Commagene Journal of Biology

Çoraman, (2025) *Comm. J. Biol.* 9(1), 86-92.
DOI: 10.31594/commagene.1680176

e-ISSN 2602-456X

Research Article/Araştırma Makalesi

Seasonal Acoustic Monitoring of Bat Activity from the Northern Marmara Coast, Türkiye: Insights into Autumn Migration and Conservation Implications

Emrah ÇORAMAN

İstanbul Technical University Eurasia Institute of Earth Sciences, Ecology and Evolution Department, İstanbul, TÜRKİYE
ORCID ID: Emrah ÇORAMAN: https://orcid.org/0000-0001-8188-8651

Received: 20.04.2025 **Accepted:** 06.05.2025 **Published online:** 26.05.2025 **Issue published:** 30.06.2025

Abstract: Migratory bats face increasing risks from habitat fragmentation, artificial light, and the expansion of wind energy infrastructure, yet their migration patterns remain poorly documented in many regions, including Türkiye. This study presents the results of seasonal acoustic monitoring conducted at a coastal site on the northern shore of the Sea of Marmara, a potential migratory corridor between Europe and Asia. Using a passive ultrasonic detector, bat activity across 18 nights in summer, autumn, and winter 2020 was recorded and analyzed for species-specific activity levels through count-per-minute values. A total of 18.937 bat passes were detected, representing at least six species, including *Myotis* sp., *Eptesicus serotinus*, *Pipistrellus pipistrellus*, *P. nathusii*, *Nyctalus noctula*, and *Plecotus* sp. *P. pipistrellus* was the most consistently active species year-round, while *P. nathusii* exhibited a pronounced activity peak during September and October, consistent with autumn migratory behavior documented in other parts of Europe. While acoustic misclassification with *P. kuhlii* cannot be entirely excluded, the seasonally restricted spike and carcass records from regional wind farms strengthen the identification of *P. nathusii* as a migratory species in the area. *N. noctula* and *E. serotinus* were also detected almost exclusively during autumn, likely indicating their migratory movements through the region. These findings underscore the importance of structured, seasonal monitoring to detect migratory activity and support conservation planning. Given the proximity of the site to the proposed offshore wind developments, the results highlight the need for broader spatial monitoring and improved integration of bat migration into environmental impact assessments in Türkiye.

Keywords: Bioacoustics, passive monitoring, ecological assessment

Kuzey Marmara Kıyısında Mevsimsel Yarasa Aktivitesinin Akustik İzlenmesi: Sonbahar Göçü ve Koruma İçin Çıkarımlar

Öz: Birçok göçmen yarasa türü; habitat parçalanması, yapay aydınlatma ve rüzgâr enerjisi altyapısının hızla genişlemesi gibi artan tehditlerle karşı karşıyadır. Ancak bu türlerin göç yolları hakkındaki bilgiler, Türkiye dahil birçok bölgede sınırlıdır. Bu çalışma, Avrupa ile Asya arasında olası bir göç koridoru oluşturan Marmara Denizi'nin kuzey kıyısında yer alan bir sahil noktasında yürütülen mevsimsel akustik izleme sonuçlarını sunmaktadır. Ultrasonik bir kayıt cihazı kullanılarak, 2020 yılının yaz, sonbahar ve kış mevsimlerine ait 18 gecede yarasa aktivitesi kaydedilmiş ve yarasa türlerinin aktivite düzeyleri, dakikadaki geçiş sayısı üzerinden analiz edilmiştir. *Myotis* sp., *Eptesicus serotinus*, *Pipistrellus pipistrellus*, *P. nathusii*, *Nyctalus noctula* ve *Plecotus* sp. türlerini temsil eden, toplam 18.937 yarasa geçişi kaydedilmiştir. *P. pipistrellus* yıl boyunca en düzenli şekilde kaydedilen tür olarak belirlenmiştir. Buna karşılık, *P. nathusii* Eylül ve Ekim aylarında belirgin bir aktivite artışı göstermiştir; bu durum Avrupa'nın diğer bölgelerinde belgelenen sonbahar göç davranışıyla tutarlıdır. Bu türün, *P. kuhlii*'den akustik olarak ayrılması tamamen mümkün olmasa da bu mevsimsel artış ve Tekirdağ'daki rüzgâr enerji santrallerinde bulunan ölü bireyler, *P. nathusii*'nin bölgede göçmen bir tür olduğunu desteklemektedir. Benzer şekilde, *N. noctula* ve *E. serotinus* kayıtlarının neredeyse tamamı sonbaharda tespit edilmiş olup, bu türlerin bölge üzerinden göç hareketlerine işaret etmektedir. Elde edilen bulgular, göçmen türlerin aktivitesini saptamak ve koruma stratejileri geliştirmek için mevsimsel akustik izlemelerin önemini vurgulamaktadır. Çalışma alanının yapılması planlanan deniz-üstü rüzgâr enerjisi projelerine yakınlığı göz önüne alındığında, daha geniş alanlarda izleme yapılması ve yarasa göçünün çevresel etki değerlendirmelerine daha etkin şekilde entegre edilmesi gerektiği ortaya konulmaktadır.

Anahtar kelimeler: Biyoakustik, pasif izleme, ekolojik değerlendirme

1. Introduction

Bats provide essential ecosystem services such as pest control, pollination, and seed dispersal. In the face of growing anthropogenic threats—including habitat loss, land-use change, and infrastructure development—understanding their spatial and temporal activity patterns is critical for informing effective conservation strategies. Migratory species, in particular, face heightened risks due to habitat fragmentation, light pollution, and the rapid expansion of wind energy infrastructure (Voigt et al., 2022). Despite increasing recognition of these pressures, key aspects of bat migration ecology—including routes, timing, and species-specific vulnerability—remain poorly understood in many regions, including Türkiye.

Acoustic monitoring has emerged as a powerful, non-invasive tool for studying bat ecology, enabling the detection of species presence, temporal activity patterns, and migratory behavior. While these techniques are

Corresponding author: coraman@itu.edu.tr

increasingly employed in Türkiye, their use has largely been restricted to documenting range extensions and compiling regional species inventories. Broader applications addressing conservation-relevant questions—such as seasonal dynamics, habitat use, or migration—remain limited. Nonetheless, recent passive acoustic surveys have extended known ranges for several species—for instance, *Barbastella barbastellus* (Karataş et al., 2020) and *Vespertilio murinus* (Karataş et al., 2022)—while deepening our understanding of regional bat diversity and activity in areas such as Köyceğiz–Dalyan (Ürker & Yorulmaz, 2020), Konya (Baş & Arslan, 2021), Antalya (Coşkun & Sert, 2023), Bolu (Gözütok, 2023), and Gökçeada (Şahin, 2024). These studies demonstrate the effectiveness of acoustic methods in filling critical data gaps, particularly for difficult-to-capture species.

Despite these advances, important aspects of seasonal and migratory bat activity remain insufficiently understood, particularly in ecologically strategic yet understudied regions. This study aims to document seasonal patterns of bat activity at the northern coast of the Sea of Marmara, with particular attention to identifying signals of migratory behavior during the autumn. Acoustic monitoring was conducted at a coastal site in Tekirdağ, Türkiye across three seasons—summer, autumn, and winter—using a passive ultrasonic detector to quantify temporal changes in species-specific activity levels.

The region represents a potential corridor for bats moving between Europe and Asia, yet it remains poorly studied. This study provides a baseline dataset that contributes to addressing this knowledge gap. Its relevance is heightened by the increasing expansion of wind energy infrastructure, both onshore and in proposed offshore zones within the Marmara Sea. Although bats are included in the environmental impact assessments in Türkiye, seasonal migration and high-risk periods are often not assessed in sufficient depth. Migratory bats, in particular, may be at increased risk from wind turbine collisions during periods of peak movement. By identifying temporal activity patterns and the species utilizing the site, this study offers foundational data for future research on bat movement ecology and supports the improved integration of bat conservation into spatial planning and impact assessment processes.

2. Material and Method

To assess seasonal variation in bat activity and to identify patterns potentially associated with autumn migration, acoustic monitoring was conducted at a coastal site along the northern coast of the Sea of Marmara. The study area is located in Tekirdağ, Türkiye (41.001°N, 27.672°E), within a region of high conservation interest due to its ecological position between Europe and Asia and its proximity to expanding wind energy infrastructure, both onshore and offshore (Fig. 1).

The site is situated within a semi-rural landscape that includes intensively cultivated agricultural fields, low-density residential settlements, and a narrow coastal strip. To the south lies the Sea of Marmara shoreline, separated from inland areas by a major highway running parallel to the coast. North of the highway, the landscape transitions into expansive farmlands, interspersed with small patches of natural vegetation and vegetated corridors usually associated with streams.

Figure 1. Geographic context and detailed location of the acoustic sampling point on the northern shore of the Sea of Marmara. (a) Regional overview of southeastern Europe and northwestern Anatolia with the study area outlined in white; (b) zoomed-in view of the Marmara Sea showing the extent of the detailed map in (c); (c) high-resolution satellite image of the sampling site with the passive ultrasonic detector marked by a white circle. North arrow and 1 km scale bar apply to panel (c) only.

The detector was positioned within a residential garden exposed to moderate levels of artificial lighting from nearby homes and streetlights, which may have influenced local bat activity. The site is located approximately 30 kilometers north of Marmara Island, near a potential migratory pathway between Europe and Asia. In addition, several proposed offshore wind energy development zones are situated in the central and southern parts of the Marmara Sea, within the broader region where migratory bats may traverse coastal and marine environments.

Acoustic surveys were conducted during three seasons—summer, autumn, and winter— in 2020 to capture temporal variation in bat activity. Monitoring occurred on 18 nights between June 30 and November 24. Four nights were sampled during the summer period (until late August), 11 nights during the autumn (September 1 to October 31), and two nights during winter (after November 1). Survey effort was intensified in the autumn to characterize potential peaks in migratory activity. Sampling was restricted to nights without rainfall to ensure favorable conditions for bat detection.

Data collection was carried out using an Elekon Batlogger M detector equipped with an omnidirectional FG Black microphone. The system operated with a crest-triggered recording algorithm and a sampling rate of 312,500 Hz. Recordings were automatically timestamped and ambient temperature was logged. The microphone was mounted approximately 2.5 meters above ground level to minimize ground-level interference and maximize call detection range.

All recordings were processed using BatExplorer v2.1.4. Species identification was performed manually, following classification protocols outlined by Barataud (2015) and supported by call parameters from Dietz & Kiefer (2014). Special attention was given to species with overlapping call characteristics, particularly *Pipistrellus nathusii* and *P. kuhlii*, as well as *Nyctalus noctula* and *N. leisleri*. When confident classification was not possible,

calls were conservatively assigned to species acoustic groups. Social calls were identified based on distinct structural and frequency characteristics (Barataud, 2015), though these were excluded from quantitative analyses.

To quantify activity, the total recording time was calculated for each survey night. Species-specific count-per-minute (CPM) values were derived by dividing the number of detected bat passes by the corresponding nightly recording duration in minutes. CPM values were used to standardize activity levels across survey nights and seasons and to support interspecies comparisons.

Finally, to explore potential patterns and associations between bat activity and environmental conditions, meteorological data were examined alongside species-specific bat activity. Meteorological data were obtained from NASA's Prediction of Worldwide Energy Resources (POWER) project, which incorporates outputs from the Clouds and the Earth's Radiant Energy System (CERES) and the Modern-Era Retrospective analysis for Research and Applications, Version 2 (MERRA-2) datasets (http://power.larc.nasa.gov/data-access-viewer/). For each survey night, average values of air temperature at 2 meters, wind speed and wind direction at 10 meters, and total precipitation were extracted to characterize meteorological conditions during monitoring.

3. Results

A total of 18.937 bat passes were recorded across summer, autumn, and winter surveys, revealing marked seasonal variations in abundance and activity intensity (Table 1). *Myotis* sp., *Eptesicus serotinus*, *P. pipistrellus*, *P. nathusii*, *N. noctula*, the *N. noctula/N. leisleri* acoustic group, and *Plecotus* sp. were detected. Count-per-minute (CPM), used as a proxy for relative activity, highlighted species-specific patterns, particularly for *P. pipistrellus* and *P. nathusii*, offering insights into their seasonal behaviors. A proportion of *P. nathusii* detections may include *P. kuhlii* due to acoustic overlap (especially in periods of increased activity) and some of the call sequences of *N. noctula* and *N. leisleri* were not distinguished individually as they cannot always be reliably separated using the methods applied.

Table 1. Seasonal and nightly bat-pass counts recorded at the sampling site. Rows are grouped by season (Summer = 4 nights; Autumn = 11 nights; Winter = 2 nights) with individual survey dates listed beneath each seasonal heading. Columns show total passes for each species or species group: *Myotis* sp. (Myo sp.), *E. serotinus* (Eser), *P. pipistrellus* (Ppip), *P. nathusii* (Pnat), *N. noctula* (Nnoc), the *N. noctula*/*N. leisleri* group (Nnoc/Nlei), and *Plecotus* sp. (Ple sp.), plus the overall total passes per date or season. The bottom row presents grand totals across all survey nights.

	Myo sp.	Eser	Ppip	Pnat	Nnoc	Nnoc/Nlei	Ple sp.	Total
Summer	13		2.783	68				2.864
30 Jun			65	1				66
02 Jul			121	2				123
21 Jul	1		1.144	11				1.156
14 Aug	12		1.453	54				1.519
Autumn	38	3	13.128	1.745	2	46	5	14.967
07 Sep	19	1	1.331	323		12		1.686
14 Sep	9	1	2.463	253	1	7		2.734
20 Sep			806	106				912
21 Sep			2.381	186		2		2.569
27 Sep	7		1.623	258	1	7		1.896
02 Oct	1		919	288		6	1	1.215
07 Oct			408	66		3	1	478
11 Oct	2	1	885	114		1		1.003
17 Oct			819	41		5		865
18 Oct			741	22		3	1	767
29 Oct			752	88			2	842
Winter			1.088	15		1	2	1.106
14 Nov			949	13		1	2	965
24 Nov			139	2				141
Total	51	3	16.999	1.828	2	47	7	1.8937

During the summer period (until late August), a total of 2.864 bat passes were recorded (Table 1). *P. pipistrellus* was the overwhelmingly dominant species, contributing 2.783 passes (97.17%), with CPM values ranging from 0.79 on July 2 to 2.54 on August 14. *P. nathusii* was present at much lower levels, with 68 passes (2.37%) and CPM values between 0.01 and 0.09, indicating limited summer activity. The highest summer detection occurred on August 14 when 1.519 total passes were recorded—1.453 of which were *P. pipistrellus* (CPM 2.54), suggesting a localized activity peak.

In the autumn (September 1 to October 31), activity levels peaked sharply, with 14.967 total bat passes, marking it as the most active and diverse period. *P. pipistrellus* remained

the dominant species with 13.128 passes (87.71%) and CPM values ranging from 1.03 (October 7) to 3.58 (September 21), indicating sustained and intense activity (Figs. 2-3). *P. nathusii* showed a notable seasonal increase, rising to 1.745 passes (11.66%) with CPMs reaching up to 0.53 on September 7—a nearly sixfold increase compared to summer. The autumn peak occurred on September 14 with 2,734 total passes, largely driven by *P. pipistrellus* (2.463 passes, CPM 3.74) and *P. nathusii* (253 passes, CPM 0.38). This strong autumn presence of *P. nathusii* is consistent with migratory activity documented in temperate European bat populations.

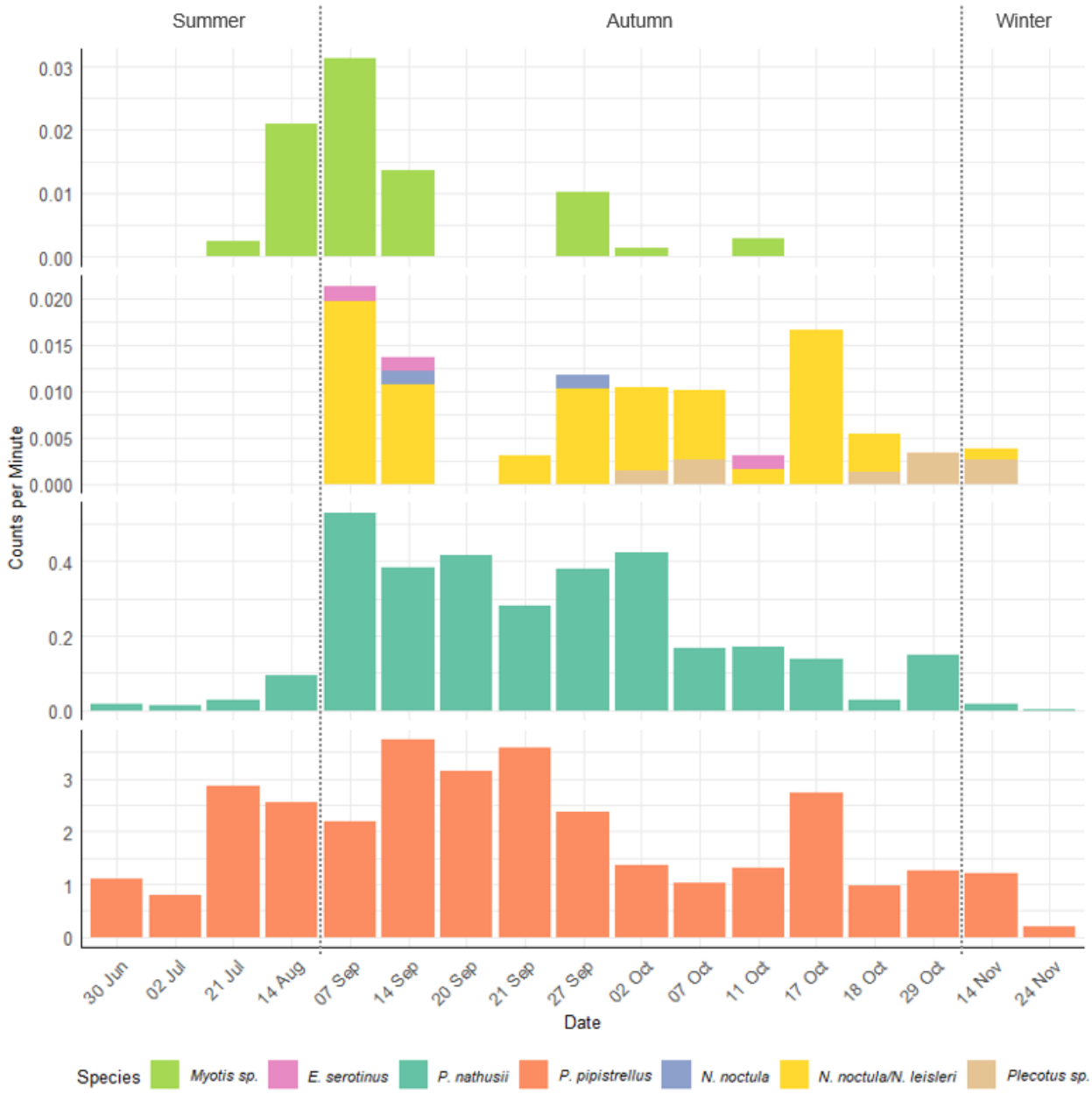

Figure 2. Nightly bat activity (counts per minute, CPM) for *Pipistrellus nathusii* (green) and P. pipistrellus (orange) at the Tekirdağ coastal sampling site. Each bar represents the CPM recorded on a survey night between 30 June and 24 November. Top labels denote the three monitoring periods (Summer, Autumn, Winter).

The autumn migration of *P. nathusii* in September and October showed some correlation with weather parameters with activity peaking in September and continuing into October (Fig. 4). In September, higher activity coincided with warmer temperatures (18.8°C–21.2°C) and variable wind speeds at 10 m (1.08 m/s–6.68 m/s) from usually north-eastern directions (~40°). In October, activity declined, aligning with cooler temperatures and shifting winds.

After November 1, in the winter period, activity declined significantly, with only 1.106 bat passes recorded. *P. pipistrellus* continued to dominate, contributing 1.088 passes (98.37%) with CPM values of 1.20 (November 14) and 0.20 (November 24), reflecting a persistent but reduced winter presence. In contrast, *P. nathusii* activity dropped markedly, with only 15 passes (1.36%; CPM 0.02), further supporting a pattern of seasonal movement out of the area.

Taken together, these findings highlight *P. pipistrellus* as the most abundant and consistently active species year-round with a total of 16.999 passes (89.76%) and CPM values ranging from 0.20 to 3.58. *P. nathusii*, by contrast,

accounted for 1,828 passes (9.65%) with a pronounced activity spike in autumn relative to summer and winter (Fig. 3). This pattern suggests a seasonal migratory influx of *P. nathusii* during early autumn, although the precise magnitude may be affected by acoustic misclassification with *P. kuhlii*. Overall, these results underscore strong seasonal dynamics in species-specific bat activity, particularly highlighting the dominance of *P. pipistrellus* and the transient autumn presence of *P. nathusii*.

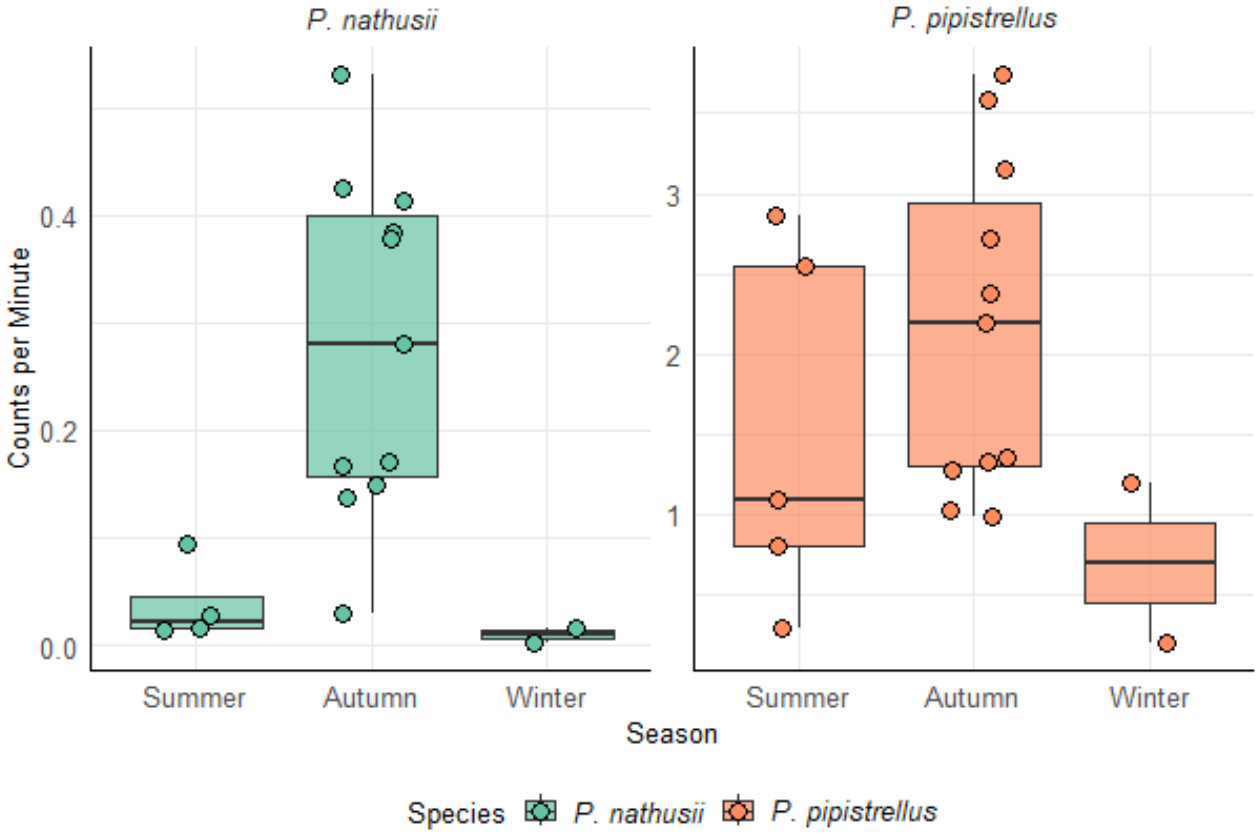

Figure 3. Seasonal variation in nightly bat activity (counts per minute, CPM) for *Pipistrellus nathusii* (left, green) and *P. pipistrellus* (right, orange) at the Tekirdağ coastal sampling site. Boxplots show the median, interquartile range, and 1.5 × IQR whiskers for each season (Summer: 4 nights; Autumn: 11 nights; Winter: 2 nights) with individual nightly CPM values overlaid as points.

4. Discussion

The acoustic monitoring conducted at a locality at the northern coast of the Sea of Marmara revealed clear seasonal variation in bat activity patterns. *P. pipistrellus* was the most consistently registered species across all seasons, indicating a resident population. In contrast, a temporally restricted surge in detections during autumn, peaking primarily in September, consistent with patterns reported in other parts of Europe. Similarly, *N. noctula*/*N. leisleri* and *E. serotinus* were detected almost exclusively during autumn, likely indicating their migratory movements through the region. These patterns support the interpretation of the site as a transit area for autumn migration. A sharp decline in detections during winter, when only two nights were sampled, aligns with the expected low bat activity in this season, limiting the need for extensive winter monitoring.

P. nathusii is known to undertake long-distance seasonal movements across Europe with documented migrations reaching up to 2.224 km between northeastern breeding areas and southwestern wintering grounds (Alcalde et al., 2021). These migrations predominantly occur in autumn, from mid-August through late October, with peak activity often observed in early September (Lagerveld et al., 2021). Studies have shown that *P. nathusii* tends to aggregate along coastlines, such as the Baltic Sea region, where activity levels decline sharply further inland (Ijäs et al., 2017). This coastal preference is likely shaped by the availability of navigational cues and foraging opportunities along shoreline habitats. The pattern observed in this study aligns closely with these continental-scale migration behaviors, suggesting that the Marmara Coast may form a part of a migratory route linking Europe and Asia.

While acoustic identification of *P. nathusii* is complicated by its similarity to *P. kuhlii*, which emits overlapping echolocation calls, several lines of evidence strengthen migratory interpretation. *P. kuhlii* is considered as a sedentary species and would be expected to occur consistently throughout the summer and autumn periods. The pronounced and seasonally restricted spike in detections suggests that the majority of calls recorded in autumn likely correspond to *P. nathusii*, not *P. kuhlii*. This interpretation is further supported by findings from Şaşmaz (2023) who reported that the second most frequently identified bat carcasses at several wind farms in Tekirdağ belonged to *P. nathusii*, while *P. kuhlii* was not reported. Nonetheless, the potential for misclassification cannot be entirely ruled out and some portion of the activity may reflect *P. kuhlii*.

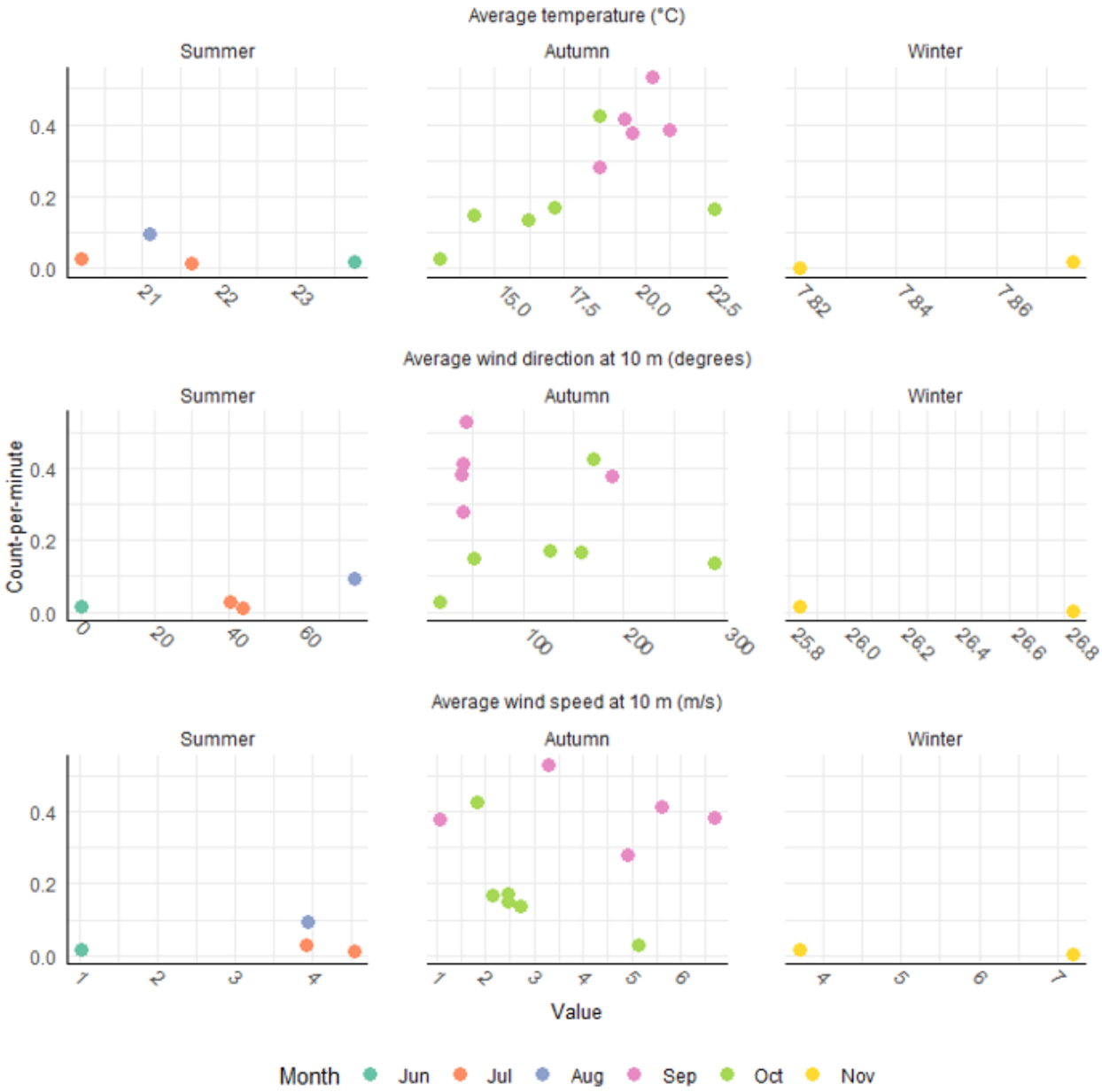

Figure 4. Relationship between nightly *Pipistrellus nathusii* activity (counts per minute, CPM; y-axis) and key weather variables at the Tekirdağ sampling site. Columns denote the three survey seasons—Summer, Autumn, and Winter—and rows show: (top) average nightly temperature (°C), (middle) mean wind direction at 10 m (degrees), and (bottom) average wind speed at 10 m (m/s). Each point represents one survey night and is colored by month (green = June, orange = July, blue = August, pink = September, light green = October, yellow = November).

The site's proximity to both existing and proposed wind energy developments, particularly offshore zones within the Marmara Sea, raises important conservation concerns. Migratory bats are especially vulnerable to turbine collisions during long-distance nocturnal flights along coastal and marine corridors. *P. nathusii*, in particular, is one of the most frequently detected species over offshore wind farms in the North Sea and is considered highly susceptible to turbine-related mortality (Kruszynski et al., 2022). Other migratory species, such as *N. noctula* and *N. leisleri*, also face high collision risks with annual turbine-related mortality estimates exceeding 200,000 individuals in Germany alone (Voigt et al., 2022). While only a small number of *Nyctalus* detections were recorded in this study, this may reflect habitat preference as these species are typically associated with more forested environments such as those found further north in the Thrace region. In parallel, this habitat mosaic—linking forested inland areas with coastal migratory routes—may also make the broader region suitable for *P. nathusii* during its autumn passage. These observations highlight the need for expanded, multi-site acoustic surveys that include inland and offshore components to more fully capture spatial patterns of migratory bat activity and inform risk assessments under wind energy development scenarios.

This study provides a baseline for understanding seasonal bat activity along the northern coast of the Sea of Marmara, offering preliminary evidence of migratory use by *P. nathusii*. Although limited to a single site and constrained by acoustic identification challenges, the results help fill a critical gap in the literature for the Eastern Mediterranean region. Future research should build on these findings by expanding monitoring to additional sites along potential flyways, incorporating spring migration periods and applying complementary methods such as

GPS telemetry or genetic analysis to improve species-level resolution. Such efforts are essential for the development of bat-inclusive conservation strategies in the context of expanding wind energy infrastructure across Türkiye's coastal landscapes.

Acknowledgment: This study was supported by the Scientific Research Projects Department of Istanbul Technical University to E.Ç. (Project Number: TGA-2021-42795).

Ethics committee approval: Ethics committee approval is not required for this study.

Conflict of interest: The author declares that there is no conflict of interest.

References

Alcalde, J.T., Jiménez, M., Brila, I., Vintulis, V., Voigt, C.C., & Pētersons, G. (2021). Transcontinental 2200 km migration of a Nathusius' pipistrelle (*Pipistrellus nathusii*) across Europe. *Mammalia*, 85(2), 161-163. https://doi.org/10.1515/mammalia-2020-0069

Barataud, M. (2015). Acoustic ecology of European bats. Species identification and studies of their habitats and foraging behaviour. Muséum National d'Histoire Naturelle, Paris; Biotope, Mèze, 352 pp.

Baş, M., & Arslan, A. (2021). Acoustical investigation of bats in Selçuklu District of Konya Province. *Kahramanmaraş Sütçü İmam Üniversitesi Tarım ve Doğa Dergisi*, 24(1), 186-195. https://doi.org/10.18016/ksutarimdoga.vi.722155

Coşkun, Ö., & Sert, H. (2023). Antalyadaki yarasa türlerinin akustik olarak araştırılması. *Kahramanmaraş Sütçü İmam Üniversitesi Tarım ve Doğa Dergisi* 26(6), 1405-1420. https://doi.org/10.18016/ksutarimdoga.vi.1163614

Dietz, C., & Kiefer, A. (2014). Die Fledermäuse Europas: Kennen, bestimmen, schützen. Franckh-Kosmos Verlags GmbH, 400 pp.

Gözütok, S. (2023). A new distribution record and some bioecological features of *Plecotus auritus* (Linnaeus, 1758) from Northwest Türkiye (Chiroptera: Vespertilionidae). *Commagene Journal of Biology*, 7(1), 38-43. https://doi.org/10.31594/commagene.1239398

Ijäs, A., Kahilainen, A., Vasko, V.V., & Lilley, T.M. (2017). Evidence of the migratory bat, *Pipistrellus nathusii*, aggregating to the coastlines in the Northern Baltic Sea. *Acta Chiropterologica*, 19(1), 127-139. https://doi.org/10.3161/15081109ACC2017.19.1.010

Karataş, A., Bulut, Ş., Sefali, A., Toprak, F., Şahin, M.K., & Özkurt, Ş.Ö. (2022). Contributions on the southern distribution of *Vespertilio murinus* Linnaeus, 1758 (Chiroptera: Vespertilionidae) from Türkiye. *Turkish Journal of Zoology*, 46(5), 434-443. https://doi.org/10.55730/1300-0179.3097

Karataş, A., Bulut, Ş., Karataş, A., Toprak, F., & Özkurt, Ş.Ö. (2020). Contribution to the natural history of *Barbastella barbastellus* in Turkey (Chiroptera: Vespertilionidae). *Lynx, series nova*, 51(1). https://doi.org/10.37520/lynx.2020.005

Kruszynski, C., Bailey, L.D., Bach, L., Bach, P., Fritze, M., Lindecke, O., ..., & Voigt, C.C. (2022). High vulnerability of juvenile Nathusius' pipistrelle bats (*Pipistrellus nathusii*) at wind turbines. *Ecological Applications*, 32(2), e2513. https://doi.org/10.1002/eap.2513

Lagerveld, S., Jonge Poerink, B., & Geelhoed, S.C. (2021). Offshore occurrence of a migratory bat, *Pipistrellus nathusii*, depends on seasonality and weather conditions. *Animals*, 11(12), 3442. https://doi.org/10.3390/ani11123442

Şahin, M.B. (2024). Gökçeada'nın (Çanakkale) yarasa varlığı ve aktivite örüntüsü. Retriewed from: https://tez.yok.gov.tr/UlusalTezMerkezi/giris.jsp

Şaşmaz, Y. (2023). Rüzgâr enerjisi santrallerinin yarasalar üzerine etkileri. Retrieved from: https://tez.yok.gov.tr/UlusalTezMerkezi/giris.jsp

Ürker, O., & Yorulmaz, T. (2020). Köyceğiz-Dalyan Özel Çevre Koruma Bölgesi'ndeki Anadolu sığla ormanlarında yarasa (Chiroptera) aktivitesinin belirlenmesi. *Ormancılık Araştırma Dergisi*, 7(1), 88-103. https://doi.org/10.17568/ogmoad.651223

Voigt, C.C., Kaiser, K., Look, S., Scharnweber, K. & Scholz, C. (2022) Wind turbines without curtailment produce large numbers of bat fatalities throughout their lifetime: A call against ignorance and neglect. *Global Ecology and Conservation*, 37, e02149. https://doi.org/10.1016/j.gecco.2022.e02149