EISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2019; 7(3): 610-615 © 2019 JEZS Received: 04-03-2019 Accepted: 08-04-2019

Nikhil Rajput
Department of Forest Products and Wildlife, Forest College and Research Institute, TNAU, Mettupalayam, Tamil Nadu, India

Dr. K Baranidharan
Department of Forest Products and Wildlife, Forest College and Research Institute, TNAU, Mettupalayam, Tamil Nadu, India

Dr. M Vijayabhama
Department of Basic and Social Sciences, Forest College and Research Institute, TNAU, Mettupalayam, Tamil Nadu, India

Akshay Sawant
Department of Forest Products and Wildlife, Forest College and Research Institute, TNAU, Mettupalayam, Tamil Nadu, India

Correspondence
Nikhil Rajput
Department of Forest Products and Wildlife, Forest College and Research Institute, TNAU, Mettupalayam, Tamil Nadu, India

Ecological impact of Prosopis juliflora on the habitat conditions of blackbuck in Sathyamangalam tiger reserve, Tamil Nadu, India

Nikhil Rajput, Dr. K Baranidharan, Dr. M Vijayabhama and Akshay Sawant

Abstract
Bhavanisagar Range of Sathyamangalam Tiger Reserve in the foothills of the Nilgiris, Tamil Nadu, known for its landscape beauty varied of forest ecosystems and wildlife diversity. Current investigation carried out to assess the impact of Prosopis juliflora on habitat condition of blackbuck. The results revealed that Prosopis eradicated area attracted more blackbuck density than the Prosopis invaded area. Density of blackbuck, in different sites viz., site I, site II and site III with the value of direct sighting 0.56 ha⁻¹, 0.39 ha⁻¹ and 0.15 ha⁻¹ respectively and indirect sighting 0.37 ha⁻¹, 0.22 ha⁻¹, 0.29 ha⁻¹ respectively. An effort was also made to study the impact of Prosopis juliflora eradication and effective management for improvement of a blackbuck habitat and indigenous floral species, which shows positive impacts towards high density population of blackbuck in the Sathyamangalam Tiger reserve.

Keywords: Blackbuck, conservation, habitat, improvement, invasive alien species

Introduction
Blackbuck Antelope cervicapra is an alluring gazelle-like antelope regarded as the handsome member of the family 'Bovidae'. It lives in open habitat (Schaller et al. 1967) [23]. In open grasslands, dry thorn, bush lands and scrublands. Blackbuck has important ecological roles in grassland ecosystem (Kunwar et al. 2015) [19]. Blackbuck was once distributed across the country however currently restricted to tiny fragmented patches. Conservation of blackbuck has perpetually been a tangle since acreage is restricted, and grassland in India is one of the least protected habitats. The disgraceful concept in the country is ‘Grasslands are Waste lands’, plantations of exotic making most grassland species dwell outside the PA’s (Prashanth et al. 2016) [17]. Invasive Alien Species (IAS), also called exotics, foreign, non-indigenous or non-native are species introduced intentionally or unintentionally outside their natural habitats (Elton, 1958) [4]. Invasive aliens are regarded as the second greatest threat to global biodiversity (Genovesi et al. 2015) [9]. Invasive alien species causing the serious threat to Tiger reserve, where Prosopis juliflora, Lantana camara and Opuntia delinii were invaded in plains and hilly regions of tiger reserve respectively (Premkumar et al. 2018) [18]. In the late 1970s and early 1980s, anxious about deforestation, desertification and fuel wood shortages provoked a wave of projects that introduced Prosopis juliflora and other hardy tree species to new environments across the world (Mwangi et al. 2008) [15]. In India, species richness is estimated to reduce by 63% under Prosopis juliflora compared to open lands (Kaur et al. 2012) [9]. Prosopis juliflora, that was introduced and now could be wide unfold in semi-arid areas, has been noted to drive substantial losses of native vegetation in savannas and grasslands, thereby leading to the potential shrinking of blackbuck habitat. Confoundingly, blackbucks also are noted to eat mesquite seeds, and unwittingly aid in its dispersion through their dung pile ( Rathore, 2017) [20]. Sathyamangalam Tiger Reserve (STR), the largest Tiger reserve of Tamil Nadu. The topography of the reserve is highly variable with plains, slopes, hills, streams and rivers. It comprises a large chunk of rain shadow forest area. On the other hand it is bestowed with perennial sources of water, such as the Moyar River. It is predominantly a tropical dry forest, which includes dry thorn, dry mixed deciduous, semi evergreen, hill and riparian forest types (Mani et al. 2017) [13]. Prosopis juliflora have severely invaded into the ecosystem in many places of the Sathyamangalam Tiger Reserve especially in Bhavanisagar Range. This has reduced the native floral composition and fodder availability to herbivores during the pinch period.
Herbivores such as blackbuck, elephants and bird communities play a major role in dispersing the seeds of those alien invasive species. Suppression of grass and other native species would result in enormous economic and ecological impacts on biodiversity (Management Plan Sathyamangalam wild life sanctuary, 2011) [13]. This study has been conducted to know the impact of *Prosopis juliflora* on the habitat condition of blackbuck in Sathyamangalam Tiger Reserve.

**Materials and Methods**

**Study area**
The study area is situated with Nilgiris in the south, Sathyamangalam in the north, BhavaniSagar in east and Segur plateau in west. Geographically, the study site lies at 11° 50’ N latitude and 77°07’ E longitude to 11° 56’ N and 77° 02’ and at an altitude ranging from 352 to 412 MSL. It receives a mean annual rainfall of 850 mm and the mean minimum and mean maximum temperatures were 21°C and 28°C, respectively. Bhavani and Moyar are the two perennial rivers that run through the reserve area (Mani et al. 2017). The study was conducted at BhavaniSagar Range of Sathyamangalam Tiger Reserve, Tamil Nadu, during October 2018 to April 2019. Sathyamangalam Tiger Reserve is the largest protected area in the state of Tamil Nadu, extending over 1455.76 km² and the BhavaniSagar range consists of 241.92 km² of forest area. The study area accounts to 35.82 km². The Forest types found in the study area are viz., Southern tropical dry thorn forest (6 A C1), Southern Tropical dry mixed deciduous forest (5A/C3), Southern Sub-Tropical hill forest (8A/C1) Southern tropical semi evergreen forest (2A/C2), and Riparian forest along the Moyar River.

**Stratification of the study area**
The study area was stratified into three areas viz., A) *Prosopis juliflora* eradicated and effectively managed area (Site-I), B) Natural forest area - non-invaded area (Site-II), and C) *Prosopis juliflora* invaded area (Site-III).

**Study period**
The blackbuck population dynamics and its habitat conditions were monitored in transect and sample plots of study areas with different seasons viz., October 2018, January 2019 and April 2019.

**Methods**

**Line transect Method**

**Direct survey**
The basic line transect method as outlined by (Burnham et al. 1980) [14] was followed in the study area, six transect lines with 2 km length of each were laid out in accordance with three different sites. Each transect was walked between 7:00 am to 9:00 am. Observing the blackbuck on the transect line was noted using a range finder along with herd size. The age and sex of each individual were noted. The transect lines were monitored and observation was recorded in three different months viz., October 18, January 19, April 19. Using following formula analysis was done.

\[
\text{Density (ha}^{-1} \text{)} = \frac{\text{Total no. of individuals of a species in all transect lines}}{\text{Total area of the transect lines sampled}}
\]

**Indirect survey**
The indirect evidence were collected from the both six transect lines and 60 sample plots with in the size of 20 x 20 m base on the species effort curve of different sites of the study area of Sathyamangalam Tiger Reserve. Distinct pellet groups were counted. In the field, these come in myriad shapes, sizes, degree of scattering, age and decomposition. It was impossible to remove all ambiguity in what is to be counted as a separate pellet group or not and, in practice each observer forms his own mental image pellet groups which should be counted. There is generally less variation within the counts by the same observer. Hence it was preferred for obtaining data on trends that the same areas be repeatedly sampled by the same observer (Plumptre, 2002) [16]. The density of the animals was calculated with the data collected on the number of pellet groups and footprints. Following formula used to analysis indirect evidences.

\[
\text{Density (ha}^{-1} \text{)} = \frac{\text{Total no. of evidences of a species in all transect lines}}{\text{Total area of the transect lines sampled}}
\]

**Habitat analysis**

**Canopy density**
The canopy density was estimated by ocular estimation method. In the sample plots, the tree canopy was counted approximately based on spread of canopy and accordingly the canopy density was prepared in percentage.

**Cover density**

Density board is a convenient method to measured cover density in the field. The density board consists of a 1.80 m long wooden board, having a width of 5 cm, was divided into 6 equal parts of 30 cm each. The alternate panels can be coloured suitably and marked with numbers 1, 2, 3, 4, 5, and 6 in the ascending order from bottom. The board was kept at random, and the obscurity of vision was noted from the distance of 20 m, visible panel numbers were with a ‘+’ mark recorded and the obscure ones as ‘0’. The cover density was prepared in percentage (Devos et al. 1971) [3].

**Grass density**
The grass density was estimated by using 1sq.m bamboo frame method. Bamboo frames with size of one meter was randomly placed and within one meter, latter the density of grass species was recorded in percentage.

**Results and Discussion**

Conservation of blackbucks was closely associated with the conservation of their habitat. Surveyed recorded blackbuck sightings which shows a significant habitat preference in the Moyar valley. From the field observations in BhavaniSagar range, it was noticed that blackbuck prefer areas with open habitat, sufficient water availability and share their habitat with cattle. The land cover used was thorny scrub which dominated the landscape. Blackbuck prefers grasslands which provide visibility to outrun predators. They do not rely on their sense of smell or hearing, but their sight, which is highly, developed *Prosopis juliflora* being a highly invasive species which strongly influences blackbuck occupancy. The positive effect of *Acacia* species on blackbuck occupancy was expected as blackbucks are known to browse these species. It is known to provide browse and mast when grass quality is low in the summers (Rathore, 2017) [20]. They were avoided the sloppy areas there was no detection of blackbuck presence in the a priori analysis on such steep slopes.

With regard to density of blackbuck, the study results of direct observation revealed that the highest density was

---

*Journal of Entomology and Zoology Studies*
observed in site I (0.56 ha⁻¹), it was followed by site II (0.39 ha⁻¹), and the least density was recorded at site III (0.15 ha⁻¹) (Table 1) (Figure 1). Based on the indirect evidence highest density was observed in site I (0.37 ha⁻¹) it was followed by site III (0.29 ha⁻¹), and the least density was recorded at site II (0.22 ha⁻¹) (Table 2) (Figure 2). The basic habitat welfare factors like food, water and space was widely distributed all over the area in site I which has leads to high blackbuck density. The site-I Prosopis eradication paved way for more open habitat area and rejuvenation of some less indigenous fodder species that attracting more blackbuck density than the Prosopis juliflora invaded in site-III. Less blackbuck population was observed in site III, this might be due to their habitat has mostly been restricted and also presence of Prosopis juliflora causing reduction of herbaceous plants leading the reduction in fodder and suitable habitat availability. Similarly findings were also stated by Senait et al. (2007) [22], that invasion of Prosopis juliflora rangelands caused the shortage of grazing land for animals and reduction in open area. The thorns of Prosopis penetrating into the skin of animals cause more physical injury than local Acacia thorns.

In different seasons, the study result shows that maximum blackbuck density was observed in the October 2018 (0.37 ha⁻¹) it was followed by January 2019 (0.33 ha⁻¹), and the least density was observed in April 2019 (0.30 ha⁻¹). This might be due to availability of many habitat welfare factors, like food spectrum, water and cover during the monsoon season. A similar finding was also stated by the Debata (2017) [2], average herd size was higher during monsoon probably because of the fresh growth of grass. Correspondingly Meena et al. (2018) [14], reported that the herd size is generally smaller in summer as compared to monsoon or winter. The Spotted Deer also major herbivores in the study area, which used to consume the pods of Prosopis juliflora, which leads to the spreading of Prosopis juliflora through pellets. The invasion of Prosopis juliflora leads to the reduction in the regeneration of other herbaceous foliage for herbivore. A similar result was also observed by Hundessa et al. (2016) [7], that Prosopis juliflora encroached lands have reduced the native herbage yield.

The number of blackbuck individuals in the herd varied significantly. Based on the direct sightings, the female adults (FA) was found to be higher than male individuals in three sites irrespective of seasons. Regarding the sex ratio of blackbuck, average number of females for one male blackbuck was higher in site I (1: 9), whereas in site II (1:3), and it was followed by site III (1:1.66). The male individuals are very less than the female individuals. This might be due to that the lack of open habitat which hindered expression of lekking behaviour of blackbucks during the mating season (Table 1). Isvaran (2003) [8] reported that Operational Sex Ratio (OSR) may also be associated with lekking, Correspondingly Langehin et al. (1989) [11], stated that habitat structure may influence mating systems through its effect on social group size.

Habitat analysis
In habitat condition of the study area, regarding canopy density, the mean value of highest canopy density was observed in site-II (68.33 per cent), it was followed by site III (38.33 per cent), and the least density was recorded at site I (28.33 per cent) (Table 3) (Figure 3). In natural forest area (site-II) canopy was covered by predominant indigenous tree species. In site-III Prosopis juliflora and coexisted tree species has contributed towards canopy density and in the site-I area which was treated under mechanical clearing of Invasive plant Prosopis Juliflora, there was large canopy opening. In case of cover density, the mean value of highest cover density was recorded in site II (71.66 per cent), followed by site I (38.33 per cent), and the least cover density was recorded at site III (31.66 per cent) (Table 3) (Figure 3). In site II natural forest area, the cover density was high because of indigenous species in Southern sub-tropical hill forest. In the site-III highest invasion of Prosopis juliflora caused less cover due to the effect on shrubs, cover and, in site-I, the clearing of Prosopis juliflora caused less cover density. Correspondingly Shetty (2014) [23] reported that due to the highest density of alien species like Prosopis juliflora, Lantana camara and Eupatorium adenophorum the cover density of Tiger Reserve was in a decreasing manner. Similarly, it was stated by Humaid et al. (1998) [6] that Prosopis juliflora plants possess allelochemical that inhibit the germination, growth and survival of other plant species whereas its seedlings growth was greater underneath and reduced the cover and grass density in Prosopis juliflora invaded area.

With respect to the grass density of study area, the mean value of highest grass density was observed in site II (60.00 per cent), it was followed by site I (43.33 per cent), and the least recorded by site III (21.66 per cent) (Table 3) (Figure 3). In the natural forest of site-II there was an absence of anthropogenic pressure and invasive plant and has led to the highest grass density. In site-I, the eradication of Prosopis juliflora was appearing to give positive impact towards grass density and in site-III; the Prosopis juliflora was influencing the low grass density. Ranjith (2018) [19] reported that the Prosopis juliflora plants possess allelochemical that inhibit the germination, growth and survival of other plant species whereas its seedlings growth was greater underneath and reduced the cover and grass density.

With respect to the habitat condition of blackbuck, it was observed that the site I – Prosopis eradicated area has paved way for more canopy opening leads for more grass growth. The moderate cover and grass density has ensured the good habitat condition for open land species- blackbuck.

<table>
<thead>
<tr>
<th>Site</th>
<th>Month</th>
<th>MA</th>
<th>MSA</th>
<th>FA</th>
<th>FSA</th>
<th>FW</th>
<th>Total</th>
<th>Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>SITE I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oct-18</td>
<td>2</td>
<td>1</td>
<td>19</td>
<td>0</td>
<td>2</td>
<td>24</td>
<td>0.6</td>
<td></td>
</tr>
<tr>
<td>Jan-19</td>
<td>1</td>
<td>0</td>
<td>21</td>
<td>0</td>
<td>2</td>
<td>24</td>
<td>0.6</td>
<td></td>
</tr>
<tr>
<td>Apr-19</td>
<td>3</td>
<td>0</td>
<td>15</td>
<td>0</td>
<td>1</td>
<td>19</td>
<td>0.48</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>2</td>
<td>0.33</td>
<td>18.33</td>
<td>0</td>
<td>1.66</td>
<td>0.56</td>
<td>0.56</td>
<td></td>
</tr>
</tbody>
</table>

| SITE II |       |      |      |     |      |     |       |          |
| Oct-18  | 3     | 2    | 9    | 0   | 3    | 17  | 0.43  |          |
| Jan-19  | 4     | 0    | 8    | 2   | 1    | 15  | 0.38  |          |
| Apr-19  | 3     | 0    | 10   | 0   | 1    | 14  | 0.35  |          |
Table 2: Season and Site wise variation in Blackbuck individuals in STR through indirect observation

<table>
<thead>
<tr>
<th>Sites</th>
<th>Month</th>
<th>Density</th>
<th>Density</th>
<th>Density</th>
<th>Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>SITE I</td>
<td>Oct-18</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Jan-19</td>
<td>3</td>
<td>0</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Apr-19</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Mean</td>
<td>2</td>
<td>0.33</td>
<td>3.33</td>
<td>0</td>
<td>0.33</td>
</tr>
</tbody>
</table>

(MA- Male adult, MSA- Male sub-adult, FA- Female adult, FSA- Female sub-adult, FW- Fawn)

Table 3: Seasonal variation of Habitat condition of Blackbuck in STR

<table>
<thead>
<tr>
<th>Sites</th>
<th>Month</th>
<th>Canopy Density (%)</th>
<th>Cover Density (%)</th>
<th>Grass Density (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site-I</td>
<td>October</td>
<td>30</td>
<td>40</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>January</td>
<td>30</td>
<td>45</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>October</td>
<td>70</td>
<td>75</td>
<td>70</td>
</tr>
<tr>
<td>Site-II</td>
<td>January</td>
<td>70</td>
<td>75</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>April</td>
<td>65</td>
<td>65</td>
<td>50</td>
</tr>
<tr>
<td>Site-III</td>
<td>October</td>
<td>40</td>
<td>35</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>January</td>
<td>40</td>
<td>30</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>April</td>
<td>35</td>
<td>30</td>
<td>20</td>
</tr>
</tbody>
</table>

Fig 1: Seasonal and Site wise density variation of Blackbuck in STR through direct observation

Fig 2: Seasonal and Site wise variation in Blackbuck density through indirect observation.
Conclusion
An effort was made to study the impact of Prosopis juliflora eradication and effective management for improvement of a blackbuck habitat and indigenous floral species which shows positive impacts towards high density population of blackbuck in the Sathyamangalam Tiger reserve. Hence there was an improvement towards shrub and herbaceous layer composition in the Prosopis juliflora eradicated area showing positive trend than Prosopis juliflora invaded area. Since the area supports the enormous number of the herbivorous population of blackbuck with spotted deer. Regarding the sex ratio of blackbuck, the male individuals are very less than the female individuals. This might be due to that the lack of open habitat which hindered expression of lekking behaviour of blackbucks during the mating season. The habitat condition of blackbuck, the site I – Prosopis eradicated area has paved way for more canopy opening leads for more grass growth. The moderate cover and grass density has ensured the good habitat condition for open land species blackbuck. Cattle from villages occupying the habitat of blackbuck and they are the main zoophily agents for Prosopis juliflora seeds. If this situation continues for few decades, the tiger reserve will be under great threat by invasive alien species. So in future more advanced ecological studies are needed to conclude this complex situation. There was immediate need of standard framework and strong modern controlling strategies (mechanical eradication, prescribed burning and chemical control) to tackle the Prosopis juliflora invasion towards biodiversity of Tiger Reserve. The Sathyamangalam Tiger Foundation has initiated the eco-development committees, with involvement community participation. Community-based Prosopis juliflora eradication in Tiger reserve will be the sustainable management strategies to ensure the ecological balance and livelihood enhancement of the local tribal community. This study will help to conclude that eradication of Prosopis juliflora has a positive impact towards biodiversity and will serve as baseline data base pertaining to the management of invasive habitats by suitable management plans in Sathyamangalam Tiger Reserve.

Acknowledgment
We thank to the Tamil Nadu Forest Department for granting permission to conduct this study at the Sathyamangalam Tiger Reserve. We acknowledge the valuable support of Dr. V. Naganathan, IFS. Field Director, Sathyamangalam Tiger Reserve. We also thank the field assistants and other forest staff of Sathyamangalam for their help and cooperation.

References
13. Mani S, Jayakumar S. A contemporary assessment of tree


