Ethno-medicinal uses of vertebrates in Chitwan-Annapurna Landscape, central Nepal

CURRENT STATUS: POSTED

Jagan Nath Adhikari
Universidade Federal de Minas Gerais Departamento Zootecnia

Bishnu Prasad Bhattarai
Tribhuvan University

bpbhattarai@cdztu.edu.np Corresponding Author
ORCiD: https://orcid.org/0000-0001-5741-6179

Maan Bahadur Rokaya
Institute of Botany, Czech Academy of Sciences

Tej Bahadur Thapa
Central Department of Zoology, Tribhuvan University

DOI: 10.21203/rs.2.21918/v1

SUBJECT AREAS
Translational Medicine

KEYWORDS
Vertebrates, Ethno-medicine, Multicultural ethnic groups, Biodiversity conservation, Central Himalaya
Abstract

**Background:** Traditional knowledge on use of animal products to maintain human health is important since time immemorial. Although a few studies are reported as food and medicinal values of different animals, a comprehensive ethno-medicinal study of vertebrates in Nepal is still lacking. Thus, present study is aimed to document the ethno-medicinal knowledge related to vertebrate fauna among different ethnic communities in Chitwan-Annapurna Landscape, central Nepal.

**Methods:** Ethno-medicinal information collected by using semi-structured questionnaires, focus group discussion and key informant interview. The data were analyzed by applying Use Value (UV), Informant Consensus Factor (ICF) and Fidelity level (FL).

**Results:** The study reported a total of 58 species of vertebrates of which 53 were wild and 5 as domestic. They were used to treat 62 different types human ailments. Four vertebrates were also used for veterinary and agriculture. The most commonly used species was *Felis chaus* (UV = 0.25) with 3 use-reports by 10 informants. Cardiovascular and dental problems had the highest ICF value (0.974) with cardiovascular problems having 351 use-reports for 10 animal species and dental problems having 77 use-reports for 3 animal species. The least ICF was found in ophthalmological problems (ICF=0.833, use reports=7 for 2 species).

**Conclusions:** The vertebrates are widely used by the local people and the traditional healers in Chitwan-Annapurna landscape against various ailments. The users collected the vertebrates mostly from wild. People intentionally or unintentionally kill wild animals that has threatened the availability of different species. Our study revealed in-depth knowledge on use of vertebrates including their status needed for the sustainable ethno-medicinal uses and their future conservation.

**Background**

Bio-resources (i.e. both flora and fauna) are integral part of the indigenous healing practices used by human beings since prehistoric time [1]. The traditional knowledge on use of bio resources for medicine has significant contribution in maintaining the human health care system even in the present modern societies [2]. In traditional medicine, it is estimated that more than 60% of drugs are based on the extraction flora and fauna [6]. A figure shows the use of more than 1500 animal species
in Traditional Chinese Medicine in China [37]. There is also a trade of high number of traditionally used natural products by various ethnic and cultural groups for the treatment of various ailments [3]. To the greater extent, many traditional medicines are traded by many big pharmaceutical companies around the world. World Health Organization (WHO) has selected a total of 252 essential chemicals to prepare drugs, where animals alone contribute 8.7% [6].

A large number of animals are used as medicine under traditional systems such as Ayurveda, Unani, Homeopathy, and Tibetan traditional medicines [4–6]. Many studies have shown use of animals as medicine in Nepal [5, 7–13] including a few studies from Chitwan-Annapurna Landscape, but are mainly related to medicinal plants [14–17] and wild edible plants [18]. Chitwan-Annapurna Landscape lies in between Chitwan National Park in the south and Annapurna Conservation area in the north with high variation in elevation (150 m to 8000 m). This area is mostly inhabited by many types of indigenous and multi-cultural ethnic groups. Therefore, such an area is important for studies related to traditional medicine.

Nepal comprises 125 different multicultural ethnic groups with more than 123 different languages [19]. Thus, Nepal is well-known for rich cultural heritage with diverse ethnic groups [9]. In most ethnic groups, indigenous knowledge on uses of different animals in medicine is generally passed verbally from one generation to the next generation. Such knowledge is commonly lost with the demise of knowledgeable person [2, 11, 20]. It is, thus, important to systematically document such indigenous knowledge so that it can be protected for future generations. This study is aimed to collect and document traditional ethnozoological (vertebrates) knowledge from the Chitwan-Annapurna landscape, central Nepal. Here, we asked following questions: (i) What are different vertebrates that are used in traditional medicines in Chitwan-Annapurna landscape, central Nepal? (ii) What are the modes of preparation and administration of vertebrate based traditional medicine? (iii) What are the major ailments categories treated by different vertebrates and also what are the most important vertebrate species used against different ailments? (iv) What is the conservation status of each vertebrate that is used as traditional medicine? To answer the above-mentioned questions, we collected data in Chitwan-Annapurna landscape, central Nepal.
Materials And Methods

Study area

The study area located in the Chitwan-Annapurna landscape, central Nepal (Fig. 1). The region is connected with the Chitwan National Park in the south and Annapurna Conservation Area in the north. This landscape is rich in globally outstanding biodiversity including three Word Wildlife Fund (WWF) Global 200 Eco-regions (Terai–duar Savanna and Grasslands, Himalayan Subtropical Broadleaf Forests, Alpine Shrubs and Meadows), and two Ramsar sites (Beeshazari lake, Chitwan and Lake Clusters of Pokhara valley, Kaski) [21].

The area is prime habitat for many mammal species such as tiger, rhinoceros, common/clouded/snow leopard, sloth/Himalayan black bear, sambar, chital, musk deer, hog deer, goral, etc. This landscape is inhabited by many ethnic, religious and cultural diversities (23 ethnic groups in Chitwan, 26 ethnic groups in Tanahun, 12 ethnic groups in Kaski) [19]. The most dominant ethnic groups in the study area are Tharu, Braman/Chhetri, Tamang, Gurung, Bote in Chitwan; Magar, Gurung, Sanyasi, Tamang, Majhi in Tanahun and Gurung, Magar, Braman/Chhetri and Dalit in Kaski districts.

Data collection

For our data collection, we divided the whole study area into four different study blocks based on topography (Fig. 1):

Block A: Barandabhar Corridor Forest and its adjoining settlement areas in Chitwan district, Bharatpur Metropolitan City (Patihani, Gitanagar, Bhojad, Ramnagar, Kabilas and Chaukidanda), Ratnanagar Municipality (Sauraha, Mohana, Tikauli, Panchakanya), Kalika Municipality (Jutpani and Padampur);

Block B: Community and National forests and its adjoining settlement areas in lower part of Tanahun district, Devghat Rural Municipality (Gaighat, Kaphaldada and Mude), Aanbookhaireni Rural Municipality (Saranghat and Deurali), Bandipur Rural Municipality (Khaharetar, Dharampani and Bandipur villages), Byas Municipality (Keshavtar, Rumsi, Nayagaun);

Block C: Community and National forests and its adjoining settlement areas in upper part of Tanahun district, Rishing Rural Municipality (Manpur, Dhaap, Pipalbot, Chalise gaun), Mygde Rural Municipality (Chhang, Fulbari, Tharpu, Mulabari), Bhimad Municipality (Rishing patan, Bhimad village areas),
Suklagandaki Municipality (Firfire, Therpek, Raipur, Taxar);
Block D: Panchase area and lower Annapurna Conservation Area, Pokhara Metropolitan City
(Nirmalpokhari, Bharatpokhari, Sidhane, Panchase, Pumdibhumdi), Annapurna Rural Municipality
(Bhadaure, Tamagi, Landruk and Ghandruk) from 2017 June to 2018 September.
The ethno-medicinal data on uses of animals (mainly vertebrates) was collected by using Participatory
Rural Appraisal (PRA) method [20, 22-24]. In this method we used sets of questions related to use of
animals as ethnomedicine and discussed their local status and medicinal properties. For that purpose,
we used the photographs of the vertebrates present to that area and discussed in group. The local
healers, medicinal practitioners, teachers, social workers were involved in the PRA. We also
considered a fair gender composition of the group.
Consent was taken from the respondent prior to formal interview. Semi-structured questionnaires
were also used to obtain information from the local people [25, 26]. The respondents were chosen
randomly, but were well represented from different ethnicity, geographic locations, age, sex,
profession and education levels [27]. Total of 204 people were interviewed during 2017-2019. We
used photographs and images of different vertebrates when conducting interviews. The detailed
information including local name of the animals, parts used, methods of preparation and mode of
administration were recorded. We also documented vernacular names, methods of preparation and
the doses of medicine used against different ailments. Latin names and classification of the animals
were obtained from standard literature [28-32]. We also recorded conservation status of each animal
by using above mentioned literature and IUCN Red data book [60].
Based on the information obtained from informants in the study area, all the reported human related
ailments were grouped into 11 categories (Table 1) viz. cardiovascular problem, dental problem,
dermatological problem, ear, nose and throat problem, gastro-intestinal problem, musculoskeletal
problem, neurological problem, ophthalmological problem, reproductive problems, respiratory
problem and others (fever and headache). In addition to this, we also recorded the veterinary and
agriculture uses.

Data Analysis
Informant consensus factor (ICF)

To see if there was agreement in the use of animals in the ailments categories between the animal users in the study area, we used the informant consensus factor (ICF) [33, 34]. The informant consensus factor (ICF) for ailment category \( c \) was calculated as

\[
ICF_c = \frac{(Nur_j - Nt_j)}{(Nur_j - 1)},
\]

where \( Nur_j \) is the number of use-reports in each ailment category \( c \) and \( Nt_j \) is the total number of taxa used in each ailment category \( c \) by all informants.

In each case if an animal was mentioned by an informant as ‘used’ then we considered it as one ‘use-report.’ If one informant used an animal to treat more than one ailment in the same category, we considered it as one use-report [61]. Thus, an animal species could be listed in several ailment categories of indigenous uses but in terms of use-reports, each animal species was considered only once per informant in a single ailment category as mentioned by Amiguet et al. [61].

The ICF ranges from 0 to 1, where high values (close to 1) are obtained when only one or a few animal species are reported to be used by a high proportion of informants to treat a particular ailment meaning that there is a narrow well-defined group of animal species used to cure a particular ailment category and/or that information is exchanged between informants. On the other hand, low ICF values (close to zero) indicate that informants disagree over which animal to use due to random choosing or lack of exchange of information about use among informants [62].

Fidelity level (FL)

To determine the most frequently used animal species for treating a particular ailment category by the local people of the study area, we calculated the fidelity level (FL) [63]. For each species \( s \) and each ailment category \( c \), we calculated the value \( FL_{sc} \) using the following formula:

\[
FL_{sc} (%) = \left( \frac{Np_{sc}}{N_s} \right) \times 100,
\]

where \( Np_{sc} \) is the number of use-reports cited for a given animal species \( s \) for a particular ailment category \( c \) and \( N_s \) is the total number of use-reports cited for any given species \( s \). The animal species with the highest \( FL_{sc} \) value is considered the most preferred species for ailment category \( c \).
Use value (UV)

The relative importance of an animal species used as medicine in the study areas was calculated with the help of the use value (UV) for species $s$ [64]:

$$UV_s = \frac{\sum U_s}{N_s}$$

where $U_s$ is the number of use-reports cited by each informant for a given animal species $s$ and $N$ is the total number of informants interviewed for a given animal species $s$. Use values are high when there are many use-reports for an animal and low when there are few reports related to its use.

To determine correlations between FL value and UV values for each animal species, we used Spearman’s correlation coefficient because data were not normally distributed.

Results And Discussion

Demographic details of informants

A total of 204 informants (70 female and 134 male individuals, aged between 18 and 82 years) participated in the study. They belong to different castes (12) and communities (eight of Indo-Aryan or Tibeto-Burman language speaking groups). A large number of respondents were in between 50 to 59 years ($n=53$). This clearly showed that ethno-medicinal knowledge was higher in aged groups than in young groups. The main reason of little knowledge among young generation might be due to growing number of hospital facilities, migration of people to urban areas and abroad for study and employment, and also the influences of mixed cultures due to cross-cultural communications or settlements in new areas [35, 36].

Mostly the people living in the villages have strong belief on the traditional healing system and traditional medicine. The male and female ratio may indicate the dominancy of the male ethno-medicinal practitioners than female. Such type of trends was also reported in different ethno-medicinal studies [2, 10, 14, 36] (Table 2). About 43% of the respondents were farmers and healers who had broad knowledge of ethno-medicine. There were 38% of the respondents with basic level and 26% of them with secondary level education. Locally popular traditional healers and wizard doctors were involved in the focus group discussion.
**Faunal diversity and uses**

The present research revealed the use of 58 animal species of 23 orders, 37 families and 53 genera to cure 62 human and 3 veterinary ailments (Table 3). Among the medicinal animals, 53 animal species are collected from the wild and five are domesticated (Table 3). Among the used animals, two animals have poisonous property (Table 3). The use of threatened wild animals was also reported in the treatment of different ailments (Table 3). It shows that many wild animals if used regularly would likely decline leading to possible extinctions.

The order, family, scientific names, English names, Nepali names, IUCN category, use value (UV), parts used, uses are presented in Table 3. Among 58 vertebrates, 24 species (41%) were Mammalia, 16 Aves (28%), 6 Reptilia (1%), 3 Amphibia (0.5%) and 9 Actinopterygii (1.5%) (Fig. 2). Local people and poachers from outside killed animals for their body parts have been causing the greatest threats to wildlife [20, 38]. Similar types of threats were also reported during this study. Mammals considered as the most important vertebrate group that were used very high in traditional medicine. Rural people believed that wildlife mainly mammals are the sources of protein and other essential supplementary foods and medicines [39]. Similar studies showed the uses of vertebrates for more than 232 traditional zoo therapeutic remedies for human and animal health [12], and food and medicinal purposes of humans [10]. The use of a number of animals and the drugs derived from them recorded from the different altitudes of the study area. Practice of using traditional medicine was found higher in the mid hills and mountainous region than Terai region (Chitwan) (Table 1). The local people used cooked meat of Golden jackal for treatment of paralysis and preparation of wine for treatment of rheumatism. Similar type of the practices also reported by Lohani [10] in Tamang community of Sindhupalchowk and Poudel and Singh [40] reported use of meat and fat of Golden jackal for treatment of the rheumatism in Darai community of Chitwan, Nepal. Similarly, Rai and Singh [13] reported such practices in Rai community of Bhojpur. Bones and meat of the animals are full of calcium, protein and phosphorous hence, soup of the bone and meat of animals is given for the person suffering from the muscular spasm, cramp, bone fracture, arthritis and energy (Table 3). A similar type of treatment methods was also recorded in the study of Lohani [10] in Tamang
community, Nepal; Vijayakumar et al. [2] in Kerela adjoining areas of Mt. Abu Wildlife sanctuary, India; Nijman and Shepherd [20] in Kyaiktiyo, Myanmar.

**Veterinary important traditional medicines and insecticides**

Medicinal fauna from four different animal families occurring in four genera and four species have veterinary importance. Generally, animal’s parts and products such as urine, droppings, fat and meat are used. They are used internally or externally (Table 3). However, most of the people in the study area have little idea and knowledge about veterinary and agricultural use of vertebrates. Furthermore, this study also indicated that more than 81% of vertebrate species used treating more than one ailment. Similar studies outside Nepal also reported the wide use of animals in ethnomedicines such as González et al. [41] recorded use of 30 wild vertebrates to treat domestic animals in Spain; Souto et al. [42, 49] reported 11 animals for ethnoveterinary medicine in the semi-arid region of Northeastern Brazil and Gupta et al. [43] reported a total of 11 species of vertebrates for treating various veterinary diseases in India.

**Animal parts used**

The animal parts used for treating different ailments were of 22 types. Meat was the most preferred parts (n=48), possibly because meat has more protein and medical properties followed by fat (n=11), fecal matter (n=6), gallbladder, horn and antler and blood (each n=5), egg and claws (each n=3), urine, skin, milk, ghee and hair (each n=2), hoofs, feathers, teeth, brain, stomach, shell, quail, bone and legs (n=1) (Fig. 3, 6,7). Similar study of Quave et al. [12] reported whole animal, milk and milk products, meat/animal flesh, fat, honey and eggs, feces, urine, and seminal fluid in different treatment in different ethnic groups of Albania, Italy, Spain and Nepal. In previous studies, it was found that the ethno medicines are prepared from the animal parts and products [2, 4, 11, 13, 46, 48].

**Medical preparations and their admission**

The medical remedies were based on many kinds of preparations ranging from a preparation made out of a single animal for a single ailment to use of animals in combination (Table 3). There were 12 types of preparations used in the study area. Cooked meat was commonly practiced (31%) followed
by boiled and oil (each 12%), paste (11%), soup (10%), raw meat (9%), dry (6%), ash (3%), powder and lotion (each 2%) and fume and wind (each 1%) (Fig. 4). Consumption practices of raw body parts of animals are common for curing diseases in many ethnic groups at global level [2, 23, 35, 40, 44, 45]. However, consumption of raw meat may increase the risks of transmitting different types of parasites and diseases to humans [11, 46].

The most common mode of admission of medicine is oral (67%) followed by topical application (30 %) and drop (4%). Topical use is an important way of remedy of musculo-skeletal problems like muscular pain, fractures, rheumatisms and arthritis. Such modes of administration were found in studies from Korea [46], in India [2] and also in Nepal [11, 40].

**Informant consensus factor, fidelity level and use value**

The results of the informant consensus factor (ICF) calculation show that the value in our study ranges from 0.833 to 0.974. Cardiovascular and dental problems have the highest ICF value 0.974, with cardiovascular problems having 351 use-reports for 10 animal species and dental problems having 77 use-reports for 3 animal species. It is followed by musculoskeletal problems (ICF = 0.973; 926 use-reports, 46 species). The least agreement between the informants was observed for animals used to cure ophthalmological uses with ICF value 0.833 with 7 use-reports for 2 animal species (Table 4). Low ICF value might be due to lack of communication for the treatment of such ailments among the people of different cultures, different localities and ethnicities of the study area. Local people believed that there was no any side effects while using these ethnomedicines. Besides, this study helps to generate ethnozoological knowledge among the local people.

When selecting the most preferred animal species for each ailment category, we took the highest FL (%) in each category of ailment (Table 5). *Leptoptilos javanicus* and *Duttaphrynus himalayanus* for cardiovascular ailments, *Bubulcus ibis* for dental problem, *Corvus splendens* *Hemidactylus flaviviridis* and *Varanus bengalensis* for dermatological problem, *Canis lupus familiaris*, *Tyto alba* and *Calotes versicolor* for gastro-intestinal problem, *Lophura leucomelanos* for musculoskeletal problem, *Rattus rattus* *Arborophila torqueola Acanthocobitis botia* and *Anabas testudineus* for reproductive problem, *Rhinolopus sp.*, *Macaca assamensis*, *Streptopelia orientalis*, *Acridotheres fuscus*, *Schizothorax*
Richardsonii and Pethia conchonius for respiratory problem has the highest FL (100 % each) and Felis chaus has the lowest (20 %) for Ophthalmological problem purposes. The 100% animals indicate that healers and local respondents were used that animals for the treatment of same disease. It implied that well-known species were used more than the little-known species to cure the disease or disorders [24, 46, 47]

The most commonly used species was Felis chaus (UV = 0.25) with 3 use-reports by 10 informants. It was followed by Panthera tigris (UV = 0.23) with 6 use-reports by 57 informants, Rhinoceros unicornis (UV = 0.16) with 6 use-reports by 43 informants and Columba livia (UV = 0.14) with 3 use-reports by 22 informants (Table 3).

The correlation between the highest fidelity level (%) in ailment categories and animal use value (UV) was not significant (Spearman’s correlation test: \( r^2 = 0.038, p = 0.209 \) indicating that the animals systematically used for a specific ailment category are not necessarily those used commonly in the region. Although animals with high FL or UV are the most preferred species in study sites (Table 4 and 5), animals with low FL or UV should not be neglected as failing to mention them to the future generation could increase the risk of gradual disappearance of the knowledge.

**Conservation status**

Due to lack of modern medical facilities and belief on the traditional healing system, some people of the study area forced to use animals and their body parts for curing various ailments. Besides, superstitions and mythologies were very popular among the ethnic groups that may also play vital roles for using the animals. Therefore, they intentionally or unintentionally kill animals for ethnomedicinal uses which might increase threats to wildlife including many Globally Threatened Species. Out of total (Table 3). Ten animals were Globally Threatened (2 Endangered, 8 Vulnerable), five were Near Threatened, one was Data Deficient and 37 Least Concerned species according to IUCN Red list [60] (Fig. 5). The Government of Nepal implemented National Park and Wildlife Conservation (NPWC) Act 1973 and Forest Act 1993 to protect wildlife and their habitats in Nepal. These laws strictly prohibited the hunting and killing of wildlife. There is no permission of killing the wildlife listed in CITES for food, medicine, and their trade. However, sometimes these laws malfunction due to local
religious norms and cultural believes enable them to kill those animals. The tribal people have scarce
knowledge about the status of wild animals, high superstition and myths associated with traditions
that cause harm to wild animals. Hence, these activities of local people may lead the extinction of
wildlife. Therefore, to protect the wild animals, the local traditional people should aware about the
alternative method of treatment systems such as the use of medicinal plants instead of animal
products. Study of Jaroli et al. [48] found that among 24 identified animals used by Garasiya people of
adjoining areas of Mount Abu Wildlife Sanctuary, India, 16 animals (including elephant, tiger, sambar,
Himalayan black bear) included in IUCN red list. If the people didn’t think about the alternative
methods of treatment systems, it will bring great problems on wildlife conservation. The global
biodiversity crisis, caused mainly by anthropogenic actions, people overexploited the wild animals for
ethnomedicine and created obstacles in animal conservation [38]. A similar type of problem was also
reported in Brazil [42].
Extinction risk is very high for the vertebrates as compared to invertebrates [50]. Vertebrates are
more prone to habitat loss, exploitation, poaching and illegal trade. Besides other studies, ethno-
medicinal uses of vertebrates offer the reasons for increasing threats to their conservation. Therefore,
this study is mainly devoted to vertebrates and not invertebrates. The ethnic communities and local
healers need search for other treatment options such as plants instead of animals. For example, fruits
of *Rhus javanica* can use instead of cooked blood of Golden jackal (*Canis aureus*) which was used
treating asthma [24, 51]. Seed oil of *Impatiens scabrida* can help to relieve body pain instead of fat of
leopard (*Panthera pardus*) [24, 52, 59]. Similarly, powder prepared from the roots of *Heracleum
wallichii* used treating stomach problems to substitute meat of Himalayan goral (*Naemorhedus goral*),
Indian crested porcupine (*Hystrix indica*) and Liebig’s frog (*Nanorana liebigii*)[53, 54]. This study
suggests that there is enough space for the researcher to document alternatives of the vertebrates
for ethno-medicinal value.

Conclusions
The study is the first effort to document primary data of the ethno-medicinal knowledge about the use
of vertebrates by the local people of Chitwan-Annapurna Landscape. Ethno-medicinal knowledge
about vertebrates and their body parts and products play the vital role in conservation and consumption of those species. A total of 58 species of vertebrates used for the treatment of 62 human ailments which were grouped into 11 categories. Mammals contributed the highest number among them (n=24) in ethno-medicine. This study also indicated that more than 76% of vertebrate species were found to be used for the treatment of more than one ailment. The most commonly used species was *Felis chaus* (UV = 0.25) with 3 use-reports by 10 informants. Cardiovascular and dental problems had the highest ICF value (0.974) with cardiovascular problems having 351 use-reports for 10 animal species and dental problems having 77 use-reports for 3 animal species. The least ICF was found in ophthalmological problems (ICF=0.833, use reports=7 for 2 species). Traditional knowledge was more common among elderly people than young people because of long experiences of utilizing nature while lack of more knowledge among youth. Therefore, our study concluded that there is necessity for documentation of detailed knowledge about the status and specific use-values of vertebrates as well as the transfer of knowledge from seniors to the youths for sustainable ethnomedicine in living with nature places like Chitwan-Annapurna Landscape, central Nepal. This empirical knowledge described in this study will help for the preparation of conservation planning to control the hunting of threatened wildlife. Furthermore, ethnic people should consider the alternative options such as the use of commonly found medicinal plants and other inorganic salts or compounds for the treatments of ailments. Any future economic gains obtained using indigenous knowledge should be share with local communities to safe guard their intellectual property rights.

**Declarations**

**Acknowledgments**

We are grateful to the Department of National Parks and Wildlife Conservation (DNPWC), Nepal, Chitwan National Park and Annapurna Conservation Area, Division Forest Offices of Chitwan, Tanahun and Kaski districts for providing the research permission. Our thanks also go to the field assistances and the respected wizard doctors (Dhami) and traditional healers for transferring hidden knowledge. We are thankful to the local people of the study area who provided the valuable information about the use of vertebrates in ethnomedicine.
Author Contributions

JNA & BPB designed and carried out research. MBR, BPB & JNA performed data analysis. JNA, BPB, MBR & TBT wrote the manuscript.

Funding

The project was supported by the Nepal Academy of Science and Technology, Kathmandu and Institute of Botany, Czech Academy of Sciences, institutional support RVO 67985939.

Availability of data and material

All data collected and analyzed during the study are included in Table and figures of this manuscript.

Ethics approval and consent to participate

Permissions were taken from concerned authorities of the study area such as Department of National Parks and Wildlife Conservation, Division Forest Offices of Chitwan, Tanahun and Kaski districts and local authorities. Prior oral informed consent was obtained from the local people who participated in the interviews and surveys.

Consent for publication

Not applicable

Competing interests

The authors declare that they have no competing interests.

References

1. Alves RRN, Rosa IL. Why study the use of animal products in traditional medicines? J Ethnobiol Ethnomed. 2005;1:5. https://doi.org/10.1186/1746-4269-1-5.

2. Vijayakumar S, Yabesh JM, Prabhu S, Ayyanar M, Damodaran R. Ethnozoological study of animals used by traditional healers in Silent Valley of Kerala, India. J Ethnopharmacol. 2015;162:296-305. https://doi.org/10.1016/j.jep.2014.12.055.

3. Cragg GM, Newman DJ. Natural products: a continuing source of novel drug leads. Biochimica et Biophysica Acta (BBA)-General Subjects. 2013;1830:3670-3695.

4. Lohani U. Traditional uses of animals among Jirels of Central Nepal. Studies on Ethno-
5. Lohani U. Man-animal relationships in Central Nepal. J Ethnobiol Ethnomed. 2010;6(1):1–11. https://doi.org/10.1186/1746-4269-6-31.

6. World Health Organization (WHO). Traditional medicine strategy 2014–23, World Health Organization. 2014. p. 76.

7. Kharel M, Chhetry DT. Turtles of Kankai (Mai) river and their ethno-medicinal uses. Nepalese Journal of Biosciences. 2012;2:126-133. https://doi.org/10.3126/njbs.v2i0.7500.

8. Shah KB. Ethnozoology of the Turtles in Nepal. J Nat Hist Mus. 2004;13:19-30.

9. Shrestha N, Prasai D, Shrestha KK, Shrestha S, Zhang X-C. Ethnomedicinal practices in the highlands of central Nepal: a case study of Syaphru and Langtang village in Rasuwa district. J Ethnopharmacol. 2014;155:1204-1213. https://doi.org/10.1016/j.jep.2014.07.002.

10. Lohani U, Rajbhandari K, Shakuntala K. Need for systematic ethnozoological studies in the conservation of ancient knowledge systems of Nepal—a review. Indian J Tradit Knowl. 2008;7(4):634-637.

11. Lohani U. Zootherapeutic knowledge of two ethnic populations from Central Nepal. Studies on Ethnomedicine. 2012;6(1):45–53. https://doi.org/10.1080/09735070.2012.11886420

12. Quave CL, Lohani U, Verde A, Fajardo J, Rivera D, Obón C, Valdes A, Pieroni A. A comparative assessment of zootherapeutic remedies from selected areas in Albania, Italy, Spain and Nepal. J Ethnobiol. 2010;30:92.

13. Rai R, Singh N. Medico-ethnobiology in rai community: A case study from baikunthe village development committee, Bhojpur, Eastern Nepal. Journal of Institute of Science and Technology. 2015;20:127-132. https://doi.org/10.3126/jist.v20i1.13935.
14. Bhuvan K, Heydon S, Norris P. Access to and use of medicines in the Annapurna region of Western Nepal and possible impacting factors. Journal of pharmaceutical policy and practice. 2019;12:11. https://doi.org/10.1186/s40545-019-0172-3.

15. Singh AG, Kumar A, Tewari DD, Bharati KA. New ethnomedicinal claims from Magar community of Palpa district, Nepal. Indian J Tradit Knowl. 2018;17(3):499–511.

16. Bhattarai S, Chaudhary RP, Quave CL, Taylor RS. The use of medicinal plants in the trans-himalayan arid zone of Mustang district, Nepal. J Ethnobiol Ethnomed. 2010;6:14. https://doi.org/10.1186/1746-4269-2-41.

17. Boesi A. The Materia Medica of Tibetan medicine according to practitioners from the Lower Mustang district in Nepal. Rivista degli Studi Orientali 2014;87(1-4):73–104.

18. Bhattarai S, Chaudhary RP, Taylor RS. Wild edible plants used by the people of Manang district, central Nepal. Ecol Food Nutr. 2009;48:1–20. https://doi.org/10.1080/03670240802034996.

19. Central Beauru of Statistics (CBS), Nepal. National population and housing census 2011 (National Report). Gov Nepal, Natl Plan Comm Secr Cent Bu reau Stat. 2012;1:1-278.

20. Nijman V, Shepherd CR. Ethnozoological assessment of animals used by Mon traditional medicine vendors at Kyaiktiyo, Myanmar. J Ethnopharmacol. 2017;206:101-106. http://dx.doi.org/10.1016/j.jep.2017.05.010.

21. Bhuju UR, Shakya PR, Basnet TB, Shrestha S. Nepal biodiversity resource book: protected areas, Ramsar sites, and World Heritage sites. International Centre for Integrated Mountain Development (ICIMOD). 2007. p. 128.

22. Alves RRN, de Faria Lopes S. The Role of Ethnozoology in Animal Studies. In Ethnozoology. Elsevier. 2018;467-479. https://doi.org/10.1016/B978-0-12-809913-1.00024-7.
23. Borah MP, Prasad SB. Ethnozoological remedial uses by the indigenous inhabitants in adjoining areas of Pobitora wildlife sanctuary, Assam. India. Int J Pharm Pharm Sci. 2016;8:90–96.

24. Rokaya MB, Münzbergová Z, Timsina B. Ethnobotanical study of medicinal plants from the Humla district of western Nepal. J Ethnopharmacol. 2010;130:485–504. https://doi.org/10.1016/j.jep.2010.05.036.

25. Hazarika M, Sharma D. A Study on the Conservation Status of Mabuya Multifasciata, on the Basis of Ethnozoological Survey, in Kokrajhar District of Assam, India. International Journal of Humanities and Social Sciences (IJHSS). 2018;7(1):1–4. Available at SSRN: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3130083

26. Setlalekgomo MR. Ethnozoological survey of the indigenous knowledge on the use of pangolins (Manis sps) in traditional medicine in Lentsweletau extended area in Botswana. Journal of Animal Science Advances. 2014;4:883–890. https://doi.org/10.5455/jasa.20140526093512

27. Malla A, Joober R, Garcia A. Mental illness is like any other medical illness: a critical examination of the statement and its impact on patient care and society. Journal of psychiatry & neuroscience: JPN. 2015;40:147. https://doi.org/:10.1503/jpn.150099.

28. Amin R, Baral HS, Lamichhane BR, Poudyal LP, Lee S, Jnawali SR, Acharya KP, Upadhyaya GP, Pandey MB, Shrestha R. The status of Nepal’s mammals. Journal of Threatened Taxa. 2018;10:11361–11378. http://doi.org/10.11609/jot.3712.10.3.11361-11378.

29. Jnawali S, Baral H, Lee S, Acharya K, Upadhyay G, Pandey M, Shrestha R, Joshi D, Lamichhane B, Griffiths J. The Status of Nepal Mammals. The National Red List Series, Department of National Parks and Wildlife Conservation Kathmandu, Nepal. Preface by Simon M Stuart Chair IUCN Species Survival Commission. 2011. p. 276.
30. Baral HS, Shah KB. Wild mammals of Nepal. Himalayan Nature, Kathmandu, Nepal. 2008. p. 188.

31. Shah KB, Tiwari S. Herpetofauna of Nepal. In World Conservation Congress 2004: Bangkok, Thailand). IUCN, Nepal. 2004. p. 237.

32. Shrestha TK. Ichthyology of Nepal. Himalayan Ecosphere. 2008. p. 389.

33. Trotter RT, Logan MH. Informant consensus: a new approach for identifying potentially effective medicinal plants. Bedford Hills, New York. Redgrave Publishing Company. 1986;p. 91-112.

34. Heinrich M, Ankli A, Frei B, Weimann C, Sticher O. Medicinal plants in Mexico: Healers' consensus and cultural importance. Social Science & Medicine. 1998;47:1859-1871. https://doi.org/10.1016/S0277-9536(98)00181-6.

35. Alves RRN, Silva JS, da Silva Chaves L, Albuquerque UP. Ethnozoology and animal conservation. In Ethnozoology. Elsevier. 2018,481–496. https://doi.org/10.1016/B978-0-12-809913-1.00025-9.

36. Singh G, Joyce EM, Beddow J, Mason TJ. Evaluation of antibacterial activity of ZnO nanoparticles coated sonochemically onto textile fabrics. The Journal of Microbiology, Biotechnology and Food Sciences. 2012;2:106. https://doi.org/10.1186/1746-4269-8-19.

37. CNCTHM. China National Corporation of Traditional and Herbal Medicine (CNCTHM): Materia medica commonly used in China. Beijing: Science Press. 1995.

38. Alves RRN. Relationships between fauna and people and the role of ethnozoology in animal conservation. Ethnobiology and Conservation. 2012;1:1-69. https://doi.org/10.15451/ec2012-8-1.2-1-69.

39. Alves RRN. Fauna used in popular medicine in Northeast Brazil. J Ethnobiol Ethnomed. 2009;5:1. https://doi.org/10.1186/1746-4269-5-1.
40. Poudel M, Singh NB. Medical Ethnobiology and Indigenous Knowledge System Found In Darai Ethnic Group of Chitwan, Nepal. Journal of Institute of Science and Technology. 2016;21:103-111. https://doi.org/10.3126/jist.v21i1.16061.

41. González JA, Amich F, Postigo-Mota S, Vallejo JR. The use of wild vertebrates in contemporary Spanish ethnoveterinary medicine. J Ethnopharmacol. 2016;191:135-151. https://doi.org/10.1016/j.jep.2016.06.025.

42. Souto WMS, Barboza RR, Rocha MS, Alves RRN, Mourão JS. Animal-based medicines used in ethnoveterinary practices in the semi-arid region of Northeastern Brazil. Anais da Academia Brasileira de Ciências. 2012;84(3):669-678. http://dx.doi.org/10.1590/S0001-37652012005000038.

43. Gupta L, Silori C, Mistry N, Dixit A. Use of Animals and Animal products in traditional health care systems in District Kachchh, Gujarat. Indian J Tradit Knowl.. 2003;2(1):346–356.

44. Alves RRN, Silva JS, da Silva Chaves L, Albuquerque UP. Ethnozoology: An Overview and Current Perspectives. In Ethnozoology. Elsevier. 2018;513–521. https://doi.org/10.1016/B978-0-12-809913-1.00027-2.

45. Hyun T, Kim H, Kim J. In vitro screening for antioxidant, antimicrobial, and antidiabetic properties of some Korean native plants on Mt. Halla, Jeju Island. Indian journal of pharmaceutical sciences. 2015;77:668. https://doi.org/10.1016/B978-0-12-809913-1.00027-2.

46. Kim H, Song MJ. Ethnozoological study of medicinal animals on Jeju Island, Korea. J Ethnopharmacol. 2013;146:75-82. https://doi.org/10.1016/j.jep.2012.11.011.

47. Ugulu I. Fidelity level and knowledge of medicinal plants used to make therapeutic Turkish baths. Stud Ethno-Med. 2012;6:1–9. https://doi.org/10.1080/09735070.2012.11886413.
48. Jaroli D, Mahawar MM, Vyas N. An ethnozoological study in the adjoining areas of Mount Abu wildlife sanctuary, India. J Ethnobiol Ethnomed. 2010;6:6. https://doi.org/10.1186/1746-4269-6-6.

49. Souto WMS, Barboza RRD, Mourao JDS, Alves RRN. Traditional knowledge of sertanejos about zootherapeutic practices used in ethnoveterinary medicine of NE Brazil, Indian J Tradit Knowl. 2012;11(2):259-265.

50. Ripple WJ, Wolf C, Newsome TM, Hoffmann M, Wirsing AJ, McCauley DJ. Extinction risk is most acute for the world’s largest and smallest vertebrates. PANS. 2017;114:10678–10683. https://doi.org/10.1073/pnas.1702078114

51. Ghimire SK, Lama YC, Tripathi GR, Schmitt S, Aumeeruddy-Thomas Y. Conservation of plant resources, community development and training in applied ethnobotany at Shey-Phoksundo national park and its buffer zone, Dolpa. Report Series No. 41, WWF Nepal Program, Kathmandu, Nepal. 2001.

52. Manandhar NP. Plants and people of Nepal. Timber Press Inc., Portland, Oregon. 2002.

53. Kunwar RM, Acharya RP, Chowdhary CL, Bussmann RW. Medicinal plant dynamics in indigenous medicines in farwest Nepal. J Ethnopharmacol. 2015;163:210–219. https://doi.org/10.1016/j.jep.2015.01.035.

54. Joshi KK, Joshi SD. Genetic heritage of medicinal and aromatic plants of Nepal Himalayas. Buddha Academic Publishers, Kathmandu, Nepal. 2001.

55. Quave CL, Pieroni A. A reservoir of ethnobotanical knowledge informs resilient food security and health strategies in the Balkans. Nature Plants. 2015;1:14021. https://doi.org/10.1038/nplants.2014.21.

56. Timilsina S, Singh N. Ethnobiology and Indigenous Knowledge about Medicinal Animals and Plants in the Balami Ethnic Group in Nepal. Journal of Institute of
57. Shrestha B, Gurung MB. Ethnoherpetological notes regarding the paha frogs and conservation implication in Manaslu Conservation Area, Gorkha District, Nepal. J Ethnobiol Ethnomed. 2019;15:23. https://doi.org/10.1186/s13002-019-0304-5.

58. Farooq A, Amjad MS, Ahmad K, Altaf M, Muhammad Umair M, Abbasi AM. Ethnomedicinal knowledge of the rural communities of Dhirkot, Azad Jammu and Kashmir, Pakistan. J Ethnobiol Ethnomed. 2019;15:45 https://doi.org/10.1186/s13002-019-0323-2

59. IUCN. The IUCN Red List of Threatened Species. Version 2019-3. 2019. https://www.iucnredlist.org

60. Amiguet VT, Arnason JT, Maquin P, Cal V, Vindas PS, Poveda L. A consensus ethnobotany of the Q’eqchi’Maya of southern Belize. Econ Bot. 2005;59(1):29-42. https://doi.org/10.1663/00130001(2005)059[0029:ACEOTQ]2.0.CO;2.

61. González JA, Amich F, Postigo-Mota S, Vallejo JR. The use of wild vertebrates in contemporary Spanish ethnoveterinary medicine. J Ethnopharmacol. 2016;191:135-151. http://dx.doi.org/10.1016/j.jep.2016.06.025.

62. Friedman J, Yaniv Z, Dafni A, Palewitch D. A preliminary classification of the healing potential of medicinal plants, based on a rational analysis of an ethnopharmacological field survey among Bedouins in the Negev Desert, Israel. J Ethnopharmacol. 1986;16(2-3):275–287. https://doi.org/10.1016/0378-8741(86)90094-2.

63. Phillips O, Gentry AH, Reynel C, Wilkin P, Gálvez-Durand BC. Quantitative ethnobotany and Amazonian conservation. Conserv Biol. 1994;8(1):225-248. https://doi.org/10.1046/j.1523-1739.1994.08010225.x.

Tables
Table 1. List of ailments grouped into different categories.

| SN | Ailment categories               | Biomedical terms              | Nepali name                                      |
|----|----------------------------------|-------------------------------|-------------------------------------------------|
| 1  | Cardiovascular problem           | Anaemia                       | Rakta alpata                                    |
|    |                                  | Malaria                        | Aulo jaro                                       |
|    |                                  | Snake bite                     | Sarpa le tokeko                                 |
| 2  | Dental problem                   | Gum bleeding                  | Dant bata ragat aune (Harsa rog)                |
| 3  | Musculoskeletal problem          | Rheumatism                    | Bath rog                                        |
|    |                                  | Muscular pain and cramp       | Masu tuteko/ Dukheko                            |
|    |                                  | Backbone pain                 | Dhad dukheko                                    |
|    |                                  | Arthritis                      | Haddi khiyeko                                  |
|    |                                  | Strength                       | Baliyo                                          |
|    |                                  | Energy                         | Sakti                                           |
|    |                                  | Protein deficiency             | Protein ko kami                                 |
| 4  | Reproductive problems            | Menstrual problem             | Mahinabari ma pida, Kharabi                     |
|    |                                  | Sexual performance            | Yaunsakti badaune                               |
|    |                                  | Low sperms                    | Sukrakti kami hunu                              |
|    |                                  | Infertile                     | Banjo pan                                       |
|    |                                  | Hermaphroditism               | Napusakata                                      |
|    |                                  | Delivery pain                 | Prasab pida                                     |
|    |                                  | Uterine bleeding              | Patheghar bata ragat bagnu                      |
| 5  | Ear, Nose and Troat problem      | Ear ache                       | Kan dukheko                                     |
|    |                                  | Speech                         | Boli ma samashya                                |
|    |                                  | Heart disease                  | Mutu dukheko                                    |
| 6  | Respiratory problem              | Asthma                         | Dam                                             |
|    |                                  | Hiccups                        | Hikka hikka hunu                                |
|    |                                  | Cough                          | Khoki lageko                                    |
|    |                                  | Tuberculosis                   | Kshyarog                                        |
|    |                                  | Pneumonia                      | Nimoniya                                        |
|    |                                  | Cold                           | Chiso lageko                                    |
| 7  | Neurological problem             | Anxiety                        | Chinta rog                                      |
|    |                                  | Will power                     | Ichhasakti                                      |
|    |                                  | Mental illness                 | Manasik rogi                                    |
|    |                                  | Epilepsy                       | Chhare rog                                      |
|    |                                  | Neurovascular                  | Nasa sambandi rog                               |
6

| 8  | Dermatological problem |
|----|------------------------|
|    | Ghost                  |
|    | Tetanus                |
|    | Rabies                 |
|    | Paralysis              |
|    | Wound                  |
|    | Pimples                |
|    | Burning                |
|    | Marks of old wounds    |
|    | Facial spots           |
|    | Skin disease           |
|    | Scabies                |
|    | Ring worm              |
|    | Loss of hair           |
|    | Allergy                |
|    | Measles                |
|    | Cracks of soles        |

| 9  | Gastro-intestinal problem |
|----|---------------------------|
|    | Poisoning                 |
|    | Nausea                    |
|    | Ulcer                     |
|    | Endogenous wind           |
|    | Stomach pain              |
|    | Gastritis                 |
|    | Constipation              |
|    | Piles                     |
|    | Vomiting                  |
|    | Dysentery                 |
|    | Jaundice                  |

| 10 | Ophthalmological problem |
|----|--------------------------|
|    | Poor vision              |

| 11 | Others               |
|----|----------------------|
|    | Headache             |
|    | Fever                |

| 12 | Veterinary and agriculture use |
|----|--------------------------------|
|    | Insecticides           |
|    | Wounds on cattle       |
|    | Mouth and foot disease |

|   | Veterinary and agriculture use |
|---|--------------------------------|
|  | Insecticides                 |
|  | Wounds on cattle             |
|  | Mouth and foot disease       |
Table 2 Demographic profile of the respondents.

| Questionnaires (n=204) | Block A | Block B | Block C | Block D | Total |
|------------------------|---------|---------|---------|---------|-------|
| No of household interviewed | 52      | 45      | 58      | 49      | 204   |
| Occupation wise         |         |         |         |         |       |
| Farmer                  | 19      | 21      | 28      | 19      | 87    |
| Students                | 4       | 6       | 4       | 3       | 17    |
| Teacher                 | 8       | 4       | 8       | 5       | 25    |
| Social workers          | 5       | 5       | 7       | 5       | 22    |
| Government employer     | 7       | 5       | 3       | 1       | 16    |
| Hotel owner             | 2       | 0       | 0       | 6       | 8     |
| Business                | 7       | 4       | 8       | 10      | 29    |
| Gender                  |         |         |         |         |       |
| Female                  | 15      | 12      | 27      | 16      | 70    |
| Male                    | 37      | 33      | 31      | 33      | 134   |
| Academic status         |         |         |         |         |       |
| Illiterate              | 4       | 5       | 6       | 9       | 24    |
| Literate                | 14      | 18      | 28      | 17      | 77    |
| Secondary               | 16      | 11      | 13      | 14      | 54    |
| Intermediate            | 9       | 6       | 7       | 4       | 26    |
| University              | 9       | 5       | 4       | 5       | 23    |
| Caste system            |         |         |         |         |       |
| Dalit                   | 1       | 6       | 2       | 6       | 15    |
| Gurung                  | 8       | 4       | 10      | 34      | 56    |
| Magar                   | 2       | 16      | 28      | 0       | 46    |
| Newar                   | 0       | 3       | 7       | 0       | 10    |
| Tamang                  | 3       | 5       | 0       | 4       | 12    |
| Darai                   | 4       | 2       | 0       | 0       | 6     |
| Sanyasi                 | 0       | 2       | 7       | 0       | 9     |
| Braman/Chhetri          | 5       | 5       | 4       | 3       | 17    |
| Gharti                  | 0       | 0       | 0       | 2       | 2     |
| Tharu                   | 18      | 0       | 0       | 0       | 18    |
| Mushahar                | 6       | 0       | 0       | 0       | 6     |
| Bote                    | 5       | 2       | 0       | 0       | 7     |
| Age group (year)        |         |         |         |         |       |
Table 3 Medicinal uses of vertebrates and their body parts in traditional medicine by the people inhabiting in Midhill Nepal.

(Where, W= Wild, D= Domestic, EN= Endangered, V= Venerable, NT= Near threatened, DD= Data deficient, LC= Least concerned, UV= Use value).

| SN | Family   | Scientific Name                  | English names      | Nepali names | IUCN category |
|----|----------|----------------------------------|--------------------|--------------|---------------|
|    |          | Class: Mammalia                  | Order: Carnivora   |              |               |
|    |          | Canidae                          | Canis aureus Linnaeus, 1758 | Golden jackal (W) | Shyal | LC |
| 1  | Canidae  |                                   |                    |              |               |
| 2  | Canidae  | Canis lupus familiaris Linnaeus, 1758 | Black dog (D)     | Kalo Kukur  |               |
| 3  | Felidae  | Panthera pardus (Linnaeus, 1758) | Leopard (W)       | Chituwa      | VU            |
| No. | Order   | Genus and Species                                      | Common Name          | Status     | Location          |
|-----|---------|--------------------------------------------------------|----------------------|------------|-------------------|
| 4   | Felidae | *Felis chaus* Schreber, 1777                          | Jungle cat (W)       | Ban Biralo | LC                |
| 5   | Felidae | *Panthera tigris* (Linnaeus, 1758)                    | Tiger (W)            | Baag       | EN                |
| 6   | Ursidae | *Ursus thibetanus* G. [Baron] Cuvier, 1823            | Asiatic black bear (W) | Kalo bhalu | VU                |
| 7   | Ursidae | *Melursus ursinus* (Shaw, 1791)                       | Sloth bear (W)       | Rukh bhalu | VU                |
| #  | Order       | Family   | Scientific Name                        | Common Names          | Status   |
|----|-------------|----------|----------------------------------------|-----------------------|----------|
| 8  | Cetartiodactyla | Bovidae | *Naemorhedus goral* (Hardwicke, 1825) | Himalayan goral (W)   | Ghoral   | NT      |
| 9  | Bovidae     |          | *Ovis aries* Linnaeus, 1758            | Sheep (D)             |          |         |
| 10 | Bovidae     |          | *Bos taurus* Linnaeus, 1758            | Cattle (D)            | Gai      |         |
| 11 | Bovidae     |          | *Bubalus bubalis bubalis* (Linnaeus, 1758) | Buffalo (D)          |          |         |
| 12 | Cervidae    |          | *Rusa unicolor* (Kerr, 1792)          | Samber (W)            |          | VU      |
| Number | Order       | Genus              | Species                        | Scientific Name | Common Name                | Status | IUCN Code |
|--------|-------------|--------------------|--------------------------------|-----------------|----------------------------|--------|-----------|
| 13     | Cervidae    | Muntiacus          | vaginalis (Boddaert, 1785)    | Northern red muntjac (W) | Rate, Rato mirga           | LC     |           |
| 14     | Cervidae    | Axis               | axis (Erxleben, 1777)         | Chital (W)      | Chital                     | LC     |           |
| 15     | Suidae      | Sus                | scrofa Linnaeus, 1758         | Wild boar (W)   | Bandel                     | LC     |           |
| 16     | Suidae      | Sus                | domesticus Erxleben, 1777     | Pig (D)         | Sungur                     |        |           |
| 17     | Rhinolophidae | Rhinolopus       | sp.                            | Bat (W)         | Chamero                    |        |           |
| 18     | Leporidae   | Lepus              | nigricollis F. Cuvier, 1823   | Indian hare (W) | Kharayo                    | LC     |           |
| 19     | Rhinocerotida | Rhinoceros        | unicornis Linnaeus, 1758      | Indian Rhinocers (W) | Gaida                     | VU     |           |
| Order: Primates          |                |                |                |                    |
|-------------------------|----------------|----------------|----------------|--------------------|
| 20 Cercopithecidae      | *Semnopithecus hector* (Pocock, 1928) | Tarai gray langur (W) | Kalo Bandar | NT                |
| 21 Cercopithecidae      | *Macaca assamensis* M'Clelland, 1840  | Assame macaque (W)    | Pahare Bandar | NT                |
| Order: Rodentia         |                |                |                |                    |
| 22 Hystricidae          | *Hystrix indica* Kerr, 1792            | Indian crested porcupine (W) | Dumi       | LC                |
| 23 Muridae              | *Rattus rattus* (Linnaeus, 1758)       | House rat (W)         | Musu        | LC                |
| 24 Sciuridae            | *Petaunista* sp.                         | Flying squirrel (W)   | Rukh Lokharke | LC                |
| Class: Aves             |                |                |                |                    |
| Order: Ciconiiformes    |                |                |                |                    |
| 25 Ciconiidae           | *Leptoptilos javanicus* (Horsfield, 1821) | Lesser adjutant (W)  | Garud       | VU                |
| Order: Charadriiformes  |                |                |                |                    |
| 26 Charadriidae         | *Vanellus indicus* (Boddaert, 1783)    | Red-wattled lapwing (W) | Hutitaun | LC                |
| Order: Columbiformes |
|----------------------|
| 27 Columbidae | *Treron sphenurus* (Vigors, 1832) | Wedge-tailed green-pigeon (W) | Haleso | LC |
| 28 Columbidae | *Columbia livia* Gmelin, 1789 | Rock dove (W) | Parewa | LC |
| 29 Columbidae | *Streptopelia orientalis* (Latham, 1790) | Oriental turtle-dove (W) | Dhukur | LC |

| Order: Galliformes |
|-------------------|
| 30 Phasianidae | *Arborophila torqueola* (Valenciennes, 1826) | Hill partridge (W) | Pyura | LC |
| 31 Phasianidae | *Lophura leucomelanos* (Latham, 1790) | Kaliz pheasant (W) | Kaliz | LC |
| 32 Phasianidae | *Francolinus francolinus* (Linnaeus, 1766) | Black francolin (W) | Titra | LC |
| 33 Phasianidae | *Gallus gallus* (Linnaeus, 1758) | Red jungle fowl (W) | Ban Kukhura | LC |
| 34 Phasianidae | *Pavo cristatus* Linnaeus, 1758 | Common pea fowl (W) | Mayur | LC |

| Order: Passeriformes |
|---------------------|
| 35 Passeridae | *Passer domesticus* (Linnaeus, 1758) | House sparrow (W) | Bhagera | LC |
|   | Order:  | Family:  | Genus:  | Species: | Common Name: | Status: | Ref: |
|---|---------|----------|---------|----------|--------------|--------|------|
| 36| Sturnidae | Acridotheres fuscus | Wagler, 1827 | Jungle myna | Sarau | LC |
| 37| Corvidae | Corvus splendens Vieillot, 1817 | House crow (W) | Kag | LC |
| 38| Ardeidae | Bubulcus ibis Linnaeus, 1758 | Cattle egret (W) | Bakulla | LC |
| 39| Psittacidae | Psittacula krameri Scopoli, 1769 | Rose-ringed parakeet (W) | Suga | LC |
| 40| Tytonidae | Tyto alba Scopoli, 1769 | Common barn-owl (W) | Huichil | LC |
| 41| Chelonidae | Nilssonia hurum Gray, 1830 | Indian peacock softshell turtle (W) | Kachhuwa | VU |
| 42| Agamidae | Calotes versicolor Daudin, 1802 | Common garden lizard (W) | Chheparo | LC |
| 43| Colubridae | Ptyas mucosa Linnaeus, 1758 | Rattle snake (W) | Dhaman | LC |
| 44| Gekkonidae | Hemidactylus flaviviridis Rüppell, 1835 | Northern house gecko (W) | Mausuli | LC |
| 45| Varanidae | Varanus bengalensis Daudin, 1802 | Bengal | Gohoro | LC |
| No. | Family         | Species                                      | Common Name          | Status   |
|-----|---------------|----------------------------------------------|----------------------|----------|
| 46  | Varanidae     | *Varanus flavescens* (Gray, 1827)            | Golden monitor lizard (W) | Sun Gohoro | LC       |
| 47  | Bufonidae     | *Duttaphrynus himalayanus* (Günther, 1864)   | Common toad (W)       | Khasre Bhyaguto | LC       |
| 48  | Dicroglossidae| *Hoplobatrachus tigerinus* (Daudin, 1802)    | Tiger frog (W)        | Pahelo Pawa | LC       |
| 49  | Dicroglossidae| *Hoplobatrachus rugulosus* (Wiegmann, 1834)  | Black frog (W)        | Kalo Pawa  | LC       |
| 50  | Anguillidae   | *Anguilla bengalensis* (Gray, 1831)          | Indian mottled eel (W) | Raj bam    | NT       |
| 51  | Balitoridae   | *Acanthocobitis botia* (Hamilton, 1822)      | Striped loach (W)     | Garela Fish | LC       |
| 52  | Cyprinidae    | *Tor putitora* (Hamilton, 1822)              | Mahasheer (W)         | Sahar      | EN       |
|   | Order: Cypriniformes | Family | Species | Common Name | Conservation Status |
|---|---------------------|--------|---------|-------------|-------------------|
| 53 | Cyprinidae          | Schizothorax richardsonii (Gray, 1832) | Asla (W) | Asala | VU |
| 54 | Cyprinidae          | Pethia conchonius (Hamilton, 1822) | Rosy barb (W) | Sidhre | LC |

Order: Osteoglossiformes

|   | Family | Species | Common Name | Conservation Status |
|---|--------|---------|-------------|-------------------|
| 55 | Notopteridae | Notopterus nopterus (Pallas, 1769) | Grey feather back (W) | Patala machha | LC |

Order: Perciformes

|   | Family | Species | Common Name | Conservation Status |
|---|--------|---------|-------------|-------------------|
| 56 | Anabantidae | Anabas testudineus (Bloch, 1792) | Climbing perch (W) | Kabai | DD |

Order: Synbranchiformes

|   | Family | Species | Common Name | Conservation Status |
|---|--------|---------|-------------|-------------------|
| 57 | Synbranchidae | Monopterus cuchia (Hamilton, 1822) | Gangetic mudeel (W) | Chuche Bam | LC |

Order: Siluriformes

|   | Family | Species | Common Name | Conservation Status |
|---|--------|---------|-------------|-------------------|
| 58 | Siluridae | Wallago attu (Bloch & Schneider, 1801) | Cat fish (W) | Buhari | NT |

**Table 4 Categories of ailments and informant consensus factor (ICF) for these categories.**
| Ailment categories                  | Number of use-reports (Nur) | Number of taxa (Nt) | Informant consensus fac (ICF) |
|------------------------------------|-----------------------------|---------------------|------------------------------|
| Cardiovascular problem             | 351                         | 10                  | 0.974                        |
| Dental problem                     | 77                          | 3                   | 0.974                        |
| Musculoskeletal problem            | 926                         | 26                  | 0.973                        |
| Reproductive problems              | 355                         | 12                  | 0.969                        |
| Ear, Nose and Throat problem       | 63                          | 3                   | 0.968                        |
| Respiratory problem                | 452                         | 16                  | 0.967                        |
| Neurological problem               | 262                         | 12                  | 0.958                        |
| Others                             | 47                          | 3                   | 0.957                        |
| Dermatological problem             | 369                         | 22                  | 0.943                        |
| Gastro-intestinal problem          | 263                         | 17                  | 0.939                        |
| Ophthalmological problem           | 7                           | 2                   | 0.833                        |
| **Total**                          | **3172**                    | **126**             |                              |

*A taxon may be reported in more than one ailment category*

Table 5 Most frequently used animal for different ailment categories based on highest FL (%) in each ailment category.
| Ailments                          | Animal                                         | FL(%) |
|----------------------------------|------------------------------------------------|-------|
| Cardiovascular problem           | *Leptoptilos javanicus* (Horsfield, 1821)      | 100   |
|                                  | *Bufo bufo* (Linnaeus, 1758)                  | 100   |
| Dental problem                   | *Bubulcus ibis* (Linnaeus, 1758)              | 100   |
| Dermatological problem           | *Corvus splendens* Vieillot, 1817             | 100   |
|                                  | *Hemidactylus flaviviridis* Rüppell, 1835     | 100   |
|                                  | *Varanus bengalensis* (Daudin, 1802)          | 100   |
| Gastro-intestinal problem        | *Canis lupus familiaris* Linnaeus, 1758        | 100   |
|                                  | *Tyto alba* (Scopoli, 1769)                   | 100   |
|                                  | *Calotes versicolor* (Daudin, 1802)           | 100   |
| Musculoskeletal problem          | *Lophura leucolophus* (Latham, 1790)          | 100   |
| Reproductive problem             | *Rattus rattus* (Linnaeus, 1758)              | 100   |
|                                  | *Arborophila torqueola* (Valenciennes, 1826)  | 100   |
|                                  | *Acanthocobitis botia* (Hamilton, 1822)       | 100   |
|                                  | *Anabas testudineus* (Bloch, 1792)           | 100   |
| Respiratory problem              | *Rhinolopus* sp.                              | 100   |
|                                  | *Macaca assamensis* M'Clelland, 1840          | 100   |
|                                  | *Streptopelia orientalis* (Latham, 1790)      | 100   |
|                                  | *Acridotheres fuscus* (Wagler, 1827)          | 100   |
|                                  | *Schizothorax richardsonii* (Gray, 1832)      | 100   |
|                                  | *Pethia conchonius* (Hamilton, 1822)          | 100   |
| Ear, Nose and Throat problem     | *Psittacula krameri* (Scopoli, 1769)          | 75.6  |
| Neurological problem             | *Wallago attu* (Bloch & Schneider, 1801)      | 60    |
| Others                           | *Tor putitora* (Hamilton, 1822)               | 56.9  |
| Ophthalmological problem         | *Felis chaus* Schreber, 1777                  | 20    |

**Figures**
Figure 1

Map showing the intensive study areas which links two biodiversity significant areas:

Chitwan National Park (CNP) and Annapurna Conservation Area (ACA).
Figure 2

Taxonomic groups of vertebrates used in ethno-medicinal practices among different ethnic communities of Chitwan-Annapurna Landscape.
Figure 3

Percentage contribution of body parts of vertebrates used in ethno-medicine.
Figure 4

Mode of preparation of medicine from body parts of vertebrates.
Figure 5

Conservation status of wild vertebrate species used for ethnomedicine in Chitwan-Annapurna Landscape, Nepal (according to IUCN Red List, 2019).
Parts of animals used by local ethnic group for the treatment of different diseases: A- Skin of Tiger (paste of dry skin and hair is prescribed in mental illness) B- Dry meat (leg) of Wild boar (the soup of dry meat (leg) is provided to relief the patient suffering from epilepsy) C- Bone of Leopard (the soup of the bone or paste is considered as aphrodisiac in nature). D- Leg of Lesser adjutant (The paste of claws of stork is applied on the place of snake bite).
Figure 7

Parts of animals used by local ethnic group for the treatment of different diseases: A- Belt made by the skin of Monitor lizard (belt made by dry skin is used during backbone pain) B- Horn of Himalayan goral (The horn of the goral is rubbed and made a fine paste and used in the navel region for curing the stomach pain) C- Treatment by local healer using traditional medicines D- Bat (The cooked meat of bat is good for asthma, tuberculosis).