

Status, current distribution and threats to the Fishing cat *Prionailurus viverrinus* (Bennett, 1833) in Nepal

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Abstract

The Fishing cat, *Prionailurus viverrinus* is a medium-sized, wild felid, native to south and Southeast Asia. The global status of the species has been assessed as ‘Vulnerable’ by the IUCN Red List of Threatened Species and it is further listed as ‘Endangered’ in Nepal. Knowledge on the species is limited due to scarce research studies, resulting in a lack of ecological information. A few conservation programs for the species have been initiated in the past but current concern is that conservation programs may not be sufficient for the long-term survival of the species in Nepal. Therefore, we reviewed the available published scientific literature and anecdotal reports relating to the Fishing cats in Nepal, and used this data to assess current population status, distribution, threats and conservation efforts for the species. We screened and selected 49 scientific papers and reports related to Fishing cats for the current study and analyzed them to produce our findings. Our results found that fishing cats are recorded from five protected areas, and three non-protected wetland areas, within the Terai region of Southern Nepal. Two publications are found that substantiate the population status of the species in the country. In Protected Areas of Nepal, most of the Fishing cat records were accessed through camera trap surveys targeting large cat species. Fishing cats have been facing extinction threats mainly due to poaching, human over-exploitation of local fish stocks, retaliatory killing, wetland shrinkage and conversion, pollution and other conflicts with humans. We believe our review will be a useful guide for conservationists, managers and wildlife researchers to promote the conservation of this charismatic and threatened species in Nepal.

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Introduction

Globally, Nepal is known to be the second richest country in terms of felid diversity and houses 12 species of wild cats ranging from the largest species, the Bengal tiger *Panthera tigris tigris* (Linnaeus, 1758) to the smallest species, the Rusty-spotted cat *Prionailurus rubiginosus* (Geoffroy Saint-Hilaire, 1831) (Dickman et al., 2015; Lamichhane et al., 2016; Lama et al., 2019). The Fishing cat, *Prionailurus viverrinus* (Bennett, 1833) locally known as Malaha biralo (Jnawali et al., 2011), is a close relative of the

Rusty-spotted cat *Prionailurus rubiginosus*, the Flat-headed cat *Prionailurus planiceps* (Vigors and Horsfield), and the Leopard cat *Prionailurus bengalensis* (Kerr) (Sunquist and Sunquist, 2002). Severe anthropogenic threats have forced the fishing cat to be listed under the Vulnerable category of the IUCN Red List of Threatened Species, Appendix II in CITES (Mukherjee et al., 2016; CITES, 2017), while it has further been classified as an endangered species in the National red list series for Nepal (Jnawali et al., 2011; Amin et al., 2018). Less than 10,000 individuals of *P. viverrinus* are present in the

world (Mukherjee et al., 2010), but 150–200 mature individuals are believed to be located within the Terai regions of Nepal (Jnawali et al., 2011).

Prionailurus viverrinus is a medium-sized felid with a stocky, powerful build, short legs with partially webbed paws, and a short tail that is used as a rudder in water for swimming (Fig. 1) (Roberts and Bernhard, 1977; Macdonald and Loveridge, 2010). It is twice the size of a large domestic cat and females are distinctly smaller (6–7 kg) than males (11–12 kg) (Nowell and Jackson, 1996; Sunquist and Sunquist, 2002). Coat color for the species is olive-brown spotted with rows of parallel solid black spots, which often form lines along the spine as well as in the neck and cheek portion (Prater, 1965; Baral and Shah, 2008).

Prionailurus viverrinus is primarily nocturnal but may also be active during the day (Jutzeler et al., 2010). Unlike other cat species, *P. viverrinus* is unique in that 70% of its diet consists of fish (Sunquist and Sunquist, 2002). It is also known to feed on birds and insects (Haque and Vijayan, 1993; Myers et al., 2006). The home range of a male individual of *P. viverrinus* is larger (16 to 22 km²) than a female (4 to 8 km²), and usually several female *P. viverrinus* territories overlap with the home range of a single male (Nowell and Jackson, 1996; Sunquist and Sunquist, 2002; Mishra, 2013). Females of *P. viverrinus* reach sexual maturity at approximately fifteen months and mating generally occurs between the months of January and February, producing litters of two to three after the gestation period of 63–70 days (Sunquist and Sunquist, 2002).

The distribution range of *P. viverrinus* is restricted to Vietnam, Cambodia, Thailand, India, Sri Lanka, Bangladesh, Pakistan, and Nepal (Cutter and Cutter, 2009; Royan, 2010; Duckworth et al., 2010; Mukherjee et al., 2010; 2012) but widely dispersed in patchy populations (Macdonald and Loveridge, 2010). Studies have reported India and Sri Lanka to be strongholds of *P. viverrinus* populations (Janardhanan et al., 2014).

Brian Hodgson, a pioneering naturalist and ethnologist, recognized the presence of *P. viverrinus* for the first time in Nepal (Suwal and Verheugt, 1995), when a male *P. viverrinus* was recorded in Bankalwa of the Morang district and was subsequently collected as a specimen for the Natural History Museum of the Zoological Society of London a century ago (Hinton and Fry, 1923). *Prionailurus viverrinus* has been reported to occur in the Himalayan forests up to an elevation of 1525 m above mean sea level, while the species is also known to be present in the swamps at the base of mountains (Prater, 1965). In Nepal, the species primarily occurs in the Koshi Tappu Wildlife Reserve (KTWR), Shuklaphanta National Park (ShNP), Chitwan National Park (CNP) and Bardia National Park (BNP) (Suwal and Verheugt, 1995). The global population of *P. viverrinus* has been

suspected of declining by 30% in the past one and a half decades (Mukherjee et al., 2016).

Out of 212 species of mammals recorded in Nepal (Amin et al., 2018), research and conservation efforts have mostly been focused on large charismatic felids like *Panthera tigris*, the Snow Leopard, *Panthera uncia* (Schreber), and the Leopard *Panthera pardus* (Linnaeus) (Thapa, 2011; Thapa et al., 2014; Karki et al., 2015). The existing information on small cat species in Nepal is mostly based on anecdotal reports, historic references, museum specimens, and a survey carried out in Protected Areas for large felids (Lamichhane et al., 2016; Taylor et al., 2016) and very limited studies have been carried out on rare and elusive smaller felids, including *P. viverrinus* in the country (Nowell and Jackson, 1996).

We, therefore, aim to provide comprehensive and updated information of *P. viverrinus* in Nepal by assessing its status, distribution, and existing threats, both inside and outside the Protected Areas of the country, and to recommend some important measures for their long-term conservation.

Material and Methods

Search engines and search terms

The initial goal of this paper was to find all the research articles and works related to *P. viverrinus* in Nepal. We searched the relevant terms for *P. viverrinus* using two search engines, Google Scholar and Research Gate (Table 1) up to June 2021. Similarly, other Nepalese reports were reviewed to gain additional information of the species.

Table 1: Search terms in both Google Scholar and the Research Gate.

Search Terms
Fishing cat
<i>Prionailurus viverrinus</i>
Fishing cat in Nepal
Fishing cat status
Fishing cat survey
Fishing cat record in Nepal
Fishing cat threats
Fishing cat in CNP
Fishing cat in Parsa National Park (PNP)
Fishing cat outside Protected Areas
Fishing cat first record in Nepal
Fishing cat conflicts
Fishing cat in BNP
Small felids of Nepal
Small mammals of Nepal
Fishing cat populations



Figure 1: Photograph of a Fishing cat, *Prionailurus viverrinus* retrieved through a camera trap.

Data screening, review, and analysis

We downloaded more than 100 papers found with the broad term “Fishing cat” and removed all duplicate articles first. Secondly, we filtered the remaining papers by inspecting the title and results section. Only specific papers, which provided us with possible data about the presence of *P. viverrinus* in Nepal were selected. We ended up screening 49 articles as final documents to be used in our study, spanning the years 1833 to 2021. They were thoroughly reviewed and the species information such as phylogenetic origin, general biology, global distribution and status, distribution in Nepal, habitat preference, photographic identifications, threats, and conservation efforts were accumulated.

The distribution records of *P. viverrinus* in Nepal were mapped using ArcGIS 10.3. The shape files for the Manaharwa, Bara district, Jagadishpur Reservoir, and Ghodaghodi Lake were acquired from open street map software (<https://www.openstreetmap.org>) and the geographic boundary for Nepal was acquired from the Department of Survey, Nepal (<http://www.dos.gov.np/nepal-map>).

Results and Discussion

Status and distribution of *Prionailurus viverrinus* inside Protected Areas

The five Protected Areas located in Southern Terai region of Nepal are known to harbor *P. viverrinus* and they are ShNP, BNP, CNP, Parsa National Park

(PNP), and KTWR (Jnawali et al., 2011; Karki, 2011; Taylor et al., 2016; Yadav et al., 2018). Chhetry and Pal (2010) recorded and listed *P. viverrinus* as occasional in KTWR in their study. Pandey and Kaspal (2011) recorded nine individuals from the eastern buffer zone of KTWR in 2011 and later Taylor et al. (2016) reconfirmed the presence of *P. viverrinus* there. Camera trap surveys carried out in KTWR focusing on fishing cat in 2017 recorded *P. viverrinus* as distributed evenly throughout the reserve with estimated population of 20 *P. viverrinus* (Mishra et al., 2021). Fishing cats were known to be present in CNP since its establishment and camera trap studies, including surveys intended originally for Tiger monitoring, found a highly restricted distribution of *P. viverrinus* in and around CNP (Karki, 2011; Mishra, 2013).

In his study, Karki (2011) reported *P. viverrinus* to be present in three locations around Rapti floodplains, namely Icherny, Ghatgain and Amrite. While conducting small mammals survey, Dahal and Dahal (2011) recorded *P. viverrinus* from Tiger Tops tented camp area, 18 km west of the park headquarters and south of Sauraha where Mishra (2013) recorded three individuals of fishing cat from the same location in 2012. Mishra (2013) reported *P. viverrinus* from marshes in CNP at three locations: Patna Lake, Tiger Tops tented camp area and Devi Lake. She recorded five individuals of *P. viverrinus* with an estimated population of 18 individuals to be present with a density of 6 individuals/100 km² around the 160 km² wetland area of CNP (Mishra,

2016). Later, Mishra et al. (2018) reported habitat shrinkage, depletion of fish in the park's wetlands and persecution as the main conservation threats to *P. viverrinus* in the area. Mishra et al. (2021), estimated a population of 20 fishing cats and density of 8.4/100 km² in KTWR and its buffer zone using Spatially Explicit Capture-Recapture models.

In 2016, a survey focusing on tiger research in PNP recorded a single individual of *P. viverrinus* in forest dominated by *Shorea robusta* (Sal) (Poudel et al., 2019). Whereas a targeted survey along rivers and streams of PNP, covering only a small area (~20 km²), failed to record any individuals of *P. viverrinus* (Sharma, 2016). Few reports are available on the existence of *P. viverrinus* in BNP and these records are from a study carried out for other carnivores using camera traps in the area (Odden and Wegge, 2005; Wegge et al., 2009; Dhakal et al., 2014). This camera trap survey of the entire BNP for Tigers has recorded *P. viverrinus* from only a single location (Yadav et al., 2018) on two separate occasions in the Babai Valley of the National Park. However, Fishing cats are reported from the Katarniaghat Wildlife Sanctuary of India, which is connected to BNP through the Khata forest corridor (Mukherjee et al., 2012) and may indicate a transboundary migration of *P. viverrinus* populations residing there, between the two countries. Yadav et al. (2018) recorded a cat with the remains of fish and crabs near their camera trapping sites (< 100 m) around BNP and presumed it to be of *P. viverrinus*, as the species mostly prefers fish for their diet (Nowell and Jackson, 1996).

Status and distribution of *Prionailurus viverrinus* outside Protected Areas

Due to their irregular distribution, *P. viverrinus* has a higher chance of being distributed outside Protected Areas in similar habitat features, such as altitude, topography, and vegetation, to those found in Protected Areas (Mukherjee et al., 2012). In 1919, a male *P. viverrinus* was recorded from Bankalwa, a small village located around 13 km east of the current KTWR, Morang (Hinton and Fry, 1923). Outside the Protected Areas in Nepal, they have been reported from the Ghodaghodi Lake at Kailali and the Jagadishpur Reservoir in Kapilvastu District (Dahal et al., 2014; Lamsal et al., 2014). A more recent report of *P. viverrinus* being present outside the Protected Areas of Nepal was from the Jagadishpur Reservoir, from a camera trap survey (Dahal et al., 2014). More recently still, in 2020, fishing cats were camera trapped from the same locations where Dahal et al. (2014) previously reported them (personal communication with Swechhya Shrestha). Lamsal et al. (2014) included *P. viverrinus* as mammals of the Ghodaghodi Lake complex in their study based on a questionnaire survey but any photographic evidence is still lacking. In 2020, the co-author Rama Mishra

also reported *P. viverrinus* as roadkill in Bara district, 15 km south of PNP. The accumulated distribution records of *P. viverrinus* from our results are represented in Figure 2.

Threats to *Prionailurus viverrinus*

Despite being an ecologically significant felid species (Mukherjee et al., 2016) and known to indicate the good health of wetland ecosystems, *P. viverrinus* is, at present, threatened for survival due to multiple reasons. *Prionailurus viverrinus* is considered to regularly venture into marsh and swamp areas in general. The species is becoming more vulnerable to extinction due to the increased rate of wetland shrinkage and their conversion to grassland (Mishra, 2013). In addition, direct killing of *P. viverrinus* by humans for fur and meat, poisoning and poaching by farmers as retaliatory killings due to their livestock depredation are also some major threats to this species (Lyanda, 2001). Similarly, other studies have reported road kill, habitat loss and destruction due to wetland shrinkage, fur pelt trade, exploitation of marshes and grasslands, and over-fishing as the most serious threats to the species (Sunquist and Sunquist, 2002; Mishra et al., 2021).

In Nepal, road kill, development of non-eco-friendly concrete fish ponds, poaching for fur, habitat loss due to wetland degradation, decreases in fish stocks because of poisoning, and over-harvesting are some of the key threats to *P. viverrinus* survival (Jnawali et al., 2011; Mishra et al., 2021). The local communities in eastern Nepal are known to retaliate against *P. viverrinus* and kill them by means of electrocution or poisoning around the privately owned fish ponds (Taylor et al., 2016). The Jayamangala area in CNP was known as a wetland with high fish stocks in the 1980s. The presence of *P. viverrinus* was considered high at that site during the same time period (Sunquist and Sunquist, 2002). In contrast, the wetlands of Jayamangala at present have been converted into grassland which may be a reason for Mishra (2013) to fail to record any *P. viverrinus* individuals at that site.

The similar feeding habits among other the small carnivores sharing this common habitat; such as the Leopard cat (*Prionailurus bengalensis*) (Kerr, 1792), the Jungle cat (*Felis chaus*) (Schreber, 1777), the Indian gray mongoose (*Herpestes edwardsi*) (É. Geoffroy Saint-Hilaire, 1818), the Small Asian mongoose (*Herpestes javanicus*) (É. Geoffroy Saint-Hilaire, 1818), the Large Indian civet (*Viverra zibetha*) (Linnaeus, 1758) and the small Indian civet (*Viverricula indica*) (É. Geoffroy Saint-Hilaire, 1803) has led to more threats as competition takes place among them for their survival (Mishra, 2013). Poisoning around fish ponds and water pollution are also threats for declining *P. viverrinus* populations in KTWR and CNP, respectively (Mishra, 2013; Taylor et al., 2016).

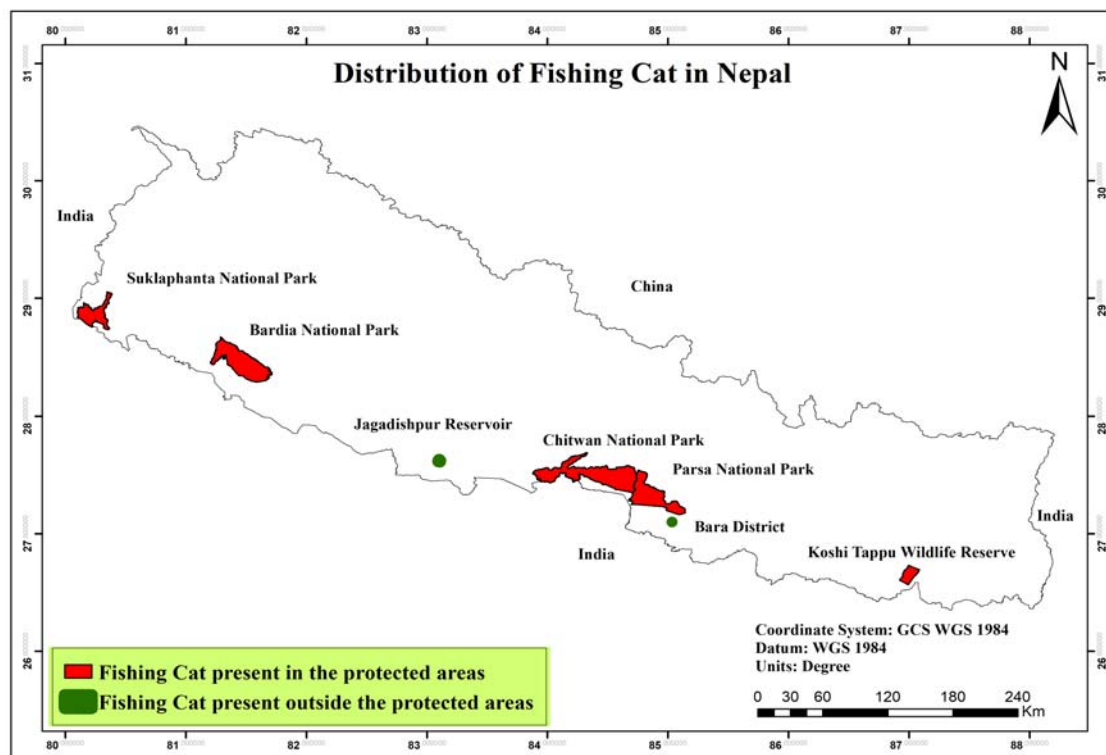


Figure 2: Distribution of the Fishing cat, *Prionailurus viverrinus* inside and outside of protected areas in Nepal.

Cutter (2009), Adhya et al. (2011) and Mishra et al. (2018) described wetland shrinkage, flooding, and exploitation of marshes and grasslands by humans as the major threats to *P. viverrinus*. Likewise, overgrazing and the removal of riparian vegetation by the grazing livestock within the reserve, are the primary threats to *P. viverrinus* in KTWR (Taylor et al., 2016). The Fishing cats are distributed in scattered small patches of lowland in the Terai region and the absence of connectivity between these populations, may hamper the genetic exchange between them, pushing the species further towards extinction in this country (Appel and Duckworth, 2015).

Conclusion

In Nepal, *P. viverrinus* has so far been recorded from five Protected Areas of the country located in the lowland of the Terai region, while the species has also been known to occur in non-Protected Areas as well. Retaliatory killing by humans, road kill, wetland conversion to dry grassland, fish-stock depletion, and poaching and poisoning have been identified as the major threats to *P. viverrinus* residing in Nepal. The habitat management of *P. viverrinus*, together with the control of retaliatory killing, fish-stock depletion, poaching, and wetland conversion may result in further increases in *P. viverrinus* populations in Nepal.

Furthermore, a targeted and detailed survey must be carried out immediately to explore their habitat in the Terai region of Nepal, in collaboration with the government of Nepal, Non-Governmental Organizations (NGOs), International Non-Governmental Organizations (INGOs), wildlife scientists, and researchers to gather more data on the species.

Our study may provide ecologists, government authorities, wildlife experts, and policymakers with baseline information on the species in order to explore both Protected Areas and non-Protected Areas as emergency protection for *P. viverrinus* in the near future.

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Conflict of interest

The authors declare that there are no conflicting issues related to this review article.

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