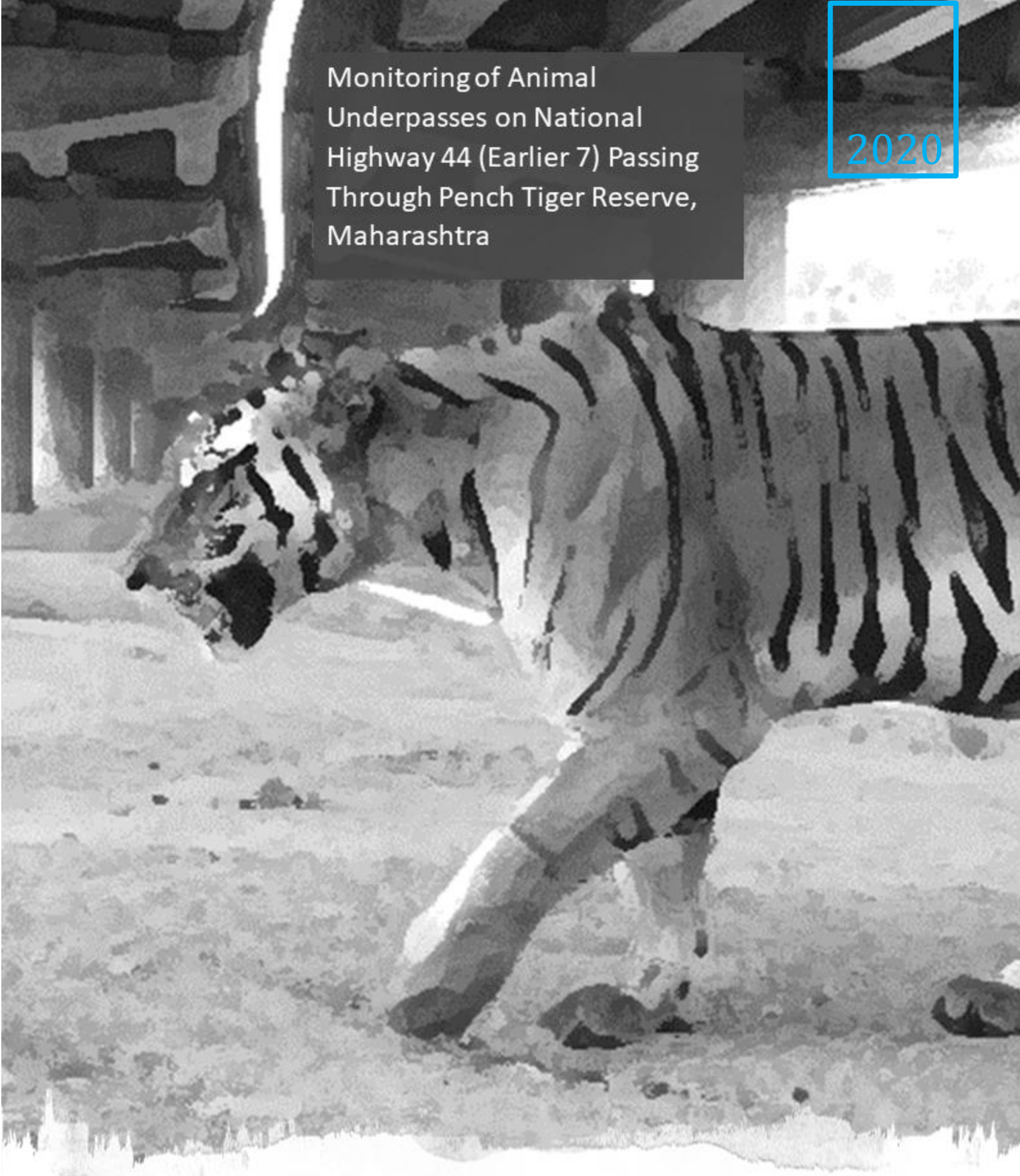
Monitoring of Animal Underpasses on National Highway 44 (Earlier 7) Passing Through Pench Tiger Reserve, Maharashtra

2020



ECOLOGICAL IMPACT ASSESSMENT OF EXISTING AND PROPOSED ROAD INFRASTRUCTURE ON IMPORTANT WILDLIFE CORRIDORS IN INDIA FOR STRATEGIC PLANNING OF SMART GREEN INFRASTRUCTURE

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Wildlife Institute of India

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Contents

Executive Summary

As part of the project funded by the National Tiger Conservation Authority, New Delhi, three sites were chosen for study- the Central Indian tiger landscape including major roads cutting across the animal corridors in the landscape, the National Highway 37 (now 715) cutting through the Kaziranga-Karbi Anglong landscape in Assam, and the State Highway 33 passing through the Nagarhole Tiger Reserve, Karnataka.

As part of the project, we also monitored the animal underpasses constructed on the National Highway 44 passing through the Pench Tiger reserve, Maharashtra. We used camera traps to capture movement of animals under the nine crossing structures during March-December 2019. We found 18 species of wild animals that were using the crossing structures, with varying frequencies. Seven species of small mammals were found to use the structures. These included Indian hare and jungle cat, which are the most frequent users of the underpasses, and the rare rusty spotted cat. Among wild ungulates, the five major species viz., spotted deer, gaur, nilgai, sambar and wild pig were found to use the structures. Spotted deer and wild pig were the most frequent visitors to the underpasses. Tiger, leopard, wild dog, sloth bear and jackal, the major carnivore species in the landscape, were found using the structures with varying frequencies. Wild dogs were found to use the structures the most, followed by tigers. A total of 89 tiger crossings were recorded from six of the nine structures, by 11 individual tigers.

1. Introduction

Roads, railway lines and other linear infrastructure are important for a developing country like India for the transport of people, goods, power and other amenities. With goals of long-term economic and social growth, India is pursuing extensive road development and upgradation projects across the length and breadth of the country. India is also home to a rich assemblage of biodiversity and forest resources, and the goals of infrastructure development and expansion are increasingly coming into conflict with the conservation of forests and natural resources.

In India, about 50,000 km of road development projects have been identified to be completed over the next 5-6 years alone. Given this rate of development of new roads and upgradation of old roads, it is imperative today to find ecologically-sound solutions to the challenges posed by road-building in natural areas. Underpasses i.e. bridge-like structures that allow for movement of wild animals across roads while vehicular traffic passes above grade, are among the commonly used strategies the world over to reduce wildlife-vehicle collisions and enhance permeability of wildlife corridors (Mark, 2014). However, the effectiveness of underpasses are subject to various factors such as dimensions, proximity to human settlements or degree of human presence, presence of natural drainage etc. (Jackson and Griffith, 2000). It is important to assess role of these factors in crossing structure use (Rytwinski, 2016), and such studies can inform mitigation needs of species and animal communities, the design of future crossing structures, and improvements to existing structures that may enhance structure use.

Central India, consisting of parts of Maharashtra, Madhya Pradesh and Chhattisgarh states, is one of the regions in India where roads are being developed at an accelerated pace. The region boasts of a thriving economy based on agriculture, tourism and mining, and road development is being seen as a means of achieving several development goals. This landscape has also been recognised as one of the regions with the highest potential for long-term tiger conservation in the country and is home to rich biodiversity within and outside of the protected area network. Several roads pass through these forested tracts and threaten the viability of long-term conservation goals in this important tiger landscape.

As part of the National Highways Development Program (NHDP), National Highway 7 (now 44) was proposed to be upgraded from a 2-lane to a 4-lane highway. The highway is critical for connecting the south to the north, as well as major urban and commercial centres along the north-south transportation corridor. However, many sections of the highway also cut through animal corridors, critical for connecting tigers, co-predators and their prey. In the central Indian tiger landscape, the highway intersected the Kanha-Pench and Pench-Navegaon-Nagzira corridors in different sections.

Permission for upgradation of the highway was granted with the condition of provision of animal crossing structures at animal crossing zones to reduce animal-vehicle collisions and animal mortality and ensure habitat contiguity in the landscape. Locations for nine animal crossing structures in the Maharashtra section of the highway were suggested vide report titled “Proposed Mitigation Measures for Maintaining Habitat Contiguity and Reducing Wild Animal Mortality on NH6 & 7 in the Central Indian Landscape” by the Wildlife Institute of India and the National Tiger Conservation Authority, New Delhi (Habib et. al., 2015; 2016).

The animal underpasses on the National Highway 44 passing through the Pench Tiger Reserve, Maharashtra, are being monitored by the Wildlife Institute of India, Dehradun since March 2019. Camera

trapping and continuous monitoring were carried out on four minor bridges (MNBs) and five animal underpasses (AUPs). The structures are located along a 16.1 km section of the highway that cuts across the tiger reserve and adjoining forests in 3 forest segments. The locations of the structures is depicted in Figure 1, and a brief description of the structures is provided in Table 1. The findings of the first year of monitoring are presented in this report.

Table 1: Details of animal crossing structures built as part of the mitigation plan for National Highway 44 passing through Pench Tiger Reserve, Maharashtra.

Forest Patch	*Location*	*Structure Number*	*Structural Dimensions*	
1	Between Manegaon Tek & Wadamba	MNB1	Structure Guide walls (both sides)	60 50+ 50
		AUP2	RCC structure Approach (both sides) Guide walls (both sides)	50 300 + 300 50 + 50
		AUP3	RCC structure Approach (both sides) Guide walls (both sides)	750 300 + 300 50 + 50
		MNB4	Structure Extension Guide walls (both sides)	80 50 + 50
		AUP5	RCC structure Approach (both sides) Guide walls (both sides)	300 300 + 300 50 + 50
2	Between Bothiya & Deolapar	MNB6	Structure Extension Guide walls (both sides)	65 100 + 100
3	Between Chorbauli & Pauni	AUP7	RCC structure Approach (both sides) Guide walls (both sides)	100 300 + 300 50 + 50
		AUP8	RCC structure Approach (both sides) Guide walls (both sides)	750 300 + 300 50 + 50
		MNB9	Structure Extension Guide walls (both sides)	50 250 + 250

*AUP- animal underpass; MNB – minor bridge

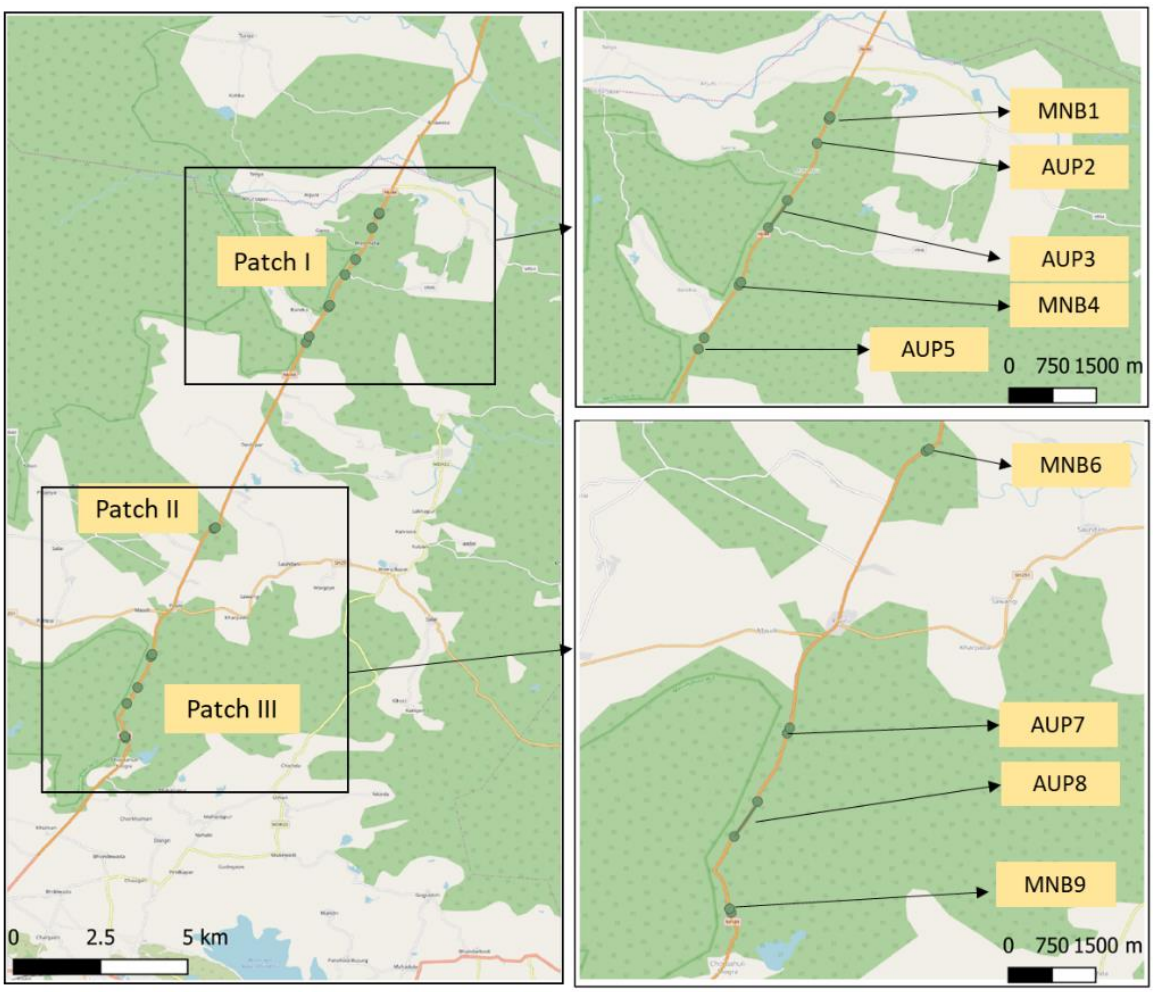


Figure 1: Locations of animal underpasses on National Highway 44

2. Monitoring Design and Plan

Animal movement under the crossing structures was sampled using remotely triggered camera traps set up at the beginning of the monitoring (7th – 8th February 2019), and regularly monitored till the end of the year (27th December 2019). A total of 72 cameras were deployed on the 9 structures, which was subsequently increased to 78. The details of number of cameras per structure are given in Table 2.

Table 2. Structure-wise details of camera traps deployed.

S. No	*Structure*	*Structure ID*	*Area (range)*	*No. of cameras*
1.	Minor bridge (60 m)	MNB1	Deolapar (T)	3
2.	Underpass (50 m)	AUP2	Deolapar (T)	2
3.	Underpass (750 m)	AUP3	Deolapar (T)	24
4.	Minor bridge (80 m)	MNB4	Deolapar (T)	4
5.	Underpass (300 m)	AUP5	Deolapar (WL)	10
6.	Minor bridge (65 m)	MNB6	Pauni (WL)	3
7.	Underpass (100 m)	AUP7	Pauni (WL)	5
8.	Underpass (750 m)	AUP8	Pauni (WL)	25
9.	Minor bridge (50 m)	MNB9	Chorbauli (WL)	2

Camera traps were deployed keeping in mind the FOV and range of the cameras. We attempted to cover the entire width of the crossing structures, and cameras were deployed on all spans of the crossing structures.

Data was downloaded fortnightly and reports were prepared. The downloaded images were sorted into species-wise folders (including humans, wild and domestic/feral animals). This data was then used to generate a record table with information on camera ID structure ID, species captured and date and time of capture, for further analyses.

3. Summary of findings

A total of 1,26,532 images of wild, domestic and feral animals, and humans were obtained from an effort of 23,628 camera days. This includes images of single animal crossing events as well as multiple images of the same individuals/groups of animals (referred to as 'use' by animals) and humans. Trapping effort per site (number of camera traps per structure x number of operational days) varied because of varying widths of the crossing structures (Table 3).

Table 3: Trapping effort per crossing structure during the monitoring period

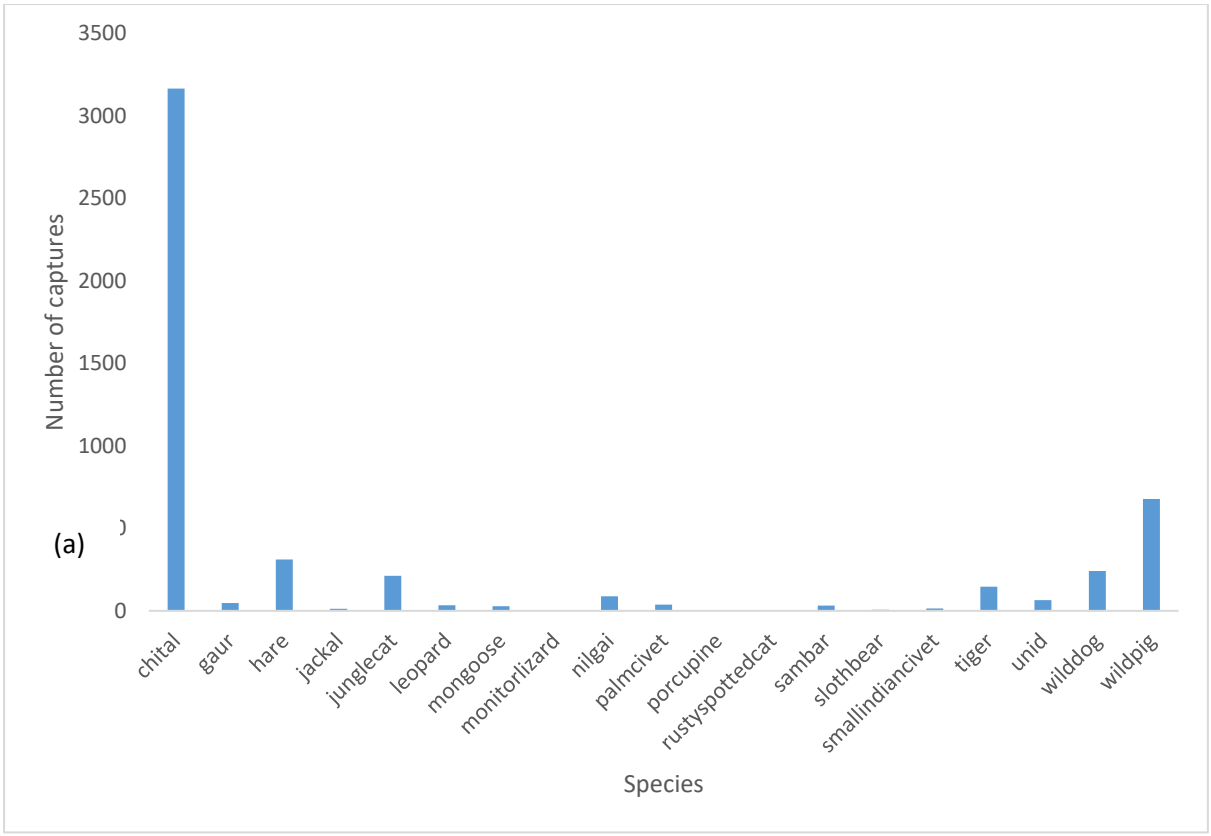
Underpass ID	*Width (in m)*	*Trapping effort per site*
MNB1	60	930.9
AUP2	50	657
AUP3	750	7115.4
MNB4	80	1247
AUP5	300	2804
MNB6	65	794.8
AUP7	100	1577
AUP8	750	7865
MNB9	50	638

A total of 18 different wild species were captured during the monitoring this year (Table 4). These include wild ungulates viz., spotted deer, sambar, gaur, nilgai and wild pig, large and medium-sized carnivores viz., tiger, leopard, sloth bear, jackal and wild dog, small mammals viz., hare, jungle cat, mongoose, common palm civet, porcupine, rusty spotted cat and small Indian civet. Monitor lizards were also captured using the structures on two occasions.

Table 4: A summary of wild, domestic and feral animals and humans captured during the first year of underpass monitoring

Species	Scientific name	Count of captures
Chital	*Axis axis*	3165
Dog	*Canis lupus familiaris*	11526
Gaur	*Bos gaurus*	47
Hare	*Lepus nigricollis*	311
Human	*Homo sapiens*	51637
Golden jackal	*Canis aureus*	12
Jungle cat	*Felis chaus*	212
Leopard	*Panthera pardus*	34
Livestock	*NA*	26072
Mongoose	*Herpestes sp.*	28
Monitor lizard	*Varanus indicus*	2
Nilgai	*Boselaphus tragocamelus*	89
Common palm civet	*Paradoxurus hermaphroditus*	38
Peafowl	*Pavo cristatus*	2
Indian porcupine	*Hystrix indica*	3
Rusty spotted cat	*Pionailurus rubiginosus*	1
Sambar	*Rusa unicolor*	31
Sloth bear	*Melursus ursinus*	6
Small Indian civet	*Viverricula indica*	15
Tiger	*Panthera tigris*	147
Unidentified	*NA*	65
Wild dog	*Cuon alpinus*	242
Wild pig	*Sus scrofa*	677

Highest captures obtained under the crossing structures were of spotted deer/chital (n=3165), followed by wild pig (n=677) and small mammals like hare (n=311) and jungle cat (n=212) (Figure 2 (a and b). Among carnivores, wild dogs (n=242) were captured the most.



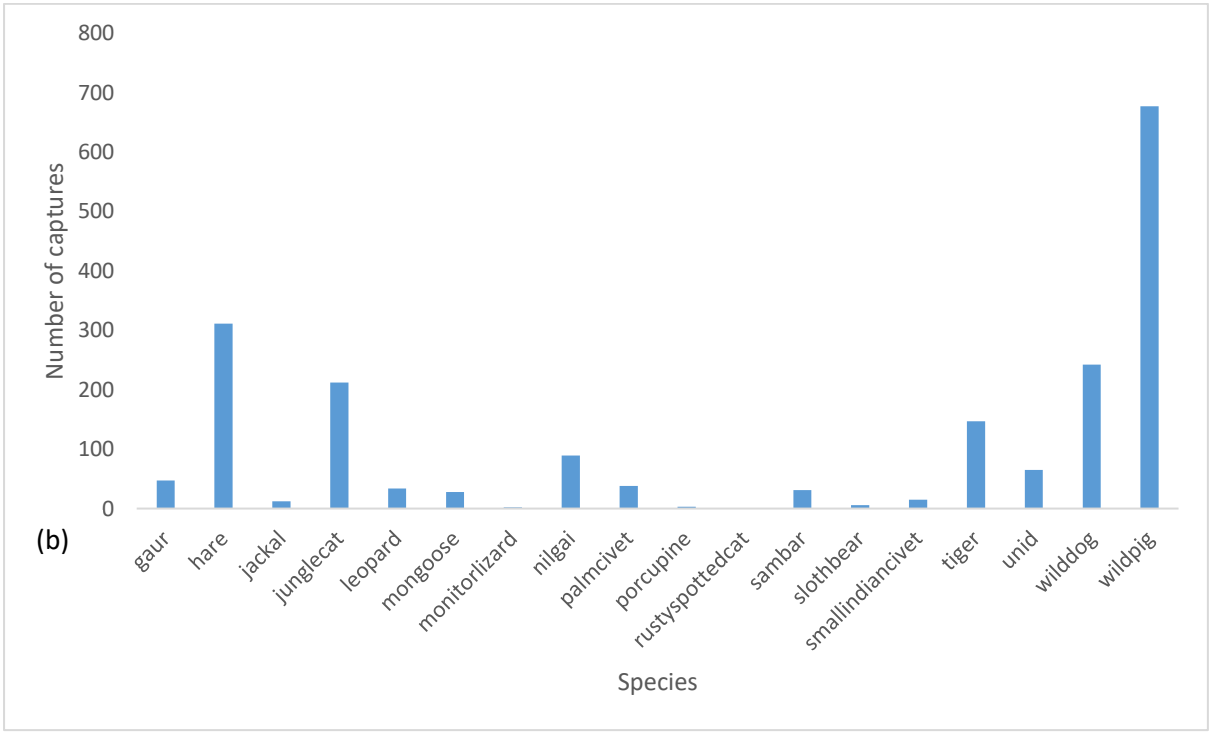


Figure 2: (a) A comparison of capture numbers among wild animal species using the animal crossing structures on NH 44; (b) comparison excluding chital

4. Structure-wise use of underpasses

Among crossing structures, higher capture rates for wildlife (wild animals captured per camera per day) were recorded under AUP7 (100m) and MNB9 (50m). Highest number of species were captured under AUP8 (14 species), followed by AUP3 (13 species) (Figure 3).

Spotted deer and wild pig were the most frequent wild ungulate visitors under all 9 of the crossing structures. High capture rates spotted deer were recorded from AUP7 (100m) and MNB9 (50m). Wild pigs were also found to frequent most structures, but the highest capture rates were recorded from under AUP2 (50 m) and MNB9 (50m) (Figure 4(a)).

Most number of small mammal species (6 of 7 species recorded) were recorded from AUPs 3 and 8 (both 750 m) (Figure 4(b)). Highest small mammal capture rate was recorded from MNB9 (50m) and AUP5 (300m). Jungle cat and hare were the most frequently captured small mammals, and were captured from all crossing structures.

Highest capture rates of carnivores were recorded from AUPs 7 and 8 (100m and 750 m). Four out of the five carnivore species were captured from AUP5 (300m). The highest carnivore capture rates were recorded for wild dogs, followed by tigers (Figure 4(c)).

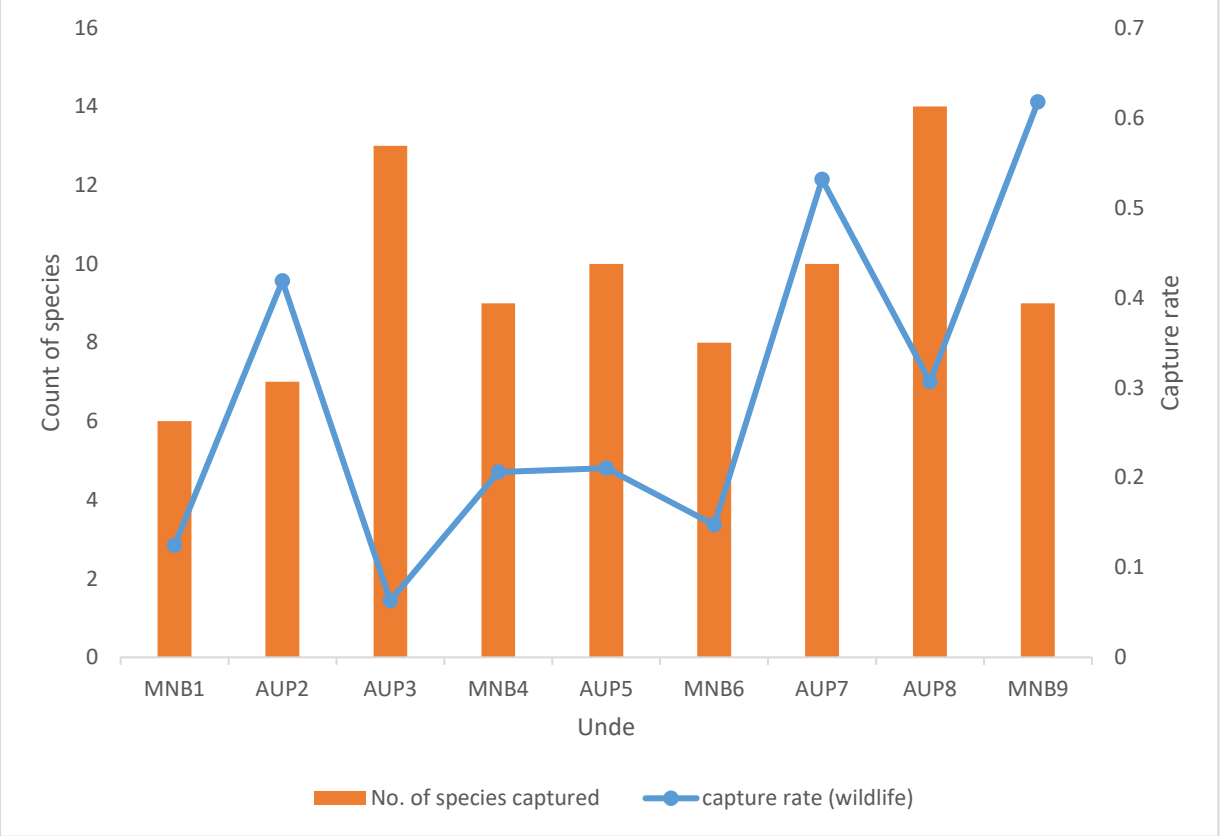
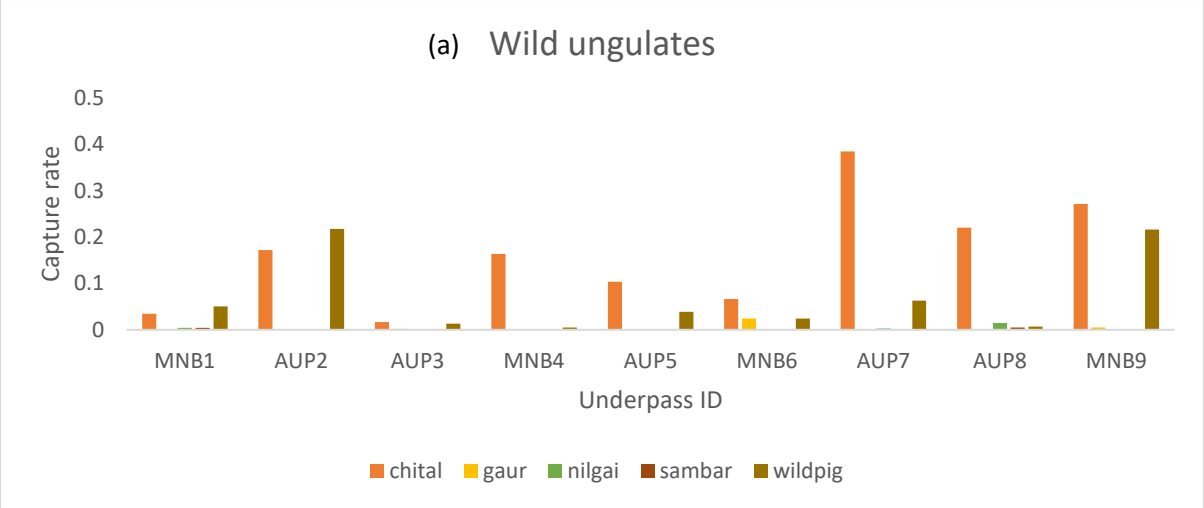
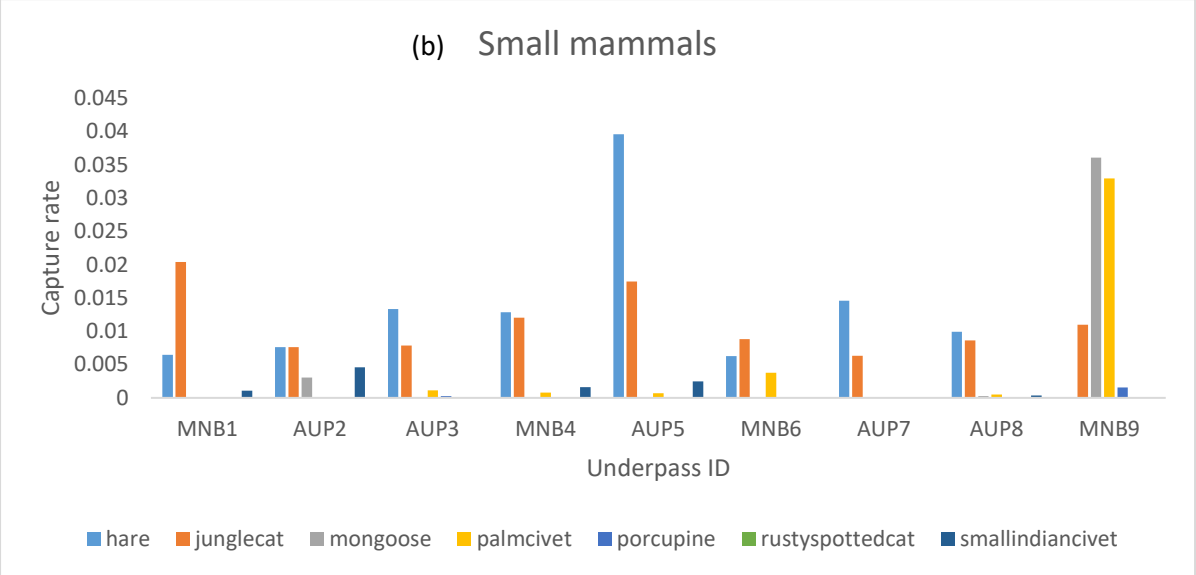


Figure 3: Capture rates and number of wild species recorded under different crossing structures





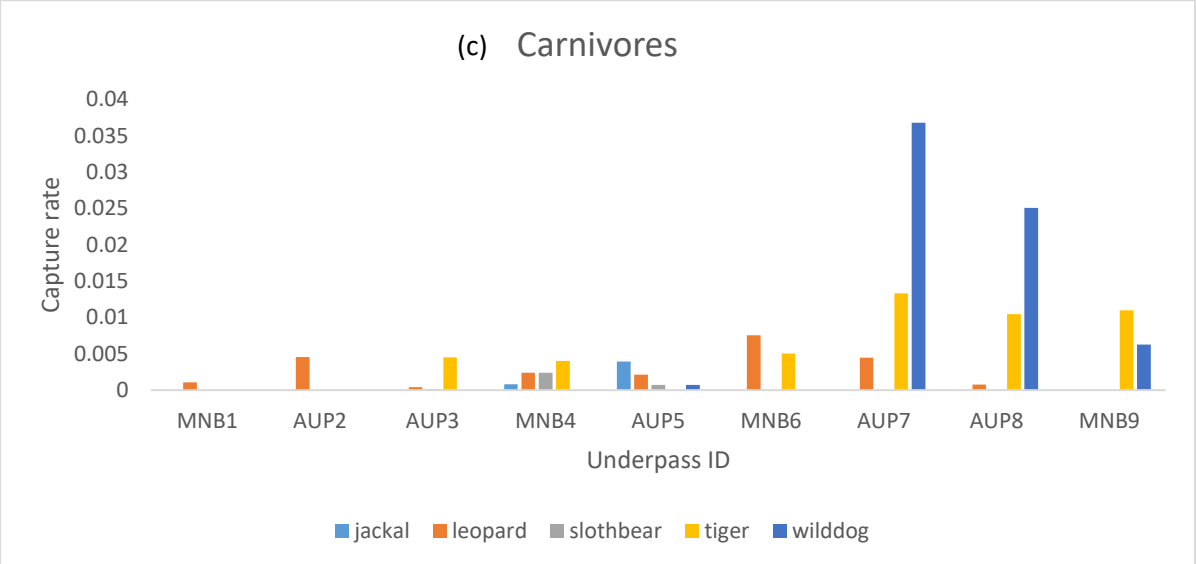


Figure 4: Relative performance of different animal underpasses with respect to capture rate of (a) wild ungulates, (b) small mammals and (c) carnivores.

Use vs. crossing

Wildlife were observed to use the crossing structures in two ways: crossing – which is the movement of animals across (perpendicular to) the structure (Figure 5(a)), and use – which is the movement of animals near the underpass either grazing or walking parallel to the structure and not crossing (Figure 5(b)). For a single individual/group of individuals, one or both of the actions were observed.

Using camera trap data from March – May 2019, we calculated the rates of crossing and use for all species and crossing structures. The rate of crossing was calculated as the total number of occasions an animal/group of animals crossing a structure divided by the total number of animals of that species that were photographed in front of the structure. The rate of use was calculated as the total number of occasions an animal/group of animals was photographed using (and not crossing) the structure divided by the total number of animals of that species that were photographed in front of the structure.

$$cross\ rate = \frac{animal\ crossing}{total\ number\ of\ animal\ captures}$$

$$use\ rate\ = \frac{animal\ using\ the\ structure}{total\ number\ of\ animal\ captures}$$

Figure 5 (a): A crossing event is defined as the movement of an animal across/towards a crossing structure

Figure 5 (b): Use of underpass by animal is defined as the parallel movement near the structure (not crossing).

The rates at which animals crossed and used the underpasses varied between species (Figure 6). Only crossing events were recorded for leopard, palm civet, porcupine and sloth bear. Gaur, hare, jungle cat and tiger showed higher rate of use than crossing. Chital, mongoose, nilgai, sambar, wild dog and wild pig also used the crossing structures, but the rate of crossing was higher. Higher rate of use could mean greater amount of time spent under the underpasses grazing or walking parallel to the structures.

The rates of crossing and use varied among crossing structures as well (Figure 7). Highest rate of crossing was observed under structure AUP2. In terms of number of occasions, highest number of crossings were observed under structures AUP7 and AUP8.

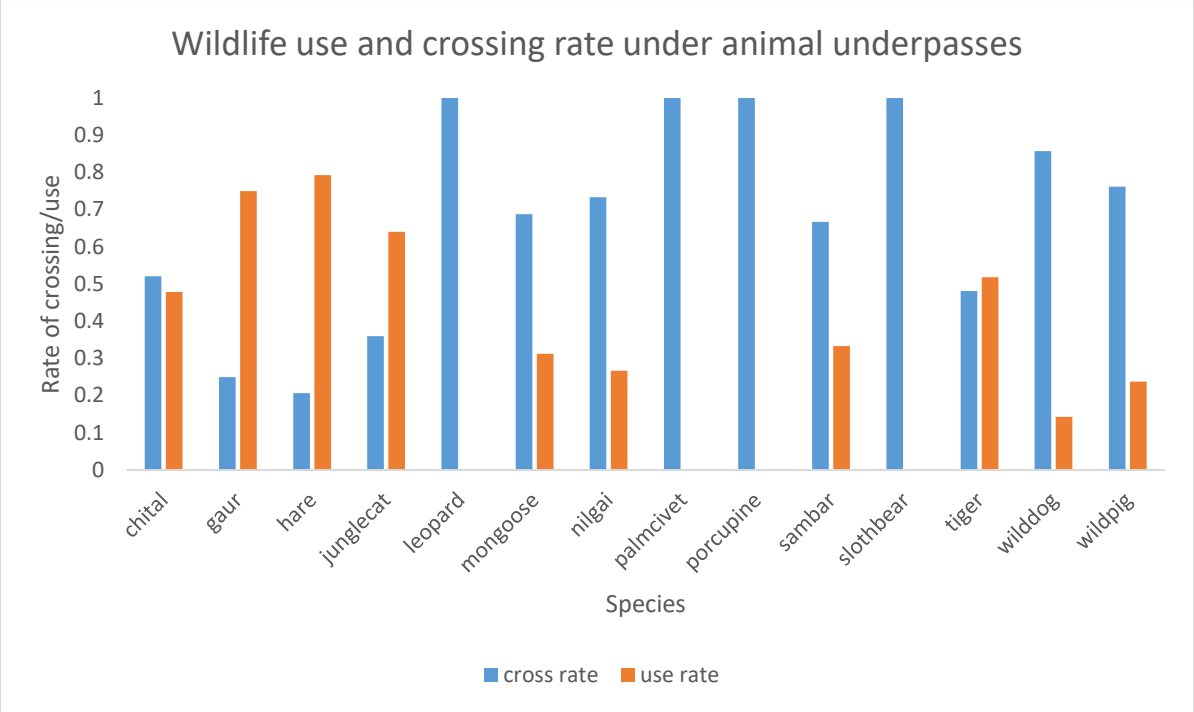


Figure 6: Rates of crossing and use of underpasses by wildlife

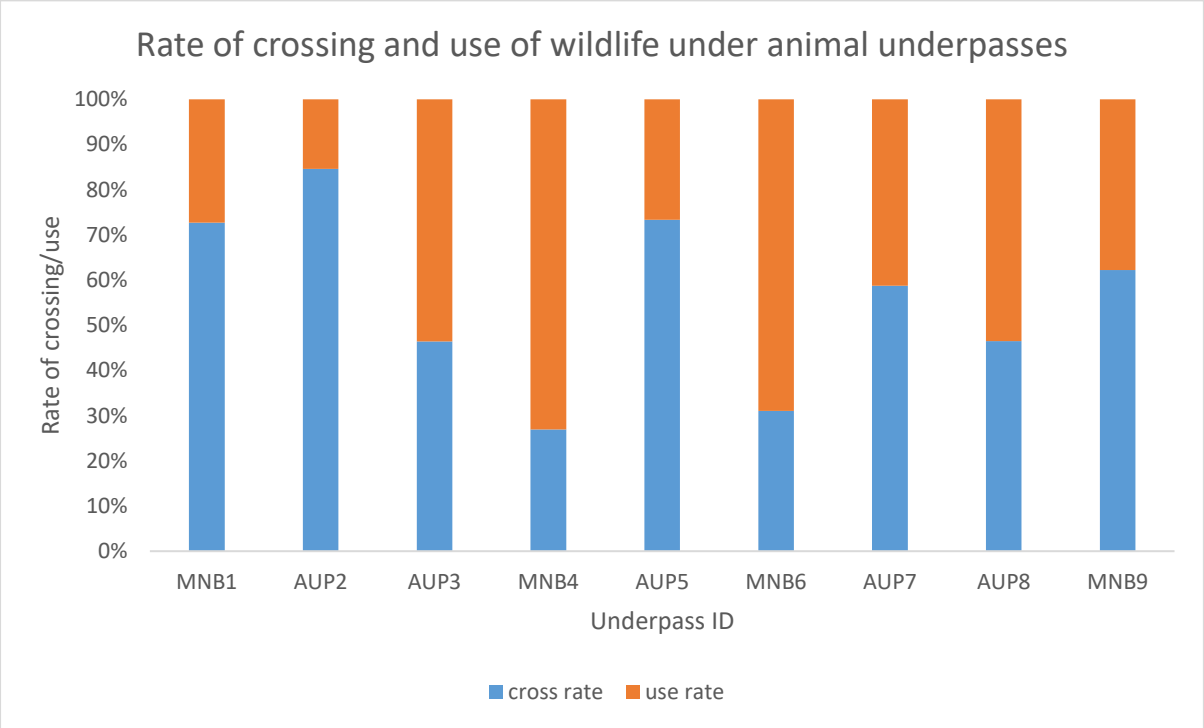


Figure 7: Comparison of crossing and use rates by wildlife under different underpasses.

5. Species-wise use of crossing structures

Time taken to use crossing structures (Figure 8), capture rates and the number of structures being used by different species would depend on the behaviour and local abundance of species.

Jungle cat, spotted deer, hare and tiger were among the first users of the underpasses that were captured within 10 days of the start of the monitoring, while species like leopard, sloth bear, jackal and rusty spotted cat were captured much later during the monitoring.

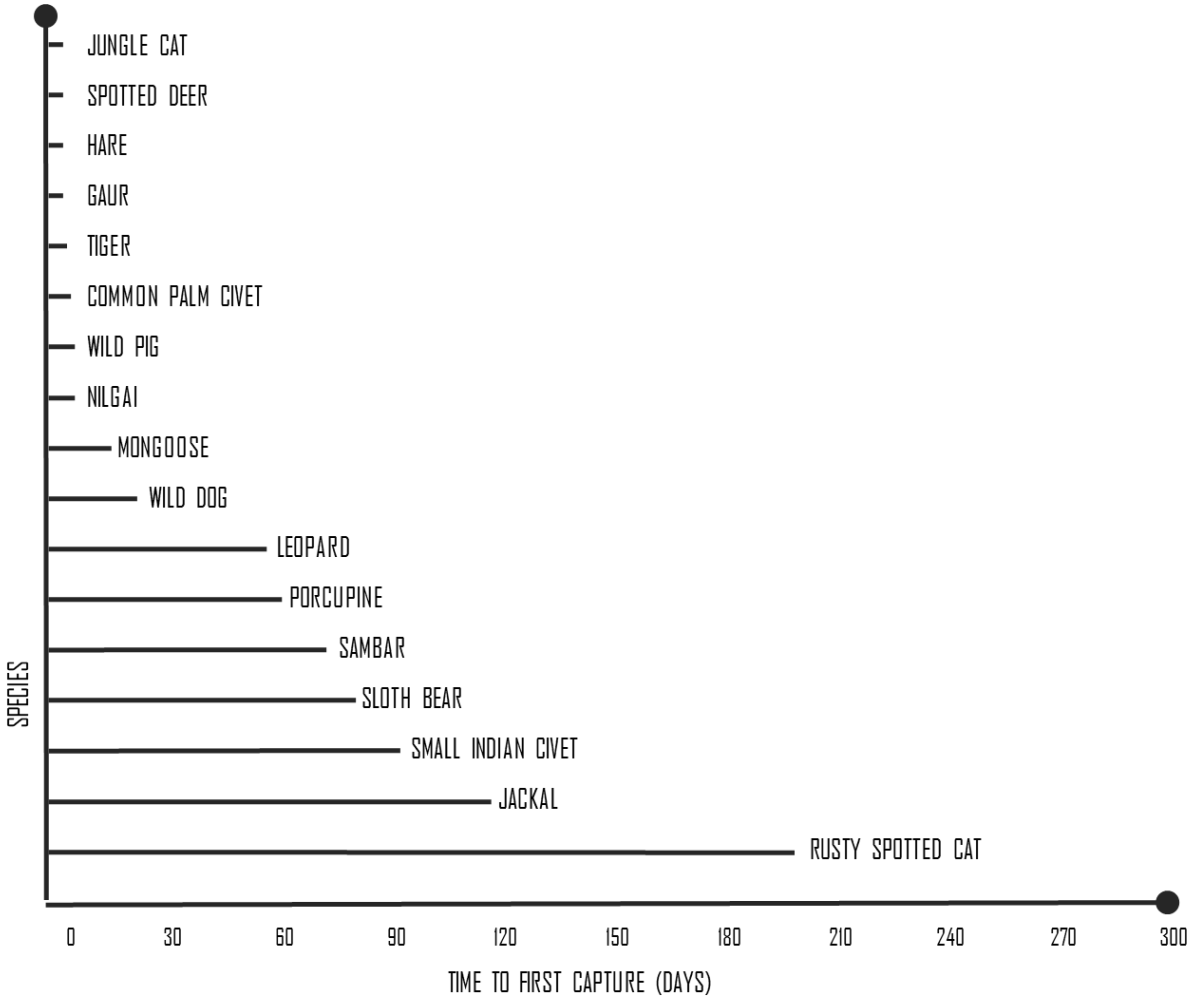


Figure 8: Time taken (in days) for different species to use the crossing structures

Among wild ungulates, spotted deer and wild pig are the most frequent users of the underpasses, and were recorded from all nine structures (Table 5). Among small mammals, hare and jungle cat are the most frequently recorded species, and were found to use most crossing structures. Among carnivores, wild dog followed by tiger were the most frequent users of the crossing structures, but were captured from only 4 and 6 structures respectively. Leopards were the most widespread in terms of number of crossing structures used (8 out of 9).

Table 5: Species-wise captures and number of crossing structures being used during the monitoring period

Species	Total captures	Number of underpasses used
Spotted deer	3324	9
Gaur	52	5
Nilgai	123	4
Sambar	46	3
Wild pig	708	9
Hare	339	8
Jungle cat	236	9
Mongoose	28	4
Palm civet	39	6
Porcupine	3	2
Rusty spotted cat	1	1
Small Indian civet	17	6
Jackal	12	2
Leopard	35	8
Sloth bear	6	3
Tiger	151	6
Wild dog	261	4

6. Use of underpasses by tigers

A total of 89 tiger crossings were recorded from six of the nine crossing structures. A total of 11 tiger individuals including 5 males, 3 females and 3 sub adults were identified using the crossing structures (Figure 9). 10 of the 11 recorded individuals were found to use the structures repeatedly (more than one occasion). On 25% of all crossing occasions, tigers were found to 'use' structures, i.e., they were captured on multiple camera traps walking parallel to or under the structures in the same occasion.

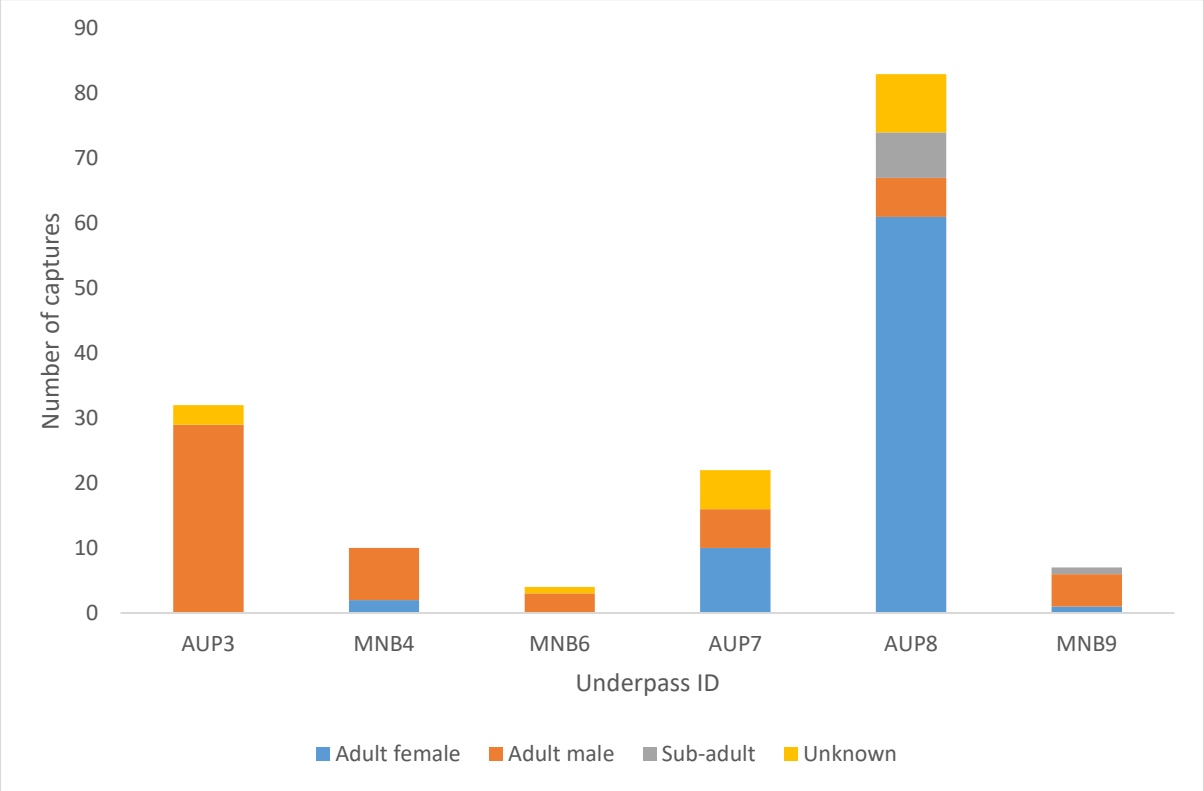


Figure 9: Number of captures of tigers of different age-sex classes under crossing structures

7. Human presence under crossing structures

The degree of use of the structures varies with species, and could be a function of the behavior of the animals and the time they would take to get accustomed to the new structures. Difference in relative use of the structures by wildlife is also a function of anthropogenic use/disturbance operating in the crossing structures. We found that generally crossing structures with low human, livestock and dog captures had greater number and diversity of wild animals using the structures, and vice versa.

A total of 91,284 captures of humans, domestic cattle, feral and domestic cats and dogs were obtained from the underpasses (Figure 10). Presence of anthropogenic disturbances under crossing structures was found to reduce the use of the structures by wildlife.

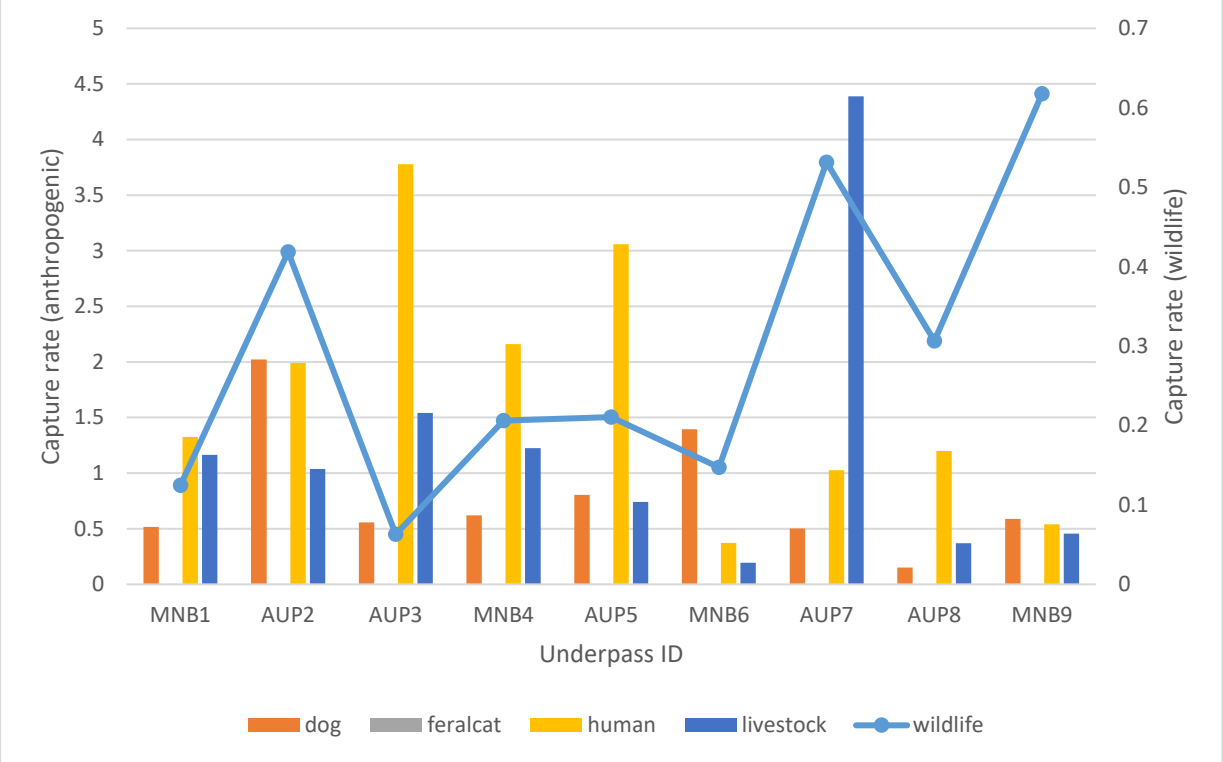


Figure 10: Capture rates of wild, feral and domestic animals, and humans under different underpasses

However, efforts to reduce human-related presence under the structures have resulted in increased use by wildlife (Figure 11 (a) and (b)). Both structures have village roads and small dirt roads that were used by the locals. However, efforts to divert and reduce the use of these roads by humans has resulted in visible increase in use of these underpasses by wildlife.

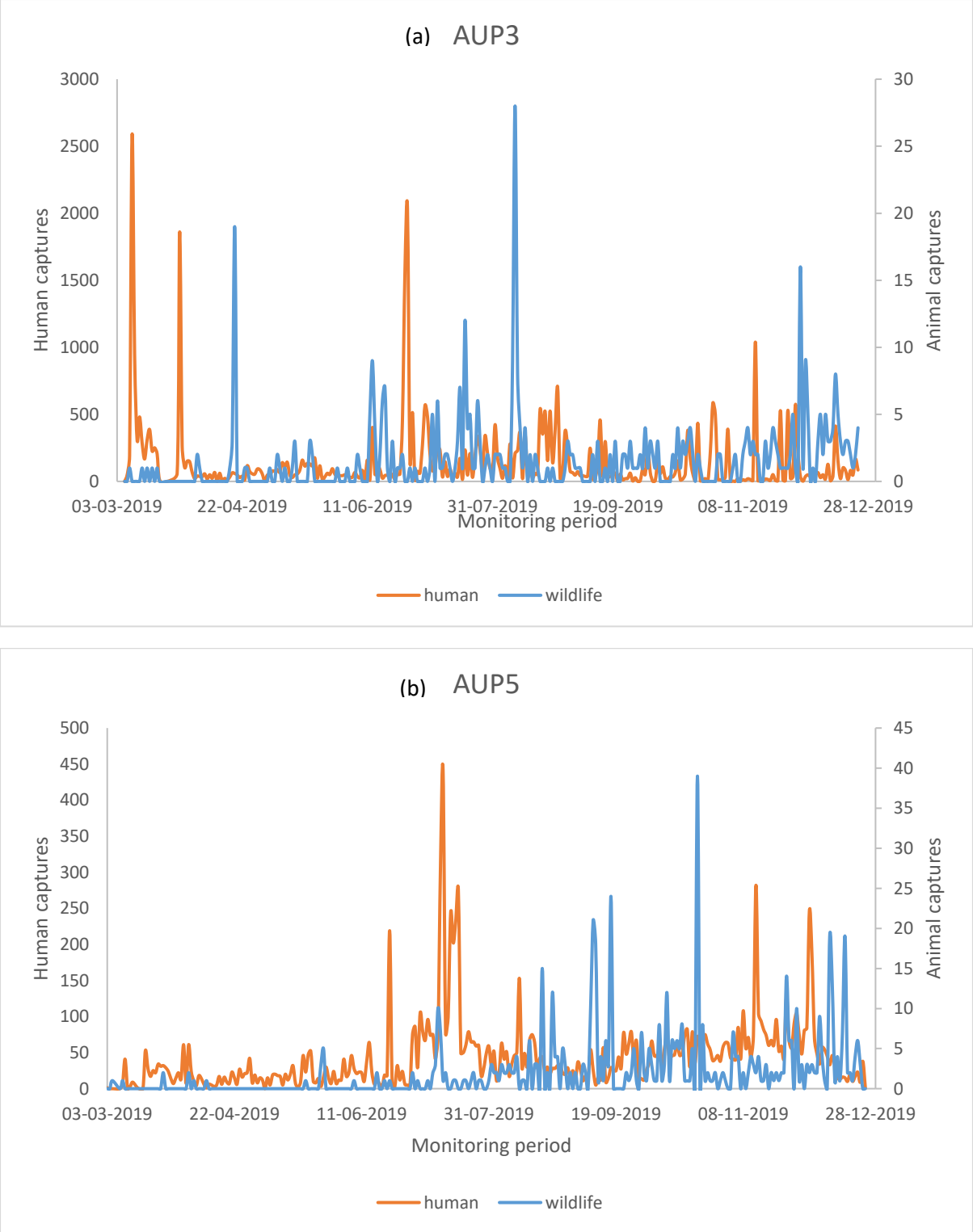


Figure 11: Trend of human and wild animal captures during the monitoring period under (a) AUP3, and (b) AUP5.

8. Observations and suggestions

Some common actions for habitat improvement and reduction of anthropogenic pressure under the crossing structures are suggested as outlined below.

i. *Levelling/ terracing/ merging with surrounds:* Presently the terrain in the vicinity of some structures is undulating. This has happened because of dumping and excavation of soil near the structures, creating steep slopes which are not suitable for movement of some wild animals. It is suggested to smoothen these slopes. Near the ends of the structures where such slopes exist and where it may not be possible to completely remove the soil, it is suggested to carry out terracing combined with pitching. This would also arrest any soil erosion during the rainy season.

ii. *Planting of shrubs/ grass:* The substrate near many structures is currently devoid of any vegetation, and this lack of shrub/herbaceous cover could inhibit movement/use by some animals. The substrate has also become compact owing to construction and post-construction activities. It is therefore suggested to plough the substrate, and subsequently planting of suitable native vegetation may be carried out.

iii. *Painting of pillars/ walls with camouflage paints:* To merge the concrete structures with the surrounding natural habitat, it is suggested to paint the structures with natural-looking shades that would camouflage the concrete appearance of the structures. Tested shades such as Corbett brown, Corbett green or any other camouflage colours as appropriate are suggested.

iv. Daily patrolling by forest guards, weekly patrolling by the round officers and fortnightly by the concerned range officers

v. Weekly cleaning of the underpasses.

vi. All approaches to the underpasses from the main highway should be closed off by excavation or planting of thorny bushes (e g., *Zizyphus*). Bushes may also be planted near the guide walls.

vii. Dirt roads from the forest may be created for monitoring, patrolling and maintenance purposes

viii. Creation of trails to enhance use by wildlife may be taken up.

ix. Habitat enrichment measures such as placement of logs and branches in addition to increasing vegetative cover near and below the underpasses.

x. Planting of suitable herbs and grassy vegetation under the structures.

xi. A monthly/bi-monthly routine for maintenance works by the highway agency may be drawn, and the concerned range officers informed accordingly. Such activities should be restricted to daytime (10 am – 3 pm) and completed with minimal machinery to avoid disturbance to wildlife.

xii. Simple and minimal sign boards may be put up at the beginning of the forest stretches informing the public about the underpasses. These may include messages about the highway stretch being

animal corridors, do's and don't's such as no littering, no stopping, feeding macaques/langurs. The sign boards should be designed using a maximum of 2-3 colours (preferably only green and black), with silhouettes of representative animals and minimal text, as this tends to increase the visibility of the sign boards. Reflective material (radium) may be used to make the sign boards visible at night.

xiii. Disposal of waste under the crossing structures by passing trucks that transport poultry, livestock and fish is a major issue. The waste acts as an attractant to feral dogs and wild pigs and could also be a source of diseases. Adequate enforcement to catch and fine culprits in association with highway agencies could help reduce the problem.

Protection Measures

Barricading

Villagers, livestock and feral and domestic dogs have been found using 4 out of the 9 crossing structures. Fewer wild animals have been photocaptured at these structures. It is therefore suggested to take steps to reduce this anthropogenic presence in the crossing structures. The dirt roads that used to access the crossing structures could be barricaded or removed completely to reduce this access by villagers.

Small roads under two underpasses (AUP3 and AUP5) leading to villages (Dulara and Navegaon) are used by vehicles, and are a source of disturbance that inhibits movement of animals under these structures. These cannot be completely closed down. Therefore it is suggested to barricade these roads to prevent traffic noise and light from vehicles from causing disturbance under the structures.

Protection huts

Considering frequent use of the structures by wildlife, the possibility of these areas becoming poaching hotspots cannot be ignored. Therefore, regular monitoring and patrolling are necessary to check any suspicious activities. Establishment of protection huts near all crossing structures, like that near AUP8, would help alleviate this risk to a large extent. The existing protection hut near AUP8 is manned by 4 personnel 24x7 with regular foot patrolling under the structure. Similar establishments near all crossing structures would reduce poaching risk, check suspicious activities under the crossing structures and help in overall maintenance and monitoring of the crossing structures.

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