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Sariska Tiger Reserve:
A Managerial Approach to the Problems of Landscape

Very high anthropogenic disturbances due to large number of villages in core and adjoining areas, poaching, high pilgrimage, state highways passing through the core area, low strength of frontline staff for enforcement and lack of commitment were the identified factors responsible for local extinction of tigers in Sariska that was officially acknowledged in the year 2005. The reintroduction of tigers in Sariska without removing the factors responsible for extinction has again brought the landscape to new risk of threat. The study reveals extremely low strength, motivation and commitment of frontline staff in wildlife law enforcement that is evident from observed declining trend in registration of forest offence/wildlife cases during last decade that has resulted in very high anthropogenic disturbances in the reserve. Immediate strengthening of enforcement agency through increasing the strength of frontline staff, much awaited creation of Sariska Tiger Protection Force (STPF), raising a physical barrier at the interface, relocation of villages from core area and ban on mass agitations like mahapanchayats basically demanding in contravention of wildlife protection act are suggested.

Key words: Wildlife laws, Protected area, Tiger reserve, Anthropogenic disturbances, Interface.

Low enforcement of wildlife laws by the frontline staff and officers due to acute shortage of staff has emerged as determining factor for the increasing anthropogenic pressures in Sariska Tiger Reserve exposing the landscape to further degradation.

Introduction

Enforcement of various wildlife and forests laws in any protected area is the key to the protection of biological diversity of the area. Despite challenges associated with patrolling vast landscapes (Moreto, 2016), research suggests that frontline law enforcement presence is necessary to curb wildlife crimes (Hilborn *et al.,* 2006). The available enforcement force with the park managers, their competence to handle the offenders and cases, the available infrastructure, socio-economic conditions of the local communities and political scenario in the landscape are the determining factors in implementation of wildlife laws. Wildlife Protection Act, 1972 is comprehensive enough to tackle the crisis with regard to wild life protection. However, it is believed that, in spite of having comprehensive legislation, there is no sign of reduction in the poaching of wild animals and other offences related to habitat destruction in many of PAs, therefore, it can be concluded that enforcement mechanism is suffering decay from within (Poddar, 2017). Accordingly, it raises the question with regard to effective implementation of the provisions of wildlife law.

Sariska Tiger Reserve, a human dominated landscape, is one of the pioneer's tiger reserves of the country that was brought under the umbrella of Project Tiger in the year 1978. When the total extinction of tigers was officially acknowledged in 2005, following the recommendations of State Empowered Committee (Singh *et al.,* 2005), tiger re-introduction was initiated in the year 2008, a joint venture of Rajasthan Forest Department, Wildlife Institute of India and National Tiger Conservation Authority (NTCA). Although many recommendations were given by the committee, re-introduction of tigers was taken as the foremost priority of the mangers and scientists. Very high anthropogenic disturbances due to large number of villages in core and adjoining areas, organized poaching, high pilgrimage,

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state highways passing through the core area, low strength of frontline staff for enforcement, lack of commitment and careless approach were some of the identified factors responsible for local extinction of tigers. Among many of the prerequisites as recommendations of Singh's Committee (Singh *et al.,* 2005) that were supposed to be fulfilled before the re-introduction, very few were implemented in the field and that too partially. Relocation of only three villages (*viz*. Baghani, Rotkela and Umri) among all (n=29) from the Critical Tiger Habitat (core area) and subsequent scientific monitoring of the re-introduced tigers by both Wildlife Institute of India and Park Authorities can be seen as two major follow up actions apart from reintroduction of tigers. Other important recommendations including strengthening of protection regime of the park administration (increase of frontline staff up to three guards at beat level, creation of Sariska Tiger Protection Force, providing arms to the staff, etc.) that could have been major breakthrough, reorganization of some of *nakas* and ranges, regulation of pilgrimage and stopping traffic through the core area are still pending. The presence of a large number of people, livestock and busy highways inside the park would certainly have an impact on the entire wildlife and the ecosystem. With this background, earlier it was hypothesized that stress caused by these anthropogenic pressures in the habitat might have an influence on the reproductive potential of the introduced tigers in Sariska and a study was conducted (Bhattacharjee *et al.,* 2015). Although the mortality of re-introduced tigers in Sariska Tiger Reserve seems to be comparatively less as compared to many other tigers reserves (with the exception of poisoning ST 1 in 2010), the recent killing of ST 11 tigers and missing of ST 5 tiger (probably dead) in the beginning of year 2018 clearly hints towards increasing human-wildlife conflict as the entire forest ecosystem is subjected to intense anthropogenic pressures from all directions. The recent survey reveals the presence of 308 religious structures in all of the Sariska Tiger Reserve (STR) and more than 167 commercial structures in the Critical tiger habitat (CTH) area resulting in increased pilgrimage and related anthropogenic consequences. This prolonged human disturbance and related infrastructure in the landscape has increased the human-wildlife interface. Forest offences like grazing, trespassing, pilgrimage etc. in the sanctuary, vehicle flow through the highways, all have multiplied at a considerable level leading to degradation of area which was reported earlier too (Johnsingh *et al.,* 1997). Many with no security of livelihoods and some because of greed, local communities are observed to maximize their short-term gains from the forest in whatever way they could, unaware of the total annual economic value worth US $ 36.34 million of STR (Tiwari and Sharma, 2017).

Although many studies have been done in Sariska tiger reserve focusing mainly on the ecological, biological and technical aspects of floral and faunal components of the landscape (Sankar *et al.,* 1993; Sankar, 1994a; Sankar, 1994b; Sankar and Johnsingh, 2002: Bagchi *et al.,* 2003; Mukherjee *et al.,* 2004; Chouhan, *et al.,* 2005; Sankar *et al.,* 2005; Shahabuddin *et al.,* 2006; Avinandan *et al.,* 2008; Sankar *et al.,* 2008; Gupta *et al.,* 2009a; Sankar *et al.,* 2009; Sharma *et al.,* 2009; Gupta *et al.,* 2009b; Sankar *et al.,* 2010; Mondal, 2011; Mondal *et al.,* 2011; Gupta, 2011; Kidwai *et al.,* 2011; Gupta *et al.,* 2012; Chourasia *et al.,* 2012; Mondal *et al.,* 2012a; Mondal *et al.,* 2012b; Mondal *et al.,* 2012c; Sankar *et al.,* 2013; Gupta *et al.,* 2013; Mondal *et al.,* 2013a; Mondal *et al.,* 2013b) or critical review of the working of forest department with local communities (Kumar and Shahbuddin, 2005; Shahbuddin and Kumar, 2005; Shahabuddin *et al.,* 2005; Shahabuddin *et al.,* 2006; Shahabuddin *et al.,* 2007; Torri, 2011; Tiwari and Sharma, 2017) but the studies related to wildlife law enforcement are still lacking. With this background the present study was conducted. It was hypothesized that the law enforcement in Sariska Tiger Reserve are at below the desired level. As the implementation of Wildlife (Protection) Act, 1972 is the determining factor in containing the forest and wildlife crime in a particular PA network, registration of cases and follow up actions can reduce the negative impact on the forests and wildlife of the area. The paper aims to show how none strengthening of protection regime of Sariska administration has resulted in minimal enforcement of the provisions of wildlife protection act, thereby increasing the anthropogenic interference, halting the process of relocation of villages leading the reserve seriously in danger. Therefore, the present study is aimed to know the extent and trend of registration of forest and wildlife cases in the study area, analyzing the consequences and suggesting the measures to conserve Sariska Tiger Reserve.

Material and Methods

Study area

The idea behind the declaration of Sariska Tiger Reserve is to protect, restore, manage and maintain representative biodiversity of Aravalli ranges along with ecological processes and conservation of gene pool with a focus on Tiger and to accommodate the viable population of tiger. According to the Champion and Seth (1968) the forest of Aravalli region falls under the broad category of Tropical Dry forests. Study area the "Sariska Tiger reserve" ($74^0 14'$ to 76^0 34′ N and 25^0 5′ to 27^0 3′ E) is situated in the Aravalli hill range and lies in the semi-arid part of Rajasthan (Rodgers and Panwar 1988). The terrain is undulating to hilly in nature and has numerous large (Sariska–Kalighati and Umri etc.) to narrow valleys, two large plateaus–Kiraska and Kankwari and two large lakes, Mansarovar and Somasagar. The altitude of Sariska ranges from 240 to 777 m.

It is located in Alwar district of the state of Rajasthan and after its expansion its area was increased from 881 square kilometers to 1213.31 km^2 after the addition of buffer area (Fig. 1) with some part of buffer (Jamwa Ramgarh Sanctuary) in the district of Jaipur. The vegetation of Sariska correspond to Northern tropical dry deciduous forests (sub group 5 B; 5/E1 and 5/E2) and Northern tropical thorn forest (Sub Group 6 B) (Champion and Seth, 1968). The forest being scattered and sparse over a large area on various geological and soil formation and vary greatly in composition. *Anogeissus pendula* (Dhok) is dominant species in the undulating area and on the hills. *Boswellia serrata* (Salar) and *Lannea coromandelica* (Garjan) grows on steep rocky areas. *Acacia catechu* (Khair), *Zizyphus mauritiana* (Bordi) and

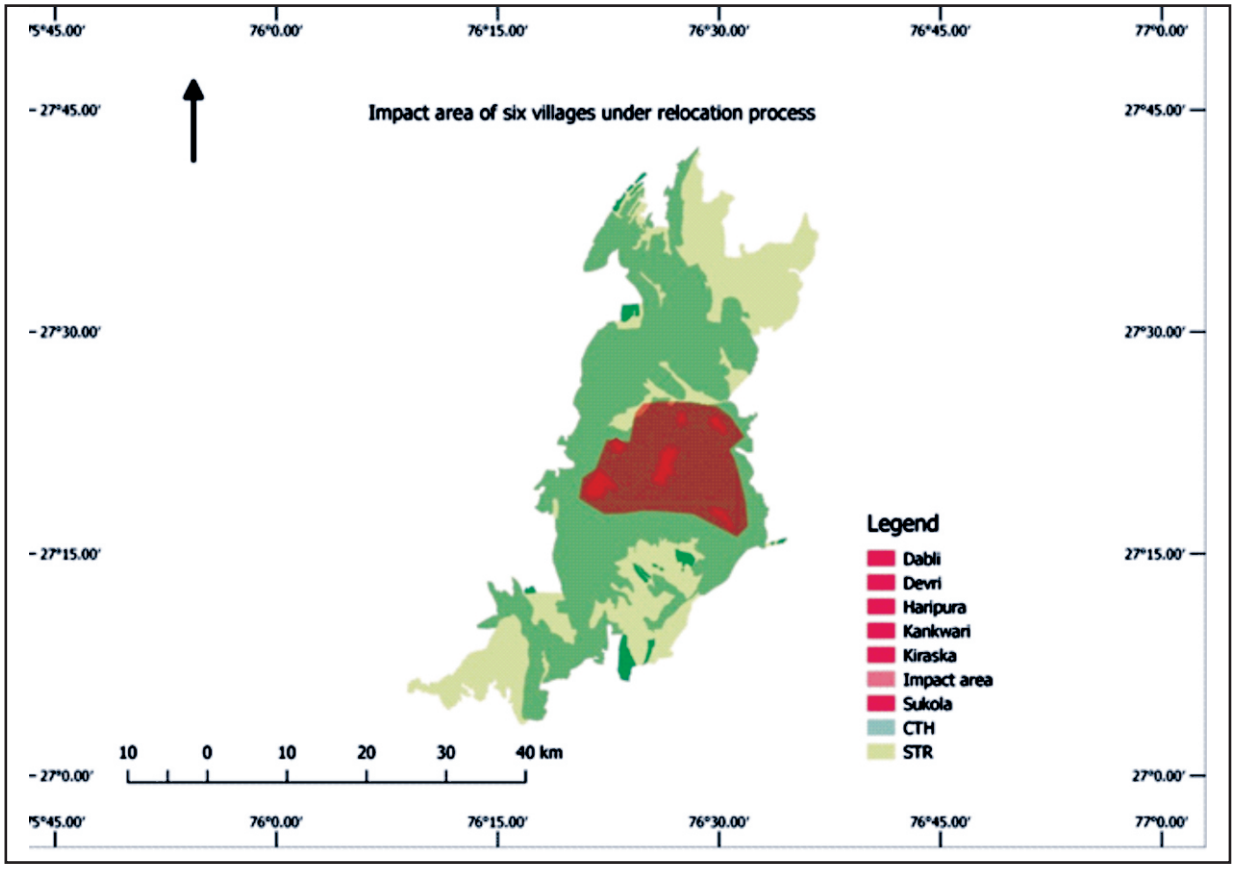

Fig: 1. Map of STR showing STR with impact area of six villages in the core area

Butea monosperma (Dhak) are found in valleys. *Dendrocalamus strictus* is extremely limited in distribution and is found along the well drained reaches of the streams and moist and colder part of the hills. Among bushes, *Grewia flavescence* and *Capparis sepiaria* form important components of vegetation of the reserve. Apart from the reintroduced tiger *Panthera tigris* (n=12) and 5 new born cubs, other carnivores present in Sariska Tiger Reserve (STR) are common leopard *(Panthera pardus)*, striped hyaena *(Hyaena hyaena)*, jackal *(Canis aureus)*, jungle cat (*Felis chaus*), common mongoose *(Herpestes edwardsi*), small Indian mongoose (*H. auropunctatus*), ruddy mongoose (*H. smithi*), palm civet (*Paradoxurus hermaphroditus*), small Indian civet (*Viverricula indica*) and ratel (*Mellivora camensis*). Chital (*Axis axis*), sambar (*Rusa unicolor*), nilgai (*Boselaphus tragocamelus*) and wild pig (*Sus scrofa*) which are the major prey species for tigers found in Sariska. Recent camera trap results have revealed the presence of Indian Pangolin (*Manis crassicaudata*) and Honey Badger (*Mellivora capensis*). Other wild prey species found are common langur (*Semnopethicus entellus*), Rhesus macaque (*Macaca mulatta*), porcupine (*Hystrix indica*), rufous tailed hare (*Lepus nigricollis ruficaudatus*), and Indian peafowl (*Pavo cristatus*). About 175 villages are situated in & around Sariska Tiger Reserve. Out of these, 29 villages (now 26 after relocation of three villages) are in Critical Tiger Habitat/ Core area and the rest 146 villages are outside the forest area. About 2254 families live in the core area while about 12000 families live around the Critical Tiger Habitat (Shekhawat, 2015) thus making this reserve as human dominated landscape that is subjected to immense anthropogenic pressures. In total there are 10 villages located inside the National Park area which are still due for relocation since 1984. The human population is over 1700 in the villages of National Park along with a population 10,000 livestock including buffalo, cow, goat and sheep (Sankar *et al.,* 2009). The human population in rest of these villages is around 6000 and the livestock population is more than 20,000 (Sankar *et al.,* 2009). Fig. 1 shows six of 26 villages in the core area which have been prioritized to be shifted inside the national park area with zone of their influence.

Methods

The present study is based on the records of Forest Offence Registers as maintained in different *nakas* of four ranges of Sariska wildlife sanctuary data was entered in MS Excel and analysis was done using simple statistical methods. Analysis of the data was done using simple statistical methods with the help of MS excel to know the extent of different types of forest/wildlife offences, trend in registration of cases (trend analysis using Excel TREND function), seasonal distribution of cases, impact of mob

Table 1: Table showing number of forest/wildlife cases as registered in different ranges.

S.No.	Range	Cases	%age
1	Akbarpur	2272	22.52
2	Sariska	3499	34.69
3	Talvriksh	1584	15.70
4	Tehla	2732	27.08
	Total	10087	100

Table 2: Showing number of forest/wildlife cases as registered in different nakas.

S.No.	Naka	Cases	%age
1	Akbarpur	478	4.739
2	Baleta	536	5.314
3	Boretha	749	7.425
4	Kalighati	1394	13.82
5	Kishanpur	655	6.494
6	Kushalgarh	314	3.113
7	Nathusar	328	3.252
8	Prithvipura	603	5.978
9	Rampur	573	5.681
10	Sadar	1077	10.68
11	Talvriksh	683	6.771
12	Tehla	1983	19.66
13	Thanagazi	714	7.078
		10087	100

demonstrations against the Sariska administration on registration and post registration follow up actions of the Sariska administration. The data was also correlated and verified from other records including First information report (FIR) books, range offence register and personal interviews with officers and field staff of the reserve.

Observations

Naka wise registration of cases

A total of 10087 cases were registered among all 16 *nakas* of all four ranges *viz*. Akbarpur, Sariska, Talvriksh and Tehla from 2005 to 2017 (Table 1). Maximum number of cases was registered in Sariska range (34.69%). It is followed by Tehla range (27.08%), Akbarpur (22.52%) and Talvriksh (15.70%). Maximum number of cases observed to be registered in *naka* Tehla Kalighati (1394) of Sariska range followed by *naka* Tehla of Tehla range, and Sadar (1077). Comparatively less number of cases registered in *nakas*, Garh (275), Khoh (250) and Kundla (199) as these have been carved out from Tehla *naka* post 2012 year (Table 2).

Monthly distribution of cases

Maximum number of cases were observed to be registered during November (13.72%), December (13.52) and January (11.2%) whereas least cases were observed to be registered during April (3.55%), May (3.8%) and June (4.6%) (Table 3). This may be due to the fact of extreme hot climatic conditions during these months with least availability of water and minimum foliage. Similarly, maximum number of cases were observed to be registered during the month of December (n=19 and January (n=24) out of total 144 reported poaching cases. Minimum were reported in April (n=6) and august (n=6) (Fig 2).

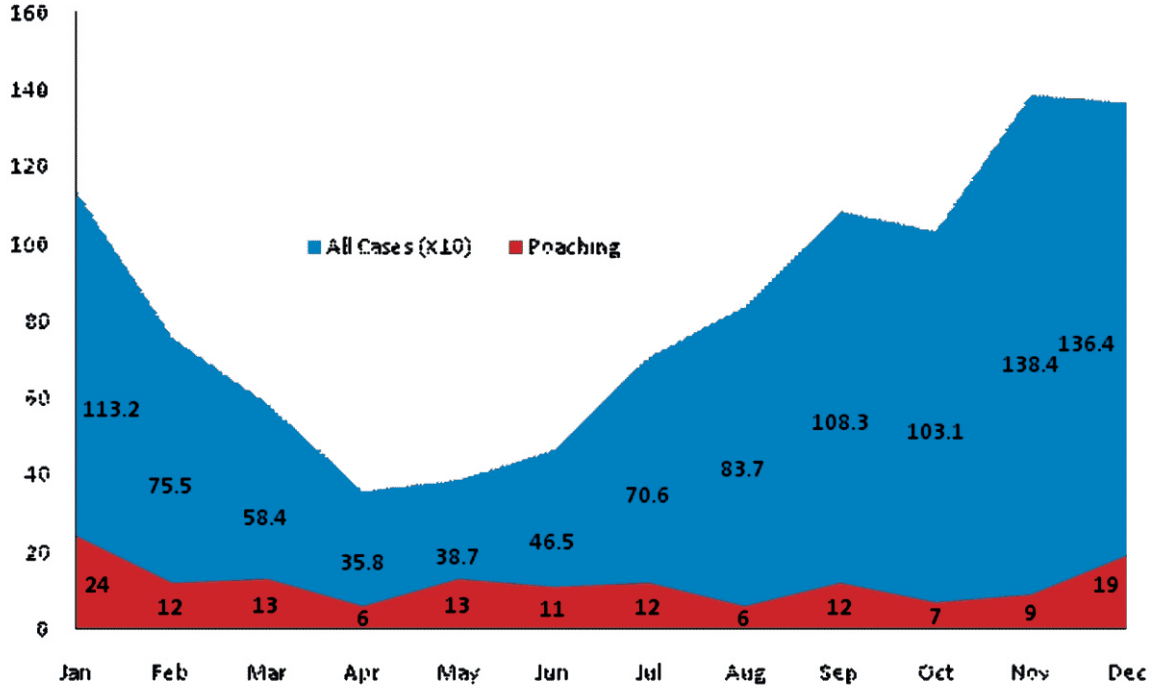

Fig 2: Chart showing comparison of the number of cases as registered during different months.

Table 3: Monthly distribution of cases.

Month	Cases	Percentage
Jan	1131	11.29
Feb	755	7.48
Mar	584	5.79
Apr	358	3.55
May	387	3.84
Jun	465	4.61
Jul	706	6.99
Aug	837	8.30
Sep	1083	10.74
Oct	1031	10.22
Nov	1384	13.72
Dec	1364	13.52
	10087	100

Categories of offences

Grazing, lopping, felling, encroachment, trespassing and hunting are observed as the major offences. Littering and feeding wild animals on the way of religious routes are also observed. Among all types of offences, felling and lopping of trees was observed to be registered most (39.43%) (Table 4). Dhonk (*Anogeissus pendula*), Dhak (*Butea monosperma*), Khair (*Acacia catechu*) etc. are the tree species which are attacked more. The milk cake business is observed to be taking maximum toll of Dhonk trees in terms of supplying fuel wood for making milk cake (*mawa*). All of the communities in the villages inside CTH and adjacent buffer areas are having kilns for making this *mawa* through burning trees. Plant species like Rounj (*Acacia leucophloea*), Dhak (*Butea monosperma*), Kikar (*Acacia nilotica*) have been observed to be lopped for fodder. As livestock rearing is the primary occupation of the majority of the communities residing inside the CTH cattle grazing is one of the most common offence in the core area. 38.12% of all forest/wildlife cases (n=10087) are for grazing offence. It has been observed that most of the time grazing is accompanied by lopping of fodder trees especially while grazing goats. 3% of the registered cases were observed to be registered for mining offence. Only 204 (2% of all) reported cases of hunting that comprises of both fishing and poaching of wild animals were registered during the period. Only 1% of all registered cases are for taking action against encroachment. Some cases like trespassing, Transit permit, littering feeding of wild animals, trespassing, fire, and collection of non-timber forest produce (NTFP) collectively observed to contribute 16% of all offences that were registered during the period. Among all types of registered hunting cases (n=204) during the period, 58.33% cases were related to poaching of different wild animals, 28.92% related to fishing and 9.31% for poaching attempt and 3.43% were related to some wildlife article. Among poaching of wild animals in the reserve, maximum cases (n=25) were observed to be registered for Common Leopard (*Panthera pardus*). It is followed by Wild boar *Sus sucrofa* (n=15), Sambar deer *Cervus unicolor* (n=13), Tiger *Panthera tigris* (n=10), Peafowl *Pavo cristatus* (12), Hyena (n=10) etc. With the exception of only one tiger (ST 1 that was poisoned in 2010), all of the reported cases of poaching tigers as registered during the period the actual poaching was done prior to the study period and the cases were registered *post facto* after the declaration of local extinction of tigers in STR.

Table 4: Table showing different types of cases as registered during the period.

S.No.	Offence Type	Cases	%age
1	Encroachment	69	0.684
2	Felling and Lopping	3977	39.427
3	Grazing	3845	38.118
4	Hunting	204	2.0224
5	Mining	293	2.9047
6	Other	1699	16.843
	Grand Count	10087	100

Post Registration cases follow up

During the study it was observed that 98% of all the registered cases (n=10086) were finalized after taking compensation from the offender or compounding the offence, a term which is misunderstood as fine by the local communities as well as by the most of the frontline staff. Only one percent of the cases were observed to be followed up and brought to the court of law as complaints. Remaining 1% of the cases is pending at the *naka* or range level. Among all the complained (n=75) cases. It has been observed that majority of the cases (80%) complained in the court of law are related to poaching only.

Trend in registration of cases

With an objective to know the trend of case registration during the decade data for all *nakas* of the Sariska wildlife sanctuary were also analyzed from 2005 to 2017. It is observed that maximum cases were registered during 2005 and 2006 when local extirpation of tigers was officially recorded in STR. The trend of registration of cases continued till 2006 and then decreased till 2009 and again increased in 2011. Fig 3 shows a line graph depicting a decreasing trend ($y = -64.791x + 1229.5$, $R^2 = 0.7801$) was observed in case registration of forest crime cases in all four ranges of STR. It is also observed that politically motivated mob agitations locally called *mahapanchayats* by the local communities gained momentum from the beginning of 2012. *Mahapanchayat* is observed as a gathering of villagers of more than one *panchayat* (local village level elected body) at one common place mostly in or around the CTH demands basically against the provisions of wildlife protection act sometimes even blocking the roads (*chakkajaam*). Permission for grazing in the core area, free access to all areas of the National Park including all of the religious places (308), lifting of forest barriers at the entry and exit of state highway 29A (it is closed vide order of Honorable Supreme Court of India), permission for sale and purchase of land in the sanctuary etc. are observed to be common demands of these agitations (*mahapanchayat*). Maintaining law and order situation of district is top priority of the district administration and for maintaining peace, though temporary, the latter often succumbs to pressure of these so called “democratic” mass agitations thereby giving a de-motivating message to the park authorities especially frontline staff. It is continuously observed a *mahapanchayat* is always preceded by a spell of strict measures by park authorities especially to implement the wildlife laws. To some extent the hidden objectives of these *mahapanchayats* are quite often observed to be

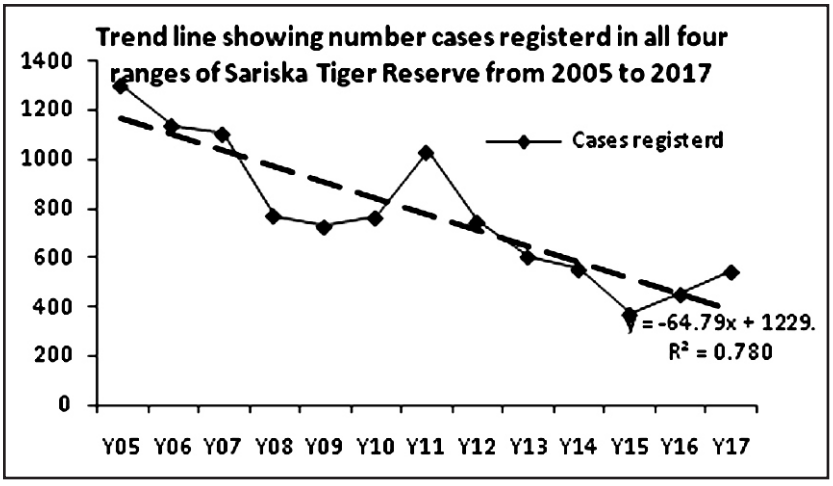

Fig. 3: Line graph showing trend in case registration in different nakas in all four ranges since from 2005 to 2017.

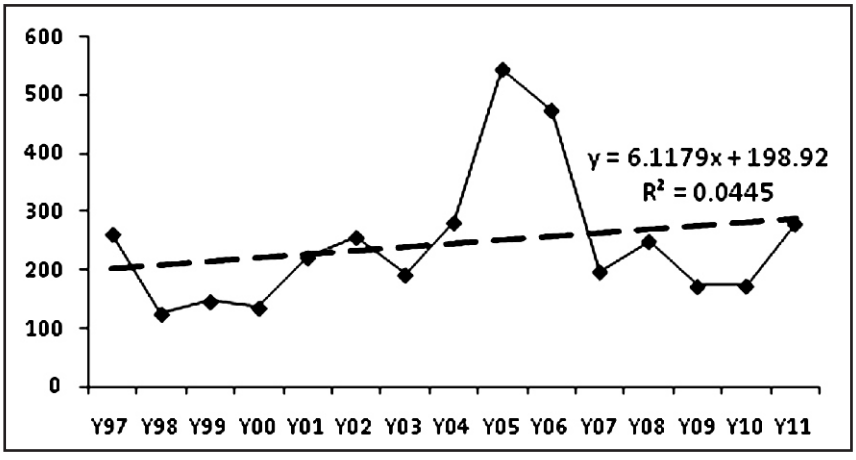

Fig. 4

achieved through demoralizing the park administration not to act against the forest offenders. Attempts were also made to analyze the data for bigger timescale to get precision. Trend line based on case registration data for five *nakas viz*. Baleta, Prithvipura, Boretha, Kishanpur and Akbarpur from 1997 to 2017 is shown in Figure 4 and 5. The observed increasing trend till from 1997 to 2011 ($y= 6.1179x + 198.92$, $R^2=0.0445$) started declining from 2012 onwards giving a resultant decline trend ($y= -4.439x +261.07$, $R^2= 0.0677$) between 1997 and 2017. It is the year 2002 onwards when the mass agitations (*mahapanchayats*) were observed to be held frequently suggesting a strong correlation between mass *mahapanchayats* and non registration of cases.

Discussion

Effectiveness of environmental legislation depends on three factors, for example, first, the provisions of the statute should not have any loopholes, that is, provisions should be prepared meticulously, second, formation of enforcement agencies should be strong enough to implement the provisions efficiently without any setback and third, the deterrence mentioned in the form of penalty or punishment must be effective one, that is, the amount of penalty and the duration of imprisonment should clearly act as a fear to the wrongdoer or polluter, which further means that the deterrence should not be taken lightly or casually by the wrongdoer (Poddar, 2017). There is another problem identified that the Forest departments and the Forest Officers are not able to work effectively in implementing the laws and facilitate the conservation activities because they are not adequately trained or have adequate resources. It is seen that the enforcement mechanism of the laws in India for the conservation and protection of wildlife is also complicated in nature. The laws, on one hand, enable the forest officers to protect the forests resources, but they are not given any powers to make policies pertaining to the situation which further creates problems in the confiscation of the felled timber or the poached animal. It was concluded that the protection of forest and wildlife depends on the efficient enforcement of meticulous provisions by the enforcement agencies (Poddar, 2017). Implementation of existing forest and wildlife laws in a protected area or a tiger reserve is the determining factor for the long term conservation of biological diversity of that area. The available resources

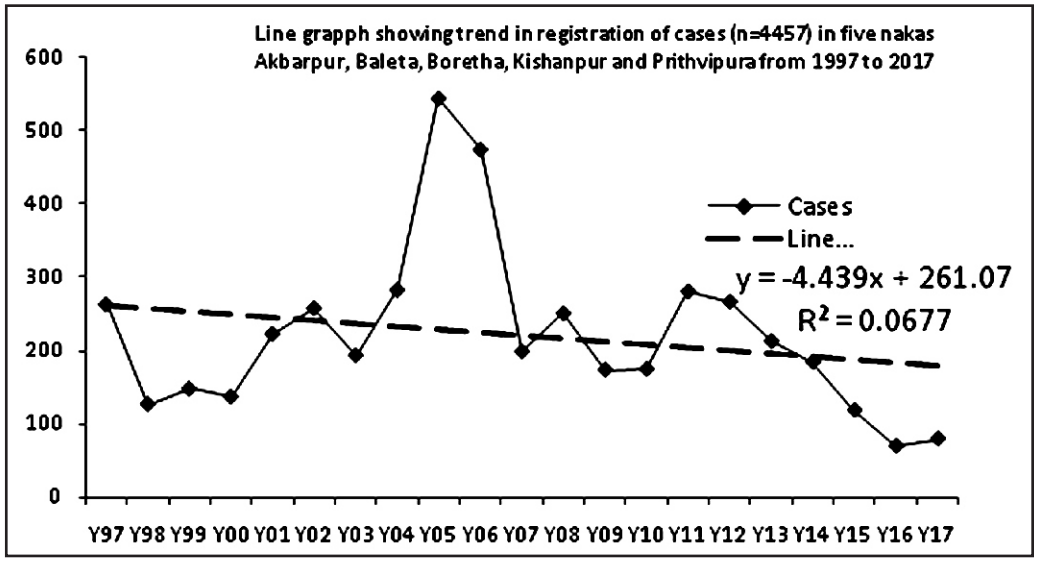

Fig. 5

with the enforcement agencies including staff personnel, infrastructure and the public support are the key requirements for the implementation of law of jungle. Notification of any landscape as National Park or a Wildlife Sanctuary is nothing but providing higher degree of protection to such area through imposing more restrictions on resource exploitation. Areas under protected area (PA) network have been accorded highest degree of protection than any other state owned area. The factors like compactness of the landscape (whether pure forest or a mosaic of revenue land and forest land), extent of interface, socio-economic conditions of local communities especially their livelihood pattern, political scenario, positive stakeholder ship, availability of staff for enforcement of the wildlife laws are responsible for achieving the desired objectives of bringing such areas under the umbrella of protected area (PA) network.

The present study is based on analysis of the preventive response by the enforcement agencies of Sariska Tiger Reserve to contain the identified factors negative to the conservation and to suggest management recommendations to save this landscape from further degradation. The livelihood pattern of local communities in and around STR is the determining factor of extent of different types of offences as per Act. Thus grazing, lopping and felling always go side by side especially when an axe carrying offender is seen accompanying goats. It is observed that tree species like Dhonk (*Anogeissus pendula*), Rounj (*Acacia leucophloea*), Dhak (*Butea monosperma*), Kala Khair (*Acacia catechu*) etc. are regularly lopped for foraging livestock especially goats. The dried left over branches are observed to be carried as head loads for fuel wood purpose. Although Park Authorities in different programs have already provided 57000 LPG connections to the communities living adjacent to the reserve, the desirable results are still lacking. Contributing 39.43% of all cases registered cases (n=10087), the felling and lopping incidences can be viewed as a major threat to the existing vegetation and most of the vegetation in the core area is heavily damaged. Similarly 38.12% of all cases are for grazing of livestock. Grazing has been observed to be a source of disturbance especially when accompanied by graziers and often results to human wildlife conflict. Based on tiger kill report submitted by the tiger monitoring parties from June 2017 to June 2018, analysis shows 72.52% of all reported kills (n=262) were observed to be of livestock especially buffaloes which is an alarming increase from 19% (Sankar *et al*. 2013). This alarming rate of increase of livestock preying by tiger clearly suggests multifold increase in grazing intensity in the area. Almost 99% of all these cases of felling, lopping and grazing are observed to be compounded by taking compensation/ fines whose amount, most of the time is decided by the concerned *Naka* in-charge or sometimes forest guard. Less than 1% of the cases of the above offences have complained in the court of law. As the poaching of wildlife is non compoundable, 60% of the registered cases (119) related to poaching of wild animals were complained in the court of law whereas the offences related to forest crime like felling, lopping, encroachment, mining, trespassing are generally compounded as an easy exit from the case which is always long, pending and tiring.

Overburden of duties, dearth of qualified range officers due to non recruitment of Range Officers for last two decades, acute shortage of frontline staff, lack of confidence to face court procedures due to insufficient training programs and lack of motivation are some of the factors responsible for exiting the process of complaining the cases in the court of law. In addition local political pressure to the field staff in law enforcement is another reason that can be quoted. The continuous observation of callous attitude of the decision makers in strengthening the protection regime of Sariska administration despite repeated requests can be viewed as a wrong message to frontline staff as a de-motivating factor. Although variation in number of case registration during different seasons was observed *viz*. maximum number of cases were observed to be registered during November (13.72%), December (13.52%) and January (11.2%) whereas least

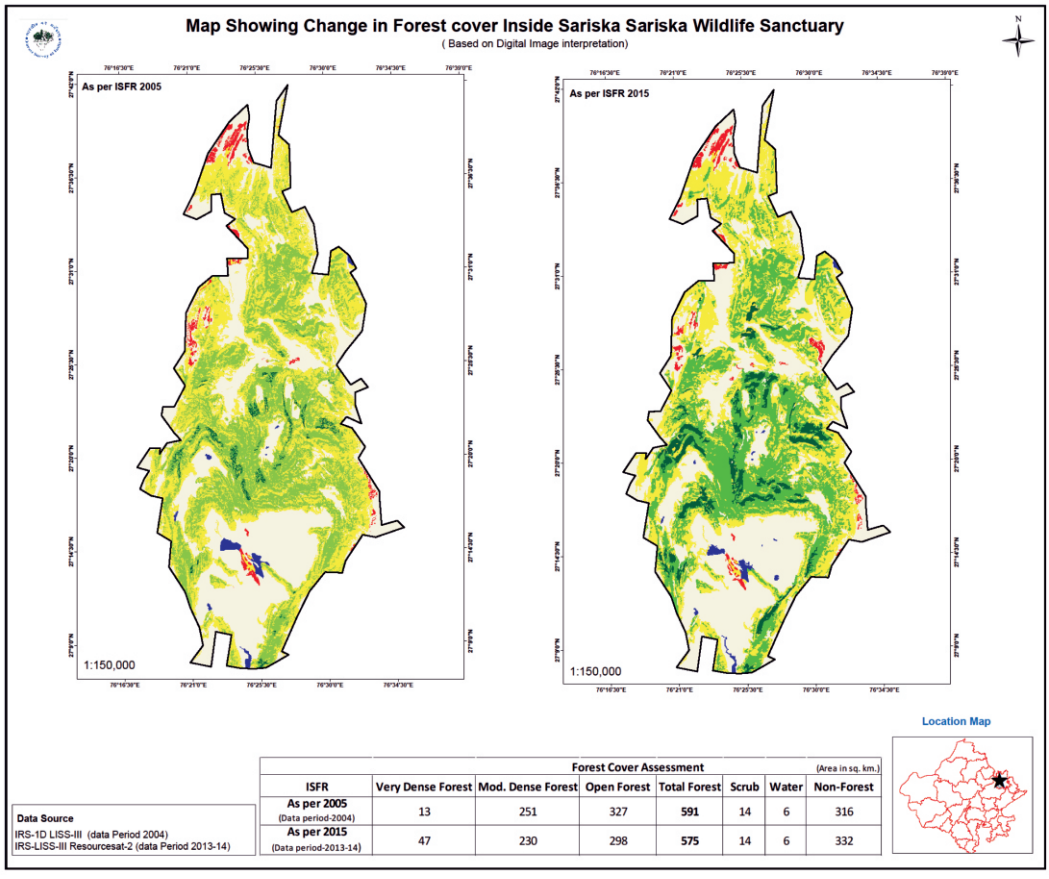

Fig .6: Comparative statement of Forest Cover of the Sariska WL sanctuary between 2005 and 2015.

cases were observed to be registered during April (3.55%), May (3.8%) and June (4.6%) there was no such observation for the cases of poaching. Non availability of water and green foliage during summers is the reason behind least trespassing, lopping and livestock grazing. Positive correlation was observed in the number of registered offences with that of available water holes for the months described above (p=0.94563) while no correlation was observed between poaching and water availability (p=0.27423). The observed decreasing trend ($y = -64.791x + 1229.5$, $R^2 = 0.7801$) in registration of cases between 2005 and 2015 can happen in two situations. One, there are no forest offences in the reserve because of best efforts done by the enforcement agencies. This might be the answer of Park Authorities in many cases who believe in “all is well” syndrome and the same is the palatable response that the present system demands. Such assumption can be true as long as there is net increase in forest of the area or no net loss of forest cover. In fact, a report from Forest Survey of India (FSI), has pointed out a decrease of 1600 hectares of forest cover between 2005 and 2015 Fig. 6. Had it been decline in forest offences, there should have been an increase in the forest cover of the said area. As per *pers comm* (Vikram, 2017 *pers comm*) based on IRS-1D LISS-III (data Period 2004), IRS-LISS-III Resourcesat-2 data showed an overall decline of 1600 hectares of forest in Sariska Wildlife Sanctuary from 2005 to 2015 (Fig. 6) Similarly, a study based on the relationship between land use/land cover (LULC) changes and land degradation over a period of 20 years (1989-2009) has been studied using remotely sensed and ancillary data revealed STR has undergone substantial LULC changes, primarily a shift from natural cover into managed agro-systems which attributed to the human and livestock pressures (Kanga *et al.* 2018). This huge loss of forest cover and the observation of increased livestock percent in the tiger's menu from 19% to 72.52% indicating increased grazing intensity in the area nullify the hypothesis of non occurrence of forest crime is reason behind non registration of forest offence cases. It's not only the tiger, but whole of the forest ecosystem that needs to be conserved, the rational for which the project tiger was launched. It is also observed that most of the efforts of enforcement agencies of STR jointly with the scientists of Wildlife Institute of India were mainly concentrated around monitoring of re-introduced tigers 2008 onwards.

With the increase of area of the reserve from 881 square kilometers to 1213.31 square kilometers the number of beats has increased from 75 to 102. The present strength of the reserve is only 102 forest guards. The strength of supporting work charge (WC) staff of cattle guards has declined from 168 in 2005 to 58. A strength of 74 FGs and 173 WCs (247 staff) was responsible for 881 square kilometers with an average of 3.64 square kilometers of forest per staff in the year 2005. The current strength of 102 FGs and 61 WCs (total 163) is responsible for

1213.31 square kilometers, the average responsibility of the area is 7.5 square kilometers per person if no other job is assigned including guarding five barriers round the clock, monitoring of all (12 adult and 5 cubs), maintaining 52 wireless stations, managing tourism and pilgrimage etc. In reality, a forest guard/cattle guard is vested with the responsibility of protecting forest of more than 10 square kilometers. In addition escalated anthropogenic pressures in terms of increased population along with unaccountable infrastructure have certainly quantified the burden on the shoulders of a forest guard/cattle guard to tackle with the problems relating to forest crime. Very less frontline staff who is vested with the responsibility of forest having very high interface, staying lonely in very hostile surroundings and poor wages as compared to their counterparts in other police/paramilitary forces can be viewed as one of the reason of low motivation and sometime leading to non disclosure of forest/wildlife crime.

The extent of interface between the sanctuary and human habitations can be viewed as driving factor responsible for long term survival of a protected area. It is the interface of wilderness and human dominated landscape that determines disturbance intensity to the biological diversity of any particular area. The intensity of human-wildlife conflict is the secondary outcome of that interface. Perimeter Interface per Unit Area (PIPUA) can be defined as ratio of length of perimeter of any protected area that forms the interface of ecologically wilderness area and that human dominated landscape to the total area of Protected Area. Under ideal conditions (for a circle) with no human habitation inside, it is 3.551m for one square kilometer of protected area, 2.505 for 2 km^2 of PA, and 2.046 for 3 km^2 and so on. There should be some sort of minimum perimeter interface per unit area (PIPUA) $(p=\frac{perimeter}{\sqrt{4\pi A}})$ while notifying any landscape as a protected area. Once notified, the excess PIPUA can be only minimized by relocating or displacing the villages from the protected areas and/or by creating a physical barrier at the interface thus making conditions for inviolate space as biologists and forest managers see displacement of ecosystem-dependent people as unavoidable to secure large 'inviolate' areas of wilderness where the needs of biodiversity conservation can be prioritized (Terborgh *et al.,* 2002; Johnsingh, 2005; Karanth, 2006). While making attempts to compare the PIPUA for of Sariska with some tiger reserves across the country, maximum index was observed for Sariska Tiger Reserve (p =3.066) as compared to Melghat Tiger Reserve (p=1.76), Kanha Tiger Reserve (p= 1.845) and Tadoba-Andhri Tiger Reserve (p=1.877). The very high PIPUA factor of Sariska can be reduced only by making a physical barrier in the form of *pucca* wall at the interface.

Very high number of registration of cases (n=1298) in the year 2005 is the result of knee jerk remedial measures following the extinction of tigers in the year 2004. Actions including constitution of high empowered Tiger task force, deployment of security forces and reshuffling of staff resulted in gearing up of the entire enforcement machinery resulting in maximum patrol of the area, searching and nabbing all of forest/wildlife offenders are viewed as driving factors resulting for this enhanced enforcement. Although the number was observed to be seen regular ups and downs but it was showing an increasing trend (y= 6.1179x + 198.92, R^2=0.0445) when the crime data was plotted from 1997 till 2011. It showed a declining trend between 1997 and 2017 (y= - 4.439x +261.07, R^2= 0.0677). The observation of sharp decline (y= -81.286x + 938.57, R^2=0.6534) in crime registration in the area (Fig 7) also observed to be coincide with increasing *mahapanchayats* in the area indicating the negative impact of *mahapanchayats* in law enforcement from 2012 onwards.

Within the patrolling literature, several studies have established a link between patrol effort and patrol success (Ford, 2005; Gandiwa *et al*., 2013; Jachmann, 2008; Jachmann and Billiouw , 1997; Leader-Williams *et al.,* 1990; Martin, 2010; Moreto *et al.,* 2014). That is the more man-hours patrolling in the field, the more effective anti-poaching officers become at increasing the risk of poaching through strengthening formal surveillance. The study clearly suggests for the urgent need of enhancing patrol efforts in Sariska tiger reserve.

Strengthening of enforcement regime of Sariska administration through immediate filling up of the vacant

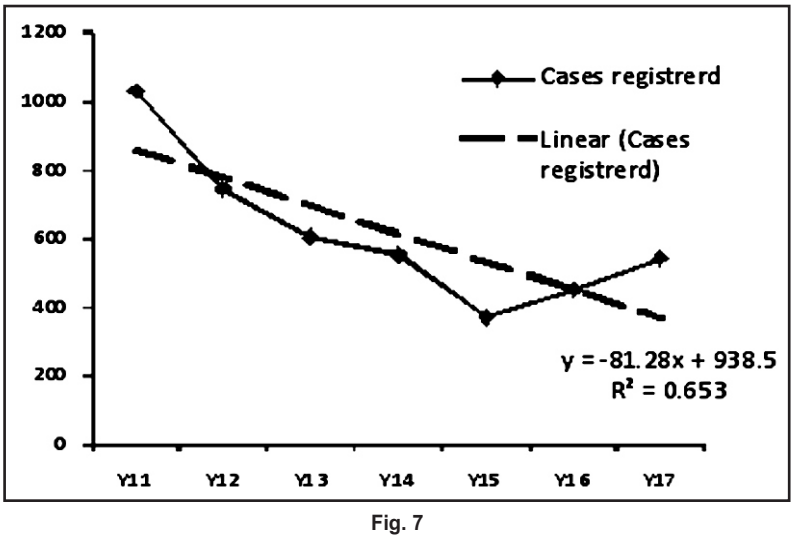

Fig. 7

posts, creation of Sariska Tiger Protection Force (STFP) and reviewing the need of creation of additional posts of frontline staff is highly recommended. It is also suggested for the creation of physical barrier (*pucca* wall) at the interface to reduce the man-animal conflict and disturbance to the biological diversity. Keeping in view of the very slow process of village relocation plan from the core area of Sariska, immediate posting of one officer of the level of Deputy Conservator of Forests with full fledged office dedicated is strongly suggested. There should be immediate ban on mass agitations like *mahapanchayats* demanding against the provision of Wildlife (Protection Act), 1972 thereby de-motivating and bringing the frontline staff and enforcement agencies thus turning them as mere spectators of forest degradation.

Spreading in an area of 1213.31 km^2, STR is a huge patch of forest ecosystem having total annual economic value worth US $ 36.34 million of STR (Tiwari and Sharma 2017), just adjacent to National Capital, New Delhi, this huge landmass is not only of the regional but it is also observed to be of immense national importance. It should be viewed as a special case by Ministry of Environment, Forests and Climate Change (MOEF&CC) and NTCA for additional support strictly in terms of law enforcement to conserve the unique landmass having immense geological, ecological and biological importance with green cover that can be viewed as source of oxygen rich air at the door steps of the citizens of National Capital Region of the nation.

सारिस्का बाघ रिजर्व : भूदृश्यी समस्याओं पर एक प्रबन्धकीय दृष्टिकोण

बाघ रिजर्व : भूदृश्यी समस्याओं पर एक प्रबन्धकीय दृष्टिकोण

गोविन्द सागर भारद्वाज

सारांश

भीतर तथा समीपवर्ती इलाकों में गाँवों की विशाल संख्या के कारण बहुत उच्च मानवोद्भवी विक्षोभों, शिकार, उच्च तीर्थयात्रा, भीतरी क्षेत्र से होकर गुजरने वाला राज्य राजमार्ग, प्रवर्तन के लिए अग्रणी कर्मचारियों की निम्न सामर्थ्य एवं वचनबद्धता का अभाव सारिस्का में बाद्यों के स्थानीय विलोपन के लिए उत्तरदायी पहचान किए गए कारक हैं, जिसे वर्ष 2005 में अधिकारिक तौर पर माना गया है। विलोपन के लिए उत्तरदायी कारकों को हटाए बिना सारिस्का में बाद्यों के पुनर सूत्रपात ने संकट के नए जोखिम के लिए भूदृश्य को तैयार कर दिया है। अध्ययन ने वन्यजीव कानून प्रवर्तन में अग्रणी कर्मचारियों की अत्यधिक निम्न सामर्थ्य, प्रेरणा तथा वचनबद्धता को दर्शाया है, जो गत दशक के दौरान वन अपराधा/वन्यजीव मामलों के पंजीकरण में प्रेक्षित ह्रासमान रूझान से स्पष्ट है, जिसके फलस्वरूप रिजर्व में बहुत अधिक मानवोद्भवी विक्षोभ हुआ है। अग्रणी कर्मचारियों की सामर्थ्य में वृद्धि के जरिए प्रवर्तन एजेन्सी का तत्काल सशक्तिकरण करके, सारिस्का बाद्य सुरक्षा बल का लम्बे समय से प्रतिक्षित सृजन, अन्तरापृष्ट में एक भौतिक अवरोध खड़ा करने, भीतरी इलाकों से गांवों का पुनरस्थान निर्धारण और बुनियादी तौर पर वन्यजीव संरक्षण अधिनियम का विरोधा कर रही महापंचायतों जैसे जनान्दोलनों पर रोक लगाने का सुझाव दिया गया है।

References

Avinandan D., Sankar K. and Qureshi Q. (2008). Prey selection by tigers (Panthera tigris) in Sariska Tiger Reserve, Rajasthan, India. *J. Bombay Nat. Hist. Soc.,* **105**: 247–254.

Bagchi S., Goyal S.P. and Sankar K. (2003). Prey abundance and prey selection by tigers (*Panthera tigris*) in a semi arid, dry deciduous forest in western India. *J. Zool*., **260**: 285–290.

Bhattacharjee S., Kumar V., Chandrasekhar M., Malviya M., Ganswindt A., Ramesh K., Sankar K. and Govindhaswamy Umapathy. (2015). Glucocorticoid Stress Responses of Reintroduced Tigers in Relation to Anthropogenic Disturbance in Sariska Tiger Reserve in India. PLoS ONE 10(6): e0127626. https://doi.org/10.1371/journal

Champion H.G. and Seth S.K. (1968). A revised survey of the forest type of India. Government of India Press, Delhi, 404 pp.

Chouhan D.S., Harihar A., Goyal S.P., Qureshi Q., Lal P. and Mathur V.B. (2005). Estimating leopard population using camera traps in Sariska Tiger Reserve, Wildlife Institute of India, Dehradun, India. 23 pp.

Chourasia P., Mondal K., Sankar K. and Qureshi Q. (2012). Food Habits of Golden Jackal (*Canis aureus*) and Striped Hyena (*Hyaena hyaena*) in Sariska Tiger Reserve, Western India. *World J. Zoology,* **7 (2):** 106-112, 2012

Ford A. (2005). An evaluation of wildlife monitoring and anti-poaching activities (Doctoral dissertation, Department of Environmental Science and Technology, Imperial College London).

Gandiwa E., Heitkönig I.M., Lokhorst A.M., Prins H.H. and Leeuwis C. (2013). Illegal hunting and law enforcement during a period of economic decline in Zimbabwe: A case study of northern Gonarezhou National Park and adjacent areas. *J.* for *Nature Conservation,* **21(3):** 133–142.

Gupta S., Mondal K., Sankar K. and Qureshi Q. (2009a). Estimation of Striped Hyena Hyena hyena population using camera traps in Sariska Tiger Reserve, Rajasthan, *India. J. Bombay Nat. Hist. Soc., **106(3):** Sept-Dec 2009.*

Gupta S., Mondal K., Sankar K. and Qureshi Q. (2009b). Record of desert cat (Felis silvestris ornata) in Sariska Tiger Reserve, Rajasthan. *Indian Forester.**135:10.***

Gupta S., (2011). Ecology of medium and small sized carnivore in Sariska tiger reserve, Rajasthan, India. *Ph.D Thesis Submitted to the Saurashtra University,* Rajkot, Gujarat.

Gupta S., Mondal K., Sankar K. and Qureshi Q. (2012). Abundance and habitat Suitability model for ratel (Mellivora capensis) in Sariska Tiger Reserve, Western India. *Wildl. Biol. Pract.,* **8(1):** 13-22.

Gupta S., Mondal K., Sankar K. and Qureshi Q. (2013). Diversity and Abundance of rodents in the semi-arid landscape of Sariska Tiger Reserve, Western India. *J. Bombay Nat. Hist. Soc.,* **110(2)** May-Aug 2013.

Hilborn R., Arcese P., Borner M., Hando J., Hopcraft G. and Loibooki M. (2006). Effective enforcement in a conservation area. *Science,* **314** (5803), 1266.

Jachmann H. (2008). Monitoring law-enforcement performance in nine protected areas in Ghana. *Biological Conservation,* **141(1):** 89-99.

Jachmann H. and Billiouw M. (1997). Elephant poaching and law enforcement in the central Luangwa Valley. Zambia. *J. Applied Ecology,* **34(1):** 233–244.

Johnsingh A.J.T. (2005). *Lessons from Uttaranchal. Frontline*. July **15**:65-71.

Johnsingh A.J.T., Sankar K. and Mukherjee S. (1997). Saving prime tiger habitat in Sariska Tiger Reserve. Cat News **27:3.**

Kanga S., Singh S.K. and Sudhanshu (2018). Landscape Classification of Sariska National Park (India) and its environment using Geospatial Technology. Research & Reviews: J. Space Science and Technology, **7** (1): 5-14p.

Karanth K.U. (2006). *A view from Machan: How Science can Save the Fragile Predator.* Permanent Black, Delhi.

Kidwai Z., Sankar K., Qureshi Q. and Khan J.A. (2011). Abundance and habitat utilisation by Galliformes in the Sariska Tiger Reserve, Rajasthan, India. Inter. *J. Galliformes Conservation,* **2**: 54-60

Kumar R. and Shahabuddin G. (2005). Effects of biomass extraction on vegetation structure, di versity and composition of an Indian tropical dry forest. *Environmental Conservation*, **32**(3): 1-12.

Leader-Williams N., Albon S.D. and Berry P.S.M. (1990). Illegal exploitation of black rhinoceros and elephant populations: Patterns of decline, law enforcement and patrol effort in Luangwa Valley. Zambia *J. Applied Ecology***, 27**(3): 1055-1087.

Martin E. (2010). Effective law enforcement in Ghana reduces elephant poaching and illegal ivory trade. *Pachyderm*, **48**: 24-32.

Mondal K. (2011). Ecology of leopard (*Panthera pardus*) in Sariska Tiger Reserve, Rajasthan. *Ph.D., Thesis, Saurashtra University*, Gujarat, India.

Mondal K., Gupta S., Qureshi Q. and Sankar K. (2011). Prey selection and food habits of leopard (*Panthera pardus*) in Sariska Tiger Reserve, Rajasthan. *Mammalia*, **75:** 201-205.

Mondal K., Sankar K., Qureshi, Q. Gupta and Chourasia P. (2012 a). Estimation of population and survivorship of Leopard *Panthera pardus* (Carnivore: Felidae) through photographic capture-recapture sampling in western India. *World J. Zoology*, **7(1):30**-39

Mondal K., Gupta S., Bhattacharjee S., Qureshi Q. and Sankar K. (2012b). Response of leopards to re-introduced tigers in Sariska Tiger Reserve, Western India,15 April, 2012. Inter. *J. Biodiversity and Conservation*, **4**(5): 228-236.

Mondal K., Gupta S., Bhattacharjee S., Qureshi Q. and Sankar K. (2012c). Prey selection, food habits and dietary overlap between leopard Panthera pardus (Mammalia: Carnivora) and re-introduced tiger Panthera tigris (Mammalia: Carnivora) in a semi-arid forest of Sariska Tiger Reserve, Western India. Italian J. Zoology, **79:**4: 607-616

Mondal K., Sankar K. and Qureshi Q. (2013a). Factors influencing the distribution of leopard in a semiarid landscape of Western India. *Acta Theriol.*, **58**:179-187

Mondal K., Bhattacharjee S., Gupta S., Sankar K. and Qureshi Q. (2013b). Home range and resource selection of 'problem' leopards trans-located to forested habitat. *Current Science*, **105** (3).

Moreto W.D., Lemieux A.M., Rwetsiba A., Guma N., Driciru M. and Kirya K.H. (2014). Law enforcement monitoring in Uganda: the utility of official data and Time-based ranger efficiency measures. *In: Situational prevention of poaching* (A. M. Lemieux (Ed.). London: Routledge.

Moreto W.D. (2016). Occupational stress among law enforcement rangers: Insights from Uganda. Oryx: *The Inter. J. Conservation,* **50:** 646-654.

Mukherjee S., Goyal S.P., Johnsingh A.J.T. and Pitman M.R.P.L. (2004). The importance of rodents in the diet of Jungle Cat (*Felis chaus*), Caracal (*Caracal caracal*) and Golden Jackal (*Canis aureus*) in Sariska Tiger Reserve, Rajasthan, India. *J. Zoology*, **262**: 405-411.

Poddar A. (2017). Effectiveness of Forest and Wildlife Laws in India. *Imperial J. Interdisciplinary Research (IJIR)*, **3** (4).

Rodgers W.A. and Panwar H.S. (1988). *Planing a wildlife protected area network in India* Vol. I & II Wildlife Institute of Dehradun.

Sankar K., Mohan D. and Pandey S. (1993). Birds of Sariska Tiger Reserve, Rajasthan, India. *Forktail,* **8**: 133-141.

Sankar K. (1994a). Ecology of three large sympatric herbivores (chital, sambar, nilgai) with special reference to the reserve management in Sariska Tiger Reserve, Rajasthan. Ph.D., Thesis. University of Rajasthan. Jaipur, India

Sankar K. (1994b) Painted spurfowl (*Galloperdix lunulata*) in Sariska Tiger Reserve, Rajasthan. *J. Bombay Nat. His. Soc.,* **90**:289

Sankar K. and Johnsingh A.J.T. (2002). Food habits of tiger (*Panthera tigris*) and leopard (*Panthera pardus*) in Sariska Tiger Reserve, Rajasthan, India, as shown by scat analysis. *Mammalia,* **66**: 285–289.

Sankar K., Goyal S.P. and Qureshi Q (2005) Assessment of status of tiger in Sariska Tiger Reserve, Rajasthan. A Report submitted to the Project Tiger, Ministry of Environment and Forests, Govt. of India, New Delhi.

Sankar K., Qureshi Q., Mondal K., Worah K.D., Srivastava T. and Gupta S. (2008) Ecological studies in Sariska Tiger Reserve. Report submitted to National Tiger Conservation Authority, Govt. of India, New Delhi and Wildlife Institute of India, Dehradun. 145 pp.

Sankar K., Qureshi Q., Mondal K., D. Worah, T., Shrivastava S. Gupta and Basu S. (2009). Ecological studies in Sariska Tiger Reserve, Final Report submitted to National Tiger Conservation Authority Gov. of India, New Delhi. Wildlife Institute of India, Dehradun.

Sankar K., Qureshi Q., Nigam P., Malik P.K., Sinha P.R., Mehrotra R.N., Gopal R., Bhattacharjee S., Mondal K. and Gupta S. (2010). Monitoring of reintroduced tigers in Sariska Tiger Reserve, Western India: Preliminary findings on home range, prey selection and food habits. *J. Trop. Conserv. Sci.,* **3**(3): 301-318

Sankar K., Nigam P., Malik P.K., Qureshi Q. and Bhattacharjee S. (2013) Monitoring of Reintroduced Tigers (*Panthera tigris tigris*) in Sariska Tiger Reserve, Rajasthan. Technical report-1. July 2008-March 2013. Wildlife Institute of India, Dehradun. 141 pp.

Shahabuddin G. and Kumar R. (2005). Linkages Between Human Use of Forests and Biodiver sity Indicators in Sariska Tiger Reserve, Rajasthan. Paper presented at seminar on 'Making Conservation Work: Attempting Solutions to Biodiversity Loss in India. Council for Social Development, March 11-12.

Shahabuddin G., Kumar R. and Shrivastava M. (2005). Forgotten Villages: A People's Perspective on Relocation from Sariska Tiger Reserve. Technical Report, Council for Social Development, New Delhi.

Shahabuddin G., Kumar R. and Verma A. (2006). Annotated checklist of the birds of Sariska Tiger Reserve, Rajasthan, India. *Indian Birds,* **2** (3): 71-76.

Shahabuddin G., Kumar R. and Shrivastava M. (2007). Creation of 'inviolate space': Lives, livelihoods and conflict in Sariska Tiger Reserve. *Economic & Political Weekly,* **42**(20): 1855-1862.

Sharma R.K., Jhala Y.V., Qureshi Q., Vattakaran J., Goyal R. and Nayak K. (2009). Evaluating capture recapture population density estimating of tigers in a population with known parameter. *Animal Conservation,* **13:** 94-103

Shekhawat R.S. (2015). Tiger Conservation Plan of Sariska Tiger Reserve, 2015

Terborgh J., Schaik C. van, Davenport L. and Rao M. (2002). Making Parks Work: Strategies for Preserving Tropical Nature. Island Press, USA.

Singh V.P., Singh B., Thapar V., Tanwar R.S., Wright B., Mathur V.B. and Kapoor R.P. (2005). *Securing the future. The Report of the State Empowered Committee on Forests and Wildlife Management*. Govt. of Rajasthan. August, 2005

Tiwari P. and Sharma J.V. (2017). Economic valuation of Sariska Tiger Reserve with special reference to village relocation (Problems, Constraints and Possible Solutions. A report submitted to Rajasthan Forest Department.

Torri C. M. (2011). Conservation, Relocation and the Social Consequences of Conservation Policies in Protected Areas: Case Study of the Sariska Tiger Reserve, India. *Conservation and Society*, **9 (1):** 54-64. 2011

Vikram E. (2017). Email dated 18/12/17. PFA analysis of Forest Cover Change based on ISFR 2005 and 2015.

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