DIVERSITY, DISTRIBUTION AND CONSERVATION CHALLENGES OF TURTLES IN SHUKLAPHANTA NATIONAL PARK, NEPAL

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Submitted to:
Central Department of Zoology
Tribhuvan University, Institute of Science and Technology
Kirtipur, Kathmandu
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DECLARATION

I hereby declare that the work presented in this thesis entitled **"DIVERSITY, DISTRIBUTION AND CONSERVATION CHALLENGES OF TURTLES IN SHUKLAPHANTA NATIONAL PARK, NEPAL"** has been done by myself, and has not been submitted elsewhere for the award of any degree. All the sources of information have been specifically acknowledged by reference to the author or institution.

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RECOMMENDATION

This is to recommend that the thesis entitled "**DIVERSITY, DISTRIBUTION AND CONSERVATION CHALLENGES OF TURTLES IN SHUKLAPHANTA NATIONAL PARK, NEPAL**" has been carried out by Mr. Omkar Bhatt for the partial fulfillment of Master's Degree of science in Zoology with special paper Ecology. This is his original work and has been carried out under my supervision. To the best of my knowledge, this work has not been submitted for any other degree in any institutions.

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LETTER OF APPROVAL

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CERTIFICATE OF ACCEPTANCE

This thesis work submitted by Mr. Omkar Bhatt entitled **"DIVERSITY, DISTRIBUTION AND CONSERVATION CHALLENGES OF TURTLES IN SHUKLAPHANTA NATIONAL PARK, NEPAL"** has been accepted as a partial fulfillment for the requirements of Master's degree of science in Zoology with special paper Ecology.

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ABBREVIATIONS AND ACRONYMS

BNP	Bardia National Park
CNP	Chitwan National Park
DD	Data Deficient
DNPWC	Department of National Park and Wildlife Conservation
EN	Endangered
EW	Extinct from the Wild
EX	Extinct
GoN	Government of Nepal
GPS	Global Positioning System
IUCN	International Union for the Conservation of Nature
LC	Least Concern
NP	National Park
NT	Near Threatened
NTNC	National Trust for Nature Conservation
PA	Protected Area
S	Susceptible
ShNP	Shuklaphanta National Park
TRCC	Turtle Rescue and Conservation Centre
VES	Visual Encounter Survey
Vu	Vulnerable
TPA	Turtle Priority Area

ABSTRACT

Turtles roamed the Earth with dinosaurs making them one of the oldest members of reptiles. In Nepal, the fresh water turtle fauna, characteristics of the Indian sub-continent is greatly supported by Rivers and other wetlands of the Terai region. Terrestrial, semi aquatic and aquatic systems are the major habitat of turtles. Turtles of Nepal are classified into three families; Geoemydidae, Testudinidae and Trionychidae. The main aim of this study is to explore the diversity, distribution and conservation challenges of turtles in Shuklaphanta National Park, Kanchanpur District, Nepal. ShNP was divided into six blocks and Visual Encounter Survey was used to record the presence of turtles in these blocks. In every 100m distance, data regarding variables and turtle presence were recorded and multivariate analysis was done. A total of five species namely- *Lissemys punctata, Melanochelys tricarinata, Nilssonia gangetica, Nilssonia hurum* and *Pangshura tecta* belonging to two different families of order Testudines comprising of 21 individuals from 9 different locations were recorded from the study area. The Shannon diversity index (H') of turtle fauna in the study area was found to be 1.56. Turtle's presence was found to be associated with lakes, rivers. Habitat loss and presence of invasive species were the major challenge for the conservation of turtles. Size of wetlands of ShNP of year 2008 and 2018 were compared to know the changes. The wetlands were decreased by 22-78 percentages in past ten years. Threat analysis was done by questionnaire survey with 103 target people. More than 85% of people knew about the declining population of turtles. Respondent showed disagreed perception towards turtles. Ethnicity, gender and age had significant relationship with conservation perception.

1. INTRODUCTION

1.1 Background of the study

Turtles and tortoises of order Testudines (Dubois and Bour 2010) are characterized by a special bony or cartilaginous shell developed by the fusion of the parts of the skeleton (vertebral processes, ribs, breast bone) with osteoderms and acting as a shield; dorsal domed carapace & ventral flat plastron (Hutchinson 1996; Schleich and Kaestle 2002). Both extant and extinct species are included in order Chelonia/ Testudines. The order includes tortoises, terrapins and marine & fresh water turtles. Tortoises live only on land. Terrapins are small fresh water chelonians and turtles are exclusively marine species. Some use land tortoise, fresh water turtle and sea turtle to distinguish these species. In general different writers have grouped the chelonians under a single heading 'turtles' (here after the chelonians will simply be termed as turtles).

Tortoises have carapace and plastron covered with horny plates, are club footed; only the claws of fingers and toes are discernible. The carapace and plastron of soft-shelled turtles have continuous leathery skin layer. Terrapins have distinct fingers and toes which are often webbed (Schleich and Kaestle 2002). Turtle's legs are highly modified for aquatic life and take the form of efficient paddles.

Turtles are one of the oldest members of the reptiles, lived on Earth since 220 million years ago (Walter 2000). However, their previously successful survival adaptations including delayed sexual maturity, high juvenile mortality, and long adult life-span with low natural mortality have left turtle populations vulnerable to new, potentially devastating threats posed by human exploitation and development related pressures. They are vital biodiversity components of the ecosystem they inhabit. They often act as keystone species (Turtle Conservation Foundation 2002).

In Nepal, the fresh water turtle fauna, characteristics of the Indian sub-continent is greatly supported by the wetlands and rivers of the Terai region (Mitchell and Rhodin 1996). Terrestrial, semi aquatic and aquatic systems are the major habitat of tortoises and fresh water turtles. Turtles of Nepal are classified into three families; Geoemydidae, Testudinidae and Trionychidae. The detail summary of status of turtles & tortoises of Nepal is given in annex II.

Till date, a total of 478 modern Chelonians comprising of 356 species, of which 60 are polytyphic and 122 additional sub species have been recognized. Seven species and three sub species (2.1%) have already been lost because of lack of sufficient conservation efforts (Rhodin 2008). Approximately 300 species of freshwater tortoises and turtles are distributed over seven major geographic regions in which Asia has the highest species diversity comprising as many as 91% of the Chelonians are listed in the IUCN red list where 75% of the species are either critically endangered (CR) or endangered (EN) or vulnerable (VU) (Turtle Conservation Foundation 2002). Turtles are at greatest risk of extinction (47.6%) amongst the known large animals (Kiester and Olson 2011). Hoffmann et al. (2010) used a different way for the calculation of the threat levels by excluding the data deficient or unevaluated species and found out 54% of the turtles are threatened.

The species distribution is not even in the world. The area with more number of species is known as biodiversity hotspot. The Ganges Brahmaputra floodplain is one of three hotspots for biodiversity of turtles in tropical and subtropical Asia. This hotspot includes Nepal, Bangladesh, Bhutan, China and India along with Indo-Burma hotspot and Sundaland hotspot. These three hotspots for biodiversity of turtles encompasses more than one quarter of the world's turtle (Mittermeier et al. 2015).

Human actuation is pushing the turtles towards extinction. There are three main causes; natural habitat destruction, hunting of turtle as food and hunting of turtle to be used as pet. This serious situation in context of Asian turtle has been given the name as "the Asian turtle crisis" (Dijk et al. 2000). The study on turtles is limited in Nepal. Their scarce presence, cryptic nature and declining population make their study hard.
This study, not only focus on the diversity and distribution but also the conservation challenges that turtles are facing, making it the first of its kind in Nepal.

1.2 Research Objectives

1.2.1 General objective

The main aim of this study was to explore the diversity, distribution and conservation challenges of turtles in Shuklaphanta National Park, Nepal.

1.2.2 Specific objectives

- To determine diversity and distribution pattern of turtles in the study area.
- To explore conservation challenges, existing threats and target people's perception towards turtles.

1.3 Rationale of the study

Among vertebrates, the herpetofauna are the most endangered group of species and their decline rate is also very rapid, and lack of conservation efforts will result in the extinction of these species (Stuart et al. 2004). Turtles act as an indicator species in wetland ecosystems and are one of the key components of aquatic ecosystem as they feed on different slow moving aquatic fauna, dead animals and their fragments, thus maintain ecological balance and water quality (Hossain et al. 2009).

The knowledge about the diversity and distribution of turtles is lacking in the Far Western region of Nepal. However, very few works have been done on their status and species diversity. Nepal's protected areas mainly focus on large mammals. Conservation of turtles is not a topic of much concern. This creates an information gap regarding occurrence, habitats and other ecological aspects of turtle species (Schleich and Kaestle 2002). Various forms of anthropogenic threats like hunting, habitat loss, agricultural practices, rapid urbanization, encroachment, draining, deforestation, pollution, siltation, etc. are considered to be the major threats to turtles.

A large number of turtles are lost due to lack of knowledge and due to such activities. This study gave baseline information about species diversity, distribution pattern and threats for conservation planning & management.

2. LITERATURE REVIEW

Diversity and Distribution

BPP (1995) investigated the wetland biodiversity of 51 wetlands comprising lakes, ponds and river floodplains of Terai and recorded the presence of nine species of turtles. They prioritized rich turtle faunal wetlands, Ghodaghodi Lake, Baisahwa Lake and Kurkhuria Lake, during their study. They confirmed the presence of three species of turtles, Red crowned roofed turtle (*Batagur kachuga*), Indian roofed turtle (*Pangshura tecta*) and Flap shell turtle (*Lissemys punctata*).

Shah (1995) recorded 14 species of turtles from Nepal. Out of 14 species, six species of turtles were recorded from Kailali district only. Shah (1997) made a study on accounts of turtles of Nepal. He recorded the presence of 14 species of turtles from Nepal comprising of one tortoise and 13 turtles. Thakulla (1999) found the occurrence of five species of turtles during his survey in Kailali district. The species recorded by him were *Kachuga kachuga*, *Indotestudo elongata*, *Nilssonia gangetica*, *Chitra indica* and *Lissemys punctata*.

Schleich and Kaestle (2002) mentioned the occurrence of following species from different places of Nepal in his book "Amphibians and Reptiles of Nepal"; *Melanochelys tricarinata* from Ghoda-ghodi Tal (Kailali) in 2000, Bardia in 2001 and Shivpur in 1994; *Melanochelys trijuga* from Bardia in 1994, Bethkot Tal (Kanchanpur) in 2000, Ghoda-ghodi Tal (Kailali) in 2000, Kasarah (Chitwan) in 1994, Koshi Tapu in 1996 and Shuklaphanta in 1994; *Pangshura flaviventer* from Koshi Barrage 1997 and 1999; *Pangshura smithii smithii* from Koshi Tappu and Koshi Barrage in 1997, 1998 and 1999; *Pangshura smithii pallidipes* from BNP in 2001; *Pangshura tecta* from Lumbini Tank in 1994; *Pangshura tentoria circumdata* Koshi Barrage in 2001; *Indotestudo elongata* from Bardia in 1994 Kasarah (Chitwan) in 1994; *Nillsonia gangetica* from Bardia in 2001, Ghoda-ghodi Tal (Kailali) in 2000 and Koshi Barrage in 2000; *Nillsonia hurum* from BNP in 2001 and Koshi Barrage in 2000; *Chitra indica* from Ithari in 1996, Kechana Jheel in 1998, Koshi Barrage in 1979 &1999 and Koshi Tappu in 1994; *Lissemys punctata* from Bardibas in 1996, Bardia in 2001, Butwal in 1998, Ghoda-ghodi Tal in 1994 & 2000, Kanchanpur in 1996, Kechana Jheel in 1998, Koshi Barrage in 1996 &2000, Lumbini in 1998, Patu in 1996, Shivpur in 1994.

Cyclemys oldhamii is only recorded from the eastern Nepal despite it belongs to Indo Malayan and Sundic sub-region (Rai 2004). He collected a juvenile from the periphery of Banmare Khola, an eastern flood plain tributary of the Tangting River, and another adult specimen was collected from Dhobi Khola (450 m), a western tributary of the river. Empty shells were also collected from Garuwa and Mai valleys, respectively.

Kharel and Chhetry (2013) reported the presence of 67 specimens of turtles belonging to eight different species including their information and body elements like carapace, plastron, egg etc. Amongst the 8 species collected, four were hard shelled and four were soft shelled.

Bhattarai et al. (2017) conducted a herpetofaunal survey in Ramsar site, Beeshazare and associated lakes of CNP and recorded the presence of four turtle species belonging to three different genera of three different families. They recorded occurrence of one species from Beeshazar Lake, two from Buff Tal, one from Batauli Pokhari Lake, two from Khorsor, one from Khageri canal and one from forest roads and trails. They made the observation of four individuals of *Lissemys punctata*, one *Melanochelys trijuga*, two *Melanochelys tricarinata* and one *Indotestudo elongata*.

Bhattarai et al. (2018) conducted a herpetofaunal survey in Parsa National Park and recorded a single specimen of *Indotestudo elongata* from Ghodemasan. Two more rescued specimens of the same species were kept in Amlekhgunj-Hattisar and finally released inside the park later.

Buhlmann et al. (2009) described the world in seven geographic regions on the basis of tortoises and freshwater turtle species occurrence. Asia has the highest species richness (77) having all of them to be endemic. 53 species of these 77 endemic species belong to family Geomydidae, 16 species belong to family Trionychidae, seven species belong to Testudinidae and one species belong to Platysternidae. They described lower Gangetic plain to be one of the three new global turtle priority areas (TPA).

Hossain et al. (2009) conducted a study on the ecology of *Lissemys punctata* in Bangladesh and found the occurrence of it in nine types of habitats studied. The highest number (17.42%) of the turtle species was found in marshland followed by puddles (17.26%), agriculture fields (17.12%), streams (12.1%), canals (10.54%), tanks (10.39%), derelict ponds (9.18%) and domestic ponds (6.08%). Most of the time the turtle was

found in burrowing condition (55.83%), rarely it was observed in feeding (7.2%) condition. They concluded the turtle being highly tolerable in all types of habitat.

Conservation challenges

According to Turtle Conservation Fund (2002), turtles are being collected, butchered, eaten, and traded in overwhelming numbers. They are used for food, pets, traditional medicine — eggs, juveniles, adults, body parts — all are exploited indiscriminately, with no regard for sustainability. Their habitats are being increasingly fragmented, destroyed, developed, and polluted. Populations are shrinking. Species worldwide are threatened and vulnerable, many are critically endangered, others teeter on the very edge of extinction, and a few have already been lost forever. If no conservation efforts are to be carried out, turtles and tortoises will be facing the risk of extinction.

Aryal et al. (2010) reported the occurrence of 16 species (1- Critically Endangered, 3- Endangered and 4- Vulnerable), including subspecies of turtles from Nepal of which 6 species of turtles from Shuklaphanta National Park. Ten species were observed exploited either alive or killed. They found 25 Kg of turtles in Rupandehi, 12-25 kg in Kapilvastu, 15 kg in Sunsari being traded in market. Though there were no sign of trade market for turtle in Kanchanpur district but whatever found were sold to the nearby settlements or villages. Bhatt (2010) studied the status of Mugger crocodile at Rani Tal, ShNP and explained about the status and degreasing trend of Rani Tal. According to him, if such declining trend persists, the Tal would disappear within about 10 years.

Bista and Shah (2010) conducted a field survey in Ghodaghodi Lake Area in September-October, 2009 for 28 days in order to document the diversity, ethno zoology and conservation issues of the turtles in the area. They recorded a total of 11 species of turtles including 1 critically Endangered, 2 Endangered and 1 Vulnerable species from the study area. Fifty Nine percentages of the individuals were found in lake water. They found 35 cases of illegal trade, 2 individuals being sold at market and two were found in an earthen pot as pet.

People's perception

Poonia (2012) recorded the presence of nine species of turtles from Northern Haryana during his PhD thesis. He surveyed 775 villages in 11 districts. He recovered these species with great difficulty. His interaction with the local people revealed the presence of turtles 25 to 40 years back in all the village ponds. His interaction also confirmed the presence of stray turtles in those ponds. He mentioned that under natural circumstances no turtles were present in Northern Haryana. During his survey period (2005-2012), he found the presence of turtles from 31 fish farming ponds (only one-two specimen) out of 100 fish farming ponds.

The literature review clearly illustrates that the study on turtles is limited. In most of the areas of Nepal the presence absence survey is lacking. Preparation of checklist has not been carried out. Most of the studies were focused in Central and Eastern part of Nepal. The scarce presence of turtle in almost every study clearly demonstrates the condition of turtles. This study will focus on inventory of turtles and challenges for their conservation.

3. MATERIALS AND METHODS

3.1 Study area

Kanchanpur is the western most district of Province number 7, Nepal (28° 33'10"N to 29° 06'29"N and 80°03'05"E to 80°33'35"E). It covers an area of 1610 square Kilometer sharing its border with Kailali district on East, Dadeldhura on North and India on South and West. One fifth of the district area is covered by ShNP (28° 53' N to 80°11'E). It was established in 1969 as a hunting reserve. Later in 1976, it was gazetted as wildlife reserve and in 2017 as national park. It is an IUCN category IV National Park located in the lowlands of the Terai region having ground elevation range from 150m to 600m.

The study was conducted in Shuklaphanta National Park. Based upon the preliminary survey the study area was divided into six blocks; Raani Lake, Baba Lake, Tara Lake, Salgaudai Tal Mahakali River inside ShNP, Chaudhar River inside ShNP and Kalikitch Lake. Also the potential habitats inside the park were studied. Bahuni khola, Ghumauna Lake and Shikari Tal were identified as the potential habitats of turtles. The climatic condition of the study area varies throughout the different season. During winter, temperature ranges from 10-12^{o}C. In February and March, it gradually rises up to 22-25^{o}C. In the monsoon period (April-June), temperatures range from 30-32^{o}C reaching as high as 42^{o}C with increasing humidity.

The vegetation throughout the range of study area includes Sal (*Shorea robusta*), Asna (*Terminalia alata*), Simal (*Bombax ceiba*), Karma (*Adina cordifolia*), Khair (*Acacia catechu*), sissoo (*Dalbergia sissoo*), Jamun (*Syzygium cumini*), Narkat (*Phragmitis vallatoria*) etc.

The study area is rich in faunal diversity with different endangered species. The major fish species of this area are Bighead Carp (*Hypophthalmichthys nobilis*), Rohu (*Labeo rohita*), Silver carp (*Hypophthalmichthys molitrix),* Naini *(Cirrihinus cirrhosus),* Catla (*Catla catla*), Mungri (*Clarias batrachus)*etc. The herpetofaunal species includes Spined toad (*Bufo melanostictus),* Garden lizard *(Calotes versicolor),* Monitor lizard *(Varanus bengalensis),* Indian tree frog *(Polypedates maculates),* Asiatic rock python *(Python morulus),* turtles and tortoises species etc. The area consists many birds such as Asian koel *(Eudynamys scolopacea),* Parrot *(Psittacula spss.),* Red jungle fowl *(Gallus gallus),*

Great egret *(Asmerodius albus)*, Black-capped Kingfisher *(Halcyon pileata)*, Red watteled lapwing *(Vanellus indicus)* etc. The mammalian species include Mongoose *(Herpestes)*, Golden Jackle *(Canis aureus)*, Loepard cat *(Felis bengalensis)*, Common otter *(Lutra lutra)*, Rhesus monkey *(Macaca mulatta)*, Jungle cat *(Felis chaus)*, Squirrel *(Funambulus pennanti)*, Fishing cat *(Felis viverrina)*, Wild boar *(Sus scrofa)* etc.

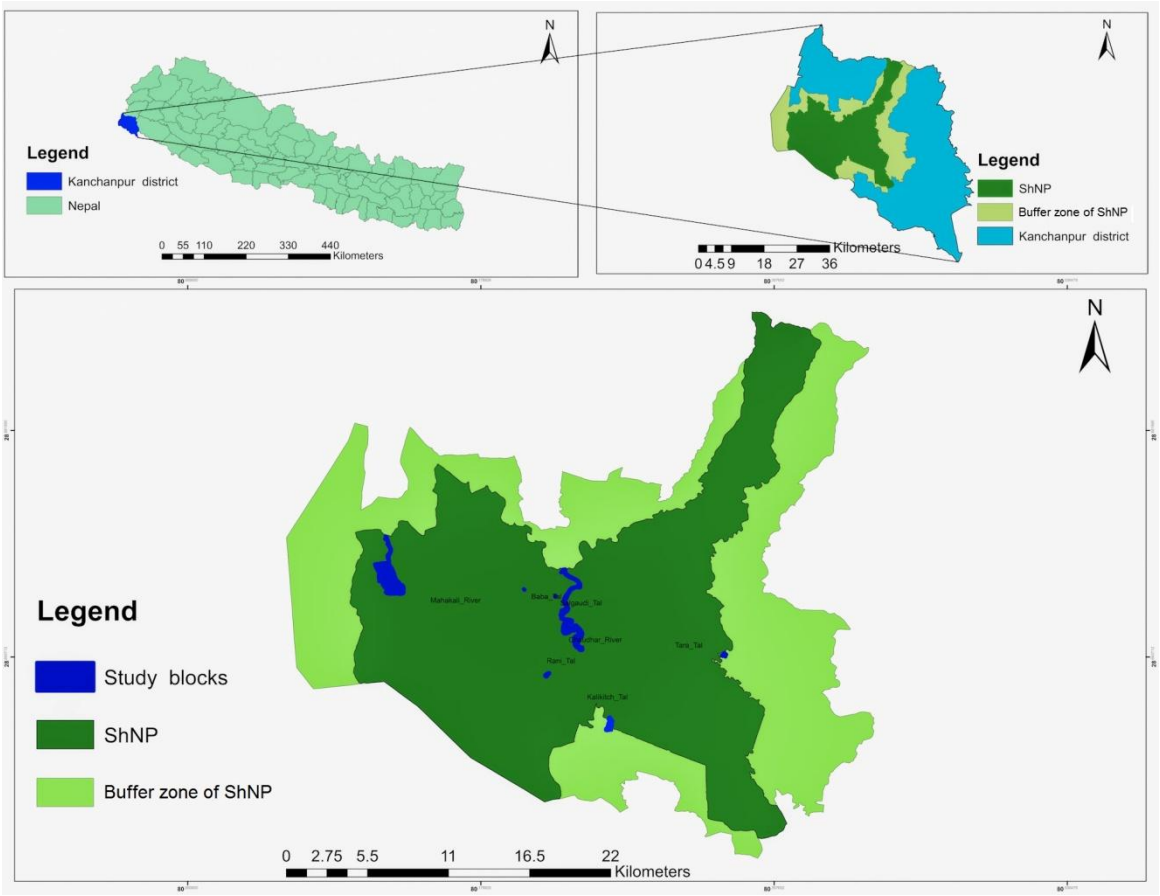

Figure 1: Location of the study area and study blocks

3.2 Materials

The following materials were used during the research work

1. GPS
2. Camera
3. Measuring tape
4. ID plates
5. Portable Weighing machine
6. Gloves
7. Topographic maps
8. Field note books and pen
9. Field guide book
10. Compass

3.3 Methods

3.3.1 Preliminary survey

The potential habitats of the turtles were identified through a preliminary site visit prior to the field sampling in January 2018. During this survey, interaction with the local people living around the ShNP was done for the assessment of the potential sites for sampling. Local Tharu community was focused more as they moved from the ShNP during the extension of the park. Geographic coordinates were recorded in GPS and transects for VES were made. The primary data were collected by simple transect walk in potential habitat of the turtles visually searching for turtles (Photo 17). Based upon the preliminary survey the study area was divided into following seven blocks
Extensive field survey was carried in these sites.

Table 1: Details of the survey site

Study blocks	Latitude	Longitude	Habitat type
Salgaudi Tal	28.880556	80.223875	Lake
Baba Tal	28.884879	80.205453	Lake
Rani Tal	28.832222	80.219167	Lake
Kalikitch Tal	28.801944	80.260278	Lake
Chaudhar River	28.893065	80.231925	River
Mahakali River	28.897846	80.124673	River
Tara Tal	28.845118	80.327219	Lake

3.3.2 Inventory of species of turtles

Visual Encounter Survey (VES)

Visual Encounter Survey (VES), formalized by Campbell and Christman (1982), and was used to document the presence of the turtles. VES was used along transects, ponds, wetlands, rivulets etc. Two of the standard sampling designs for VES are opportunistic or randomized walk along transects. VES was done through a systematic observation, walking along transects through a designated area for a prescribed time visually searching for animals (Photo 17). In every 100m (50m in case of small wetlands), data were collected for different variables (distance to nearest post, width of sand bank, availability

of basking area). The study was carried out with more than 200 hours of observations in the study area. All the observations and data were collected without disturbing the animals in their natural condition. The most appropriate time for VES technique is at dusk and dawn for about an hour or two hour (Menegon 2007). VES was also done during the mid-day for basking animals. Specimens were collected by direct hand picking wherever necessary.

Opportunistic Survey

Opportunistic survey secures the incorporation of species found besides other standardized methodologies (Durkin et al. 2011). Incidental observations of turtles that were obtained other than specified sampling method were pooled with systematic method.

Species identification

Morphological characteristics and high resolution photographs were used to for the identification of the species. All the specimens were identified with the help of field guide "Field guide to Amphibians and Reptiles of Nepal", by Kaestle, Rai and Schleich 2013, the literatures and keys used in (Schleich and Kastle 2002; Schleich and Rai 2012a, 2012b, 2012c; Schleich and Rai 2016; Kastle et al. 2013). Collection and preservation of specimens was not done. Photographs of Doubtful specimens were discussed with Prof. Dr. Hermann Schleich and Mr. Tapil Prakash Rai. Online data base of http://www.reptile-database.org/ was also used as reference. Vernier caliper and measuring tape were used for the morphometric (Photo 9) analysis of the turtles. The measurements thus obtained were used for the identification of the specimens.

3.3.3 Diversity and distribution pattern

GPS (Ertx X10) was used to record the geographic position of the species and a spatial distribution map was drawn with the help of Arc GIS (version 10.4) and Google Earth Pro. Variance by mean ratio was calculated to know the distribution pattern of turtles.

3.3.4 Conservation challenges, existing threats and target people's perception

Trade in local markets was inspected. Exploitation of the turtles and tortoises was examined through direct field visit. Questionnaire survey was conducted using structured and semi structured questionnaire to collect information of the target people's perception

(Photo 13) towards the species determine existing threats, conservation practices and future needs.

Questionnaire survey was focused on amongst the target group. The target group included knowledgeable informants such as Tharu (Rana and Chaudhary) community people, park staffs, workers inside ShNP, fishermen, conservationist, herdsmen, and local people nearby the wetlands. One hundred and three respondents gave positive response. Respondent's perception (Photo 13) towards turtles was examined amongst these respondents.

3.3.5 Presence of Turtle and its association with different variables

Variables like presence of turtle, disturbance and environmental variables were sampled in every 100 m sampling point (Bhattarai and Kindlmann 2013). The variables were as species variables, direct observation and indirect sign of turtle presence (due to the scarce presence of turtles the observation made in between these 100 m sampling points were summed to the nearest sampling site).

Disturbance variables: People's presence based upon the number of footprints, leftover dead fishes, leftover plastic bags of gutkha/tobacco/noodles, lopped tress, sites for harvesting grass and presence of livestock based upon their dung and foot print. The human disturbances were recorded in 10m left and right of each transects. The sign of human disturbance were made comparable and a habitat disturbance status (HDS) was calculated using all the disturbance variables mentioned above. All the disturbance factors were merged and an ordinal scale of 1,2,3,4 specifying a very low, low, moderate and high HDS.

Environmental variables: Availability of basking area, sand bank for nesting, Forest association and wetland type was noted in every sampling point.

3.4 Data analysis

Statistical analysis was performed using CANOCO v. 4.5 and SPSS.16.0. Arc GIS 10.4 and Google earth pro were used for the preparation of maps and for the analysis of decrease in the area.

3.4.1 Analysis for inventory of species of Turtles and Tortoises

Analysis of Abundance and Diversity

Relative Abundance of the species was calculated by using following formula:

Pi (Relative abundance) = *ni*/N

Where,

ni = Number of individuals of species

N = total number of individuals of all species

By using Shannon's Diversity Index (H'), data were analyzed for diversity of the species.

H' (Shannon diversity index) = -Σ (*pi*ln*pi*)

Where,

Pi = relative abundance of species

i=1

H'= the Shannon Diversity Index

Ln = Log with base 'e' (Natural logarithm)

Higher value of *H'* shows the higher diversity and the lower value shows the lower diversity. The maximum value of *H'* can be more than one.

3.4.2 Analysis of Turtle species relation with disturbance categories and habitat variables

Canonical correspondence analysis (CCA) was used for the analysis to measure associations of the species with habitat and disturbance. For all analysis, a Monte-Carlo permutation test (using 499 unrestricted permutations) was used to identify the environmental variables that are significantly associated with the variation in the distribution of species using CANOCO (Ter Braak 2009; Leps and Similaur 2003).

3.4.3 Analysis of conservation challenges

The area of wetlands of year 2008 and year 2018 were compared to find out the decrease in their size. Google Earth pro was used to know the size of wetlands. Arc GIS version 10.4 was used to calculate the area.

3.4.4 Analysis of existing threats and local people's perception

The existing threats on turtles were known from the local people and analyzed. The respondents' perceptions towards turtles were measured in a Likert scale (Babbie 1995) of agree to disagree (1-3) as shown in Table 5. Perceptions toward turtle conservation were tested by 11 variables (Table 5). The scores of the nine questions were summed to produce an overall scale score on conservation attributes towards the turtles. The scale of conservation was dichotomized into two categories (agree and disagree) for further analysis. For example, a respondent was assigned a value 1 if he/she has a more favorable perception and '0' if otherwise i.e., neutral or no favorable perception. To measure overall conservation perception towards turtle one point was given to that statement if the respondents agreed and no point was given if they disagreed. The maximum points a respondent could score was nine. A respondent scoring fewer than the four was considered as unfavorable perception while those scoring five or greater than six was considered to have favorable perception towards turtle.

4. RESULTS

4.1 Species diversity

A total of five species belonging to two different families (Geomydidae and Trionychidae) of order Testudines were recorded in this study. The species recorded were *Nilssonia gangetica* (Photo 6 and 10), *Nilssonia hurum* (Photo 7 and 8), *Lissemys punctata* (Photo 2 and 3), *Melanochelys tricarinata* (Photo 14) and *Pangshura tecta* (Photo 4). Altogether 29 sighting of turtles were observed from the study area comprising of 21 individuals from nine different locations were recorded from the study area. Amongst 21 individuals, eight specimens were from family Geoemydidae, 13 specimens were from family Trionychidae. *Lissemys punctata* was recorded the most, six times. *Melanochelys tricarinata* was recorded only twice.

Table 2: Check list of Turtle fauna recorded from the study area.

S. No.	Taxon	Common name	Conservation status		NRDB
			IUCN	CITES	
	Class- Reptilia Order- Tetudinidae Family-Geomydidae				
1	*Melanochelys tricarinata*	Tricarinata hill turtle	VU	I	V
2	*Lissemys punctata*	Indian flap-shelled turtle	LC	II	S
	Family- Trionychidae				
3	*Nilssonia gangetica*	Ganga softshell turtle	VU	I	V
4	*Nilssonia hurum*	Indian peacock softshell turtle	VU	I	S
5	*Pangshura tecta*	Indian roofed turtle	LC	II	S

The Shanon Diversity Index (H') of turtle species recorded in the study area was 1.56 (Appendix 1). The diversity was remarkably dominated by the family Trionychidae (H' = 1.085) followed by family Geomydidae (H' = 0.63651) (Table 3).

Table 3: Shannon diversity Index of different families of turtle species

SN	Family	Shannon Diversity Index (H')
1	Geomydidae	0.63651
2	Trionychidae	1.08519

Abundance of Turtle species

Among all recorded species of turtle species, *Lissemys punctata* was the most abundant species (*Pi* = 28.57) followed by *Nilssonia gangetica* (*Pi*=23.81), *Nilssonia hurum* and *Pangshura tectas* each with *Pi* = 19.05. The least abundant species was *Melanochelys tricarinata* (*Pi=9.52*) (Annex III).

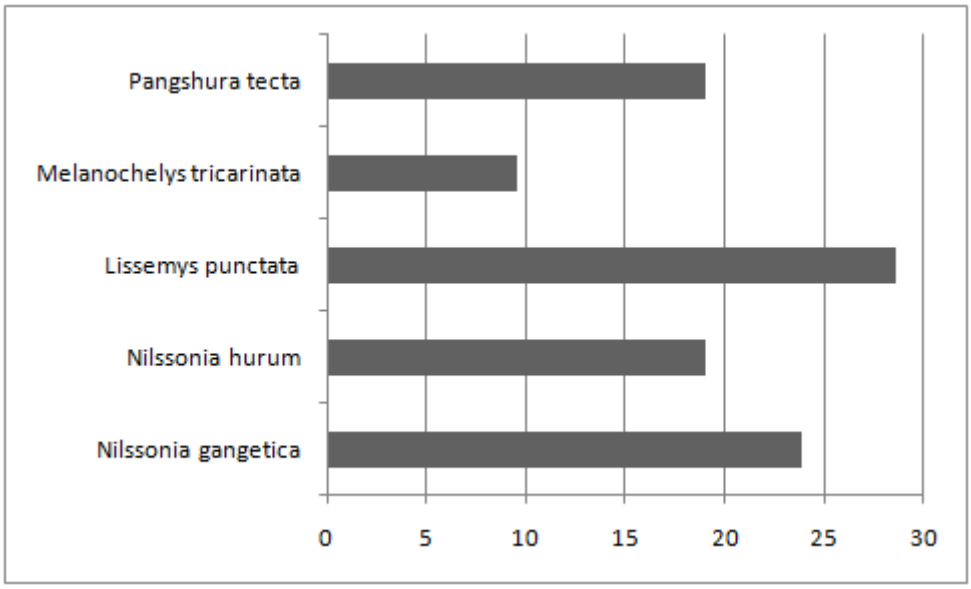

Figure 2: Percentage of relative abundance of turtle species

4.2 Distribution

The distribution of turtles ranged from 28.801451°N to 28.932066°N and 80.124673°E to 80.260976°E. Variance to mean ratio was calculated to evaluate the distribution pattern of turtles in the study area. The variance to mean ratio was found to be 1.25. This shows the clumped distribution pattern of turtles in the study area (Figure 3).

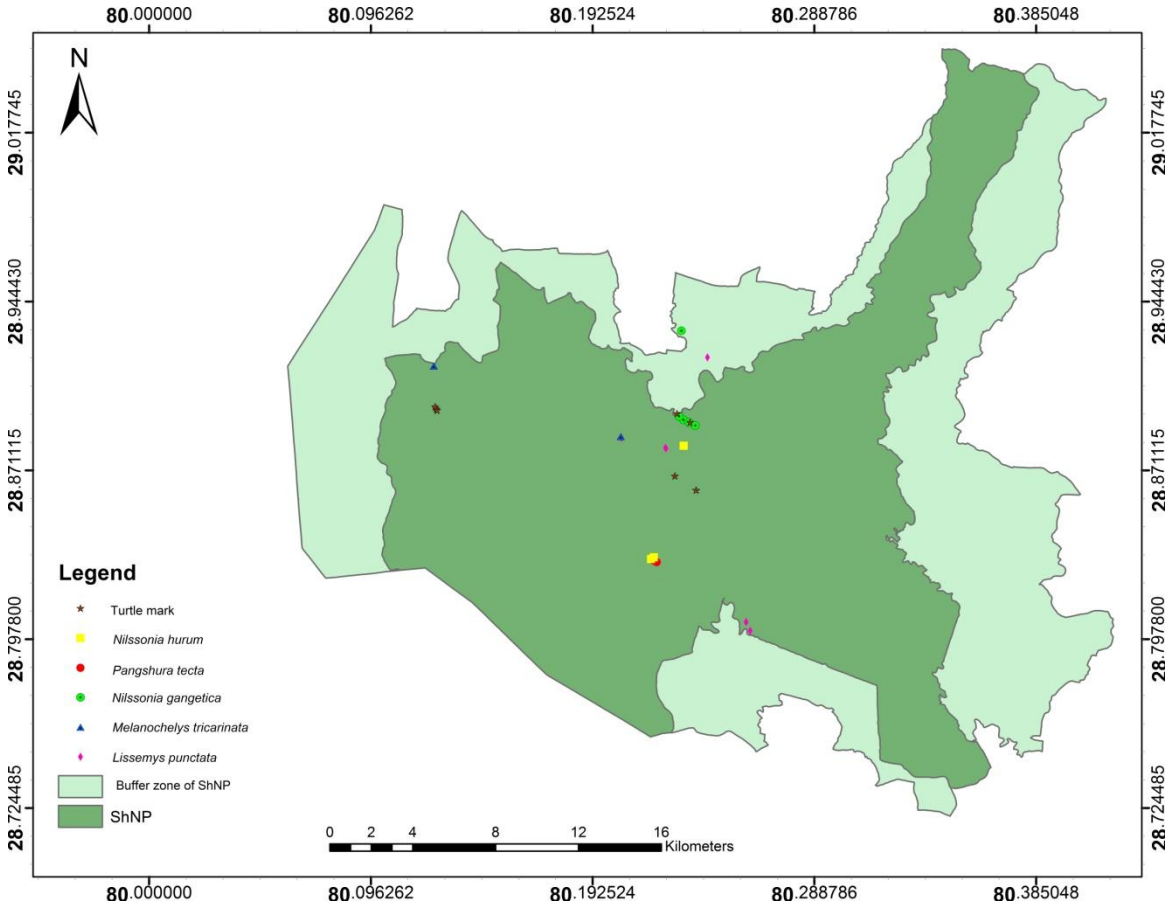

Figure 3: Distribution map of turtles in the study area

4.3 Turtle species relation with different factors

4.3.1 Disturbance variables

The result shows a close association of *Melanochelys tricarinata* species of turtle with very highly human disturbed areas. *Lissemys punctata* show close association with moderately disturbed areas. However, other species i.e. *Nillsonia hurum, Nilssonia gangetica* and *Pangshura tecta* had a close association with those areas where there is less human disturbed (Figure 4).

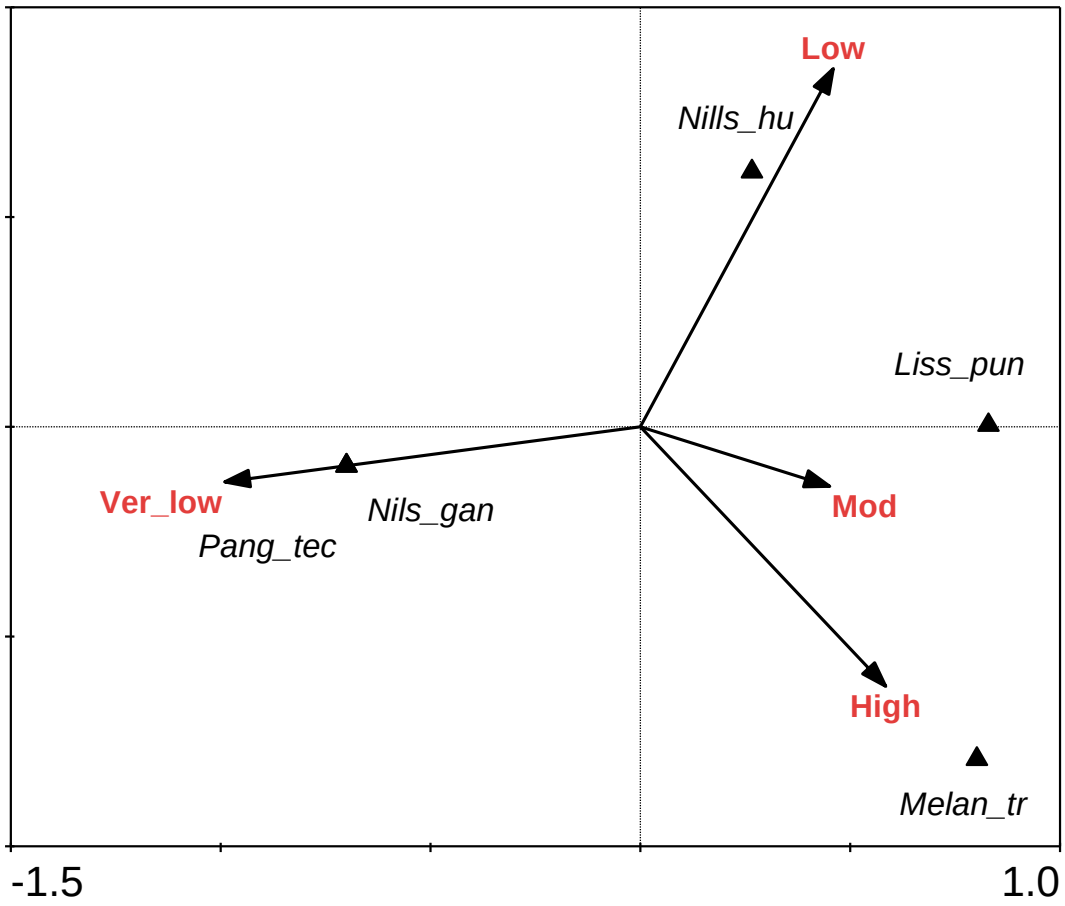

Figure 4: CCA ordination diagram (biplot) showing species response to human disturbance. Monte-Carlo permutation test of significance of all canonical axes: Trace= 0.746, F= 1.968, P =0.05 (with 499 permutations). First two axes are displayed. The first axis accounts for 70.4% and the second axis 21.8% of the variability (*Liss_punc= Lissemys punctata, Nils_gang= Nilssonia gangetica, Nills_hurum=Nillsonia hurum, Melan_trica=Melanochelys tricarinata, Pang_tecta=Pangshura tecta).*

4.3.2 Habitat variables

The species were found closely associated with the lake than others. *Lissemys punctata* and *Pangshura tecta* show more associated with lake areas (Figure 5). *Nillsonia hurum* had more association with the availability of basking area rather than with Sal forest association and width of sand bank. When categorical habitat was used as variables, *Nillsonia hurum* show close association with the riverine forest (Figure 5). *Nilssonia gangetica* was in close association with river area than Riverine forest (Figure 5). Only

Melanochelys tricarinata species shows association with the distance to post (Figure 5) while this species don't show any response with any categorical habitat (Figure 5).

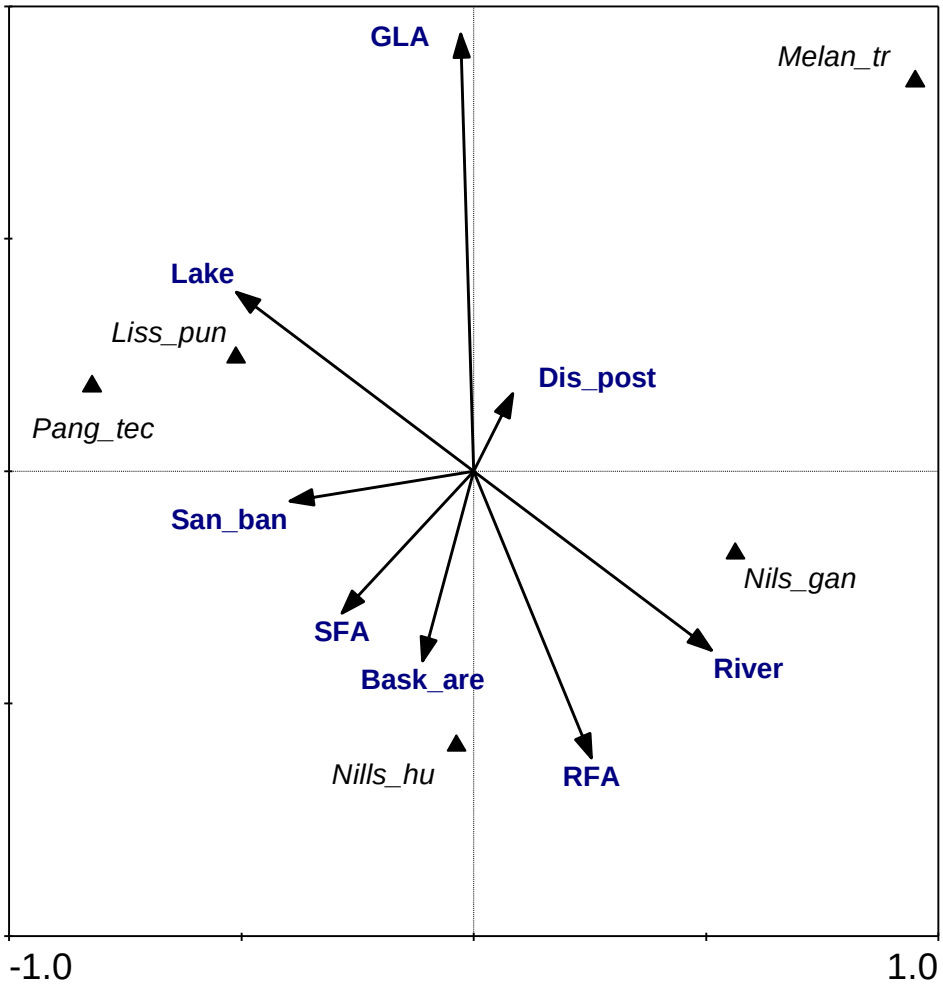

Figure 5: CCA ordination diagram (biplot) showing species response to all habitat variables. Monte-Carlo permutation test of significance of all canonical axes: Trace= 0.768, F= 1.979, P =0.049 (with 499 permutations). First two axes are displayed. The first axis accounts for 64.7% and the second axis 18.8% of the variability (Dis_post= Distance to nearest post, San_ban= Width of sand bank, Bask_are= Availability of basking area, RFA= Riverine Forest Association, SFA= Sal Forest Association, GLA= Grass land Association).

Discriminant analysis shows significant relationship with rivers and lakes that are associated with riverine forests.

Table 4: Tests of Equality of Group Means

Habitat	Wilks' Lambda	F	df1	df2	Sig.
RFA	.980	3.681	1	179	.057
SFA	.993	1.339	1	179	.249
GLA	.991	1.563	1	179	.213
River	.947	9.965	1	179	**.002**
Lake	.947	9.965	1	179	**.002**

4.4 Conservation challenges

Habitat loss is one of the major challenges for the conservation of any species in their natural habitat. The wetland size in the interval of ten years (2008 and 2018) of study area showed that the wetlands were in verge decrease. This will be major challenges in the near future if no any conservation works is done.

The result showed wetlands were decreasing rapidly. The size of wetlands of year 2008 and year 2018 were compared to find out the decrease in their area. It is found that Tara Tal has lost 78.07% from its size in year 2008. While Raani Tal had lost 65.97% of its area in past ten years. Kalikitch Tal has a supply of water from irrigation canal, although it has decreased by 21.45%. This supply of water has maintained the water level to some contest. ShNP has installed a bore well motor to maintain the water level in Baba Tal. All the wetlands of study area had been found decreasing (Figure 11).

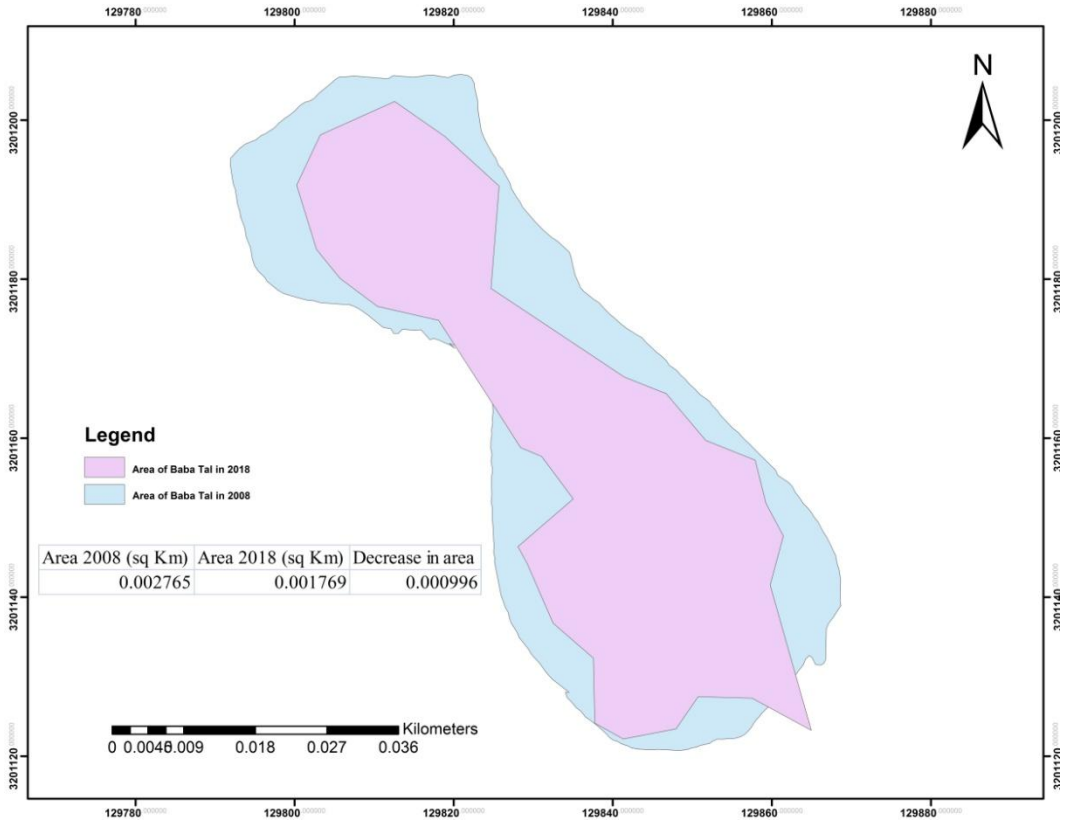

Figure 6: Decrease in the area of Baba Tal in last ten years

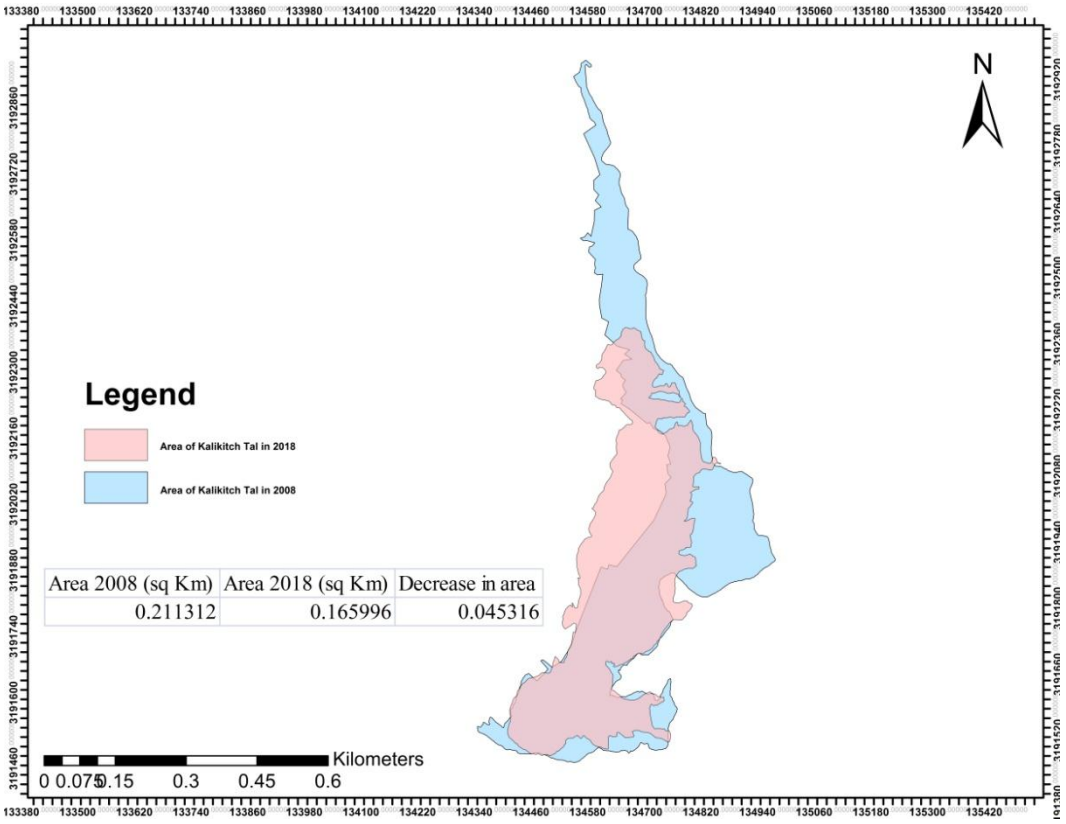

Figure 7: Decrease in the area of Kalikitch Tal in last ten years

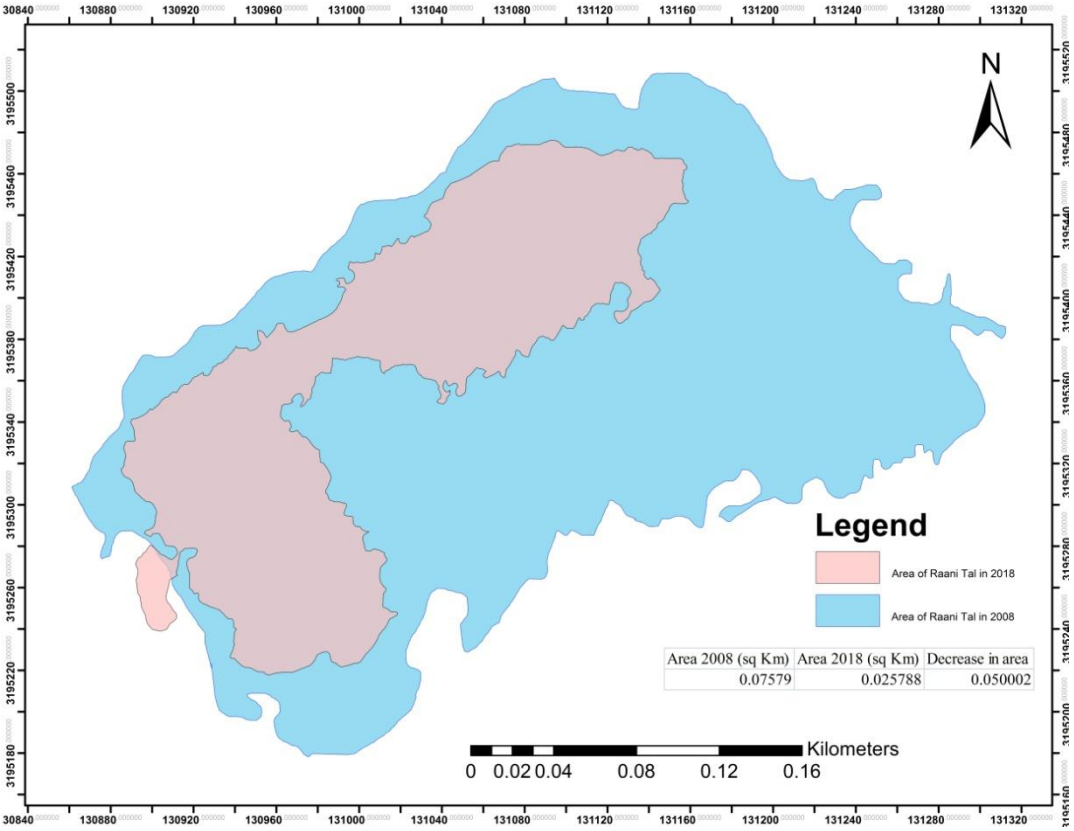

Figure 8: Decrease in the area of Rani Tal in last ten years

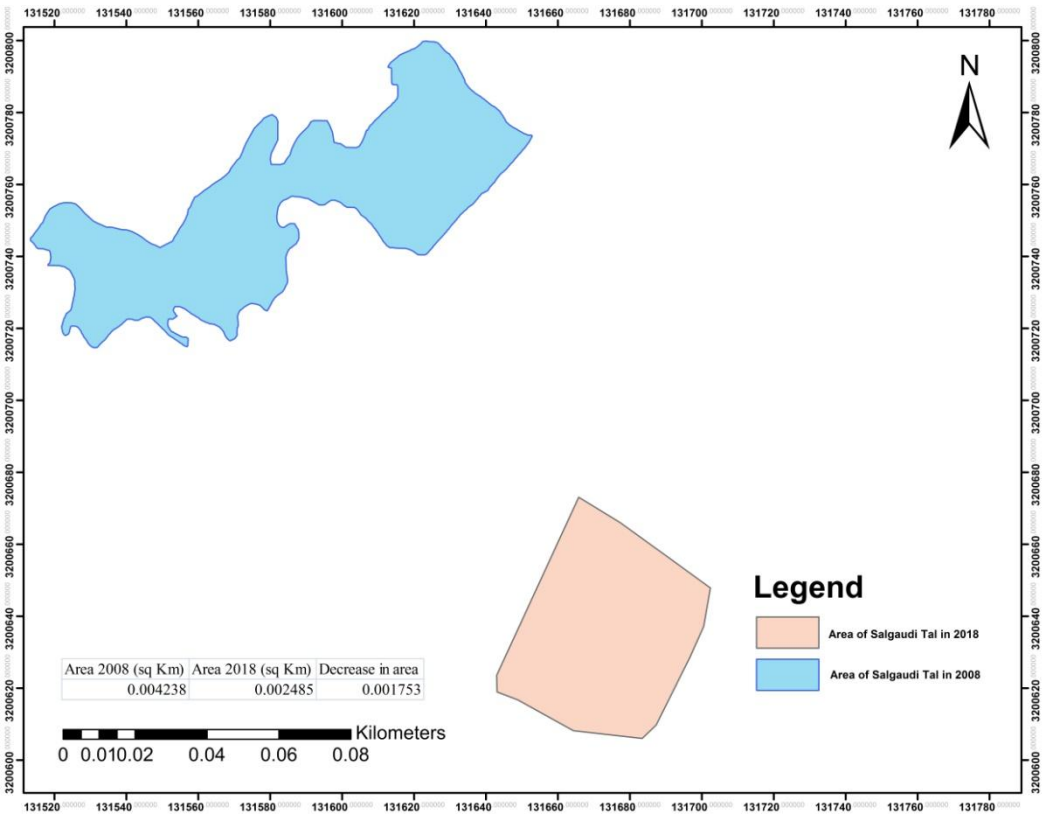

Figure 9: Decrease in the area and shifting of Salgaudi Tal in last ten years

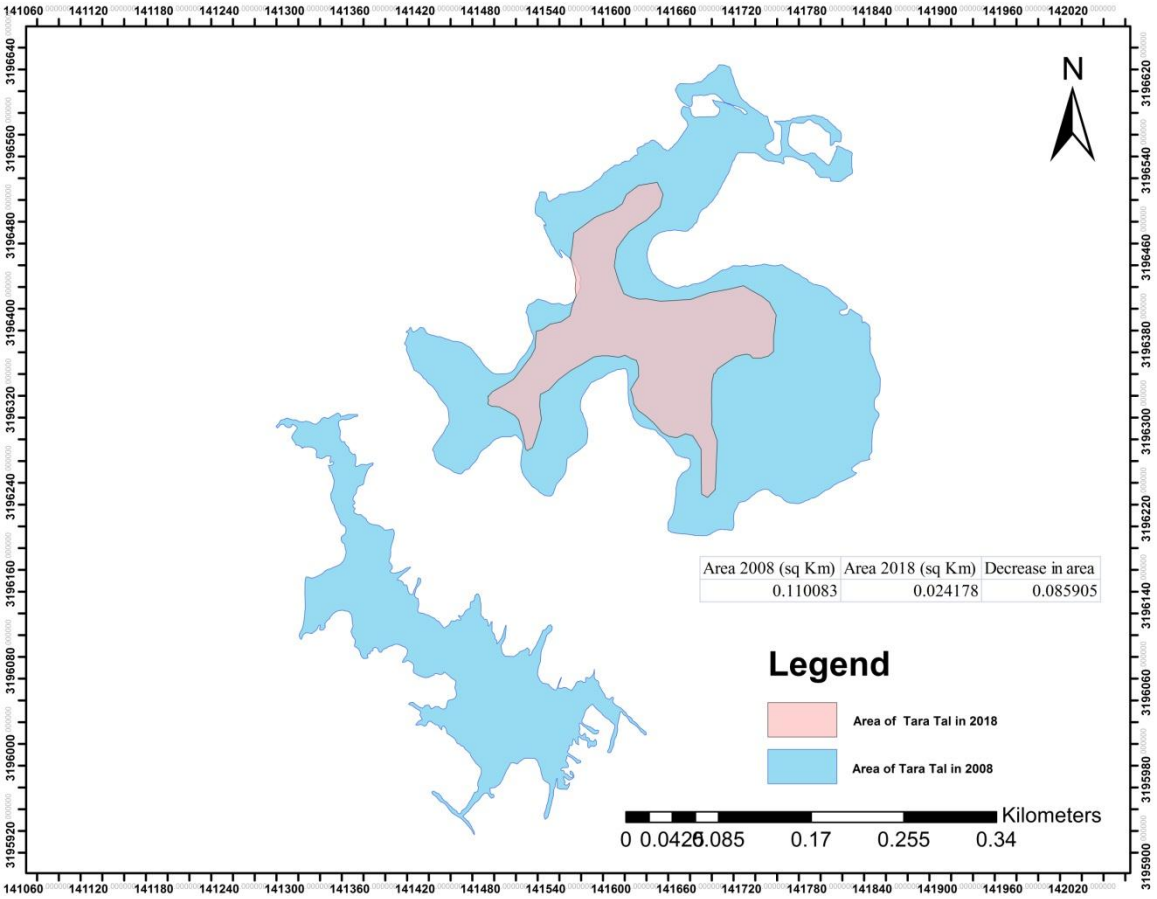

Figure 10: Fragmentation and decrease in the area of Tara Tal in last ten years

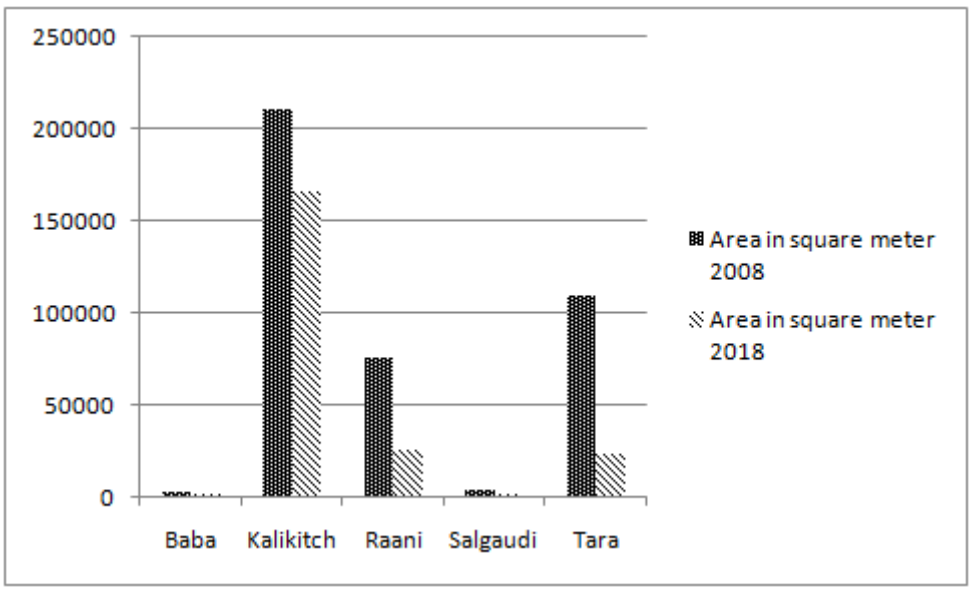

Figure 11: Decrease in size of wetlands in past ten years

4.5 Conservation threats and people's perception

Threats

In Hindu religion, turtles are believed to be the sacred incarnation 'Kurma avataar' of lord Bishnu. Based upon this belief people of Hindu religion, especially Brahmin people refuse the consumption of turtle's meat (Shah 2004). All Tharu people were involved in consumption of turtle's meat. They regularly do not go to catch turtles but whatever and when ever found were eaten by them.

According to the local people, the result shows that high percentage (82.5%) of threats to turtle was commercial exploitation and unsustainable use. Threats due to habitat loss was 11.7% followed by non-anthropogenic causes (disease, drought etc.) 3.9% and others was 1.9%.

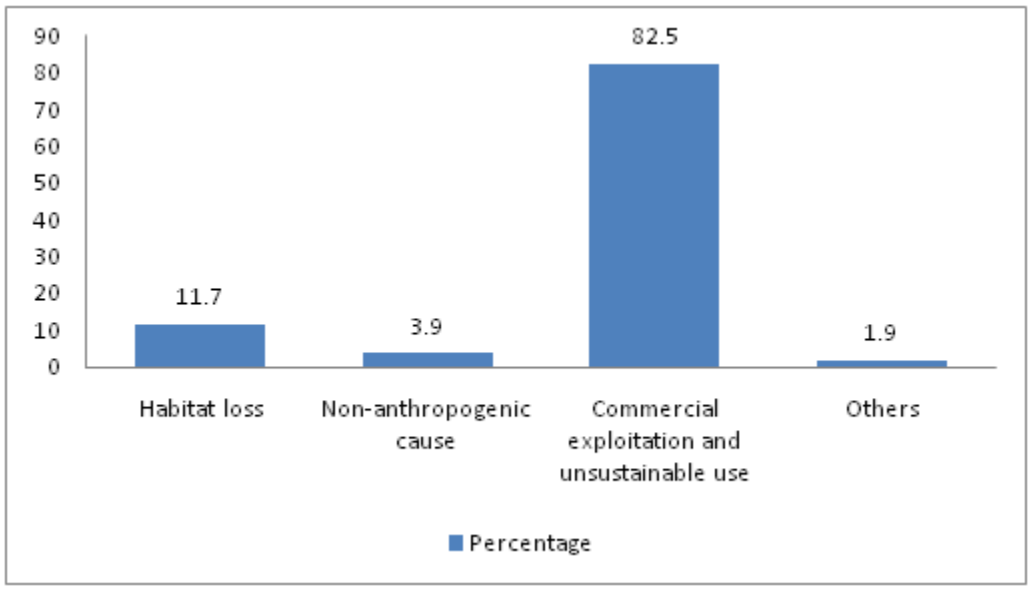

Figure 12: Existing threats of turtles in the study area

People's perception

Among the total respondents, 75.73% were male and 24.27% were female. The age of the respondents were ranged from 15 to 65 years with a median age of 30 years. The highest percentage of respondents (51.46%) belonged to the younger age class followed by middle (35.92%) and older age classes (12.62%). The average family size was 5.09. The 64.08% of the respondents belonged to Tharu followed by Bharmin/Chetri (26.21%) and others (9.71%). The 47.57% of the respondents were passed secondary level, 29.12%

passed primary level, 14.56% college level and rest were illiterate. The main occupation of the study area was agriculture.

The overall perception of respondents towards turtles was towards partially disagree and partially neutral as the total weighted mean is 2.53 (average total weighted mean of Likert Scale is 2). The scores of the nine questions were summed to produce an overall scale score on conservation attributes towards the turtles.

The majority (88.35%) was aware about the declining condition of turtles in their area and 82.52% agreed that people kill turtles. About 25.24% respondents claimed about the participation of people in illegal trading of turtles. The 88.35% of respondents agree with the statement "Turtles should exist in nature". A significantly large of respondents agrees about the conservation of turtles by educating people and 84.47% knew this creature as beneficial. Only few 14.56% have regards for turtles as religious significance. The maximum respondents agree decrease in wetlands/habitat and anthropogenic causes/habitat fragmentation may cause decline in turtle population.

Table 5: Overall perceptions of people towards turtles

SN	Statements	Agree	Neutral	Disagree	WM
1	Turtles are declining in your areas.	88.35	9.71	1.94	2.86
2	People kill turtles.	82.52	4.85	12.63	2.7
3	People participate in illegal trading of turtle's part.	25.24	50.49	24.27	2.01
4	Turtles should exist in nature.	88.35	6.8	4.85	2.84
5	It is important to educate people about turtle conservation.	82.52	12.62	4.85	2.78
6	Peoples have high regards for turtles due to cultural and religious significance.	14.56	69.9	15.53	1.99
7	Turtles are beneficial to humans.	84.47	2.91	12.62	2.72
8	Wetlands/habitat of turtles has decreased in recent year.	66.01	22.33	11.66	2.54
9	Anthropogenic causes/habitat fragmentation may cause decline in turtle population.	51.45	30.1	15.45	2.3
	Average mean of total weighted mean				2.53

Factors affecting people's perception towards turtle conservation

The results shows the average weighted mean (1.63) shows towards unfavorable perception (average weighted mean scale is 1.5). The dichotomized scale was used to test the significant predictors of conservation perception.

All the ethnicities have like same favorable perceptions while Brahmin/Chetri were more favorable (72.02%) as compared to others (χ^2=5.95, p=0.05) (Table). Male respondents showed more favorable perceptions than female (χ^2=5.78). The younger age class (72.12%) shows more favorable as compared to another age class. Those respondents who have attend college education were more favor (71.85%) towards turtle followed by secondary education respondents, primary level and illiterate respondents (χ^2=7.15, p<0.05). Hence, there was no significant association of conservation perceptions with socio-economic variables such as education and resource dependency while ethnicity, gender and age were major predictor of conservation perceptions.

Table 6: Relation between socioeconomic and conservation perceptions

Factors	**Category**	**F (%)**	**UF (%)**	**WM**	**X^2**	**df**	**P**
Ethnicity	Brahmin/Chetri	72.02	27.98	1.7202	5.95	2	0.05
	Tharu	65.15	34.85	1.6515			
	Others	55.55	44.44	1.5554			
Gender	Male	68.23	31.77	1.6823	5.78	1	0.02
	Female	51.56	48.44	1.5156			
Age	Young(15-35)	72.12	27.88	1.7212	13.43	2	0.001
	Middle(35-55)	62.46	37.54	1.6246			
	Old(>55)	47.01	52.99	1.4701			
Education	Illiterate(<1year)	54.32	45.68	1.5432	7.15	3	0.07
	Primary(1-5 years)	67.04	32.96	1.6704			
	Secondary(5-10 years)	64.17	35.83	1.6417			
	College(>10 years)	71.85	28.15	1.7185			
Resource Dependency	Dependent	67.35	32.65	1.6735	2.04	1	0.15
	Not dependent	57.58	42.42	1.5758			

*=p<0.05, F=Favorable, UF= Unfavorable, WM=Weight mean, χ^2 = Chi-square.

5. DISCUSSION

Diversity and distribution

Five species of turtles (*Nilssonia gangetica, Nilssonia hurum, Lissemys punctata, Melanochelys tricarinata* and *Pangshura tecta*) were recorded during the study period. Aryal et al. (2010) recorded the presence of six species of turtles (*Nilssonia gangetica, Nilssonia hurum, Lissemys punctata, Melanochelys tricarinata, Melanochelys trijuga a*nd *Pangshura tecta*) from Shukla phanta National Park. The presence of Melanochelys trijuga could not be confirmed from this study. The presence might not have been recorded due to extreme climatic conditions like no sun shine for many days and drought in pre monsoon season. Schleich and Kaestle (2002) mentioned the occurrence of following species from different places of Nepal in his book "Amphibians and Reptiles of Nepal"; *Melanochelys tricarinata* from Ghoda-ghodi Tal (Kailali) in 2000, Bardia in 2001 and Shivpur in 1994. *Melanochelys trijuga* from Bardia in 1994, Bethkot Tal (Kanchanpur) in 2000, Ghoda-ghodi Tal (Kailali) in 2000, Kasarah (Chitwan) in 1994, Koshi Tappu in 1996 and Shuklaphanta in1994 which was not encounter during this study. They recorded *Nillsonia gangetica* from Bardia in 2001, Ghoda-ghodi Tal (Kailali) in 2000 and Koshi Barrage in 2000; *Nillsonia hurum* from BNP in 2001 and Koshi Barrage in 2000. *Lissemys punctata* from Bardibas in 1996, Bardia in 2001, Butwal in 1998, Ghoda-ghodi Tal in 1994 & 2000, Kanchanpur in 1996, Kechana Jheel in 1998, Koshi Barrage in 1996 &2000, Lumbini in 1998, Patu in 1996, Shivpur in 1994. The presence of *Melanochelys trijuga* could not be confirmed from this study. Two individuals of *Melanochelys tricarinata* were observed during this study. Their occurrence was recorded from Hattisar near Mahakali River and grassland near Baba Tal. Both of the sites are highly human disturbed as a tourist destination. One individual of tricarinata hill turtle was observed inside the post of hattisar. It might have come in search of stray food.

Shah (1995) recorded six species of turtles from Kailali district. Thakulla (1999) found the occurrence of five species of turtles during his survey from Kailali District. He mentioned the presence of *Nilssonia hurum* and *Lissemys punctata* from Ghoda ghodi Lake of Kailali district. The species recorded by him were *Kachuga kachuga, Indotetudo elongata, Nilssonia gangetica, Chitra indica* and *Lissemys punctata*. Although no sign of

presence of *Kachuga kachuga*, *Indotetudo elongata* and *Chitra indica* were observed during this study. Furthermore, Shah and Tiwari (2002) have reported *Nilssonia hurum* as a new species from Kailali district. The presence of *Nilssonia hurum* has been already reported from Koshi River by Rai (2003). Later on, Shah and Tiwari (2004) reported the presence of *Nilssonia hurum* from the lowlands of Kanchanpur, Bardiya and Sunsari districts. The presence of *Nilssonia hurum* was also confirmed from this study. Two hatchlings of *Nilssonia hurum* was recorded by a ranger of ShNP. One nest of turtle was found by the game scouts of Malumela post near Chaudhar River This showed a positive sign of the presence of nesting adults in the study area.

The Shannon Diversity Index (H') of turtle species recorded in study area was 1.56. The diversity was dominated by the family Trionychidae (H' = 1.085) over family Geomydidae (H' = 0.636). Slow moving River and lakes are the perfect habitat for soft shelled turtles (Trionychidae) whereas *Melanochelys tricarinata* (family Geomydidae) is a predominantly terrestrial species. Forest fire in ShNP might have decreased their number. Variance to mean ratio (1.25) shows a clumped type of distribution. The relative abundance of the family Trionychidae was found dominating. The aquatic nature of the members this family indicates the clumped distribution in and around the wetlands.

The species were found closely associated with the lake than others. *Lissemys punctata* and *Pangshura tecta* show more associated with lake areas. *Nilssonia hurum* had more association with the availability of basking area rather than with Sal forest. *Nilssonia gangetica* was in close association with river area than Riverine forest. It means *Nilssonia gangetica* avoid the dense area while it prefer the open area like sand area and edge of river for basking. Only *Melanochelys tricarinata* species shows association with the distance to post. Near the post area there is availability of food and due to which this species can tolerant and adapted to human disturbance also.

Discriminant analysis showed the significant association of turtle's presence with lakes and rivers. The family Trionychidae was found dominating over Geomydidae. The members of family Trionychidae are strongly aquatic (Schleich and Kaestle 2002), this favors the association of presence of turtles with lakes and rivers.

Conservation challenges and threats

The areas of all the wetlands inside ShNP were found decreasing. According to Scot (1989), the area of Rani Tal was 220 hectare BPP (1995) reported 200 hectare of water coverage in Rani Tal. Suwal and Shrestha (1992) reported the turning of 150 hectare of Rani Tal into grassland due to vegetation succession. Bhandari (2009) reported the area of Rani Tal to be 11 hectare. During monsoon season, most of the nutrients are carried to the wetland from surrounding due to the surface flowing. This high nutrient condition of lake helps in the growth of aquatic flora and leads to the eutrophication and finally deterioration of the wetland. This research also showed the decrease in the area of Rani Tal by 65.98% over past 10 years. If such pattern in the decrease of wetlands persists, all the wetlands will disappear in near future. Erratic drying of the lake during drought might be due to the climate change as in temperature and rainfall pattern. The area of Kalikitch Tal was found to be decreased by 21.45% and Baba Tal by 36.02%. Kalikitch Tal has a supply of water from a canal with high sand content. In spite of this supply, the sedimentation and siltation process help to decrease the Lake area, as well as growth and survival of water fauna and flora. The area of Baba Tal was found to be less decreased as compared to other wetlands. This was made possible by installing a water boring machine (Photo 18) near by the Tal. During dry out of the lake, water is refilled in the Tal with the help of this machine. The Salgaudi Tal was found to be decreased by 41.36%. Also the Tal was shifted from its position in the year 2008 to 90m South-East in the year 2018.

Two individuals of *Pangshura tecta* and one individual of *Nilssonia hurum* were found drained in Rani Tal (Photo 8). They were released to the limited water available in Dam side of Rani Tal with the help of a ranger and game scout of ShNP. One individual of *Nilssonia hurum* was found dead (photo 5) in Rani Tal. The body posture of it looked like if it was searching either for water or food. Lack of food and drought caused its death. Ghumauna Tal and one more unnamed wetland area was found lacking water. This illustrates the present scenario of wetlands of ShNP.

Nilssonia gangetica, *Nilssonia hurum* and *Lissemys punctata* were found most exploited. This is because of higher abundance of *Lissemys punctata* and their high value for their meat. Bista and Shah (2010) also mentioned about the higher consumption of these species. The local fishermen were found using poison for the mass killing of the fish. This decreases the fish population and also increases the water pollution. This resulted in

imbalance of the wetland ecosystem. Use of poison for mass killing of fish in Gobraiya khola which mix in Chaudhar River was observed during the field. Poisoning cause bioaccumulation and effect the whole of the aquatic ecosystem. Such poisoning activity might hamper the survivorship of the hatchling of the turtles. Chaudhar River is one of the prime habitats of Turtle. Local fishermen were found using poison in the river outside the ShNP, and during night and early morning they collect dead fishes in the rivulets and river inside ShNP. Children of 10-15 years are used as collector of dead fish. Children are excused easily by the Nepalese army and the park staffs even if they are caught. Sometimes children are sent to inspect whether if there is any patrolling or not, if not the adults go for the collection. If nothing is done now, turtles will be in a great danger of extinction. The local people can be encouraged to easily, anonymously and securely report the information regarding the wild life trade to authorities through communication technologies for the conservation of the turtles (Cooney et al. 2017). The high school and bachelor level students can be encouraged to develop the conservation project. Economic alternatives can be promoted through ecotourism and recreational tourism in specific locations. 53% of the respondent said that they would kill Turtles, play or damage a turtle if they find one. This is completely due to the lack of awareness. If awareness campaign can be run, these groups of people would change their view. During the study period when people knew about the status of turtle, they were willing to change mind. Lack of knowledge and awareness is found to be the major threat for the survival of the turtles. Changing the local people's perception leads to the successful conservation of the turtles. This can be achieved by educating the local people about the biological importance of the turtles. Such educational programs decrease the harvesting rate and helps in ensuring the long term survival of turtles (Stewart et al. 2016).

Minimum of five different kinds of mesh net were examined during the study period to check the mesh size of net. The study revealed a minimum size of mesh to be 8cm. Rana Tharu go for fishing using these nets (Photo 11). These nets are indiscriminate in their catches resulting in the removal of both adult and young individuals of the turtles. The use of these kinds of nets should be banned during the mass emergence of freshwater turtles in nesting periods (Shrestha 2001). Few of the local Tharu people are involved in poaching as well. Two dead turtles along with a swamp deer were caught by the park staffs though the poacher escaped they ceased the turtles and the deer and buried it. Two

Nilssonia gangetica were also caught by park completely pierced in the neck region and hanged by a grass rope (Photo 10).

During night, the patrolling is decreased. Taking the benefit of this, Tharu people go for night fishing in Chaudhar River. Along with fishes they catch turtles. Children and ladies are involved in this as well. Children and ladies go to check whether there is any patrolling going on or not by game scouts or Nepalese army. If they do not find any sign of patrolling, males and other team members go for fishing. If children are caught, they have high chance of not being punished as mercy or the level of punishment is low. This has increased the team work of women, children and other members.

The major wetlands of ShNP were heavily encroached by the *Nelumbo lucifera, Eichhornia crassipes, Hydrilla verticillata*. Presence of these species was found to be disturbing the movement of the biota of the wetlands. The large biomass of these species might have added organic content to water body resulting in the depletion of Oxygen level especially during summer. Reduced level of oxygen impairs the survival rate of aquatic fauna like fishes upon which the turtles depend for their nutrition. The major wetlands (Rani, Ghumauna, Baba, Bathania and Swami) inside ShNP were lacking water during summer. Presence of water was limited to small ditches. This might have caused the decline of turtles in these lakes. One dead (photo 5) specimen juvenile *Nilssonia* was found in Rani Tal due to the dry out. Due to the growth of grass in in Rani Tal other turtles that might have suffered the same could not be observed. One *Nilssonia hurum* was found hiding under the dry mud. It was found stressed due to the lack of water and food. With the help of the park staff it was released to a location with very little water in same Tal. Two Juveniles of *Pangshura tecta* were also found on dry mud trying to hide from the hot sun. They were also released with the help of park staff.

The presence of water was observed in Salgaudi Tal, Baba Tal and Kalikitch Tal only. In Baba Tal there was an artificial supply of water using a pump set. In Salgaudi Tal water level was not more than few feet in core area only without any vegetation. In Kalikich Tal water was available in plenty amount. This is because water from a rivulet of Mahakali was released in this Lake. This has resulted in the siltation of the lake. Also it heavily encroached by *Nelumbo lucifera, Eichhornia crassipe* and *Hydrilla verticillata*.

Otter, Monitor lizards, Jackals, wild boars, wild dogs and mongoose have been recorded as potential predators on eggs of the turtles Shrestha (2000). These predators are regarded

as the natural threat for the survival of the turtles. During the questionnaire survey, a strange story, swamp deer eating turtle, was heard. Later on interaction with the people working in ShNP and game scout was carried out focusing on this story. The same story was repeated by many people in different areas although no proof for it could be collected.

No regular trade on turtle was recorded but whatever found were either eaten by the collector or they are sold to nearby villager for meat. The volume of the Turtle trade is in eastern regions of Nepal. The trade in turtle is low in Western regions of Nepal as compared to the Eastern regions in spite of high exploitation rate. During the questionnaire survey, few people said that there is a silent trade going on. One of the Rana tharu was once offered Rs. 80,000 for a single turtle. Aryal et al. (2010) also reported that there is no trade of turtle in Kanchanpur district, although whatever found was sold to nearby village for meat. Decline in the population of turtles has decreased intensive haunting of turtles.

The local Tharu community has given different names to the turtles, some of which are as follows ‘Kaira’ , ‘Badhar’, ‘Sewai’, ‘Gumre’, ‘paatal’, ‘Hadiya’, ‘padani’, etc. different amazing and hard to believe stories regarding turtles were also known. Some of which are “turtles climbing trees”, “swamp deer eating turtles”.

6. CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

A total of 21 individuals of turtles comprising five species from two families were observed in this study. Shannon diversity index showed turtles of family Trionychidae were found dominating over family Geomydidae. The variance to mean ratio shows a clumped distribution pattern of turtles in the study area. All the wetlands of ShNP are under erratic degradation. The wetlands were decreased by 21 to 78% in past 10 years. If such pattern continues, wetlands will disappear in near future. Habitat degradation was found to be the major challenge for the conservation of turtles in ShNP. The areas that were near to the post of ShNP were found with higher number of turtle presence. Better patrolling increased with decrease of distance to post resulting in increased turtle presence in the area. Preservation of habitat must be given priority in order to conserve the wetland ecosystem. Conservation efforts must be increased for the survival of turtles. People's perception revealed that, majority of them knew about the declining trend of turtles and people are exploiting turtles. Ethnicity, gender and age were found as the major determinant factor for the conservation perception.

6.2 Recommendations

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

- More detailed and systematic study on species specific ecological exploration followed by the development of local conservation strategy should be carried out.
- Conservation awareness programs on turtles should be conducted as most of the turtles are killed by the local people due to the lack of awareness.
- Proper trapping technique should be used for the study of the turtles as they are very fast and cryptic in water and very rarely come out of water to bask.

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Annex I: Questionnaire survey

Questionnaire used during the Research

Respondent information box
Questionnaire Number: - …… Date: - ……
Respondents Name: - ……..……. Age: - ……...
Sex: - Male Female other Religion: - ……
Education: - …….

1. Do you know turtles?

a) Yes b) No

2. When and where have you seen turtle last time?
3. Which species of turtle have you seen? (Displaying ID cards).
4. What was the approximate size of the turtle?
5. In which season do turtles are seen the most?

   a) Summer b) Rainy c) Winter d) Throughout the year

6. At what time turtles are seen the most?

   a) Morning b) Day c) Evening d) Night

7. Do you know the ecological importance of herpetofauna?

   a) Yes b) No

8. Do turtles also have cultural and religious significances?

   a) Yes b) No

9. Do turtles have any economic significance? If yes, what are the significances?

   a) Food b) Medicine c) Money d) Recreation

10. Is the population of turtles increasing or decreasing?
11. Will it affect your life if it increases or decreases? Y/N
12. If yes what are the effects?
13. Do you know turtles are being killed by humans / animals?
14. If yes, by whom and why?

15. Do you know about the illegal trading of turtles? If yes, which part; egg, body, carapace
16. What will you do if you find a turtle's nest?

a. Damage it
b. b. take the eggs
c. c. tell others
d. d. do nothing

17. What will you do if you find a turtle in your area?

a. Kill it for meat
b. Play and damage it
c. Leave as it is
d. Other

18. Do you think turtles should exist in your area? Y/N
19. Do you know any activities that have been affecting turtle?
20. Do you know any organization working to protect the turtles? If yes, mention the Organization and its activity……..
21. Do you have any idea for the conservation of the turtles?
    Y/N. If yes what are they?: …….

Annex II: Turtle conservation form (Turtle survey form)

Data sheet No: -------

Reporter: ----------

Name: ----------

Address: ----------

Species

Data: ---------- Time: ----------

Place: ---------- Location: ----------

Hard-shell/Soft shell: ----------

Common name: ----------

Scientific name: ----------

Dead/alive: ----------

Caught by (equipment used): ----------

General condition: ----------

Coloring: ----------

Size in cm

Carapace: -------

Plastron: -------

Weight in Kg: ----------

Male/Female: ----------

Juvenile/Adult: ---------

Special characteristics: ----------

Notes: ----------

Source: ARCO-Nepal, Fuhlrott Museum, Wuppertal-Germany.

Annex III: Shannon's Diversity Index and Relative abundance of Turtle species

SN	Name of species	No. of individuals recorded	Relative abundance	Relative Abundance(percentage)	H'
1	*Nilssonia gangetica*	5	0.238095238	23.80952381	-0.34169
2	*Nilssonia hurum*	4	0.19047619	19.04761905	-0.31585
3	*Lissemys punctata*	6	0.285714286	28.57142857	-0.35793
4	*Melanochelys tricarinata*	2	0.095238095	9.523809524	-0.22394
5	*Pangshura tecta*	4	0.19047619	19.04761905	-0.31585
	Total	21			1.55527

Annex IV: Summary of status of turtles & tortoises of Nepal

S.N.	Family	Name of species	IUCN status	CITES status
1.	Geoemydidae	*Batagur Dhongoka* (GRAY, 1834)	EN	II
2.	Geoemydidae	*Batagur kachuga* (GRAY, 1831)	CR	II
3.	Geoemydidae	*Cyclemys oldhamii* (GRAY, 1863)		II
4.	Geoemydidae	*Geoclemys hamiltonii* (GRAY, 1831)	VU	I
5.	Geoemydidae	*Hardella thurjii* (GRAY, 1831)	VU	II
6.	Geoemydidae	*Melanochelys tricarinata* (BLYTH, 1856)	VU	I
7.	Geoemydidae	*Melanochelys trijuga* (Schweigger, 1814)	NT	II
8.	Geoemydidae	*Morenia petersi* (ANDERSON, 1879)	VU	II
9.	Geoemydidae	*Pangshura flaviventer* (GÜNTHER, 1864)		
10.	Geoemydidae	*Pangshura smithii pallidepes* (MOLL, 1987)	NT	II
11.	Geoemydidae	*Pangshura smithii smithii* (GRAY, 1863)	NT	II
12.	Geoemydidae	*Pangshura tecta* (GRAY, 1831)	LC	II
13.	Geoemydidae	*Pangshura tentoria circumdata* (GRAY, 1834)	LC	II
14.	Testudinidae	*Indotestudo elongata* (BLYTH, 1854)	EN	II
15.	Trionychidae	*Chitra indica* (GRAY, 1831)	EN	II
16.	Trionychidae	*Lissemys punctata* (BONNATERRE, 1789)	LC	II
17.	Trionychidae	*Nilssonia gangetica* (CUVIER, 1824)	VU	I
18.	Trionychidae	*Nilssonia hurum* (GRAY, 1831)	VU	I

Annex V: Photo Plates

Photo 1: Carapace of *Nilssonia*

Photo 2: *Lissemys punctata*

Photo 3: *Lissemus punctata* caught by a fisherman

Photo 4: *Paghshura tecta*

Photo 5: A dead *Nilssonia*

Photo collected from Malumela post,

Photo 6: *Nilssonia gangetica* swimming in Chaudhar River

Photo 7: *Nilssonia hurum*

Photo 8: *Nilssonia hurum*

Photo 9: Observer doing morphometric analysis

Photo 10: *Nilssonia gangetica* caught from poacher

Photo credit: Yam Rawat

Photo 11: A fisherman demonstrating fishing net

Photo 12: Grass grown on Rani Tal

Photo 13: People's perception

Photo 14: *Melanochelys tricarinata*

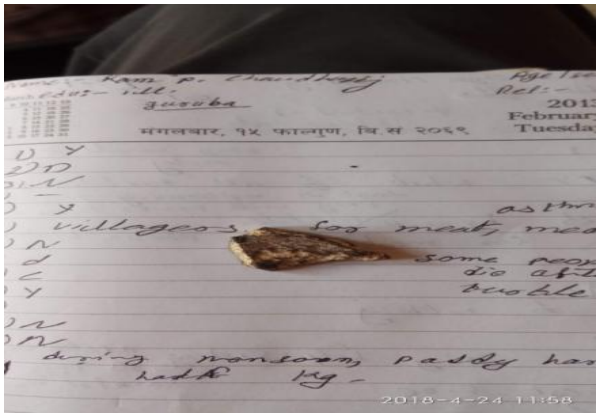

Photo 15: A piece of turtle used as medicine

Photo 16: Turtle swimming

Photo 17: Observer in the field (VES)

Photo 18: Refilling of Baba Tal

Photo 19: Fisherwomen catching fish

Photo 20: Marks left by turtles