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E: ISSN NO.: 2349-980X **Shrinkhla Ek Shodhparak Vaicharik Patrika**

Impacts of Anthropogenic Noise on the Behavioural Patterns of Mammalian Fauna of Ecopark at Hamirgarh, Bhilwara, Rajasthan, India

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Abstract

The impact of noise on wildlife has only recently been considered a threat to animal health and long-term survival. Most researchers agree that noise can affect an animal's physiology and behaviour, and if it becomes a chronic stress, it can be injurious to an animal's energy budget, reproductive success and long-term survival. Equipped with this understanding, an attempt should be made to minimize the threat to wildlife by reducing the amount of noise that they are exposed to in natural areas.

Keeping this in mind, this study was conducted to understand and assess the impacts of anthropogenic noise on the behavioural patterns of mammalian fauna of Ecopark at Hamirgarh, Bhilwara, Rajasthan, from March 2017 to December 2017.

The sources of noise pollution were established which were being, the loud noise from the loudspeakers from the temple situated in the western part of the park, the others being the vehicular noise from the vehicles crossing this ecological park, and still others were the dj music sounds coming from the villages nearby, the trains passing by and the occasional thundering sounds of the aircrafts coming to and fro on the airstrip a few km away.

For the study, intensity of noise- disturbances were recorded at regular intervals at various times of the day, on a try-monthly basis, using digital sound level meter. The sound levels (in decibels) were then tabulated and compared with the corresponding behaviours of the animals at the ecopark. The animals were found to be reacting in response to these anthropogenic noises. Anxious behaviours were observed in the form of trembling and running away from the source of noise and abandoning their habitats at sudden exposure of noise-disturbances. Infant-mortality and decreased reproduction as a result of high decibels of noise from various sources, were confirmed from the forest gaurds and villagers living around the ecopark. Mammal vocalization was found to be decreasing at the times of such disturbances. So it was compounded that anthropogenic noise has detrimental impacts on the mammalian fauna if exposed instantly or for a longer period of time and therefore the study compels for recommending that such disturbances should be curbed down for the proper functioning of any ecosystems and such ecoparks.

Keywords: Anthropogenic, Noise, Behaviour, Mammals, Ecopark, Hamirgarh.

Introduction

Undesirable sound is referred to as noise. In recent years, noise pollution has been a hot topic of discussion among researchers.Common sources of noise include loudspeakers in public places, vehicular traffic, factories involved in the manufacturing process, and DJ music systems and many more. As human beings continue their encroachment upon the last remaining forest areas, wildlife populations around the globe continue to diminish in size. The impacts of human encroachment and environmental pollution including noise pollution are:

1. Loss of habit at and territory;
2. Loss of food supply;
3. Behavioural changes
4. Changes in interspecies relationships.

5. Altered predator-prey balance.
6. Increased competition for food and shelter.

Human-induced noise pollution is one of many factors contributing to the depletion of wildlife populations. Laboratory studies and limited field research have uncovered four major ways in which animals are adversely affected by noise pollution:

1. Hearing loss, resulting from noise levels of 85 dB or greater;
2. Masking, which is the inability to hear important environmental cues and animal signals;
3. Non-auditory physiological effects, such as increased heart rate and respiration and general stress reaction; and
4. Behavioural effects, which vary greatly between species and noise characteristics, resulting in, for example, abandonment of territory and lost reproduction.

Plenty of evidence exists to indicate that serious damage is occurring to animals in the wild. High intensity sound induces fear, forcing them to abandon their habitat. Anxious behaviour in animals is commonly observed in the form of trembling when they are exposed to high decibel levels. Intolerable noise levels can decrease a cow's capacity of milk production. These animals require a calm and relaxed environment to provide a better milk yield.

Research has proven that a high decibel of noise is responsible for a significant decrease in reproduction activity in a wide range of animals. The ill-effects of noise can also be seen on chicken in the form of a sharp drop in egg production. Stunted growth in chickens due to intense noise has also been observed.

The implications for wildlife, particularly given how important sound production and hearing are for a range of behaviours, such as locating food, avoiding predators and finding a mate are quite varied. For example, bats and dolphins rely on high frequency sonar to detect highly mobile prey, while great tits, red deer and grasshoppers are among the many species that advertise their dominance and desirability using vocalisations.

Roads are a major source of terrestrial noise.One research demonstrated that prairie dogs, which commonly live in habitats near roads and urban areas, significantly reduced their foraging and increased their vigilance behaviour when exposed to road noise. Such shifts in behaviour could have impacts on their long-term population health particularly in combination with other stressors such as disease and habitat loss.Furthermore,the human-wildlife disturbances plays a major role in noise related problems as stated by **Bezihalem** et al.(2017).

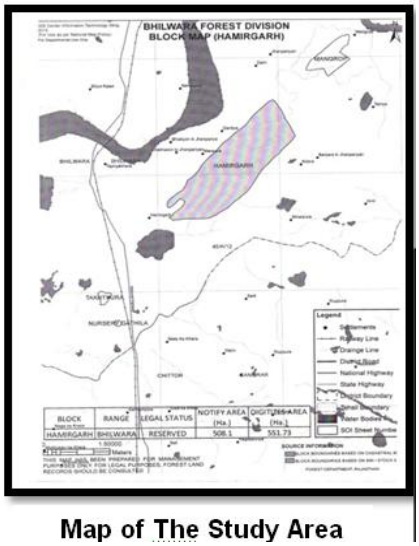
Study Area

The Ecopark wildlife reserve (fig—1) is situated in Hamirgarh, an old princely town in the district of Bhilwara, Rajasthan, India. It is situated at an attitude of 425 meter above the sea level between $25^0$11'0" North, 74^0 38'0" East, and is spread in 567 hectares and was declared an Ecopark by the Government of Rajasthan in the year 2012 to conserve the mammalian fauna present in the wild reserve, specially Chinkara or the Indian Gazelle (*Gazella bennetti*)

Figure-1

Map of Rajasthan in India

Map of Bhilwara In Rajasthan



Map of The Study Area

It is located 20 Km towards south of the district headquarter, Bhilwara and lies on four-lane highway NH-79, which gives a good enough opportunity to general public to have a glimpse of the wild-life. This park has an old temple (Mansha mahadev) in its western part and an air strip for aircrafts just a few km away, outside the ecopark.The town of Hamirgarh lies just on the western outskirts of this study area and also, few many villages are almost clinging to its boundary wall.

This ecopark is home to various kinds of mammalian fauna, namely, indian fox (*Vulpes bengalensis*), golden jackal (*Canis acereus*), nilgai (*Boselaphus tragocamelus*), chinkara or the indian gazelle (*Gazella bennetti*), wild boar (*Sus-scrofa*), porcupine (*Hystrix indica indica*), and hyena (*Hyaena*

hyaena). The forest type is tropical dry deciduous and has many types of hybrid fodder species, like, salar (*Bosewellia serrata*), kherni (*Wrightia tincteria*), kher (*Acacia catechu*) ber (*Ziziphus mauritiana*), Palas (*butea monosperma*), Dhawda (*Anogeissus pendula*) gory Dhawan (*Anogeissus latifolia*) and many types of wild grass.

The configuration of land at ecopark includes small hills, hillocks, flat areas, riverlets & valleys. The temperature remains average throughout the year, though very high at times in summer and has average kind of rainfall.

Objective of the Study

The main objective of this study is to assess the impacts of anthropogenic noise on the behavioural patterns of the mammalian fauna of ecopark at Hamirgarh, Bhilwara, Rajasthan, to an extent that it may change the entire floristic makeup of the its ecosystem, when exposed to noise related disturbances and to suggest ways and means to minimise such impacts so as the very aim of setting up of ecopark for conserving wildlife in it, can be achieved.

Review of Literature

A significant number of studies of noise effects on terrestrial mammals occurred between 1989 and 1996. Since then, only a few studies have been performed on this class of animals. Though, Shannon et al (2016) had estimated the possible upsurge in noise-related researches.

The studies conducted by Rao et al. (1987), Rao and Rao (1991), Ravichandran et al. (1997a), (1997b), (2000), Tandon & Pandey (1998), Naik and Purohit (1999) &Gupta and Chakraborty (2003), in different parts of India, has established that the noise levels reach undesired levels by the use of speakers in public places and has adverse effects on human beings as well as on animals equally. Job (1988) & Dutta et al. (2000) have exerted their thoughts that It is both hazardous to physical and mental health as noise levels in Indian cities soar during festivals. Farzana and Tripathi (2018) compacted the theory that the anthropogenic pressures like ecotourism, which is one of the source of man-made noise disturbances, can affect the mammalian fauna if not taken into consideration of management policy. Tripathi (2018) further asserted that vehicular disturbances on the roads increases the animal mortality rate, in particular the birds.

Bradshaw et al. (1998) reported concern of petroleum exploration disturbing Wood Caribou in Alberta Canada. Similar concerns were shown by Krausman et al. (2001)for ungulates that live in the desert, and monitored behaviour of adult and fawn Sonoran Pronghorn's exposure to military noise, yet another noise-pollutant.

Slabbekoorn and Ripmeester (2008) indicated that this pollutant(noise pollution) is expanding in scope and intensity with human population growth and urban development and anthropogenic noises are often louder, more frequent and more common than natural acoustic stimuli as has been told by Patricelli and Blickley (2006) &Popper and Hastings (2009). Although the bulk of anthropogenic noise research has been conducted in terrestrial habitats, aquatic environments also suffer from noise pollution, which travels faster in the water and at less per unit of distance from the stimulus source as researched by Berg and Stork (2004).

The studies conducted by Rabin et al. (2003), Patricelli and Blickley (2006), Warren et al. (2006), Dooling and Popper (2007), Popper and Hastings (2009), Rı´os-Chele´n (2009), Barber et al. (2010) and Slabbekoorn et al. (2010) indicates that, in recent years, there have been several excellent reviews summarising major developments in the field of anthropogenic noise and suggesting future avenues of research. These have focused mainly on the relatively small (although steadily increasing) body of work investigating how animal behaviour, is impacted by anthropogenic noise.

The effects of aircraft noise have been studied more intensively because of their threat to wildlife populations in national and state refuges and parks. Impacts to wildlife habitat in remote areas have increased from military aircraft overflights and helicopter activity related to the tourism and resource extraction industries (National Park Service, 1994).

Disturbances from aircraft noise range from mild, such as an increase in heart rate to more damaging effects on metabolism and hormone balance. Long term exposure to noise can cause excessive stimulation to the nervous system and chronic stress that is harmful to the health of wildlife species and their reproductive fitness as confirmed by Fletcher (1980 & 1990) in his study on anthropogenic noise.

Manci, et al.(1988) elaborates that,the study of animal response to noise is a function of many variables including characteristics of the noise and duration, life history, characteristics of the species, habitat type, season and current activity of the animal, sex and age, previous exposure and whether other physical stressors (e.g. drought) are present. Swaddle et al (2015) proposed the framework for understanding and evaluating the responses of species to noise-disturbances. Dadem et al. (2018) studied the adverse effects of human-traffic in the same context.

Behavioural and physiological responses have the potential to cause injury, energy loss (from movement away from noise source), decrease in food intake, habitat avoidance and abandonment, and reproductive losses (National Park Service, 1994). Studies by Bunnell et al and (1981) and Gladwin (1987) have shown that when certain bird species are flushed from nests in response to noise, eggs are broken and young are exposed to injury and predators.

Miller and Broughton (1974) observed that young mammals have been trampled as adults attempt to flee from aircraft when exposed to sudden noise thunders from aircraft similarly, another study byHarrington and Veitch (1992) compared mortality rates of caribou calves, exposed to overflights to those not exposed. Studies by Bondello (1976)have documented hearing loss caused from motorcycle noise in the desert iguana and the kangaroo rat, an

endangered species and again confirmed by Bondello and Brattstrom(1979).

A few studies say that, noise does not have to be loud to have negative effects. Very low frequency sounds including infrasound are also being investigated for their possible effects on both humans and wildlife. Salt and Hullar (2010) said in their study that, wind turbine noise results in a high infrasound component. Infrasound is inaudible to the human ear but this unheard sound can cause human annoyance, sensitivity,disturbance, and disorientation (Renewable Energy World 2010). For birds, bats, and other wildlife, the effects may be more profound. Dooling 2002, Lohr et al. (2003) investigated that, noise from traffic, wind and operating turbine blades produce low frequency sounds (< 1-2 kHz). Bird vocalizations are generally within the 2-5 kHz frequency range as exerted by Dooling and Popper (2007) and birds hear best between 1-5 kHz (Dooling 2002).

Animals that respond to noise stressors by increasing vigilance, hiding and retreating may correspondingly decrease the amount of time they spend foraging. This could decrease weight gain, as observed in rats exposed to noise stress for 30 days by Alario et al. (1987).

Baldwin et al. (Baldwin et al. 2006; Baldwin & Bell 2007) found that acoustic stress leads to cellular leakage in the mesentery, which suspends the small intestine from the abdominal wall.

Concepts and Hypotheses

Hypotheses of this study can be expressed as :

1. Human induced or anthropogenic noise has deep negative impacts on the behavioural patterns of the mammalian fauna.
2. Noise pollution may affect the physiological processes in mammals.
3. Noise pollution may disturb the ecological balance as a whole.

Methodology

The study of impacts of anthropogenic noise on mammalian fauna was carried out at ecopark , Hamirgarh, Bhilwara, Rajasthan from March 2017 to December 2017.The aim was to stress the fact that human-induced noise-pollution affects the behavioural patterns of the mammals to an extent that it may change the entire ecosystem, when exposed to noise related disturbances and to suggest ways and means to minimise such impacts so as the very aim of setting up of ecopark for conserving wildlife in it, can be achieved. In the initial period of study, random surveys were carried out through out the ecopark for animal sighting, at times on foot and on vehicle. Mammal-watching had been an important routine in knowing the implications of noise disturbances, as has been suggested by Clarke (2016) and Vladimir &Hall (2018).

For the purpose, the ecopark was divided into two zones, A (eastern part) and B (western part).Zone B has an old temple (Mansha Mahadev) where the locals and other visitors throng for worship on Sundays and various festivals, crossing all the way through the ecopark on vehicles, creating vehicular noise pollution. The animals were sighted with the help of binoculars (Canon-Bak-4 Field 8.2), photographed with the camera (Nikon coolpix B700, 60X wide optical zoom ED VR) as shown in fig-2.Their presence and movement were assured at various locations and times.

Figure-2

Sound Level Meter

Binocular

Camera

The timings of loudspeakers being played from the temple were observed. Sound levels of the noise coming from the loudspeakers of the temple in the form of mantras or religious songs, the dj music sound echoing from the nearby villages, the trains passing near to this study area, and the occasional thundering sound of the aircrafts flying over the ecopark to the airstrip nearby, were recorded with the help of digital sound level meter.

Such readings were taken on the first week in the months of March, June, September and December 2017 on Sundays and Wednesdays (when the park would be closed), twice, one in the morning (7-9 am) and other in evening (5-7 pm).These readings and observations were taken in both the zones A and B .In addition to this, we stayed, occassionally , late evenings to find the differences in behaviours of these mammals in response to the noise disturbances using direct observations from the watch-towers and adjoining places(fig-3).All the observed activities were then compared with the sound levels.

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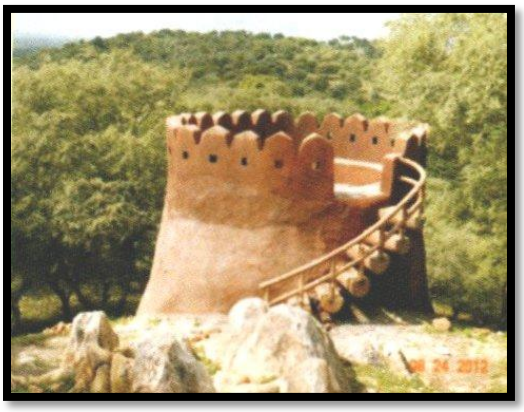
Figure- 3



Watch Tower

Water Hole

Regular information regarding the movement foraging, reproduction, infant-mortalityand other activities of the animals were gathered from the forest gaurds monitoring the park and the villagers living around the ecopark. At times temple officials were also contacted for the same purpose. Furthermore, villagers from the nearby villages were also interviewed about the straying animals from the ecopark, who would venture into the villages at the times of noise-disturbances.

Results and Findings

The random surveys carried out in the initial period of study recorded seven species of mammals at the ecopark, namely, chinkara (*Gazella bennettii)*, nilgai (*Boselaphus tragocamelus*), golden jackal (*Canis aureus*), Indian fox (*Vulpes bengalensis*), hyena (*Hyaena hyaena*), wild boar (*sus scrofa*) and porcupine (*Hystrix indica indica*).

The measured average sound levels are tabulated in the tables 1&2. From the tables it is clear that noise levels due to loudspeakers in zone B is very high as compared to zone A which is at a distance from the noise source (loudspeakers).

Table -1
Zone – A

Months	Time of Observation	Sound Levels in Decibels							
		Sunday				Wednesday			
		LS	DJ	VEH	AC	LS	DJ	VEH	AC
March	7-9 a.m.	Nil	Nil	70-75	Nil	Nil	60-70	Nil	Nil
	5-7 p.m.	75-80	Nil	75-80	Nil	Nil	70-80	Nil	Nil
June	7-9 a.m.	70-80	60-70	Nil	Nil	Nil	Nil	Nil	100-110
	5-7 p.m.	72-78	62-72	Nil	Nil	75-80	Nil	Nil	Nil
September	7-9 a.m.	65-70	Nil	Nil	Nil	Nil	Nil	70-80	Nil
	5-7 p.m.	70-75	Nil	80-85	110-120	Nil	Nil	75-78	Nil
December	7-9 a.m.	62-68	Nil	70-74	Nil	Nil	60-65	Nil	Nil
	5-7 p.m.	70-74	60-70	72-76	Nil	72-85	64-68	Nil	Nil

LS = Loudspeaker DJ = Music VEH = Vehicle AC = Aircraft, Nil = No Activity

Table -2
Zone –B

Months	Time of Observation	Sound Levels in Decibels							
		Sunday				Wednesday			
		LS	DJ	VEH	AC	LS	DJ	VEH	AC
March	7-9 a.m.	Nil	Nil	80-85	Nil	Nil	70-75	Nil	100-110
	5-7 p.m.	85-95	Nil	90-94	Nil	Nil	80-85	Nil	Nil
June	7-9 a.m.	85-90	70-80	Nil	Nil	Nil	Nil	Nil	Nil
	5-7 p.m.	88-92	72-85	85-90	Nil	85-90	Nil	Nil	Nil
September	7-9 a.m.	82-88	Nil	Nil	100-110	Nil	Nil	80-90	Nil
	5-7 p.m.	87-90	Nil	90-95	Nil	Nil	Nil	85-90	Nil
December	7-9 a.m.	85-92	Nil	80-85	90-100	Nil	70-80	Nil	Nil
	5-7 p.m.	90-94	64-72	90-95	110-120	90-95	75-85	Nil	105-110

A marked difference can be observed in the data of two zones as given in fig- 2&3.

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Average Sound Levels (dB) of Various Noise- Pollutants

Fig - 2

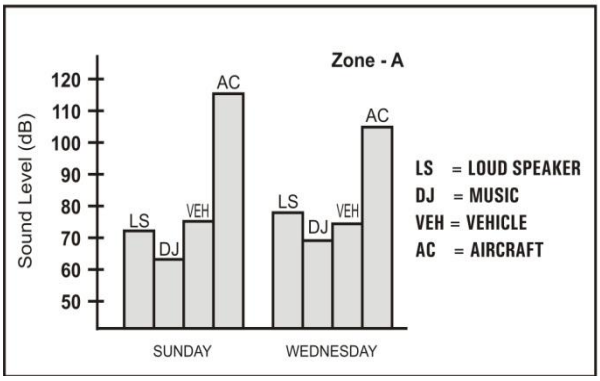
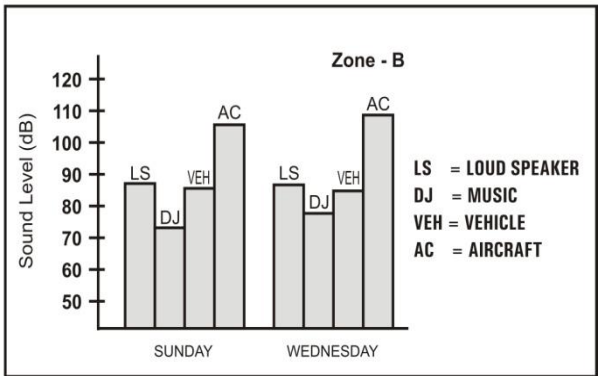


Fig - 3



The difference is also seen on the sound levels taken on Sundays and Wednesday, it being closed for visitors and a day of quite less of an activity, few vehicular disturbances and occasional sound pollution from loud speakers. Also, the readings taken in the evenings were of high decibels than those of the morning ones, which has been displayed in Table 3 & fig-4 &5.

Table - 3

Average Sound Level (dB) at different Time Zones

	Zone - A				Zone - B			
Days	Sunday		Wednesday		Sunday		Wednesday	
Months	AM(7-9)	PM(5-7)	AM(7-9)	PM(5-7)	AM(7-9)	PM(5-7)	AM(7-9)	PM(5-7)
March	72	77	65	75	82	91	88	82
June	70	71	15	77	81	85	82	87
Sept.	67	77	75	76	95	90	85	87
Dec.	68	73	62	72	88	92	75	86

Fig - 4

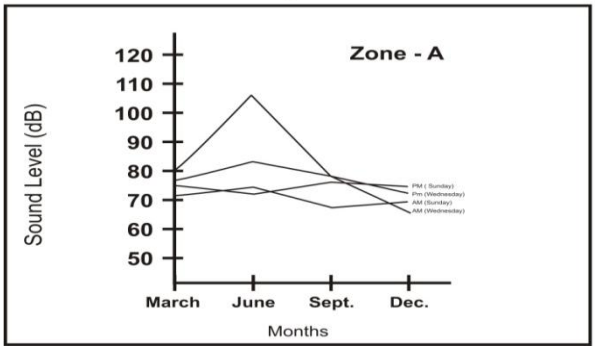
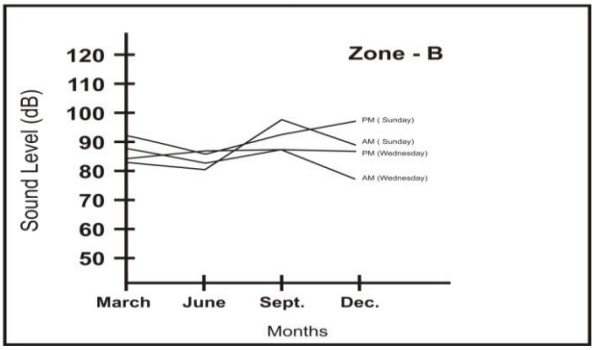


Fig - 5



Furthermore, the geographical location played a role of its kind in the sense that any sound activity like playing of dj music in the nearby villages, honking of the passing trains several times of the day and even at night sends echoing effects to this ecopark, were affecting the routine life of the animals present in the ecopark.

During the times of high intensity sounds, almost all mammals barring porcupine, and even birds like pigeon and few reptiles were found showing anxious behaviour in the form of trembling, raised ears, increased sniffing. In the absence of noise disturbances, usually on Wednesdays, the mammal species were seen foraging near the waterholes in the zone – B, but when these same animals were exposed to treacherous loud noise-disturbance from the loudspeakers, the first reactions observed were the fleeing of the mammal species from that particular location away from the noise-source making distress sounds making sudden defecation a few times.

The young chinkaras would be the first ones to react and run, as they are the most sensitive of the whole lot, and then followed by elderly chinkara and nilgai females, probably mothers. The older nilgai males were found to the most stubborn type to shift away, but even they defecated in bulk at such sudden responses.

When exposed to continuous noise of above 85 dB for a longer period of times, the mammals we observed showed less of foraging and social behaviour, especially in the case of jackal and fox. They would hide behind the bushes and howl repeatedly. Few were observed to be gushing in their burrows a few times to hide themselves.

Few groups of chinkara were found to be grazing in the zone A, where the noise-level were moderate. We could also observe, that sudden introduction of new sounds of high decibels affected the animals more than such noise for longer periods. The jackals, foxes and even wild boars were found to be avoiding the dirt tracks from where the vehicles or the locals would pass. They were found to be avoiding the water-holes at such disturbances.

Wild boars though are habitual of living in pair or groups were seen to be straying singally at high levels of sounds, especially in the evenings. The herds of nilgai would drift away from the western edge (zone-B) of the park, when the trains would pass screeching their honks. They were noticed to be trotting wildly away towards the eastern part (zone A) of the ecopark.

The occasional passing of the aircraft over the ecopark was also taken into account for creating panic among the animals .We observed an instant decrease in vocalisation of the animals at such times. So, this study could confirm that such anthropogenic noise of high decibels has tremendous influence on the behaviour and co-ordination of the mammals which could totally destroy the ecosystem of the park.

Conclusion

Previous authors have discussed ways in which noise can impact animal behaviour and community ecology **(Francis et al. 2009; Barber et al. 2010).** Anthropogenic noise is likely to have both diverse and complex impacts on wildlife, as it can influence multiple biological systems both directly and indirectly.

Most of the literature reviewed, describes how terrestrial mammals respond to noises ranging from 65 to 130 dB (like that of the aircraft or jet).Although exposure to noise levels at the lower end of this spectrum may not be uncommon in some anthropogenic habitats, only a small minority of animals will encounter amplitudes at the middle and upper end of the scale. There is much to learn from experimental studies that have utilised these extreme noise levels, given that they offer possible explanations for previously observed behavioural and fitness responses to human-generated noise, much additional work is still needed to determine which of the patterns and mechanisms are directly applicable to wildlife.

As noise research is conducted on an increasing diversity of focal species and populations, comparative studies may allow us to determine why different species sometimes react differently to the same noise stimuli. When investigating the effects of noise on physiology, behaviour and fitness, it is helpful to determine which aspects of the acoustic stress (e.g. duration, amplitude, spectral and temporal frequency and predictability) would create various responses. This information is likely to be important on a mechanistic level, as well as for suggesting useful conservation and management strategies.

That said, it is important to keep in mind that these various influences may influence animal physiology, behaviour and reproduction, higher-level effects will be easier to examine once we have achieved a better baseline understanding of the influence of each stimulus individually. A decrease in human expansion is unlikely to occur in the near future, making it increasingly important to understand the implications of anthropogenic stressors, such as noise, on wildlife. We are only just beginning to discover the variety of ways in which human noise pollution impacts behaviour and fitness. More in-depth investigations of physiological, developmental, cellular and genetic responses to noise are vital and required for understanding how molecular processes interact within the body and how these interactions, in turn, lead to altered behaviours.

Suggestions

Noise pollution is one of the most important environmental pollution, but, unfortunately, equally neglected. Not much research work, action plans, and acoustical planning has been done so far on this subject, especially on terrestrial mammals. Since this pollution creates a number of physiological and behavioural changes in mammals, which ultimately results in fragmentation of their habitats, loss of bio-diversity and further into complete collapse and imbalance of the ecosystem, care should be taken to control and limit all such sources of noise-disturbances.

As regarding this study area, a few suggestions could be arrived at, which may achieve the very aim of the study and the ecopark itself. There can be an alternate route to the temple, which would avoid the vehicular-noise to a great extent. The various trails/paths in the park (like jackal path, chinkara path, and wild-boar path) should be crowded less with the people visiting the park, so that the animals could move freely in their habitats. Also the temple management could be instructed to play the religious chants and mantras at a low volume. In the same context, the villagers around should be ordered to either stop playing dj music or may be at low volumes, and to request the railway department to pass-off their trains from this area without honking whistle and sirens, and last but not the least, recommendation can be made to the aviation ministri for stopping the aircrafts flying over the ecopark and take an alternate route to the air-strip nearby, which may be possible as the chief minister of the state herself has been taking special interest in the development of this ecopark for quite sometime.

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