore, awareness campaigns are essential in Bahundagi Forest to save the tortoise.

There is a missed opportunity for both active conservation efforts and for local education about the forest and its biodiversity. Residents were found to be unaware of any organizations, laws, or regulations related to the protection of the elongated Tortoise. This lack of knowledge can result in unintentional harm to the species, as individuals may not recognize the importance of protecting it or understand the legal frameworks in place to do so. Awareness campaigns are vital for educating the local community and visitors about the significance of conserving wildlife. The absence of such campaigns means there is little to no effort being made to inform people about the threats facing the elongated tortoise or the actions they can take to help protect it.

These findings suggest that without proper management, education, and awareness, the conservation of the elongated tortoise in Bahundagi Forest is at risk. The implementation of effective management practices and awareness programs is essential to safeguard the species and its habitat.

Human settlement around the periphery of study area, along with the invasion by the invasive species, are destroying the dense vegetation, which is the prime habitat for elongated tortoise in Bahundagi Forest in field observation. In addition, (Ihlow et al., 2016; Khaing & War, 2018) reported that habitat degradation, fragmentation, and destruction have negatively impacted the species. Bahundagi Forest is close to farmland and human settlements, which has led to a decline in the tortoise population. This was also seen in the Indo-Gangetic Plain in India, the Chao-Phraya region in central Thailand, and in India in which tortoises tend to avoid heavily disturbed areas with dense human populations and intensive farming and loss of dipterocarp forest (Ihlow et al., 2016). During questionnaire survey, out of 110 respondents, 10% (n=9) saw the tortoise in agricultural land near their houses. The invasive species makes it difficult for foraging and basking behavior of elongated tortoise in Bahundagi Forest according to some of the respondents which

was also mentioned by (Subba & Khanal, 2023) where *Mikania micrantha* shows negative effect to elongated tortoise. Likewise, In Bahundagi Forest, Predators such as rat snake, and eagle harm the elongated tortoise' habitat. Increase of harmful invasive species and raw materials such as bottles, plastics destroy the plant species and habitat in which elongated tortoise live. During survey, People showed lack of interest towards tortoise conservation and do not appreciate the value of their responsibility. It is believed that if a tortoise is exposed to dry or hot conditions, it may leave the forest and go into farmland or near human houses. This is thought to cause floods and landslides in the area, and it is considered a curse.

The study area is open to access inside, thus people burnt firewood during the winter. In the dry season, people set fires on purpose for farming and to help grass grow for grazing, causing many elongated tortoises to die (Som & Cottet, 2016; Van Dijk, 1998). This was also practiced in Bahundagi Forest by local people. During the survey, it was reported that an elongated tortoise weighing approximately 3.5 kg was burnt by forest fire three months ago near the forest edge. The fire damaged its shell, making it difficult to breathe and survive, which later led to its death. Natural fires occur in Bahundagi Forest every year from April to May due to winds, causing to threaten tortoise survival and making it easier for hunters to catch tortoises.

During the survey, information on trade is important serious threats of elongated tortoise in Bahundagi Forest. In Bahundagi, distinctive black and yellow pattern carapaces are used to make helmet, dog plates and bike mirror decoration were described by the local people. During the questionnaire survey, trade was identified as a serious issue seen in the local community of Bahundagi. The trade occurred both within community and across the border outside India. Bahundagi Forest provides easy access for buyers from India, who purchase tortoises from local people. During questionnaire, People also keep them as pets or worship them as a form of Lord Vishnu, believing it brings wealth. It is believed to remove curses and bring good luck. Furtive and Indigenous hunters sold adult and juvenile tortoises, along with their eggs, for profit. The eggs are leathery, white or off-white in color, like chicken eggs but larger according to some of the respondents. Tortoises grow slowly, lay few eggs, and have low juvenile survival rates (Deepak & Vasudevan, 2014). In Bahundagi Forest, rat snakes eat tortoise eggs, leading to low clutch survival and reproductive success. So, their populations are especially vulnerable when breeding adults are lost. Additionally, people were unaware of whether adult tortoises were being hunted by natural

predators. During survey, about 58% (n=41) knew the decorative marks of elongated tortoise made up of clay, metals, whereas 42% (n=30) weren't aware of it.

6. Conclusion and recommendations

6.1. Conclusion

The elongated tortoise (*Indotestudo elongata*) was recorded in 24.61% of the surveyed grids, covering an area of 3.07 km², based on the findings of the present survey conducted in Bahundagi Forest. The distribution of elongated tortoises in Bahundagi Forest is primarily influenced by three factors: distance from the river, food availability, and canopy cover. These elements have a favorable impact on the species, therefore regions with more food, tree cover, and distance from the river are more likely to have tortoises. The main threats to tortoises in Bahundagi Forest are habitat destruction and forest fires, followed by hunting for food and medicine. In addition, collection of edible mushrooms (food of the elongated tortoise) and local and across the border trade are the prominent additional threats to elongated tortoise. The conservation status and ecological significance of the tortoise are not well known to many locals in Bahundagi. Their opinions on conservation vary depending on their occupation, age, gender, and level of education. The absence of appropriate field guides and forest management is a significant problem in the region. Awareness campaigns should be launched in order to safeguard the tortoise population, and habitat conservation should be prioritized.

6.2. Recommendations

Based on the results of this study following recommendations have been made:

- i. Canopy cover was identified as the major determinant of elongated tortoise occurrence. Therefore, community forests should be conserved.
- ii. Implement forest fire prevention strategies, such as early warning systems and controlled burning techniques.
- iii. Regular monitoring and management of forest help to maintain ecosystem balance and provide a safe habitat for the elongated tortoise.

7. References

- Aryal, P. C., Dhamala, M. K., Bhurtel, B. P., Suwal, M. K., & Rijal, B. (2010). Turtles of Nepal: A field guide for species accounts and distribution. Environmental graduates in himalaya (EGH), resources himalaya foundation, lalitpur, Nepal, and companions for amphibians and reptiles of Nepal (CARON), Kathmandu, Nepal. The First National Youth Conference on Environment, Kathmandu, Nepal.
- Brattstrom, B. H. (1965). Body temperatures of reptiles. *The American Midland Naturalist*, 73(2), 376–422. <https://doi.org/10.2307/2423461>
- Buhlmann, K. A., Akre, T. S. B., Iverson, J. B., Karapatakis, D., Mittermeier, R. A., Georges, A., . . . Gibbons, J. W. (2009). A global analysis of tortoise and freshwater turtle distributions with identification of priority conservation areas. *Chelonian Conservation and Biology*, 8(2), 116–149. <https://doi.org/https://doi.org/10.2744/CCB-0774.1>
- D'Cruze, N., Elwin, A., Ghosh, S., Asfaw, A. E., Coulthard, E., Megson, D., . . . Harrington, L. (2024). Ritualistic hunts: exploring the motivations and conservation implications in West Bengal, India. *Nature Conservation*, 56, 243–273. <https://doi.org/10.3897/natureconservation.56.132178>
- Deepak, V., & Vasudevan, K. (2014). Factors influencing the occurrence and vulnerability of the Travancore tortoise *Indotestudo travancorica* in protected areas in south India. *Oryx*, 49(4), 669–676. <https://doi.org/10.1017/s0030605313001166>
- Dhamala, M. K., Paudel, E., Kharel, S. C., Suwal, M. K., Rijal, B., Shah, K. B., . . . Pokhrel, G. K. (2012). Herpetofaunal diversity in Nagarjun forest. *Nepal Journal of Science and Technology*, 12, 358–365. <https://doi.org/10.3126/njst.v12i0.6524>
- Drukpa, D., Kinley, K., Tamang, D., Gyeltshen, G., Dema, T., Phuntsho, Y., . . . Letro, L. (2020). Record of the critically endangered elongated tortoise *Indotestudo elongata* (Blyth, 1853) at high elevation, Bhutan. *Bhutan Journal of Natural Resources and Development*, 7(2), 84–87. <https://doi.org/10.17102/cnr.2020.55>
- Dubois, A., & Bour, R. (2010). The distinction between family-series and class-series nomina in zoological nomenclature, with emphasis on the nomina created by Batsch (1788, 1789) and on the higher nomenclature of turtles. *Bonn Zoological Bulletin*, 57(2), 149–171.
- Duc, L. D., & Broad, S. (1995). Investigations into tortoise and freshwater turtle trade in Vietnam. *International Union for Conservation of Nature (IUCN)*, 1–34.

- Ensafi, R., Winter, P., Mueen, A., & Crandall, J. R. (2015). Analyzing the great firewall of china over space and time. *Proceedings on Privacy Enhancing Technologies*, 2015(1), 61–76. <https://doi.org/10.1515/popets-2015-0005>
- Ginal, P., Stahlberg, J., Rauhaus, A., Wagner, P., Rödder, D., & Ziegler, T. (2023). Threatened turtles and tortoises (Testudines) in zoos: A ZIMS database analysis for improved One Plan Approach to Conservation actions. *Salamandra - German Journal of Herpetology*, 59, 262–274.
- Hartmann, T., Ihlow, F., Edwards, S., Sothanin, S., Handschuh, M., & Bohme, W. (2013). A preliminary annotated checklist of the amphibians and reptiles of the kulen promtep wildlife sanctuary in northern cambodia. *Asian Herpetological Research*, 4(1), 36–55. <https://doi.org/10.3724/sp.J.1245.2013.00036>
- Ihlow, F., Dawson, J. E., Hartmann, T., & Som, S. (2016). *Indotestudo elongata* (Blyth 1854) – elongated tortoise, yellow-headed tortoise, yellow tortoise. *Chelonian Conservation and Biology*, 5, 1–14. <https://doi.org/10.3854/crm.5.096.elongata.v1.2016>
- Ihlow, F., Geissler, P., Sovath, S., Handschuh, M., & Böhme, W. (2012). Observations on the feeding ecology of *Indotestudo elongata* (Blyth, 1853) in the wild in Cambodia and Vietnam. *Herpetology Notes*, 5, 5–7.
- Jnawali, S. R., Baral, H. S., Lee, S., Subedi, N., Acharya, K. P., Upadhyay, G. P., . . . Amin, R. (2011). *The status of Nepal mammals: The National Red List Series* (Department of National Parks and Wildlife Conservation Kathmandu, Nepal, Issue.
- Kästle, W., Khambu, K. R. R., & Schleich, H. H. (2013). *Field guide to amphibians and reptiles of Nepal*. Amphibian and Reptile Conservation (ARCO) Nepal.
- Khaing, K. T., & War, K. W. (2018). Current population status, diversity and exploitation of tortoises and freshwater turtles in Myeik area, Tanintharyi region. *Journal of the Myanmar Academy of Arts and Science*, 16(4), 56–66.
- Khan, S., Nath, A., & Das, A. (2020). The distribution of the elongated tortoise (*Indotestudo elongata*) on the Indian subcontinent: implications for conservation and management. *Herpetological Conservation and Biology*, 15(1), 212–227.
- Khanal, L., Pandey, N., Upadhyaya, L. P., Chand, D. B., Karki, M., Chalise, M. K., & Kyes, R. C. (2023). Projected distribution of the westernmost subpopulation of Assamese macaques (*Macaca assamensis pelops*) under climate change conservation implications of a

- threatened population. *Conservation Science*, 4, 1–10.
<https://doi.org/10.3389/fcosc.2023.1235595>
- Kharel, M., & Chhetry, D. T. (2012). Turtles of Kankai (Mai) river and their ethno-medicinal uses. *Nepalese Journal of Biosciences*, 2, 126–133.
- Khatiwoda, B., Budhathoki, S., & Neupane, B. (2018). Human-Elephant Conflict and Mitigation Measures in Jhapa District, Nepal. *Journal of Forest and Livelihood*, 16(1), 103–112.
<https://doi.org/10.3126/jfl.v16i1.22885>
- Landert, K. A. (2019). Comparing photographic and GIS-based applications for estimating canopy cover in Southern Appalachian Bogs. The National Conference on undergraduate research (NCUR), Asheville, North Carolina.
- McCormick, B. (1992). The elongated tortoise, Tortuga Gazette. *American Tortoise Rescue*, 28(3), 1–3.
- Montano, Y., Marshall, B. M., Ward, M., Silva, I., Artchawakom, T., Waengsothorn, S., & Strine, C. T. (2022). A stable home: autocorrelated kernel density estimated home ranges of the critically endangered elongated tortoise. *Herpetological Journal*, 32, 1–24.
<https://doi.org/https://doi.org/10.33256/32.3.120129>
- Monti, M. M. (2011). Statistical Analysis of fMRI Time-Series: A Critical Review of the GLM Approach. *Front Hum Neurosci*, 5, 1–13. <https://doi.org/10.3389/fnhum.2011.00028>
- Mudar, K., & Anderson, D. (2007). New evidence for Southeast Asian Pleistocene foraging economies: Faunal remains from the early levels of Lang Rongrien Rockshelter, Krabi, Thailand. *Asian Perspectives*, 298–334.
- Ono, K., Hata, T., Yoshimura, T., & Kinjo, K. (2016). Wood decaying properties of the termite mushroom *Termitomyces eurhizus*. *Journal of Wood Science*, 63(1), 83–94.
<https://doi.org/10.1007/s10086-016-1588-x>
- Phuntsho, T., Koirala, B. K., Tshering, Y., & Tshomo, K. (2022). Diversity and distribution of tortoises and turtles in Phibsoo Wildlife Sanctuary and Adjoining areas in Southern Bhutan. *Reptiles And Amphibians*, 29, 439–443.
<https://doi.org/https://doi.org/10.17161/randa.v29i1.18114>
- Pokharel, M., Subba, A., Rai, D., Bhandari, S., & Ghimirey, Y. (2022). Fine-scale ecological and anthropogenic variables predict the habitat use and detectability of sloth bears in the Churia

- habitat of east Nepal. *Ecology and Evolution*, 12(1), 1–12. <https://doi.org/10.1002/ece3.8512>
- Prasad, D., & Pokhrel, B. (2017). Mushroom diversity of Amrite Community Forest, Kapilvastu, Nepal *Himalayan Biodiversity*, 5, 84–91.
- Rahman, A. A. A., Mohamed, M., Tokiman, L., & Mohd Sanget, M.-S. (2019). Species Distribution Modelling to Assist Biodiversity and Conservation Management in Malaysia. *IOP Conference Series: Earth and Environmental Science*, 269(1). <https://doi.org/10.1088/1755-1315/269/1/012041>
- Rai, M. (2022). Edible mushrooms from forests of Sikkim Himalaya. *Journal of Mycopathological Research*, 60(2), 197–205.
- Rai, T. P. (2020). An elongated tortoise (*Indotestudo elongata*) attempting to prey on a Buff-striped Keelback (*Amphiesma stolum*) at the turtle rescue and conservation centre in eastern Nepal. *Reptiles And Amphibians*, 27(2), 297–299.
- Rai, T. P. (2021). How long can an Elongated Tortoise (*Indotestudo elongata*) survive without food? *Reptiles And Amphibians*, 28(2), 360–362. <https://journals.ku.edu/reptilesandamphibians>
- Rein, G., & Huang, X. (2021). Smouldering wildfires in peatlands, forests and the arctic: Challenges and perspectives. *Current Opinion in Environmental Science and Health*, 24, 1–10. <https://doi.org/10.1016/j.coesh.2021.100296>
- Rhodin, A. G. J., Iverson, J. B., Bour, R., Fritz, U., Georges, A., Shaffer, H. B., . . . Van Dijk. (2017). Turtles of the world annotated checklist and atlas of taxonomy, synonymy, distribution, and conservation status (9th Ed.). *Chelonian Research Monographs*, 20(2), 225–228. <https://doi.org/10.3854/crm.8.checklist.atlas>
- Schleich, H. H., & Kästle, W. (2004). Amphibians And Reptiles of Nepal. *Herpetological Review*, 35(1), 88–90.
- Shrestha, A., Sapkota, R. P., & Paudel, K. (2021). Record of Indian Roofed Turtle *Pangshura tecta* (Reptilia: Testudines: Geoemydidae) from koshi tappu wildlife reserve, Nepal. *Journal of Threatened Taxa*, 13(6), 18663–18666. <https://doi.org/10.11609/jott.7065.13.6.18663-18666>

- Shrestha, R., & Koirala, D. P. (2013). Elephant- human conflict in Bahundangi region, Jhapa district, Nepal. *Journal of Natural History Museum*, 27, 59–65. <https://doi.org/10.3126/jnhm.v27i0.14153>
- Shrestha, T. K. (2001). *Herpetology of Nepal: a field guide to amphibians and reptiles of trans-Himalayan region of Asia*. Steven Simpson Books.
- Sodhi, N. S., Koh, L. P., Brook, B. W., & Ng, P. K. (2004). Southeast asian biodiversity: an impending disaster. *Trends in Ecology and Evolution*, 19(12), 654–660. <https://doi.org/10.1016/j.tree.2004.09.006>
- Som, S., & Cottet, M. (2016). Rescue and relocation programme of turtles and tortoises and elongated tortoise monitoring programme in the Nam Theun 2 Reservoir (Laos). *Hydroécologie Appliquée*, 19, 383–406. <https://doi.org/10.1051/hydro/2015007>
- Spencer, B. (1987). The elongated tortoise and its management at the Minnesota Zoo. *Journal of Bulletin of the Chicago Herpetological Society*, 23, 37–40.
- Sriprateep, K., Aranyavalai, V., Aowphol, A., & Thirakhupt, K. (2013). Population structure and reproduction of the elongated tortoise *Indotestudo elongata* (Blyth, 1853) at Ban Kok Village, Northeastern Thailand. *Tropical Natural History*, 13(1), 21–37.
- Subba, A., & Khanal, L. (2023). Threats to the critically endangered yellow-headed tortoise *Indotestudo elongata* in Jalthal forest, eastern lowland Nepal. *Oryx*, 58(1), 129–132. <https://doi.org/10.1017/s0030605323001308>
- Subba, A., Tamang, G., Lama, S., Limbu, J. H., Basnet, N., Kyes, R. C., & Khanal, L. (2024). Habitat occupancy of the critically endangered Chinese Pangolin (*Manis pentadactyla*) under human disturbance in an urban environment: Implications for conservation. *Ecology and Evolution*, 14(12), 1–11. <https://doi.org/10.1002/ece3.70726>
- Van Dijk, P. P. (1998). *The natural history of the elongated tortoise, Indotestudo elongata (Blyth, 1853) in a hill forest mosaic in western Thailand, with notes on sympatric turtle species*. Ph. D Dissertation. National University of Ireland, Galway]. National University of Ireland.
- Ward, M., Ihlow, F., Nadolski, B., Artchawakom, T., Crane, M. S., Knierim, T., . . . Strine, C. T. (2018). First record of male combat in the Elongated Tortoise *Indotestudo elongata* (Blyth, 1853) from north-eastern Thailand. *Herpetology Notes*, 11, 585–587.

- Ward, M., Marshall, B. M., Hodges, C. W., Montano, Y., Artchawakom, T., Waengsothorn, S., & Strine, C. T. (2021). Nonchalant neighbors: Space use and overlap of the critically endangered tortoise. *Biotropica*, 52, 1342–1355. <https://doi.org/10.1111/btp.12981>
- Zhang, W., Du, F., Wang, L., Zhao, L., Wang, H., & Ng, T. B. (2015). Hydrolysis of Oligosaccharides by a Thermostable alpha-Galactosidase from *Termitomyces eurhizus*. *International Journal of Molecular Science*, 16(12), 29226–29235. <https://doi.org/10.3390/ijms161226159>

Appendices

Appendix 1. Questionnaire survey form for elongated tortoise and their conservation threats.

Distribution, Habitat Use and Threats of Elongated tortoise (*Indotestudo elongata*) of Bahundagi forest, Jhapa

Namaste, my name is Binu Rai. I am a student. Currently, I am doing my thesis for Master's degree, Central Department of Zoology, Tribhuvan University. I want to know the perception of people on terrestrial tortoise. I want to ask you some question regarding the species of your area? You can decline to answer to any questions and your participation is entirely voluntary. Whatever information you provide and your identification will be kept strictly confidential. It will take 20-30 minutes. May we begin?

Section A: Basic Information Co-ordination: Questionnaire ID ___ Date _____

A01	District		A02	Municipality/Rural	
A03	Ward		A04	Village/Tole	
A05	Name		A06	Age (in Years)	
A07	Gender		A08	Family status	
A09	Profession		Agriculture		
			Business		
			Employee		
			Student		
A10	Education	Illiterate			
		2. Primary			
		Secondary			
		College			
A11	Religion	1. Kirati		4. Buddhisim	
		2. Christainity		5. Sanatan	
		3. Hinduism		6. Others	
A12	Caste	Brahmin		4. Aadibasi	
		Chhetri		5. Madhesi	
		Janajati		6. Dalit	

Section B: General tortoise's information

B01	Which tortoise are found in your locality? Present: 1 Absent: 0	Three-keeled land turtle		Bengal black turtle	
		Indian black turtle		Yellow-bellied roofed	
		Indian flapshell turtle		Indian roofed turtle	
		Elongated tortoise		Indian peacock softshell turtle	
		Black throated leaf turtle		Black softshell turtle	

Read aloud: Now I am going to ask you about elongated tortoises in your locality

B01	B02	B03	B04	B05
Does <i>Indotestudo elongata</i> tortoise is found in your locality? Present: 1 Absent: 0	Local name	Location: 1.Forest 2.Agricultural land 3.Wetland 4.Market	Time 1.Morning 2.Noon 3.Evening 4.Night 5.Never	What were the tortoises doing? 1.Eating 2.Walking 3.Egg laying 4.Basking 5.Never

B09	What were the tortoises doing?	B10	Under what conditions did you observe a tortoise?	B11	How often do this species seen	B12	Nature of tortoise?	B13	Feeding habitat?
	1.Eating 2.Walking 3.Egg laying 4.Basking 5.Never		1.Opportunistics 2.Purpose to hunt 3.Never		1.Frequently 2. Rarely 3. Never 4. No idea		1.Shy 2.Danger 3.Neutral 4.No idea		
B14	Do you know elongated tortoise is endangered?	B14	Do you think it is important species?	B15	What is the status of it now in your opinion?	B16	Do you believe elongated tortoise is declining?		How often it is seen in crop areas?
	1.Strongly agree 2.Agree 3.Neutral 4.Strongly disagree		1.Strongly agree 2.Agree 3.Neutral 4.Strongly disagree		1.Increase 2.Decrease 3.Constant 4.No idea		1.Strongly agree 2.Agree 3.Neutral 4.Strongly disagree		1.Frequently 2. Rarely 3. Never 4. No idea
B18	Do you think crop is damaged by tortoise?	B19	Do you think it affect other animals?	B20	Do you think it is affected by other animals?	B21	Do you believe is invasive plants affect the tortoise?		
	1.Strongly agree 2.Agree 3.Neutral 4.Strongly disagree		1.Stronglyagree 2.Agree 3.Neutral 4.Strongly disagree		1.Strongly agree 2.Agree 3.Neutral 4.Strongly disagree		1.Strongly agree 2.Agree 3.Neutral 4.Strongly disagree		

Section: C Threats/Human dimension/Religious perspective/value

C1	Have you heard any killing? 1. Yes 2.No 3.No idea	C2	When and where?	C3	Causes of hunting? In your opinion	C4	Do you believe, hunting is the main cause of tortoise decline?	C5	How often people hunt the tortoise?
					1.Meat 2.Pet 3.Decorative purpose 4.Others		1.Strongly agree 2.Agree 3.Neutral 4.Strongly disagree		1.Strongly agree 2.Agree 3.Neutral 4.Strongly disagree
C6	Do you believe, we can use turtle as an ethnomedicine?	C7	Which body parts used?	C8	Uses for	C9	Any side-effects of ethnomedicine	C10	From where did you learn ethnomedicine? Which ethnicity practices it?

	1.Strongly agree 2.Agree 3.Neutral 4.Strongly disagree		1.Head 2.Bone 3.Carapace 4.Intestine 5.Liver 6.Others						
C11	Do you believe, we can use tortoise as decorative purpose?	C12	Which body parts used?	C13	Materials made	C14	Do you believe, tortoise as a symbol of Lord Vishnu?	C15	Do you believe, pet tortoise help to increase the prosperity of house?
	1.Strongly agree 2.Agree 3.Neutral 4.Strongly disagree		1..... 2.....		1..... 2.....		1.Strongly agree 2.Agree 3.Neutral 4.Strongly disagree		1.Strongly agree 2.Agree 3.Neutral 4.Strongly disagree

Section D: Information about trade:

D1	Do you believe, we can trade tortoise?	D2	Trade: 1.Within country 2.Between country	D3	Do you believe, trade affect the elongated totoise?	D4	
	1.Strongly agree 2.Agree 3.Neutral 4.Strongly disagree				1.Strongly agree 2.Agree 3.Neutral 4.Strongly disagree		
D5	Selling price of tortoise?	D6	Do you know any decorative masks of it in shop?				
			1.Yes 2.No				

Section E: Save tortoise

E1	Do you think we can save tortoise?	E2	Do you think it's important to keep tortoise as a pet in a house?	E3	Do you believe raring improve the saving of species?	E4	Do you think is it important to save tortoise?	E5	Do you know any organization/law to save tortoise?
	1.Strongly agree 2. Agree 3.Neutral 4.Strongly disagree		1.Strongly agree 2.Agree 3.Neutral 4.Strongly disagree		1.Strongly agree 2.Agree 3.Neutral 4.Strongly disagree		1.Strongly agree 2. Agree 3.Neutral 4.Strongly disagree		1.Yes 2.No 3.No idea

Section F: We are at the end of the interview. Please tell me about your opinion on elongated tortoise.

F1	What's the taste of meat of it?	F2	If you found tortoise, then what will you	F3	Reason to keep tortoise as	F5	What is the importance of elongated	F6	Do you think the elongated tortoise is
	1..... 2..... 3..... 4.....		1.Eat 2.Release 3.Trade 4.Pet		1.... 2.... 3.... 4....		1.Ecological 2.Religious 3.Recreation 4.Education		1.Strongly agree 2.Agree 3.Neutral 4.Strongly
F7	Do you think tortoise balanced the	F8	Do you think the ecological role is the most	F9	Why is it important to save?	F10	What can we do to save the species?	F11	Myths
	1.Strongly agree 2.Agree 3.Neutral		1.Strongly agree 2.Agree 3.Neutral		1. 2. 3..... 4.....		1..... 2..... 3..... 4.....		

Thank you for your time!!!Namaste Observation note/comments:

Appendix 2. Demographic composition of surveyed people

Demographic Profile	Categories	Surveyed People Number (in percent)
Gender	Male	68(62%)
	Female	42(38%)
Age	Young adults (16-39)	45(41%)
	Mid adults (40-59)	49(45%)
	Older adults (60 and above)	16(14%)
Occupation	Agriculture	93(85%)
	Students	7(6%)
	Business	5(5%)
	Employees	5(5%)
Education	Illiterate	26(24%)
	Primary	48(44%)
	Lower	14(13%)
	Higher	14(13%)
Religion	Hinduism	59(54%)
	Buddhism	12(11%)
	Kirati	11(10%)
	Sanatan	3(3%)
	Others	17(15%)
Ethnic	Janajati	27(25%)
	Dalit	20(19%)
	Madhesi	15(17%)
	Brahmin	16(14%)
	Adibasi	19(13%)
	Chhetri	13(12%)

Appendix 3. Spearman's rank correlation

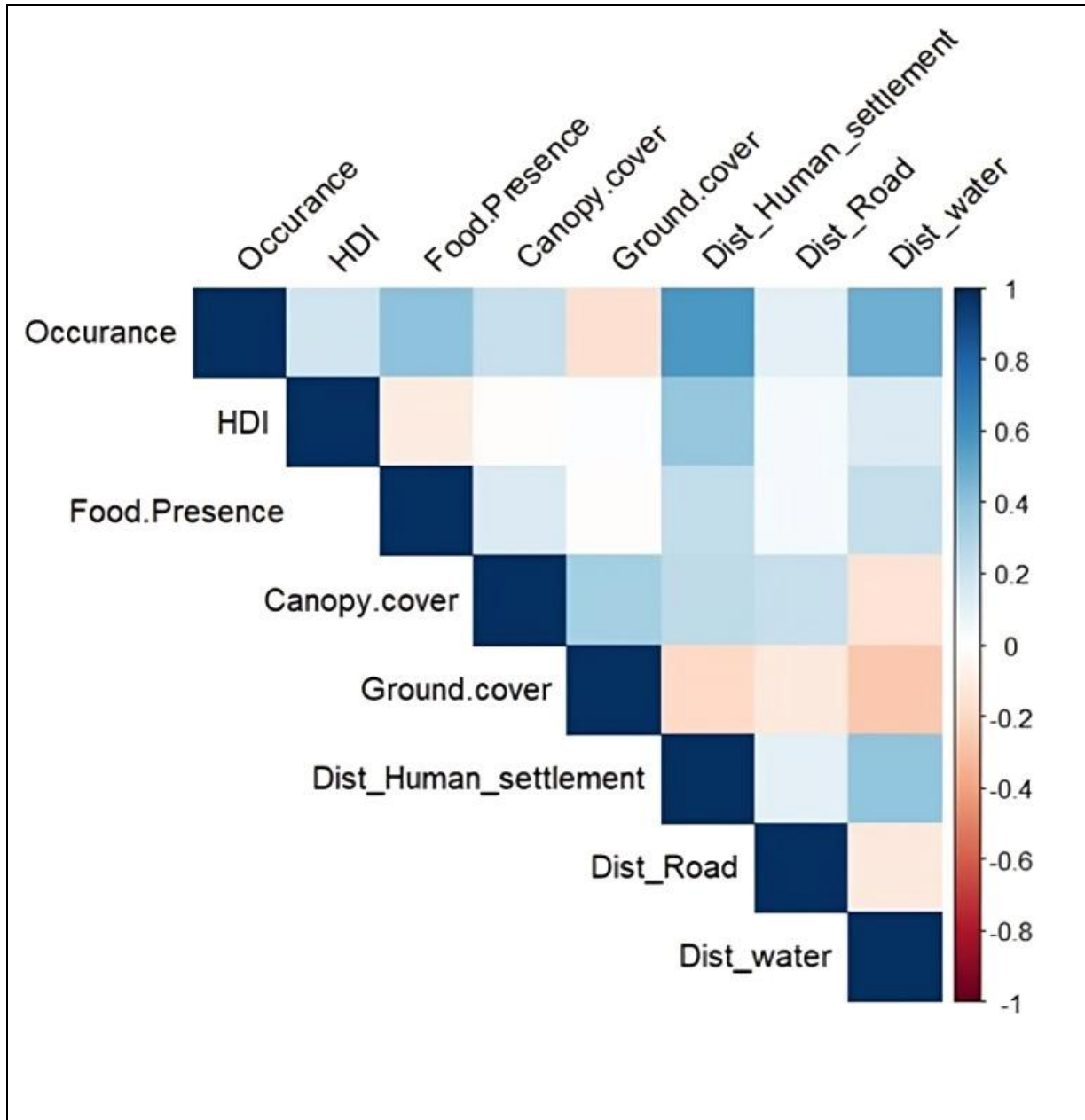


Figure 10. Multicollinearity test of all variables

Appendix 4. GLM analysis

Table 2. Generalized linear models with Δ AICc values < 2 describe the presence of the elongated tortoise. These models are arranged in descending order of Akaike information criteria (AICc).

Model	df	Predictor variables	logLik	AICc	Δ AICc	Weight (ω_i)
1	5	~CC+R ₁ D+FD+HDI	-17.26	45.64	0.00	0.44
2	4	~CC+R ₁ D+FD	-18.62	45.97	0.33	0.37
3	6	~CC+R ₀ D+R ₁ D+FD+HDI	-16.86	47.30	1.66	0.19

Note: Elongated tortoise presence was the response variable, while canopy cover (CC), distance to the nearest road (R₀D), distance to the nearest river (R₁D), food presence (FP), and human disturbance index (HDI) were predictor variables. Degrees of freedom (df), Δ AICc (difference between the top model's AICc and others), and ω_i (Akaike model weight) were used for model evaluation.

Appendix 5. Local people's perception and knowledge on elongated tortoise

S.N.	Statement	χ^2	P-value
V ₁	The ecological role is the most important aspect of the tortoise's significance.	53.2053	< 0.00001**
V ₂	The tortoise helps to balance the environment.	55.9468	< 0.00001**
V ₃	Raring can help in saving the tortoise.	22.0429	0.0001**
V ₄	It is important to keep tortoise as a pet in a house.	6.0153	0.1980
V ₅	We can save the elongated tortoise.	23.7871	0.0001**
V ₆	Tortoise help bring prosperity of the house.	28.1284	0.00001**
V ₇	Tortoises are regarded as a symbol of Lord Vishnu.	21.6944	0.0002**
V ₈	Tortoise is used as decorative purpose.	23.6312	0.0001**
V ₉	Tortoise is used as ethnomedicine.	63.8487	< 0.00001**
V ₁₀	Hunting is the main cause of declining tortoise population.	46.5167	< 0.00001**
V ₁₁	Invasive plants affect the tortoise.	41.3166	< 0.00001**
V ₁₂	The tortoise population is declining in Bahundangi Forest.	48.7774	< 0.00001**
V ₁₃	Elongated tortoise is an important species.	21.1926	0.0003**
V ₁₄	Elongated tortoise is endangered.	7.8016	0.9912

Appendix 6. Relation between demographic profile and conservation perception of tortoise in Bahundagi Forest.

Demographic Profile	Categories	Conserve tortoise		P-value
		Agree	Disagree	
Gender	Male	48	20	0.674
	Female	32	10	
Age	Young-adult (16-39)	16	10	0.2445
	Mid-adult (40-59)	27	7	
	Old-adult (above 60)	5	3	
Education	Illiterate	20	6	0.4912
	Primary	36	12	
	Secondary	20	8	
	College	4	4	
Ethnicity	Brahmin	13	3	0.4724
	Chhetri	10	3	
	Janajati	17	10	
	Aadibasi	14	5	
	Madhesi	9	6	
	Dalit	17	3	
Occupation	Agriculture	75	18	0.02652**
	Business	3	4	
	Employee	4	1	
	Student	2	3	

Appendix 7. Photographs of elongated tortoise recorded during the field survey.



Photo 1. Elongated tortoise found in Sal Forest in Bahuban Community Forest during field study.



Photo 2. Scale of rat snake (*Ptyas mucosa*) found under bushes in Bahuban Community Forest during field work.



Photo 3. A termite mound found in Bahuban Community Forest during field work.



Photo 4. A piece of carapace found in Meeche Community from Telpani Community Forest during questionnaire survey.



Photo 5. Carapace of elongated tortoise was found in Magar Community during questionnaire survey from Bahuban Community Forest.



Photo 6. Three carapaces (male, female and small female carapace) of elongated tortoise found during questionnaire survey.



Photo 7. Measuring carapace length of male elongated tortoise during questionnaire survey.

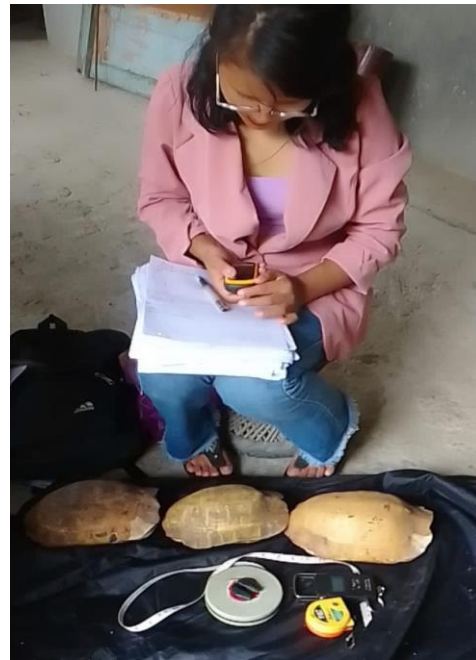


Photo 8. Recording the carapace data during questionnaire survey.



Photo 9. Goats grazing in the Bahuban Community Forest during field work.



Photo 10. Cutting down of tree in Telpani Community Forest during field work.



Photo 11. Invasive species (IS) *Lantana camara* in Bahuban Community Forest during field work.



Photo 12. Freshly chopped tree in Telpani Community Forest during survey.



Photo 13. Field guide showing Kalunge cheu (*Termitomyces eurrhizus*) found in Bahuban Community Forest during field work.



Photo 14. Habitat preference “Chapgairee” of the elongated tortoise in Telpani Community Forest.



Photo 15. Burnt tree due to forest fire in Telpani Community Forest.



Photo 16. Soil disturbance along forest edge near river in Telpani Bahundagi Community Forest



Photo 17. During field survey, an elongated tortoise was kept in a well while rearing.



Latitude: 26.718053
Longitude: 88.120673
Elevation: 167.76±56 m
Accuracy: 2.5 m
Time: 21-10-2024 10:46
Note: 1

Photo 18. Questionnaire survey with local people around the periphery of Bahundagi Forest.




Photo 19. Kalikhola Simsar in Bahuban Community Forest.

Appendix 8. Research Permission Letter

फोन नं.: ५३२७५७४

नेपाल सरकार
वन तथा वातावरण मन्त्रालय
वन तथा भू-संरक्षण विभाग


(कृपया पत्रोत्तरमा प्राप्त पत्र संख्या
र मिति उल्लेख गर्नुहोला।
बबरमहल, काठमाडौं, नेपाल
मिति : २०८१/०३/०२

प्राप्त पत्र संख्या र मिति:-
पत्र संख्या:- ०८०/८१
च. नं.- १२३१


विषय: अनुसन्धान अनुमति सम्बन्धमा ।

श्री बिनु राई,
झापा, नेपाल ।

प्रस्तुत विषयमा Tribhuvan University, Department of Zoology मा M.Sc. 3rd semester मा अध्ययनरत तपाईंले "Distribution, Habitat Use and Threats of Elongated Tortoise in Bahundangi Forest, Jhapa, Nepal" को विषयमा अध्ययन अनुसन्धानका लागि अध्ययन अनुमति उपलब्ध गराइदिनु हुन भनि मिति २०८१/०२/३२ गते यस विभागमा दिनु भएको निवेदन साथ प्रपोजल प्राप्त भयो । सो सम्बन्धमा कारवाही हुँदा उक्त अध्ययन अनुसन्धानबाट अध्ययन क्षेत्रमा The most preferred habitat, estimated population density and major conservation threats of elongated tortoise बारे जानकारी प्राप्त हुने भएकोले उक्त प्रपोजलमा उल्लेखित Methodology (Line Transect Survey and Questionnaire Survey) अनुसार तपसिलको शर्तहरूको अधिनमा रही डिभिजन वन कार्यालयसँग समन्वय गरि सन् २०२४, जुन १७ देखि सन् २०२४, डिसेम्बर-१६th सम्मका लागि अनुसन्धान गर्नु हुन निर्देशानुसार अनुमति छ ।

शर्तहरू

१. अनुसन्धानकर्ताले वन ऐन २०७६ तथा वन नियमावली २०७९, राष्ट्रिय निकुञ्ज तथा वन्यजन्तु संरक्षण ऐन, २०२९ र नियमावली २०३० तथा यस मातहतका नियमावलीहरूको पूर्ण पालना गर्नुपर्नेछ ।
२. अनुसन्धान कार्य डिभिजन वन कार्यालयसँगको समन्वयमा गर्नुपर्नेछ ।
३. नमूना संकलन गर्न पाईने छैन ।
४. अनुसन्धानको क्रममा प्राप्त भएको जैविक विविधता संरक्षणसँग सम्बन्धित संवेदनशिल सूचनाहरू गोप्य राख्नु पर्नेछ अनाधिकृत रूपमा त्यस्ता सूचनाहरू कसैलाई पनि उपलब्ध गराउन पाइने छैन ।
५. अनुसन्धान कार्य समाप्त भए पश्चात एक प्रति रिपोर्ट/प्रतिवेदन (कागजी तथा विद्युतिय) यस विभागमा अनिवार्य रूपमा बुझाउनु पर्नेछ ।
६. तोकिएका शर्तहरूको पालना नगरिएमा विभागले कुनै पनि समयमा अनुसन्धान अनुमति रद्द गर्न सक्नेछ ।


(सबनम पाठक)
सहायक वन अधिकृत

बोधार्थ
श्री डिभिजन वन कार्यालय, झापा। : आवश्यक सहयोग तथा अनुगमनको लागि अनुरोध छ ।

Plagiarism Test Report

The M. Sc. thesis title " **Distribution, Habitat Use and Threats of Elongated Tortoise (*Indotestudo elongata*) in Bahundagi Forest, Jhapa, Nepal** " submitted by Binu Rai for a plagiarism test on 2081/12/15 has been checked by the iThenticate plagiarism checker software. The software found an overall similarity index of 10% based on the following criteria.

Criteria :

Crossref	: Excluded
Crossref Posted Content	: Excluded
Internet	: Excluded
Submitted Works	: Excluded
Publications	: Excluded
Quotes	: Excluded
Bibliography	: Excluded
Small Match	: Word Count (<8 words)

Exclude customization sections : Select

