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## *Editorial*

*Journal of Nepal Science Olympiad has been started to provide a platform for publishing innovative, original, and high quality research articles dealing with both theoretical and applied aspects of academic endeavor broadly classified as science and technology. Nepal Science Olympiad (NeSO) defines that science and technology is for peace, prosperity and posterity. With this publication, NeSO wants to encourage works of national and international researchers and promote the discovery, innovation, advancement and dissemination of basic and transitional knowledge in science, technology and related disciplines.*

*The book now in your hand is the first issue of the Journal of Nepal Science Olympiad. The journal is scheduled to be published in quarterly basis. The contents of the publication is supposed to be helpful for wider public of researchers, planners, academicians, students, and all concerned individuals. The present issue consists of five research articles and one review article covering the broad science subjects: Chemistry, Zoology and Botany. The specific fields of the issue include Phytochemistry, Pharmacology, Conservation Biology, Anatomy, Ethnobiology and Biotechnology.*

*The views, opinions, and assumptions expressed in the articles are solely those of the authors and do not necessarily reflect the official policy, strategy or position of NeSO. Any questions regarding the contents of the article should be directed to the author(s).*

*We express our sincere gratitude to all those who have contributed in this issue. We pledge to timely optimize the quality and standard of our publication. The editorial board is fully liable for any shortcomings incurred in this issue. Valuable suggestions from our esteemed readers are always awaited and for which we are committed to improve our future issues.*

# CHALLENGES OF RHINO CONSERVATION IN CHITWAN NATIONAL PARK: A REVIEW

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**Abstract:** *Rhinoceros unicornis*, one horned rhino is one of the magnificent mammals of Chitwan National Park (CNP). Because of the habitat degradation, illegal hunting and poaching, the animal is under brink of extinction. These days, the invasive plant species, *Mikania micrantha* (Banmara) has also been one of the major factors for destroying the natural habitat of the rhino besides, human encroachment and other developmental activities. The local people along with the national and international stakeholders need to be concerned in protecting the animal because the animal is of international significances, as it is the source of attraction for many tourists worldwide.

## Introduction

Five species of rhinoceros survive globally and three of the species are found in Asia - Greater one horned rhinoceros (*Rhinoceros unicornis*), Sumatran rhinoceros (*Dicerorhinus sumatrensis*) and Javan rhinoceros (*Rhinoceros sondaicus*). The remaining two rhinoceros are found in Africa-White rhinoceros (*Ceratotherium simum*) and Black rhinoceros (*Diceros bicornis*).

The greater one horned-rhinoceros (*Rhinoceros unicornis*), also called as Indian rhinoceros has been listed as a vulnerable species on IUCN Red List of Threatened species (IUCN, 2008) and is listed in Appendix I of the Convention on International Trade in Endangered species of Wild Fauna and Flora (CITES)(NTNC, 2014/<http://ntnc.org.np/publications>). *Rhinoceros unicornis*, one horned rhino, has huge body but it can run at the speed of 55 km per hour and possess innate swimming features. The animal has a poor vision but their auditory and olfactory sense is high. The Indian rhinoceros has one horn and is found in both male and female. They are solitary by nature. The animal prefers tropical and subtropical grasslands, Savannas and Shrub lands (<http://www.worldwildlife.org/>). The food of Rhinoceroses includes *Saccharum bengalensis*, *Narenga porphyrocoma*, *Imperata cylindrical*, *chrysopogon aciculatus*, *Eragrostis* (Acevedo,2005) but the most nutritious food for them is *Saccharum sponataneuem* (Dinerstein, 2003). Primarily, they are found in few protected areas of India and Nepal though they were found formerly in the Gangetic plains. There are more than 3,000 rhinos; India (Assam) only possesses about 2,544 rhinos according to the census 2014(<http://www.pmi.org.in/manageindia>) and in case of Nepal, according to 2015 census (CNP, Kasara), it is about 645 individuals and 605 individuals resides only in Chitwan National Park. The rhinoceros has been a huge concern throughout the world today because the overexploitation of an animal for illegal trade of its body parts has led the animal prone to extinction.

**Chitwan National Park (CNP)**

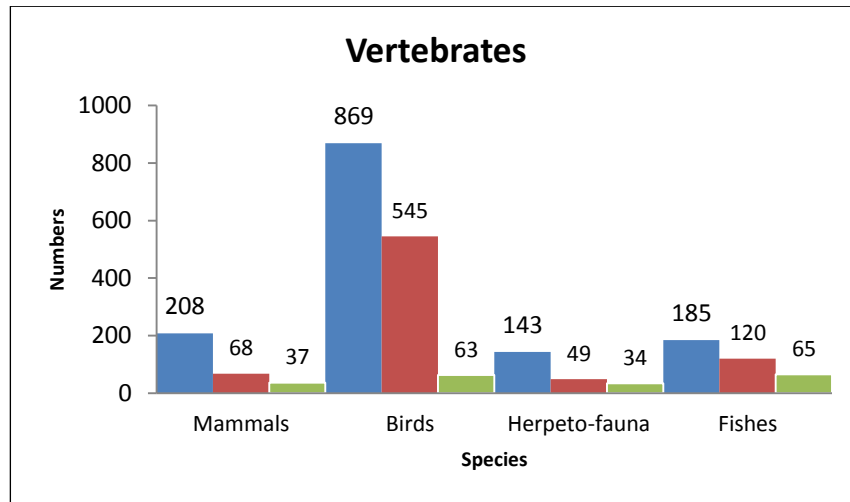


**Fig. 1** Map of Chitwan National Park (CNP) (Source: nepal.de-keizer.net)

Chitwan National Park (CNP) was formerly recognized as Royal Chitwan National Park. It lies in the inner terai region of Chitwan, Makwanpur, Nawalparasi and Parsa districts of Nepal. It is located between 83° 87' to 84° 74' East longitudes and 27°34' to 27°68' North latitude in the southern part of Chitwan district. The altitude ranges from 110 m to 850m above the sea level. Chitwan National Park is in a tropical and subtropical bioclimatic zone. The mean annual rainfall is about 2000-2100 mm. The maximum temperature is 35°C during summer and it falls around 20°C during night time. Similarly, in winter the maximum temperature is around 25°C and falls below 10°C in night time. Initially, the area of CNP covered 544 sq km. In 1996, 750 sq km was separated as a buffer zone (DNPWC, 1997), 55% as an agricultural land and 45% as a community forest (DNPWC and PPP, 2000). The Buffer zone is situated between longitudes 83° 50' 44" – 84° 44' 58"E and latitudes 27° 16' 56" – 27° 42' 13"N. The Park now covers a total area of 932 sq km and is surrounded by Parsa wildlife reserve in the east and India in the southeast. Balmiki tiger sanctuary and Udaipur sanctuary lies across the border of India. The park has magnificent fauna and flora. The faunal diversity comprises 68 species of mammals, 544 species of birds, 56 species of herpeto-fauna, and 126 species of fishes (CNP, 2012). While, the floral diversity comprises 600 plant species that includes 3 gymnosperms, 13 pteridophytes, 415 dicotyledons, 137 monocots, 16 species of orchids (Subedi, 2010). CNP is rich in many endangered and vulnerable animal species. The Chitwan National Park (CNP) has the world's second largest population of one-horned rhinoceros (*Rhinoceros unicornis*) along with large population of tigers (*Panthera tigris*). Other animals found in the park are leopards (*Panthera pardus*), gaur bison (*Bos gaurus*), sloth bear (*Melursus ursinus*), wild Asian elephant (*Elephas maximus*), marsh mugger crocodile (*Crocodylus palustris*), gharial (*Gavialis gangeticus*) and the Gangetic dolphin (*Platanista gangetica*) (BES, 1998). CNP has been well-known globally because of its unique and diversified ecosystems, thus has international significances. The eight types of ecosystem constituting seven forest types, six grassland types, five wetland and three main river system habitats has been an additional advantage (DNPWC, 2008). Moreover, its listing as a world heritage site by United Nations Educational, Scientific and Cultural Organization (UNESCO) in 1984 has been more advantageous.

**Table 1.** Vertebrate Diversity (Source: CNP, Kasara)

Taxa	Nepal	Chitwan	Percentage
Mammals	208	68	37
Birds	869	545	63
Herpeto-fauna	143	49	34
Fishes	185	120	65



**Fig. 2** Vertebrates' diversity

Out of 208 mammalian species, found in Nepal, 68 species of mammals are reported from CNP, Out of 869 birds species, 545 bird species are reported from CNP, Out of 143 species of herpeto-fauna, 49 species are reported from CNP and 120 species of fishes out of 185 fishes species have been reported from CNP. These data shows that Chitwan National Park is rich in vertebrates.

**Rhino population trend in Nepal**

More than 800 rhinos survived in Nepal until 1950s but in mid 1960s, the number of rhinos dropped below 100. The main reason for the fall in number was the agricultural expansion and poaching of an animal. The government of Nepal then established the first national park in Nepal in the year 1973 which formerly was named as Royal Chitwan National Park (RCNP) and now the name has been transformed to Chitwan National Park (CNP). After the establishment of national park, the local people was displaced from the area to extend the Park and armed forces were mobilized as a result the number of rhinos increased to 612 in 2000 which again dropped to 409 in 2005. In the year, 2008, again their number rose to 435 which subsequently increased to 534 in the year 2011 and currently according to the census 2015, the number of rhino in Nepal has reached to 645 which basically explain the progress in management of the animal's habitat along with the protection of animal. This has been determined to be the milestone in the wildlife management basically incase of magnificent animal, one horned Rhino.

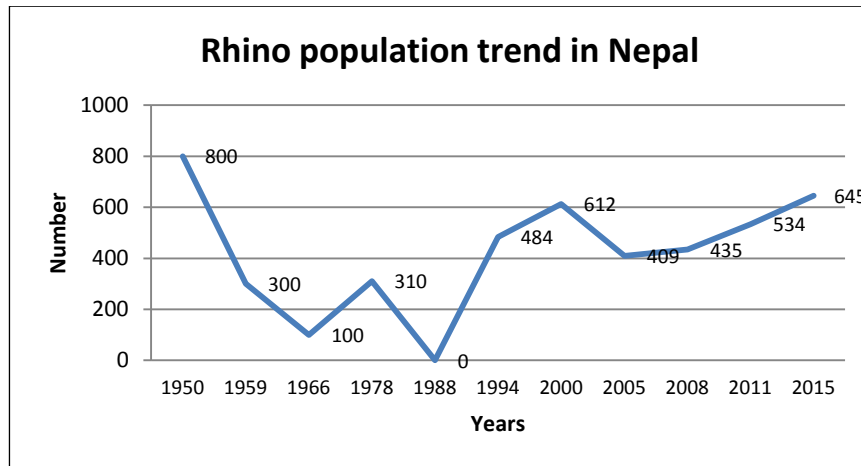


Fig. 3 Rhino population trend in Nepal (Source: CNP, Kasara)

### Rhino Population trend in Chitwan National Park (CNP)

The recorded data on rhino population trend in CNP shows that the number of rhinos in the year 1988 was 358 which increased gradually to 446 in 1994 and 544 in the year 2000. Again because of habitat degradation and poaching pressure the number of rhino was decreased to 372 in the year 2005. This decrease in rhino population became a huge concern to the National and International level and certain policies were changed in favor of wildlife management. This showed a positive outcome because the number of rhinos gradually rose up. In the year 2008, the population of rhino was 408 which increased to 503 in the year 2011. The latest census record shows the number of rhino has reached to 605 out of 645, only in Chitwan National Park which shows a huge success in the path of Conservation of this magnificent animal, rhino.

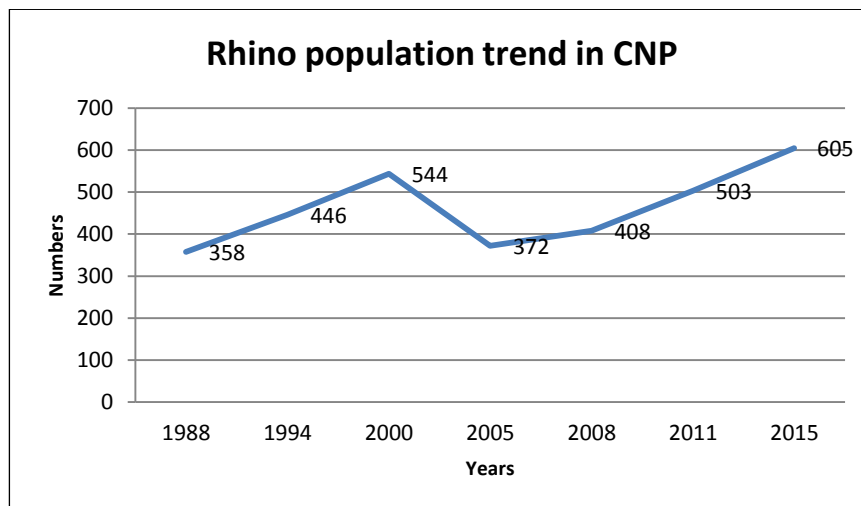


Fig. 4 Rhino Population trend in CNP (Source: CNP, Kasara)

Rhinoceroses are one of the major attractions of Chitwan National Park (CNP) and numerous national as well as international tourist visits to the National Park every year. Chitwan National Park (CNP) holds the second largest global population of wild greater one horned rhino in South Asia (Talukdar, 2014). During 15<sup>th</sup> century, rhinos were large in number and were found between Indo-Burmese border in the east and Pakistan in the west

(Dinerstein, 2003). In the case of Nepal, during 1960s, population of rhinos dropped below 100 and the major reason for this decline in their number was because of poaching and habitat fragmentation. After the declaration of Chitwan as a malaria free zone, population of human increased leading to habitat degradation (Laurie, 1978). Until 1950s, about 1000 rhinos were found in Chitwan valley (Dinerstein, 2003). In 1954, about 72 rhinos and in 1958, about 60 were poached (Gee, 1959). By late 1960s, the population of rhino dropped to less than 100. The declaration of national park in the year 1973 was able to recover the number of rhinos to 612 because of its implementation of the strict policies (DNPWC, 2000). Out of that, 544 were in CNP, 67 in Bardia National Park and 1 in Shuklapanta wildlife reserve. However, the population of rhino again decreased to 372 (Thapa et al. 2013) in CNP during the year (1996-2005) the period of armed conflict. The decline was about 32% from 2000. Later, 2002 was declared as the worst year because poaching has escalated. The record showed that the poaching was done for horn. The report of 2003 showed that among 19 poached rhinos, 16 rhinos were without horn and 3 without hooves. Subsequently in 2004, 9 rhinos were without horn and 2 had no hooves and in the year 2005, 12 out of 15 rhinos poached were without horns and one of them without tail (DNPWC, unpublished report). The unstable politics and insecurity was said to be responsible for the escalation of poaching (Martin & Martin, 2006). Poaching has major negative effect on rhino numbers (Rothley et al., 2004). The year 2001/2002 and 2002/2003 as compared to other years had high rate of poaching in case of rhino. The report during the war period showed that more than 37 rhinos were killed in Nepal in single year that is during the 10 years of the war, more than 141 rhinos were killed (Source: DNPWC). But, after signing Comprehensive Peace Agreement (CPA), only 23 rhinos were found killed which showed reduced poaching rate. In 2008, 7 rhinos were poached in and around CNP, 6 within the park and 1 outside; all had been found shot. In 2009, 10 rhinos were shot dead, 7 inside the park and 3 in the Buffer Zone (Martin and Martin, 2010). In 2010, 9 individuals were poached, 8 inside the park. The police were however able to arrest the poachers in February 2011 who had killed 7 of the rhinos in 2010 and they were all from the same family, according to press reports. On 3 April, 2012, again, one rhino was poached which was an adult female found shot on the western side at Sailimaili Khola, inside the park. An average of 10 rhinos were found poached a year in Nepal between 2008 to 2010, however, in 2011 and 2012, the number dropped to only 1 a year. Some effective rhino-protection strategies must have been the reason. The one reason might be the increase to 51 posts in CNP because there were only 32 posts in late 2009. Recently, the year 2014 was declared as the Zero poaching year because not a single rhino was found hunted/poached. The Park has released the data explaining that no rhinos were killed in the last 365 days beginning from February 16, 2013, only 10 rhinos died naturally (Source: *nepalnews.com*, 06 Mar 2014). The data as a whole shows that the poaching incident of rhino in the latest year seems to be negligible as compared to the past.

The major threat to rhinoceroses is due to relentless poaching especially for horn (CNP, 2012) despite the report of removal of hooves and occasionally pieces of skin have also been in record. Some analysis has been drawn out regarding the high rate of rhino poaching. The body of rhino is large and due to their large body structure, they cannot hide themselves. This let the poachers make ease in attacking and poaching them. Besides, the regular pathways that the rhino uses to travel toward and from their feeding and watering sites also makes the poachers easy to track them. These factors highlight the complex nature of rhino's survival in any environment. In Nepal, poaching of one-horned rhinos

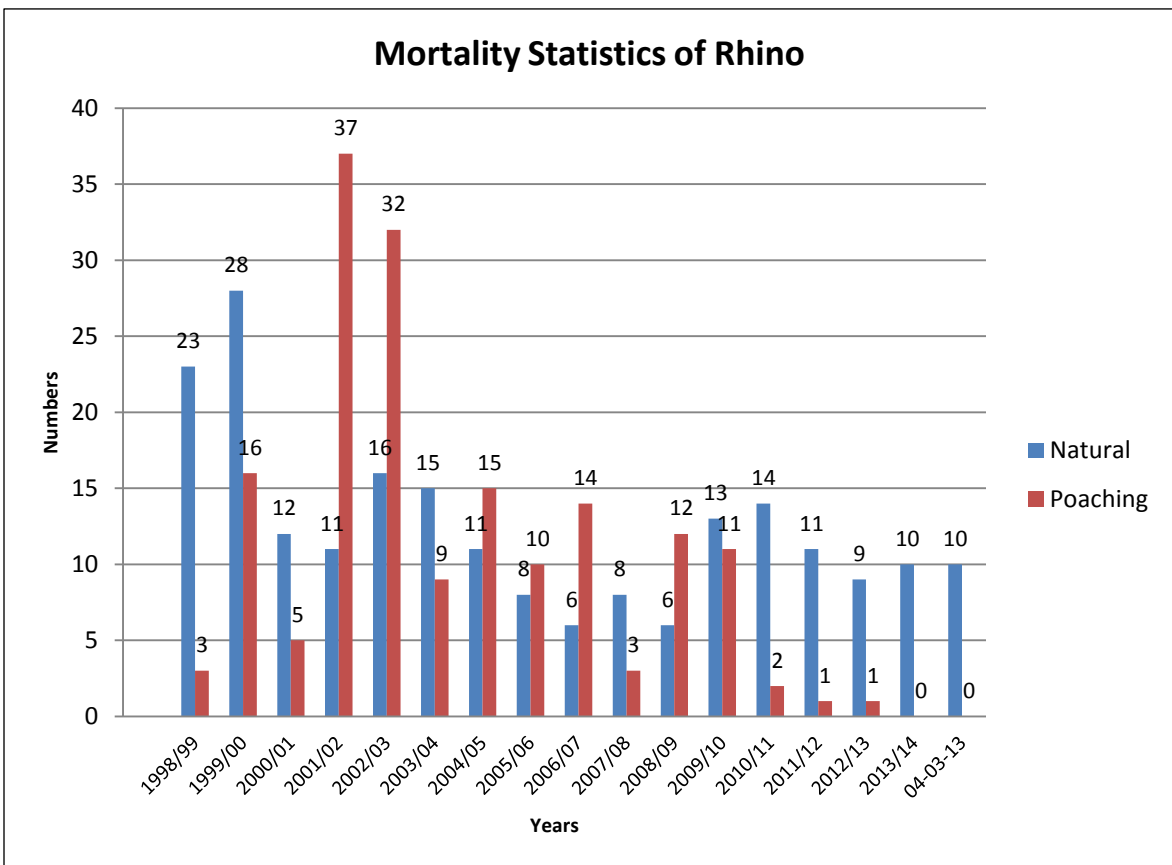
involves local poachers, middlemen, and buyers. Mostly, it has been found that the poor and local people are used for the poaching activities.

*Poaching has been one of the many reasons for the declination in the population of wild animals however it is not only the single cause. There are various other causes like drought, fragmentation of habitats and populations, slow reproductive rate, destruction and reduction of viable habitat, over-exploitation and political instability.*

The number of one horned rhinos is growing throughout the world but yet the animal is prone to extinction because of illegal poaching and illegal trade. The animal has been listed currently as vulnerable by the IUCN Red List but among the Asia's three rhino species, one horned rhinos are said to be least threatened because their number is rising. The raise in the number of one-horned rhinos in Assam (India), illustrates that the species is least threatened because the announcement of 2,544 one horned rhinos has been done, the population boost of 27 percent in eight years. Similarly, in the context of Nepal also the numbers of rhino are increasing. 534 rhinos were recorded in Nepal during the year 2011, marking an increase of 99 rhinos from the last census 2008, which were 435 in numbers. Of that total 534, 503 rhinos were recorded in Chitwan National Park (an increase of 95 from 2008 data), 24 in Bardia National Park (an increase of 2 from 2008 data) and 7 in Shuklaphanta Wildlife Reserve (an increase of 2 from 2008 data). This increase in numbers of rhinos reflected the success of conservation efforts along with the protective measures adopted for this species and management of their habitat. According to the latest survey in Nepal (2015), 645 one-horned rhinos (*Rhinoceros unicornis*) were counted which was 375 in numbers about ten years ago and 534 in the year 2011. The data reflects the rise of 72 percent over the last 10 years. This achievement of Nepal has been the landmark in the history of conservation and there is no doubt that the constructive outcome on conservation of wildlife is due to the continuous and collective efforts from local community, conservationists and all national and international stakeholders. The establishment of the CNP thus is a progressive step towards the conservation of rhinos of Nepal within natural condition and gradually the conservation measure was improved by introducing the patrolling of Nepalese army, anti-poaching units (APUs) and the motives to the local people in terms of reward in case of information and to combat poaching/illegal hunting (HMG/DNPWC, 2003). To bring this zero poaching, there have been continuous and collective efforts from local community, conservationists and all national and international stakeholders otherwise it is quite impossible. Therefore, despite the various challenges the result has become positive however, still there needs an improvement in policies in terms of wildlife conservation.

**Table 2.** Mortality records of rhino from the year 1998/99-2013/14(Source: CNP, Kasara)

Year	Natural Poaching	Artificial Poaching	Total
1998/1999	23	3	26
1999/2000	28	16	44
2000/01	12	5	17
2001/02	11	37	48
2002/03	16	32	48
2003/04	15	9	24
2004/05	11	15	26
2005/06	8	10	18
2006/07	6	14	20
2007/08	8	3	11
2008/09	6	12	18
2009/10	13	11	24
2010/11	14	2	16
2011/12	11	1	12
2012/13	9	1	10
2013/14	10	0	10



**Fig. 5** Mortality Statistics of Rhino (Source: CNP, Kasara) Threats to rhino



Since time immemorial, rhino are being slaughtered especially for their horn though other parts of the body are used as well. The horn is about 20-60 cm long with a grey-brown hide having fold of skins. The prominent horn has made it well known globally because it is used as medicines in China, Taiwan, Hongkong and Singapore. It was the Dr. Esmond Bradley Martin who for the first time introduced the use of rhino horn and its illicit trade in international market. According to him, traditionally, rhino's horn are used as medicines in East Asia and as dagger handles in North Yemen. Other various threats to rhino include:

### **Habitat loss**

Destruction of their habitat since many years has been a major threat to the rhinos causing brink of extinction. Due to the rise in human population, there has been a major problem in space and food which has converted their habitat to agricultural land. The limited space and food resources have led human and rhino to compete with each other because of overlapping of the same land.

### **Use of chemicals in the field**

Various kinds of chemicals are used in the agricultural field. These chemicals used may be harmful or injurious to wild animals. Seven types of fertilizers are used in Nepal which includes Urea, Diammonium Phosphate (DAP), Murate of Potash (MOP), Ammonium Sulphate (AS), Single Super Phosphate (SSP), Ammonium Phosphate Sulphate (APS) and NPK. This may affect the animal although at least.

### **Human –Rhinos conflict (HRC)**

Human-Wildlife Conflicts has become a big concern worldwide but it has become a major initiate especially in the developing countries like Nepal where most of the people solely depend on the forest products and agriculture. Wild animals like rhinos, whenever get a chance they are found raiding the crops. Their crop raiding behavior affects the local people directly and indirectly in various ways. The problem is because the human and wild animals share same habitat which decreases the habitat of wild animal on one side and on other side they are attracted to the palatable crops grown nearby as it becomes the ease way for them to feed themselves whenever they are hungry. Sometime the entry of animals to the field might be a threatening one as they might injure or kill human being and livestock. The local people are not compensated for the losses so they are found involved in retaliatory killing of wild animals along with the adoption of various destructive measures to protect the crop against wild animals( Straede and Treves, 2006).Osborn and Parker (2003) has classified the defensive measures into two types- Active and Passive. The active methods includes frightening devices and tactics as yelling, banging metals to produce sounds, deploying fireworks (Osborn and Parker, 2003), patrolling the field (Gillingham and Lee, 2003) and also making scary dummies while the Passive methods includes biological fences (Wang et al., 2006), Construction of walls (Sekhar, 1998) digging trenches (Nyhus et al., 2000).Beyond this trapping and hunting are also done with the worst offenders (Wang et al., 2006). Hedges and Gunaryadi (2009) has explained that people are found using chilli-based repellants to reduce crop depredation. The potentiality of conflict exists in the place where human and wildlife are found together however the extent varies spatially (Heinen and Yonjon, 1994).

## **Hunting/ Poaching**

The illicit hunting has been one of the crucial factors for decline of the greater one horned rhino. Wild animals are vulnerable to the exploitation by human and it is the means of capturing of animals illegally or hunting of endangered animals for the economic benefits. The civilization and development has made the illegal trade easier through communication, networking and technology. The biggest threats to rhinos thus has been a poaching because of the increase demand for its horn. Rhinoceros as is highly valued and is used in traditional Chinese medicines. The horn of rhino is used in reducing fever, fear, increase sexual drive and as an aphrodisiac (Baum & Goldstein, 1993). The toenail of rhino is used in reducing fever, blood as a tonic and skin to cure skin ailments. The main threats to rhinos thus come from poaching for use in Traditional Chinese Medicine(TCM) even though rhino horn has been removed from the official TCM pharmacopeia with alternatives encouraged, and trade in rhino horn though banned under international law, demand for rhino horn still remains high.

## **Illegal trade**

Illegal trade of wild animals constitutes illicit transport and distribution of animal body parts locally, nationally and internationally. The illegal trade of wildlife products has become a growing illicit business because at minimum it is expected to worth \$ 5 billion and maximum it worths more than \$ 20 billion (Wylter & Sheikh, 2008). Thus it has been estimated to be the World's third largest illegal trade (Baum & Goldstein, 1993). Wild life trade threatens around one third of mammals and aves globally (Baillie et al. 2004). The most lucrative assets include parts of tiger, ivory of an elephant, horn of rhino, and exotic bird and reptiles. Illicit trade has been growing because of ease transit, weak policies and penalties systems, corrupted officials, political corruption and ease networking system. Asia is considered to be as the place where high trade of wild animals takes place (Wylter & Sheikh, 2008). Since, 1975, CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) has been supporting biodiversity conservation however the wildlife trade has not been overall controlled. The trade of wild life threatens the flora and fauna populations along with the consistency of ecosystems. According to Leader-Williams et al. (1990), the decline of rhinos is mainly due to the increase in price of their horn in an international markets and decline of opportunities to local people living close to Protected areas (PAs).

## **Impact of *Mikania micrantha* on rhino's habitat**

*Mikania micrantha*(*Asteraceae*) is a tropical vine with fast growing capacity which has been a major problematic invasive weed especially in Chitwan National Park (CNP).The weeds has negative impact on other native grasses and shrubs. The *Mikania* not only affect the growth of other plants but it has also created negative impacts on the wild habitat. Besides, this invasive plant has also affected the life of local community residing nearby the national park as they rely on the fodder of Park for their domesticated livestock. *Mikania* has created an extensive damage to many of the Chinese ecosystems recently so the excessive growth of these weeds in CNP has been a huge concern today in terms of wildlife conservation. Invasive alien species are now considered to be one of the serious threats to global biodiversity (Porte et. al., 2011) and *Mikania* has been listed among the top 100 worst invasive species and as one of the top 10 worst invaders in the world(Zhang et. al., 2004).

## Conservation methods

WWF has been working on rhino conservation for over four decades. The conservation efforts are required and it can be done in following ways:

1. Translocation of rhinos from vulnerable areas reduces poaching.
2. Improvements in security- Yonzon (2002) reported that the increase in patrolling reduces poaching.
4. Adoption of anti-poaching measures
5. Penalties for poachers
6. Use of radio-tags and collars
7. Policy reforming
8. Community based conservation approaches

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