World Journal of Environmental Biosciences
Available Online at: **www.environmentaljournals.org**

Volume 15, Issue 2: 39-49

https://doi.org/10.51847/u3pwuL5K2I

ISSN 2277- 8047

Impact of Noise and Artificial Light at Night on Dawn Chorus and Avian Behaviour in Pune

Ashish Vilas Mane[1]*, Tarak Vinay Sawant[1], Lokshiva Abhijay Pitchuka[1], Arshaan Sajid Shaikh[1]

[1]Department of Environmental Science, Fergusson College (Autonomous), Pune, Maharashtra, India.

ABSTRACT

Urbanization and anthropogenic disturbances strongly affect avian behavior, especially dawn chorus activity. This study examined the effects of environmental variables such as noise levels and light intensity on dawn chorus dynamics. Surveys were conducted at four urban and semi-natural habitats in Pune during the monsoon 2025 and winter 2026. Variations in bird vocalization patterns, timing, and behavioral responses were analyzed in relation to increasing urban noise and artificial light at night. Sampling was conducted at Prabhat Road, BMCC Road, Hanuman Tekdi, and Vetal Tekdi during early morning hours at five-minute intervals. Ambient noise and illuminance were measured using calibrated mobile applications, while bird species were identified using Merlin Bird ID and field observations. Results showed that urban sites had higher noise levels and greater anthropogenic disturbance than hillock ecosystems. Dawn chorus activity increased with sunrise and rising light intensity. Winter observations recorded higher lux values and stronger bird vocalization. Variations in chorus timing and activity reflected the influence of urban environmental conditions on avian behavior. Principal Component Analysis (PCA) revealed significant associations among seasonal variation, light intensity, and noise conditions.

Keywords: *Dawn chorus dynamics, Urban noise pollution, Artificial light at night (ALAN), Avian behavior, Urban ecology*

Corresponding author: Ashish Vilas Mane
e-mail ✉ ashish.mane@fergusson.edu
Received: 28 January 2026
Accepted: 12 April 2026

INTRODUCTION

Urbanization is a dominant driver of environmental change in the 21st century (Wang *et al*., 2021). It alters natural habitats through increased infrastructure, human activity, and resource consumption (Ahmed *et al*., 2020; Chen & Chen, 2023; Cissé *et al*., 2024). Among the less visible but ecologically significant consequences of urban growth are elevated noise levels and widespread artificial light at night (ALAN) (Gaston & Sánchez, 2022; Salikhova *et al*., 2023; Nyamagoud *et al*., 2024). These factors disrupt natural sensory environments that many organisms rely on for survival and reproduction. Birds, in particular, are highly sensitive to both acoustic and light cues (Boycott *et al*., 2021; Tam *et al*., 2023; Kariri *et al*., 2024). Daily and seasonal behaviours of birds are closely synchronized with environmental rhythms (Greenfield *et al*., 2021; Singh *et al*., 2023; Hashem *et al*., 2024). One of the most prominent behavioral phenomena in birds is the dawn chorus (Gil & Llusia, 2020; Guzek *et al*., 2023; Csep *et al*., 2024). It is a period of intense vocal activity that occurs at first light and plays a critical role in territory establishment, mate attraction, and intra-species communication. In rapidly developing cities such as Pune, the intensification of anthropogenic disturbances raises important questions about how urban conditions are reshaping these natural behaviors (Patel & Raval, 2024; Manfredini *et al*., 2024; Petronis *et al*., 2025). The expansion of road networks, commercial zones, and residential complexes has led to a continuous increase in background noise and skyglow, even during pre-dawn hours (Jechow & Hölker, 2020; Çınaroğlu *et al*., 2023; Cakmak *et al*., 2024). Such persistent exposure can interfere with circadian rhythms, leading to physiological stress and behavioral adaptations in urban bird populations (Bratt & Naimi-Akbar, 2023; Leadbeatter & Tjaya, 2024; Sayuri, 2026). These changes may contribute to long-term ecological shifts within urban biodiversity.

The dawn chorus is regulated by endogenous biological clocks and external environmental signals, mainly light intensity and ambient sound conditions (Marín-Gómez & MacGregor-Fors, 2021). Marín-Gómez (2022) reported that artificial light at night (ALAN) can extend perceived daylight hours, leading birds to initiate singing earlier than they would under natural conditions (Çınaroğlu *et al*., 2023; Muthanandam *et al*., 2024). Similarly, elevated urban noise can mask bird vocalizations, forcing species to adjust the timing, frequency, or amplitude of their calls (Merrall & Evans, 2020). These behavioral modifications may have cascading ecological consequences, including altered species interactions, reduced reproductive success, and shifts in community composition (Wilson *et al*., 2020; Fisher *et al*., 2021; Ahmed *et al*., 2023a; Ahmed *et al*., 2023b; Ahmed, 2023c; Carita *et al*., 2025).

The study examines correlations between environmental noise, artificial light at night (ALAN), and bird behavior, particularly dawn chorus patterns. Prabhat Road and BMCC Road represented urban and commercial areas, while Hanuman Tekdi and Vetal Tekdi represented relatively less disturbed urban green spaces with dense vegetation in Pune. It also investigates seasonal variation and consistency in dawn chorus characteristics, while assessing overall avian diversity.

A standardized methodology was used to ensure reliable data across sites and seasons, with observations conducted during monsoon and winter mornings. Light and noise were measured using calibrated smartphone applications, and birds were identified through smartphone-based acoustic and visual tools. Data were recorded at five-minute intervals using tripod-mounted devices, supported by qualitative field observations for context. Therefore, the present investigation highlights critical research gaps in understanding the effects of urban environments on avian behavior.

MATERIALS AND METHODS

Study area and site selection

To capture environmental and ecological variation across an urban gradient, multiple sites were selected within Pune based on accessibility, safety, and contrasting levels of artificial light and noise. The selected sites differed in land use, vegetation, human activity, and bird composition, representing habitat types within a rapidly urbanizing landscape **(Figure 1)**.

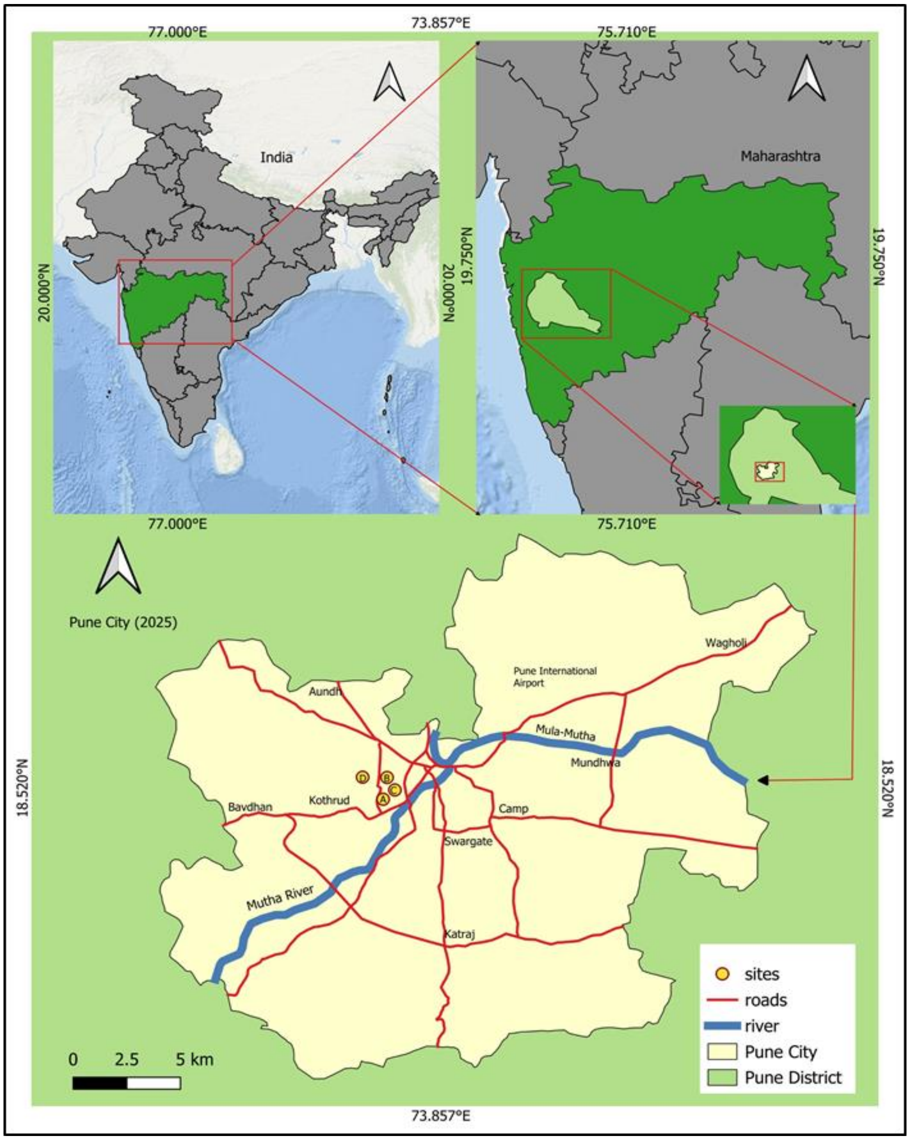

Figure 1. Study Area Locations in Pune

Sampling design and temporal coverage

All sites were visited repeatedly during the early morning hours across two seasonal periods, namely the monsoon (August-September 2025; 05:00-06:45 AM) and winter (January-February 2026; 06:00-07:30 AM). Data were collected at five minute intervals under similar environmental conditions to study changes in bird call activity in response to environmental factors.

Sampling sites and classification

The study was conducted at four sampling locations in Pune, Maharashtra. Prabhat Road (Site A; 18°30'53"N, 73°49'53"E) and BMCC Road (Site C; 18°31'09"N, 73°50'09"E) represented urban and commercial jogging-track areas, whereas Hanuman Tekdi (Site B; 18°31'29"N, 73°50'00"E) and Vetal Tekdi (Site D; 18°31'33"N, 73°49'19"E) represented relatively less disturbed urban green spaces characterized by hillock ecosystems with dense vegetation.

Equipment and calibration

Field data collection was conducted using minimal yet effective equipment suitable for simultaneous sampling across urban locations. Three smartphones equipped with relevant mobile applications were used as primary tools for recording environmental variables, and all applications were calibrated prior to data collection through repeated measurements to ensure consistency and reliability.

Measurement of environmental variables

Ambient light levels were recorded using a lux meter application obtained from the Google Play Store, with maximum, minimum, and average lux values considered to capture illuminance levels immediately before and after sunrise. Ambient noise levels were measured using a decibel meter application, with maximum, minimum, and average sound pressure levels (dB) recorded to assess traffic noise, honking, and background urban soundscape.

Bird species identification

Bird species identification was carried out in real time using the Merlin Bird ID application, which facilitated identification based on both visual and acoustic cues. Species identifications were further reviewed and verified using standard field guides to ensure accuracy in documenting avian presence during each sampling session.

Data recording procedure

All smartphones were mounted on adjustable tripods to ensure stable placement during recording, and data were logged at five-minute intervals throughout the sampling period. This setup minimized handling noise and ensured consistency in device positioning across sites and sampling events.

Field observations and supplementary data

In addition to quantitative measurements, a field notepad was used to record qualitative observations, including weather conditions (i.e., cloud cover, rain, and wind), chorus onset time, species detected, and any anomalies (e.g., construction noise or animal interference).These observations supported the interpretation of variations in avian behavior.

Statistical analysis

Principal Component Analysis (PCA) was performed using the software PAST to evaluate variations and associations in noise levels and light intensity (lux) recorded across different study sites and sampling times. The PCA biplot was used to identify clustering patterns, temporal shifts, and correlations among environmental variables and monitoring locations.

RESULTS AND DISCUSSION

The results of field measurements of climatic and urban environmental variables during the sampling period are shown in **Table 1**.

Table 1. Field Measurements of Climatic and Urban Environmental Variables during Sampling Period

Sr. No.	Date	Site Code	Sunrise Time	Weather	Min Temp (Celsius)	Max Temp (Celsius)	Relative Humidity (%)	UV Index	Wind Speed (kmph)	Streetlights
1	20 Sep 2025	C	6:23 AM	Partly cloudy	19.9	26.7	93	6	12.2	Present
2	21 Sep 2025	B	6:23 AM	Partly cloudy	20.2	27.6	92	7	14.4	None
3	22 Sep 2025	D	6:23 AM	Partly cloudy	19.4	25.8	95	4	13	None
4	23 Sep 2025	A	6:23 AM	Partly cloudy	18	23.8	94	3	14.8	Present
5	16 Jan 2026	B	7:10 AM	Partly cloudy	14.8	29.4	63	8	11.9	None
6	18 Jan 2026	D	7:10 AM	Clear conditions	15.8	28.1	65	8	16.2	None
7	21 Jan 2026	A	7:10 AM	Clear conditions	14.3	28.1	61	8	14.4	Present
8	27 Jan 2026	D	7:10 AM	Partly cloudy	18.4	28.1	75	7	14	None
9	28 Jan 2026	B	7:10 AM	Partly cloudy	15.2	28.8	70	8	11.2	None
10	29 Jan 2026	C	7:09 AM	Partly cloudy	16.8	28.2	65	7	14.8	Present
11	30 Jan 2026	A	7:09 AM	Partly cloudy	18.4	28.3	63	7	14.4	Present
12	01 Feb 2026	D	7:08 AM	Clear conditions	16.2	27.8	64	8	11.9	None
13	04 Feb 2026	D	7:07 AM	Partly cloudy	18.5	30	55	8	14.8	None
14	05 Feb 2026	C	7:07 AM	Clear conditions	17.7	29.6	54	8	14.8	Present
15	06 Feb 2026	B	7:07 AM	Clear conditions	16	28.7	52	9	15.1	None
16	10 Feb 2026	C	7:05 AM	Clear conditions	16.4	30.6	58	9	10.1	Present
17	12 Feb 2026	C	7:04 AM	Clear conditions	17.3	30.1	47	9	13.3	Present
18	13 Feb 2026	A	7:04 AM	Clear conditions	15.7	29.8	52	9	7.9	Present
19	14 Feb 2026	A	7:03 AM	Clear conditions	16.4	30.2	49	9	9.4	Present
20	15 Feb 2026	B	7:03 AM	Clear conditions	17.6	30.5	51	9	7.6	None

The results of combined seasonal variation in noise, light intensity, and active dawn chorus period across all study sites are shown in **Table 2**.

Table 2. Combined Seasonal Variation in Noise, Light Intensity, and Active Dawn Chorus Period Across All Study Sites

Sr. No.	Site Code	Season	Date	Max dB	Min dB	Max Lux	Min Lux	Active Dawn Chorus Period	Dominant Species
1	A	Monsoon	29 Sep 2025	78.4	28.5	32	2	6:20-6:30 AM	Crow, Rose-ringed Parakeet
2	A	Winter	21 Jan 2026	79.4	33.7	210	2	7:10-7:25 AM	Rose-ringed Parakeet
3	A	Winter	30 Jan 2026	76.3	33.3	758	8	7:15-7:25 AM	Alexandrine Parakeet
4	A	Winter	13 Feb 2026	74.9	30.8	574	28	6:45-7:15 AM	Crow, Rose-ringed Parakeet
5	A	Winter	14 Feb 2026	76.5	35.8	591	27	6:50-7:10 AM	Mixed species
6	B	Monsoon	21 Sep 2025	76.1	21.2	185	0	6:00-6:25 AM	Alexandrine Parakeet
7	B	Winter	16 Jan 2026	78.6	35.4	3157	0	6:45-7:25 AM	Parakeets and Crow
8	B	Winter	28 Jan 2026	73.2	18.6	1940	0	6:50-7:25 AM	Parakeets and Crow
9	B	Winter	15 Feb 2026	59.6	36.5	2734	0	6:55-7:20 AM	Alexandrine & Rose-ringed Parakeet
10	B	Winter	15 Feb 2026	59.6	36.5	2734	0	6:55-7:20 AM	Alexandrine & Rose-ringed Parakeet
11	C	Monsoon	20 Sep 2025	69.4	26.6	137	1	6:10-6:30 AM	Alexandrine & Rose-ringed Parakeet
12	C	Winter	29 Jan 2026	71.7	30.4	579	0	6:55-7:15 AM	Rose-ringed & Alexandrine Parakeet
13	C	Winter	05 Feb 2026	75.2	32.8	652	0	6:50-7:15 AM	Alexandrine & Rose-ringed Parakeet
14	C	Winter	10 Feb 2026	73.3	30.2	483	0	6:50-7:25 AM	Alexandrine & Rose-ringed Parakeet
15	C	Winter	12 Feb 2026	73.9	32.3	425	0	6:50-7:20 AM	Asian Koel, Alex. Parakeet, Bulbul
16	D	Monsoon	22 Sep 2025	53.6	25.5	33	0	6:05-6:30 AM	Peacock, Bulbul, Alex. Parakeet
17	D	Winter	18 Jan 2026	52.2	22.6	360	0	7:00-7:30 AM	Alexandrine & Rose-ringed Parakeet
18	D	Winter	27 Jan 2026	51.9	21.4	301	0	7:00-7:20 AM	Alexandrine parakeet, Red-vented bulbul
19	D	Winter	01 Feb 2026	56.1	26.8	579	0	6:55-7:25 AM	Alexandrine & Rose-ringed Parakeet
20	D	Winter	04 Feb 2026	56.0	27.9	487	0	6:55-7:25 AM	Alexandrine & Rose-ringed Parakeet

Table 3 shows the list of bird species observed during the study period.

Table 3. List of Bird Species Observed During Study Period

Sr. No.	Common Name	Scientific Name
1)	Large-billed Crow	*Corvus macrorhynchos*
2)	Crow (House Crow)	*Corvus splendens*
3)	Asian Koel	*Eudynamys scolopaceus*
4)	Rose-ringed Parakeet	*Psittacula krameri*
5)	Red-vented Bulbul	*Pycnonotus cafer*
6)	Alexandrine Parakeet	*Psittacula eupatria*
7)	Common Tailorbird	*Orthotomus sutorius*
8)	Red-whiskered Bulbul	*Pycnonotus jocosus*
9)	Black Kite	*Milvus migrans*
10)	Little Swift	*Apus affinis*
11)	Ashy Prinia	*Prinia socialis*
12)	Greater Coucal	*Centropus sinensis*
13)	Indian Nightjar	*Caprimulgus asiaticus*
14)	Tickell's Blue Flycatcher	*Cyornis tickelliae*
15)	Indian Peafowl	*Pavo cristatus*
16)	Oriental Magpie-robin	*Copsychus saularis*
17)	Coppersmith Barbet	*Psilopogon haemacephalus*

18)	Red-wattled Lapwing	*Vanellus indicus*
19)	Purple Sunbird	*Cinnyris asiaticus*
20)	Asian Green Bee-eater	*Merops orientalis*
21)	Black Drongo	*Dicrurus macrocercus*
22)	Rufous Treepie	*Dendrocitta vagabunda*
23)	Laughing Dove	*Spilopelia senegalensis*
24)	Plum-headed Parakeet	*Psittacula cyanocephala*
25)	House Sparrow	*Passer domesticus*
26)	Spot-breasted Fantail	*Rhipidura albogularis*
27)	Spotted Owlet	*Athene brama*
28)	Asian Tit (Cinereous Tit)	*Parus cinereus*
29)	Common Myna	*Acridotheres tristis*
30)	Indian Paradise Flycatcher	*Terpsiphone paradisi*
31)	Red-breasted Flycatcher	*Ficedula parva*
32)	Indian White-eye	*Zosterops palpebrosus*
33)	Purple-rumped Sunbird	*Leptocoma zeylonica*
34)	Pale-billed Flowerpecker	*Dicaeum erythrorhynchos*
35)	Indian Grey Hornbill	*Ocyceros birostris*
36)	Shikra	*Accipiter badius*
37)	Grey-breasted Prinia	*Prinia hodgsonii*
38)	White-throated Kingfisher	*Halcyon smyrnensis*

General field observations at study areas

Observations across all four sites showed clear differences in noise levels, illuminance, and dawn chorus activity between seasons. Urban sites, Site A and Site C, recorded higher noise levels (30.2-79.4 dB) from vehicular traffic, construction, and pedestrian activity as shown in **Figure 2**, while hillock sites showed lower baselines overall. Illuminance was suppressed during the monsoon across all sites due to cloud cover, rarely exceeding 185 lx. In contrast, winter produced much higher values, peaking at 3,157 lx at Site B on 16 January 2026, as shown in **Figure 3**. Site A recorded a consistent pre-dawn lux of 19-20 lx from 6:10 AM onwards, reflecting the direct influence of streetlights even before sunrise.

Chorus onset timing shifted with season and site type. During the monsoon, activity began between 5:55 and 6:30 AM, aligning with the 6:23 AM sunrise, though overall intensity was lower due to cloud cover and rainfall. In winter, onset ranged from 6:45 AM at Site B to 7:10 AM at Site A, despite a similar sunrise window of 7:03-7:10 AM across all sites, suggesting that urban noise delayed chorus initiation beyond the photoperiod cue. Rose-ringed Parakeet and Alexandrine Parakeet were the most consistently active species at all sites. At the same time, while Indian Peafowl and Red-vented Bulbul were largely confined to Site B, indicating that habitat quality remains a key factor in supporting avian diversity during the chorus window.

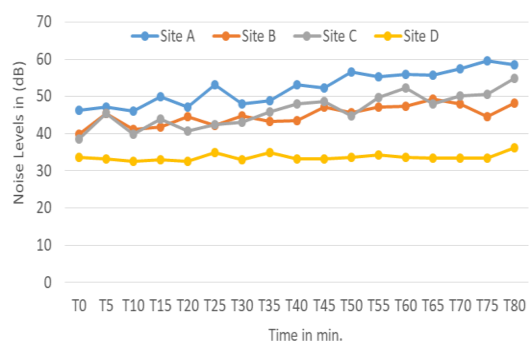

Figure 2. Time-wise Noise Level Variations Across Study Sites

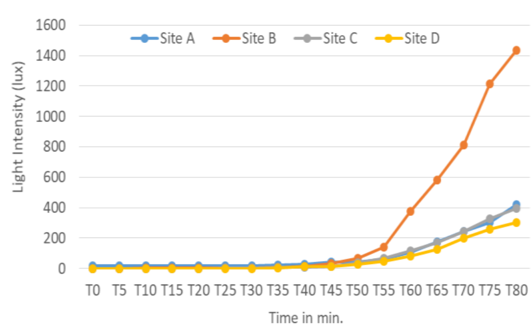

Figure 3. Time-wise Light Intensity Variations Across Study Sites

Seasonal variation in dawn chorus activity, noise levels, and light intensity at site A

Monsoon observations at Site A on 29 September 2025 recorded a maximum noise level of 78.4 dB and a minimum of 28.5 dB at 5:10 AM. Light intensity ranged from 2 lx (5:10-5:20 AM) to 32 lx at 6:30 AM. Chorus activity increased after 5:30 AM, peaking between 6:20-6:30 AM, indicating a shift from vehicular noise dominance to increased bird activity after sunrise.

Winter observations on 21 January 2026 recorded maximum and minimum noise levels of 79.4 dB (7:20 AM) and 33.7 dB (6:15 AM), respectively. Light intensity varied from 2 lx (6:15-6:40 AM) to 210 lx at 7:30 AM. Chorus activity increased after 6:50 AM, peaking between 7:10-7:25 AM, mainly dominated by rose-ringed parakeets.

Observations on 30 January 2026 showed noise levels ranging from 33.3 dB (6:40 AM) to 76.3 dB (7:10 AM), while light intensity increased from 8 lx at 6:50 AM to 758 lx at 7:30 AM. Peak chorus intensity occurred at 7:25 AM and was dominated by Alexandrine parakeets.

On 13 February 2026, noise levels ranged from 30.8 dB (6:20 AM) to 74.9 dB (7:15 AM), while light intensity varied between 28 lx (6:10-6:40 AM) and 574 lx at 7:30 AM. Chorus activity increased after 6:45 AM, with medium intensity dominated by rose-ringed parakeets and crows.

Observations on 14 February 2026 recorded the maximum and minimum noise levels of 76.5 dB (7:30 AM) and 35.8 dB (6:10 AM), respectively. Light intensity ranged from 27 lx (6:10-6:35 AM) to 591 lx at 7:30 AM. Peak chorus activity occurred between 6:50-7:10 AM, followed by moderate fluctuations as daylight increasded.

Time-wise observations at Site A showed seasonal variation in noise and illuminance. During the monsoon, noise levels ranged from 40.5 dB (5:25 AM) to 56.4 dB (5:50 AM), reflecting moderate fluctuations under limited human activity. In winter, noise levels were higher, ranging from 42.4 dB (6:15 AM) to 65 dB (7:25 AM), indicating increased anthropogenic activity. Monsoon illuminance remained low, between 3 lx and 25 lx, due to cloud cover and reduced sunlight. Winter lux values increased sharply from 5 lx (6:10 AM) to 740 lx (7:30 AM), reflecting clearer skies and stronger solar radiation. Overall, winter conditions showed greater intensity and variability in both noise and light compared to monsoon conditions.

Seasonal variation in dawn chorus activity, noise levels, and light intensity at site B

Monsoon observations at Site B on 21 September 2025 recorded a maximum noise level of 76.1 dB at 6:15 AM and a minimum of 21.2 dB at 6:25 AM. Light intensity ranged from 0 lx (5:10-5:15 AM) to 185 lx at 6:30 AM. Chorus activity increased after 6:00 AM, with Alexandrine parakeets dominating later intervals. Rainfall reduced anthropogenic disturbance and early bird vocalizations.

Winter observations on 16 January 2026 recorded the maximum and minimum noise levels of 78.6 dB (6:55 AM) and 35.4 dB (6:20 AM), respectively. Light intensity varied from 0 lx (6:10-6:25 AM) to 3157 lx at 7:30 AM. Chorus activity increased rapidly after 6:40 AM, with high intensity from 6:45 AM onwards, dominated by parakeets and later crows despite pedestrian and vehicular disturbance.

Observations on 28 January 2026 showed noise levels ranging from 18.6 dB (6:45 AM) to 73.2 dB (6:35 AM), while light intensity increased from 0 lx (6:10-6:30 AM) to 1940 lx during 7:25-7:30 AM. Chorus activity rose sharply after 6:40 AM, with high intensity from 6:50 AM onwards under pedestrian and loudspeaker disturbance.

On 6 February 2026, noise levels ranged from 36.4 dB (6:20 AM) to 68.4 dB (7:15 AM), while light intensity varied from 0 lx (6:10-6:25 AM) to 2669 lx at 7:30 AM. Chorus activity increased after 6:40 AM, peaking between 6:55-7:20 AM, and was dominated by Alexandrine and rose-ringed parakeets.

Observations on 15 February 2026 recorded the maximum and minimum noise levels of 59.6 dB (7:25 AM) and 36.5 dB (6:20 AM), respectively. Light intensity ranged from 0 lx (6:10-6:25 AM) to 2734 lx at 7:30 AM. High chorus intensity occurred between 6:55-7:20 AM, dominated by rose-ringed and Alexandrine parakeets under low initial disturbance followed by pedestrian activity.

Time-wise observations at Site B showed seasonal differences in noise and illuminance. During the monsoon, noise levels ranged from 28.9 dB (6:25 AM) to 57.1 dB (6:15 AM), indicating low to moderate acoustic activity in a less disturbed environment. Winter noise levels ranged from 35.6 dB (6:10 AM) to 53.8 dB (7:30 AM), reflecting increased morning activity. Monsoon illuminance remained low, from 0 lx to 83 lx, due to cloud cover and limited sunlight. In winter, lux values increased sharply from 0-1 lx to 2384 lx at 7:30 AM, indicating clearer skies and stronger solar intensity. Overall, monsoon conditions were more stable, while winter showed greater variation, especially in light intensity.

Seasonal variation in dawn chorus activity, noise levels, and light intensity at site C

Monsoon observations at Site C on 20 September 2026 recorded maximum and minimum noise levels of 69.4 dB (6:30 AM) and 26.6 dB (5:20 AM). Light intensity ranged from 1 lx (5:10-6:00 AM) to 137 lx at 6:30 AM. Chorus activity increased after 6:00 AM, peaking between 6:10-6:30 AM and dominated by Alexandrine and rose-ringed parakeets despite vehicular, human, and construction noise.

Winter observations on 29 January 2026 showed noise levels ranging from 30.4 dB (6:10 AM) to 71.7 dB (7:10 AM), while light intensity increased from 0 lx to 579 lx at 7:30 AM. Chorus activity increased after 6:45 AM, peaking between 6:55-7:15 AM with parakeets and other species under continuous vehicular and pedestrian disturbance.

Observations on 5 February 2026 recorded noise levels ranging from 32.8 dB (6:15 AM) to 75.2 dB (6:35 AM). Light intensity ranged from 0 lx (6:10-6:40 AM) to 652 lx at 7:30 AM. Chorus intensity increased after 6:45 AM, peaking between 6:50-7:15 AM, dominated by Alexandrine and rose-ringed parakeets despite traffic, pedestrian activity, and prayer-call noise.

On 10 February 2026, noise levels ranged from 30.2 dB (6:10 AM) to 73.3 dB (7:10 AM), while light intensity varied from 0 lx to 483 lx at 7:30 AM. Chorus activity increased steadily after 6:45 AM, peaking between 6:50-7:25 AM under vehicular, pedestrian, and construction disturbances.

Observations on 12 February 2026 recorded the maximum and minimum noise levels of 73.9 dB (6:55 AM) and 32.3 dB (6:20 AM), respectively. Light intensity ranged from 0 lx (6:10-6:35 AM) to 425 lx at 7:30 AM. High chorus activity was observed from 6:50-7:20 AM, involving Asian koel, Alexandrine parakeet, and red-vented bulbul despite continuous urban disturbance.

Comparative observations at Site C showed seasonal variation in noise and illuminance. During the monsoon, noise levels ranged from 31.3 dB (5:20 AM) to 53.6 dB (6:10 AM), indicating low to moderate early morning activity. In winter, noise levels ranged from 30.2 dB (6:30 AM) to 59.4 dB (7:30 AM), reflecting increased vehicular and urban activity. Monsoon illuminance remained low, between 1 lx and 56 lx, due to cloud cover and reduced sunlight. Winter lux values increased from 0-1 lx to 608 lx at 7:30 AM, indicating clearer skies and stronger solar radiation. Overall, winter conditions showed greater variability and intensity in both noise and light compared to monsoon conditions.

Seasonal variation in dawn chorus activity, noise levels, and light intensity at site D

Monsoon observations at Site B on 22 September 2025 recorded maximum and minimum noise levels of 53.6 dB (5:55 AM) and 25.5 dB (6:30 AM), indicating low background noise. Light intensity increased from 0 lx to 33 lx at 6:30 AM. Chorus activity rose rapidly after 5:55 AM, peaking between 6:05-6:30 AM with peacocks, red-vented bulbuls, and Alexandrine parakeets dominating under minimal anthropogenic disturbance.

Winter observations on 18 January 2026 showed noise levels ranging from 22.6 dB (7:15 AM) to 52.2 dB (6:45 AM). Light intensity increased from 0 lx to 360 lx at 7:30 AM. High chorus activity occurred between 7:00-7:30 AM, dominated by Alexandrine and rose-ringed parakeets, peacocks, and red-vented bulbuls despite minor disturbances.

Observations on 27 January 2026 recorded noise levels between 21.4 dB (6:45 AM) and 51.9 dB (6:35 AM), while light intensity rose from 0 lx to 301 lx at 7:20 AM. Chorus activity increased from medium intensity at 6:50-6:55 AM to high intensity between 7:00-7:20 AM, dominated by parakeets and red-vented bulbuls under minimal disturbance.

On 1 February 2026, noise levels ranged from 26.8 dB (6:55 AM) to 56.1 dB (7:30 AM). Light intensity increased from 0 lx to 579 lx at 7:30 AM. Chorus activity became high between 6:55-7:25 AM, dominated by Alexandrine and rose-ringed parakeets and red-vented bulbuls despite pedestrian, train, and plane noise.

Observations on 4 February 2026 showed noise levels ranging from 27.9 dB (6:20 AM) to 56.0 dB (7:00 AM), while light intensity increased from 0 lx to 487 lx at 7:30 AM. Chorus activity reached high intensity between 6:55-7:25 AM, dominated by parakeets and red-vented bulbuls under moderate disturbance from pedestrian movement, train noise, and prayer calls.

Time-wise observations at Site B showed clear seasonal differences in noise and illuminance under relatively undisturbed natural conditions. During the monsoon, noise levels ranged from 29.7 dB (6:30 AM) to 38.6 dB (5:10 AM), indicating minimal anthropogenic disturbance. In winter, noise levels ranged from 27.6 dB (7:15-7:25 AM) to 45.1 dB (7:30 AM), showing slight increases with morning activity while remaining generally quiet. Monsoon illuminance remained very low, from 0 lx to 16 lx, due to dense cloud cover. In winter, lux values gradually increased from 0 lx to 440 lx at 7:30 AM, reflecting clearer skies and stronger sunlight. Overall, Site B maintained low and stable noise levels in both seasons, while winter showed higher light intensity than monsoon conditions.

The study generated novel baseline data for Pune, Maharashtra, thereby addressing an existing regional research gap on urban dawn chorus dynamics. It identified measurable deviations from the expected timing and intensity of the dawn chorus and demonstrated the impact of noise pollution and artificial light on behavior of bird vocalization. The study further documented site-specific differences in bird behaviour across relatively undisturbed and urban environments, and established the influence of weather variables, including temperature, light intensity, and wind, on avian activity. In addition, it analyzed the spatial distribution and species composition across the selected study locations.

Urbanization significantly alters avian dawn chorus timing and structure through anthropogenic noise and light pollution, affecting bird acoustic communication across urban environments (Marín-Gómez & MacGregor-Fors, 2021; Bustamante *et al*., 2024). Wood *et al*. (2026); Zhang *et al*. (2022) and Guenat and Dallimer (2023) reported that light and noise pollution significantly affect terrestrial biodiversity and ecosystem services, with combined exposure producing synergistic effects on wildlife behavior, physiology, and ecological functioning in urban and disturbed habitats. Artificial light at night (ALAN) caused earlier dawn singing in Saffron Finches inhabiting highly urbanized tropical areas, while anthropogenic noise showed no significant effect on chorus timing (Marín Gómez, 2022; Foppen *et al*., 2024). Yang *et al*. (2025); Wang *et al*. (2021) and Leveau (2020) reported that artificial light at night (ALAN) significantly influenced urban bird diversity, with birds showing behavioral adaptation to nocturnal light conditions in urban habitats. Combined exposure to anthropogenic noise and artificial light at night (ALAN) can produce interactive ecological effects on wildlife, including behavioural, physiological, and population-level changes (Halfwerk & Jerem, 2021; Mathiaparanam *et al*., 2024). Urban green cover, anthropogenic noise, and artificial light at night (ALAN) influenced the occurrence and vocal activity of the Mottled Owl in urban environments (Marín-Gómez *et al*., 2020). Artificial light at night (ALAN) and anthropogenic noise negatively affect owl communication, hunting success, behavior, and occurrence, contributing to ecological disturbance and reduced reproductive success (Sordello *et al*., 2025; Orlando *et al*., 2026). Xu *et al*. (2026) reported that urbanization altered birds' acoustic circadian timing and song characteristics, with urban bird species advancing dawn singing by an average of 23.89 minutes and modifying vocal frequencies to adapt to urban environments. Traffic infrastructure and associated stressors such as noise and artificial light at night negatively influence urban bird communities and urban biodiversity (Sander & Tietze, 2022; Fröhlich *et al*., 2025; Mori *et al*., 2025). Artificial light at night (ALAN) affects ecosystem functions by altering animal behavior, plant growth, and ecological interactions in urban green spaces and parks (Svechkina, *et al*., 2020; Katabaro *et al*., 2022; Seymoure *et al*., 2023). Artificial light at night (ALAN) significantly increased nocturnal vocalization and extended foraging activity in Tropical Kingbirds, altering their natural behavioral patterns (Ramírez-Adame *et al*., 2026; Sayuri *et al*., 2026). Broad *et al*. (2024) and Patel *et al*. (2025) reported that anthropogenic noise and light disturbance disrupted vocal communication and collective behavior in jackdaws, affecting roosting patterns, sleep-related activity, and group coordination during collective movements. Artificial light at night (ALAN) disrupts circadian rhythms, behavior, physiology, and ecosystem functions in plants and animals, producing widespread ecological consequences (Falcón *et al*., 2020).

Principal component analysis

The time-wise noise variation across sites, illustrated in **Figure 2**, shows that Site A and Site C recorded consistently elevated noise levels throughout the monitoring window, attributable to vehicular traffic, pedestrian activity, and construction disturbances. The PCA biplot reflects this pattern, with T0-T35 clustered at negative PC1 values, representing pre-sunrise noise levels of 33-46 dB across sites, during which **Table 2** records either absent or minimal chorus activity. As anthropogenic activity increased toward the T55-T80 interval, noise levels at Sites A and C reached 73-79 dB **(Figure 2)**, corresponding to delayed chorus onset of 6:45-7:25 AM at these urban sites, despite a 7:03-7:10 AM sunrise **(Table 2)**. The loading vectors indicate that Site A showed a stronger negative association with Component 2, consistent with its higher and more variable noise profile relative to other sites. Site D, which **Figure 2** consistently shows as the quietest monitoring location (21-56 dB) due to minimal anthropogenic disturbance, corresponds with the strongest negative PC1 clustering and the earliest chorus onset of 6:05 AM recorded across the entire study period **(Table 2)**, indicating that lower acoustic interference supported earlier and more consistent avian vocal activity.

The time-wise light intensity variation across sites, illustrated in **Figure 3**, shows Site B recording markedly higher illuminance values than the remaining three sites throughout the monitoring window, attributed to its hillock elevation, absence of streetlights, and open canopy structure. The PCA biplot reflects this, with Site B showing notable separation along Component 2 relative to the other sites. The clustering of T25-T50 at negative PC1 values represents the low pre-sunrise illuminance phase, during which **Table 2** records minimal to absent chorus activity across all sites. The progressive shift toward positive PC1 values at T65-T80 aligns with the post-sunrise illuminance surge visible in **Figure 3**, coinciding with peak active chorus periods documented in **Table 2**. This pattern was most pronounced at Site B, where illuminance reached 3,157 lux on 16 January 2026 **(Figure 3)** and high-intensity chorus activity dominated by Alexandrine and Rose-ringed Parakeets was recorded from 6:45 AM onwards **(Table 2)**. Sites A, C, and D clustered near the origin on Component 2, indicating comparatively lower and similar light intensity profiles. Monsoon sessions, characterized by partly cloudy to overcast conditions and high relative humidity, produced a compressed low-lux cluster in both **Figure 3** and the PCA biplot, corresponding with the shortened active chorus periods and reduced vocal intensity observed across all sites during that season in **Table 2**. The principal component analysis for average light intensity (lux) across all four sites is shown in **Figure 4**.

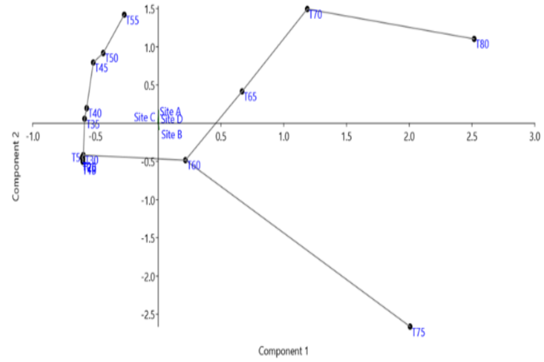

Figure 4. The Principal Component Analysis for average light intensity (lux) across all four sites was carried out using PAST version 4 software.

CONCLUSION

The present study demonstrated significant relationships between anthropogenic noise, artificial light intensity, seasonal variation, and avian dawn chorus activity across different urban habitats in Pune, Maharashtra. Urban sites such as Site A and Site C recorded higher noise levels and greater anthropogenic disturbance, whereas relatively undisturbed habitats like Site B showed lower and more stable acoustic conditions. Across all sites, bird chorus activity increased progressively with sunrise and increasing light intensity. Winter observations generally exhibited higher illuminance and stronger chorus activity compared to monsoon conditions. Dominant vocal species included rose-ringed parakeets, Alexandrine parakeets, crows, bulbuls, peacocks, and Asian koel.

The study identified measurable shifts in dawn chorus timing and vocal intensity associated with urban disturbance, artificial light at night (ALAN), and environmental variables such as temperature, wind, and weather conditions. Relatively natural habitats supported richer avian diversity and more stable vocal activity, while urban environments exhibited greater fluctuations linked to vehicular, pedestrian, and construction disturbances. Seasonal variation also influenced light availability and acoustic conditions, affecting bird behavior across sites. The findings provide important baseline data for Pune, Maharashtra, and contribute to understanding the ecological impacts of urbanization, noise pollution, and artificial lighting on avian behavioral patterns and urban biodiversity conservation.

ACKNOWLEDGMENTS: Authors sincerely thank Principal of Fergusson College, Pune, for providing the necessary facilities for this research. We sincerely acknowledge the management of the Deccan Education Society, Pune, for their continuous support and encouragement throughout the study.

CONFLICT OF INTEREST: None

FINANCIAL SUPPORT: None

ETHICS STATEMENT: None

REFERENCES

Ahmed, O. H. (2023). GC-MS analysis and antioxidant effect of some Iraqi plants. *Journal of Natural Science, Biology and Medicine, 14*(2), 115–121. doi:10.4103/jnsbm.JNSBM_14_2_7

Ahmed, O. H., Abbas, A. H., & Yaseen, Y. S. (2023). GC/MS analysis of crude extract of fig leaves naturally grown in Iraq. *Journal of Advanced Pharmacy Education & Research, 13*(3), 96–101. doi:10.51847/TF4ouLslks

Ahmed, O. H., Bdulqader, A. A., & Ezghayer, M. A. (2023). Antibacterial activity of the methanolic extract of leaves of Indigofera suffruticosa naturally grown in Iraq. *Journal of Advanced Pharmacy Education & Research, 13*(4), 99–103. doi:10.51847/fRbzdpKkBV

Ahmed, Z., Asghar, M. M., Malik, M. N., & Nawaz, K. (2020). Moving towards a sustainable environment: The dynamic linkage between natural resources, human capital, urbanization, economic growth, and ecological footprint in China. *Resources Policy, 67*, 101677. doi:10.1016/j.resourpol.2020.101677

Boycott, T. J., Mullis, S. M., Jackson, B. E., & Swaddle, J. P. (2021). Field testing an "acoustic lighthouse": Combined acoustic and visual cues provide a multimodal solution that reduces avian collision risk with tall human-made structures. *PLOS ONE, 16*(4), e0249826. doi:10.1371/journal.pone.0249826

Bratt, A., & Naimi-Akbar, A. (2023). A comparative study of ethical issues in the Egyptian clinical research law. *Asian Journal of Ethics and Health Medicine, 3*, 66–80. doi:10.51847/mjnPnkn27U

Broad, H. R., Dibnah, A. J., Smith, A. E., & Thornton, A. (2024). Anthropogenic disturbance affects calling and collective behaviour in corvid roosts. *Philosophical Transactions of the Royal Society B: Biological Sciences, 379*(1905), 20230185. doi:10.1098/rstb.2023.0185

Bustamante, N., & Garitano-Zavala, Á. (2024). Natural patterns in the dawn and dusk choruses of a neotropical songbird in relation to an urban sound environment. *Animals, 14*(4), 646. doi:10.3390/ani14040646

Cakmak, C., Cinar, F., Çapar, H., & Cakmak, M. A. (2024). The connection between cancer screening, awareness, and perceptions: Insights from the American population. *International Journal of Social Psychology Aspects of Healthcare, 4*, 32–41. doi:10.51847/CCd71JaG8g

Carita, A. J. Q., Cutipa, R. A., Vargas, J. C. J., Cueva, A. L., Figueroa, E. N. T., & Torres-Cruz, F. (2025). Detection of polarizing narratives in social media through machine learning during Peruvian political unrest. *Journal of Organisational Behaviour Research, 10*(4), 106–115. doi:10.51847/ePYLFVct7c

Chen, A. M. H., & Chen, Y. (2023). Pharmacognostic and phytochemical comparison of *Moringa oleifera* and *Moringa concanensis*. *Special Journal of Pharmacognosy and Phytochemistry Biotechnology, 3*, 1–9. doi:10.51847/iVjkOGlcDE

Çınaroğlu, M., Ahlatcıoğlu, E. N., Prins, J., & Nan, M. (2023). Psychological challenges in cancer patients and the impact of cognitive behavioral therapy. *International Journal of Social Psychology Aspects of Healthcare, 3*, 21–33. doi:10.51847/ZDLdztUSsw

Cissé, C., Konaré, M. A., Samaké, M., & Togola, I. (2024). Exploring the anti-inflammatory potential of *Sericanthe chevalieri* and *Ceiba pentandra* as natural antitussives for children. *Special Journal of Pharmacognosy and Phytochemistry Biotechnology, 4*, 49–58. doi:10.51847/0OVczhRtw1

Csep, A. N., Voiţă-Mekereş, F., Tudoran, C., & Manole, F. (2024). Understanding and managing polypharmacy in the aging population. *Annals of Pharmacy Practice and Pharmacotherapy, 4*, 17–23. doi:10.51847/VdKr0egSln

Falcón, J., Torriglia, A., Attia, D., Viénot, F., Gronfier, C., Behar-Cohen, F., Martinsons, C., & Hicks, D. (2020). Exposure to artificial light at night and the consequences for flora, fauna, and ecosystems. *Frontiers in Neuroscience, 14*, 602796. doi:10.3389/fnins.2020.602796

Fisher, D. N., Kilgour, R. J., Siracusa, E. R., Foote, J. R., Hobson, E. A., Montiglio, P. O., Saltz, J. B., Wey, T. W., & Wice, E. W. (2021). Anticipated effects of abiotic environmental change on intraspecific social interactions. *Biological Reviews, 96*(6), 2661–2693. doi:10.1111/brv.12772

Foppen, K., Pinxten, R., Meijdam, M., & Eens, M. (2024). Artificial light at night advances the onset of vocal activity in both male and female great tits during the breeding season, while noise pollution has less impact and only in females. *Animals, 14*(22), 3199. doi:10.3390/ani14223199

Fröhlich, A., Bidziński, K., Jankowska-Jarek, M., Swearer, S., & Ciach, M. (2025). Noise, light pollution, and human presence predict forest habitat degradation: A key agent in biodiversity decline. *Ecological Applications, 35*(7), e70131. doi:10.1002/eap.70131

Gaston, K. J., & Sánchez de Miguel, A. (2022). Environmental impacts of artificial light at night. *Annual Review of Environment and Resources, 47*(1), 373–398. doi:10.1146/annurev-environ-112420-014438

Gil, D., & Llusia, D. (2020). The bird dawn chorus revisited. In *Coding strategies in vertebrate acoustic communication* (pp. 45–90). Springer. doi:10.1007/978-3-030-39200-0_3

Greenfield, M. D., Honing, H., Kotz, S. A., & Ravignani, A. (2021). Synchrony and rhythm interaction: From the brain to behavioural ecology. *Philosophical Transactions of the Royal Society B, 376*(1835), 20200324. doi:10.1098/rstb.2020.0324

Guenat, S., & Dallimer, M. (2023). A global meta-analysis reveals contrasting impacts of air, light, and noise pollution on pollination. *Ecology and Evolution, 13*(4), e9990. doi:10.1002/ece3.9990

Guzek, K., Stelmach, A., Rożnowska, A., Najbar, I., & Cichocki, Ł. (2023). A preliminary investigation of genetic variants linked to aripiprazole-induced adverse effects. *Annals of Pharmacy Practice and Pharmacotherapy, 3*, 40–47. doi:10.51847/ZT28xcs95J

Halfwerk, W., & Jerem, P. (2021). A systematic review of research investigating the combined ecological impact of anthropogenic noise and artificial light at night. *Frontiers in Ecology and Evolution, 9*, 765950. doi:10.3389/fevo.2021.765950

Hashem, W., Mokhtar, M., Rahman, A. A., & Rashad, A. (2024). Adult acute lymphoblastic leukemia: Insights from six years of clinical practice in an Egyptian tertiary care center. *Asian Journal of Current Research in Clinical Cancer, 4*(2), 51–61. doi:10.51847/fFirKGgI3X

Jechow, A., & Hölker, F. (2020). Evidence that reduced air and road traffic decreased artificial night-time skyglow during COVID-19 lockdown in Berlin, Germany. *Remote Sensing, 12*(20), 3412.

Kariri, H. D. H., Radwan, O. A., Somaili, H. E., Mansour, M. E. I., Mathkoor, S. A., & Gohal, K. M. M. (2024). The role of psychological capital in enhancing empowerment among female leadership. *Annals of Organizational Culture, Communications and Conflict, 5*, 17–27. doi:10.51847/w41TjwMAzM

Katabaro, J. M., Yan, Y., Hu, T., Yu, Q., & Cheng, X. (2022). A review of the effects of artificial light at night in urban areas on the ecosystem level and the remedial measures. *Frontiers in Public Health, 10*, 969945. doi:10.3389/fpubh.2022.969945

Leadbeatter, D., & Tjaya, K. C. (2024). Human rights and bioethical principles in correctional settings: A systematic review of the evidence. *Asian Journal of Ethics and Health Medicine, 4*, 97–106. doi:10.51847/wSNBedLrGt

Leveau, L. M. (2020). Artificial light at night (ALAN) is the main driver of nocturnal feral pigeon (*Columba livia f. domestica*) foraging in urban areas. *Animals, 10*(4), 554. doi:10.3390/ani10040554

Manfredini, M., Poli, P. P., Giboli, L., Beretta, M., Maiorana, C., & Pellegrini, M. (2024). Determinants of dental implant prognosis: A systematic review of key influencing factors. *Journal of Current Research in Oral Surgery, 4*, 41–49. doi:10.51847/Gv4h1XyPfr

Marín Gómez, O. H. (2022). Artificial light at night drives earlier singing in a Neotropical bird. *Animals, 12*(8), 1015. doi:10.3390/ani12081015

Marín-Gómez, O. H., & MacGregor-Fors, I. (2021). A global synthesis of the impacts of urbanization on bird dawn choruses. *Ibis, 163*(4), 1133–1154. doi:10.1111/ibi.12949

Marín-Gómez, O. H., García-Arroyo, M., Sánchez-Sarria, C. E., Sosa-López, J. R., Santiago-Alarcón, D., & MacGregor-Fors, I. (2020). Nightlife in the city: Drivers of the occurrence and vocal activity of a tropical owl. *Avian Research, 11*, 9. doi:10.1186/s40657-020-00194-9

Mathiaparanam, K. J., Mulder, R. A., & Hale, R. (2024). Anthropogenic double jeopardy: Urban noise and artificial light at night interact synergistically to influence abundance. *Environmental Pollution, 363*, 125078. doi:10.1016/j.envpol.2024.125078

Merrall, E. S., & Evans, K. L. (2020). Anthropogenic noise reduces avian feeding efficiency and increases vigilance along an urban-rural gradient regardless of species' tolerances to urbanisation. *Journal of Avian Biology, 51*(9). doi:10.1111/jav.02341

Mori, E., Di Lorenzo, T., Viviano, A., Jakovljević, T., Marra, E., Moura, B. B., Garosi, C., Manzini, J., Ancillotto, L., Hoshika, Y., et al. (2025). Under pressure: Environmental stressors in urban ecosystems and their ecological and social consequences on biodiversity and human well-being. *Stresses, 5*(4), 66. doi:10.3390/stresses5040066

Muthanandam, S., Muthu, J., Babu, B. V., Rajaram, S., & Kengadharan, S. (2024). Raising awareness of oral precancer and cancer among Indian long-distance heavy vehicle drivers: A neglected group. *International Journal of Social Psychology Aspects of Healthcare, 4*, 20–25. doi:10.51847/2JNlaeP6n5

Nyamagoud, S. B., Swamy, A. H. V., Chacko, A., & James, J. (2024). A case report on actinomycetoma of the left foot: Highlighting a neglected tropical disease and the consequences of poor medication adherence. *Interdisciplinary Research in Medical Sciences Special Issue, 4*(2), 41–47. doi:10.51847/UcEjBW4qBs

Orlando, G., Coursey, F., Sumasgutner, P., Bogdanova, M. I., & Dominoni, D. M. (2026). The impact of urban-related sensory and risk factors on owls: A systematic review. *Journal of Ornithology, 1–16*. doi:10.1007/s10336-026-02406-4

Patel, J. B., & Raval, Z. (2024). The impacts of urbanization on ecological systems: A comprehensive study of the complex challenges arising from rapid urban growth. *Research Review Journal of Indian Knowledge Systems, 1*(1), 1–10. doi:10.31305/rrjiks.2024.v1.n1.001

Patel, K., Gaviraghi Mussoi, J., Stanley, M. C., & Cain, K. E. (2025). The impacts of sleep disturbance on birds: A review of the knowledge gaps. *Journal of Avian Biology, 2025*(5), e03454. doi:10.1002/jav.03454

Petronis, Z., Golubevas, R., Rokicki, J. P., Guzeviciene, V., Sakavicius, D., & Lukosiunas, A. (2025). A systematic review and meta-analysis on trigeminal neuralgia linked to neurovascular compression using MRI analysis. *Journal of Current Research in Oral Surgery, 5*, 17–24. doi:10.51847/sptZWIrWeo

Ramírez-Adame, D., Valenzuela-Inzunza, C. C., Beltrán-López, R. G., Acosta-Morán, E. M., & Guerrero, J. A. (2026). Altered nocturnal vocal activity patterns in Tropical Kingbird (*Tyrannus melancholicus*) at a site with artificial lighting. *Journal of Threatened Taxa, 18*(4), 28607–28614. doi:10.11609/jott.9740.18.4.28607-28614

Salikhova, L. R., Khantueva, K. K., Magomedkerimova, N. N., Arganov, F. I., Tambieva, T. S., & Brodskaya, T. A. (2023). Evaluating the likelihood of hypoxia in pregnant women through analysis of erythrocyte membrane permeability. *Interdisciplinary Research in Medical Sciences Special Issue, 3*(1), 20–25. doi:10.51847/nsfOJO4IDe

Sander, M. M., & Tietze, D. T. (2022). Impacts of traffic infrastructure on urban bird communities: A review. *Sustainability, 14*(24), 16805. doi:10.3390/su142416805

Sayuri, D. P., Pablo, C. L., Davide, D., Mariusz, C., & Joanna, S. (2026). Artificial light at night consistently impacts avian physiology and behaviour: A meta-analysis. *Ecology Letters, 29*(4), e70382. doi:10.1111/ele.70382

Seymoure, B., Dell, A., Hölker, F., & Kalinkat, G. (2023). A framework for untangling the consequences of artificial light at night on species interactions. *Philosophical Transactions of the Royal Society B, 378*(1892). doi:10.1098/rstb.2022.0356

Singh, D., Piplani, M., Kharkwal, H., Murugesan, S., Singh, Y., Aggarwal, A., & Chander, S. (2023). Comprehensive review on the anticancer potential of thiazolidin-4-one derivatives. *Asian Journal of Current Research in Clinical Cancer, 3*(1), 46–62. doi:10.51847/MpJ9fZKGZT

Singhal, R. K., Chauhan, J., Jatav, H. S., Rajput, V. D., Singh, G. S., & Bose, B. (2021). Artificial night light alters ecosystem services provided by biotic components. *Biologia Futura, 72*(2), 169–185. doi:10.1007/s42977-020-00065-x

Sordello, R., Coulon, A., & Reyjol, Y. (2025). A narrative review of the impact of anthropogenic light and noise on owls. *Ibis*. Advance online publication. doi:10.1111/ibi.13435

Svechkina, A., Portnov, B. A., & Trop, T. (2020). The impact of artificial light at night on human and ecosystem health: A systematic literature review. *Landscape Ecology, 35*(8), 1725–1742. doi:10.1007/s10980-020-01053-1

Tam, L. T., An, H. T. T., Linh, T. K., Nhung, L. T. H., Ha, T. N. V., Huy, P. Q., & Luc, P. T. (2023). The impact of COVID-19 on value co-creation activities: A study of economics students in Vietnam. *Annals of Organizational Culture, Communications and Conflict, 4*, 25–34. doi:10.51847/QeaHrAoLoL

Wang, J. S., Tuanmu, M. N., & Hung, C. M. (2021). Effects of artificial light at night on the nest-site selection, reproductive success and behavior of a synanthropic bird. *Environmental Pollution, 288*, 117805. doi:10.1016/j.envpol.2021.117805

Wang, J., Chen, Y., Liao, W., He, G., Tett, S. F. B., Yan, Z., Zhai, P., Feng, J., Ma, W., Huang, C., et al. (2021). Anthropogenic emissions and urbanization increase risk of compound hot extremes in cities. *Nature Climate Change, 11*(12), 1084–1089. doi:10.1038/s41558-021-01196-2

Wilson, M. W., Ridlon, A. D., Gaynor, K. M., Gaines, S. D., Stier, A. C., & Halpern, B. S. (2020). Ecological impacts of human-induced animal behaviour change. *Ecology Letters, 23*(10), 1522–1536. doi:10.1111/ele.13571

Wood, M. D., Hancocks, G., Barnett, C. L., Tysiac, P., Goulart, V. D. L. R., Teixeira, C. P., Zielinska-Dabkowska, K. M., Sikander, D., Castrop, E., Klenke, R., et al. (2026). Review of light and noise pollution impacts on terrestrial biodiversity and ecosystem services (PLAN-B Report, 107 pp.). PLAN-B.

Xu, W., Li, J., Xu, Y., Han, Z., Huang, W., & Wang, H. (2026). Urbanization modifies birds' acoustic circadian timing and characteristics. *Integrative Zoology*. Advance online publication. doi:10.1111/1749-4877.70089

Yang, Z., Chen, S., Yang, Y., & Li, S. (2025). Effects of nocturnal light environments on urban bird diversity: Birds adapted to and inhabiting cities. *Journal of Environmental Management, 394*, 127638. doi:10.1016/j.jenvman.2025.127638

Zhang, Y., Wang, Z., Lu, Y., & Zuo, L. (2022). Biodiversity, ecosystem functions and services: Interrelationship with environmental and human health. *Frontiers in Ecology and Evolution, 10*, 1086408. doi:10.3389/fevo.2022.1086408