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Review

A Review on Eurasian Otters in Urban Areas: Principles for the Enhancement of Biodiversity

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Abstract: Eurasian otters, as apex predators in freshwater ecosystems, are crucial to maintaining nutrient cycling and habitat stability. Although Eurasian otters prefer unaltered natural habitats, their adaptive and opportunistic behavior allows them to occupy suboptimal environments, including urbanized areas. As urbanization increases, the pressure on apex carnivores like the Eurasian otter will continue to grow. To date, urban stream restoration plans have not used the Eurasian otter as a keystone species, but given their influence across the trophic levels, Eurasian otter-focused restoration plans could enhance otter populations and overall biodiversity in urban areas. Here, we lay out six principles designed as a template for enhancing urban habitats for Eurasian otters as well as biodiversity. The principles (enhancing habitat structure complexity, restoring natural riparian vegetation and habitats, safeguarding water quality, providing native prey species, reducing otter mortality, and promoting positive public perception) are essential for urban ecosystem regeneration focused on Eurasian otters. Although there have been no urban restoration projects specifically tailored toward Eurasian otters, initiatives based on similar principles have been effective in promoting biodiversity and otter presence. Overall, an urban habitat restoration plan focused on Eurasian otters will not just increase otter presence but biodiversity across all trophic levels.

Keywords: Eurasian otters; urban; habitat enhancement; riparian habitat

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1. Introduction

The Eurasian otter (*Lutra lutra*) is an apex predator [1] whose presence can help maintain ecological network integrity and promote habitat stability through nutrient cycling and population control [2,3]. In addition, this charismatic species can be considered a bioindicator for the freshwater ecosystems in which it occurs [4], having been found to be reliable for biomonitoring of contaminants, including organochlorines and heavy metals [5,6], as well as microplastics [7]. Their diet can also be used to monitor the recovery of fish species and as a supplementary method in river health status [8,9]. Due to these and other potential benefits to urban ecosystems, enhancing urban rivers and streams to benefit Eurasian otters could also significantly improve biodiversity conservation and the ecological status of freshwater ecosystems [9]. In this paper, we first review Eurasian otter behavior and habitat requirements, discuss what little is known about otters in urban areas, and then develop principles for enhancing urban habitats for otter presence, with resulting benefits for overall biodiversity in urban areas.

Eurasian otters are semiaquatic mammals in the Mustelidae family specialized for swimming and hunting in aquatic settings [10,11]. Otters are of a similar size and coloration

to dogs and cats so could go unnoticed in urban habitats: their overall color is brown with light-colored fur around the throat [10,12], and the typical size of a fully grown Eurasian otter is 96–137 cm (body length 60–90 cm and tail length 36–47 cm) for males and 90–125 cm (body length 59–70 cm and tail length 35–42 cm) for females [11–13]. Males tend to be heavier than females, typically weighing around 10 kg, while females average around 7 kg [10].

The Eurasian otter has the largest distribution of the 13 known otter species, with its range extending from Portugal to China, encompassing Europe, North Africa, the Middle East, South and Southeast Asia, and East Asia [13,14]. Although widespread, the majority of their distribution and most research on the species is concentrated in Europe, with many populations either reduced to isolated zones or extirpated across other parts of their range [15]. The Eurasian otter is currently listed as near threatened by the International Union for Conservation of Nature (IUCN) [16]. In China, however, the perception of the Eurasian otter as a pest and a combination of other factors has led to a steep decline and its current listing as an endangered species [17–19].

The Eurasian otter is solitary [10], territorial [20], and usually found at low density [21,22], again making them difficult to observe even in urban settings. Their expansive ranges of up to 40km of freshwater networks [23] and requirements for prey availability, habitat quality, and interactions with neighboring otters [24] make degraded urban rivers and streams poor habitats for these animals. River connectivity is critical for proper otter habitat; urbanization may, therefore, affect the dispersal of Eurasian otters and function as a barrier [25] to movement, so the fragmentation of habitats in urban areas by weirs and roads can alter behavior and population dynamics [26].

Their feeding habits are influenced by various environmental factors, like elevation and climate, among others [27]. The Eurasian otter has a generalist diet [28], so it can alter its feeding habits based on prey availability and seasonality, which is potentially necessary in urban areas. In Spain, otters adjust their diet depending on the season, preferring an invasive species of goldfish in the fall and the native northern straight-mouth Nase in the winter [29]. Across England and Wales, the Eurasian otter diet and the degree of urbanization had no significant correlation, implying little variation across habitats [30]. While Eurasian otters will adjust to the prey species available, Dettori et al. [31] assert that ecological management and restoration efforts should focus on the improvement of native prey species assemblages.

Due to their adaptability and opportunistic behavior, Eurasian otters are able to withstand moderate amounts of human disturbance and are known to exist in some urbanized areas throughout their range. For example, along the Spanish coast, otters were observed in urban and urban-adjacent areas such as ports and golf courses and traveling across beaches and even an airport to reach other habitat patches [32]. This opportunistic behavior enables Eurasian otters to survive in suboptimal conditions but could potentially increase the chance of mortality, especially in urban areas. Otters are highly vulnerable to road accidents and can be susceptible to other causes of death, like poaching or stray animals [33–37]. Otters are more likely to tolerate human disturbance in areas where they are transient rather than in the core parts of their territory [38].

Urban environments containing Eurasian otters usually contain sufficient amounts of prey species, riparian vegetation, and habitat complexity, including plenty of structures near the surface of the water [9,39–41]. Even artificial structures such as concrete pipes and bridges can be used by otters as shelter [42,43], and relevant to restoring otters in urban areas, these elements become more crucial as the level of human disturbance increases. Otters often utilize areas of high biological productivity [9], indicating that restoring

urbanized streams with Eurasian otters as the keystone species will require increasing biodiversity as a whole.

Due to Eurasian otters' distribution and adaptability, they operate within a wide range of aquatic habitats, ranging from rivers, streams, wetlands, lakes, marshes, and coastal regions [10]. Habitats may differ, but they all contain the essentials for foraging and breeding [44]. The standard range of an otter usually contains a river, smaller adjacent streams, ponds, bordering woodlands, and marshes [17]. Despite preferring undisturbed natural habitats, Eurasian otters can tolerate disturbances to a moderate degree [9,45] but always require non-disturbed resting sites [9,40], which are critical for these shy animals. This stresses the importance of bankside elements, especially riparian vegetation, for otters to coexist in human-dominated areas. Other factors to consider in quality habitat are healthy macroinvertebrate communities, isothermality, and water temperature [19,45]. On the other hand, a poor otter habitat usually contains one or more of these elements: (1) a lack of prey availability, (2) underdeveloped or a lack of riparian vegetation, or (3) poor water conditions due to pollutants [46].

Little research has been undertaken on Eurasian otters in mainland China, and even less on their potential presence or absence in urban areas. In Yushu, China (population: 141,308 [47]), otter defecation (sprainting) sites mainly occurred on natural riverbanks with plenty of riparian vegetation, while steep banks lacking vegetation were avoided [42]. In Northeast China, the distribution of suitable habitats for Eurasian otters was negatively correlated with the percentage of residential areas [48]. Our research (unpublished data) in the Changbai mountain region of Northeast China found no correlation between Eurasian otter presence and various land-use categories, including urban areas. While studies on urban otters in mainland China are limited, more research has been conducted in Hong Kong. In this region, otter presence is linked to coastal alluvial wetlands, which are unrepresented in the protection plans by the local government [49].

From 1950 to 2018, the estimated urban population grew from an estimated 0.8 billion to 4.2 billion, and by 2041, it is expected to increase to 6 billion [50]. As urbanization continues to increase worldwide, the pressure on species, especially apex carnivores, will continue to grow [51], yet urban areas can be important locations for increasing and conserving biodiversity [52,53]. In urban areas that were once habitats for the Eurasian otter, the pollution and destruction of aquatic habitats not only affect the otters but their prey species as well [54]. Principles focused on the improvement of prey species, riparian habitats, habitat complexity, water quality, and the public perception of Eurasian otters provide a solid foundation for conservation and increasing biodiversity in these areas. Promoting Eurasian otters as a keystone species in the enhancement of urban aquatic areas can strengthen otter presence and benefit overall biodiversity.

2. Principles for Improving Urban Areas for Eurasian Otters

Principles for improving urban areas for Eurasian otters and, therefore, for increased biodiversity are extracted from what is known about otter behavior and habitat requirements. For many urban areas already undergoing urban green space regeneration and habitat restoration, these principles will be relatively straightforward extensions of their current trajectories. For others, significant gaps still exist between the degraded, often channelized, and polluted waterways and the kinds of habitats required for otters. In either case, however, these principles can function as guidelines for planning urban ecosystem regeneration [52] that will benefit otters (Table 1).

2.1. Enhance Habitat Structural Complexity

In an urban environment, Eurasian otters will require a high level of habitat structural complexity for breeding and overall habitability. For example, large river islets, often distant from the riverbank, have little human disturbance and provide refuge and possibly latrine sites [55]. Large woody debris, along with riverbank refuges, are key components in the selection of breeding sites. In a comparison between the downtown area of Yushu, China, and the Tangjiahe nature reserve, the removal of river rocks and simplification of the river system led to no otter presence in the downtown area, while the abundance of river rocks and riparian zones was associated with greater otter presence in the nature reserve [42]. In Korea, otters avoided areas in which vegetation and rocks were too far from the water [39]. In terms of river morphology, otters prefer natural physical dynamics and little to no incisions or simplifications [9]. A degree of secondary forest development can allow otters to exist in areas of increased pressure from urbanization [56]. In restoration projects, restored gravel pits can potentially alleviate urbanization pressure and provide habitats for Eurasian otters [38]. Managers should focus on restoring natural floodplains, recreating natural channel morphology, and dechannelizing urban rivers and streams. The addition of islets or gravel pits that encounter little to no human disturbance can also provide resting and latrine sites for Eurasian otters. Large rocks and woody debris close to the water are essential for otter habitats and provide latrine sites. These elements will ensure habitat complexity.

2.2. Restore Natural Riparian Vegetation and Habitats

Organized riparian habitats, which are required for Eurasian otters, provide resting sites, flood protection, and birth dens, especially in areas of anthropogenic disturbances [9]. Weinberger et al. [40] identified 285 resting sites, finding that a substantial number of sites (95%) were natural riparian vegetation with a preference for narrow riparian belts with no human disturbance; however, as human disturbance increased, otters selected a wider riparian belt. Riparian habitat is often correlated with otter presence and absence sites [57]. Along a natural to urban habitat gradient, Eurasian otter marking sites varied from 0.65 to 0.31 per 100 m, respectively [58]. Planting native riparian trees and shrubs along the water's edge creates a buffer for Eurasian otters from human disturbance and provides critical cover for birthing.

2.3. Safeguard Water Quality

As an apex predator, Eurasian otters are subject to pollutants, which have led to their decline or even extirpation in many parts of Europe [59]. Organochlorines like PCBs and DDT show strong evidence that they negatively affect reproductive success and populations of Eurasian otters [60]. In Europe, even with PCBs and other organochlorines banned from being used, the residuals of POPs (persistent organic pollutants) still persist in the water and the tissues of Eurasian otters [5,61,62]. Marcelli et al. [63] suggested that Eurasian otters recolonized urban lands in the Czech Republic because of the reduction in point source pollution. In addition, pollutants from waste and plastic present a problem [36,37]. The focus should be on preventing point and nonpoint pollution sources from entering the water and maintaining water clarity by cleaning up plastic and waste. Restoring the surface flow will increase the water quality, as shown in the restoration of the Cheonggye stream in Seoul, South Korea [64].

2.4. Provide Native Prey Species

One of the most common determinants of otter habitat preference is prey abundance. Kruuk and Morehouse [65] argued that the spatial organization of Eurasian otters was

tied to resource distribution, and Ruiz Olmos et al. [66] found that otter density and the quantity of prey available were closely related. Dettori et al. [31] found through diet analysis that otters can thrive in urban areas as long as they have sufficient resources. Therefore, providing sufficient prey species could potentially lessen the need for Eurasian otters to leave their habitat, thereby limiting negative human–otter interactions and roadkill incidents. Providing adequate prey species is not as straightforward as the other principles. The implementation of principles 2.1, 2.2, and 2.3 will lead to increased prey species, but there should also be a focus on suppressing non-native invasive species and boosting native species.

2.5. Reduce Otter Mortality

As stated above, the risk of mortality mainly from road collisions is a significant threat for Eurasian otters, particularly in urban areas where road density and traffic volume are high [67,68]. In Italy, road traffic collisions were a major cause of death, especially for young individuals [69], and the main threat to otters in Bucharest, Romania, was car traffic [36]. Where otters persist, significant efforts are being made to minimize incidents. In South Korea, the use of signboards alerting motorists to reduce speed for otter protection, along with car navigation systems providing a warning when nearing a spot of common otter roadkill, are measures to prevent and avoid otter mortality [70]. Traffic signs warning of otters nearby, speed reductions in areas of high mortality risks, and otter warnings on GPS apps are effective ways to prevent otter death. Managing stray pets, especially dogs, is another way to prevent not only otter fatalities but other species as well.

2.6. Promote Positive Public Perception

In urbanized areas where wildlife is seldom seen, Eurasian otters can be a charismatic species garnering positive attention from locals, and cooperation between local citizens, conservation agencies, and governments is crucial for future otter success [71]. In Singapore, smooth-coated otters (*Lutrogale perspicillata*) made a comeback in part due to positive public opinions from residents. A combination of social media [72] and local and international news sources tell stories and follow the lives of urban otters, giving them a personality that draws the interest of locals [54]. While the growth in population has been encouraging, the rise in numbers has led to an increase in negative interactions. The number of negative interactions, including biting incidents and fishing in private ponds, has become a source of tension for local inhabitants [73]. Similar events involving private ponds and commercial fishers have occurred with Eurasian otters [32,74,75]. In Hong Kong, fish farmers conveyed mixed emotions toward Eurasian otters—largely negative in regard to their impact on fish stocks and mostly positive toward otter conservation [76]. Social media sites like Facebook and Instagram [77] are an excellent tool to bring attention to Eurasian otters. Videos demonstrating the charisma of the species, specifically focusing on individual otters, can attach human emotions to them and draw the interest of residents. Along with social media, including locals in restoration and conservation activities gives a sense of purpose and creates a connection with nature [78]. Specific otter groups like The Otter Working Group [54] comprise government and private agencies whose roles include otter rescue, conservation, public education, and the mitigation of negative human–otter interactions.

Table 1. Six principles for improving urban otter habitats.

Principles for Improving Urban Areas for Eurasian Otters	Description	Citation
Enhance Habitat Structural Complexity	Importance of river islets, woody debris, and large rocks for habitat complexity	Martin-Collado et al., 2020 [38]; Wang et al., 2022 [41]; Kim et al., 2024 [55]
Restore Natural Riparian Vegetation and Habitats	Plant native trees and shrubs along the water's edge to provide breeding and resting sites	Tolrà et al., 2024 [9]; Weinberger et al., 2019 [40]
Safeguard Water Quality	Prevent point and nonpoint pollution sources from entering the water, maintain water clarity by cleaning up plastic and waste, and restore surface flow	Esposito et al., 2020 [5]; Singh et al., 2023 [37]; Marcelli et al., 2012 [63]; Lee et al., 2020 [64]
Provide Native Prey Species	Enhance native prey species while suppressing invasive species	Dettori et al., 2019 [31]; Kruuk and Moorhouse., 1991 [65]; Ruiz-Olmo et al., 2001 [66]
Reduce Otter Mortality	Reduce traffic collisions and mortalities from stray animals	Fusillo et al., 2022 [69]; Kim et al., 2011 [70]
Promote Positive Public Perception	Drive interaction through social media, garner public participation, and proper governance can increase otter awareness	Khoo and Lee., 2020 [54]; Tan., 2021 [72]; Kowarik et al., 2025 [78]

3. Outlook

Several urban river restoration projects have focused on principles similar to the ones listed above, even when otters are not the focus. For example, the Cheonggye Stream in Seoul, South Korea, was reconstructed to better mimic its natural state [79]. By reintroducing native riparian vegetation, restoring the watercourse, and improving hydrological connectivity, the species diversity increased from 17 to 400, and the water quality increased substantially [64]. Kim et al. [80] evaluated the Cheonggye Stream as a potential habitat for Eurasian otters using a habitat suitability index and found that multiple areas of the restored stream were suitable for otters. The utilization of daylighting (restoring previous open waterways) by removing concrete was an effective method for increasing biodiversity, and restoring surface flow enhanced water quality [64]. In another example, the LIFE+ RIPISILVANATURA project in Spain was implemented for the removal of the giant reed (*Arundo donax*) along the Segura River [81]. Eurasian otters responded positively to the restoration efforts [25], with otter spraint intensity increasing to 1.8 spraints/100 m compared to 0.76 spraints/100 m on the unmanaged section [82]. In addition to large-scale restoration projects, focusing on small urban habitats like ponds can provide resources to numerous species [83].

While not tailored to Eurasian otters, restoration projects valuing principles similar to those developed in this paper can have a positive impact on otter populations. The above examples demonstrate that when urban governments or other organizations embark on urban ecosystem regeneration projects in riparian areas, success is possible, and in fact, otters can benefit significantly. It is also clear that urban riparian areas, having been restored as otter habitats, will provide increased biodiversity and other conservation values.

4. Conclusions

The six principles we have outlined can provide a structural guide for improving urban habitats for Eurasian otters and overall biodiversity. Enhancing habitat structure complexity, restoring natural riparian habitats, safeguarding water quality, providing prey species, reducing mortality, and promoting positive public perception create a template for urban enhancement that strengthens otter populations and ecosystems as a whole. The principles we identified for benefiting otter populations and biodiversity are intertwined and can be accomplished at the same time. We suggest a plan starting with improving habitat structure complexity, increasing riparian vegetation, and altering channel shapes to their natural state. The addition of large woody debris and rocks, riparian trees and shrubs, and alluvial inlets provides resting sites and a buffer for Eurasian otters while also increasing species diversity. Restoring surface flow is an effective method to increase water quality. To prevent mortality, the use of signboards, fences, and technology is an effective method of reducing otter deaths. To bring about positive public opinions, the use of social and news media displays the charismatic behavior of Eurasian otters and creates a connection between the public and the otters. Otter-focused groups provide education to the public and help prevent and resolve negative human–otter interactions.

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