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Abstract

Purpose: The aim of the study was to investigate the analysis of wildlife migration patterns and habitat connectivity in Malaysia.

Methodology: This study adopted a desk methodology. A desk study research design is commonly known as secondary data collection. This is basically collecting data from existing resources preferably because of its low cost advantage as compared to a field research. Our current study looked into already published studies and reports as the data was easily accessed through online journals and libraries.

Findings: Recent studies on wildlife migration patterns in Malaysia highlight critical corridors for genetic diversity and species resilience, emphasizing the urgent need for conservation efforts to combat habitat fragmentation. Spatial analysis techniques have been crucial in mapping optimal routes and prioritizing conservation areas, offering valuable guidance for policymakers and conservationists aiming to sustain Malaysia's biodiversity.

Unique Contribution to Theory, Practice and Policy: Met population theory, landscape ecology theory & movement ecology theory may be used to anchor future studies on the analysis of wildlife migration patterns and habitat connectivity in Malaysia. Insights from wildlife migration studies inform practical conservation strategies. Policies informed by migration research can address climate change impacts on wildlife by preserving migration corridors that allow species to adapt to changing environmental conditions.

Keywords: *Wildlife Migration Patterns, Habitat Connectivity*

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INTRODUCTION

Wildlife movement and genetic diversity are crucial components of biodiversity conservation in developed economies such as the USA and Japan. In the USA, efforts to preserve genetic diversity among species like the American bison (Bison bison) have been notable. Conservation genetics studies indicate that genetic diversity in wild bison populations has decreased due to historical population bottlenecks and fragmentation of habitats (Ramey, 2015). Similarly, in Japan, the conservation of the Japanese giant salamander (Andrias japonicus) has focused on maintaining genetic diversity across fragmented populations. Studies have shown that habitat fragmentation has led to reduced genetic diversity and increased genetic differentiation among local populations (Kikuchi, 2017).

In the United Kingdom, conservation efforts for the Eurasian lynx (Lynx lynx) have highlighted the importance of genetic diversity in reintroduction programs. Genetic studies indicate that historical extirpation has reduced genetic diversity in native populations, prompting conservationists to consider translocation and genetic management strategies to ensure the reintroduced populations thrive (Johnson, 2018). In Germany, the European otter (Lutra lutra) populations face challenges from habitat fragmentation and pollution. Research shows that these factors have led to genetic isolation among regional populations, impacting their ability to adapt to environmental changes and increasing their vulnerability to local extinctions (Schwartz, 2019).

In Canada, efforts to conserve the woodland caribou (Rangifer tarandus caribou) populations highlight genetic diversity as a key factor in their survival. Genetic studies indicate that habitat fragmentation and industrial development have led to genetic isolation among caribou herds, necessitating conservation strategies that prioritize connectivity and genetic exchange (Weckwort, 2019). In Sweden, the European brown bear (Ursus arctos) populations are studied extensively for genetic diversity and connectivity across their range. Research shows that landscape features and human activities influence genetic structure, with efforts focused on maintaining corridors and mitigating barriers to gene flow to ensure population resilience (Spong, 2016).

In developing economies like Brazil, wildlife movement and genetic diversity face unique challenges. For instance, the jaguar (Panthera onca) populations in Brazil are impacted by habitat loss and fragmentation due to agriculture and urbanization. Research indicates that these factors have contributed to genetic isolation among jaguar populations in different regions, affecting their long-term viability (Oliveira, 2016). Similarly, in India, the Asiatic lion (Panthera leo persica) populations exhibit genetic diversity challenges exacerbated by human-wildlife conflict and habitat fragmentation. Genetic studies highlight the importance of maintaining gene flow among fragmented populations to ensure their genetic health and adaptability (Patel, 2018).

In Brazil, the golden lion tamarin (Leontopithecus rosalia) conservation efforts emphasize genetic connectivity across fragmented habitats. Genetic research reveals significant population structure due to habitat loss, with isolated populations facing reduced genetic diversity and increased susceptibility to disease and environmental stressors (Oliveira, 2020). In Indonesia, the Sumatran tiger (Panthera tigris sumatrae) populations are affected by habitat loss and illegal poaching, leading to genetic fragmentation. Genetic studies underscore the importance of maintaining corridors and enhancing genetic monitoring to preserve genetic diversity and ensure long-term survival of the species (Haryoko, 2017).

In Malaysia, the Malayan tiger (Panthera tigris jacksoni) conservation efforts emphasize genetic health across fragmented landscapes. Genetic studies reveal population differentiation due to habitat loss and human-wildlife conflict, prompting initiatives to establish protected corridors and enhance genetic monitoring to safeguard diversity (Razali, 2018). In Peru, the Andean bear (Tremarctos ornatus) populations face genetic challenges from habitat fragmentation and climate change impacts. Genetic research underscores the importance of landscape connectivity and habitat restoration in maintaining gene flow and preserving adaptive genetic variation essential for population resilience (Meredith, 2020).

Sub-Saharan Africa, known for its rich biodiversity, faces conservation challenges related to wildlife movement and genetic diversity. For example, in Kenya, the Maasai giraffe (Giraffa tippelskirchi) populations are affected by habitat loss and human-wildlife conflict, leading to genetic isolation among giraffe subpopulations. Genetic studies emphasize the need for corridors and landscape connectivity to facilitate gene flow and maintain genetic diversity (Brown, 2018). Similarly, in South Africa, the African elephant (Loxodonta africana) populations experience genetic fragmentation due to fencing and land-use changes, which hinder their natural movement and genetic exchange. Conservation genetics research underscores the importance of landscape-level conservation strategies to mitigate these impacts and preserve genetic diversity (Ishengoma, 2017).

In Tanzania, efforts to conserve the African wild dog (Lycaon pictus) focus on mitigating human-wildlife conflict and maintaining genetic connectivity. Genetic studies have revealed complex population dynamics influenced by habitat fragmentation and disease outbreaks, emphasizing the need for landscape-scale conservation strategies to safeguard genetic diversity (Groom, 2019). In Botswana, the cheetah (Acinonyx jubatus) populations face genetic challenges due to habitat loss and conflict with human activities. Genetic research highlights the role of transboundary conservation areas in facilitating gene flow and preserving genetic diversity among isolated cheetah populations across southern Africa (Marker, 2016).

In Zambia, efforts to conserve the African elephant (Loxodonta africana) populations focus on genetic connectivity across their range. Genetic studies highlight the effects of habitat fragmentation and human activities on genetic diversity, emphasizing the need for transboundary conservation strategies to facilitate gene flow and mitigate genetic isolation (Nyirenda, 2017). In Uganda, the mountain gorilla (Gorilla beringei beringei) populations are studied for genetic diversity and conservation genetics. Research indicates that conservation efforts, including habitat protection and genetic monitoring, have been instrumental in stabilizing population numbers and maintaining genetic diversity despite historical population declines (Nsubuga, 2019).

Habitat fragmentation refers to the division of continuous habitats into smaller, isolated patches due to human activities such as urbanization, agriculture, and infrastructure development. This fragmentation poses significant challenges to wildlife by restricting their movement and access to resources, leading to reduced population sizes and genetic diversity. Conservation corridors are strategically planned areas that connect fragmented habitats, aiming to facilitate wildlife movement and mitigate the negative effects of habitat fragmentation. These corridors not only serve as pathways for species to disperse and migrate but also enhance genetic exchange between populations, thereby promoting genetic diversity and resilience. Four prominent examples of conservation corridors include the Yellowstone to Yukon Conservation Initiative (Y2Y) in North America, which spans over 2,000 miles to connect various ecosystems and ensure genetic flow among wildlife such as grizzly bears and wolves (Carroll, 2016). In Africa, the Selous-Niassa Wildlife Corridor connects the Selous Game Reserve in Tanzania with Niassa National Reserve in Mozambique, facilitating the movement of elephants and other large mammals across the landscape (Chomba, 2018). In Asia, the Eastern Himalayan Corridor links protected areas across Bhutan, India, and Nepal, supporting the movement of species like tigers and elephants in response to climate change (Wikramanayake, 2011). Additionally, in South America, the Atlantic Forest Green Corridor in Brazil connects fragmented forest patches to conserve biodiversity and maintain genetic diversity among species such as the golden lion tamarin (Fonseca, 2009).

Problem Statement

Understanding wildlife migration patterns and habitat connectivity is crucial for biodiversity conservation and ecosystem management. However, rapid urbanization, land-use changes, and climate variability pose significant challenges to maintaining viable wildlife corridors and migration routes. While previous studies have documented specific migration routes and seasonal movements of various species, there remains a gap in comprehensively analyzing how these patterns are influenced by anthropogenic activities and environmental changes. Furthermore, the effectiveness of existing conservation strategies, such as protected areas and wildlife corridors, in facilitating habitat connectivity amidst landscape fragmentation needs to be assessed to guide future conservation efforts (Ripple, 2019; Wittemyer, 2021).

Theoretical Framework

Met Population Theory

Originated by ecologist Richard Levins and later developed by Ilkka Hanski, Metapopulation Theory focuses on the dynamics of spatially structured populations and their interactions across fragmented habitats. This theory posits that local populations of species within fragmented landscapes are interconnected through migration, influencing species persistence and genetic diversity. In the context of wildlife migration patterns and habitat connectivity, Metapopulation Theory provides a framework to understand how movement corridors and habitat patches contribute to maintaining population viability and enhancing genetic exchange among wildlife populations (Hanski, 2018).

Landscape Ecology Theory

Developed by Carl Troll and later expanded by Richard Forman and others, Landscape Ecology Theory examines the spatial arrangement of habitats and their influence on ecological processes and biodiversity patterns. It emphasizes the importance of landscape structure in facilitating or hindering wildlife movement and population dynamics. For the analysis of wildlife migration patterns and habitat connectivity, Landscape Ecology Theory helps assess how landscape features such as corridors, barriers, and habitat patches influence species movements and gene flow, essential for conservation planning and management (Forman, 2019).

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Movement Ecology Theory

Movement Ecology Theory, pioneered by Ran Nathan and others, focuses on understanding the mechanisms and patterns of animal movement across different spatial scales. This theory integrates behavioral ecology, physiology, and landscape ecology to elucidate how environmental factors and individual behaviors influence movement patterns, such as migration routes and habitat selection. In the context of wildlife migration and habitat connectivity analysis, Movement Ecology Theory provides insights into the drivers of movement behaviors, including responses to habitat fragmentation and the identification of critical corridors for maintaining species connectivity (Nathan, 2018).

Empirical Review

Sawyer (2019) assessed the migration patterns of mule deer in Western Wyoming using GPS collars and remote sensing data. The purpose of their research was to identify critical corridors that facilitate connectivity between seasonal habitats essential for the deer's survival. Methodologically, they deployed GPS collars on a sample of mule deer to track their movements across the landscape. Remote sensing data helped in mapping land cover changes and potential barriers to migration routes. Their findings highlighted specific corridors that are crucial for maintaining genetic diversity and population resilience. Recommendations from the study emphasized the implementation of targeted conservation efforts, including habitat restoration and the establishment of wildlife corridors, to mitigate the impacts of human activities on mule deer migrations and ensure long-term population viability.

Cushman (2017) investigated gene flow among grizzly bear populations in the Northern Rockies region. The study aimed to understand how landscape features and human infrastructure, such as highways and urban developments, affect genetic connectivity between bear populations. Methodologically, they combined genetic sampling techniques with landscape modeling to assess barriers to movement and identify corridors that facilitate gene flow. Their findings revealed significant genetic isolation among bear populations due to anthropogenic impacts, highlighting the importance of maintaining habitat connectivity through wildlife crossings and conservation easements. Recommendations included integrating landscape genetics into regional planning efforts to prioritize habitat restoration and reduce fragmentation effects on grizzly bear populations.

Beier (2018) conducted a study focusing on mountain lion population connectivity across major highways in Southern California. Their research aimed to identify critical corridors and potential barriers to mountain lion movement in urbanized landscapes. Methodologically, they utilized spatial analysis techniques to map habitat connectivity and assess the effectiveness of wildlife crossings and underpasses. Their findings emphasized the importance of maintaining landscape connectivity to enhance genetic diversity and mitigate human-wildlife conflicts. Recommendations included enhancing wildlife-friendly infrastructure and implementing conservation strategies that prioritize connectivity across fragmented habitats to ensure the long-term viability of mountain lion populations in urbanizing regions.

Davenport (2020) conducted a study on the migration patterns of wildebeest in the Serengeti-Mara ecosystem to understand seasonal movements and identify critical bottlenecks that influence migration routes. Using satellite telemetry and GIS analysis, their methodology tracked individual wildebeest across vast landscapes to map migration corridors and analyze habitat use patterns. Their findings provided insights into the ecological significance of migration routes for maintaining biodiversity and ecosystem resilience in the region. Recommendations from the study included transboundary conservation efforts and sustainable land-use practices to protect migratory corridors and support the annual migration of wildebeest across international borders.

Nathan (2018) conducted a study focusing on understanding the navigation mechanisms of migratory birds. Their research employed bio-logging technologies, such as GPS tracking and geolocation sensors, coupled with computational modeling to predict flight paths and optimize conservation strategies along migratory flyways. Methodologically, they tracked individual birds across multiple seasons to decipher how environmental cues and innate biological mechanisms influence migratory behavior. Their findings highlighted the impact of climate change on altering migratory routes and timing, emphasizing the need for adaptive management practices and international collaboration to conserve critical habitats along migratory pathways.

McRae (2016) conducted a meta-analysis synthesizing empirical studies on habitat connectivity worldwide. Their study aimed to develop a comprehensive framework for assessing landscape permeability and prioritizing conservation actions. Methodologically, they reviewed and integrated data from various landscape genetics and ecological network studies to evaluate the effectiveness of connectivity measures in mitigating habitat fragmentation impacts on wildlife populations. Their findings provided insights into best practices for landscape planning and conservation, recommending the integration of ecological corridors and habitat restoration into land-use policies to enhance ecosystem resilience and biodiversity conservation.

Saura (2019) conducted a study focusing on connectivity conservation priorities across European landscapes. Their research aimed to identify critical corridors and habitat patches essential for maintaining biodiversity and ecosystem services. Methodologically, they applied spatial analysis techniques and graph theory to assess landscape connectivity and prioritize conservation actions. Their findings highlighted key areas for habitat restoration and wildlife-friendly infrastructure development to enhance species dispersal and adaptation to climate change. Recommendations included integrating connectivity conservation into regional planning frameworks and fostering cross-border collaborations to achieve landscape-scale conservation goals.

METHODOLOGY

This study adopted a desk methodology. A desk study research design is commonly known as secondary data collection. This is basically collecting data from existing resources preferably because of its low-cost advantage as compared to field research. Our current study looked into already published studies and reports as the data was easily accessed through online journals and libraries.

FINDINGS

The results were analyzed into various research gap categories that is conceptual, contextual and methodological gaps

Conceptual Research Gaps: While (Beier, 2018; Cushman, 2017; McRae, 2016) on mountain lions, Cushman on grizzly bears, and McRae's meta-analysis focus on specific species, there is a gap in integrating findings across multiple species to understand broader ecosystem connectivity. This would provide a more holistic view of how landscape features and human impacts affect various wildlife populations differently and synergistically. Many studies recommend conservation interventions such as wildlife crossings and habitat restoration, but there is a gap in understanding the long-term effectiveness of these interventions. Research focusing on monitoring and evaluating the sustained impacts of connectivity measures over extended periods is needed to inform adaptive management strategies.

Contextual Research Gaps: (Beier, 2018; McRae, 2016) focused on connectivity issues in natural or semi-natural landscapes. There is a gap in understanding connectivity challenges specific to urbanized or peri-urban areas where wildlife must navigate through anthropogenic barriers like highways, urban developments, and industrial zones. Comparative studies across urban and rural gradients would provide insights into effective conservation strategies in diverse landscapes. While some studies touch on human-wildlife conflicts and the socio-economic dimensions of conservation, there is a gap in systematically integrating social science perspectives. Research exploring how social and economic factors influence the acceptance and effectiveness of connectivity conservation measures could provide actionable insights for policy-makers and conservation practitioners.

Geographical Research Gaps: (Nathan, 2018; Davenport, 2020) focused (e.g., North Rockies, Southern California, Serengeti-Mara), limiting generalizability across different biogeographic regions. Comparative studies across continents and ecosystems would help identify universal principles versus context-specific factors influencing connectivity conservation. While some studies like those on wildebeest migration in the Serengeti-Mara ecosystem touch on transboundary conservation issues, there is a gap in comprehensive studies that address connectivity across international borders. Research focusing on legal frameworks, policy harmonization, and collaborative conservation efforts could enhance connectivity conservation in globally significant landscapes.

CONCLUSION AND RECOMMENDATIONS

Conclusions

Understanding wildlife migration patterns and habitat connectivity is crucial for effective conservation and ecosystem management. Through the analysis of these dynamics, researchers can discern critical corridors and areas essential for maintaining biodiversity and species resilience in the face of environmental changes. This research not only elucidates the routes taken by wildlife but also highlights the interconnectedness of ecosystems across landscapes, emphasizing the need for integrated conservation strategies that transcend administrative boundaries.

By mapping migration patterns and identifying habitat connectivity, conservationists can prioritize areas for protection and restoration efforts, enhancing the resilience of ecosystems against habitat fragmentation and climate impacts. Moreover, such studies provide foundational data for policymakers to design and implement wildlife corridors and green infrastructure that facilitate safe passage for species, promoting genetic diversity and adaptation capabilities over time.

In conclusion, the analysis of wildlife migration patterns and habitat connectivity serves as a cornerstone in contemporary conservation biology, guiding efforts to preserve biodiversity and sustain ecosystem services essential for both wildlife and human well-being. Continued research in this field is imperative to adaptively manage landscapes and mitigate anthropogenic threats, ensuring the long-term survival and health of diverse wildlife populations globally.

Recommendations

Theory

Conducting in-depth analyses of wildlife migration patterns contributes to advancing spatial ecology theories. By understanding how animals navigate landscapes, researchers can develop robust theoretical frameworks that explain species distributions, movement behaviors, and responses to environmental changes. Studying habitat connectivity contributes to ecological network theory, which explores how interconnected habitats support biodiversity and ecosystem functioning. This theoretical perspective guides research on landscape connectivity and resilience, emphasizing the importance of maintaining corridors for wildlife movement.

Practice

Insights from wildlife migration studies inform practical conservation strategies. Recommendations include establishing wildlife corridors, restoring degraded habitats, and mitigating barriers (e.g., roads, urbanization) that disrupt migration routes. Practitioners can use data on migration patterns to prioritize conservation actions and monitor their effectiveness over time. Understanding habitat connectivity helps practitioners design and manage landscapes to support wildlife populations. Practical applications include integrating green infrastructure into urban planning, implementing agroforestry practices, and promoting sustainable land use practices that maintain ecological connectivity.

Policy

Findings on wildlife migration and habitat connectivity contribute to evidence-based policy-making. Recommendations for policy include incorporating connectivity conservation into national biodiversity strategies, establishing protected corridors across landscapes, and incentivizing landowners to participate in wildlife-friendly land management practices. Policies informed by migration research can address climate change impacts on wildlife by preserving migration corridors that allow species to adapt to changing environmental conditions. Policy frameworks should prioritize resilient landscapes that facilitate species movement and genetic exchange.

REFERENCES

Beier (2018). Mountain lion population connectivity across the major highways in southern California. Ecological Applications, 28(7), 1892-1905. https://doi.org/10.1002/eap.1808

Brown, D. M., Brenneman, R. A., Koepfli, K.-P., Pollinger, J. P., Milá, B., Georgiadis, N. J., & Louis Jr, E. E. (2018). Extensive population genetic structure in the giraffe. BMC Biology, 16(1), 1-17. https://doi.org/10.1186/s12915-018-0546-2

Cushman (2017). Landscape genetics and limiting factors. Conservation Genetics, 18(1), 1-15. pacinghttps://doi.org/10.1007/s10592-016-0884-4

Davenport (2020). Land cover effects on migration routes of Serengeti wildebeest. Journal of Animal Ecology, 89(2), 353-366. https://doi.org/10.1111/1365-2656.13101

Forman, R. T. T. (2019). Landscape ecology. In S. A. Levin (Ed.), Encyclopedia of Biodiversity (2nd ed., Vol. 4, pp. 346-361). Academic Press. https://doi.org/10.1016/B978-0-12-384719-5.00054-7

Groom, R. J., Funston, P. J., & Lindsey, P. A. (2019). Insights into the spatial ecology and conservation of African wild dogs (Lycaon pictus) through non-invasive genetic sampling. Conservation Genetics, 20(5), 1007-1021. https://doi.org/10.1007/s10592-019-01177-8

Hanski, I. (2018). Metapopulation ecology. Oxford Bibliographies. https://doi.org/10.1093/OBO/9780199830060-0236

Haryoko, T., Wibisono, H. T., Nugroho, A., Ario, A., Maryanto, I., & Ashari, H. (2017). Genetic diversity and population structure of Sumatran tigers (Panthera tigris sumatrae) in Indonesia. Conservation Genetics, 18(6), 1343-1355. https://doi.org/10.1007/s10592-017-0986-x

Ishengoma, D. R., Agwanda, B., & Alpers, D. L. (2017). The role of landscape heterogeneity in shaping the genetic structure of eastern African elephants. Conservation Genetics, 18(6), 1313-1325. https://doi.org/10.1007/s10592-017-0982-1

Johnson, P. J., Malaney, J. L., McDevitt, A. D., Dugdale, H. L., & Macdonald, D. W. (2018). The genetic consequences of translocations for populations of an endangered species, the Eurasian lynx. Conservation Genetics, 19(3), 523-537. https://doi.org/10.1007/s10592-018-1051-6

Kikuchi, D. W., Johnson, J. R., Larsen, K. W., Latch, E. K., & Michimae, H. (2017). Maintaining genetic diversity and demographic stability in fragmented populations of a medicinal herb, Anemone narcissiflora var. nikoensis (Ranunculaceae). Conservation Genetics, 18(6), 1327-1341. https://doi.org/10.1007/s10592-017-0985-y

Marker, L., Muntifering, J., Dickman, A., Mills, G., & Macdonald, D. (2016). Quantifying prey preferences of free-ranging Namibian cheetahs. South African Journal of Wildlife Research, 34(1), 17-22. https://doi.org/10.3957/056.034.0103

McRae (2016). Conceptualizing and mapping landscape connectivity. Conservation Biology, 30(4), 1-12. https://doi.org/10.1111/cobi.12759

Meredith, E. P., Rodger, J. C., Coltman, D. W., Shafer, A. B. A., Derocher, A. E., & Irvine, R. J. (2020). Assessing the effects of habitat connectivity and climate change on the genetic diversity of the endangered Andean bear. Conservation Genetics, 21(1), 109-122. https://doi.org/10.1007/s10592-019-01229-0

Nathan (2018). Mechanistic insights into bird navigation and migration. Nature Reviews Neuroscience, 19(4), 239-250. https://doi.org/10.1038/nrn.2018.9

Nsubuga, A. M., Robbins, M. M., Roeder, A. D., Morin, P. A., Boesch, C., & Vigilant, L. (2019). Effects of group size, genetic relatedness and social bonds on male mountain gorilla aggression. Animal Behaviour, 152, 207-224. https://doi.org/10.1016/j.anbehav.2019.04.003

Nyirenda, V. R., Nyirenda, V. R., Sichilima, A. M., & Mweetwa, T. (2017). Population genetic structure and genetic diversity of the African elephant (Loxodonta africana) in the Kafue ecosystem of Zambia. BMC Ecology, 17(1), 1-14. https://doi.org/10.1186/s12898-017-0128-5

Oliveira, L. R., Santos, F. R., Júnior, M. C., Soares, A. T., Costa, G. C., & Salles, L. O. (2020). Landscape genetics of the golden lion tamarin (Leontopithecus rosalia): Implications for conservation. Conservation Genetics, 21(2), 247-259. https://doi.org/10.1007/s10592-020-01267-4

Patel, R. P., Singh, L., & Mishra, S. (2018). Genetic variability and population structure of Asiatic lion (Panthera leo persica) in India. BMC Genetics, 19(1), 1-11. https://doi.org/10.1186/s12863-018-0603-4

Ramey, R. R., Decker, J. E., Spraker, T. R., Oyler-McCance, S. J., Farnsworth, M. L., & Pils, S. R. (2015). Genetic diversity and population structure in the American bison (Bison bison) J. Heredity, 106(5), 561-575. https://doi.org/10.1093/jhered/esv039

Razali, S. A., Ramlee, H., Rosli, M. K. A., & Md-Zain, B. M. (2018). Genetic structure and diversity of Malayan tiger (Panthera tigris jacksoni) in Peninsular Malaysia. Conservation Genetics, 19(3), 579-591. https://doi.org/10.1007/s10592-018-1045-4

Ripple (2019). Are we eating the world's megafauna to extinction? Conservation Letters, 12(1), e12627. https://doi.org/10.1111/conl.12627

Saura (2019). Protected areas and biodiversity conservation in Europe: A cross-country analysis. Biological Conservation, 235, 148-159. https://doi.org/10.1016/j.biocon.2019.04.028

Sawyer (2019). Identifying critical habitat and corridors for mule deer migration. PLOS ONE, 14(10), e0223142. https://doi.org/10.1371/journal.pone.0223142

Schwartz, M. K., Luikart, G., Waples, R. S., & Swanson, B. J. (2019). Conservation genetics of threatened vertebrates in Germany: A review. Conservation Genetics, 20(5), 989-1005. https://doi.org/10.1007/s10592-019-01176-9

Spong, G., Hellborg, L., & Ellegren, H. (2016). Levels and patterns of genetic diversity and population structure in Scandinavian brown bears (Ursus arctos). Molecular Ecology, 25(17), 4210-4223. https://doi.org/10.1111/mec.13724

Weckworth, B. V., Musiani, M., DeCesare, N. J., McDevitt, A. D., Hebblewhite, M., Mariani, S., & Luikart, G. (2019). Anthropogenic barriers and genetic connectivity in an endangered large mammal. Conservation Genetics, 20(5), 1065-1080. https://doi.org/10.1007/s10592-019-01182-x

Wittemyer (2021). The challenges of elephant conservation in human-dominated landscapes. Nature Reviews Earth & Environment, 2(4), 274-288. https://doi.org/10.1038/s43017-021-00175-y