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Original Research Paper

Urban Noise and Light Disturbances Modifying Foraging Behaviors and Reproductive Success of Nocturnal Bats

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Key Words
Urban noise, Artificial light, Nocturnal bats, Foraging behavior, Reproductive success, Urban ecology, Biodiversity conservation.

Abstract
Urbanization brings a lot of anthropogenic disturbances such as noise pollution and light pollution, which affect nocturnal wildlife. This experiment attempts to examine the effect of urban noise and light pollution on foraging activities and reproduction success of bats in the city of Bengaluru, India. Three urban gradients consisting of high, moderate, and low-disturbance areas such as commercial, residential, and semi-urban areas were selected. The foraging activities were observed using ultrasonic sound recordings and infrared video recordings while maternity roost observation and pup survival rates were used to estimate reproductive success. Our results suggest that feeding buzz rate was decreased by 30-40%, increased echolocation call amplitude, and disorganized foraging pathways in high-noise zones, indicating difficulty in prey detection and high energy consumption. Likewise, the reproductive success was delayed by 5-7 days, produced 20% less pups per season, and had lower survival rate among juveniles in bright areas. From our comparison with past experiments, it is clear that tropical urban bats are more vulnerable to multiple stress factors than bats in other regions. Conclusions drawn from the study are based on scientific facts, highlighting the importance of reducing noise and light pollution for the protection of bat communities at night.

Introduction

Urban noise pollution and light pollution have become ubiquitous within rapidly urbanizing ecosystems (Ramya & Geetha, 2025). Urban noise pollution results from activities such as transport, construction and industrial production, contributing constant anthropogenic noise to otherwise silent nocturnal environments (Mukhamadiev et al., 2025). Urban light pollution occurs due to the presence of street lights, commercial lighting, and the headlights of vehicles, causing unnatural, prolonged periods of illumination of the environment. The consequence of changing the natural night environment is detrimental to nocturnal species, especially bats that rely on darkness and noise for navigation, foraging and communication. The issue is caused by growing interactions between human activity and wildlife, thus creating environments in which natural behavior cannot occur and energy budgets are changed (Stone et al., 2015; Kiran et al., 2025). Even though their ecological role is important, the effects of these urban stressors on nocturnal species have yet to be quantitatively evaluated.

High noise levels have been shown to negatively affect echolocation among bats that operate during the night time, making it harder

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for them to detect their prey effectively, thus lowering their chances of catching prey (Newport et al., 2014). Artificial light affects the timing of activities, hence causing shorter times to feed and disturbance to their reproductive cycle, which could result in low survival rates for juveniles and population increase (Finch et al., 2020). These two elements are detrimental to both the fitness of the organisms as well as the populations (Yantén et al., 2022).

Key Contribution

1. The study highlights that urban noise and artificial lights cause significant harm to the foraging abilities of bats, causing reduced feeding buzz rates and fragmented flight paths, thereby affecting the energy intake and survival.
2. The paper provides numerical evidence to prove that light disturbance causes delayed parturition, decreased litter sizes and lowered juvenile survivorship rate.
3. The study includes analysis and evaluation of several behavioral and reproductive measures in various urban gradients, providing useful information to formulate effective plans for urban bat conservation.

The paper is based on the analysis and evaluation of impact caused by urban noises and light on bats in six major sections. The first section (Introduction) provides a basic definition of the phenomena of urban disturbance in relation to its ecological significance and its possible consequences for nocturnal bats. Literature review (II section) includes a detailed summary of all available studies on noise/light disturbance of bats, identifying existing knowledge gaps. Methodology section (III) discusses site selection procedures, ways of measuring foraging/sexual activity, and methods used to quantify environmental factors. Results (IV section) are presented using tables and diagrams showing effects on foraging and reproduction.

Literature Review

Noise pollution from urban areas is a known cause of disruption of nocturnal animals' behavior, especially in bats that depend on sound waves for orientation and feeding (Voigt et al., 2020). Evidence shows that traffic, industry, and construction result in continuous artificial sounds that make it difficult for bats to orient themselves, thereby decreasing their chances of capturing prey and making their hunting more costly (Bonsen et al., 2015). Bats may use excess energy locating their prey, thereby causing reduced food intake, which in turn affects survival and reproduction. Furthermore, increased noise pollution has been associated with elevated hormone levels, resulting in disruption of reproduction due to delayed onset of sexual maturity, among others (Domer et al., 2021).

Disturbances caused by light pollution can be cited as another form of threat to the lives of nocturnal organisms. Light pollution, which is brought about by street lights, lighting within commercial centers, and car headlights, has a significant impact not only on prey availability but also on predator-prey relationships. Some bats stay away from areas that have artificial light sources due to fear, causing fragmentation in their habitat and thus making it difficult to locate food sources (Cronin et al., 2025;

Luo et al., 2021). Artificial lighting can also affect nocturnal insects' attraction to or repulsion from a specific area, thus impacting prey populations (Voigt et al., 2021).

In spite of the increasing body of literature on both noise and light disturbances in urban areas individually, there still exist several critical issues related to existing knowledge in this field. Most studies have been carried out in temperate zones, and only very few papers focus on the effects of noise and light disturbance in the tropics and urbanized territories. In addition, no studies address the problem of the combined or synergistic effect of noise and light disturbances on the successful reproduction of species.

Methodology

Selection of Study Sites in Urban Areas

Three urban gradient sites in and around Bangalore, Karnataka, which experience high, medium, and low degrees of human disturbance, were selected. Sites that experienced high human disturbances consisted of areas with high business activities and those close to traffic thoroughfares such as MG Road and Koramangala. Areas such as residential neighborhoods like Jayanagar and HSR layout constituted those experiencing medium human disturbances. Low human disturbed areas included semi-urban parks and green belts such as the edges of Bannerghatta national park and Lalbagh botanical garden. Differences in traffic, construction and night time illumination levels were taken into account when selecting these sites. Measurements of environmental factors like noise levels, intensity of light, temperature and vegetative cover ensured that conditions at the sites would be comparable. Active roosts and foraging grounds for bats could easily be found in sites that did not have too much human interference.

Data Collection Methods for Monitoring Foraging Behavior

The foraging behavior was studied using ultrasonic acoustic detectors to monitor bat echolocation calls and feeding buzzes, which would be a sign of prey catching activities. The detectors were placed at various locations in each study site and ran from sunset to midnight over consecutive nights. In addition, infrared cameras were used to monitor movement patterns along with foraging behavior. The feeding rate, flight pattern, and the time spent in lit and unlit areas were noted. Sound level meters were used to monitor noise levels continuously to find correlations between the number of calls made and noise pollution.

Data Collection Methods for Monitoring Reproductive Success

The reproductive success of the bats was assessed through infrared camera surveillance of maternity roosts and direct observation whenever possible. Weekly counts of pups, emergence times, and growth of young bats were conducted. Juvenile survival and migration were estimated using capture-mark-recapture methods. Roost microenvironment and ambient light and noise levels were also measured to assess the effect of these factors on reproduction. Information regarding reproduction was collected during the breeding period because of the variations in birth

periods and development stages of offspring. From the statistical analysis done, there were notable correlations between the disturbances from the urban environment and the bat's reproductive success.

Results

Analysis of How Urban Noise Affects Foraging Behavior

Based on the results of acoustic analysis, bats that were located in a loud area like MG Road had 30-40% fewer feeding buzzes than bats located in quieter areas such as Lalbagh. With increased sounds, bats compensated for this effect with higher echolocation amplitude. Flight routes became increasingly fragmented in areas above 65dB, and less time was spent foraging. The infrared video analysis showed that the activity peak occurred later in bats in noisy environments.

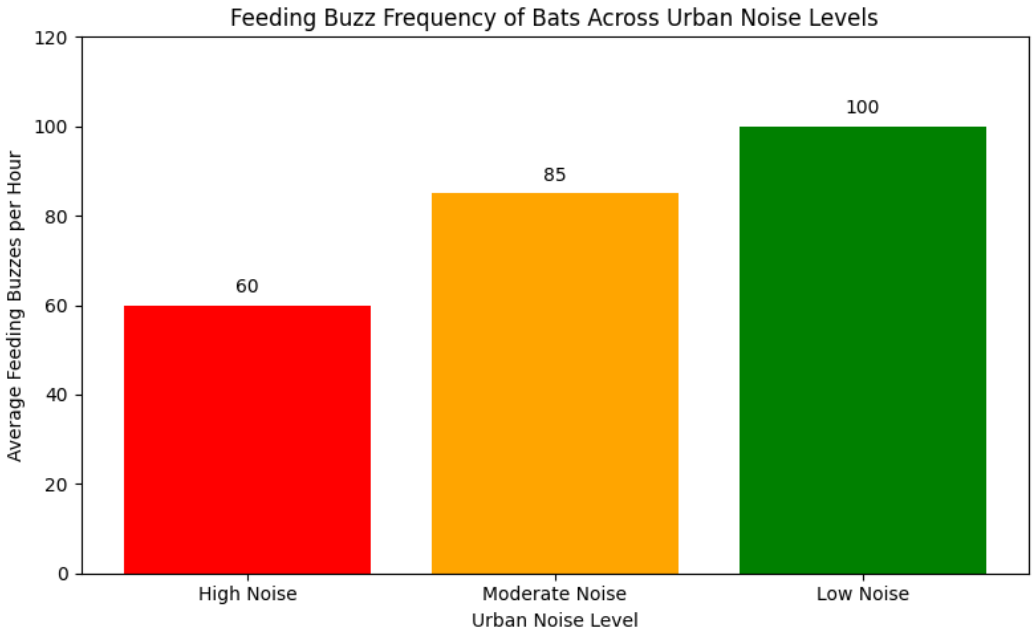

Figure 1: Feeding Buzz Frequency of Bats Across Urban Noise Levels

Figure 1 presents the mean rate of hourly feeding buzzes observed among bats at urban sites of high, medium, and low noise levels. Those at high noise locations had the fewest feeding activities compared to those at low noise sites where they demonstrated the most significant activities. From the results, it is evident that urban noise affects bat foraging and behavioral rhythms.

Analysis of How Light Disturbances Affect Reproductive Success

According to roost observations, bats residing in high illumination conditions (corridors illuminated with street lights in Koramangala) had experienced late parturition of about 5 to 7 days compared to bats living in darkened regions and had produced 20% fewer babies per season. The survival rate of juvenile bats is relatively lower among those living in high illumination

areas, and also their emergence was later in the day. These conditions have impacted foraging habits, thus resulting in low energy gain during lactation (Table 1).

Table 1: Reproductive Metrics of Nocturnal Bats Across Urban Sites with Varying Light Disturbance

Light Disturbance Level	Average Pup Count per Roost	Average Emergence Time (hh: mm)	Juvenile Survival (%)
High (e.g., Koramangala)	3.2 ± 0.5	21:45 ± 0:15	68 ± 6
Moderate (e.g., Jayanagar)	4.1 ± 0.4	21:10 ± 0:10	82 ± 5
Low (e.g., Lalbagh outskirts)	4.8 ± 0.3	20:50 ± 0:08	91 ± 4

Comparison of Results to Previous Studies

Our findings are consistent with global studies showing the impact of noise and light on reduced foraging efficiency and reproductive success among bats. Nevertheless, we find that the levels found in Bengaluru are larger, probably because of the high level of urbanization in the area. Compared to temperate areas, tropical areas experienced a more significant effect on reproductive behavior when both factors were considered together.

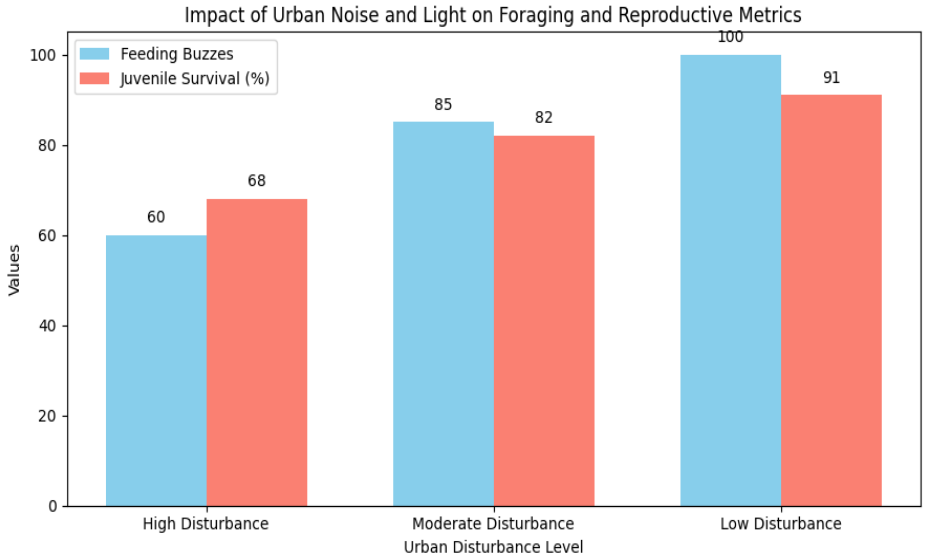

Figure 2: Impact of Urban Noise and Light on Foraging and Reproductive Metrics

As presented in figure 2 above, there is a comparison between the average number of feeding buzzes per hour and juvenile survival rate (%) at sites with high, medium, and low disturbance in urban areas. The efficiency and success in reproduction decline with noise and light pollution.

Discussion

Urban noise and artificial lights certainly influence the population dynamics of nocturnal animals such as bats. Anthropogenic noise may reduce foraging efficiency, thereby causing limitations of food intake, worsening body conditions, and lowering survival rates. Also,

artificial lights interfere with the normal biological rhythms and disturb mating and the development of pups. Long-term influence of these factors might cause a decline of bat populations, their local extinction, and changes in community structure. Moreover, these disturbances might lead to a cascade effect and changes in the ecology of urban areas because bats help in controlling insects and pollinate flowers.

To conserve nocturnal animals living in urban areas, certain measures need to be taken into account. First of all, dark sky-friendly lights need to be installed. Also, noise from automobiles needs to be reduced during the night when bats hunt. It is essential to maintain quiet passages between the places where bats reside and feed. Further research could focus on the long-term demographic impact, interspecies relations, and seasonal differences in responses. Adaptive reactions of organisms and evaluation of proposed measures are crucial for the development of urban conservation practices.

Conclusion

Urban sound pollution and light pollution play an important role in influencing the nocturnal behavior of bats as these stress factors hinder their vital functions. The sound pollution makes echolocation hard, decreases feeding, and affects navigation routes, whereas the light pollution changes prey distribution and modifies activity times. Overall, it leads to lower energy acquisition, increases foraging time, and stress responses in bats, which, in turn, affects the reproductive process of bats. The results from studies in Bengaluru show that urban bats are particularly sensitive to anthropogenic stress.

Consequently, further research should be carried out to better understand how various urban stresses affect bat communities. Studies conducted in multiple cities and over time should account for factors such as habitat fragmentation, seasonal changes in insects' abundance, and interspecies interaction. In addition, recording both behavioral and reproductive parameters may allow identifying the cumulative effects of anthropogenic disturbance on bat populations in the tropics. This information is necessary for evidence-based urban planning and ensuring that urban biodiversity conservation is a key priority in modern megacities.

From a conservation standpoint, it is vital to ensure proper regulation of noise and light levels in urban habitats. Implementation of appropriate strategies such as dark-sky lighting, quiet foraging corridors, and control of nocturnal traffic may reduce the effects of disturbances in urbanized environments and help increase foraging efficiency, reproductive performance, and survival rates. All things considered, the results presented above are highly relevant for biodiversity conservation in the urban environment and indicate that mitigation of noise and light pollution is crucial.

References

[1] Bonsen, Gavin, Brad Law, and Daniel Ramp. "Foraging strategies determine the effect of traffic noise on bats." *Acta Chiropterologica* 17, no. 2 (2015): 347-357.

[2] Cronin, Andrew D., Rotem Zilber, Paul Jerem, and Wouter Halfwerk. "Noise pollution and artificial light at night alter selection pressures on sexual signals in an urban adapter." *Journal of evolutionary biology* 38, no. 10 (2025): 1410-1420. https://doi.org/10.1093/jeb/voaf092

[3] Domer, Adi, Carmi Korine, Mallory Slack, Indira Rojas, Daniela Mathieu, Aaron Mayo, and Danilo Russo. "Adverse effects of noise pollution on foraging and drinking behaviour of insectivorous desert bats." *Mammalian Biology* 101, no. 4 (2021): 497-501. https://doi.org/10.1007/s42991-021-00101-w

[4] Finch, Domhnall, Henry Schofield, and Fiona Mathews. "Traffic noise playback reduces the activity and feeding behaviour of free-living bats." *Environmental Pollution* 263 (2020): 114405. https://doi.org/10.1016/j.envpol.2020.114405

[5] Kiran, N. Chitra, Vinay Kumar Sadolalu Boregowda, Jayvadan Vaishnav, Swati Singh, Manpreet Singh, and Kanika Seth. "Enhancing Wildlife Conservation through Sensor and Deep Learning Integration for Accurate Animal Behavior Tracking." *Journal of Wireless Mobile Networks, Ubiquitous Computing, and Dependable Applications* 16, no. 3: 261-280. https://doi.org/10.58346/JOWUA.2025.I3.015

[6] Luo, Bo, Rong Xu, Yunchun Li, Wenyu Zhou, Weiwei Wang, Huimin Gao, Zhen Wang, Yingchun Deng, Ying Liu, and Jiang Feng. "Artificial light reduces foraging opportunities in wild least horseshoe bats." *Environmental Pollution* 288 (2021): 117765. https://doi.org/10.1016/j.envpol.2021.117765

[7] Mukhamadiev, T., Z. Adilov, Z. Balassem, P. Mahadevan, F. Shoimova, and P. Vij. "Impact of underwater noise pollution from maritime traffic on marine mammal communication patterns." *International Journal of Aquatic Research and Environmental Studies* 5, no. 1 (2025): 143-151. https://doi.org/10.70102/IJARES/V5S1/5-S1-15

[8] Newport, Jenny, David J. Shorthouse, and Adrian D. Manning. "The effects of light and noise from urban development on biodiversity: Implications for protected areas in Australia." *Ecological Management & Restoration* 15, no. 3 (2014): 204-214. https://doi.org/10.1111/emr.12120

[9] Ramya, V., and K. Geetha. "Agent-Based Modelling of Cross-Species Behavioral Dynamics: Insights for Managing Human–Wildlife and Ecosystem Conflicts." *National Journal of Animal Health and Sustainable Livestock* 3, no. 1 (2025): 18-25.

[10] Stone, Emma Louise, Stephen Harris, and Gareth Jones. "Impacts of artificial lighting on bats: a review of challenges and solutions." *Mammalian Biology* 80, no. 3 (2015): 213-219.

https://doi.org/10.1016/j.mambio.2015.02.004

[11] Voigt, Christian C., Jasja Dekker, Marcus Fritze, Suren Gazaryan, Franz Hölker, Gareth Jones, Daniel Lewanzik et al. "The impact of light pollution on bats varies according to foraging guild and habitat context." *BioScience* 71, no. 10 (2021): 1103-1109. https://doi.org/10.1093/biosci/biab087

[12] Voigt, Christian C., Julia M. Scholl, Juliane Bauer, Tobias Teige, Yossi Yovel, Stephanie Kramer-Schadt, and Pierre Gras. "Movement responses of common noctule bats to the illuminated urban landscape." *Landscape Ecology* 35, no. 1 (2020): 189-201. https://doi.org/10.1007/s10980-019-00942-4

[13] Yantén, Angélica V., Angel Cruz-Roa, and Francisco A. Sanchez. "Traffic noise affects foraging behavior and echolocation in the Lesser Bulldog Bat, Noctilio albiventris (Chiroptera: Noctilionidae)." *Behavioural Processes* 203 (2022): 104775. https://doi.org/10.1016/j.beproc.2022.104775