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Urbanization and Predators: A Systematic Review of the Multifaceted Impacts on Predation Dynamics

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Abstract: Urbanization dramatically alters ecosystems, particularly predator-prey dynamics, through human activities, habitat modification and changes to food webs. This systematic review synthesizes current research on how urbanization influences predation success across taxa and ecological contexts. Studies are categorized into three groups: negative, positive, and context-dependent effects. The research studies identified several critical research gaps, including inconsistent methodologies (lack of standardized sampling protocols and variable monitoring duration) and limited long-term data. Standardized research methods and ecologically informed urban planning are essential to understanding how urbanization shapes predator behavior—an understanding critical for maintaining biodiversity, restoring food webs, and fostering sustainable human-wildlife coexistence.

Keywords: Urbanization; Predator-Prey Dynamics; Urban Ecosystems; Trophic Interactions; Anthropogenic Impacts.

1. Introduction

Urbanization—the transformation of rural areas into urban centers—disrupts landscapes and ecological systems, contributing to habitat loss, fragmentation, pollution, and biodiversity decline. As global urbanization accelerates, its effects on living conditions, including the displacement of native species and alterations to air and water cycles, soil function, and nutrient flows, become increasingly pronounced. Balancing development with environmental sustainability is therefore an urgent global challenge.

Urban ecosystems have become central to ecological research due to their significant influence in animal migration, nesting, and predation patterns. Predation plays a critical role in energy transfer, nutrient cycling, and the regulation of population dynamics, as exemplified by the trophic cascades following apex predator declines, such as the Yellowstone wolf reintroduction effects [3]. In urban environments, however, predator-prey relationships are often disrupted, posing risks to biodiversity and ecosystem health. Predators, which serve both as indicators of ecosystem health and natural pest controllers, may experience reduced effectiveness in urban settings, where their influence on prey populations is often diminished [21].

Despite increasing research, the effects of urbanization on predator-prey interactions remain unclear, with contradictory findings across studies. A notable gap in research is the lack of a comprehensive analysis of the impact of urbanization on predators. Urban areas, with their diverse microhabitats—ranging from parks and gardens to densely built environments, offer unique challenges and opportunities for predators, particularly regarding prey availability and hiding places. While some studies suggest that mesopredators dominate nest depredation in urban settings, others indicate that raptors and small birds are more common in rural areas [20]. Inconsistent methodologies and study subjects have contributed to fragmented results.

This review addresses this gap by systematically categorizing existing studies into three distinct outcome types—positive, negative, and mixed effects—thereby offering a clearer understanding of the impact of urbanization on predation dynamics and informing future strategies for urban wildlife management and conservation.

2. Effects of Urbanization on Predation

2.1. Negative Effects

Urbanization introduces several environmental changes that disrupt traditional predator-prey dynamics, often impairing predation success [21]. Key factors include: (1) human population density, (2) anthropogenic activity, (3) top-down control and bottom-up forcing, (4) artificial food availability, and (5) vegetation structure.

2.1.1. Human Population Density

Higher human density correlates with increased anthropogenic mortality and reduced prey diversity. Recent studies demonstrate that human-related deaths were found to reduce both prey abundance and diversity in mammalian predators [13]. Similarly, higher human population density led to declines in large predatory fish and a dominance of smaller-bodied prey [25]. Moreover, anthropogenic activity—including urban construction, artificial light, and traffic—disrupts predation efficiency. [13] found that such factors reduced predation rates by birds and arthropods, supported by [17], reporting that birds attacked caterpillars less frequently in areas with extensive built cover. These results indicate that increased human presence negatively impacts predator-prey interactions, weakens predator effectiveness across birds, mammals, and invertebrates, emphasizing the need to incorporate wildlife considerations into urban design and planning.

Top-down control and bottom-up forcing are also critical components in understanding ecological responses to urbanization. Urbanization often leads to an increase in predator numbers but a reduction in predation rates, driven by weakened top-down control-where predators exert less regulatory pressure on prey, and intensified bottom-up forcing, in which changes in resource availability, such as food or habitat, become the dominant ecosystem dynamics drivers. For instance, [11] demonstrated that urbanization weakened predator impact, likely due to increased access to anthropogenic food sources such as human waste, which reduced reliance on natural prey. Similarly, [9] observed comparable patterns in insect communities within agricultural landscapes, suggesting that urbanization-induced declines in predation span multiple taxa and reflect broader ecosystem-level shifts.

Artificial Food Sources further complicate predator-prey dynamics. [11] described a "predation paradox," where predator populations increase, yet attacks on natural prey decrease. This paradox is further elucidated by study [14], which demonstrates that urban predators increasingly incorporate anthropogenic food—such as human waste—into their diets. This dietary shift reduces predation pressure on native prey, disrupts natural trophic dynamics, and intensifies competition among predators. Moreover, these changes may have cascading effects on co-occurring species by intensifying interspecific competition, potentially leading to ecological imbalance or species decline. Together, these studies highlight the extensive influence of artificial food sources on urban ecosystem structure and function.

Habitat and vegetation structure also shape predation outcomes. While urban areas often exhibit greater structural complexity in vegetation compared to natural habitats [18], this complexity offers more refuges for prey and hinder predator foraging. Habitat fragmentation further restricts predator mobility and hunting efficiency. Supporting this, [19] showed that increased vegetation in urban gardens reduced vertebrate predation on caterpillars. Despite focusing on different predator groups—arthropods and vertebrates respectively—both studies highlighted how urban habitat features weaken predator-prey interactions.

In summary, current research reveals that urbanization reduces predation success through a combination of increased human disturbance, altered food availability, and habitat modification. These changes weaken top-down ecological control and shift trophic dynamics, ultimately threatening biodiversity and ecosystem balance. Addressing these challenges requires integrated management strategies that support functional predator-prey relationships in urban ecosystems. Key strategies focus on preserving natural foraging behaviors, maintaining habitat connectivity, and managing anthropogenic food sources that disrupt predator-prey dynamics.

2.2. Positive Effects

While urbanization often disrupts predator-prey interactions, it can also create positive ecological outcomes for predators [20]; [1]; [2]; [28]; [15]. These benefits arise from increased access to anthropogenic food, artificial shelter, changes in vegetation, and reduced competition from apex predators.

2.2.1. Anthropogenic Food Sources

Urban ecosystems provide abundant, energy-rich anthropogenic food resources that support predator persistence. [20] reported that urban predators—including mesopredators, corvids, raptors, small birds, mammals, and snakes—adapt their foraging strategies in response to these human-derived resources. These shifts often reduce predation pressure on native prey but support predator persistence by offering stable, energy-rich alternatives. [1] further showed that medium-sized carnivores, such as raccoons and red foxes, benefit from food subsidies, often leads to increased population densities and greater predation success. However, disadvantages could also arise; [11] and [14] report that reliance on anthropogenic foods may reduce natural predation, introducing a paradox where urbanization supports predator survival and weakens ecological regulation simultaneously. This tension is explored further in the discussion.

2.2.2. Artificial Shelter and Habitat

Urban infrastructure provides novel shelter and breeding opportunities, enhancing predator survival. [1] noted that buildings, sewers, and other structures facilitate higher predator densities in cities compared to natural areas. [28] observed higher predation rates in artificial nests within urban settings, indicating elevated predator efficiency. Similarly, [24] shows that energy-efficient shelters enable year-round breeding for species like urban foxes and raccoons, increasing predation pressure. Coyotes also use railway corridors as concealed travel and hunting routes, as shown by [26]. Even raptors benefit from urban infrastructure: [6] find that they hunt more efficiently from elevated perches like poles and rooftops. These findings highlight the broad utility of urban structures for predator species across ecological roles and also emphasize the need for wildlife-inclusive urban design that balances predator conservation with ecosystem function.

2.2.3. Changes in Vegetation

Urbanization-induced vegetation shifts also enhance predator success. [2] report that exotic shrubs improve nest detection by mammalian predators, while [7] shows that short grass cover in urban areas facilitates robins foraging. Likewise, [23] reveals that simplified urban habitats promote wolf spider abundance and insect predation. Similarly, [4] demonstrates that foxes hunt more efficiently in dry, grassy urban patches than in rural habitats. Together, these findings suggest that urban vegetation changes frequently support predator success and population growth.

2.2.4. Release from Apex Predator Competition

Urbanization often leads to the decline of apex predators, enabling mesopredator expansion. [12] find that in areas lacking coyotes, raccoon populations tripled, increasing nest predation on ground-nesting birds. Similarly, [5] show that the absence of wolves leads to higher fox densities and intensified predation on scrub-nesting birds. In urban bird communities, [15] document that American crows benefit from reduced competition with forest raptors, increasing their predation on nestlings. These studies collectively illustrate how predator release in urban landscapes facilitates mesopredator expansion and elevated predation success.

Overall, urbanization can promote predator success by providing abundant food, shelter, favorable vegetation, and reduced competition, whichcan enhance predator success across taxa, including mammals, birds, raptors, arthropods, and generalist carnivores. These patterns are widespread and predictable, urging the integration of predator ecology into urban planning to ensure balanced biodiversity and mitigate unintended ecological consequences.

2.3. Complex Cases

While previous sections discussed broadly positive or negative trends, many predator-prey outcomes under urbanization are context-dependent. Factors such as predator identity, habitat structure, spatial scale, artificial inputs, climate, and pollution introduce variability, producing outcomes that could not be simply defined as positive or negative [8]; [22]; [27]; [16]; [10]; [29].

2.3.1. Scale and Habitat Fragmentation

[8] demonstrated that nest predation is influenced by spatial scale and landscape structure. While some predators, like corvids and foxes, benefit from fragmented or modified landscapes, others rely on continuous vegetation cover. No

uniform spatial scale can be applied across species.

2.3.2. Hydrological Modifications

Urban development often alters water regimes, with cascading effects on predator activity. [22] found that shallow water increases nest vulnerability to terrestrial predators, whereas deeper water favors aquatic predators. These divergent outcomes underscore the importance of context-specific hydrological design in urban planning.

2.3.3. Multifaceted Urban Impacts

[27] outlined several urban-driven dynamics. Food waste concentrates predators into urban hotspots, enhancing foraging for generalists, while fragmented infrastructure constrains the range and effectiveness of wide-ranging predators. Additionally, prey clustering in human-dominated areas (the "human shield" effect) may also benefit predators. Furthermore, artificial lighting supports visual predators but impairs scent-reliant species, and polluted water bodies can both attract and harm aquatic predators. This study highlights how a single urban factor can produce contrasting effects depending on species and ecological context.

2.3.4. Cognition and Adaptability

Behavioral plasticity significantly mediates predator success in urban areas. [16] found that generalists like corvids thrived in Moscow, aided by food waste and larger brain sizes, while specialists such as owls declined due to light-induced sensory disruption. These findings align with broader theories linking urban adaptability to cognitive flexibility and generalist diets.

2.3.5. Habitat Complexity Across Taxa

[10] showed that the same habitat type can yield opposite outcomes across predator groups. Birds exhibited higher predation success in heterogeneous environments, while arthropod predation peaked in more homogeneous settings. Such divergence emphasizes the necessity of tailoring conservation strategies to the ecological requirements of specific taxa.

2.3.6. Climate and Water Management

Urbanization also interacts with climate variability to influence predation. [29] demonstrated that drought conditions expose nests, favouring terrestrial predators, whereas wetter periods increase aquatic predator activity. This variability introduces instability into predator-prey relationships, complicating conservation and management efforts.

In conclusion, urbanization produces complex, often contradictory effects on predation depending on predator traits, local environmental conditions, and broader ecological interactions. Effective urban biodiversity management must therefore adopt species-specific, context-sensitive strategies that reflect this ecological complexity.

3. Discussion

The reviewed studies demonstrate that urbanization does not exert uniform effects on predation dynamics. Instead, outcomes vary and shaped by species traits, habitat structure, resource distribution, and urban design. Rather than viewing urban impacts as strictly beneficial or detrimental, a more productive framework considers how urban ecosystems restructure trophic dynamics through altered ecological pressures and emergent interactions.

A central theme is the decoupling of predator presence from predation function. Several studies [21]; [9]; [6] report stable or even increased predator abundance in urban environments alongside reduced predation rates. This apparent contradiction is often driven by behavioral changes, such as diminished hunting effort, reduced prey detection due to complex habitats, or increased reliance on anthropogenic food sources. These findings challenge the ecological validity of predator population metrics in urban systems: is abundance a meaningful proxy for ecological function when foraging patterns have fundamentally shifted?

Another key pattern is the paradoxical role of anthropogenic food sources. While supplemental feeding and resource subsidies can enhance predator survival and reproduction initially, they may degrade ecological function over time by displacing natural foraging, altering spatial behavior, and weakening top-down control. This highlights the need for policy strategies that balance predator support with long-term ecosystem health. Eliminating food subsidies entirely may be unrealistic, but unmanaged provisioning risks reinforcing dysfunctional trophic relationships.

The variability in outcomes also highlights the importance of species-specific traits such as diet breadth, cognitive flexibility, and foraging plasticity. Generalists-particularly those with larger relative brain sizes and high behavioral adaptability- tend to benefit disproportionately from urban conditions. Specialists, by contrast, are more vulnerable to decline or maladaptive shifts. These findings support broader ecological theories linking urban success to phenotypic flexibility and cognitive capacity and challenge one-size-fits-all conservation strategies.

Beyond species-level traits, landscape configuration and temporal scale emerge as critical mediators. Fragmented habitats, artificial lighting, and hydrological alterations can have opposing effects depending on predator guild and spatial scale. Moreover, the contrast between short-term observational studies and long-term modeling approaches reflects a temporal gap in our understanding: what may appear adaptive in the short run could signal ecological dysfunction in the long term. Bridging this gap requires integrated, multi-scale research frameworks that combine direct behavioral observation with long-term monitoring of ecosystem processes.

These insights carry practical implications for urban planning and biodiversity conservation. Ecologically informed design—such as connected wildlife corridors, structurally heterogeneous habitats, and predator-sensitive lighting—can mitigate the harmful impacts and promote functional biodiversity. Rather than attempting to restore pre-urban trophic structures, urban ecology must embrace novel ecosystems as dynamic systems requiring context-specific management.

Ultimately, the relationship between urbanization and predation is far too complex to be captured by simplistic, linear models. It is shaped by interacting ecological, behavioral, and spatial factors that demand interdisciplinary approaches. Future research should prioritize mechanistic understanding, longitudinal analysis, and adaptive management strategies that reflect the complexity of urban ecological systems.

4. Conclusion

Urbanization reshapes predator–prey interactions through a diverse spectrum of effects—negative, positive, and context-dependent—reflecting the complexity and variability of ecological responses across taxa and environments. While some predators experience reduced hunting success due to anthropogenic disturbances, weakened top-down control, and habitat fragmentation, others adapt by exploiting human-derived resources and altered urban structures.

These divergent outcomes highlight that predator abundance does not always equate to ecological functionality. The consequences of urbanization are not uniform but mediated by interacting factors such as landscape configuration, resource distribution, behavioral plasticity, and species-specific traits. Generalists often thrive, while specialists and sensitive taxa face greater risks of functional decline.

This review highlights the need to move beyond simplified assessments of predator presence and toward evaluating their ecological roles and contributions to urban ecosystem stability. As predators often serve as indicators of ecosystem integrity, understanding how urban systems alter their behavior and efficacy is critical for sustaining biodiversity and ecosystem resilience.

Future research must adopt long-term, cross-regional, and multi-trophic approaches to capture temporal dynamics and inform responsive, evidence-based urban planning. Supporting functional predator-prey relationships will be essential to fostering coexistence between urban development and ecological stability.

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