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Habitat Use, Resource Acquisition, and Risk Management of Raccoons in Human-Modified Landscapes across North America

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Abstract. Urbanization creates concentrated food sources, artificial habitats and fragmented living environments for adaptable medium-sized carnivores. However, ecological studies of raccoons mostly carry out separately on habitat utilization and so on, which hinders the understanding of their continued existence in human-altered landscapes. During the period from 2000 to 2026, a systematic review in line with PRISMA guidelines was carried out on the content carried in Science Network, focusing on North American raccoons. After deduplication and screening, 25 empirical studies were retained and sorted out according to habitat selection and other situations. Raccoons in the suburbs of cities choose to live in edge areas, and their activity ranges are smaller than those of their counterparts in rural areas. They obtain resources through a wide range of dietary approaches. Responses to risks vary with the environment. The number of predators in cities has decreased, but conflicts such as diseases have increased. The successful establishment of raccoons in human-altered landscapes can be explained by the flexible trade-off in food and other aspects, and then the core points of urban wildlife management can be clarified.

Keywords: Urbanization, Procyon lotor, Urban ecology, Mesopredator, Human-wildlife coexistence

1. Introduction

Urbanization is a common situation in land use change. It includes land cover situations where natural and semi - natural habitat areas are transformed into human - dominated built environments. The land cover and other conditions in many places have changed due to the expansion of cities. For wild animals, these changes can reshape the availability of habitats, increase the chance of contact with vehicles, and change the dynamic relationship between predators and prey. Although urban expansion often reduces the richness of local species, it may be beneficial to many opportunistic species that can make use of artificial resources.

In urban ecosystems, medium-sized carnivores play a key role. They have characteristics such as flexible diets, which enable them to establish themselves in human-dominated and fragmented environments. There are factors like predictable human-provided food in the urban environment, which create opportunities for them. But cities also bring new and amplified risks to wildlife. So it is

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extremely important to clarify the status of species under such conditions for urban ecosystems and so on.

Raccoons are *medium-sized* animals in North America. They have an omnivorous nature and are within the category of carnivores. They are mammals that are closely related to human living environments and are easy to recognize. Recent research has emphasized that they are widely present in urban and rural areas and are mostly close to the areas where humans live. The reason why they can succeed in the ecological field is that they have a wide diet range, flexible nest construction, are active at night, can tolerate disturbances, and have the ability to utilize natural and human resources. Through empirical research, it is found that the activity range of raccoons in urban and suburban areas is generally smaller than that in rural areas and is more stable, which is due to factors such as the sufficient food provided by humans. Relevant explorations in the Baltimore metropolitan area show that raccoons can retain the characteristics of being close to humans in the urban environment and will adjust their use of habitats according to the changes in development intensity.

Although raccoons have been widely studied, most existing studies focus on individual topics such as habitat use, and there is a lack of summarizing and integrating the mechanisms of their success in human-altered landscapes. So, it is not clear how resources and so on shape their persistence in different urban environments, and need to comprehensively study the multi-faceted impacts of urban environmental conditions on them. This systematic review integrates the empirical ecological information of raccoons in North American cities to address three research issues: how urban environments affect raccoon habitats; how raccoons optimize the acquisition of resources in time and space; and how raccoons balance risks through anti-predation and other strategies in different ecological environments to ensure their own survival. By integrating evidence, it can have a deeper understanding of the adaptation of wildlife to urbanization, and then provide ideas for management, protection planning and coexistence with wildlife.

2. Methods

2.1. Study design

This study adopts the method of systematic literature review to explore the role of the urban environment in aspects such as the selection of raccoon habitats, spatial composition, activity patterns, resource acquisition, and survival means. *This review* needs to integrate empirical evidence to explore ecological patterns in human-modified landscapes such as cities, suburbs, rural areas, agricultural areas, plantation areas, and residential areas. The PRISMA-style framework is used to carry out the review work. This framework can provide a standardized and transparent approach for the identification, screening, evaluation, and reporting of literature, which can improve the clarity of the method, enhance the reproducibility of the results, reduce the bias in selection, and help to rigorously integrate the existing evidence.

2.2. Search strategy

Carry out relevant research with Web of Science. As a comprehensive multidisciplinary academic resource library, this tool can index peer-reviewed literature and has the functions of citation tracking and filtering. Retrieve publications from 2000 to 2026, and capture the latest developments in fields such as urban ecology. Determine Boolean search strings for three research questions. Question 1 is related to raccoon characteristic identification, North American regional vocabulary,

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urbanization-related vocabulary, and habitat and other elements; Question 2 focuses on aspects such as foraging; Question 3 focuses on content such as predation risk.

2.3. Eligibility criteria

For the research, if it takes raccoons as the main research object, or clearly defines raccoons as the main species in the multi-species research and is within the North American geographical range (published from 2000 to 2026), and also checks at least one ecological theme related to the review (such as the selection of habitats in human-modified landscapes like cities, etc.), it will be taken into consideration. Exclude the situations where there are many that do not contain raccoons, the results are difficult to distinguish, are not in North America, the focus does not match, and are reviews with incomplete data.

2.4. Study selection process

The research was carried out in accordance with the PRISMA process. 155 records were obtained through Web of Science, and 152 remained after deduplication. The titles and abstracts of these records were screened, 126 were excluded because they did not meet the requirements, the remaining 26 were evaluated for full text, and 1 was excluded, and finally 25 empirical studies that met the standards were included in the analysis (Figure 1).

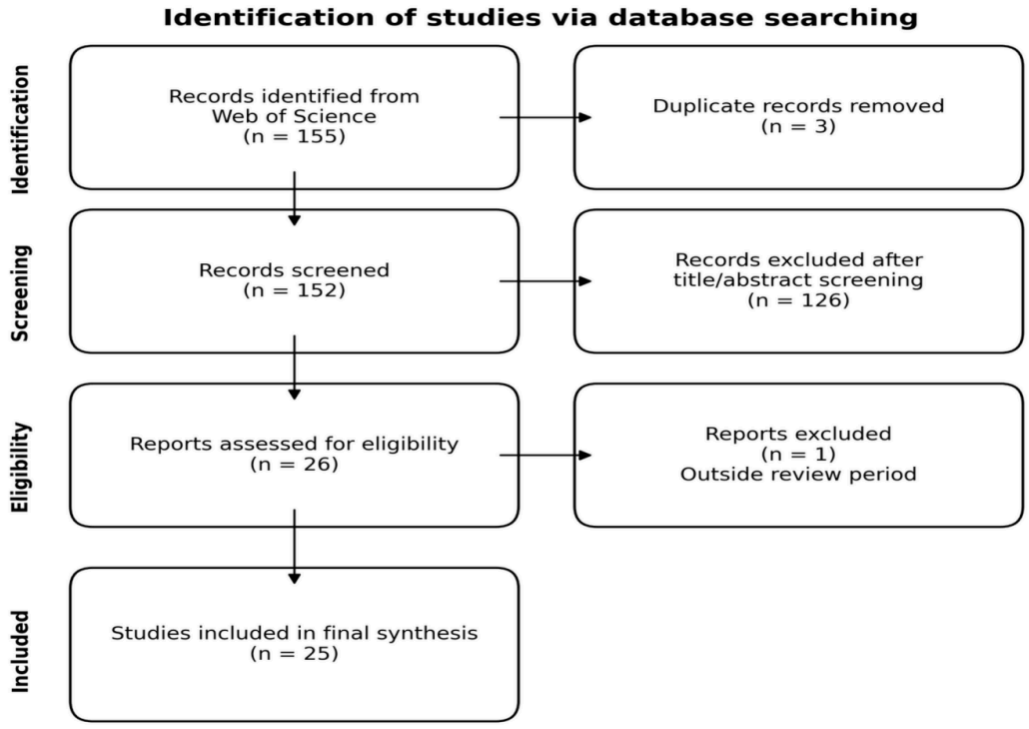

Figure 1. PRISMA flow diagram for study identification, screening, eligibility assessment, and final inclusion (picture credit: original)

2.5. Data extraction

The data was obtained after the final synthesis of 25 studies. For each study, the publication year, article title, author, geographical location, research objective, environmental background, research

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method used, results of habitat selection, findings on movement and spatial organization, behavioral responses, strategies for resource acquisition, responses for anti-predation or risk management, survival-related results and key conclusions were all extracted. The information extraction was structured according to three research questions, so as to provide support for direct comparison between studies and synthesis of themes. This structure can be used to evaluate raccoons' habitat use, spatial ecology, foraging behavior, risk response and survival strategies in different urban, suburban, rural, agricultural and other human-intervened landscapes.

2.6. Data synthesis

Incorporate the discovered findings from the research through narrative synthesis, which is more appropriate compared to statistical meta - analysis, considering that there are obvious differences in many aspects among various studies. This approach can carry out systematic comparison of all kinds of research evidence, while retaining the differences in background and methods. Based on the comprehensive exploration of the research problem theme, and with the investigation around the habitat and so on, the pattern of urban raccoons adapting to the ecology can be identified, and the differences in environmental gradients and between systems are highlighted.

3. Results

3.1. Overview of included studies

This review covers 25 eligible empirical studies. Most of these studies were conducted in the United States and Canada, involving various environmental scenarios such as highly urbanized metropolitan areas and suburban communities, and different research methods such as radio telemetry were used.

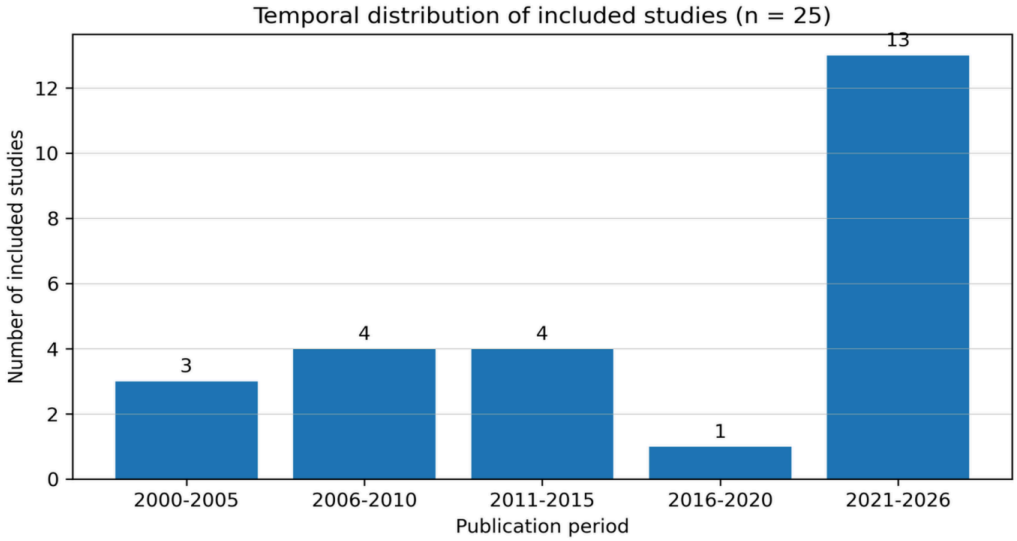

Figure 2. Temporal distribution of the 25 included studies by publication period (picture credit: original)

The research covers three themes: the first is about the selection of habitats, the dynamic changes of home ranges, the location of nests and activity patterns in rural landscapes in suburban areas; the second is the strategy of resource acquisition, including foraging behavior, the use of artificial food

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sources, damage to crops, dietary flexibility and behavioral adaptation to resource changes; the third is risk management under the transformation of the environment by humans, including interaction with predators, management related to diseases, environmental stressors, risk of death and response to human disturbance. In general, this research provides a broad empirical basis for how the environment of Mingcheng and its surrounding areas shape the ecology of raccoons and help them survive in different landscapes (Figure 2) [1-7].

3.2. Habitat selection, spatial organization, and movement

The urban environmental condition has an obvious impact on the raccoon's selection of habitats and so on. It achieves this by adjusting the distribution of food, habitats and so on. When reviewing the literature, it can be found that raccoons show a very high behavioral flexibility in the use of human resources and so on. Many system-level evidence shows that the raccoon's space utilization is not only affected by urbanization, but also related to the mutual influence of resources and so on. This pattern is very prominent in the comparative research of urban and rural populations. In the environment of developed areas, raccoons' activities are mostly focused on places such as residential areas, while individuals in rural landscapes need to use a wider area to meet their own needs.

According to relevant research on habitat selection, it is known that raccoons have selectivity in the utilization of urban landscapes and do not present a random state. Research in the Baltimore metropolitan area found that raccoons would choose living communities, urban green spaces, and areas with abundant food and shelter resources, which shows that even in highly modified landscapes, raccoons will respond to small changes in habitat quality [8]. The habitat preferences in different research areas are different, which shows that the local environmental conditions play a regulatory role in raccoons' adaptation to urbanization, which is in line with the broader landscape research situation. The landscape research points out that the occurrence of raccoons' activities is affected by relevant indicators such as landscape composition, roads, trails, development degree, and other human disturbances. Based on these explorations, it is shown that raccoons can survive in cities not only because they can tolerate the disturbances brought by humans but also because they can recognize and utilize the specific habitat characteristics in cities that can provide food, shelter, and activity space.

From the relevant evidence of cave site selection, it can be seen that human transformation of the environment has created key habitat resources for raccoons. In agricultural landscapes, raccoons will use structures such as buildings, and such structures are crucial in winter [9]. Lactating female raccoons excluded from suburban residences often migrate to nearby buildings [10]. This shows that artificial structures are not randomly formed, but are key nesting and living resources, especially when energy requirements are quite high. When the number of natural caves is insufficient, artificial structures such as buildings built by humans can serve as safe rest and breeding places for raccoons to stay for a long time in the human-dominated landscape, so as to meet the needs of raccoons for long-term survival here.

The activities and spatial connectivity of raccoons are influenced by urban infrastructure. Research found that raccoons use the rainwater sewer system and often appear near the exits [11]. This means that these systems may be exploratory habitats, refuges or activity corridors in the fragmented urban landscape, which expands the understanding of raccoons' use of habitats. At the same time, the urban characteristics of the metasurface highlight the role of hidden infrastructure in promoting activities in developed areas. Raccoons in Cleveland city have a relatively small annual activity range but can still cross obstacles such as highways and rivers, which means that raccoons can navigate in the complex urban landscape and may maintain activities between resource patches

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with the help of natural or artificial corridors [12]. This flexibility can reduce the isolation impact brought by fragmentation and allow raccoons to survive in areas where roads, buildings and other restrictions have a poor adaptability to species activities.

Urbanization causes changes in the spatial organization of raccoons. Raccoons in urban suburbs have a smaller range of activities than those in rural areas [13]. The reason is that there are artificially provided food resources in the suburbs, which are rich, predictable and concentrated, so that raccoons can shorten the moving distance when obtaining resources. Evidence from rural landscapes shows that, in an environment with lower resource concentration, the spatial utilization of raccoons presents a broader and more gender - differentiated situation [14]. The research comparison shows that urbanization can indirectly reduce the movement demand by concentrating resources in a small spatial area. However, the concentration of resources may increase the density of raccoons, increase the spatial overlap and the contact probability, and then have an impact on competition, disease transmission and human - animal conflicts.

The exploration of wildlife communities in cities reflects that raccoons are extremely well-adapted in developed environments. Many scholars have recorded the appearance of raccoons in cities and other places, highlighting that they are a mammalian species that can survive in human-altered environments to different degrees. Concentrating human efforts and resources can promote more interactions among raccoons and increase spatial overlap, and the supply of urban resources may have an impact on their habitats and the composition of individuals [15]. From the overall evidence, raccoons can survive in the urban landscape for a long time because they can use habitats with abundant food. Raccoons have strong tolerance to disturbances, a wide diet, flexible nest site selection, and can navigate in man-made infrastructure. These characteristics allow them to occupy diverse urban environments and avoid places that many disturbance-sensitive species avoid.

3.3. Resource acquisition across space and time

In the context of the interaction between city and people, the key to the success of raccoons lies in being able to obtain resources. In the research it reviewed, raccoons use food resources provided by nature and humans, and their behaviors are adjusted with the change of resources, time and space. This flexibility enables them to survive in cities, suburbs, farms and other transformed landscapes, where food resources are usually rich but unevenly distributed. Raccoons adopt rich strategies to obtain resources, including using opportunities to seek food, using human-related ways of obtaining food, flexibly moving in resource distribution areas and adjusting according to the changing environment, rather than relying on narrow natural food sources.

The food resources provided by humans greatly influence the activities, distribution, and spatial structure of raccoons. The activities of raccoons in urban and suburban areas revolve around abundant food resources [13]. Compared with rural individuals, their movement range is smaller, and predictable food subsidies can reduce the spatial area required to meet energy needs. A similar situation exists outside traditional cities. In agricultural landscapes, the utilization of cornfields by raccoons is related to local crop damage [16]. This means that raccoons' access to resources is not limited to urban areas but also extends to landscapes where humans transform food resources and the space is relatively concentrated. In general, these investigations show that raccoons have obvious responses to patches with abundant resources, whether the resources are food waste in residential areas, garbage, things in gardens, crop fields, or other forms of artificial subsidies.

Recent research shows that raccoons' successful foraging depends on the flexibility of behavior and the decision-making ability to adjust in changes. Refuse and other anthropogenic resources can concentrate raccoon activity and increase interactions among individuals, indicating that food

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subsidies may influence not only foraging behavior but also social contact and spatial overlap [15]. Experimental evidence shows that raccoons can adjust exploration and exploitation strategies when solving foraging problems [17]. In that study, raccoons explored more under easier conditions but relied more heavily on known solutions when problems became difficult. This capacity to balance information gain and energetic reward is likely advantageous in urban environments, where resources can be abundant but heterogeneous, patchy, and sometimes unpredictable. Such behavioral plasticity may allow raccoons to rapidly learn, remember, and exploit profitable feeding opportunities in complex human-dominated landscapes.

The acquisition of resources is influenced by the structure of habitats, the condition of landscape connectivity, and the accessibility of movement routes. The stormwater sewer system in cities provides raccoons with conditions to move with the urban infrastructure, enabling them to enter areas where the ground is disconnected, which indicates that urban infrastructure is a passage for raccoons to obtain food resources [11]. Raccoons' selection of habitats changes with seasons, they move at multiple spatial scales, and the utilization of resources is affected by the local habitats and the broader landscape background [18]. Habitats in cities are used vertically, and the orientation of camera traps can show the activities of mammals above the ground because raccoons use elevated structures when foraging, avoiding predators, and entering nests [19]. These research results show that raccoons' acquisition of resources is not limited to the ground, but also involves three-dimensional array structures. In future research, integrating these aspects will help understand how raccoons use the human-modified environment and adjust management strategies accordingly to maintain ecological functions while restricting their problem behaviors.

3.4. Risk management, predator interactions, and disease

Under the situation where humans transform the landscape, raccoons have to cope with many risks, such as threats from predators, invasions of diseases, impacts of pollution, dangers brought by infrastructure construction, and conflicts with humans and other different risks. It can be known from reviewing relevant studies that their responses to risks vary with scenarios, and there is no uniform avoidance mode. On the contrary, raccoons achieve the balance between risks and resource acquisition by means of flexible behaviors, flexible use of habitats, and selection of shelters. This ability is the key for them to survive in the suburbs.

Generally speaking, in cities, the predation risk will decrease due to the decrease or disappearance of the number of large predators, but the research on raccoons presents a more detailed correlation. When the calls of large carnivores were played, the foraging behavior of raccoons decreased, which reflects that the fear of predators will have a chain effect [20]. When raccoons and coyotes were in the same landscape, raccoons did not have continuous spatial avoidance, which shows that the reaction of raccoons to predation risk is not limited to avoidance [21]. The dynamics of raccoons and coyotes are context-based, and the release of medium-sized predators cannot fully explain the phenomenon that raccoons succeed in human areas [22]. According to the resource abundance, when raccoons are in such situations, they will show a situation of accommodating some predation risks rather than avoiding them all.

The behavioral response of individuals to predator cues is related to the reliability of the cues and the intensity of competitive motivation. Commercially available predator odor showed almost no indication that it could significantly hinder raccoons from foraging [23]. This shows that just indirect predator cues may be difficult to change the behavior of raccoons, especially when they are in an environment accustomed to complex stimuli or with rich food rewards. It also shows that the direct presence of predators, multiple encounters with real risks or more ecologically meaningful

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fear cues have a more critical impact on raccoons' foraging decisions compared with just the odor of predators.

From the management perspective, the existing evidence shows that: without the test and evaluation of specific locations, it cannot be determined that predator odor deterrents can actually reduce the activity frequency of raccoons.

Risk management of raccoons in suburban landscapes can obtain important perspectives from disease ecology. Raccoons play a key host role in rabies prevention and control, and their activities and other situations have an important impact on disease prevention and control work. Accounting for raccoon movement can optimize relevant oral vaccination strategies [24]. The space utilization of raccoons in cities is also key to designing bait placement [12]. It can be seen from these studies that raccoon risk management is not limited to the behavioral performance at the individual level, but is also related to many aspects such as public health. Considering that raccoons have a small range of activities, the urban landscape structure should be incorporated into disease prevention and control strategies in terms of constructing their movement routes and contact situations.

Human transformation of the environment has led raccoons to encounter pollutants, dangers from infrastructure, and management interventions. In some areas of the Seattle-Tacoma metropolitan area, the activity of raccoons is related to areas of pollutant risk [25]. Even with environmental stress factors, raccoons still use highly resourceful habitats in cities. Raccoons are capable of crossing complex urban barriers and infrastructure [11, 12]. These research results show that raccoons have the ability to move in fragmented urban environments, but this adaptability may make them more vulnerable to threats such as roads and pollutants. The management of human-wildlife conflicts can affect the behavior of raccoons [10]. Female raccoons in lactation that are excluded by suburban residences often move to nearby buildings instead of completely abandoning nest structures related to humans. This means that management measures may change the use of space by raccoons and not necessarily reduce their dependence on human-related habitat characteristics.

Evidence obtained during the review shows that raccoons rely on their flexible behaviors to balance risks for survival. The urban landscape provides raccoons with abundant food sources, but also exposes them to more risks of contact with diseases. Raccoons can survive here because they adjust their behaviors according to the local conditions, not relying on fixed avoidance strategies. The ability to continuously use human modifications of resources and accept managing risks is the key mechanism for their success in many places.

4. Discussion

4.1. Mechanisms supporting raccoon persistence in human-modified landscapes

Three research findings reveal a common mechanism: Raccoons do not simply treat urbanization as a single environmental condition to cope with. Their survival depends on the proper allocation of local food supply, habitats and other resources. Concentration of food and habitat resources reduces the need for movement and narrows the range of activities. Facilities such as roads help to obtain resources but increase contact risks. Habitats in cities have the characteristics of rich resources, which makes frequent contact between individuals, and then increases the risk of diseases and so on. The formation of a city depends on resource acquisition and agile adjustment to risks, not just being a simple place to accommodate humans.

The variability of behavior makes reactions interrelated. Raccons will change the location of their dens according to various clues in the environment, move through corridors, also expand the use of garbage food, and adjust their own foraging methods. Research on predators also shows that their

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avoidance of non-fixed situations is not a fixed pattern, but a corresponding reaction based on the reliability of clues and the value of resources. Many evidences all point to the situation-dependent model, and raccons can still stay in favorable habitats with the generality of diet and flexible use of space even if the cost of habitats is quite high.

4.2. Strengths and limitations of the review

This review integrates 25 empirical studies, when humans change the environment, using telemetry, camera traps, habitat models, behavioral experiments and disease management models, organizing evidence according to habitat use, resource acquisition, risk management, able to compare individual research processes and detect the connections among them.

Some restricted elements need to be interpreted in a mild way. The evidence is mostly from relevant studies in the United States, and there are obvious differences in their design, scale and measurement results, which not only hinder meta-analysis but also restrict quantitative comparison. Some studies focus on the fields of agriculture or management, not within the urban scope, and a small number of them are preprints or papers written by postgraduates. In the recently published articles, long-term trends or regional differences may be underestimated. These constraints urge wider regional sampling and the adoption of unified methods in the future.

4.3. Knowledge gaps and recommendations for further studies

There has been significant progress in understanding raccoon ecology in urban and human-altered environments, but there are still key knowledge gaps. The main limitation lies in the fact that many existing studies only conduct research on a single field of raccoon ecology, such as the selection of habitats. Although these studies are of certain value, few studies can evaluate the use of habitats and other aspects under a single comprehensive framework. This is a key gap, arising from the interconnection of ecological processes. For example, introducing raccoons into residential areas with human-made resources may lead to more overlapping of spaces. Future research can start from a more comprehensive approach to explore how raccoons coordinate food acquisition and other situations in different areas of the city.

The second difference lies in the paucity of long-term studies on how raccoons respond to the continuous expansion of cities. The landscape of cities is not fixed but keeps changing due to many factors. However, most of the current studies are short-term snapshots of raccoon behavior in specific situations. Longitudinal studies that track raccoon populations or the process of urban expansion over a long period can lay the foundation for understanding whether their behavioral responses to urban expansion are stable, aggravated, or changing. It can also explain whether raccoons only incidentally use urban resources or repeated exposure to human-dominated environments will lead to long-term changes in spatial utilization and so on.

In the future research process, it is necessary to integrate movement ecology more closely with disease risks and conflict management models. The movement patterns of raccoons, etc., are directly related to the transmission of pathogens, etc. Movement-related vaccination models show the significance of integrating spatial behavior and epidemiological management, but it is still necessary to know more in-depth the role of resources, etc., in the spread of urban diseases [24]. Human resources can promote the interaction between raccoons, which lays the foundation for the comprehensive approach [15]. Linking movement data with disease monitoring, etc., can enable wildlife managers to be more able to actively predict high-risk areas and design targeted intervention measures.

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In the future research process, the mutual influence of climate change and urbanization on the ecology of raccoons needs to be investigated. Changes in temperature, precipitation conditions, extreme weather conditions, and the availability of resources will all have an impact on the habitat. In cities, environmental pressure increases due to heat islands and other situations, and a warm winter may be beneficial to raccoons. To predict the response of raccoon populations in the urban ecosystem, it is necessary to understand the key points of these mutual influences. Filling the knowledge gap depends on long-term interdisciplinary research, and many elements need to be integrated in the dynamic urban landscape.

5. Conclusion

25 studies conducted between 2000 and 2026 focused on North American cities and analyzed how human transformation of the environment affects the ecological status of raccoons. The research results show that raccoons can survive in cities due to factors such as the plasticity of their behavior, and they often make use of a variety of transformed habitats. Raccoons in urban suburbs have a smaller range of activities because the resources provided by humans are relatively superior, but this may lead to an increase in their spatial overlap and so on. The core is resource acquisition. Some predation in the urban environment has the effect of reducing risks, but also leads to new risks. Raccoons balance between resource acquisition and risk facing, which can be used as an effective model for understanding the adaptation of omnivorous medium-sized carnivores to urbanization and other situations.

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