

Diversity of snake in Kaski district of Gandaki Province, Nepal

Rishi Baral^{1,2,3*}  | Keshab Raj Sapkota²  | Mahendra Prasad Katila²  | Roshan Giri²  | Sagar Pandey²  | Aakash Bhandari²  | Abhisek Sapkota²  | Ramji Gautam^{2,3} 

¹National Trust for Nature Conservation - Annapurna Conservation Area Project, Hariyo Kharka, Pokhara, Nepal

²Snake Conservation Society Nepal, Simpani-1, Pokhara, Nepal

³Department of Zoology, Prithvi Narayan Campus, Bhimkalipatan-1, Pokhara, Nepal

* Correspondence: right.rishi1@gmail.com

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Abstract

Snakes are one of the most diverse vertebrates on the globe, mostly prefer arid zones. Nepal harbors a high unrecognized reptilian diversity. Information on the diversity and distribution of snakes in the western Nepal are derived from relatively from old literatures. This study updated the diversity and distribution of snakes from the Kaski district based on rescuing activities, field survey and literature review. Altogether 40 species of snake from five families were recorded in the Kaski district. The family Colubridae (70%) had the highest species diversity followed by Elapidae (12.5%), Viperidae (12.5%), Pythonidae (2.5 %), and Typhlopidae (2.5 %) respectively. Based on the IUCN global status of snake, 5 % are vulnerable, 5 % data deficient, 27.5 % are Least Concern and 62.5 % are Not Evaluated. Six species were found new distribution records in Kaski. Four species were the species listed on CITES II. Out of 40 species, 27.5% venomous (2.5 % were venomous but not fatal to human, 12.5% were neurotoxic, 12.5% were hemotoxic which are deadly venomous), 20% were weakly venomous and not fatal to human and 50 % were non-venomous. Habitat loss, nest destroyed, road-killed and meaningless killing by the negative perception of people was the most threat to snake in Kaski district.

Keywords: Hemotoxic, Kaski district, Neurotoxic, Weakly venomous

1 | Introduction

Reptiles are one of the most widespread diverse vertebrates on the earth and about 11,301 species and 2237 subspecies are currently known. Among them, more than 3500 species of snakes are recorded and out of these only 754 species of them are reported as venomous (Uetz et al. 2020, Scott 2013). Nepal supports high snake diversity (Shah & Tiwari 2004, Kästle et al. 2013) but most of these records are primarily based on either from presence-only surveys or from anecdotal information.

Snakes found in grassland, cultivate land and forest area. Major determinant affecting the snake distribution is due to the topography and climate. In Nepal, the Arun valley, the Annapurna-Dhaulagiri region and the Chitwan National Park have been extensively studied from the herpetofauna perspective and other few protected areas such as Koshi Tappu, Bardia National Park, Suklaphanta National Park and eastern and central Nepal have also been studied to some extent. But the mid- and far-

western regions of Nepal remains least studied due to remoteness and inaccessibility (Shah & Tiwari 2004).

Snakes are very important to nature and humans which have an ecological niche in the overall pattern of life, providing food for some animals and control over others (Shah & Tiwari 2004). Snakes are important ecologically, religiously and help to balance the nature (Shrestha & Shah 1985). The meaningless killing of snake is the main reason of declining their number and species diversity (Shah & Gautam 2010).

Human and snake conflict is seen more in different place of Nepal which led the snakebites case where Terai region have quite high cases compare to mountain regions (Sharma et al. 2004). A community-based study in South-eastern Nepal showed an annual incidence of 1162 bites/100000, annual mortality rate of 162/100000 and case fatality rate of 27% (Sharma et al. 2004). This conflict results in negative impact on people that they think all the snakes are venomous and being killed ruthlessly (Shah & Gautam 2010).

Nepalese snakes are divided into 5 families of which 3 Typhlopidae and Pythonidae are non-venomous, Colubridae have one species venomous i.e. *Rhabdophis subminiatus* and fatal bite cases have been recorded (Shah & Tiwari 2004) and few are weakly venomous and more species are non-venomous of this family while Elapidae and Viperidae are deadly venomous. Colubridae is the largest family of snakes which contains 2000 species found in the world (Shah & Tiwari 2004) and 46 species and 6 subspecies of non-venomous and mildly venomous snakes in Nepal. (Shah & Tiwari 2004). The venomous family of Elapidae contains Cobras, Kraits, and Coral Snakes and represented by 4 genera, 8 species, and 1 subspecies of deadly venomous snakes in Nepal. Cobras have characteristic hood behind the neck (Shah & Tiwari 2004). This family also includes the king cobra (*Ophiophagus hannah*) which is the longest venomous snake in the world. In Nepal, Cobras have a religious value where people worship as Kali Nag and Set Nag. Another venomous family of Viperidae contains the vipers and pit viper's snakes which represented by 5 genera, 9 species, and 2 subspecies in Nepal (Shah & Tiwari 2004).

In the context of Kaski, it provides good habitat for snakes both venomous and non-venomous due to its different topographic feature and climate (Shah & Gautam 2010). In Pokhara, the previous record of snake's species consists 20 species of snake (Shah & Gautam 2010). Very few information of snakes is available in Nepal from all protected areas as well as outside protected area. This gives the information of snake's species richness of Kaski district with the aim of raising public awareness to snake conservation.

2 | Materials and methods

2.1 | Study area

Kaski District is a part of Gandaki Pradesh, is one of the seventy-seven districts of Nepal. It lies at the latitude of 28°18'19.08" North and longitude 84°04'37.20" East. The name is disambiguated from Kaskikot, the ancient Kaski Kingdom (DDC 2015). Kaski covers an area of 2,017 square km and Pokhara is the district headquarter and had a total population of 492,098 according to 2011 Census. This district lies at the centroid point of the country. The altitude of Kaski district ranges from 450 meters the lowest land to 8091 meters the highest point in the Himalaya range. Kaski District politically has One Metropolitan City, 4 rural municipalities and 3 electoral sectors (DDC

2015). The district is full of rivers such as Seti Gandaki, Modi and Madi along with other rivulets. The district headquarters Pokhara lies about 750 m above the sea level and is one of the best tourist destinations in the world (DDC 2015).



Figure 1. Map of Kaski District

2.2 | Opportunistic search, rescue events and literature review

The information of the snakes was collected from different parts of Kaski district from January 2018 to October 2020. The secondary information collected from the previous literature reviewed of Kaski district and list were made. Opportunistic survey (OP) and searches were done through different sources via social media. The rescue data of the team from Snake Conservation Society was collected from three years. Permission and coordination of rescuing was taken from Division Forest Office, Kaski for rescuing the snakes. The number of rescuers was circulated from different social media via Facebook, YouTube so that people called the team for immediate rescue. We identified the snake species by using published guide book Shah and Tiwari (2004), and Kästle and Schleich (2002) the dead specimens were deposited in Annapurna Natural History Museum which was 6 in number.

3 | Results

A total 40 species (including one subspecies) of snake from five families were recorded from Kaski district (Annex 1). The rescue data of three years 2018- 2020 (up to October) were included. The secondary information was collected from the previous literature review. The family Colubridae (70%) had the highest species diversity followed by Elapidae (12.5%), Viperidae (12.5%), Pythonidae (2.5%), and Typhlopidae (2.5%) respectively. Out of 40 species, five species were neurotoxic,

deadly venomous, another five species were Hemotoxic, other eight species were weakly venomous and 21 species were non venomous and one species of Colubridae family is venomous i.e *Rhabdophis subminiatus* (red-necked keelback). Based on the IUCN global status of snake consists of two Vulnerable species i.e *Python bivittatus* and *Ophiophagus hannah*. Likewise, *Liopeltis rappi* and *Boiga multifasciata* were two species which is in data deficient list, 11 were least concern species and the rest are not evaluated in Kaski. Four species were the species which listed on CITES II i.e *Python bivittatus*, *Ptyas mucosa*, *Naja kaouthia* and *Ophiophagus hannah* from Kaski district. Six species were the species which have new distributional records from Kaski district. Among them, total 23 species were found rescuing from different place of Kaski. Habitat loss, nest destroyed, road-killed and meaningless killing by the negative perception of people was the most threat to snake in Kaski district.



Figure 2. Maximum rescued and seen snake of Colubridae family. Photos: 1- *Ptyas mucosa* (Asiatic rat snake); 2- *Coelognathus radiatus* (Copper headed trinket snake); 3- *Coelognathus helena* (Common trinket snake); 4- *Lycodon aulicus* (Common wolf snake); 5- *Boiga trigonata* (Common cat snake); and 6- *Amphiesma stolatum* (Buff-striped keelback). (Photos by Rishi Baral)

Colubridae snakes

The Colubridae family reaches the highest number of species which consists 28 species (including one subspecies) including *Ptyas mucosa*, *Fowlea piscator*, *Coelognathus helena*, *Coelognathus radiatus*, *Amphiesma stolatum*, *Lycodon aulicus*, *Boiga trigonata trigonata* was found more in Kaski district in compare to other snake species of colubridae family. In Kaski,

total eight species were found weakly venomous of this family and one species is venomous i.e *Rhabdophis subminiatus* (red-necked keelback) and fatal bite case have been recorded (Shah & Tiwari 2004)

Deadly venomous snakes



Figure 3. Species of Elapidae family. Photos: 7- *Ophiophagus Hannah* (King cobra) guarding its nest in Kaski; 8- *Bungarus niger* (Greater black krait) (Photos by Rishi Baral). Photo: 9- *Sinomicrurus maclellandii univirgatus* (Maclelland's coral snake), (Photo by Sangita Gautam)



Figure 4. Species of Viperidae family. Photos: 10- *Gloydius himalayanus* (Himalayan pit viper) (Photo by Mahendra Katila); and 11- *Trimeresurus septentrionalis* (Kramer's pit viper) (Photo by Rishi Baral)

Out of 40 species, five species were neurotoxic, deadly venomous of family Elapidae and another five species were Hemotoxic, deadly venomous of family Viperidae. In Kaski, total eight species were found weakly venomous and one species was venomous i.e *Rhabdophis subminiatus* (red-necked keelback) of family Colubridae which cause fatal bite. 20 species were non venomous. The world venomous snake King Cobra was found nesting in Kaski district.

New distribution records of snakes in Kaski district

The six new distribution records were seen from this area, *Rhabdophis subminiatus* in 2018, *Lycodon jara* and *Sibynophis sagittarius* in 2019, and *Lycodon striatus*, in 2020 and *Naja naja* in 2018 and 2019, *Naja kaouthia* in 2018, 2019 and 2020 (Fig. 5).



Figure 5. New distribution records of snakes. Photos: 12- *Naja kaouthia* (Monocled cobra); 13- *Naja naja* (Spectacled cobra), (Photo by Rishi Baral). Photos: 14- *Lycodon jara* (Twin-spotted wolf snake) (Photo by Sabin Subedi); 15- *Lycodon striatus* (Banded wolf snake) dead (Photo by Rajan Gurung)

4 | Discussion

In Nepal, there are 123 species of reptiles (Schleich & Kastle 2002). Shah and Tiwari (2004) listed 80 species of serpent in Nepal where Kaski district contain 40 species (including one subspecies) which is 50% of the country. Nepalese snakes are divided into 5 families of which the families Typhlopidae and Pythonidae are non-venomous while Elapidae and Viperidae are venomous (Shah & Tiwari 2004). But Colubridae have one species venomous i.e. *Rhabdophis subminiatus* and fatal bite cases have been recorded (Shah & Tiwari 2004) and few are weakly venomous and more species are non-venomous of this family. All these five families' snakes were present in Kaski district.

The previous research of snakes in Pokhara valley include the 20 species (Shah & Gautam 2010). And the other researches were from Modi Khola watershed including the Ghandruk region studies by Nanhoe and Ouboter (1987), Shah (2001), Shah and Tiwari (2004), Giri (2013), Project abroad Status report (2018) and (2019) and Kästle et al. (2013) recorded a total of 66 species of amphibians and reptiles from the entire Annapurna Conservation Area. In this study, we recorded 40 species of snakes from the Kaski district. The six new distributional record *Rhabdophis subminiatus*, *Lycodon jara*, *Sibynophis sagittarius*, *Lycodon striatus*, *Naja naja* and *Naja kaouthia* for the first time from Kaski district. The first nest of King Cobra was sighted at Gairi Gau, Dangsing on 2016 at an altitude of 1749 m from Kaski and the 100% hatching was success (Baral et al. 2019) as well as the first time King cobra was feeding on green pit viper was recorded from Kaski district (Baral & Koirala 2020) which shows

the habitats of Kaski district were favorable for King Cobra. Snake diversity is believed to be exceptionally rich in Nepal due to its great climatic variation and altitude variation from lower terai to high mountain (Shah & Gautam 2010) and we found 50% of the snakes were recorded from Kaski which shows the district is favorable and good habitat of many species. But, study of serpent was less in priority although they are equally importance in religious point of view, economically as well as scientifically too. Snakes are very important to nature and humans which have an ecological niche in the overall pattern of life, providing food for some animals. Habitat loss, nest destroyed, road-killed and meaningless killing by the negative perception of people was the most threat to snake in Kaski district (Shah & Gautam 2010).

5 | Conclusions

Total 50 % of the country serpent's species were found from the Kaski district with 11 species were venomous where 10 were deadly venomous species including the world's venomous snake too. The Colubridae family reaches the maximum number with one subspecies. We found 15 species in global list, four species in CITES list and six species new distributional record which shows that the Kaski district is highly suitable for different snake's species. Negative perception, road-killed and meaningless killing of people were the main threats to snake species. Conservation and awareness should be necessary to conserve snake species in this area.

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Authors' contributions

Baral R. collected the data, review all, wrote the manuscript. All authors contributed in rescue event in all three years and approved it for the submission.

Conflicts of interest

Authors declare no conflict of interest.

ORCID

Rishi Baral  <https://orcid.org/0000-0001-6718-0016>

Keshab Raj Sapkota  <https://orcid.org/0000-0001-7061-2238>

Mahendra Prasad Katila  <https://orcid.org/0000-0001-5618-832X>

Roshan Giri  <https://orcid.org/0000-0001-7769-8193>

Sagar Pandey  <https://orcid.org/0000-0001-5419-2085>

Aakash Bhandari  <https://orcid.org/0000-0003-2109-9102>

Abhisek Sapkota  <https://orcid.org/0000-0003-2384-9384>

Ramjii Gautam  <https://orcid.org/0000-0003-3344-3556>

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Annex 1. List of Snakes found in Kaski districts with their details. Note: OP- Opportunistic record

S.N.	Species	Common name	IUCN Global Status	Venomous/ Non Venomous	Source of Information	2018	2019	2020	Rescued	Remarks
Family: Typhlopidae										
1	<i>Indotyphlops braminus</i> (Daudin, 1803)	common blind snake / Brahminy worm snake/ flowerpot snake, Brahminy blindsnake/ bootlace snake	Not Evaluated	Non Venomous	OP + Literature	✓	✓	X		
Family: Pythonidae										
2	<i>Python bivittatus</i> (Kuhl, 1820)	Burmese python	Vulnerable A2acd	Non Venomous	OP + Literature	✓	✓	✓		
Family : Colubridae (Natricidae)										
3	<i>Herpetoreas platyceps</i> (Blyth, 1854)	mountain keelback/ Asiatic keelback / eastern keelback	Not Evaluated.	Weakly venomous	OP + Literature	✓	✓	✓	✓	
4	<i>Amphiesma stolatum</i> (Linnaeus, 1758)	buff striped keelback	Not Evaluated.	Weakly venomous	OP + Literature	✓	✓	✓	✓	
5	<i>Rhabdophis himalayanus</i> (Günther, 1864)	Himalayan keelback / Himalayan boigine snake	Not Evaluated.	Weakly venomous	OP + Literature	✓	X	X	✓	
6	<i>Rhabdophis subminiatus</i> (Schlegel, 1837)	red-necked keelback	Least Concern	Venomous	Literature	✓	X	X		New distribution record
7	<i>Boiga multifasciata</i> (Blyth, 1861)	many-banded tree snake /Himalayan cat snake	Data Deficient	Weakly venomous	Literature	X	X	X		
8	<i>Boiga ochracea ochracea</i> (Theobald, 1868)	common tawny cat snake	Not Evaluated.	Weakly venomous	OP + Literature	✓	X	X		
9	<i>Boiga ochracea stoliczkae</i> (Wall 1909)	Stoliczka's tawny cat snake	Not Evaluated.	Weakly venomous	Literature	X	X	X		
10	<i>Boiga trigonata trigonata</i> (Schneider, 1802)	common cat snake / common Indian cat snake / Indian gamma snake	Least Concern	Weakly venomous	OP+ Literature	✓	✓	✓	✓	
11	<i>Coelognathus helena</i> (Daudin, 1803)	common trinket snake	Not Evaluated.	Non Venomous	OP + Literature	✓	✓	✓	✓	
12	<i>Coelognathus radiatus</i> (Boie, 1827)	Copper headed trinket snake / Copper headed rat snake/ Copper headed racer	Not Evaluated.	Non Venomous	OP + Literature	✓	✓	✓	✓	
13	<i>Elaphe hodgsoni</i> (Günther, 1860)	Himalayan trinket snake / Hodgson's racer	Not Evaluated.	Non Venomous	OP + Literature	✓	X	✓	✓	
14	<i>Oreocryptophis porphyraceus</i> (Cantor 1839)	black banded trinket snake/red bamboo snake / western black-banded trinket snake	Not Evaluated.	Non Venomous	OP + Literature	✓	X	✓	✓	
15	<i>Liopeltis rappi</i> (Günther, 1860)	Himalayan stripe necked snake	Data Deficient	Non Venomous	OP + Literature	✓	✓	X	✓	Ghandruk only
16	<i>Lycodon aulicus</i> (Linnaeus, 1758)	common wolf snake /Indian wolf snake	Not Evaluated.	Non Venomous	OP + Literature	✓	✓	✓	✓	
17	<i>Lycodon jara</i> (SHAW, 1802)	twin-spotted wolf snake	Least Concern	Non Venomous	OP	X	✓	X	✓	New distribution record
18	<i>Lycodon striatus</i> (SHAW, 1802)	banded wolf snake / northern wolf snake/ barred wolf snake	Not Evaluated.	Non Venomous	OP	X	X	✓		New distribution record
19	<i>Oligodon erythrogaster</i> (Boulenger, 1907)	Nagarkot kukri snake / Red bellied kukri snake	Not Evaluated.	Non Venomous	OP + Literature	✓	X	✓	✓	
20	<i>Oligodon arnensis</i> (Shaw, 1802)	Russet kukri snake/ common kukri snake/ banded kukri	Not Evaluated.	Non Venomous	OP + Literature	X	X	✓	✓	
21	<i>Pseudoxenodon macrops</i> (Blyth, 1855)	Indian false cobra / (Large-eyed or) big-eyed bamboo snake, Mock cobra	Least Concern	Weakly venomous	OP + Literature	✓	✓	X		

22	<i>Ptyas mucosa</i> (Linnaeus, 1758)	Asiatic rat snake / dhaman / Oriental ratsnake	Not Evaluated.	Non Venomous	OP Literature ⁺	✓	✓	✓	✓	
23	<i>Sibynophis collaris</i> (Gray, 1853)	collared black headed snake / common black headed snake / common many-tooth snake	Least Concern	Non Venomous	OP+ Literature	✓	X	X	✓	
24	<i>Sibynophis sagittarius</i> (Cantor, 1839)	Cantor's black headed snake	Not Evaluated.	Non Venomous	OP	X	✓	X		New distribution record
25	<i>Sibynophis melanocephalus</i> (Gray, 1834)	black-headed collared snake / Malayan many-tooth snake	Least Concern	Non Venomous	Literature (Report)	X	X	X		
26	<i>Trachischium fuscum</i> (Blyth, 1854)	blackbelly worm-eating snake /Darjeeling wormsnake / Darjelling oriental slender snake	Not Evaluated	Non Venomous	Literature	X	X	X		
27	<i>Trachischium laeve</i> (Peracca, 1904)	olive oriental slender snake	Not Evaluated	Non Venomous	Literature	X	X	X		
28	<i>Trachischium guentheri</i> (Boulenger, 1890)	Günther's worm-eating snake / rosebelly worm-eating snake	Least Concern	Non Venomous	Literature	X	X	X		
29	<i>Fowlea piscator</i> (Schneider, 1799)	checkered keelback/ Asiatic water snake	Not Evaluated	Non Venomous	OP+ Literature	✓	✓	✓	✓	
30	<i>Fowlea sanctijohannis</i> (Boulenger, 1890)	St. John's keelback	Not Evaluated	Non Venomous	Literature	✓	X	X		
Family: Elapidae										
31	<i>Bungarus niger</i> (Wall, 1908)	greater black krait	Not Evaluated	Neurotoxic, deadly venomous	OP+ Literature	✓	✓	✓	✓	
32	<i>Sinomicrurus maccllellandi</i> (Reinhardt, 1844)	MacClelland's coral snake	Not Evaluated	Neurotoxic, deadly venomous	OP+ Literature	✓	✓	✓	✓	
33	<i>Naja kaouthia</i> (Lesson, 1831)	Monocled cobra / Monocellate cobra	Least Concern	Neurotoxic, deadly venomous	OP	✓	✓	✓	✓	New distribution record
34	<i>Naja naja</i> (LINNAEUS, 1758)	spectacled cobra/ common cobra	Not Evaluated	Neurotoxic, deadly venomous	OP	✓	✓	✓	✓	New distribution record
35	<i>Ophiophagus hannah</i> (Cantor, 1836)	King cobra/ Hamadryad	Vulnerable A2cd	Neurotoxic, deadly venomous	OP+ Literature	✓	✓	✓	✓	
Family: Viperidae										
36	<i>Gloydius himalayanus</i> (Günther, 1864)	Himalayan pit viper	Not Evaluated	Haemotoxic	OP+ Literature	✓	✓	✓	✓	
37	<i>Ovophis monticola</i> (Günther, 1864)	Chinese mountain pit/ western blotched pit viper/ Oriental mountain pit viper	Least Concern	Haemotoxic	Literature	X	X	X		
38	<i>Trimeresurus albolabris</i> (Gray, 1842)	White lipped pit viper / White-lipped Tree Viper	Least Concern	Haemotoxic	OP+ Literature	✓	✓	✓	✓	
39	<i>Trimeresurus erythrurus</i> (Cantor, 1839)	Naga-hill pit viper, redtail (bamboo) pit viper/ spot-tailed pit viper	Least Concern	Haemotoxic	Literature	X	X	X		
40	<i>Trimeresurus septentrionalis</i> (Kramer, 1977)	Kramer's pit viper / Himalayan white-lipped pit viper / Nepal pit viper	Not Evaluated	Haemotoxic	OP+ Literature	✓	✓	✓	✓	
Total						28	22	22	23	