

Review

The Ural Owl as a Keystone Species in Interspecific Interactions Among Avian Predators—A Review

Łukasz Kajtoch 

Institute of Systematics and Evolution of Animals, Polish Academy of Sciences, 31-016 Krakow, Poland;
lukasz.kajtoch@gmail.com

Abstract: Ural owls are one of the largest owls in Europe, exhibiting known aggressive behaviour toward other raptors. They are known to interact with nearly all sympatric owls and many diurnal raptors. To summarise these interactions, a literature search was undertaken in the Web of Sciences and Scopus databases using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses methodology as well principal books on owl biology. The search revealed 22 relevant publications that (along with the book data) described the Ural owl's relations with seven owls and six diurnal raptor species. The Ural owl is subordinate only to the largest predators like golden eagles and eagles, although only its chicks are known to be killed. Contrary to that, the Ural owls shape the distribution of numerous other species, mostly by strong competition (e.g., forcing tawny owls to breed in suboptimal habitats) or by predation (killing smaller owls and diurnal raptors). Their occurrence could be also protective for some species like boreal owls thanks to the removal of intermediate predators. The relations of Ural owls with goshawks are interesting, which seem to live in some balance—temporal avoidance of activity with frequent co-occurrence. Thanks to their association with old-growth forests and their impact on other predators in their territories, Ural owls act as keystone species in mountainous and boreal forests in Europe. Considering this ecosystem service, Ural owls should be effectively protected e.g., by designing forest-management-free zones around their nesting sites.

Keywords: *Strix uralensis*; Strigidae; competition; predation–prey interactions; protective behaviour



Academic Editor: Michael Wink

Received: 6 January 2025

Revised: 24 January 2025

Accepted: 31 January 2025

Published: 1 February 2025

Citation: Kajtoch, Ł. The Ural Owl as a Keystone Species in Interspecific Interactions Among Avian Predators—A Review. *Diversity* **2025**, *17*, 109. <https://doi.org/10.3390/d17020109>

Copyright: © 2025 by the author. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

1. Introduction

Predatory species are considered the top parts of food web chains in ecosystems [1]. They play a crucial role in limiting the number of their prey. Species killing other animals never act alone in the environment and have to challenge interactions with other members of their trophic guild [2,3]. Usually, predators are structured hierarchically, with smaller and “weaker” species being subordinated to top (apex) predators that are the largest and “strongest” [4,5]. The latter assumption is not always valid, as some species with aggressive behaviour are known to successfully compete with species of larger body sizes (e.g., a case of medium-size goshawks *Accipiter gentilis* facing eagles or wolverines *Gulo gulo* effectively defending prey against wolves *Canis lupus* or bears *Ursus arctos* [6,7]. Species interactions are also complex among predators due to their competition for space (habitats, breeding/nesting sites) and resources (prey) [8]. Displacement of space or food niches often relaxes these interactions and allows for co-occurrence in sympatry [9,10]). Moreover, there are known protective associations among predators when the presence of the top predator forces some subordinates to avoid its surroundings, which opens “safe” space for some other smaller predators that are not considered prey for the top one [11–13].

The best known are interactions among mammalian predators due to the long interest of people in biology, ecology, and the behaviour of large predators like bears or lions *Panthera leo*. Also, smaller mammal predators attract attention due to their high abundance and impact on wild and domestic animals (e.g., foxes *Vulpes vulpes* and martens *Martes spp.*) [14]. The knowledge of interactions among bird predators is also large but focuses mostly on diurnal raptors like eagles *Aquila* spp., hawks *Accipiter* spp., or falcons *Falco* spp. [15]. Contrary to that, information about the interactions of owls is limited [2–5,14]. This is mostly due to difficulties in studies on these nocturnal species, which have been overcome recently thanks to the development of new tools and techniques.

Owls are a diverse group with species of various sizes, habitats, and food preferences. The European assemblage of owls consists of 13 species living from the southernmost Mediterranean shrublands across temperate and boreal forests to the northernmost Arctic tundra [16]. The most diverse assemblages are known from forests, especially in borderlands of temperate broadleaved and boreal coniferous woodlands, where most species co-exist [17]. Among the forest-dwelling species, the largest ones are the eagle owl *Bubo bubo*, the grey great owl *Strix nebulosa*, and the Ural owl *Strix uralensis*, and the smallest ones are the pygmy owl *Glaucidium passerinum*, the Eurasian scops owl *Otus scops*, and the boreal owl *Aegolius funereus*. The medium-sized owls living there include the short-eared owl *Asio otus*, the northern hawk owl *Surnia ulula*, and the tawny owl *Strix aluco*. Interactions among these species are generally known, with the eagle owl being the top predator [5]. Among the other owl species, only the Ural owl has sporadically been found to be a prey of larger predators like the eagle owl as well as the white-tailed eagle *Haliaeetus albicilla* and the golden eagle *Aquila chrysaetos* [16,18]. The Ural owl is distributed mostly in the boreal forests of Eurasia, from Scandinavia to Japan. Its isolated populations live in the mountains of central Europe, mostly in the Carpathians and the Balkans [16,17]. It has also been reintroduced in the Bohemian Massive (Bohemian Forest) [19]. The population in Central Asia mountains is now assigned to a separate species, i.e., the Sichuan wood-owl *Strix davidi* [20], whereas in the remaining range, there still exist 9 or 10 subspecies. This owl utilises mostly large tree cavities for breeding, although it can also breed in the twig nests of raptors or in man-made constructions (e.g., hunting ambos, barns, and nest boxes). It prefers old-growth forests, both coniferous and deciduous, but it usually prefers open beech *Fagus sylvatica*, pine *Pinus sylvestris*, or spruce *Picea abies* woods [21–24]. The Ural owls hunt for various prey of small and medium sizes, mostly voles, but they can also take insects, amphibians, and birds, with the largest prey the size of a grouse or hare [16]. The generalist nature of the Ural owl and its aggressiveness make this species involved in many interactions with other raptors, both nocturnal and diurnal, although detailed knowledge in this matter is limited. Moreover, the Ural owl's territories are known as biodiversity hotspots for forest bird assemblages [25–27], and it is known that this species can act protectively for birds breeding in the neighbourhood [28,29]. This additionally makes the Ural owl potentially important for ecology in forest ecosystems.

2. Materials and Methods

To review the current state of the knowledge on the interaction of the Ural owl with other predators, a search of the scientific literature using the Web of Science (WoS) and Scopus electronic databases was conducted in December 2024 according to the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA; <https://www.prisma-statement.org/> (accessed on 20 December 2024)) using the following keywords: “*Strix uralensis*” AND (*interspecific* OR *interaction*). The downloaded metadata were organised into a single sheet with information on the title, authors, year of publication, keywords, and journal. Each text was briefly examined based on its title and abstract to

provide a short classification in the form of keywords or to eliminate the publications that were not connected to the research goals (e.g., there were cases when studies found dealt with other species, or there were studies dealing with Ural owl distribution, biology, or ecology but without any link to interactions with other species). Topics which were not directly connected to our study were excluded from the analysis. Also, all non-English studies and with no access to the full text were omitted. Finally, duplicates from both databases were deleted. Due to the absence of articles outside of Europe, this review was restricted only to the European continent.

An initial literature search revealed 53 articles using the WoS and 30 using the Scopus databases. Among these articles, 31 and 17, respectively, turned out to be irrelevant (2 were non-English, 1 was without access to the full text, 13 were not about the Ural owl, and 29 did not include information about interactions with other species except prey (19 cases) or raccoons *Procyon lotor* (1 case). Moreover, 3 hits were papers dealing with the protective role of Ural owls with respect to non-predatory birds.

Finally, 34 hits included information relevant to this review, and after the removal of duplicates, 22 papers were left from both databases (Table 1).

Additionally, data about interactions (mostly prey–predator accidents) among Ural owls and other raptors were retrieved from the “Owls of Europe” handbook [16] (Mikkola 1983). Due to the nature of the information available in the examined studies, it was not possible to conduct any statistical analyses in the way required for meta-analyses. Instead, the collected articles were examined concerning their (i) forest zones and subspecies (temperate–mountainous (= *S. u. macroura*) vs. boreal (= *S. u. liturata*); (ii) geographic localisation (considering the following geographic regions: Fennoscandia, Eastern Europe, the Carpathians with their surroundings, the Alps, and the Balkan Mountains (Dinarids), as well as the countries of the study); (iii) species that were involved in interactions (either single or multiple); (iv) methods of study (field observations, playback, capture–mark–recapture); and (v) types of interactions (e.g., predation, competition for habitats, nest sites or prey, protective, others). Finally, the available information was discussed to describe and explain the reasons, mechanisms, and consequences of interspecific interactions, with special attention being paid to the ecology and conservation biology of owl species in Europe.

Table 1. Characteristics of selected articles describing interactions between the Ural owl and other owl or diurnal raptors.

Author	Year	Interacting Species													Country					Type of Interaction									
		<i>S. aluco</i>	<i>S. nebulosa</i>	<i>B. bubo</i>	<i>A. funereus</i>	<i>G. passerinum</i>	<i>A. otus</i>	<i>S. ulula</i>	<i>A. gentilis</i>	<i>A. nisus</i>	<i>P. apivorus</i>	<i>B. buteo</i>	<i>H. albicilla</i>	<i>A. chrysaetos</i>	Europe (General)	Sweden	Finland	Russia	Belarus	Romania	Poland	Slovakia	Slovenia	Predation	Habitat Competition	Nests Competition	Prey Competition	Neutral	Protection
Lundberg	1980	✓														✓									✓				
Mikkola *	1983	✓		✓	✓		✓	✓					✓	✓	✓									✓	✓	✓	✓		
Korpimäki	1986	✓	✓														✓								✓	✓	✓		
Korpimäki	1987	✓		✓	✓	✓											✓								✓	✓	✓		
Solonen	1993	✓		✓		✓			✓	✓	✓	✓					✓							✓	✓	✓	✓		
Hakkarainen and Korpimäki	1996			✓	✓												✓										✓		✓
Byshnev	2002											✓							✓					✓					✓
Ambrozic	2002	✓				✓																							✓
Vrezec	2003	✓				✓																							✓
Vrezec and Tome	2004	✓				✓																							✓
Vrezec and Tome	2004	✓																											✓
Vrh and Vrezec	2006	✓																											
Pačenovský and Šotnár	2010						✓																						
Byholm et al.	2012								✓																		✓		
Pavón-Jordán et al.	2013	✓																											
Bolboaca et al.	2013	✓																											
Kajtoch et al.	2015	✓																											
Kajtoch et al.	2016	✓				✓	✓																						✓
Andreychev and Lapshin *	2017								✓									✓											
Šotnár et al.	2020	✓				✓	✓																						✓
Brambilla et al.	2020	✓					✓																						
Fedyń et al.	2021								✓																		✓		✓
Kouba et al.	2023					✓			✓																				
Andreychev	2024	✓																	✓										
Stój et al. *	2024													✓															

* Indicates studies not retrieved in the systematic literature search.

3. Results

3.1. Publication History

The oldest available study was from 1980, and in total, five articles were published before the year 2000. Between 2000 and 2010, seven articles were published, and between 2010 and 2020, another seven were published. The newest three papers were from 2021, 2023, and 2024 (Table 1).

3.2. Geography

The majority of the studies were carried out in Fennoscandia ($N = 8$, including seven from Finland), and the Dinarids ($N = 6$, all from Slovenia), followed by the Carpathians ($N = 6$, including three from Poland, two from Slovakia, and one from Romania), and two studies were from Eastern Europe (one from Russia and one from Belarus) (Table 1).

3.3. Study Methods

Nearly all of the 22 examined articles were based on observational data, usually accompanied by playback stimulation of owls. The capture–mark–recapture method was implemented in only one study. Also, modeling was used in only one study to predict future changes in the range of owls due to climate change and how it could affect species interactions.

3.4. Species Involved

Nearly half of the studies described interactions of Ural owls with only one other species, and in most cases, it was a tawny owl. The latter species was present in 16 studies, followed by the boreal owl ($N = 8$), pygmy owl ($N = 6$), eagle owl ($N = 3$), and great grey owl ($N = 1$). Among the diurnal raptors, the Eurasian goshawk *Accipiter gentilis* was present in four studies, followed by the common buzzard *Buteo buteo* ($N = 2$), the honey buzzard *Pernis apivorus* ($N = 1$), and the sparrowhawk *Accipiter nisus* ($N = 1$).

In six, articles two species interacted with Ural owls, two articles described tree species, one article examined four species, and another article examined seven species (although this study also referred information to other sources rather than original data from the field).

3.5. Interactions

A total of 15 of the studies reported competition for habitats among Ural owls and other predators. A total of 6 articles described the protective effects of Ural owls on another species (only the boreal owl). Four studies informed about direct predation, and four also informed about competition for prey. Only three papers reported direct competition for nest sites, and one article presented neutral interactions between Ural owls and goshawks.

3.5.1. Ural Owl vs. Eagle Owl

According to Korpimäki [30] and Solonen (1993) [31], these two owl species usually occupy different locations when living in sympatry, but this is mostly forced by the different habitat requirements of these species. There are known cases of the eagle owl preying on Ural owl broods [16,18], likely due to niche segregation and the aggressive behaviour of the Ural owls.

3.5.2. Ural Owl vs. Great Grey Owl

Only Korpimäki [32] described the co-occurrence of these two congeneric owls in Finland, but he reported competition between them as unimportant due to partial spatial, temporal, and habitat segregation (the great grey owl occupies loose woods in the northernmost localities and hunts all throughout the day and night, whereas the Ural owl occupies

dense woods and hunts mostly during the night). Mikkola [16] reported the aggressive behaviour of the Ural owl against the great grey owl on its nest as well as an opposite interaction of the great grey owl taking a nestling of the Ural owl.

3.5.3. Ural Owl vs. Tawny Owl

Interactions between these two species are the best known thanks to numerous studies in various populations with numerous records of tawny owls being the prey of Ural owls [16]. Generally, the findings are similar across the ranges of both species, although competition or predation seem to be more pronounced in mountainous populations between *S. u. macroura* and the tawny owl. The largest number of studies were carried out in the Dinarids [9,11,12,33–35], where clear altitudinal separation was described, with the tawny owl occupying lower elevations than the Ural owl. It was also reported that the Ural owl is sensitive to the voice of the tawny owl [9,36]. Spatial segregation was also reported for populations of these species in the Carpathians, where the Ural owl is forcing the tawny owl to breed in fragmented forests of worse habitat quality [10,13,37,38]. Also, in Fennoscandia, habitat displacement between these owls was reported, although it was partially explained by a sympatric distribution only in the southern part of this peninsula [22,31,32,39].

3.5.4. Ural Owl vs. Long-Eared Owl

No articles reporting interactions between these species were found, although according to Mikkola [16], a long-eared owl was once found to be a prey of a Ural owl.

3.5.5. Ural Owl and Hawk Owl

The literature search did not reveal any articles on both species, whereas Mikkola [16] provides information on the hawk owl being the prey of the Ural owl.

3.5.6. Ural Owl vs. Boreal Owl

According to studies in the Dinarids and the Carpathians [10,13,33,37,38], the Ural owl acts protectively toward the boreal owl, as it removes tawny owls from its territory, which creates space for boreal owl breeding. In Fennoscandia, the opposite effect was reported by Hakkarainen and Korpimäki [40]. By hanging nest boxes to manipulate the densities of boreal owls, they found that Ural owls decreased the breeding success of the former species, whereas no such effect was visible in eagle owl territories. This is also supported by Kouba et al. [41], who identified Ural owls and goshawks as the main predators of boreal owls in Finland. The boreal owl is also included among the prey of the Ural owl by Mikkola [16].

3.5.7. Ural Owl vs. Pygmy Owl

The pygmy owl is known to be hunted by the Ural owl [16], and it therefore avoids breeding in the proximity of this top predator. Such behaviour was reported in the Carpathians [13,37,42] as well as in the Dinarids [35] and in Fennoscandia [31,32].

3.5.8. Ural Owl vs. White-Tailed Eagle and Golden Eagle

Single cases of Ural owls found in the food remains of eagles are reported by Mikkola [16] and Stój [18].

3.5.9. Ural Owl vs. Honey Buzzard

According to Solonen [31], both species compete for twig nests in Fennoscandia.

3.5.10. Ural Owl vs. Common Buzzard

There is only one report of a probable hunting attempt of the Ural owl toward a buzzard [43]. Moreover, these two species could compete for twig nests and common prey (rodents) [31].

3.5.11. Ural Owl vs. Sparrowhawk

According to Solonen [31], the Ural owl predated sparrowhawks.

3.5.12. Ural Owl vs. Goshawk

According to Solonen [31], both species compete for twig nests in Fennoscandia, and the same is known in southern Poland [44], as the Ural owl takes over unoccupied nests of goshawks. In Poland, competition for nests increases in fragmented forests with a deficiency of suitable nesting sites, whereas in extensive forests, both species are neutral to each other [45]. Ural owls and goshawks could compete for the same prey—the Siberian flying squirrel *Pteromys volans* [46,47] and boreal owls [41]. There are records of juvenile Ural owls being killed by goshawks [16], but also the Ural owl hunts juvenile goshawks [48]. These two species are known as similar keystone species for high biodiversity in boreal [25,26] and temperate forests [27].

4. Discussion

The Ural owl interacts with many other predatory species (Table 1, Figure 1). It is known to compete with or predate other nocturnal and diurnal raptors. It could be subordinate to the largest species, like the eagle owl and the golden eagle, or species of a similar size, like the goshawk and the great grey owl [16], but nearly all cases of Ural owls being killed concern its nestlings, not adults. The adult Ural owl is aggressive toward other raptors, which makes this species be avoided by other predators due to the risk of injuries.

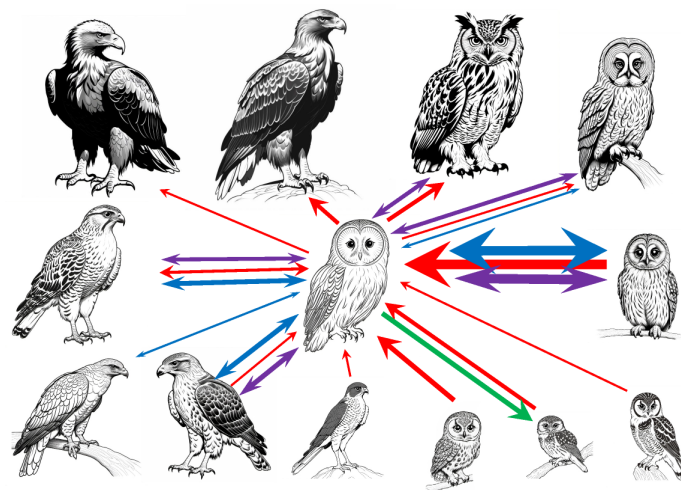


Figure 1. Schematic presentation of interspecific relations among Ural owls (central) and other owls and diurnal raptors in Europe according to the literature review. Red arrows—predation, blue arrows—competition for habitats/nest sites, violet arrows—competition for prey, and green arrows—protective effects. The direction of the arrow indicates dependency (an arrow toward a species means that it is the recipient). The width of the arrow corresponds to the frequency of interaction (a larger arrow means more frequent interaction or a higher “strength” of interaction). Owl and raptor images were generated in <https://openart.ai/> (accessed on 2 January 2025).

On the other hand, the Ural owl is a known predator for numerous other raptors, with a special emphasis on smaller owls like the tawny, boreal, and pygmy owls, as well raptors, e.g., sparrowhawks. The impact of the distribution of the Ural owl on tawny

owl populations is especially pronounced. The tawny owl is usually forced to move to small fragmented forests in lower altitudes in the case of the Carpathians and the Dinarides [10,13,33,37,38] or in lower latitudes in the case of Fennoscandia [22,31,32,39]. This shift is forced not only by competition for space and nest places but also by Ural owls directly hunting tawny owls. What is interesting is that this interaction could be beneficial for smaller owl species, particularly the boreal owl, that occupy Ural owl territories due to the territories being free of their main predator—the tawny owl. The Ural owl can hunt boreal owls, but the daytime activity of these two species only partially overlaps, and the boreal owl is likely not the preferred prey for the Ural owl. Contrary to that, pygmy owls seem to avoid Ural owl territories, so protective behaviour is not valid for this pair of species [12,13].

Moreover, the Ural owl is known to hunt diurnal raptors [16,31], which could limit their occurrence in owl territories. This could partially explain the high diversity of birds within Ural owl territories [25,26], as it is known that this species can act protectively for birds breeding in the neighbourhood [28,29]. The most pronounced interactions are between the Ural owl and the goshawk, as these two species express many commonalities (similar body mass and shape, similar flight and hunting modes, a generalism toward prey, and preferences toward old-growth forests). It seems that these two species rarely interact with each other, usually avoiding direct contact, which could be a risk for both of them. However, this avoidance is more temporal than spatial, as Ural owls and goshawks frequently occupy the same areas [45].

What is interesting is that the Ural owl interacts with mammalian predators, mostly by killing them (e.g., pine martens *Martes martes* [16,31], weasels *Mustela nivalis*, stoats *Mustela ermine* [47]) or by competing for tree cavities (e.g., racoons [49]).

The question is how the predation of Ural owls on small- and medium-sized bird and mammal predators influences their distribution in forests. Unfortunately, reports and publications on this matter are too scarce and restricted to detection in prey remains, which does not allow for the assessment of the impact of Ural owls on predator populations. The exception is only the known frequent predation of Ural owls on tawny owls, the consequences of which are already explained above. The known high biodiversity of birds within Ural owl territories could also be linked to protective associations; however, this is still speculative and requires further studies, which, however, could be extremely hard to perform, as they must rely on indirect evidence (e.g., the detection of prey remains in various predators present in the same area) and correlating said evidence with differences in biodiversity. This could be especially important considering the expansion of the Ural owl in Central Europe [17], which likely changes the associations of predators in forests as well as potentially impacting the general biodiversity, as was already reported in Poland [27].

5. Perspectives

The largest gap in the knowledge on the interactions of the Ural owl with other predators is that all the available data are from Europe, and there is nothing from its Asian populations, where most subspecies exist and other owl and raptor species can interact. This particularly concerns East Asia (Russia, China, Japan) and the central Asian mountains (Mongolia, Kazakhstan, and China, if considering the closely related Sichuan wood owl). It would also be interesting to examine the interactions in the reintroduced population in the Bohemian Forest [19]. Manipulating experiments (by hanging nest boxes without removing birds, as this would be difficult and unethical) [40] would also help in explaining some of the observed or unknown patterns like the protective behaviour of the Ural owl toward the boreal owl, niche displacement between the Ural owl and the tawny owl, or relations with goshawks.

The majority of the available studies on the Ural owl and other predator interactions are limited to field observations, limiting the records available and restricting conclusions. The incorporation of modern methods like remote recording and tracking or the genetic identification of individuals would facilitate studies on these interactions. The use of photo cameras would allow for the precise detection and recording of direct interactions like the killing of other animals (or being killed by other predators) [50]. Radio, satellite, or GSM tracking would allow for the precise determination of territory boundaries, which would help in understanding the spatial distribution of owls and diurnal reports as well as their prey [51]. The use of DNA barcoding facilitates the determination of species in prey remains [52], and the genotyping of individuals with the use of next-generation sequencing techniques [53] would allow for the precise determination of direct interactions among species. Additionally, advanced analytical tools [54] should be implemented to model and predict spatial and temporal interactions among predatory species.

In terms of the Ural owl's interactions with other species, the currently available information should be implemented in practical conservation actions and in the proper management of forest environments. The Ural owl is protected in Europe and in the majority of countries, although this protection does not always work well [55]. The Ural owl is being killed, on purpose or by accident, but the larger threat for this species is the loss of suitable habitat—old-growth forests in managed woods [45]. Considering that this species is known as a keystone for biodiversity in forests, the nesting sites of Ural owls should be protected by designing zones like those in the case of eagle owls and the rarest raptors in Europe. Even if the Ural owl is known to hunt other birds, its occurrence could limit other predators, both native, e.g., tawny owls, sparrowhawks, pine martens, weasels, and stoats [16,32,47,48], as well as invasive ones like raccoons [49]. In this way, it acts beneficially for the health of forest ecosystems and should be considered as a keystone species in the mountainous and boreal forests of Europe.

Funding: This research received no external funding.

Data Availability Statement: All source data in this study are available in the article.

Conflicts of Interest: The author declares no conflicts of interest.

References

1. Sergio, F.; Newton, I.; Marchesi, L. Top predators and biodiversity. *Nature* **2005**, *436*, 192. [[CrossRef](#)] [[PubMed](#)]
2. Berger, K.M.; Gese, E.M. Does interference competition with wolves limit the distribution and abundance of coyotes? *J. Anim. Ecol.* **2007**, *76*, 1075–1085. [[CrossRef](#)] [[PubMed](#)]
3. Chakarov, N.; Krüger, O. Mesopredator release by an emergent superpredator: A natural experiment of predation in a three level guild. *PLoS ONE* **2010**, *5*, e15229. [[CrossRef](#)]
4. Zuberogitia, I.; Marti'nez, J.A.; Zabala, J.; Marti'nez, J.E. Interspecific aggression and nest-site competition in a European owl community. *J. Raptor Res.* **2010**, *39*, 156–159.
5. Sergio, F.; Marchesi, L.; Pedrini, P.; Penteriani, V. Coexistence of a generalist owl with its intraguild predator: Distance-sensitive or habitat-mediated avoidance? *Anim. Behav.* **2007**, *74*, 1607–1616. [[CrossRef](#)]
6. Khalil, H.; Pasanen-Mortensen, M.; Elmhagen, B. The relationship between wolverine and larger predators, lynx and wolf, in a historical ecosystem context. *Oecologia* **2014**, *175*, 625–637. [[CrossRef](#)]
7. Sarasola, J.H.; Grande, J.M.; Negro, J.J. (Eds.) *Birds of Prey Biology and Conservation in the XXI Century*; Springer: Berlin/Heidelberg, Germany, 2018.
8. Brambilla, M.; Bassi, E.; Ceci, C.; Rubolini, D. Environmental factors affecting patterns of distribution. *Ibis* **2010**, *152*, 310–322. [[CrossRef](#)]
9. Vrh, P.; Vrezec, A. Interspecific territorial vocal activity of the Ural Owl (*Strix uralensis*) towards Tawny Owl (*Strix aluco*), sympatric owl competitor: A playback experiment. *Razpr. Razreda SAZU* **2007**, *47*, 99–105.
10. Kajtoch, Ł.; Żmihorski, M.; Wieczorek, P. Habitat displacement effect between two competing owl species in fragmented forests. *Popul. Ecol.* **2015**, *57*, 517–527. [[CrossRef](#)]

11. Vrezec, A.; Tome, D. Altitudinal segregation between Ural owl *Strix uralensis* and tawny owl *Strix aluco*: Evidence for competitive exclusion in raptorial birds. *Bird Study* **2004**, *51*, 264–269. [\[CrossRef\]](#)
12. Vrezec, A.; Tome, D. Habitat selection and patterns of distribution in a hierarchic forest owl guild. *Ornis Fenn.* **2004**, *81*, 109–118.
13. Kajtoch, Ł.; Matyssek, M.; Figarski, T. Spatio-temporal patterns of owl territories in fragmented forests are affected by a top predator (Ural owl). *Ann. Zool. Fenn.* **2016**, *53*, 165–174. [\[CrossRef\]](#)
14. Lindström, E.R.; Brainerd, S.M.; Helldin, J.O.; Overskaug, K. Pine marten—Red fox interactions: A case of intraguild predation? *Ann. Zool. Fenn.* **1995**, *32*, 123–130.
15. Kostrzewa, A. Interspecific interference competition in three European raptor species. *Ethol. Ecol. Evol.* **1991**, *3*, 127–143. [\[CrossRef\]](#)
16. Mikkola, H. *Owls of Europe*; Poyser: Calton, UK, 1983.
17. Billerman, S.M.; Keeney, B.K.; Rodewald, P.G.; Schulenberg, T.S. *Birds of the World*; Cornell Laboratory of Ornithology: Ithaca, NY, USA, 2022.
18. Stój, M.; Kruszyk, R.; Zawadzka, D.; Zawadzki, G. Habitat Impacts on the Golden Eagle's Foraging Ecology and Nest Site Selection in Poland. *Diversity* **2024**, *16*, 123. [\[CrossRef\]](#)
19. Scherzinger, W. Die Wiederbegründung des Habichtskauz-Vorkommens *Strix uralensis* im Böhmerwald. *Ornithol. Anz.* **2006**, *45*, 97–156.
20. Scherzinger, W.; Fang, J.; Sun, Y.H.; Klaus, S. Revised description of Pere David's Owl *Strix davidi* based on field observations in Central China. *Ornithol. Anz.* **2014**, *53*, 54–93.
21. Lahti, E. Nest sites and nesting habitats of the Ural Owl *Strix uralensis* in Finland during the period 1870–1969. *Ornis Fenn.* **1972**, *49*, 91–97.
22. Lundberg, A. Why are the Ural Owl *Strix uralensis* and the Tawny Owl *Strix aluco* parapatric in Scandinavia. *Ornis Scandinavica* **1980**, *11*, 116–120. [\[CrossRef\]](#)
23. Mihelič, T.; Vrezec, A.; Perušek, M.; Svetličič, J. Ural Owl *Strix uralensis* in Slovenia. *Acrocephalus* **2000**, *21*, 9–22.
24. Bylicka, M.; Kajtoch, Ł.; Figarski, T. Habitat and landscape characteristics affecting the occurrence of Ural Owl *Strix uralensis* in agroforestry mosaic. *Acta Ornithol.* **2010**, *45*, 33–42. [\[CrossRef\]](#)
25. Burgas, D.; Juutinen, A.; Byholm, P. The cost effectiveness of using raptor nest sites to identify areas with high species richness of other taxa. *Ecol. Indic.* **2016**, *70*, 518–530. [\[CrossRef\]](#)
26. Burgas, D.; Byholm, P.; Parkkima, T. Raptors as surrogates of biodiversity along a landscape gradient. *J. Appl. Ecol.* **2014**, *51*, 786–794. [\[CrossRef\]](#)
27. Kajtoch, Ł.; Kusal, B. The long-lasting territories of forest apex predators sustain diverse bird communities throughout the year. *Forests* **2022**, *13*, 2128. [\[CrossRef\]](#)
28. Halme, P.; Häkkinen, M.; Koskela, E. Do breeding Ural owls *Strix uralensis* protect ground nests of birds?: An experiment using dummy nests. *Wildl. Biol.* **2004**, *10*, 145–148. [\[CrossRef\]](#)
29. Morosinotto, C.; Thomson, R.L.; Hänninen, M.; Korpimäki, E. Higher nest predation risk in association with a top predator: Mesopredator attraction? *Oecologia* **2012**, *170*, 507–515. [\[CrossRef\]](#)
30. Korpimäki, E. Composition of the owl communities in four areas in western Finland: Importance of habitats and interspecific competition. *Proc. Fifth Nord. Ornithol. Congress* **1987**, *14*, 118–123.
31. Solonen, T. Spacing of birds of prey in southern Finland. *Ornis Fenn.* **1993**, *70*, 129–143.
32. Korpimäki, E. Niche relationships and life-history tactics of three sympatric *Strix* owl species in Finland. *Ornis Scand.* **1986**, *17*, 126–132. [\[CrossRef\]](#)
33. Ambrozic, S. Owls of Trnovski gozd (SW Slovenia): Their density, altitudinal distribution and interspecific relationship. *Acrocephalus* **2002**, *23*, 113–114.
34. Vrezec, A. Breeding density and altitudinal distribution of the Ural, tawny, and boreal owls in North Dinaric Alps (Central Slovenia). *J. Raptor Res.* **2003**, *37*, 55–62.
35. Brambilla, M.; Scridel, D.; Bazzi, G.; Ilahiane, L.; Iemma, A.; Pedrini, P.; Bassi, E.; Bionda, R.; Marchesi, L.; Genero, F.; et al. Species interactions and climate change: How the disruption of species co-occurrence will impact on an avian forest guild. *Glob. Chang. Biology* **2020**, *26*, 1212–1224. [\[CrossRef\]](#) [\[PubMed\]](#)
36. Andreychev, A. Vocal interaction between Tawny Owl (*Strix aluco*) and Ural Owl (*Strix uralensis*) in the Middle Volga. *E3S Web Conf.* **2024**, *510*, 03011. [\[CrossRef\]](#)
37. Bolboacă, L.E.; Baltag, E.S.; Pocora, V.; Ion, C. Habitat selectivity of sympatric Tawny Owl (*Strix aluco*) and Ural Owl (*Strix uralensis*) in hill forests from north-eastern Romania. *Analele Stiintifice Ale Univ. "Al. I. Cuza" Din Iasi Sect. Biol. Anim.* **2013**, *59*, 69–76.
38. Šotnár, K.; Obuch, J.; Pačnovský, S.; Jarčuška, B. Spatial distribution of four sympatric owl species in Carpathian montane forests. *Raptor J.* **2020**, *14*, 1–13. [\[CrossRef\]](#)

39. Pavón-Jordán, D.; Karell, P.; Ahola, K.; Kolunen, H.; Pietiäinen, H.; Karstinen, T.; Brommer, J.E. Environmental correlates of annual survival differ between two ecologically similar and congeneric owls. *Ibis* **2013**, *155*, 823–834. [\[CrossRef\]](#)
40. Hakkarainen, H.; Korpimäki, E. Competitive and predatory interactions among raptors: An observational and experimental study. *Ecology* **1996**, *77*, 1134–1142. [\[CrossRef\]](#)
41. Kouba, M.; Bartoš, L.; Tulis, F.; Ševčík, M.; Sovadinová, S.; Bušina, T.; Janouš, M.; Kouba, P.; Bartošová, J.; Hongisto, K.; et al. Post-fledging survival of Tengmalm's owl offspring in boreal forests: Interactive effects of varying dynamics of main prey and habitat composition. *Front. Ecol. Evol.* **2023**, *11*, 1151622. [\[CrossRef\]](#)
42. Pačenovský, S.; Šotnár, K. Notes on the reproduction, breeding biology and ethology of the Eurasian pygmy owl (*Glaucidium passerinum*) in Slovakia. *Raptor Res.* **2010**, *4*, 49–81. [\[CrossRef\]](#)
43. Byshnev, I.I. Interesting case of aggressive interaction between common buzzard (*Buteo buteo*) and Ural owl (*Strix uralensis*). *Subbuteo* **2002**, *1*, 1.
44. Czuchnowski, R. Ecology of the Ural owl *Strix uralensis* in the Niepołomice Forest. *Remiz* **1993**, *2*, 7–12.
45. Fedyń, I.; Grzędzicka, E.; Wiehle, D.; Kajtoch, Ł. The co-occurrence of Ural Owl and Northern Goshawk differs between extensive and fragmented forests. *Bird Study* **2021**, *68*, 267–278. [\[CrossRef\]](#)
46. Byholm, P.; Burgas, D.; Virtanen, T.; Valkama, J. Competitive exclusion within the predator community influences the distribution of a threatened prey species. *Ecology* **2012**, *93*, 1802–1808. [\[CrossRef\]](#) [\[PubMed\]](#)
47. Korpimäki, E.; Sulkava, S. Diet and breeding performance of Ural Owls *Strix uralensis* under fluctuating food conditions. *Ornis Fenn.* **1987**, *64*, 57–66.
48. Andreychev, A.; Lapshin, A. Quantitative and qualitative composition of diet of the Ural Owl, *Strix uralensis* (Strigidae, Strigiformes), in the central part of European Russia (the example of the Republic of Mordovia). *Vestn. Zool.* **2017**, *51*, 421–428. [\[CrossRef\]](#)
49. Kobayashi, F.; Toyama, M.; Koizumi, I. Potential resource competition between an invasive mammal and native birds: Overlap in tree cavity preferences of feral raccoons and Ural owls. *Biol. Invasions* **2014**, *16*, 1453–1464. [\[CrossRef\]](#)
50. Reif, V.; Tornberg, R. Using time-lapse digital video recording for a nesting study of birds of prey. *Eur. J. Wildl. Res.* **2006**, *52*, 251–258. [\[CrossRef\]](#)
51. Washburn, B.E.; Maher, D.; Beckerman, S.F.; Majumdar, S.; Pullins, C.K.; Guerrant, T.L. Monitoring Raptor Movements with Satellite Telemetry and Avian Radar Systems: An Evaluation for Synchronicity. *Remote Sens.* **2022**, *14*, 2658. [\[CrossRef\]](#)
52. Bourbour, R.P.; Martinico, B.L.; Crane, M.M.; Hull, A.C.; Hull, J.M. Messy eaters: Swabbing prey DNA from the exterior of inconspicuous predators when foraging cannot be observed. *Ecol. Evol.* **2019**, *9*, 1452–1457. [\[CrossRef\]](#)
53. Kraus, R.H.S.; Wink, M. Avian genomics: Fledging into the wild! *J. Ornithol.* **2015**, *156*, 851–865. [\[CrossRef\]](#)
54. La Sorte, F.A.; Lepczyk, C.A.; Burnett, J.L.; Hurlbert, A.H.; Tingley, M.W.; Zuckerberg, B. Opportunities and challenges for big data ornithology. *Condor* **2018**, *120*, 414–426. [\[CrossRef\]](#)
55. Burfield, I.J. The Conservation Status and Trends of Raptors and Owls in Europe. *AMBIO A J. Hum. Environ.* **2008**, *37*, 401–407. [\[CrossRef\]](#)

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.