Sound levels assessment in an ecotourism destination: A case study on Binsar Wildlife Sanctuary of Indian Himalayan Region

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Abstract- Travelling to relatively pristine or natural areas is rapidly growing among visitors worldwide, which not only stimulates impacts on landscape and its wildlife but affects the visitors' experience -as well. Considering sound associated with anthropogenic activities as an impact causing indicator, the present study reports and discusses the result of monitoring sound levels in Binsar Wildlife Sanctuary, an ecotourism destination situated in mid of Kumaon Himalayas. The equivalent sound pressure level (Leq) was determined both in presence and absence of visitors, at key locations within high usage tourism sites of different zones of Binsar. The results indicated that the ambient noise level remains within the prescribed standard limit being stable around 50 dB in the absence of visitors, which increases up to 70dB in the presence of visitors. Using L_N statistics five sites reported to exceed 50 dB of sound level for 10% of the recorded time. The outcome suggests non-violation of standard limits within sanctuary; however, it necessitates control of visitor activities by sanctuary management at locations where animal habitats exist, considering increasing visitation.

Index Terms- Ecotourism; Himalayan region; impacts; noise-monitoring; visitors; wildlife

I. INTRODUCTION

Ecotourism stands on the cornerstones of communities, conservation and interpretations (TIES, 2015) and is practiced mainly to minimize the realised consequences of conventional tourism. Travelling as an activity to explore new places has become a major interest of people worldwide. However, with any human activity, also come several other by-products that can affect the local environment of the place. Even in case of eco-friendly tourism, frequent visitation by visitors including their activities is often seemed to endanger the biodiversity of environmentally fragile areas. Such disturbances when occur constantly may affect destinations integrity and subsequently visitors own experience.

Ecotourism impacts

Locations where impacts are most obvious include alpine areas, coastlines, islands, lakes, and habitat areas (Farrell and Runyan, 1991). Ecotourism acts in both ways as an agent of increasing disturbances on natural ecosystems if not happening responsibly and the same time as a medium of salvation for the conservation of these regions (Lowman, 2004). According to Boo (1999) the theoretical impacts of ecotourism include potential costs (environmental degradation, economic inequity and instability, and negative socio-cultural changes) and potential benefits (generation of funds for protected areas, creation of jobs for people who live near protected areas, and promotion of environmental education and conservation awareness) as a result of which "on one side the opportunities in ecotourism advance our efforts and on the other side, problems with ecotourism hinder our work". Ecotourism can have direct and indirect effects on the environment and biodiversity of any ecosystem. Direct effects have a negative impact directly on the floral and faunal species, communities and populations by influencing their feeding, reproductive and social behaviours (Medina, 2005) whereas, ecologically significant indirect effects are not as conceivable as the direct effects but can result in secondary impacts including long-term damage to terrestrial and aquatic wildlife habitat and ultimately their survival. For example a study on whale watching by boat along the coast of North America identified the disruptive effects on feeding and separation of calves from mothers, interference with the sound-communication systems of whales (Edington and Edington, 1986), similarly, decreased feeding time and increased alert behaviour in response to the tour boats (Galicia et al. 1997) were observed with American flamingos in Yucatan, Mexico. Impact of human visitation to nesting sites of Megallanic penguins at Punta Tombo, Chubut, Argentina causes changes in behaviour in both adults and chicks, such as higher predation of nests, lower hatching rates of eggs, increased abandonment of nests, retarded chick growth and higher mortality rates (Fowler, 1999).A study on water bird communities in the Ding Darling National Park identified the difference between behaviour of water birds that used the reserve as a feeding and breeding ground to those species that used it as an over-wintering site. The migratory birds were clearly unaccustomed to the humans and fled at the mere site of humans and cars (Klein et al. 1995). One of the well-designed experimental studies is conducted on the mountain sheep at Sheep River Wildlife Sanctuary, south-western Alberta (MacArthur, 1982). Such studies highlight the role and impact anthropogenic sound and activities have on animal behaviour, suggesting that ecotourism is often one component of conservation and development programs, but it is unknown that where does it actually intersects with conservation and development work.

Factors influencing the impact of noise on wildlife

The physical properties of sound and the environment, in which it is generated and perceived; the threat-response characteristics of faunal species and the situational factors such as habitat type, lifecycle stage and previous exposure to noise or

disturbance as reported by Harbrow et al. (2011) form important factors controlling the responses of wildlife to noise. Also, the sensitivity of animals to sound differs from that of humans in both the level of sound and the range of frequencies that they can detect (Bowles 1995). It indicates that animals can potentially be sensitive to and impacted by sounds that seem quiet to human ears or to which humans are unaware.

Need for monitoring impacts

According to Drumm and Moore (2005) 'careful planning and management steps' are crucial before designating a site as an ecotourism destination. But according to Rome (1999) while initiating such projects 'impacts are rare or minimal and initial symptoms of negative impacts become difficult to perceive, especially when there is little or no data on baseline conditions to compare to'. He further comments, that "in developing countries, comprehensive baseline surveys are rarely conducted at the outset because time, budgets and technical resources are limited and the needs are not perceived. Often, it is only when severe impacts are manifested that questions are asked and management actions are deemed necessary". Buckley (1999) further argues that "reducing visitor number, limiting their activities, 'hardening' the environment, or making it more resistant to impacts, is difficult and requires increased budgets for infrastructure and subsequent maintenance", suggesting that 'if impacts are measured progressively from the start and actions taken early on to reduce them, less or no harm might occur". Also, with 'the establishment of a monitoring program at the outset of project development and the gathering of baseline information allows for early warning of impending changes, enabling timely management programs to be put into place'.

Simultaneously, intensity of use, highly related to impact, forms a primary factor in management (Farrell and Runyan, 1991). Following such background, the present paper focuses on determining the sound pressure levels generated due to visitor noise within an ecotourism destination, in order to strengthen the existing baseline data for future long term monitoring of the impacts of sound on wildlife, conducted in one of the protected areas of the Indian Himalayan Region (IHR).

II. STUDY AREA

Binsar Wildlife Sanctuary (hereafter Binsar) lies in the Kumaon administrative division of Uttarakhand, India, at an altitude varying between 1500 – 2500 metres and offers the view of the great Indian Himalayan peaks namely - Nanda Devi, Trishul and Panchachuli, presenting a unique nature experience to its visitors. The geographic location of Binsar is 29° 39′ N–29° 44′ N latitudes and 79° 41′ E–79° 49′ E longitudes and covers an area about 47 km², with a core area of about 4km^2 (Figure 1). Mean monthly temperatures range from 2.2° C to 15.5° C during winter and from 17.2° C to 26.6° C during summer. Average rainfall was reported approximately 1,200 mm by Sharma et al. (1999). It was declared as a Reserve Forest in 1880 and was upgraded as Wildlife sanctuary on 25th May 1988. Throughout the sanctuary, the terrain is hilly and characterized by deep ravines, crevices and elevated ridges. Binsar represents the Himalayan Moist Temperate Forest of India (Champion and Seth, 1968). The forested hilltops and slopes are covered by chir pine (*Pinus roxburghii*), banj oak (*Quercus leucotrichophora*) and rhododendron (*Rhododendron arboreum*) as pure or mixed stands (Majila et al.2005; Kala and Majila 2013).

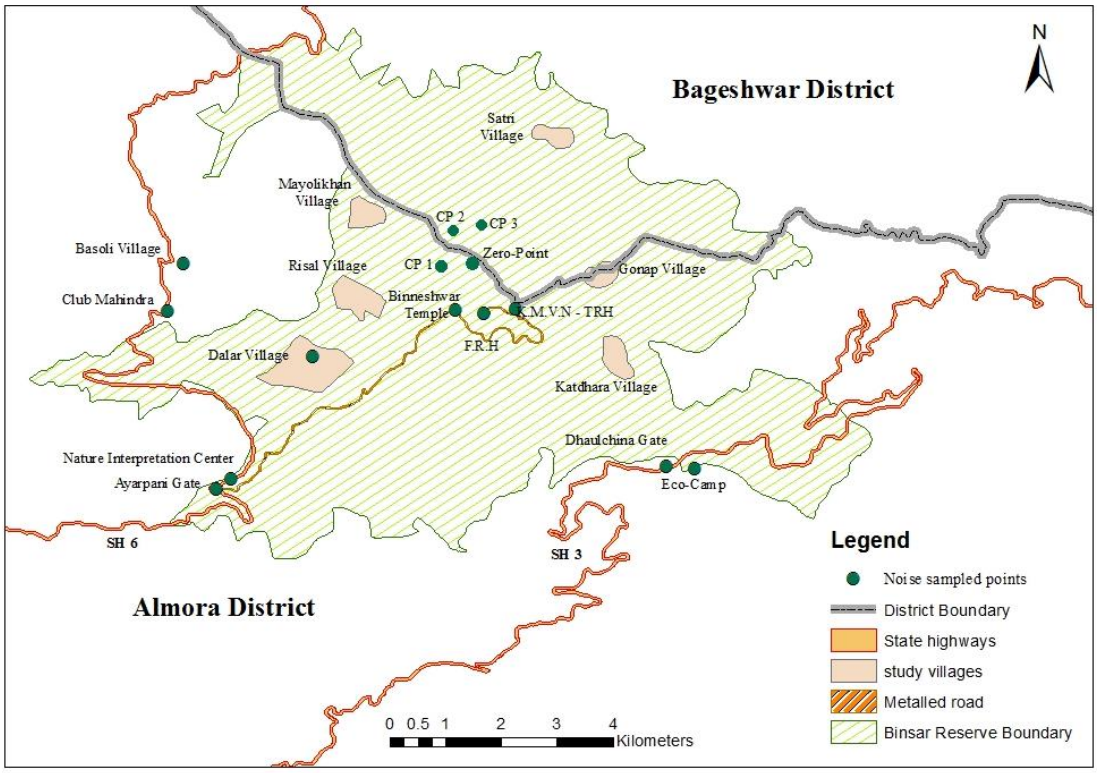

Figure 1: Location map for Binsar WLS showing sampling sites for sound levels assessment

The charismatic wildlife species inhabiting Binsar is the Leopard (*Panthera pardus)* and is the top predator here. Other predators reported by Khan et al. (2000) and Majila and Kala (2010) include jungle cats (*Felis chaus*), major ungulate species include gorals (Nemorhaedus goral), barking deer (*Muntiacus muntijak*), serows (*Capricornis sumatrensis*), and wild boar (*Sus scrofa*), other mammal species in the sanctuary are common langurs (*Presbytus entellus*), rhesus macaques (monkey; *Macaca mulatta*), Himalayan black bears (*Selenarctos thibetanus*), and jackals (*Canis aureus*). The sanctuary also harbors 166 species of birds (Uttarakhand Forest Department, 2014), including black francolins (*Francolinus francolinus*), koklass pheasants (*Pucrasia macrolopha*), kaleej pheasants (*Lophura leucomelana*), hill partridges (*Arborophilla torqueola*), great barbets (*Megalaima virens*), hawk eagles (*Spizaetus nipalensis*), Himalayan griffons (*Gyps himalayensis*), lammergeiers (*Gypaetus barbatus*), and yellow-billed magpies (*Cissa flavirostris*).

III. RESEARCH DESIGN AND METHODS

Approach to measure sound

Sound measurement without response measurement, referred to as 'acoustical approach' (Gramann, 1999) is common in environmental and workplace monitoring and have several advantages. Such measurement using scientific instruments is a recent development in recreational settings where the area of concern usually relates to short-term exposure and reduction in the quality of visitor experience, rather than health effects from ongoing sound exposure. 'Percentage of time audible' acts as a useful metric to describe how long sounds are heard, particularly at the extremes of recording duration (Miller, 2008). Use of such metric however makes interpretations on sound simple. For example, if human-produced sounds are audible for 5% of the time, it is likely that most people will judge such a soundscape as relatively pristine or natural. Conversely, if human-produced sounds are audible 50–90% of the time at some location, then people would probably decide that it is not a place to expect solitude or escape from the sounds of civilization.

The present study aims to determine the sound levels prevailing in high visitor usage sites through a control impact design and check whether the ambient noise level remains within the prescribed day time noise level standard limit, as decided by the Noise Pollution (Regulation and Control) Rules, 2000, Government of India. According to which the forest area would fall under (D) Silence Zone as mandated by Law. To address this, first we determined the visitor attraction sites within the different zones of Binsar, where there is maximum visitor footfall thereafter we recorded the sound levels in different seasons with and without the presence of visitors in these zone specific sites. Preliminary field observation followed by quantitative measurement in key locations, accessed through snow-ball sampling was employed to determine the aforementioned objectives.

Data collection

Binsar remains open to its tourists throughout the year and consists of peak and non-peak seasons. Firstly, these seasons were identified and confirmed from the visitor record books present at the main sanctuary gate and months decided for conducting measurements. Secondly, the entire sanctuary was explored to mark the most commonly visited sites (high-use zone) within the sanctuary using GPS. Personal observations supported by sanctuary staff interaction yielded the selection of study sites. Identification of visitor attractions and accompanying activities within the sanctuary supported in determining visitor usage pattern within the sanctuary, based on snowball sampling method. Priority was given to sites that were observed to be occupied at most during peak season. Thus field observations for identifying visitors' usage pattern assisted for choosing representative sites within each zone, wherein the presence and absence of visitor factor was addressed, as control and impact, while making acoustic measurements. Thirdly, at these sites measurements were made using a basic type 1 Integrating Sound level meter with free-field microphone supplied by the parent university. The Cirrus Research plc, basic unit, CR:811A integrating averaging sound level meter was placed away from facades and obstacles at 1.5 meter above the ground level using the tripod (Bruel and Kjaer, 2000) and run for one hour duration each (anytime during day between 6am to 7pm, as per the availability and activity of visitors at the key locations). Sound monitoring at each site, both in the presence and in the absence of visitors were made for summer peak and non-peak seasons for the year 2014.

Sampled Sites in each zone

The summer peak-season lasts from April to June month and winter peak-season from October to November month, with patches of both foreign and domestic tourists visiting throughout the year. The summer peak month decided for taking peak season readings was May whereas, in the month of July, non-peak season readings were obtained. Based on the preliminary observations 14 sites in four different zones of Binsar were selected for conducting sound measurements in presence and absence of visitors.

Data analysis

The responses were recorded in a fast mode, A-weighting and 30-90 range set-ups. Equivalent sound pressure level (L_{eq}) i.e. 'a preferred method to describe sound levels that vary over time, resulting in a single decibel value which takes into account the total sound energy over the period of time of interest' (EPA, 2003; Hansen, undated; Noise measurement manual, 2013 and Whitman, 2012) were recorded mainly besides determining L_N statistic readings. The L_N Statistics, which tells about the level exceeded for N% of the recorded time (Whitman, 2012), along with other standard measurements were downloaded using Deaf Defier 3.3 software for further analysis. Graphical representations showing trends and comparisons within and between different sites were prepared using MS Excel. Further, a number of limitations confined the study results i.e. i) only day time sampling was permitted within the sanctuary, as of the fear of wildlife during night time ii) instrument limitations; and iii) wind and natural sound interference.

IV. RESULTS

Preliminary Findings

Zoning within Binsar Wildlife Sanctuary

Zone permits focus on specific areas in order to accommodate different management needs as per the requirement of the area. Within Binsar WLS, different areas catered different needs and demands from diversified sections of the society. Therefore, to meet these requirements zonation of the sanctuary was framed legally (Binsar management plan, 2000-2010) in a most scientific, sustainable and logical manner by the regional forest department in consultation with the villagers and concerned stakeholders as follows:

I. Core zone – It is actually a mini core zone (4km^2) that comprise forest areas of strategic importance, mainly the different oak tree species along with its rich under-storey biodiversity. Extraction of forest produce in form of rights and concessions is seldom allowed.

II. Tourism zone – It comprise of the motor road passing through Binsar compartments, which terminates at the forest rest house (hereafter FRH). From here a nature trail is made upto Jhandi Dhar (Zero-point), highest point of Binsar WLS, from where a magnificent view of mighty Himalayas is seen. All resort accommodations and four villages lay within this zone, that provide as tourist attractions.

III. Buffer zone – Rest of the areas not covered in above two zones fall under the Buffer zone. These areas are open for regulated grazing and address the rights and concessions requirement of villagers. At present there are two entry gates for visitors into Binsar WLS, one at Ayarpani, and other at Dhaulchina, which lay within this zone along with two villages.

IV. Eco-development zone – Covers the area up to a 5 km from the boundary of Binsar WLS. It comprise of a several villages and few resorts for visitor accommodations.

Visitor attraction sites and visitor activities

Binsar attracts an increasing number and diversity of visitors based on its natural, cultural and historical assets. Starting from the Ayarpani Gate (Figure 1), i.e. where main sanctuary reception exists, both visitors and vehicular sounds are heard as a result of their registering process and their visit to the nature interpretation centre or the souvenir shop that are situated closely. From here, a single 13 km long, one-way, motor able road runs into the sanctuary up to a government run Forest Rest House. It forms the only road within the sanctuary and rest all paths are designated as trekking trails where no vehicular movement is permitted. The designated trekking trails are namely, Trishul trail, Nanda Devi trail, Panchchuli trail, Gailekh's trail and Dhaulchina trail along with many unnamed, created by villagers for short-cuts and other conveniences. At the Dhaulchina Gate, there is a comparatively smaller reception without a nature interpretation centre and the trail starts from the gate itself. Also, vehicular safaris are not practiced within this sanctuary.

There are five privately owned estates in Binsar, one forest rest house, an eco-lodge and Kumaon Mandal Vikas Nigam (KMVN-tourist rest house) that offer visitor accommodation. The five privately owned Estates are i) Khali estate; ii) Mary Budden estate; iii) Nanda Devi; iv) Binsar Retreat and v) The Grand Oak Manor. At present there are six villages within sanctuary, which are not the revenue villages but small hamlets namely Dalar, Risal, Mayolikhan, Satri, Gonap and Katdhara. There are eight home-stays distributed within five villages out of which five home-stays are a part of Village Ways Company, community-based tourism initiative and three are privately owned home-stays. There is an above 100 years old Shiv Temple called as Binneshwar Mahadev Temple, where both villagers and visitors come to worship and perform religious ceremonies. The ecotourism activities permitted within Binsar are nature trek, photography, sunrise and sunset views at specific view-points, wildlife sightings, bird-watching, Himalayan view, visiting nature interpretation centre and experiencing home-stay along with its related activities. It was observed that the 'zero-point' view-point was visited by nearly all Binsar visitors, as from this point the Greater Himalayan peaks can be observed. In order to arrive at this point, i.e. the highest point of Binsar called as the Jhandi Dhar Hill, visitors needs to trek two km approximately.

Visitor activities at these sites were observed to be accompanied by different intensities of sound ranging from a small whisper to a loud laughter. Clapping, shouting, screaming and conversations, from all age groups of visitors, were observed to prevail throughout their activity period, while on trail or standing at a view point. Through preliminary observations, it was observed that visitors arriving in groups or with family or friends seemed to make more sounds.

Visitor usage pattern

The high usage visitor sites found within the different zones of Binsar WLS are listed within Table 1.

Table 1: Visitor usage pattern and selected sites for sound level measurements

Zone (Site code)		Selected Visitor Usage Sites
Core (C1, C2, C3)		No visitor allowed
Tourism	(T1)	- Zero-point
	(T2)	- K.M.V.N-TRH
	(T3)	- F.R.H
	(T4)	- Binneshwar Temple
	(T5)	- Dalar Village
Buffer	(B1)	- Ayarpani Gate
	(B2)	- Interpretation Center
	(B3)	- Dhaulchina Gate
Eco-development	(ED1)	- Club Mahindra
	(ED2)	- Basoli village
	(ED3)	- Binsar Eco-camp

Out of the six within sanctuary villages, Dalar village was selected due to the following reasons, i) closely situated to the sanctuary road -that exists at trek of 1.5km, in comparison to

other villages; ii) wide and properly managed trail; and iii) it is the first village that comes on the way while entry from Ayarpani gate. Three sites frequently visited or crossed by visitors in the eco-development zone were selected for the study based on convenience.

Final Readings

Sound levels monitoring

Based on the preliminary visits to sanctuary and adjoining areas, it was decided to set-up the sound level meter at 30-90 dB range, fast and at 'A' weighting mode. As visitors are not allowed within the core zone, impact readings were not obtained, but using control readings Leq values were compared with other sites in different zones. The recorded day-time control readings (Figure 2) at sampled sites within all zones of Binsar lie between a Leq of 30 dB to 50 dB that are in compliance with the standard silence zone limits. Whereas, in presence of visitors Leq was observed to fluctuate between a range of 40 dB to 70 dB, which can be clearly considered as non-silence. Significantly large difference exists in Leq values in absence and presence of visitors except in both the sampled villages. Sound level in Dalar village recorded control Leq value of 38 dB in visitor absence and 40.2 dB in visitor presence (impact). Whereas in Basoli village though both control (48.9 dB) and impact (49.6 dB) readings were more than the Leq values for Dalar, the difference between them was quite low i.e. 0.7dB. Highest Leq in different zones were reported to be: at zero-point in tourism zone, at Ayarpani gate in buffer zone and near EDC1 in eco-development zone.

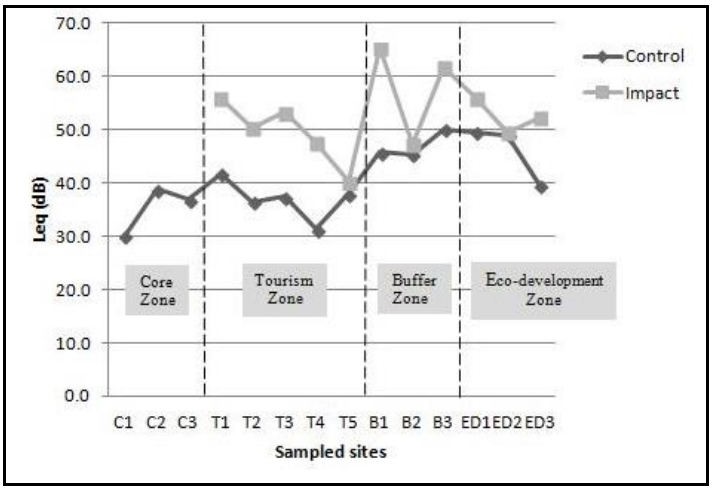

Figure 2: Leq (dB) in presence (impact) and absence (control) of visitors at sampled sites in four zones of Binsar WLS

Within tourism zone where most of the tourist activity concentrates showed variation in Leq values for 5 different sites, which when interpreted using trend line (Figure 3) yield a best fit line with a R^2 value of 0.9111; suggesting a good fit to line for the recorded data. Also, within this zone a positive correlation between the two variables – altitude and Leq was determined that suggests high impact activity concentrates at the zero-point (2406 m) in comparison to lower altitude visitor attraction sites.

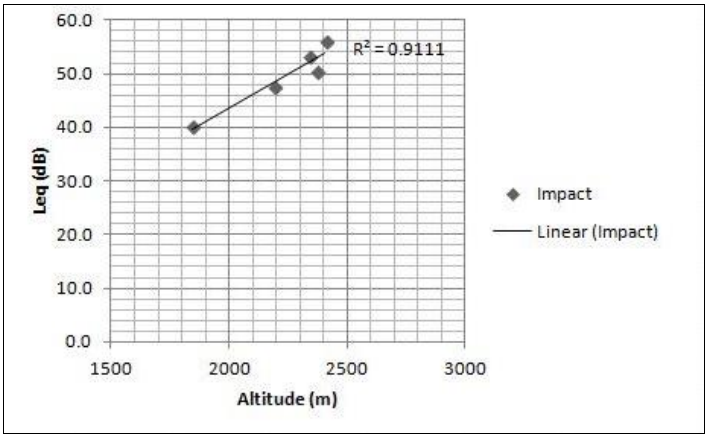

Figure 3: Trendline for equivalent sound levels (dB) within tourism zone of Binsar WLS

Further, on analysing L_{10} statistic for the recorded data (Figure 4), it was observed that at five sites, namely, zero-point, K.M.V.N-tourist rest house, Ayarpani gate, Dhaulchina gate, EDC 1 and at EDC 3, 50 dB of sound was exceeded for 10% of the recorded time (1 hour), while taking impact readings. The data also suggests that 40 dB of sound was exceeded for 10% of the recorded time while taking control measurements at both buffer and eco-development zones.

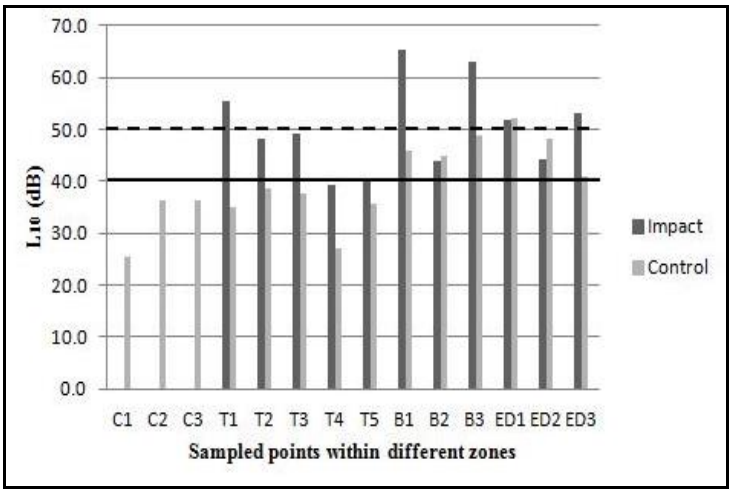

Figure 4: Sound Levels exceeding 10% of the time in presence (impact) and absence (control) of visitors at sampled sites in four zones of Binsar WLS

The reason for getting higher sound levels at buffer and eco-development zones even while taking control measurements owes to the presence of the State Highway 6 and State Highway 3 passing closely through the sanctuary both at the south-west and south-east direction to Binsar. However, the recorded sounds crossing 50dB of standard limit by CPCB, in which human-produced sounds are emphasised upon, are audible or exceeded for only 10% of the recorded time; making it likely that most people will judge such a soundscape as relatively pristine or natural.

V. DISCUSSION

Overall results convey that the ambient noise level remains within the prescribed day time noise level standard limit i.e. around 50 dB in Binsar WLS, in visitor absence. However the ambient sound level increases (up to 70dB) in presence of visitors owing to their different activities and its accompanying sounds, like making calls, whistling, laughter, screaming, clapping or any type of conversation. In support, according to Karp and Root (2009) an average noise level (50 db), the highest recorded noise level (60 db), a negative control (no noise), and a positive control (70 db) determined from five group of tourists, were further used to observe the Hoatzine bird response, where flight initiation distance and agitation initiation distance were used as metrics to quantify Hoatzins' responses to each noise level. The study reported ecotourist conversation as a negative stimulus to Hoatzins and suggested that in order to have the best chance of seeing birds (Hoatzins, in their case) at a short distance and minimizing potentially negative disturbances, ecotourists should cease all conversation and that, silence is probably the best strategy when looking for many wildlife species. Here, in case of Binsar, where bird-watching comprises of the main ecotourism activity, was observed to be performed with whistling and making calls, which may result in a similar outcome, but need to be tested experimentally.

Villages within or outside the sanctuary are occasionally visited by visitors mainly interested in experiencing village lifestyle, which forms a major attraction for foreign visitors especially. Altitude, natural surroundings and road network are responsible factors for inter-village sound value differences, whereas numbers of visitors affect the intra-village control and impact sound values in Binsar case. Vehicular sounds are comparatively not felt within the tourism and core zones, but impact greatly within the buffer and eco-development zones Lynch et al. (2011), in support state that 'a large percentage of the noise sources in national parks (such as highways or commercial jet traffic) originates outside park boundaries and beyond the management jurisdiction of national park services, indicating that opportunities to experience noise-free intervals are disappearing throughout in United States'. Remote location and no electricity positively impact the natural setting of Binsar. It can be supported by the fact that there are no generators within sanctuary that add to noise pollution. In support to this, a study conducted in Bandipur Tiger Reserve in Karnataka (Swarna, 2013) reported that due to generators a maximum of 82.2 dB of noise was generated, that significantly exceeds the permissible sound levels within a protected area. Further the noise pollution created by jeep safaris, ranged between 59 dB to 80 dB, an activity not present within Binsar currently. In total the visitor sounds were not the only sources responsible for significant differences between the control and impact values obtained at a specific site, but were subjected to other sounds like leaf rustling, nearby located natural spring water sources and vehicular sounds (honking and engine noise), which needs addressing while monitoring impacts. Several authors also report limitations of using acoustical approaches, like the equipment cost, lack of standards for preserving recreational experiences or the well-being of wildlife and instrument sensitivity to detect low levels of noise (Kariel, 1990). Besides this, failure of instrument to discriminate between natural and non-natural sounds, and wind interference at relatively low wind speeds also tends to affect the readings. Natural sounds, such as birds, frogs, insects, waterfalls, wind and rain, may be relatively loud and this can add complexity to monitoring (Miller 2008).

VI. CONCLUSION

Physical characteristics of a sound, when it reaches the listener, are only part of a wide range of factors that influence the response of humans or wildlife to that sound. Obtained results, however, do not violate the prescribed standard limits extremely but indicate priority high tourism usage sites that can impact the sensitive wildlife habitats of Binsar region; making it an important consideration for the sanctuary management staff. This particular study, a part of ongoing research to monitor environmental impacts of ecotourism in Binsar, can serve as pilot study to indicate the presence of some interesting sound level patterns, but cannot serve to show the full effects ecotourism has on the forest or wildlife. The study can be extended to know the consequences that noise can have on the environment, animal behaviour and reproduction. Impact monitoring conducted both longitudinally and cross-sectional, periodically, can only help ecotourism survive sustainably; otherwise will only add pressure on our existing pristine natural areas of ecological importance.

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