

# Predation of Sympatric Owl Species by Eurasian Eagle Owls

Ezra Hadad<sup>1</sup> and Reuven Yosef<sup>2,\*</sup> <sup>1</sup> Israel Nature and Parks Authority, 3 Am Ve'Olam Street, Jerusalem 95463, Israel; ezra.hadad9@gmail.com<sup>2</sup> Eilat Campus, Ben Gurion University of the Negev, P.O. Box 272, Eilat 881020, Israel

\* Correspondence: ryosef60@gmail.com

**Simple Summary:** This study investigates intraguild predation among owl species in the Judea Region, focusing specifically on Eurasian Eagle Owls as the predator. The findings indicate that Eagle Owls consistently prey on Barn, Long-eared, Little, and Scops owls (N = 172). This predatory behavior not only affects the targeted species but could also have broader implications for the ecosystem, potentially disrupting food chains and altering habitat balances. Our study aligns with previous studies of predation by the largest of the owl species and emphasizes the need for future research to assess the long-term impacts of such interactions on owl populations over time. It suggests that understanding these dynamics is vital for conservation efforts. Additionally, our research calls for exploring and implementing effective conservation strategies aimed at supporting smaller diurnal and nocturnal raptors. In environments where larger apex nocturnal predators, like Eagle Owls, dominate, it becomes crucial to ensure the survival and stability of smaller raptor species. By addressing these issues, we can contribute to the preservation of biodiversity and ecological balance in the region.

**Abstract:** Our study investigates predation among sympatric owl species in the Judea Region, specifically focusing on the predation by Eurasian Eagle Owls (*Bubo bubo*) on smaller owl species. Field observations conducted between 2006 and 2009 revealed recurrent predation events, with 172 individuals documented as preyed upon by Eurasian Eagle Owls. These results align with previous studies, demonstrating the role of larger owl species as intraguild predators that affect the survival and reproduction of smaller owls. Our findings emphasize the need for further research on intraguild predation and its ecological consequences. This study contributes to a broader understanding of the complex interactions within nocturnal raptor communities and underscores the importance of incorporating such dynamics into conservation strategies to safeguard owl biodiversity in fragmented landscapes.

**Keywords:** predator–prey dynamics; species competition; owl species



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## 1. Introduction

Research on sympatric raptors primarily focuses on diet, feeding ecology, trophic structure [1–5], niche overlap [6,7], spatial distribution [8], prey selection [9,10], and home range and habitat selection [11]. Intraguild predation influences population dynamics, persistence, and habitat use [12–15]. This intraguild competition for resources typically results in the predation of sympatric diurnal and nocturnal raptors and predatory Passerine species [12,15,16]. For example, Great Horned Owls (*Bubo virginianus*) are known to affect smaller nocturnal raptors in North America [17], Barn Owls (*Tyto alba*) kill broods of Tawny Owls (*Strix aluco*) in nest box colonies [18], and Little Owls (*Athene noctua*) target Southern

Grey Shrikes (*Lanius meridionalis*) [19]. However, intraguild predation remains little studied, and its subtle but complex species-specific effects on the prey populations are unclear [12].

Larger owls often have a broader dietary breadth, but taxon specialization significantly shapes diet composition [20]. Intraguild predation, where one species preys on another within the same trophic guild, can impact survival, distribution, and reproductive success [21–23]. This is particularly relevant for smaller owl species, which may experience competition and predation pressure from larger, dominant owls [21,22].

Lourenço et al. [24] introduced the concept of superpredation, a phenomenon where apex predators prey upon other predators. While not a primary food source, superpredation may serve as a strategy for diet diversification, particularly when primary prey availability declines [25]. Its occurrence is often influenced by habitat heterogeneity. It is associated with reduced breeding success, supporting the food stress hypothesis [26], which links prey scarcity to increased intraguild predation and its negative effects on reproduction.

The Judea Region of central Israel provides an ideal setting to study intraguild predation among sympatric owls, including the Eurasian Eagle Owl (*Bubo bubo*) and the other owl species that nest in proximity. Understanding these interactions may offer profound insights into the regulation of owl populations and the broader implications of predator–prey dynamics in sympatric ecosystems [27].

By analyzing intraguild predation in the Judea Region, this research contributes significantly to understanding how interspecific interactions shape nocturnal raptor ecology and population dynamics. It highlights the potential benefits of considering competition for resources and direct predation as critical factors influencing the survival and persistence of sympatric owl species.

## 2. Methods

The study was conducted over a 2644 km<sup>2</sup> area in the Judea region of Israel during four consecutive breeding seasons from 2006 to 2009. The landscape, which comprises a mix of natural habitats, including steppe and grasslands, interspersed with agricultural areas such as crop fields, vineyards, and carob groves, also contains human settlements and planted pine forests [27,28].

EH surveyed the study site weekly from March to July each year to identify Eurasian Eagle Owl territories. During the study, 201 active nest sites were identified; with pellet and prey remains collected from each nest that was visited 5–8 times per season [28].

A total of 14 nests were monitored for prey analysis, which resulted in the collection of pellets and prey remains from 43 nesting attempts (Figure 1). We sampled 10 nests in 2006 and 11 each in 2007, 2008, and 2009. At each visit, all signs and remains of predated prey were removed to evaluate the prey in subsequent visits [28].

Pellets and prey remains were collected to minimize potential bias toward small or large prey items [29,30]. Prey was identified based on published data [31,32], while avian prey identification followed [33].

Eurasian Eagle Owls predate on other owl species, including the Barn Owl, Long-eared Owl (*Asio otus*), Little Owl, and Eurasian Scops Owl (*Otus scops*).

Evidence of predation was identified discovering owl remains, such as feathers, bones, and skulls, in or near the nests of Eurasian Eagle Owls (Figures 2a,b and 3). In some cases, predation was also evident in the pellets of the Eagle Owls (see [27]). In each group of prey remains and pellets, we collectively evaluated the remains (wings, legs, body parts) and compared these to the feathers and bones in the pellets to count the total number of prey in the collected sample.



**Figure 1.** An Eagle Owl (*Bubo bubo*) parent at the nest with the carcass of a Cape Hare (*Lepus capensis*) in its talons and the remains of a Common Kestrel (*Falco tinnunculus*) behind the three nestlings. Photo: Ezra Hadad.

Basic descriptive statistics, including mean, standard deviation (SD), and percentage of total predation, were calculated for each species. These metrics provided an overview of predation frequencies and interannual variation.



(a)

**Figure 2.** Cont.



(b)

**Figure 2.** (a). Remains of predated Barn Owls (*Tyto alba*). (b). Remains of predated of Eurasian Scops Owls (*Otus scops*; grayish wings) and of Little Owl (*Athene noctua*; brown-and-white wings) found at Eagle Owl nests (*Bubo bubo*). Scale is 1 cm for each black or white square. Photos: Ezra Hadad.

A Chi-square test for independence was performed to determine whether the distribution of predation events varied significantly across years. This test assessed whether fluctuations in predation rates were due to random variation or underlying ecological factors. The results of this test provide insights into the stability and consistency of the Eurasian Eagle Owl's predation patterns over the four-year period.

$$\chi^2 = \frac{\sum E(O - E)^2}{E}$$

where O represents observed frequencies, and E represents expected frequencies, assuming an even distribution across years. We used a statistical significance threshold of  $p < 0.05$  to determine significance.

To evaluate the diversity of predation events across prey species, the Shannon–Wiener diversity index [34] was calculated.

$$H' = -\sum p_i \ln p_i$$

where  $p_i$  is the proportion of predation events for species  $i$ . Higher  $H'$  values indicate greater diversity in prey selection, while lower values suggest a preference for specific species.

To assess evenness in predation across species, Simpson's Index [35] was calculated.

$$D = 1 - \sum p_i^2$$

where  $p_i$  represents the proportion of predation events for each species. Values closer to 1 indicate more even predation across species, while values closer to 0 suggest dominance by one or two species.

All statistical analyses were conducted using R software (version 4.2.0) [36].

### 3. Results

A total of 172 prey predated by Eurasian Eagle Owls on other owl species were recorded from 2006 to 2009. The most frequently predated species were Barn Owl (41.3%) and Long-eared Owl (38.4%), while Eurasian Scops Owl (11.0%) and Little Owl (9.3%) were predated at lower frequencies (Table 1).

**Table 1.** The remains of the number of individuals of the four prey species found over the study period at the 14 Eagle Owl nests. KMQ denotes Kfar Menachem Quarry; BG—Bet Guvrin Nature Reserve; KRQ—Khavat Royim Quarry; NQ—Nahala Quarry; ND—Nahal Dolev; NT—Nahal Tzafit; NZ—Nahal Zanuach; NA—Nahal Adorayim; KB—Khurbat Beten; GQ—Gaya Quarry; TZ—Tzora; JQ—Julis Quarry; GA—Galon; TI—Tel Iton.

|              |                      | KMQ  | BGQ | KRQ  | NQ  | ND  | NZ  | NT  | NA  | KB   | GQ  | TZ  | JQ   | GA  | TI  | Totals |
|--------------|----------------------|------|-----|------|-----|-----|-----|-----|-----|------|-----|-----|------|-----|-----|--------|
| 2006         | <i>Tyto alba</i>     | 4    | 2   | 1    | 1   | 1   | 1   | 1   | 2   | 3    | 5   |     |      |     |     | 21     |
|              | <i>Asio otus</i>     | 2    |     | 2    | 1   |     |     | 1   |     | 3    | 2   |     |      |     |     | 11     |
|              | <i>Athene noctua</i> | 2    |     |      | 2   |     | 1   | 1   | 1   |      |     |     |      |     |     | 7      |
|              | <i>Otus scops</i>    |      |     | 1    |     | 1   |     |     | 1   | 1    |     |     |      |     |     | 4      |
| 2007         | <i>Tyto alba</i>     | 2    | 1   | 2    |     |     |     | 2   | 1   | 2    | 1   | 1   | 6    | 1   |     | 19     |
|              | <i>Asio otus</i>     | 1    |     | 3    |     |     |     | 2   |     |      | 2   |     | 5    | 3   |     | 16     |
|              | <i>Athene noctua</i> |      |     |      |     |     |     |     |     | 1    |     |     |      | 1   |     | 2      |
|              | <i>Otus scops</i>    |      |     | 1    |     |     |     | 1   | 1   | 1    |     |     |      | 1   |     | 5      |
| 2008         | <i>Tyto alba</i>     | 2    | 2   | 2    |     |     |     |     |     | 2    | 1   |     | 2    | 2   | 2   | 15     |
|              | <i>Asio otus</i>     | 6    | 2   | 3    |     |     |     |     | 2   |      | 2   |     | 8    |     | 2   | 25     |
|              | <i>Athene noctua</i> |      |     |      |     |     |     |     |     | 2    |     |     |      |     | 2   | 4      |
|              | <i>Otus scops</i>    | 2    | 1   | 2    |     |     |     |     |     | 2    |     |     |      | 1   |     | 8      |
| 2009         | <i>Tyto alba</i>     | 2    | 1   | 2    |     |     |     | 2   |     | 2    | 1   | 2   | 1    | 2   | 1   | 16     |
|              | <i>Asio otus</i>     | 5    |     | 2    |     |     |     | 2   |     | 2    |     |     | 1    | 1   | 1   | 14     |
|              | <i>Athene noctua</i> | 2    |     |      |     |     |     |     |     | 1    |     |     |      |     |     | 3      |
|              | <i>Otus scops</i>    |      |     | 1    |     |     |     |     |     | 1    |     |     |      |     |     | 2      |
| <b>Total</b> |                      | 32   | 10  | 24   | 4   | 2   | 2   | 13  | 11  | 23   | 15  | 3   | 25   | 13  | 9   | 172    |
| <b>%</b>     |                      | 18.5 | 5.7 | 13.8 | 2.1 | 1.1 | 1.1 | 7.5 | 6.3 | 13.3 | 8.6 | 1.6 | 14.4 | 7.5 | 5.1 |        |

We studied 14 quarries, 10 in 2006, and included 4 others in the other years, to document predation by Eurasian Eagle Owls on other owl species. Owl remains were discovered in the nests of all the Eagle Owls at these sites, indicating predation across multiple years.

Predation on Barn Owls ranged from 15 to 21 per year (mean  $17.75 \pm 2.75$ ; 41.3%), while those on Long-eared Owl showed more significant fluctuation, with a peak in 2008 (25 cases) and a minimum in 2006 (11 cases) (mean  $16.50 \pm 6.03$ ; 38.4%). Predation on Eurasian Scops Owl ( $4.75 \pm 2.50$ ) and Little Owl ( $4.00 \pm 2.16$ ; 9.3%) remained relatively low and stable across years. A Chi-square test ( $\chi^2 = 11.28$ ,  $p = 0.257$ ) indicated no statistically significant variation in predation rates over time, suggesting that the predation pattern remained consistent across years.

The Shannon–Wiener diversity index ( $H' = 1.20$ ) indicates a moderate level of diversity in owl prey selection, meaning that while all four owl species were targeted, certain species (Barn Owl, Long-eared Owl) were preferred (Figure 3). The Simpson's Index ( $D = 0.66$ ) further suggests a relatively even distribution of predation events, without extreme dominance of a single species.

The owl species affected by predation included Barn Owls, Long-eared Owls, Little Owls, and Scops Owls (Figure 2a,b). The predation events varied, with the highest number of preyed-upon individuals observed in 2006 and 2009.

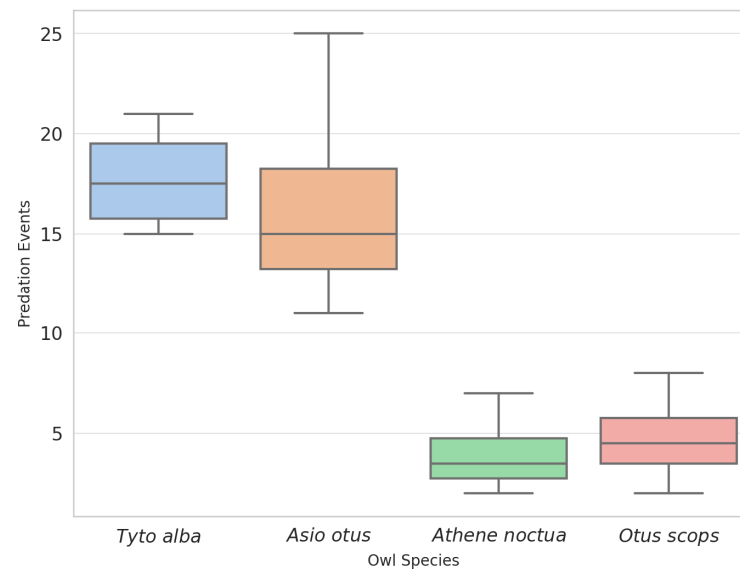


**Figure 3.** Distribution of predation events by Eurasian Eagle Owls on sympatric owl species.

#### 4. Discussion

Our findings indicate that Eurasian Eagle Owls regularly prey on other owl species in the Judea Region, with Barn Owl and Long-eared Owl being the most frequently consumed prey. Over the four-year study period, these species accounted for 71 (41.3%) and 66 (38.4%) predation events, respectively, suggesting they are either preferred or more readily available. In contrast, Little Owl and Eurasian Scops Owl were preyed at lower frequencies (16 and 19 events, respectively), possibly due to lower encounter rates or reduced susceptibility. These findings align with previous studies on intraguild predation among owls wherein the largest owl species preys upon the smaller owl species [15,37,38]. Sergio and Hiraldo [12] found that intraguild predation was more widespread than understood in the scientific literature. The phenomenon was size-based, i.e., the larger species preying upon the smaller ones.

Chi-square analysis showed no significant variation in predation rates across years, indicating a stable pattern. However, increased predation on Long-eared Owls in 2008 (25 cases) may reflect an increase in the species' populations [39], fluctuations in prey populations, seasonal availability, or habitat use. This underscores the need for further research to determine the underlying drivers of these variations. One must also consider the fact that nest boxes for Barn Owls were erected over the years to serve as biological controls of rodents in the agricultural fields [40] and may have contributed to their relative abundance in the diet of the Eagle Owls than would have occurred naturally in the diet.

Shannon–Wiener and Simpson's Diversity Indices point to a moderate dietary diversity, with Barn Owls and Long-eared Owls being disproportionately targeted. This is likely due to their size, behavior, and habitat overlap with Eagle Owls. These findings align with previous research showing that larger owls, due to their broad dietary preferences [41], can suppress populations of smaller raptors [12,42].

The phenomenon of intraguild predation carries significant ecological implications, influencing prey behavior, distribution, and population dynamics. High predation pressure on Barn Owls and Long-eared Owls may alter small vertebrate populations and increase competition among nocturnal raptors [12,43]. Previous studies have shown that larger raptors tend to dominate resource-rich habitats, potentially intensifying competition [5,8].

Comparing owl consumption percentages in the Eagle Owl's diet [27] further supports this conclusion. Other owl species comprised only 1.82% of all identified prey at nests, with Barn Owls at 0.75%, Long-eared Owls at 0.7%, Eurasian Scops Owls at 0.2%, and

Little Owls at 0.17%. This suggests that while intraguild predation occurs, owls are not a primary prey source, though predation is consistent. Similarly, neither were diurnal raptors a significant part of the Eagle Owls' diet and comprised only 0.9%. This suggests that the intraguild predation we report here may be opportunistic and not a strategy by the Eagle Owls to enhance their fitness levels. Future studies should attempt to elucidate the population-level effects of this intraguild predation on territory occupancy, breeding success, and the persistence of the prey species in the study area [12].

As human activities alter landscapes [28] and facilitate human commensals to increase [39], the spatial overlap between Eagle Owls and their prey may increase, exacerbating intraguild predation risks. Continued attempts at the biological control of rodents with Barn Owls and the recent re-colonization and increase in urban and suburban populations of breeding Long-eared Owls [39] will probably continue to contribute to the intraguild predation in the Judea Region. Conservation strategies should minimize habitat overlap between large and small raptors while ensuring adequate prey availability to mitigate predation impacts [12,44].

## 5. Conclusions

In conclusion, our study highlights the intraguild predation in owl species in the Judea Region. The consistent predation of Barn Owls and Long-eared Owls suggests significant ecological consequences. Future research should examine long-term impacts on owl populations. It is imperative that we explore and implement conservation strategies to support smaller diurnal and nocturnal raptors in landscapes dominated by larger apex nocturnal predators.

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