Depredation and deteriorating condition of *Shorea robusta* and *Terminalia alata* in Bardia National Park: an imperative to address park biodiversity sustainably

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The paradigm shift in park management from a fortress mentality to the participatory concept is represented as a major transformation in the conservation discourse in Nepal. The involvement of local people in the management of resources in national parks has been significantly effective in attaining the conservation goals of conserving wildlife without compromising the basic forest resource needs of the local people. Nevertheless, some economically important species have not been afforded due consideration during such management. This study investigates the species composition and regeneration status of *Shorea robusta* (Sal) and *Terminalia alata* (Saj) in 4 Buffer Zone community Forests of Bardia National Park in Thakurdwara VDC in 1999/2000, 2002/2003 and 2005. The results reveal that *Shorea robusta* (Sal) and *Terminalia alata* (Saj) both constituted a large proportion of species diversity but that their regeneration from seedlings to established stages were low, suggesting vulnerability of this forest and their sustainability at risk due to their dwindling conditions. Immediate management concern of these economically important forest tree species is warranted.

Keywords: Biodiversity, national park, s*horea robusta*, sustainability, *terminalia alata*

Bardia National Park (BNP) covering an area of 968 sq.km is the largest protected area of Terai and Bhabar regions. It lies in the mid western development region and represents the subtropical climate of Nepal. BNP is famous for its wild habitats that is home to animal species such as wild elephants, tigers, deers, and translocated rhinos (Bhatta, 1994; Gyawali, 1995).

One of the largest rivers of Nepal, the Karnali flanks the western bank of the national park while many other rivers, including the Babai, flow through it. These rivers provide habitats for aquatic animals and waterfowl as well as for the rearing of endangered amphibians and reptiles.

The old concept of segregating people from the national park has been reconsidered to accommodate the participation of local people (Acharya and Dhungana, 2009). In this process the forest areas buffering the national park were declared as Buffer Zones in 1996 and the neighbouring people were mobilized to manage these forests properly by organizing them into user groups (PPP, 1999; Karki, 1997).

Before the implementation of the buffer zone concept, the people residing in the vicinity were not granted access to the national park resources. The park was sealed from the people. Later it was realized that such isolation of the national park from the people threatened the sustainability of the park and its resources. This notion has been validated in all kinds of community based natural resource managements (Allendorf, 1999; Acharya, 2007; Tamrakar and Sharma, 2002).

With the declaration of buffer zone areas in the BNP, the concern for effective Buffer Zone Community Forest (BZCF) management is rising within the user groups. Activities such as benefit sharing, Non Timber Forest Product (NTFP) promotion, forest species composition and management are gaining attention (Acharya, 2002).

Knowledge about the species composition and their regeneration status is a necessary tool for managing the forests scientifically. This knowledge enables the selecting of species that have the most importance to the users and their sustainable management for the wildlife in the park.

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Materials and methods

Study site

The study area is located in Bardia district of mid western development region of Nepal. The study was carried out in four BZCFs of BNP. Of the four BZCFs, Chidkaiya, Thakurdwara and Betani had areas of 62 hectares each whereas the area of Bhudkaiya was 92 hectares, consisting of a 50 ha natural forest and a 40 ha plantation.

Only the natural forests were considered for this study. Similarly Bhudkaiya was a separate BZCF whereas the other remaining three BZCFs were contiguous with each other. All four BZCFs were part of the Thakurdwara VDC. The BNP headquarter is located at Thakurdwara and is accessible by a 13 km gravel road from Ambasa, on the East-West Highway of Nepal.

Data collection and analysis

Tree species composition and regeneration survey of BZCF were carried using stratified systematic sampling method. Stratification was done based on stand density and canopy cover. For the study of tree species composition, a 1% sampling intensity was conducted with plots of 10mx10m. Within these plots, only tree species compositions were identified by counting the number of trees in each plot. Later, tree numbers were tabulated as percentages. The total number of plots in Chidkaiya, Thakurdwara and Betani BZCFs were 62 and in Bhudkaiya, it was 50.

Similarly for regeneration survey, a 0.1% sampling intensity was used for plots of 2m x 2m within the (10m*10m) plots used for tree species composition. The total number of plots in Chidkaiya, Thakurdwara and Betani BZCFs were 155 and in Bhudkaiya, it was 125. The regeneration survey was carried out by recording the regeneration of the species into various categories as follows (Khanna, 1996):

- Established (e): whose height should be in between 2.5 m to 4 m.
- Woody (w): unestablished seedling, whose height should be between 1.5 m to 2.5 m
- Whippy (u): unestablished seedling, whose height should be between 50 cm to 1.5m
- Sub whippy(s): unestablished seedling whose height is between 20 cm to 50 cm
- Recruit(r): current year's seedling, whose height is up to 20 cm with six leaves maximum

Data was analyzed using descriptive statistics and presented graphically.

Results and discussions

Species composition

Figure 1 reveals that within all BZCFs, *Shorea robusta* and *Terminalia alata* were found to be the major species.

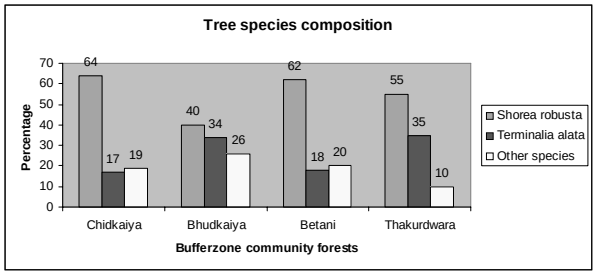


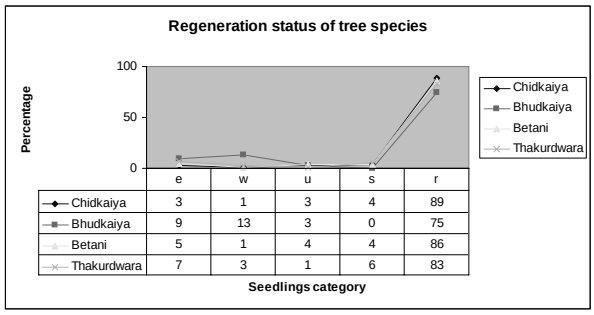
Figure 1: Tree species composition on Buffer Zone community forests

Other species category in the Figure 1 included: *Acacia catechu* (Khayer), *Adina cordifolia* (Haldu), *Bassia indica* (Mahuwa), *Cassia fistula* (Rajbriksha), *Ficus religiosa* (Peepal), *Garuga pinnata* (Dabdabe), *Lagerstroemia parviflora* (Botdhaire), *Mallotus phillippinensis* (Rohini), *Myraine semiserrata* (Kalikath), *Schleichera trijuga* (Kusum), *Semecarpus anacardium* (Bhalayo) and *Syzyzium cumini* (Jamun) among others.

The management system needs to promote economically important species such as *Shorea robusta* and *Terminalia alata,* which are valued as timber for their durability and superior quality while species such as *Mallotus phillippinensis* are economically less important but could still be used as fodder for animals.

Regeneration and species density

Figure 2 shows that in terms of the regeneration status, current year recruits seedling occupied the highest percentage of seedlings in all 4 Buffer Zone Community Forests, followed by other categories.



	e	w	u	s	r
Chidkaiya	3	1	3	4	89
Bhudkaiya	9	13	3	0	75
Betani	5	1	4	4	86
Thakurdwara	7	3	1	6	83

Figure 2: Regeneration status of tree species

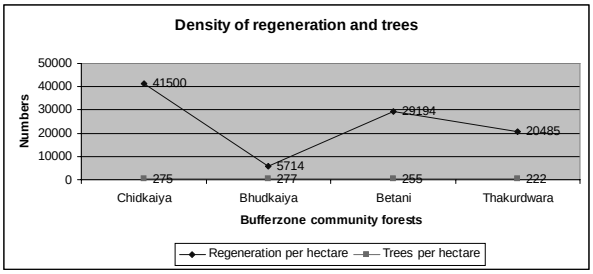


Figure 3: Regeneration and tree status of the species

Figure 3 above shows that in all BZCFs, the numbers of trees per hectare were similar (222-277) but regeneration numbers differed significantly. Chidkaiya CF had the highest number of regeneration (41,500) whereas Bhudkaiya had the least (5714). Fencing along the boundary and strict prohibition on grazing in Chidkaiya forest contributed to its highest regeneration. The worst regeneration in Bhudkaiya was due to unrestricted grazing allowed inside this forest.

Profuse regeneration of *Shorea robusta* occurred under the open canopy. Similarly, protection also contributed to the profuse regeneration. As Chidkaiya and Betani forests were controlled from grazing, the number of seedlings in these forests was comparatively higher. Erecting fencing along the boundary is expensive and may not always be feasible. Instead the prohibition of open grazing system can help in facilitating high regeneration like that in Chidkaiya.

Condition of *Shorea robusta* and *Terminalia alata* in future

Table 1 reveals that there was no established seedlings "e" of *Shorea robusta* in all the forests studied. Table 2 shows the absence of "e" category from all the forests; this is an indication of the deteriorating status of *Shorea robusta* and *Terminalia alata* species. In particular, the absence of "w", "u", and "s" categories of *Terminalia alata* seedlings reveals an even more vulnerable condition for this species.

The absence of established seedlings of *Shorea robusta* and *Terminalia alata* in all the BZCFs underscores the high risk to the future sustainability of these forests. This absence also suggests that species management of BZCF has not been scientific. Between these two species, the condition of *Terminalia alata* is more vulnerable with zero established, woody and whippy categories. If this condition is not redressed in due time, eventually this species will head towards extinction in the BZCFs.

Shorea robusta and *Terminalia alata* represent important species in the Terai region of Nepal. Both species are not only economically but also ecologically very important. While managing these species, other species in the forest should also be given importance because of their ecological and economic significance (Jackson, 1994; Ojha et al., 2008, Acharya et al., 2009).

Conclusions

The findings on tree species composition and regeneration survey will be helpful in understanding the composition of forest. These findings will further help in selecting important species. *Shorea robusta* and *Terminalia alata* were found as dominant tree species in the BZCFs but their regeneration indicated an even lower representation in established form (e). Both these species need immediate attention for their management and this research could serve as a benchmark for further investigations.

Acknowledgements

We would like to thank NTNC team of Bardia (formerly KMTNC/BCP) for partial funding to

Table 1: Condition of established seedling of *Shorea robusta*

Chidkaiya (%)	**Bhudkaiya** (%)	**Betani** (%)	**Thakurdwara** (%)
e=0	e=0	e=0	e=0
w=0.12	w=0	w=0	w=0
u=0.5	u=0.48	u=0	u=0
s=0.95	s=0.93	s=0.89	s=0
r=97.5	r=97	r=93.15	r=50

Table 2: Condition of established seedling of *Terminalia alata*

Chidkaiya (%)	**Bhudkaiya** (%)	**Betani** (%)	**Thakurdwara** (%)
e=0	e=0	e=0	e=0
w=0	w=0	w=0	w=0
u=0	u=0	u=0	u=0
s=o	s=o	s=o	s=o
r=1.6	r=1	r=2.3	r=8.4

undertake this research. We would also like to thank Dr. Shanta Raj Gyawali, Mr. Baban Prasad Kayastha and Dr. Rajendra Prasad Adhikari for their input, help and suggestions. Inputs from anonymous reviewers are duly acknowledged.

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