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Impacts of Community Forestry on the Bengal Monitor, *Varanus bengalensis* (Daudin, 1802): An Empirical Study from Nepal

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Abstract - Although the Bengal monitor lizard (*Varanus bengalensis*) is considered to be a species of least conservation concern, its populations are thought to be decreasing. In Nepal, community forestry was initiated around 33 years ago but its actual impact on faunal biodiversity has been poorly studied. This study was conducted in Jana Jagaran Community Forest of Parasan VDC, Kanchanpur to investigate the impacts of community forestry on *V. bengalensis* by studying the habitat preferences of monitors in habitats created by community forestry management activities. Fencing has had a positive impact, whereas plantations did not have a significant impact on *V. bengalensis*. Most lizards were observed on the ground, but the presence of both ground cover and large trees were equally important for the species. To date, community forestry has had a positive impact on *V. bengalensis* in the Jana Jagaran Community Forest, but further studies on the impact of plantations are recommended.

Introduction

The Bengal monitor lizard (*Varanus bengalensis*) is a wide-ranging species, occurring from Iran to South Asia and throughout Southeast Asia (Papenfuss *et al*., 2010). It is a generalist species inhabiting forests, agricultural lands and grasslands (Shah & Tiwari, 2004), and is categorized as a species of Least Concern in the IUCN Red Data List of Threatened Species (Papenfuss *et al.*, 2010), but listed in Appendix I of CITES (CITES, 2012).

Previously in Nepal, the rate of deforestation had been high (Shrestha *et al.,* 2010), threatening its biodiversity. In response to this, a community forestry program was started in Nepal around 33 years ago, which has helped slow the rate of deforestation (Kanel *et al*., 2005). Community forestry is considered as one of the most successful natural resource management programs of Nepal (Shrestha *et al.,* 2010); however, the exact role of community forestry in conserving biodiversity is unclear, as only a few research projects have studied its impacts (e.g. Pokhrel & Shah, 2008). Understanding the role of community forestry in faunal conservation is important, as community forests account for more than 21% of the total forests in Nepal (Gautam, 2011).

This study investigates the impacts of community

forestry on a population of *V. bengalensis* in Nepal. Although listed as a species of least concern, its populations are believed to be decreasing (Papenfuss *et al.*, 2010). In Nepal, various forestry management activities are carried out inside community forests that may affect wildlife, such as the construction of fencing and the creation of Teak and Eucalyptus plantations. The effects of these activities on *V. bengalensis* were assessed by studying its habitat preferences in areas created through forestry management activities. The null hypothesis is that fences and plantations do not have any effects on the habitat preferences of *V. bengalensis*. The behavior of *V. bengalensis* was also studied, which may be helpful in understanding the impacts of forestry management activities.

Methods

This study was conducted in Jana Jagaran Community Forest (28°36'04"N; 80°30'00"E), which lies in wards 4 and 5 of the Parasan Village Development Committee (VDC) of Kanchanpur District, Nepal. The location of the Parasan VDC is shown in Fig. 1. The Parasan VDC is bordered by Tribhuwan Basti VDC on its northern side, Duduwa National Park (India) on its eastern side, and by India on its remaining borders. The community forest is the only remnant natural forest of the Parasan VDC, and was declared a community forest in 2000. The climate of this area is dominated by tropical monsoons from June to September with a mean rainfall of 2100 mm, and temperatures ranging from 44 °C in summer to 2.5° C in winter (DHM, 2012). The Donda River flows through the northern side of the community forest. Sal (*Shorea robusta*) is the dominant tree species, whereas monkeys, squirrels, monitor lizards and jackals are the prominent faunal species found in the area. There are two extended parts of the community forest in the south (a narrow strip of forest along the southern slope) and northwest (entirely planted with Sissoo [*Dalbergia sissoo*]), which were excluded from this study. The total area of the community forest is about 200 hectares, of which 120 hectares comprised the study area.

Most of the community forest has been protected by barbed wire fencing since 2002, but some parts have been left unprotected for cattle grazing. In this study, the protected area inside the fence is referred to as the bounded area and the unprotected area left for grazing is referred to as the unbounded area; each was treated as separate habitat for *V. bengalensis*. Inside the bounded area, some parts have been planted with Eucalyptus (*Eucalyptus* sp.) and Teak (*Tectona grandis*) trees since 2003. Both species are planted in different areas within the bounded area, so these plantations occur as monocultures. Two different habitats were identified inside the bounded area: one with naturally occurring vegetation, and the other with a mix of planted and natural vegetation. These two habitats are identified in this study as the unplanted and planted areas,

Fig. 1. Location of the study area.

respectively.

The numbers of *V. bengalensis* sighted in different habitats were taken as indices of the habitat preferences to these habitats. Observations were conducted in July and August 2011. Time constraint visual survey (Campbell & Christman, 1982 cited in Cruze & Kumar, 2011; Corn & Bury, 1990 cited in Muths, undated; Crosswhite *et al*., 1999), with some modifications, was adopted for observing *V. bengalensis*. For observations, the community forest was divided into three equal parts with the help of a GPS device (Garmin Etrex H GPS; Garmin International Inc., Olathe, Kansas, USA). Daily observations of *V. bengalensis* were carried out over three periods; morning, afternoon and evening, and were conducted in an alternating manner. For example, if the first section of the community forest was observed during the morning of the first day, then the second sector was observed during the morning of the second day, and so on. Similar alternations were used for observations made in afternoons and evenings. This was done to minimize the bias caused by differences in observation times. Observation periods were 0700-1000 h (morning), 1200-1500 h (afternoon) and 1600-1900 h (evening) for six days in July, and 0730-1030 h (morning), 1200-1500 h (afternoon) and 1530-1830 h (evening) for six days in August.

During the survey, the researcher walked along a transect and recorded data if any monitor was seen within 20 m of either side of the transect. Monitors seen more than 20 m from the researcher were not considered. Habitat type, location, and the lizard's response to disturbance caused by the researcher's movements were also noted during observations. All observations were made by a single observer (principal author) on dry days (days receiving less than 30 minutes of rainfall). Altogether, two days were spent in the field prior to data collection and another twelve days were spent collecting data, totaling 108 hours of searching. Juvenile *V. bengalensis* were not considered in the study and only specimens greater than 50 cm in total length were considered for data collection.

The proportions of habitats in the study area were calculated using a non-mapping technique (Marcum & Loftsgaarden, 1980). A total of 150 random points were plotted, of which only 114 points fell inside the study area due to the irregular shape of the community forest. With the help of these random points in each habitat, the expected frequencies of *V. bengalensis* observations were calculated. Next, habitat preferences were calculated by using the chi squared goodness of fit test (Neu *et al*., 1974) with an adjustment for continuity (Emden, 2008). If there were significant differences in the use and availability of habitats by the monitors, then they were further clarified using confidence intervals (Byers *et al*., 1984). Observations of *V. bengalensis* in different situations and their responses to disturbance are presented in Table 3 and Figure 2.

Results

Habitat Preferences

Altogether, 64 observations of *V. bengalensis* were recorded during the study. The number of random points and the observed and expected frequencies of sightings in the bounded and unbounded areas are given in Table 1. The $\chi 2$ value calculated from Table 1 ($\chi 2$= 4.19, p= 0.041) indicates that *V. bengalensis* did not use bounded and unbounded areas according to their availability. The 5% confidence interval of the proportion of observations in the bounded area is 0.8562-0.9876, which is more than its expected proportion (0.8145). Therefore, *V. bengalensis* appears to be more abundant in the bounded area than the unbounded area.

The number of random points and observed and expected frequencies in the planted and unplanted areas are given in Table 2. The $\chi 2$ value calculated from Table 2 ($\chi 2$= 0.38, p= 0.538) implies that *V. bengalensis* was equally abundant in both planted areas and unplanted areas inside the bounded area of the community forest.

Table 1. Observed and expected frequencies of *V. bengalensis* observations in bounded and unbounded areas of the community forest.

Habitat type	Random points	Observed frequency of observations	Expected frequency of observations
Bounded area	86	59	52.13
Unbounded area	28	5	11.87

Table 2. Observed and expected frequencies of *V. bengalensis* observations in planted and unplanted areas inside the bounded area of the community forest.

Habitat type	Random points	Observed frequency of observations	Expected frequency of observations
Planted area	14	6	8.14
Unplanted area	72	53	50.86

Table 3. Observations of *V. bengalensis* in different situations within the community forest.

Substrate type	Number of observations	% of total observation
Tree	14	21.88
Ground	50	78.12

Behavior

More *V. bengalensis* were observed on the ground than in trees. Observations of monitors in different situations are summarized in Table 3. Fifty nine lizards (92% of total sighting) responded to disturbance. Among these, 39% used living trees, 8% used dead trees and 53% used bushes in response to disturbance (Fig. 2).

Discussion

Habitat preference is an important factor for the conservation of any species. In this study, *V. bengalensis* preferred the bounded area over the unbounded area, suggesting a positive impact on the abundance of monitor lizards from fence construction. More than 90% of *V. bengalensis* observed in this study responded to disturbance, indicating their wariness of people. Since there are more disturbances from humans and cattle outside the fence than inside, this may partly explain their preferences for areas within the bounded area. Due to grazing, trampling, and human activities, unbounded areas have substantially less ground cover than bounded areas (compare Figs. 4 & 6). Reptiles generally favor areas with ground cover and woody debris (Crosswhite *et al.*, 2004). Since more than 50% of *V. bengalensis* used

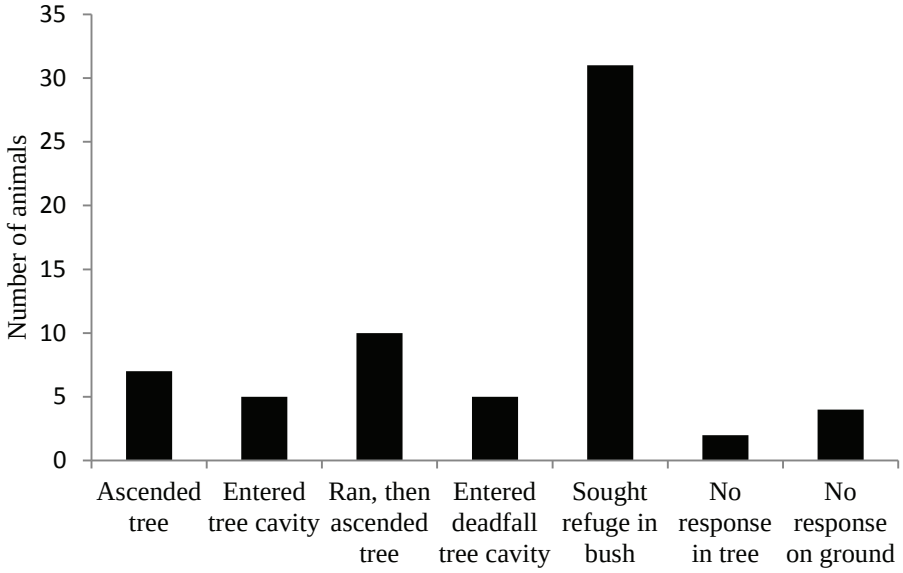

Fig. 2. Responses of *V. bengalensis* to disturbance.

Fig. 3. *V. bengalensis* in a Sal tree.

bushes for retreat (Fig. 2), the presence of ground cover could also explain why bounded areas were preferred by monitors.

Monoculture is a common practice in community forests of Nepal (Shrestha *et al*., 2010), and plantations have been established as a way of increasing the supply of wood used for fuel. Some reptiles can be affected by silvicultural operations (Crosswhite *et al*., 2004). In the present study, plantations do not appear to have had an impact on the habitat preferences of *V. bengalensis*, but single species plantations can have other effects on the species. For example, Eucalyptus is an alien species in Nepal, and both Eucalyptus and Teak have smooth trunks. As no *V. bengalensis* were seen using either of these tree species, it is possible that the monitors avoid these trees due to their difficulty to climb. Monoculture can also affect the availability of tree cavities, which serve as important refuge sites for *V. bengalensis* (Pattanavibool & Edge, 1996; Fig. 2), as both Eucalyptus and Teak trees usually lack hollows or cavities. Eucalyptus trees can also decrease the abundance of insects (Majer & Recher, 1999), the major food source of *V. bengalensis* (Auffenberg, 1994). Ground cover, which is also important for *V. bengalensis*, was less common in planted areas than in unplanted areas (compare Figs. 5 & 6).

Since *V. bengalensis* have large home ranges of 40 to 300 hectares in size (Auffenberg *et al*., 1991), plantations in the community forest, which are less than 25 m wide, may have a negligible effect on the habitat preference of the species. However, if the size of plantations were greater, *V. bengalensis* may not have exhibited the same preferences seen in this study.

Beetles are the major dietary component of *V.*

Fig. 4. Unbounded area of the community forest.

Fig. 5. Area planted with Teak trees inside the bounded area of the community forest.

Fig. 6. Unplanted (natural) area inside the bounded area of the community forest.

bengalensis, and their abundance and availability to monitors is often particularly high in the presence of cattle dung, in which the beetles live and feed (Auffenberg, 1994). Therefore, the presence of grazing cattle in the unbounded area might be expected to increase the abundance of *V. bengalensis* in this area of the community forest. However, there were fewer observations of monitors in this area than the bounded area, suggesting there are fewer individuals utilizing this habitat. Most human inhabitants of the area are farmers, and local people, especially herders, collect the dung for its use as organic fertilizer. Hence, cattle dung does not remain in the wild long enough to allow for beetles to utilize it, which will limit the ability of *V. bengalensis* to utilize them as a source of food.

As seen in Table 3 and Fig. 2, both trees and ground cover are important for *V. bengalensis*. Most *V. bengalensis* forage on the ground, which may be the reason why more individuals were seen on the ground than in trees. However, when fleeing from danger, ground cover and trees are equally as important to the species. Fewer than 10% of *V. bengalensis* used deadfall trees, but this may be due to the limited number of fallen trees when compared to living ones.

While there have been some negative impacts on biodiversity from current community forest management programs (Shrestha *et al.*, 2010), there have been some positive impacts as well (Pokhrel & Shah, 2008). From the results of this study, it seems that the construction of fences helped to conserve *V. bengalensis* in the protected area of the community forest. If the fence had not been constructed, all of the forest might have been disturbed by human activities and cattle grazing to the same extent as the unbounded area. The unbounded area can serve as a reference for the impacts of community forestry because the condition of the forest before its declaration as a community forest was virtually the same as the unbounded area today. Protective efforts began following its declaration as a community forest and handover to a managing group. The construction of fences has offered the forest more protection than before by excluding humans and cattle, thereby initiating the forest's regeneration. Therefore, community forestry appears to be beneficial to the conservation of *V. bengalensis* through the creation of fences and/or plantations, but further studies on the impacts of planting alien species on *V. bengalensis* and other wildlife are needed.

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