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**Abstract:** The Vulnerable clouded leopard *Neofelis nebulosa* is believed to be one of the most threatened felid species in Nepal. Information on its status and population size in the country mostly comprises crude estimates. We compiled information on the species' status and distribution from published papers, grey literature, camera-trap images, direct observations, pelt, zoo and museum records, wildlife seizures and verified newspaper reports. All confirmed records of the species (three museum specimens, one dead specimen, 13 live records (including from camera traps), and 14 pelts) were from eastern and mid-central Nepal. Two unconfirmed reports from the western and far-western regions of the country need to be verified. Although the status of the species is still uncertain, the frequency of confirmed and unconfirmed reports and the extent of the area of occurrence indicate that it is not as rare as previously assumed. The main threats to the species are habitat loss and illegal wildlife trade.

# The Vulnerable clouded leopard *Neofelis nebulosa* in Nepal: an update

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**Abstract** The Vulnerable clouded leopard *Neofelis nebulosa* is believed to be one of the most threatened felid species in Nepal. Information on its status and population size in the country mostly comprises crude estimates. We compiled information on the species' status and distribution from published papers, grey literature, camera-trap images, direct observations, pelt, zoo and museum records, wildlife seizures and verified newspaper reports. All confirmed records of the species (three museum specimens, one dead specimen, 13 live records (including from camera traps), and 14 pelts) were from eastern and mid-central Nepal. Two unconfirmed reports from the western and far-western regions of the country need to be verified. Although the status of the species is still uncertain, the frequency of confirmed and unconfirmed reports and the extent of the area of occurrence indicate that it is not as rare as previously assumed. The main threats to the species are habitat loss and illegal wildlife trade.

**Keywords** Camera trap, clouded leopard, habitat loss, Nepal, species distribution, wildlife trade

The clouded leopard *Neofelis nebulosa*, categorized as Vulnerable on the IUCN Red List, occurs from the Himalayan foothills in Nepal through mainland South-east Asia into China (Grassman et al., 2016). In Nepal the species is believed to occur along the mid-hills eastwards of Langtang National Park (Nowell & Jackson, 1996). The species has been reported to occur in the protected areas of Annapurna Conservation Area, Chitwan National Park, Kanchenjunga Conservation Area, and Langtang, Makalu–Barun, Rara and Shivapuri Nagarjun National Parks (Jnawali et al., 2011; Pandey, 2012; Ghimirey et al., 2013; Lamichhane et al., 2014; D.W. Macdonald, pers. comm.). However, the claim that Rara National Park holds a clouded leopard population seems to be based on a single record of a misidentified leopard cat *Prionailurus bengalensis* pelt and can thus be discounted. The record of a clouded leopard in Annapurna Conservation Area at a straight-line distance of 170 km west of Langtang National Park in 2012 is the confirmed westernmost limit of the species' distribution (Nowell & Jackson, 1996; Ghimirey et al., 2013). There have been reports of clouded

leopards from Kailali district (Jnawali et al., 2011), Ghodaghodi Lake (Jnawali et al., 2011), Khaptad National Park (Khaptad National Park Management Plan, unpublished) and Api-Nampa Conservation Area (DNPWC, 2012). However, the reliability of reports west of Annapurna Conservation Area needs to be verified before drawing conclusions about the species' westward distribution.

The first study of the clouded leopard in Nepal was conducted in 2009 but the species was not recorded by camera trap for the first time until 2010, in Shivapuri Nagarjun National Park (Ghimirey et al., 2012; Pandey, 2012). The species was subsequently recorded by camera trap in Annapurna Conservation Area and Chitwan National Park in 2012 and 2013, respectively (Ghimirey et al., 2013; Lamichhane et al., 2014). A study conducted in 2015 detected the clouded leopard in Langtang National Park, as had been suggested previously (Nowell & Jackson, 1996). Table 1 presents all records and unconfirmed reports of the clouded leopard in Nepal and Fig. 1 shows their location. Prior to these detections the species had not been detected in some previous studies, generating speculation that it might have gone extinct in the country. However, false absences may be attributed to the short duration of the studies and small study areas, as the clouded leopard is an elusive species. The species also has a small core area of use, which could further hinder detection, particularly if camera traps are deployed in places outside this core area and the duration of study is short. In Thailand the clouded leopard's core area of use has been calculated to be  $2.9\text{--}6.0 \pm \text{SD } 2.1$  km<sup>2</sup>, with home ranges of up to 51 km<sup>2</sup> (Grassman et al., 2005; Austin et al., 2007). The species' core area of use could be similar in Nepal, considering the similar mountainous terrain. In Nepal only one study of the clouded leopard has covered an area of > 50 km<sup>2</sup> (Pandey, 2012). It is imperative to conduct studies covering larger areas to reduce the probability of false absences.

The preferred habitat of clouded leopards has long been debated. Although the species is most strongly associated with primary tropical forest (Nowell & Jackson, 1996; Brodie & Giordano, 2012), clouded leopards have also been recorded in secondary forest, dry tropical forest, scrub and grassland, and mangrove swamps (Davies & Payne, 1982; Dinerstein & Mehta, 1989; Rabinowitz & Walker, 1991). In Nepal, it has been suggested that the Mahabharat range is the best habitat for the species (C. McDougal, 1992, unpubl. data), which may be found at 1,000–2,500 m elevation (Upreti, 1999). However, clouded

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TABLE 1 All available confirmed records of the clouded leopard *Neofelis nebulosa* in Nepal (see numbered locations in Fig. 1), with year, location, geographical coordinates, altitude, type of evidence, and source of data. Blank cells indicate no data were available.

| ID                      | Year | Location                                   | Geographical coordinates        | Altitude (m) | Type of evidence  | Source  |
|-------------------------|------|--|---------------------------------|--------------|---|---|
| <b>Museum specimens</b> |      |  |                                 |              |   |   |
|                         | 1853 | Kathmandu                                  |                                 |              | One pelt  | Hodgson (1853)  |
|                         | 1858 | Nepal                                      |                                 |              | One pelt in BMNH  | Kitchener et al. (2006)   |
|                         | 1930 | Nepal                                      |                                 |              | One pelt in BMNH  | Kitchener et al. (2006)   |
| <b>Live individuals</b> |      |  |                                 |              |   |   |
| 1                       | 1977 | Langtang                                   | 28°1'21.58"N,<br>85°35'35.79"E  |              | Direct observation of one individual  | Borradaile et al. (1977)  |
|                         | 1994 | Tribhuvan International Airport, Kathmandu |                                 |              | Three cubs seized alive from trader   | Shakya et al. (1999)  |
|                         | 1996 | Baghbazar                                  |                                 |              | Three cubs seized alive from trader   | Shakya (2004)   |
| 2                       | 1987 | Janakpur                                   | 26°59'19.08"N,<br>86°3'5.98"E   |              | Two cubs captured alive by local people   | Dinerstein & Mehta (1989)   |
| 3                       | 1988 | Nawalparasi                                | 27°38'33.81"N,<br>83°44'43.88"E |              | One individual captured alive by local people                                     | Dinerstein & Mehta (1989)   |
| 4                       | 1988 | Pokhara                                    | 28°15'50"N, 83°58'20"E          | 900          | Direct observation; stoned to death   | Dinerstein & Mehta (1989)   |
| 5                       | 2001 | Dillibazar, Kathmandu                      | 27°42'25.4"N,<br>85°19'40.2"E   | 1,315        | One individual captured alive by zoo officials                                    | Sarita Jnawali, Central Zoo, Kathmandu (pers. comm.)              |
| 6                       | 2002 | Jorpati, Kathmandu                         | 27°43'39.9"N,<br>85°22'41.6"E   | 1,344        | One individual captured alive by zoo officials                                    | Sarita Jnawali, Central Zoo, Kathmandu (pers. comm.)              |
| 7                       | 2007 | Dhamaura, Chitwan                          | 27°36'44.8"N,<br>84°38'4.3"E    | 229          | One individual captured alive by local people and brought to National Park office | Ghimirey et al. (2014)  |
| 8                       | 2010 | Shivapuri Nagarjuna National Park          | 27°48'53.1"N,<br>85°16'47.7"E   | 1,985        | Camera-trap image of one individual   | Pandey (2012)   |
| 9                       | 2012 | Annapurna Conservation Area                | 28°22'52.2"N,<br>84°7'21.8"E    | 2,274        | Camera-trap image of one individual   | Ghimirey et al. (2013)  |
| 10                      | 2013 | Chitwan                                    | 27°28'57.2"N,<br>84°12'46.4"E   | 301          | Camera-trap images of three individuals   | Lamichhane et al. (2014)  |
| 11                      | 2014 | Langtang NP                                |                                 |              | Camera-trap image of one individual   | E. Can & D. Macdonald (pers. comm.)                               |
| <b>Pelt records</b>     |      |  |                                 |              |   |   |
|                         | 1988 | Kathmandu                                  |                                 |              | Four pelts for sale   | Barnes (1989)   |
| 12                      | 1991 | Sunumla, Sankhuwasava                      | 27°11'37.01"N,<br>87°23'41.03"E | 1,200        | One pelt from hunter  | Karan Bdr. Shah (pers. comm.),* Natural History Museum, Kathmandu |
|                         | 1992 | Kathmandu                                  |                                 |              | Two pelts for sale  | Van Gruisen & Sinclair (1992)                                     |

Table 1 (Cont.)

| ID                         | Year    | Location                      | Geographical coordinates        | Altitude (m) | Type of evidence                             | Source  |
|----------------------------|---------|-------------------------------|---------------------------------|--------------|--|---|
| 13                         | 2006    | Zhongim, Taplejung            | 27°29'23.92"N<br>87°46'17.48"E  | 2,400–2,600  | One pelt from hunter                         | Badri Vinod Dahal (pers. comm.)*  |
|                            | 2008    | Kathmandu                     |                                 |              | One pelt seized from a poacher               | WCN (2008)  |
| 14                         | 2009    | Chyamtang, Sankhuwasava       | 27°46'20.82"N,<br>87°26'22.14"E | 2,267        | One pelt photographed in a house             | Ghimirey et al. (2012)  |
| 15                         | 2009    | Hatiya, Sankhuwasava          | 27°44'11.64"N,<br>87°20'15.84"E | 1,600        | One pelt photographed in a house             | Ghimirey et al. (2012)  |
|                            | 2011    | Shuklaphanta, Kanchanpur      |                                 |              | One pelt seized from a poacher               | SAWEN (2011)  |
|                            | 2011    | Kathmandu                     |                                 |              | One pelt seized from a poacher               | Shrestha (2012)   |
|                            | 2012    | Manamaiju, Kathmandu          |                                 |              | One pelt seized from a poacher               | WCN (2012)  |
|                            | 2013    | Khadbari, Sankhuwasava        |                                 |              | One pelt seized from poachers                | Prabhat Pal, District Soil Conservation Office, Sankhuwasava (pers. comm.)* |
|                            | 2014    | Bhakundebesi, Kavrepalanchowk |                                 |              | One pelt with bones seized from two poachers | Press note from Nepal Police*   |
|                            | 2014    | Kathmandu                     |                                 |              | One pelt seized from two poachers            | Wildlife Conservation Nepal official (pers. comm.)*                         |
|                            | 2014    | Kathmandu                     |                                 |              | One pelt & teeth seized from a poacher       | Onlinekhabar (2015)   |
| <b>Unconfirmed reports</b> |         |                               |                                 |              |  |   |
| 16                         | Unknown | Khaptad National Park         | 29°19'33.07"N,<br>81°8'31.98"E  |              |  | (Khaptad National Park Management Plan, unpublished)                        |
| 17                         | 2012    | Api-Nampa Conservation Area,  | 29°48'34.7"N,<br>80°32'45.87"E  |              |  | DNPWC (2012)  |

\*Verified from photographic evidence

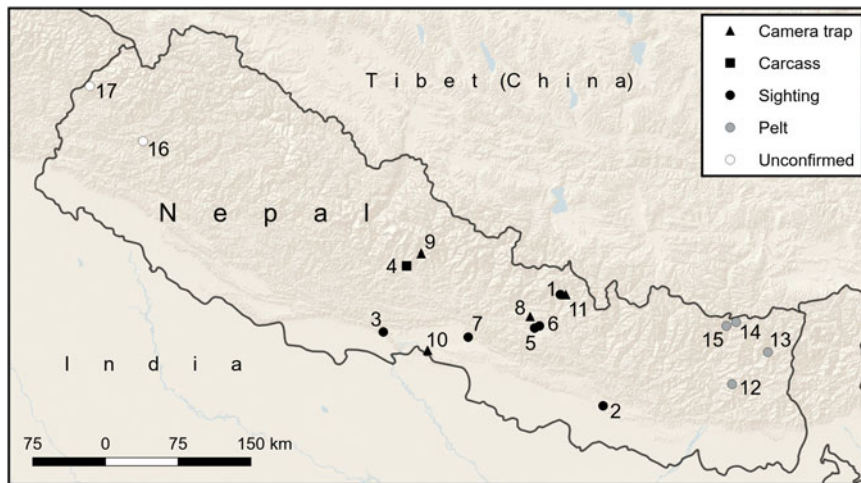


FIG. 1 Records (Numbers refer to Table 1) of the clouded leopard *Neofelis nebulosa* in Nepal.

leopards have also been reported from marginal scrub forest in the Eastern Terai, subtropical broad-leaved forest in central Nepal and tropical broad-leaved forest in the lowlands (Dinerstein & Mehta, 1989; Ghimirey et al., 2013; Lamichhane et al., 2014). Prey availability has been reported as a major factor influencing the occurrence of clouded leopards (Rabinowitz et al., 1987; Mohamad et al., 2015). The species has been shown to use a wider range of habitats than previously thought (Mohamad et al., 2015), and has been recorded in forests close to highly populated areas such as Kathmandu, Chitwan and Pokhara. Although the species appears to tolerate some degree of disturbance, it is important that well-connected habitat patches remain for use and dispersal. Little is yet known of the species' ecology in lower quality habitats.

Illegal trade in the clouded leopard is prevalent in Nepal, but there are fewer cases than in South-east Asian countries (Nowell, 2007), although the number of cases has increased since 2006 (Table 1). Official data on wildlife trade can be misleading (Niraj, 2009); for example, many cases of illegal wildlife trade in Nepal go unrecorded because of the porous international border with India (Das, 2008). Even the comparatively more regulated border with China has army stations at only a few locations because of the harsh geographical conditions. Although retaliatory killings have been reported to be one of the primary threats to the clouded leopard (Jnawali et al., 2011), we found only one case of retaliatory killing of the species. We therefore suggest that retaliatory killing is probably not the most important threat to the species, as it is to the leopard *Panthera pardus* in Nepal.

The clouded leopard is perceived to be rare in Nepal, where it is considered to be threatened by habitat loss and degradation, and illegal wildlife trade. However, camera trapping results indicate that its frequency of occurrence and range may be increasing (Sanderson et al., 2008; Ghimirey et al., 2013). The species has also been confirmed in areas where its presence was previously unknown, including Annapurna Conservation Area, Chitwan National Park

and Shivapuri Nagarjuna National Park (Pandey, 2012; Ghimirey et al., 2014; Lamichhane et al., 2014). These findings, in particular the recent camera-trap records, indicate that further research is required to clarify the distribution and status of the clouded leopard in Nepal, and that there is potential for research on the metapopulation dynamics of the species and its interactions with other felid species.

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### Author contributions

YG and RA both contributed to collecting the data and writing the article.

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## Biographical sketches

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