frontiers | Frontiers in Conservation Science

TYPE Editorial
PUBLISHED 10 April 2025
DOI 10.3389/fcosc.2025.1590562

OPEN ACCESS

EDITED AND REVIEWED BY
Ronald R. Swaisgood,
San Diego Zoo Wildlife Alliance, United States

*CORRESPONDENCE
Anton Baotic
contact@antonbaotic.com

RECEIVED 09 March 2025
ACCEPTED 31 March 2025
PUBLISHED 10 April 2025

CITATION
Baotic A (2025) Editorial: Understanding rest-activity rhythms: uncovering factors shaping behavioural rhythms in diverse ecological contexts.
Front. Conserv. Sci. 6:1590562.
doi: 10.3389/fcosc.2025.1590562

Editorial: Understanding rest-activity rhythms: uncovering factors shaping behavioural rhythms in diverse ecological contexts

Anton Baotic*

Acoustics Research Institute, Austrian Academy of Sciences, Vienna, Austria

KEYWORDS

rest-activity rhythms, behavioral adaptation, zoo and field research, anthropogenic influences on wildlife, animal welfare, wildlife conservation, bio-logging and monitoring

Editorial on the Research Topic
Understanding rest-activity rhythms: uncovering factors shaping behavioural rhythms in diverse ecological contexts

Temporal patterns regulate biological processes across the animal kingdom, influencing how species allocate time to optimize survival. These patterns shape rest-activity rhythms and allow animals to balance energy, foraging, social interactions, predator avoidance, and anthropogenic disturbances. Because species must balance these competing demands, rest-activity cycles may vary across ecological contexts (Helm et al., 2017; Salguero-Gómez et al., 2022; Wong and Candolin, 2015).

Studying these patterns in the wild is challenging, but recent technological advancements, including bio-logging, remote sensing, and artificial intelligence, have transformed behavioral research. Autonomous recording units and passive acoustic monitoring provide valuable insights into vocalization patterns and behavioral rhythms without direct human interference (Penar et al., 2020; Rasmussen et al., 2024). Advancements in accelerometry and GPS tracking have also expanded our understanding of nocturnal activity budgets and species-specific rest-activity patterns providing insights into how animals allocate time (Chimienti et al., 2021; Kays et al., 2015).

Beyond monitoring wildlife in natural habitats, technical tools also advance research in managed settings, where environmental factors can be controlled. In zoos, behavioral monitoring helps assess how enclosure design and human interactions influence rest-activity rhythms. As part of these efforts, broader welfare assessments emphasize the need for science-based tools to track zoo animal well-being (Tallo-Parra et al., 2023). Among these tools, acoustic research has demonstrated how environmental noise affects behavior including vocalization patterns, stress responses, and social interactions in captive animals (Clark and Dunn, 2022), while deep learning applied to accelerometer data has improved the detection of subtle shifts in activity rhythms, providing insights into behavioral flexibility (Otsuka et al., 2024). These innovations enhance researchers' ability to track behavioral adaptations more precisely, supporting conservation efforts and mitigating anthropogenic impacts in both captive and wild populations.

Comparative research shows that while some behavioral traits remain stable across environments, others shift in response to ecological constraints and management conditions (Kelly et al., 2025). Recognizing these differences is key to assessing behavioral flexibility as species continually adjust their activity to environmental challenges. As environments change, animals must continuously adjust their behavior, balancing foraging, avoiding predators, and responding to human presence (Hairston et al., 2005; Wong and Candolin, 2015). These behavioral adjustments shape resilience to habitat changes, including human pressures and climatic conditions (Kelly et al., 2025). Understanding these shifts provides valuable insights into species persistence and ecosystem stability. To support adaptive management, long-term behavioral monitoring should be integrated with ecological analysis to assess how species respond to environmental change.

In managed care, controlled environments allow researchers to examine how factors such as age, enclosure design, and social compositions and behaviors influence rest-activity rhythms (Kelly et al., 2025; Tallo-Parra et al., 2023). Understanding how these factors shape behavioral flexibility and species-specific activity patterns is essential for refining best practices in zoo management and improving animal welfare. The study *'Overnight monitoring reveals the behavioral rhythms of a geriatric male elephant: an animal-centered case study of rest and stereotypy'* by McGuire et al., examines how habitat access, musth, and feeding schedules influence overnight behavior. The findings show that musth reduced recumbent rest, while access to both indoor and outdoor spaces decreased stereotypic behavior. However, automatic feeders did not significantly alter stereotypy. This study underscores the importance of adjusting management strategies to better support the well-being of aging elephants in zoos.

Early-life behavioral development is equally important for welfare and conservation breeding. The study *'From birth to weaning: maternal investment, cub development and behavior in Sumatran tigers (Panthera tigris sumatrae)'*, examines how maternal care shapes a cub's early development. Naidenov et al. found that as cubs grew, they nursed and groomed less frequently but remained socially close to one another. Moreover, the mother gradually interacted less with her cubs as they approached weaning, encouraging them to become more independent. These findings reinforce the value of evidence-based zoo management strategies that greatly support maternal care and enhance cub survival in conservation breeding programs.

Social structure also plays a vital role in shaping behavioral rhythms in animals. In their study *'Around the clock: unveiling giraffe rest-activity rhythms and social dynamics'*, Mebus et al. investigated how group composition can have an effect on rest-activity cycles in zoo-housed giraffes. Their findings indicate that stable groups maintained consistent activity patterns, while alterations, particularly the introduction of a male, led to increased standing and reduced feeding during the day. Despite these shifts, nocturnal activity budgets remained relatively stable. These results highlight the significance of structured group management and continuous behavioral monitoring for ensuring welfare in captive giraffe populations.

While zoos provide valuable insights into social influences on rest-activity patterns, examining these behaviors in the wild is essential for conservation. The final study by Hejcmanová et al. in this Research Topic, *'Diurnal activity and resting time allocation of the West African giraffe in an agropastoral human-dominated landscape'*, shifts the focus to a free-ranging giraffe population. The authors showed that human presence had minimal impact on overall resting time, while giraffes rested more frequently in proximity to livestock and conspecifics. This pattern suggests that in modified landscapes, livestock presence might create a 'safety effect', and reduce the need for individual vigilance. Their findings highlight the importance of species-specific assessments in understanding how wildlife adapts to human-altered environments while maintaining key behavioral patterns.

Taken together, these studies illustrate the complex interplay between environmental, social, and anthropogenic factors in shaping rest-activity rhythms. Integrating findings from both wild and captive settings can improve *in situ* and *ex situ* management strategies, ensuring that conservation efforts are informed by a deeper understanding of behavior.

Author contributions

AB: Writing – original draft, Writing – review & editing.

Funding

The author(s) declare that financial support was received for the research and/or publication of this article. This research was funded in whole or in part by the Austrian Science Fund (FWF) (grant-doi 10.55776/P36120). For open access purposes, the author has applied a CC BY public copyright license to any author-accepted manuscript version arising from this submission.

Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declare that no Generative AI was used in the creation of this manuscript.

Publisher's note

References

Chimienti, M., van Beest, F. M., Beumer, L. T., Desforges, J.-P., Hansen, L. H., Stelvig, M., et al. (2021). Quantifying behavior and life-history events of an Arctic ungulate from year-long continuous accelerometer data. *Ecosphere* 12, e03565. doi: 10.1002/ecs2.3565

Clark, F. E., and Dunn, J. C. (2022). From soundwave to soundscape: A guide to acoustic research in captive animal environments. *Front. Veterinary Sci.* 9. doi: 10.3389/fvets.2022.889117

Hairston, N. G. Jr., Ellner, S. P., Geber, M. A., Yoshida, T., and Fox, J. A. (2005). Rapid evolution and the convergence of ecological and evolutionary time. *Ecol. Lett.* 8, 1114–1127. doi: 10.1111/j.1461-0248.2005.00812.x

Helm, B., Visser, M. E., Schwartz, W., Kronfeld-Schor, N., Gerkema, M., Piersma, T., et al. (2017). Two sides of a coin: ecological and chronobiological perspectives of timing in the wild. *Philos. Trans. R. Soc. B: Biol. Sci.* 372 (1734), 20160246. doi: 10.1098/rstb.2016.0246

Kays, R., Crofoot, M. C., Jetz, W., and Wikelski, M. (2015). Terrestrial animal tracking as an eye on life and planet. *Science* 348(6240), aaa2478. doi: 10.1126/science.aaa2478

Kelly, R., Freeman, M., and Rose, P. (2025). What behavior is important behavior? A systematic review of how wild and zoo-housed animals differ in their time-activity budgets. *Front. Ethology* 4. doi: 10.3389/fetho.2025.1517294

Otsuka, R., Yoshimura, N., Tanigaki, K., Koyama, S., Mizutani, Y., Yoda, K., et al. (2024). Exploring deep learning techniques for wild animal behaviour classification using animal-borne accelerometers. *Methods Ecol. Evol.* 15, 716–731. doi: 10.1111/2041-210X.14294

Penar, W., Magiera, A., and Klocek, C. (2020). Applications of bioacoustics in animal ecology. *Ecol. Complexity* 43, 100847. doi: 10.1016/j.ecocom.2020.100847

Rasmussen, J. H., Stowell, D., and Briefer, E. F. (2024). Sound evidence for biodiversity monitoring. *Science* 385, 138–140. doi: 10.1126/science.adh2716

Salguero-Gómez, R., Evans, D. M., Gaillard, J.-M., Lancaster, L., Sanders, N. J., Scandrett, K., et al. (2022). Time counts in animal ecology. *J. Anim. Ecol.* 91, 2154–2157. doi: 10.1111/1365-2656.13821

Tallo-Parra, O., Salas, M., and Manteca, X. (2023). Zoo animal welfare assessment: where do we stand? *Animals* 13, 1966. doi: 10.3390/ani13121966

Wong, B. B. M., and Candolin, U. (2015). Behavioral responses to changing environments. *Behav. Ecol.* 26, 665–673. doi: 10.1093/beheco/aru183