Exploration of Invasive Alien Plant Species on Habitat of Rhino in Icharni, Chitwan National Park, Nepal

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Abstract

The study was conducted with main purpose to assess the floral diversity and explore invasive species on rhinoceros habitat in two different research sites with in Chitwan National Park. The rhino is placed in the list of endangered species by International Union for Conservation of Nature and highly threatened due to loss their habitat by rapidly increasing invasive species. The study was done for a period of one month in (September to October) 2020. The 10 m, 5 m, and 1 m radius circular quadrates were utilized to gather data on trees, shrubs, and herbs, respectively. A total of 25 plant species were recorded from 15 plots. The importance values of each species of trees were analyzed. Seven species of invasive types were recoded from 15 plots (10 plots from riverine forest and 5 plots from grassland). Mikania micrantha was most dominant species with IVI 103.02 followed by Pogostemon benghalensis with IVI 78.93 and Chromolaena odorata with IVI 34.57 as the second and third most dominant invasive species respectively. The conclusion is that invasive species have an impact on the grassland and riverine forest, which are needed by the mega herbivore. The management of rhino habitat and the preservation of the rhino population are seriously threatened.

Keywords

Forest, grassland, IVI, riverine, shrub.

1 Introduction

Chitwan National Park (CNP) is situated in south-central Nepal, with an area of 952.63 sq. km It is expanded in the subtropical lowlands of the inner Terai from elevation range of 110 to 850 masl. The park vegetation provide excellent habitat for the mega-herbivores (rhino and elephant), big cats (tiger and leopard) and several species of ungulates [1]. The park is the home to more than 120 species of fishes, 49 species of reptiles and amphibians, 486 species of birds, and over 40 species of mammals. The park is drained by Rapti, Reu and Narayani rivers [2].

Invasive plant species that have colonized natural areas and dominate the local vegetation are referred to as invasive plant species. It has been demonstrated that invasive plants have a negative impact on native biodiversity and ecosystem processes in a variety of ways [3]. In CNP there are two main problematic invasive plant species, they are Mikania in the wet areas and Chromolaena in the dry zones. About 50% of potential rhino areas are now affected by the principal invasive species with primary rhino habitats [4]. Rhino population is estimated at 645 individuals in Nepal. In CNP the population of rhino is 605 [1]. It is mega-herbivorous animal which play important role in environment to maintain ecological balance [5]. The rhinoceros is listed as a protected animal by National Parks and Wildlife Conservation Act (1973) and is also listed in CITES Appendix-I since 1975 [1]. Rhinos are highly threatened due to loss their habitat by rapidly increasing invasive species [6] wildlife disease [7], poaching, climate change, infrastructure development, fragmentation and degradation [1] in their area.

It is also found that some invasive species were consumed by Rhinoceros as stuff food mixed with grasses and still the details of vegetation on the habitat of rhino and analysis of existence of invasive plant species are not studied till the date. There was not exploratory research and vegetation analysis in Icharni, a selected habitat of rhino till now. After analysis literatures we found the study of invasive species with the statistical analysis has not studied yet. The present study aims to explore the existence of invasive alien species with their inter specific statistical analysis in Icharni. This research work may be useful to prioritize area for control invasive species in CNP and it gives background for further research belonging to it.

2 Materials and Methods

2.1 Study Area

The study area is Chitwan National Park, the first national park in Napal. Founded in 1973. It was declared a World Heritage Site by UNESCO in 1984 [8]. It covers an area of 952.63 square kilometers and is located in the subtropical inland Terai lowlands of central-south Nepal in the Nawalpur, Parsa, Chitwan and Makwanpur districts. Its coordinates are $(27^0 \ 16.56" - 27^0 \ 42.14"$ N and $83^0 \ 50.23" - 84^0)$ $46.25"$ E). The elevation varies from 100 m in the river valley to 815 m in the churia hills. The park is dominated by forest ($> 80\%$) and includes much of monkey (Sorea robusta) forest, followed by mixed riverine forest and broadleaf forest. Productive alluvial pastures near adjacent rivers cover 9.6% of the park, 5% of the exposed land surface, and 3% of the water body [9].

The park has a monsoon-dominated subtropical climate, characterized by an average monthly maximum temperature of $24C-38^0C$, a monthly minimum temperature of 11^0C-26^0C, annual rainfall of 2250 mm and relative humidity 89–98% from 2000 to 2010 [10]. Icharni is the park's most prominent biomass space zone, and its surroundings make for optimal tracking areas.
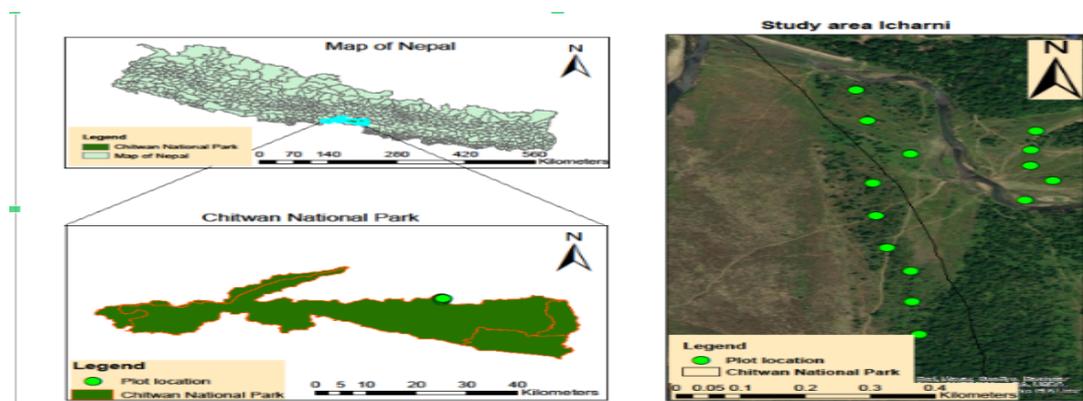

Figure 1: Study area Icharni, CNP.

2.2 Methods

2.2.1 Sampling Design

The whole study area was divided in to two sites-riverine forest and grassland. In field survey circular plot were used in riverine forest and grassland [11]. Circular plots were taken 100 m distance to each other with help of GPS. For tree species 10 m radius, shrubs species 5m radius and herbs species 1m radius were used. 10 circular plots were taken from riverine forest and 5 circular plots taken from grassland in Icherni area of Chitwan National Park.

2.2.2 Data Collection

For data collection of tree species local name, scientific name, DBH and height were collected. For data collection of shrub species local name, scientific name, number and crown cover were studied. And, for herbs species local name, scientific name and coverage were collected. The plant species were identified according to reference [12] and invasive species according to reference [13]. Some of the spontaneously unrecognized plant species were snapped, hand-picked and collected and later identified with the help of locals and experts. The unidentified plants were taken to Department of Botany, Degree Campus, Biratnagar for identification.

2.2.3 Data Analysis

Vegetation analysis and calculations were performed using MS Excel software according to the method proposed by reference [14] and his formula was used for vegetation analysis. Using vegetation data collected from the field, we calculated species richness, density, relative density, abundance and relative abundance of trees, shrubs, herbs and grasses using the following relationships.

Density of species A = Total No. of individuals of species A / Total No. of individuals Area plot.
Relative density of Species A = Total No. of individual of species A / Total number of individual of all species.
Frequency of Species A = (Number of plots in which species A occurs 100) / Total number of plot samples.
Relative frequency of Species A = (Frequency value of species A 100) / total frequency value of all species.

Relative dominance of Species A = Total basal area of specie A 100) / Total basal area of all species.
Importance Value Index (IVI) for herbaceous and grass species is sum of Relative Density (RD), Relative Frequency (RF) and Relative Coverage (RC)
IVI = RD + RF + RC
Importance Value Index (IVI) for Shrub species is sum of Relative Density (RD), Relative Frequency (RF) and Relative Crown Cover
IVI = RD + RF + Relative Crown Cover
Importance Value Index (IVI) for Tree species is sum of Relative Density (RD), Relative Frequency (RF) and Relative Basal Area
IVI = RD + RF + Relative Basal Area
Importance Value Index (IVI) for Invasive species is sum of Relative Density (RD), Relative Frequency (RF) and Relative Coverage (RC)
IVI = RD + RF + RC

2.2.4 Statistical Analysis

Calculation and statistical data were analyzed and bar diagram were constructed in Microsoft Excel 2010.

3 Results

3.1 IVI of Herbaceous and Grass Species in Riverine Forest

A total of 8 species of herbaceous and grasses were recorded out of which dominant species in riverine forest Banmara (*Mikania micrantha*) with IVI of 110.51 was followed by Unew (*Pteris vittata*) with IVI of 50.92 and Seto Banmara (*Chromolaena odorata*) with IVI of 36.06 as the second and third most dominant species respectively. The relative coverage of Banmara (*Mikania micrantha*), Unew (*Pteris vittata*) and Seto Banmara (*Chromolaena odorata)* were 43.09%, 13.29% and 12.62% respectively.

3.2 IVI of Herbaceous and Grass Species in Grass Land

All total 6 species of herbaceous and grass were recorded out of which dominant species recorded in grass land Siru (*Imperata cylindrica*) with IVI of 176.83 followed by Mothe (*Cyperus rotundus*) with IVI of 39.74 and Lazzawote (*Mimosa pudica*) with IVI of 39.25 as the second and third most dominant species respectively. The relative coverage of Siru, Mothe and Lazzawote were 73.71%, 39.74% and 7.86% respectively.
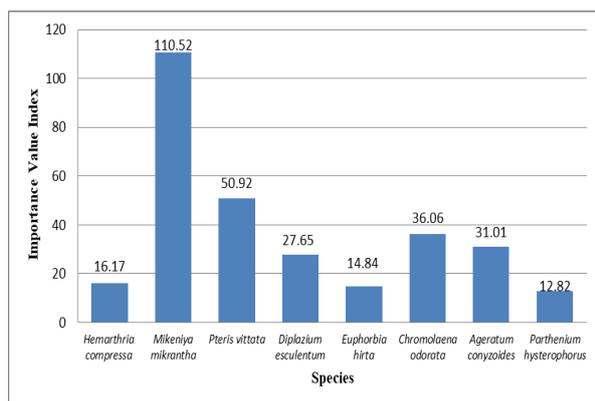
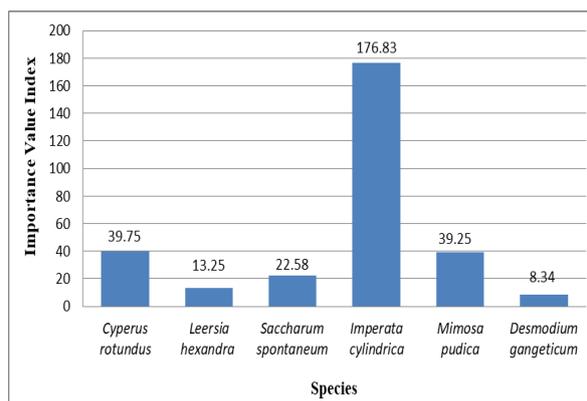Figure 2: IVI of Herbaceous and Grass Species.

Figure 3: IVI of Herbaceous and Grass Species.

3.3 IVI of Shrubs in Riverine Forest

All total 7 species of shrubs species were recorded out of which the dominant grass species recorded in the riverine forest was Rudilo (*Pogostemon benghalensis*) with IVI of 108.86 followed by Dhursil (*Colebrooken oppositifolia*) with IVI of 52.72 and Daikamala (*Collicarpa macrophylla*) with IVI of 50.62 as the second and third most dominant species respectively.

The relative density of Rudilo, Dhursil and Daikamala were 45.05%, 14.28% and 17.58% respectively and the relative coverage were 41.22%, 15.85% and 16.91% respectively
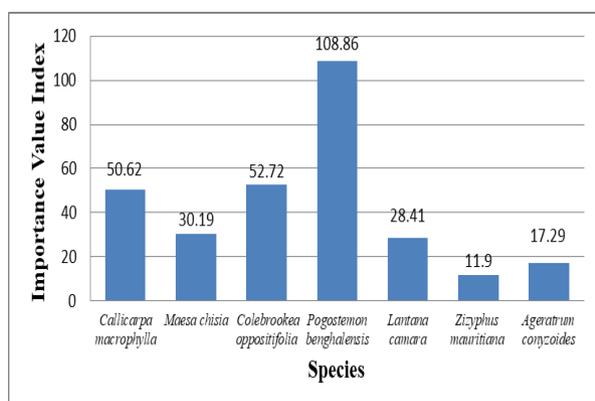
3.4 IVI of Tree Species in Riverine Forest

Totally 3 species of tree species were recorded out of which the dominant tree species in the riverine forest was Bhellor (*Trewia nudiflora*) with IVI of 248.42 followed by Kutmero (*Litsea monopetala*) with IVI of 36.58 and Dhatrung (*Ehretia laevis*) with IVI of 14.98 as the second and third most dominant species respectively. The relative density of Bhellor, Kutmero and Dhatrung were 88.09%, 9.52% and 2.38% respectively and the relative basal area were 97.83%, 2.06% and 0.10% respectively.
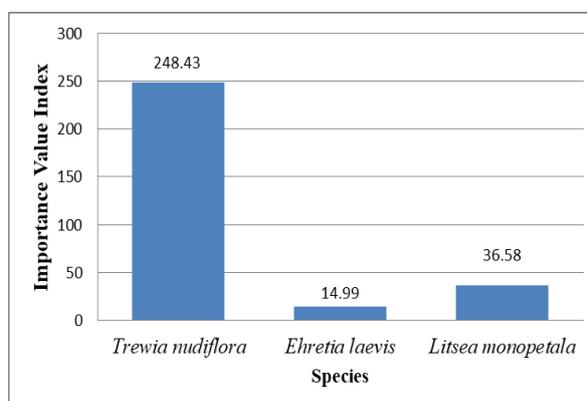

Figure 4: IVI of Shrubs Species in Riverine forest.

Figure 5: VI of Tree Species in Riverine forest.

3.5 IVI of Invasive Species in Riverine Forest and Grassland

All total 7 species of invasive species were recoded from 15 plots which is 10 plots from riverine forest and 5 plots from grassland. Out of the dominant invasive species recorded in the study area was *Mikania micrantha* with IVI of 103.02 followed by *Pogostemon benghalensis* with IVI of 78.93

and *Chromolaena odorata* with IVI 34.57 as the second and third most dominant invasive species respectively. The relative frequency of *Mikania micrantha*, *Pogostemon benghalensis* and Chromolaena odorata were found to be 29.03%, 22.58% and 12.90% respectively and the relative coverage were found to be 36.99%, 28.17% and 10.83% respectively.
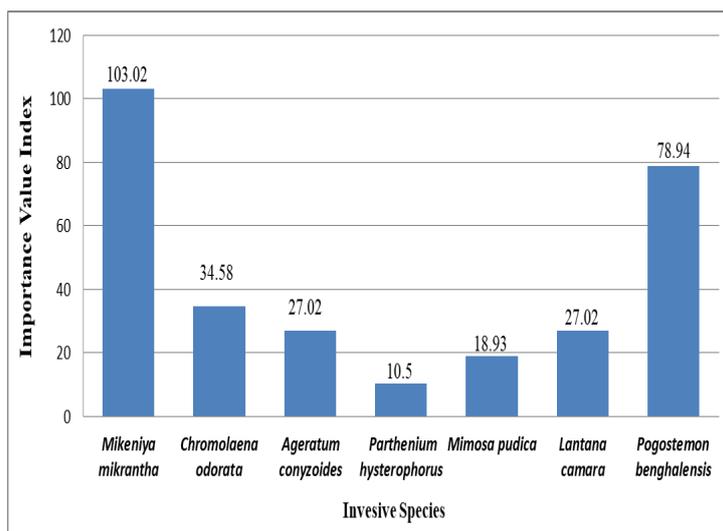
Figure 6: IVI of Invasive species in Riverine forest and Grassland.

4   Disscussion

Previous studies have found riverine habitats, grasslands and woodlands to be heavily infested with the weed *Mikania micrantha*. 146 plant species were recorded from 93 plots in CNP. In Icharni island Triwia nudiflora with IVI of 47.35 were found most dominant followed by *Bombax ceiba* with IVI of 29.95 and *Dalbergia sisso* with IVI of 10.87 [15]. *Trewia nudiflora* with IVI of 110.534 had a higher or major controlling influence by its number and its size in the tree canopy layer, followed by *Albizia julibrissin* with IVI of 103.059 then by *Dysoxylum binectariferum* with IVI of 33.853 then by *Caesalpinia decapetala* with IVI of 19.538 then by *Antidesma acuminatum* with IVI of 16.508 and by *Psidium guajava* with IVI of 16.508 respectively [16].

Present study found that the riverine forest and grassland were also highly invaded by the *Mikania micrantha*. Total 25 plant species were recorded from 15 plots which were 10 plots from riverine forest and 5 plots from grassland. The highest tree species were found T*rewia nudiflora* with IVI of 248.42 followed by Litsea monopetala with IVI of 36.58 and *Ehretia laevis* with IVI of 14.98 in riverine forest. Present study found that total 7 species of invasive species were recoded from 15 plots which are 10 plots from riverine forest and 5 plots from grassland.

Lahkar and other researchers found that the greatest threat from invasive species lies in grassland habitats, which directly reduce flora suitable for rhinos and other herbivores [4]. Dominant invasive species recorded in the study area were *Mikania micrantha* with IVI of 103.02. Murphy and other researchers found that *Mikania micrantha* is now found in 44% of his sampled habitats, with high infestation rates (50% coverage) in nearly 15% of these [17]. Highest densities were recorded in riverine forests, tall grasses and wetlands [18]. Species richness showed unimodel response to the Mikania cover percent with the decrease after 35% of Mikania cover. Present study found that total 8 species of herbaceous and grasses were recorded out of which dominant species in riverine forest *Mikenia micrantha* with IVI of 110.51 were followed by Pteris vittata with IVI of 50.92 and *Chromolaena odorata* with IVI of 36.06 as the second and third most dominant species respectively. Total 6 species of herbaceous and grass were recorded out of which dominant species recorded in grass land *Imperata cylindrica* with IVI of 176.83 followed by *Cyperus rotundus* with IVI of 39.74 and *Mimosa pudica* with IVI of 39.25 as the second and third most dominant species respectively. One research work found that in the grassland habitat type, Chepte Jhar species with PV of 105.399 were found to be the most prominent species, followed by *Cynodon dactylon* with PV of 75.434 [16].

5   Conclusion

Among two research sites of Icharni island (Riverine forest and Grassland), in riverine forest herbaceous and grass species *Mikania micrantha* was dominant with IVI of 110.51 which was followed by *Pteris vittata* with IVI of 50.92. The third dominant was *Chromolaena odorata* with IVI of 36.06. In the riverine forest the dominant shrub species were *Pogostemon benghalens* is with IVI of 108.86 followed by *Colebrooken oppositifolia* with IVI of 52.72 and *Collicarpa macrophylla* with IVI of 50.62 as the first, second and third dominant species respectively. Tree species were Trewia nudiflora with IVI

of 248.42 followed by *Litsea monopetala* with IVI of 36.58 and *Ehretia laevis* with IVI of 14.98 as most dominant three species respectively found. In grassland *Imperata cylindrica* with IVI of 176.83 was the first dominant which was followed by Cyperus rotundus with IVI of 39.74 and *Mimosa pudica* with IVI of 39.25 as the third most dominant species respectively found.

Totally seven invasive species were found in the study area. Among them the most dominant invasive species was *Mikania micrantha* with IVI of 103.02 followed by Pogostemon benghalensis with IVI of 78.93 and *Chromolaena odorata* with IVI 34.57 as third most dominant invasive species respectively. Riverine forest and grassland with sparse trees, shrubs, herbs and grass were being degraded due to high invasion of the invasive species. The nature of the invasion of invasive species in this primary habitat indicated a serious threat to rhino habitats and management. Finally, it is concluded that the megaherbivore is also dependent on grasslands and riparian forests, and these are affected by invasive species. This is a serious threat for the management and protection of rhinoceros habitats.

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Authors' contribution

Concept and planning of research: Ram Chandra Adhikari, Field study and data collection: Birendra Bahadur Bist, Data analysis, interpretation, writing and finalizing the article: Birendra Bahadur Bist and Ram Chandra Adhikari

Conflict of interest

The authors declare there was not conflict of interest.

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