



Save the King: Human-King Cobra, *Ophiophagus hannah* (Cantor 1836), Conflicts and the Need for Conservation Strategies in Nepal

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Abstract.—Snake research tends to have a low priority in Nepal and very little information, mostly confined to populations in small areas, addresses the biology and threats to the King Cobra (*Ophiophagus hannah*). Herein we provide data that could facilitate an assessment of the species’ status in Nepal and begin to address its conservation needs. We recorded data on King Cobras from 2015–2020, crosschecking with previous studies to avoid any duplication of records. A King Cobra from Siddhara, Arghakhachi District, was the first record of the species in the district. We recorded a total of 50 King Cobra mortalities from 20 districts, with most of them killed near human settlements adjacent to forested areas. We mapped the locations of all mortalities and recorded land-use changes within a 500-m buffer around each site over a 30-year period (1990–2020), revealing extensive landscape fragmentation in previously connected natural areas. Our data suggest that the major threats to King Cobras are deliberate killing by humans and large-scale habitat loss due to an increasing human population. We recommend increased research to better understand the biology of this charismatic species and continued conservation education and community outreach programs to facilitate the development of effective conservation strategies.

The King Cobra, *Ophiophagus hannah* (Cantor 1836), is listed as Vulnerable (VU) on the International Union for Conservation of Nature (IUCN) Red List, because populations are thought to be declining throughout the species’ range in southern and southeastern Asia (Stuart et al. 2012). King Cobras also have been listed by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) Appendix II. Primary threats to King Cobras are thought to be habitat destruction, illegal collection for the skin trade, food, pets, and traditional medicines, and persecution by humans (Stuart et al. 2012; Shankar et al. 2013; Marshall et al. 2018). The species occurs in a wide variety of habitats, including forests, grassland, shrubland, wetlands, and in the vicinity of human habitations, such as agricultural fields and rural villages (Bhaisare et al. 2010; Stuart et al. 2012; Barve et al. 2013).

Although many species of snakes appear to be experiencing population declines (Reading et al. 2010), detailed

research is lacking in Nepal (Schleich and Kästle 2002; Shah and Tiwari 2004; Bhattarai et al. 2018; Pandey et al. 2018), and snakes are rarely included in conservation management plans, often due to insufficient ecological data (Steen 2010). Although the King Cobra has been confirmed from 41 districts (Fig. 1) of Nepal (Thapa et al. 2019; Devkota et al. 2020; Rai 2020; Rawat et al. 2020), research on the species has been limited, with most confined to small areas (Schleich and Kästle 2002; Shah and Tiwari 2004; Bhattarai et al. 2018; Pandey et al. 2018; Baral et al. 2019).

Methods

From 2015–2020, we obtained data on King Cobra sightings while capturing and relocating snakes as part of our Save Snakes Save Nature Programme in various districts throughout Nepal (Fig. 2). We collected information via photographs and videos obtained while interacting with local people, through social media (Facebook, Twitter, Instagram, etc.),

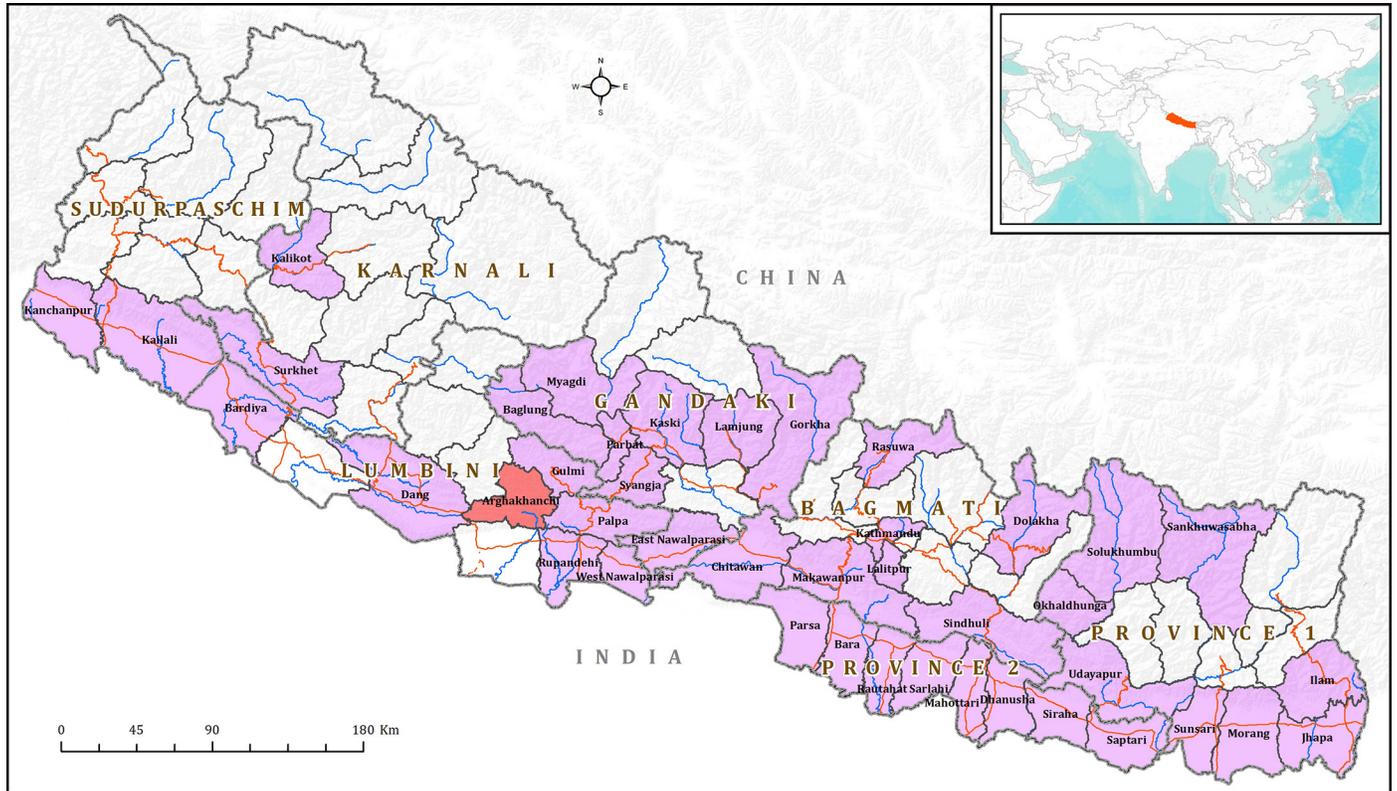


Fig. 1. Map of Nepal showing districts in which King Cobras (*Ophiophagus hannah*) have been recorded. Districts indicated by violet shading are those with published records of King Cobras; that in Arghakhanchi District (in red) is a new record reported herein.

and also received photographs and videos (with associated GPS coordinates) of King Cobras that had been killed. We recorded localities and crosschecked these data with Thapa et al. (2019) and Baral et al. (2019) to avoid any duplication of records. We mapped locations of all King Cobra mortalities in GIS (ArcGIS, v. 10.7), added a 500-m circular buffer around all locations, and recorded land-use changes over a 30-year period (1990–2020). We obtained land-use and land-cover (LULC) data from the Regional Database System (RDS) of the International Centre for Integrated Mountain

Development (ICIMOD) (Uddin et al. 2015) and from Google Earth (Gorelick et al. 2017). Data for mapping was obtained from the Department of Survey (Gyawali 2018).

Results and Discussion

Human Persecution and Development Activities.—We recorded a total of 50 King Cobra deaths from 20 districts (Table 1) at elevations of 100–2,094 m asl. Of the 50 King Cobras recorded, only two were juveniles, one from Siddhara, Arghakhanchi District (Fig. 3A), which was the first record of the species for the district, and one from Kulekhani, Makwanpur District (Fig. 3B). Thapa et al. (2019) reviewed and compiled a total of 37 King Cobra mortalities from various sources, including their own observations. Baral et al. (2019) recorded two mortalities from the southern Annapurna Conservation Area; Harit (2016) recorded four mortalities in northeastern India; and Marshall et al. (2018) recorded 10 deaths attributable to humans, including deliberate killing, road mortality, swallowing plastic, fish traps, and for consumption (Strine et al. 2014; Marshall et al. 2018). Although a number of studies have recorded human-mediated mortality of snakes, most research has focused on accidental mortality due to vehicles (Santoshkumar and Kannan 2017; Deshmukh et al. 2020). Our data indicated that the majority of deaths were attributed to persecution by

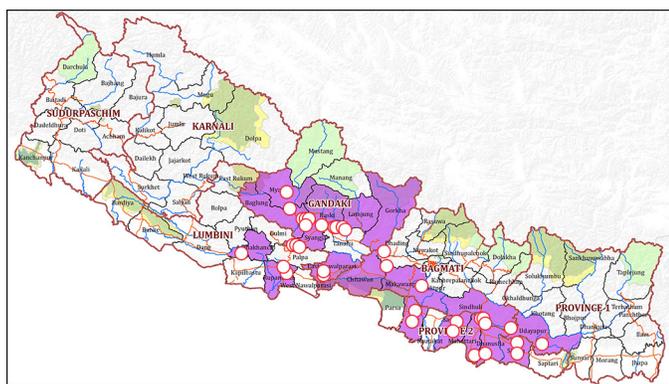


Fig. 2. Map of Nepal showing districts (in violet) where King Cobras (*Ophiophagus hannah*) were encountered during this study. Dots mark sites where dead King Cobras were recorded.

Table 1. Locations and land-use and land-cover data for locations where a total of 50 King Cobras (*Ophiophagus hannah*) were killed in 20 districts.

Location, District (coordinates) (number of snakes)	Year Found	Land-use and Land-cover (LULC) Data			
		1990	2000	2010	2020
Binayi-Triveni, Nawalpur (27°39'41"N, 83°49'37"E) (1)	2015	Agriculture	Agriculture	Agriculture	Settlement
Dudhali, Sindhuli (26°58'51"N, 86°19'08"E) (1)	2015	Forest	Forest	Agriculture	Agriculture
Jyamireghat, Gorkha (27°48'80"N, 84°42'37"E) (1)	2015	Forest	Forest	Forest	Forest
Lohana, Janakpur, Dhanusha (26°41'09"N, 85°57'26"E) (1)	2016	Agriculture	Agriculture	Agriculture	Agriculture
Siddhara, Arghakhachi (27°50'31"N, 82°54'42"E) (1)	2016	Forest	Forest	Forest	Forest
Shankarnagar, Rupandehi (27°39'11"N, 83°28'55"E) (1)	2016	Forest	Agriculture	Agriculture	Settlement
Sukhipur, Siraha (26°44'26"N, 86°20'19"E) (1)	2017	Agriculture	Agriculture	Agriculture	Agriculture
Tulsi, Mithila, Dhanusha (27°01'55"N, 85°55'58"E) (3)	2018	Forest	Forest	Forest	Forest
Tulsi, Mithila, Dhanusha (27°02'26"N, 85°57'03"E) (3)	2018	Forest	Forest	Forest	Grassland
Sukhipur, Siraha (26°44'26"N, 86°20'19"E) (1)	2018	Agriculture	Agriculture	Agriculture	Agriculture
Nawalpur, Sarlahi (27°04'57"N, 85°35'12"E) (1)	2018	Barren	Agriculture	Barren	Agriculture
Banke, Mahottari (26°33'51"N, 86°11'29"E) (1)	2018	Agriculture	Agriculture	Agriculture	Settlement
Binamare, Jaimuni, Baglung (28°11'38"N, 83°38'14"E) (1)	2018	Agriculture	Agriculture	Agriculture	Agriculture
Tulsi, Mithila, Dhanusha (26°59'37"N, 85°56'58"E) (2)	2019	Forest	Forest	Forest	Shrubland
Golbazar, Siraha (26°50'23"N, 86°20'38"E) (1)	2019	Agriculture	Agriculture	Agriculture	Agriculture
Ambott, Kusma, Parbat (28°14'57"N, 83°42'52"E) (1)	2019	Agriculture	Agriculture	Agriculture	Settlement
Khurkot, Kusma, Parbat (28°15'50"N, 83°41'37"E) (1)	2019	Forest	Forest	Forest	Forest
Unknown, Kathmandu (unknown) (1)	2019	—	—	—	—
Butwal, Rupandehi (27°42'90"N, 83°27'10"E) (1)	2020	Forest	Forest	Forest	Shrubland
Phedikhola, Syangja (28°09'31"N, 83°54'20"E) (2)	2020	Agriculture	Agriculture	Agriculture	Agriculture
Balam, Syangja (27°56'41"N, 83°36'13"E) (1)	2020	Agriculture	Agriculture	Agriculture	Settlement
Birgha, Syangja (27°56'31"N, 83°33'39"E) (1)	2020	Forest	Forest	Forest	Forest
Kaligandaki Gaupalika, Syangja (27°57'11"N, 83°32'51"E) (1)	2020	Agriculture	Agriculture	Agriculture	Settlement
Tulsi, Mithila, Dhanusha (27°01'39"N, 85°56'31"E) (1)	2020	Forest	Forest	Forest	Shrubland
Kulekhani, Makwanpur (27°34'46"N, 83°10'24"E) (1)	2020	Agriculture	Agriculture	Agriculture	Agriculture
Madi Gaupalika, Kaski (28°08'58"N, 84°04'46"E) (1)	2020	Agriculture	Agriculture	Agriculture	Settlement
Lekhnath Sisuwa, Kaski (28°09'51"N, 84°04'14"E) (1)	2020	Agriculture	Agriculture	Agriculture	Settlement
Thumki, Kaski (28°07'23"N, 84°11'23"E) (1)	2020	Forest	Forest	Forest	Agriculture
Lothar, Chitwan (27°41'32"N, 84°44'26"E) (1)	2020	Forest	Forest	Forest	Agriculture
Madi, Chitwan (27°41'59"N, 84°45'20"E) (1)	2020	Forest	Forest	Forest	Agriculture
Nijgadh, Bara (27°10'17"N, 85°07'18"E) (1)	2020	Forest	Forest	Forest	Settlement
Nijgadh, Bara (27°12'11"N, 85°06'29"E) (1)	2020	Forest	Forest	Forest	Forest
Bagmati Kholra border, Sindhuli (26°58'45"N, 85°31'38"E) (1)	2020	Agriculture	Agriculture	Agriculture	Settlement
Kuinemangale, Myagdi (28°30'14"N, 83°30'55"E) (1)	2020	Grassland	Agriculture	Agriculture	Agriculture
Beni, Myagdi (28°20'48"N, 83°32'25"E) (1)	2020	Agriculture	Agriculture	Agriculture	Agriculture
Baglung, Baglung (28°15'27"N, 83°36'00"E) (1)	2020	Forest	Forest	Forest	Forest
Madhya Nepal, Lamjung (28°05'19"N, 84°14'16"E) (1)	2020	Agriculture	Agriculture	Agriculture	Settlement
Arunkhola, Nawalpur (27°36'53"N, 83°57'11"E) (1)	2020	Agriculture	Agriculture	Agriculture	Settlement
Triyuga, Udaypur (26°46'45"N, 86°38'46"E) (1)	2020	Agriculture	Barren	Agriculture	Settlement
Unknown, Udaypur (unknown) (1)	2020	—	—	—	—
Unknown, Gorkha (unknown) (1)	2020	—	—	—	—
Unknown, Baglung (unknown) (1)	2020	—	—	—	—
Unknown, Parbat (unknown) (1)	2020	—	—	—	—
Unknown, Parbat (unknown) (1)	2020	—	—	—	—

humans. Only three cases were the result of road mortality, in Kulekhani, Makwanpur District (Fig. 3B), in Ambott, Parbat District (Fig. 3C), and in Arunkhola, Nawalpur District (Fig. 3D). One death occurred during inappropriate capture and handling in Balam, Syangja District (Fig. 3E). Three deaths were the result of construction associated with development (killed by an excavator) in Tulsi, Mithila, Dhanusha District

(Figs. 3F–G). Four instances of mortality occurred when people killed King Cobras during the mating season while males were engaged in combat in Tulsi, Mithila, Dhanusha District (Fig. 3H) and in Phedikhola, Syangja District (Fig. 3I). We also received information that villagers tried to destroy a nest with eggs in Dhanusha and Kaski Districts. One King Cobra was killed in Nawalpur District (Fig. 3J) while it was attempt-



Fig. 3. King Cobras (*Ophiophagus hannah*) killed by humans: Juvenile, the first record for Arghakhachi District (A); road-killed juvenile from Kulekhani, Makwanpur District (B); road-killed adult from Ambott, Kusma, Parbat District (C); road-killed adult from Arunkhola, Nawalpur District (D); a King Cobra killed due to unprofessional rescue and handling in Balam, Syangja District (E); deaths during construction from Tulsi, Mithila, Dhanusha District (F & G); after killing two males fighting over a mate, local residents pulled the female out of a hole and killed her in Tulsi, Mithila, Dhanusha District (H); local residents killed two King Cobras while mating in Phedikhola, Syangja District (I); local residents killed a King Cobra in Nawalpur District while it was trying to prey on a monitor lizard (*Varanus* sp.) (J).

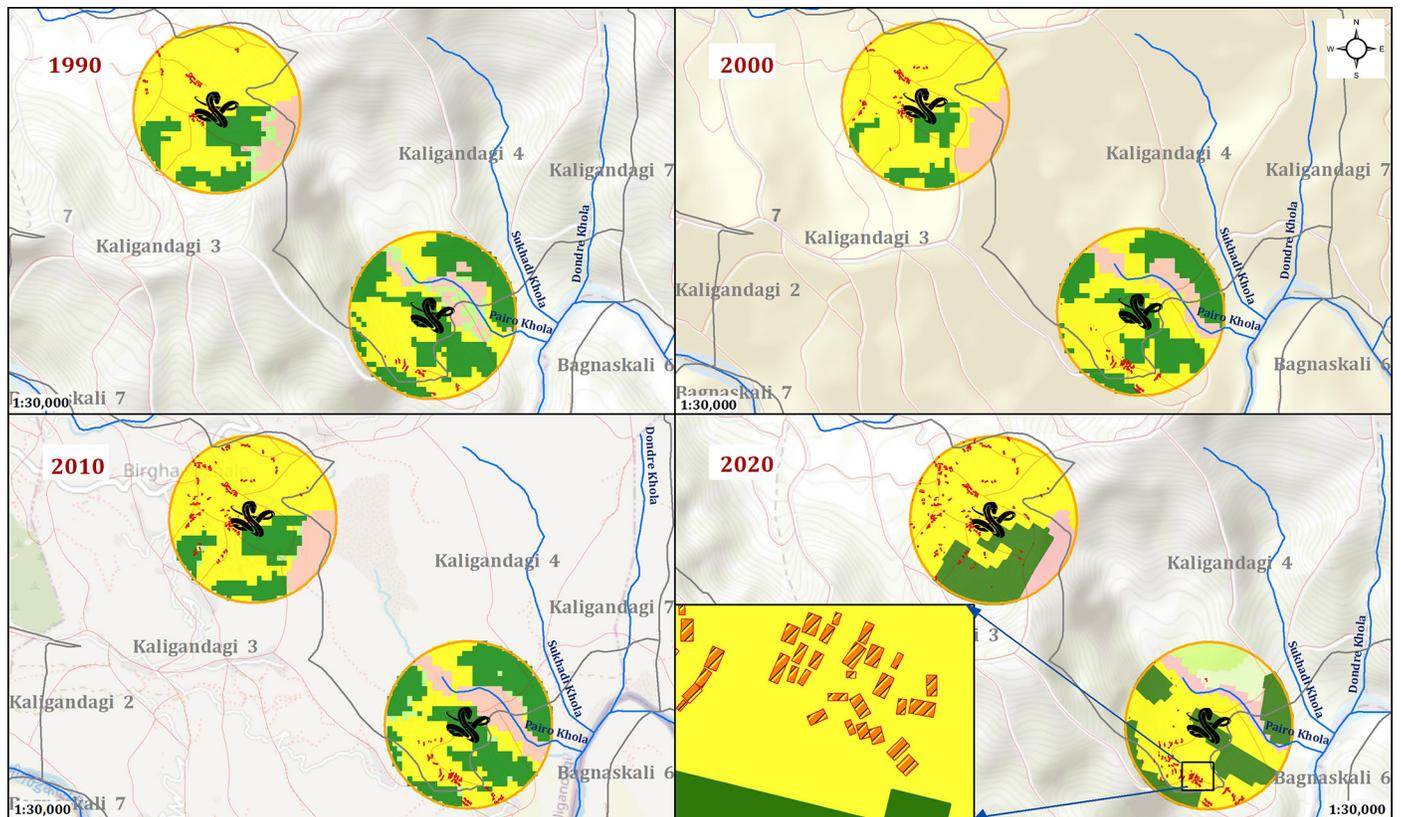


Fig. 4. Land-use and land-cover (LULC) changes from 1990–2020 at sites (with a 500-m buffer) where King Cobras (*Ophiophagus hannah*) were killed in Syangja District, Nepal. Dark green = forest, medium green = shrubland, light green = grassland, pink = barren area, yellow = agricultural area, orange = buildings (settlements).

ing to prey on a Bengal Monitor (*Varanus bengalensis*), which was in a tree near human habitation. The people burned the tree, and while the snake was trying to escape, they beat it on the head until it died. Marshall et al. (2018) recorded only two natural deaths (of 14 documented), both of which were attributable to attacks by predators in a protected area in Thailand. We found that snakes encountered outside forested areas and near human settlements were significantly more likely to be killed by humans (Figs. 4 & 5), which was similar to previous findings in Nepal (Pandey et al. 2016), India (Shankar et al. 2013), and Thailand (Marshall et al. 2018).

Our data suggest an increasing trend in King Cobra deaths, from 3 in 2015, to 27 in 2020 (Table 1). However, the apparent increase in deaths more likely reflected increased reporting by people who became familiar with our community-based awareness programs and an increase in captures and relocations by our team than an actual increase in mortality. In 2020, in response to lockdowns associated with the coronavirus pandemic, we suspect that more people reported King Cobra deaths, if only because their use of social media increased. In short, we suspect that many deaths went unreported in earlier years.

We hope that deaths will decrease in the future, as people become more familiar with King Cobra behavior. King Cobras rarely bite humans unless provoked or harmed (Harit 2016). Characteristic hooding behavior, hissing, and striking are defensive behaviors meant to intimidate natural predators. Because King Cobras are much larger than other venomous snakes, they are easily recognized. Unfortunately, most people consider them to be extremely dangerous, frequently killing them when encountered (Shankar et al. 2013; Marshall et al. 2018). In Nepal, approximately 20,000 venomous snake bites are recorded per year, and approximately 1,000 people die (WHO 1987). However, hospital reports indicate that King Cobra bites are extremely rare compared to those of other venomous snakes (Sharma et al. 2004; Magar et al. 2013). Indeed, we are aware of only one reported death from a King Cobra bite, which was due to misidentification and mishandling of the snake during an attempted “rescue and relocation” in Kathmandu in 2016 (Maden 2019; B. Rijal, pers. comm.).

Clearly, fear of being bitten by snakes is common in Nepal and elsewhere. Previous studies indicate that most people are inclined to kill snakes on sight rather than leave

them alone (Shankar et al. 2013; Pandey et al. 2016; Marshall et al. 2018; Devkota et al., in press). Despite this fear, some respondents indicated that snakes are important to the environment (Pandey et al. 2016; Marshall et al. 2018; KD, manuscript). Shankar et al. (2013) reported that people were more likely to kill snakes when encountered during the day. In this study, we also found that the majority of King Cobras were killed during daytime, which likely reflects the diurnal nature of both humans and King Cobras (Shankar et al. 2013). Although some Hindus and Buddhists have deep-rooted traditional, cultural, and religious beliefs involving snakes, and the worship of snakes (i.e., “ophiolatry”) as gods (Shah and Tiwari 2004; Perry et al. 2020), we found that most people kill snakes when encountered whether the snake is venomous or not. For example, we found that people readily killed non-venomous species, such as pythons (*Python* spp.), wolfsnakes (*Lycodon* spp.), and ratsnakes (*Ptyas mucosa*). In Rupandehi, of 131 individual snakes recorded by our team (Devkota et al., in press), 21 individuals were killed on roads and 54 were killed as a result of human persecution. Pandey et al. (2018) also recorded high human-mediated mortality of snakes. Interestingly, people generally avoid killing the snakes on Nag Panchami, a Hindu holiday famous for its snake festival, during which snake images and sculptures are worshiped

(Atreya and Kanchan 2018). Unfortunately, this attitude is not perpetuated throughout the year.

Habitat Loss.—While mapping observations of King Cobra mortality, we observed a significant amount of landscape fragmentation in previously connected natural areas (Figs. 4 & 5). Large areas of intact landscape had been converted to urban and agricultural land or separated by physical barriers, such as roadways. Landscape fragmentation results in smaller, more isolated patches, which can result in population-level changes to native flora and fauna. King Cobras are considered an apex predator (Shankar et al. 2013; Marshall et al. 2018) that feeds mainly on a variety of snakes (Bhaisare et al. 2010; Barve et al. 2013; Shankar et al. 2013; Marshall et al. 2018) and occasionally on monitor lizards (*Varanus* spp.; Shankar et al. 2013; Marshall et al. 2018). Existing protected areas are likely not adequate to mitigate against anthropogenic mortality (Shankar et al. 2013; Marshall et al. 2018) because King Cobras can move long distances leaving protected areas, which places them at higher risk of encountering humans (Thapa et al. 2019). In Nepal, the unprecedented rate of land conversion to agriculture has led to significant changes in forest cover over the last 30 years. As land is converted from natural forests to agriculture, King Cobras are forced to leave

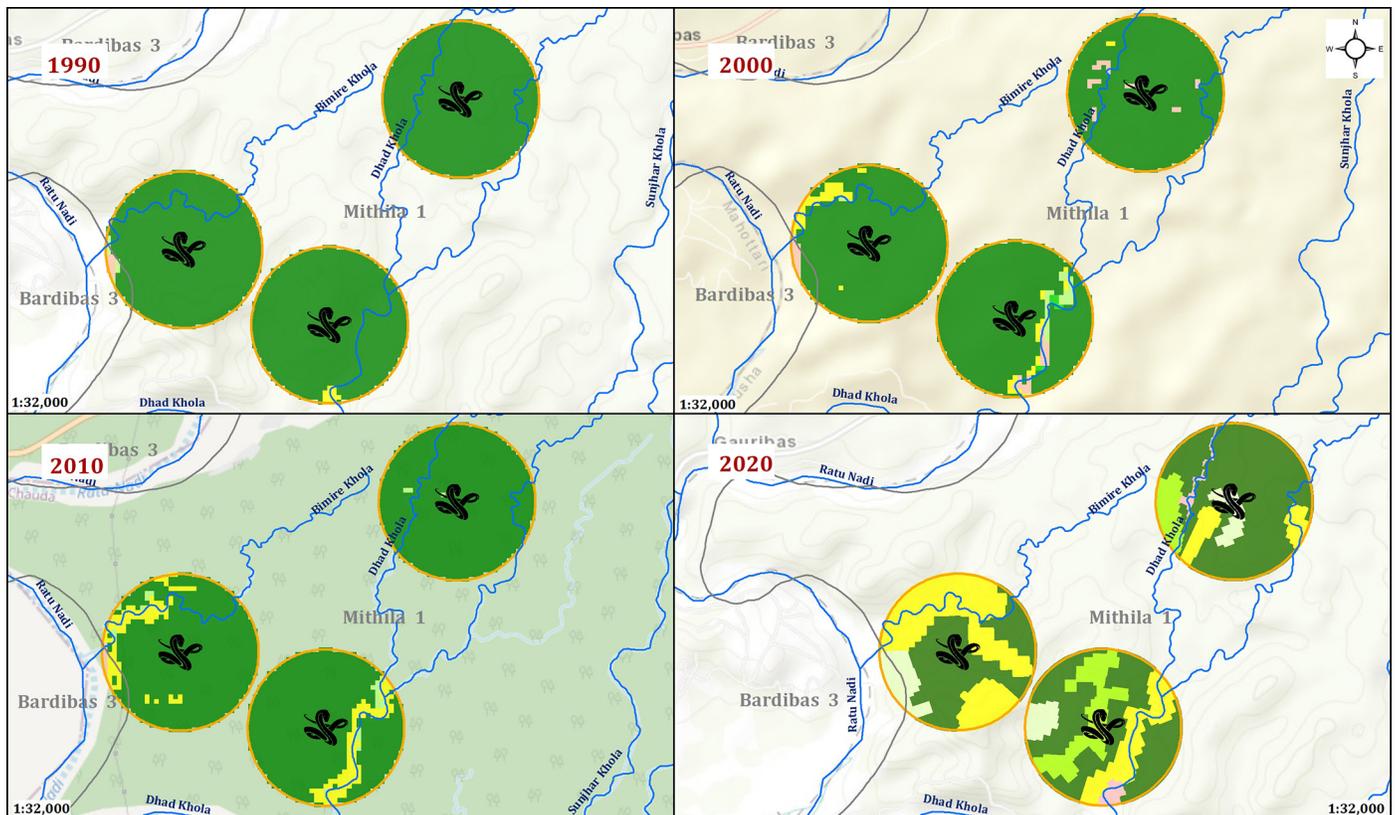


Fig. 5. Land-use and land-cover (LULC) changes from 1990–2020 at sites (with a 500-m buffer) where King Cobras (*Ophiophagus hannah*) were killed in Dhanusha District, Nepal. Dark green = forest, medium green = shrubland, light green = grassland, pink = barren area, yellow = agricultural area.

protected areas in search of food, often entering farmed areas and human settlements (Stuart et al. 2012). These human-dominated areas likely support rodents, which, in turn, attract Ratsnakes (*Ptyas mucosa*) and Spectacled Cobras (*Naja naja*) (Shankar et al. 2013). Our study also shows that most King Cobras were killed near human settlements adjacent to forested areas. The rapidly growing human population of Nepal has led to a dramatic increase in anthropogenic activities, causing drastic declines in forested areas, which result in increased human-King Cobra conflicts, supporting the recent designation of King Cobras as Vulnerable by the IUCN (Stuart et al. 2012).

Conclusion

Our results suggest that principal threats to King Cobras are deliberate killing by humans and large-scale habitat loss due to the increased presence of humans. Conservation efforts focused on maintaining forested areas can only be successful by engaging local communities. Due to suspected underreporting of King Cobra mortality due to humans, we recommend increased research on this charismatic species to better understand its natural history and ecology and an expansion of conservation education and community outreach programs to facilitate the development of effective conservation strategies.

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