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Under the bridge: marking sites prove the presence of Eurasian otter *Lutra lutra* in the Poljanska Sora River valley, Slovenia

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Abstract. Knowledge on distribution of the Eurasian otter (*Lutra lutra*) in Slovenia in the past was very limited, due to the lack of studies of this species. Hunting and persecution reduced the species distribution area and densities. After its legal protection in 1973, the species seems to have increased in population size. A few studies had shown the Eurasian otter repopulating the Alpine region. To confirm the presence of the species in the Slovenian Pre-Alps, we searched for otter scat – spraint, on six tributaries to the Poljanska Sora River of Polhograjsko hribovje, the Pre-Alpine mountains around Polhov Gradec. Otter marking sites were exclusively in the riverbed (100 %), with a great majority found under the bridges (83 %). Using camera traps, we were able to collect video evidence of the otter reproduction and confirm that the species is reproducing in the studied region. Since this area could act as a corridor for the otter's recovery in the Adriatic River basin, it is crucial to continue to monitor its presence and the potential expansion to the west of the country.

Key words: *Lutra lutra,* recolonisation, alpine streams, marking behaviour, ecology

Izvleček. Pod mostom: markiranje evrazijske vidre *Lutra lutra* potrjuje njeno stalno prisotnost v Poljanski dolini, Slovenija – Znanje o pretekli razširjenosti evrazijske vidre (*Lutra lutra*) v Sloveniji je zaradi pomanjkanja študij pomanjkljivo. Lov in preganjanje živali sta pripomogla k upadu številčnosti osebkov in območja razširjenosti. Z zavarovanjem vrste leta 1973 se je populacija sčasoma ponovno prostorsko in številčno razširila. Nekaj študij tudi nakazuje na ponovno poselitev Alpskega območja. Za potrditev vidre v slovenskem predalpskem prostoru smo iskali iztrebke vider – vidrekov na šestih pritokih Poljanske Sore s Polhograjskega hribovja. Mesta iztrebljanja vidre so bila izključno v strugi potoka (100 %), ki so bili večinoma pod mostovi (83 %). Prek uporabe avtomatskih fotopasti smo zabeležili video dokaze o reprodukciji in s tem potrdili, da razmnoževanje že poteka v predalpskem prostoru. Ker je območje študije koridor do Jadranskega povodja, je to lahko pomembno območje za povezovanje in okrevanje populacije v Jadranskem povodju. Zato je ključno za nadaljnje spremljanje širjenja proti zahodu države.

Ključne besede: *Lutra lutra*, rekolonizacija, alpski potoki, markiranje, ekologija

Introduction

In the mid-20th century, the Eurasian otter (*Lutra lutra*) was considered a widespread species in Slovenia, which was hunted and prosecuted. This decimated its numbers, pushing the species close to extinction in many parts of the country (Kryštufek 1991, Balestrieri et al. 2015). Lack of studies limited the possibility to evaluate their true extent at the time. The only available data about the historical otter distribution were hunting bags, showing a decimation of population in Slovenia since 1940 (Kryštufek et al. 1986). After the legal protection of the species in 1973, hunting bags were not available anymore and no monitoring was established ever since, even after 2004 (Hönigsfeld Adamič 2003) when Slovenia adopted the EU legislation and listed the Eurasian otter as a Natura 2000 species in 12 reference areas (Hönigsfeld Adamič 2003). Thus, the knowledge of the species distribution in Slovenia is currently restricted to data acquired from locally limited small scale studies (Hönigsfeld Adamič 2003, Hönigsfeld Adamič et al. 2011).

The Poljanska Sora River Valley is one of many Alpine river valleys for which reliable data on the presence of otters are lacking (Kryštufek 2001). In 2019, however, some information about observations of otters in the Poljanska Sora River were published in a local fishermen news websites (Križnar 2019). These observations indicate the Eurasian otter might have returned to the Slovenian Alpine region, completing the findings from Austria where the return of the species was the fastest amongst the Alpine countries (Kranz & Poledník 2020, Loy & Duplaix 2020). The closest area to the Poljanska Sora River Valley, where the presence of the Eurasian otter has been confirmed, is the Ljubljansko barje with tributaries from southern slopes of Polhograjsko hribovje, the Pre-Alpine mountains around Polhov Gradec (Kryštufek 2001, Hönigsfeld Adamič et al. 2009, Hönigsfeld Adamič et al. 2011).

The most straightforward and cost-effective method for detecting the presence of otters is to search for their scat, also called spraints. These are usually found in the proximity of their dens, called holts, or at feeding sites (Kruuk 2006). A high number of spraints indicates regular presence of otters in an area (Guter et al. 2008). The relationship between otter densities and spraint abundance can vary between different habitats and seasons (Lampa et al. 2015, Sittenthaler et al. 2020). As otters are territorial, spraints are used for marking their territory, as well as for other communication among the individuals living on the same shared territory, like establishing and/or maintaining social hierarchy, key food sources, or finding a mate (Trowbridge 1983, Kruuk 2006, Remonti et al. 2011). Some otter territories are used by several females at the same time with different and exclusive core areas, usually around holts, where they spend most of their time. Territories of males, which are usually larger, overlap with several female's territories (Kruuk & Moorhouse 1991). Due to a solitary lifestyle, two or more otters seen together are usually a female with her young (Kruuk 2006).

Spraints are easily identified by their shape and odour, which resembles fish oil. They are mostly deposited on surfaces or objects, which are standing out from their surroundings, such as large rocks striking form the water, confluences, grass tussocks in the riverbed, or on the riverbanks (Lampa et al. 2015). For example, otters living in slow-flowing rivers in karst poljes usually deposit spraints on the grass tussocks, meadows or moles on the riverbank (Krofel & Potočnik 2016). Human structures such as bridges with concrete shelves and other surfaces

underneath can also provide an important site for marking, as they protect the spraints from weather conditions (Hönigsfeld Adamič 2003). An otter marking site is considered as an area where spraints are deposited within 1 m or are grouped (Kruuk et al. 1986). These sites can be used repeatedly by same individuals or even by several generations (Hönigsfeld Adamič 2003). Besides spraints, otters can also chemically communicate via urinating and cheek rubs (Hönigsfeld Adamič et al. 2011).

An initial discovery of signs indicating the presence of otter in the nearby area of the Poljanska Sora River Valley in spring 2020 (the Mavelščica stream; Kraševec own unpublished data) motivated us to explore the presence of the species in the Poljanska Sora River Valley and determine whether reproduction occurs. We first systematically searched for otter spraints in the fast-flowing alpine streams to confirm the otter presence in the study area. Then we analysed otter marking behaviour through listing accurate locations of the spraints in the fast-flowing alpine streams and comparing them to the ones typical for lowland slow-flowing water habitats (e.g. grass tufts on stream banks).

Materials and methods

Study area

We conducted our study in in the Poljanska Sora River Valley (Central Slovenia) on small alpine streams, all of them being southern tributaries to the Poljanska Sora River between Gorenja vas and Škofja Loka. The streams all originate in the northern slopes of Polhograjsko hribovje, which is largely protected as a Polhograjski Dolomiti Landscape Park. The mountains range consisting of dolomite and limestone is situated in the central part of Slovenia between the Poljanska Sora River in the north, the Gradaščica River to the south, and to the Brebovščica stream to the west (Fig. 1). The Poljanska Sora River is the only larger body of water in the area, being a small to medium sized river (with average discharge of approximately 10 m^3/s) with strong torrential character (ARSO 2021). It is one of the Sava River tributaries, part of the Danube River basin.

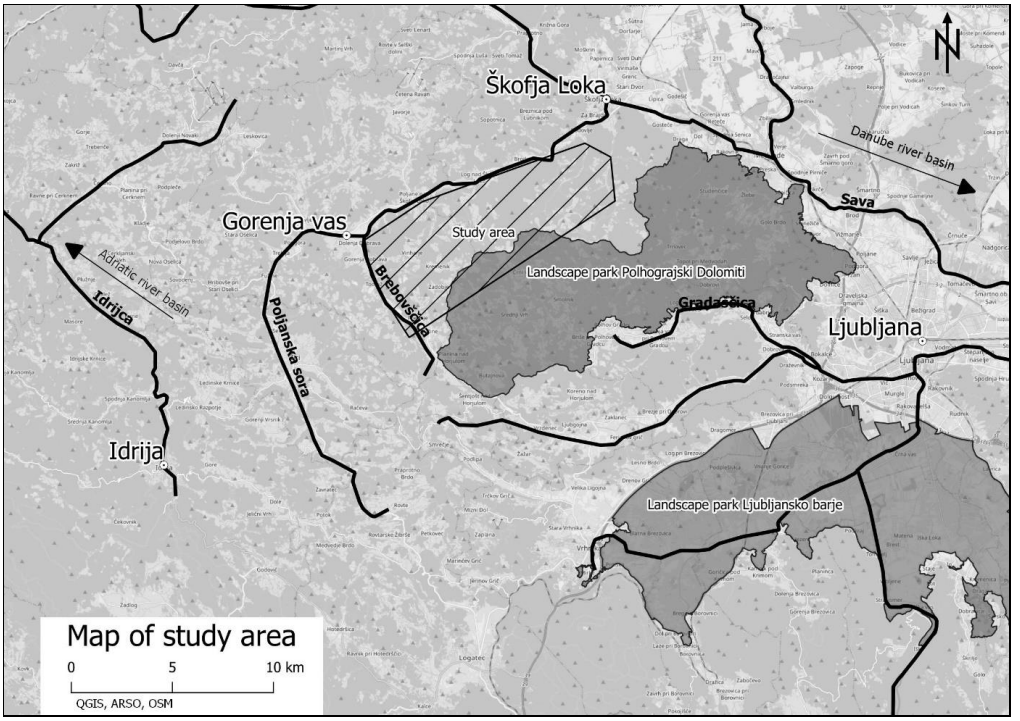

Figure 1. A map showing the overview of the study area and nearby protected areas of nature. Only major rivers important for the understanding of the study are marked down, and the Brebovščica stream limiting the study area. Flows towards the Adriatic and Danube River basins are also shown.

Slika 1. Zemljevid s prikazom območja raziskave ter bližnjih zavarovanih območij narave. Prikazane so samo glavne reke, ki so pomembne za razumevanje raziskave, ter potok Brebovščica, ki omejuje študijsko območje. Označeni sta tudi smeri toka proti Jadranskemu oziroma Donavskemu povodju.

The studied streams are fast and cascading in the upper parts with deep valleys and very steep, impassable banks in some parts, which distinguish them greatly from the lowland slow-flowing waters. Lower parts of the streams are also relatively fast flowing with easily accessible riverbanks. The widths of the streams range from 1 to 5 metres, with average discharge 0.15 m^3/s and with strong torrential character. Streambanks are mostly covered with mixed forest in the upper parts, whereas the lower parts of the valley also include cultivated fields, artificial landscapes with human infrastructure, houses, and small villages. Some of the streams are channelized in parts. No stagnant waters exist in the vicinity.

Study design

Field work was carried out on July 20 and 21, 2020. We searched for spraints under bridges, the most probable location for finding otter marking sites (Kruuk 2006). Each bridge represented a sampling site. Additionally, we surveyed 50 m upstream and 50 m downstream from the sampling site, both in the streambed and on the streambanks, in the width of 6 m from the stream (Fig. 2). The standard otter survey method recommends 600 m transects, but we chose 100 m transects, which represent more than 60% probability of detection if otter is present (Mason & Macdonald 1987).

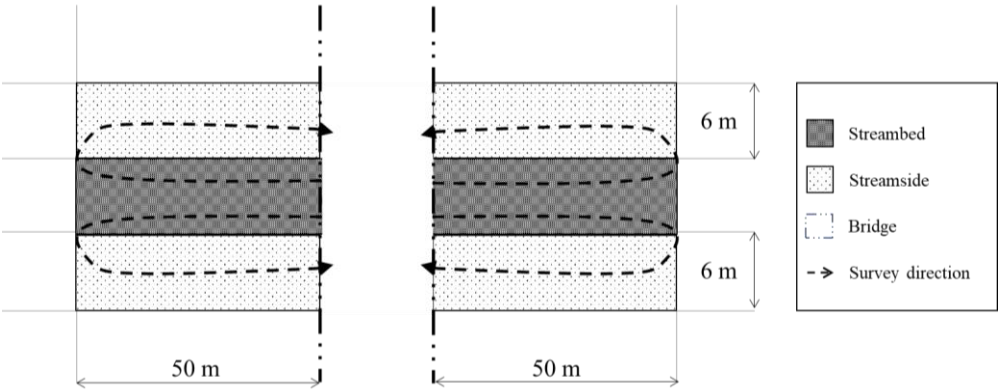

Figure 2. Otter spraint survey protocol scheme. We searched the streambed (dark grey), and 6 metres of streambank (light grey) 50 metres upstream and downstream from the bridge (dots and lines).
Slika 2. Shematski prikaz protokola iskanja vidrinih iztrebkov. Preiskali smo strugo (temno siva) in 6 metrov široki pas brežine (svetlo siva), 50 metrov gorvodno in dolvodno od mostu (črtkana črta s pikami).

The field work was carried out on 29 sampling sites on 6 different streams (Brebovščica, Todražica, Hotoveljščica, Sovpat, Bodoveljščica and Hrastnica). Most of the sampling sites were located downstream on parts of the stream that were closer to the outflow to the Poljanska Sora River. Our highest bridge was at an altitude of 611 metres and the lowest at an altitude of 366 meters. The number of sampling sites per waterbody was between 2 and 9 (Tab. 2). We chose sampling sites regardless of the type (wooden, concrete, etc.) and size of the bridge, i.e., culverts, up to 6 metres in length, and minor bridges, ranging from 6 up to 60 metres in length. The bridges were mostly of local importance. We had selected our sampling sites prior to the field survey. If it turned out that the water underneath our chosen sampling site was not accessible, we surveyed the adjacent sampling site instead. All sampling sites on the same water body were surveyed in the same day. At each sampling site (e.g., bridge), we categorized artificial changes of the streambed based on anthropogenic changes made to the banks (Natural, banks on both sides of the stream are not modified by humans; Moderately modified, banks are modified by less than 50% of our surveyed area or only one bank is almost completely modified by humans, while the other is strictly not; Artificial, banks are almost completely modified by humans), and the streamside land use (Meadow, area adjacent to the stream is covered mostly by meadows and/or fields; Forest, area adjacent to the stream is covered mostly by forest and/or shrubs; Artificial, area adjacent to the stream is mostly modified by humans) (Tab. 1).

Table 1. Category of streambank modification and type of surroundings 6 metres from the edge on each sampling site, with given proportions (n=116). Darker colour of the field matches the higher percentage.
Tabela 1. Kategorije spremenjenosti rečne brežine in tip okolice 6 metrov od roba struge na vsakem vzorčnem mestu, s podanimi deleži (n=116). Temnejša obarvanost polj se ujema z višjim deležem.

Type of streambank/ Tip okolice / **Streambed modification/ Spremenjenost struge**	Forest/ Gozd (n = 50)	Meadow/ Travnik (n = 31)	Artificial/ Umetno (n = 35)	Total/ Skupno
Natural/Naravno (n = 80)	42.2	17.2	9.5	68.9
Moderately modified/Zmerno spremenjeno (n = 14)	0.9	2.6	8.6	12.1
Artificial/Umetno (n = 12)	0.0	6.9	12.1	19.0
Total/Skupaj	43.1	26.7	30.2	

We identified the spraints following the descriptions from Krofel & Potočnik (2016). Then we determined if the location of found spraints was a marking site or not, based on whether a single spraint or a group of them was found. Finally, we set up 3 camera traps (MAGINON 4WKD) as a supplemental method to monitor the otter presence (for locations see the description of Fig. 4).

Results

We confirmed the presence of otters where otter spraints were detected, hence we confirmed the presence of otter under 17 out of 29 sampling sites (Fig. 4), located on 4 out of 6 surveyed streams (Tab. 2). On one of these sampling sites (site number 1) where spraints indicated otter presence, we also video recorded two otters at the same site together (Fig. 5).

Table 2. An overview of the distribution of sampling sites along selected streams, their full lengths, and the number of found marking sites and collected samples.
Tabela 2. Podrobnejši prikaz razporeditve števila vzorčnih mest, markirnih mest, št. vzorcev in dolžin obravnavanih vodotokov.

Stream/Potok (km)	No. of sampling locations/ Št. vzorčnih mest	No. of marking sites/ Št. markirnih mest	No. of samples/ Št. vzorcev
Brebovščica (9.4)	9	2	66
Todražica (3.8)	2	2	15
Hrastnica (9.3)	2	0	8
Sovpat (2.8)	4	0	0
Hotoveljščica (3.1)	4	0	0
Bodoveljščica (7.1)	8	2	25
Sum/Skupno	29	6	114

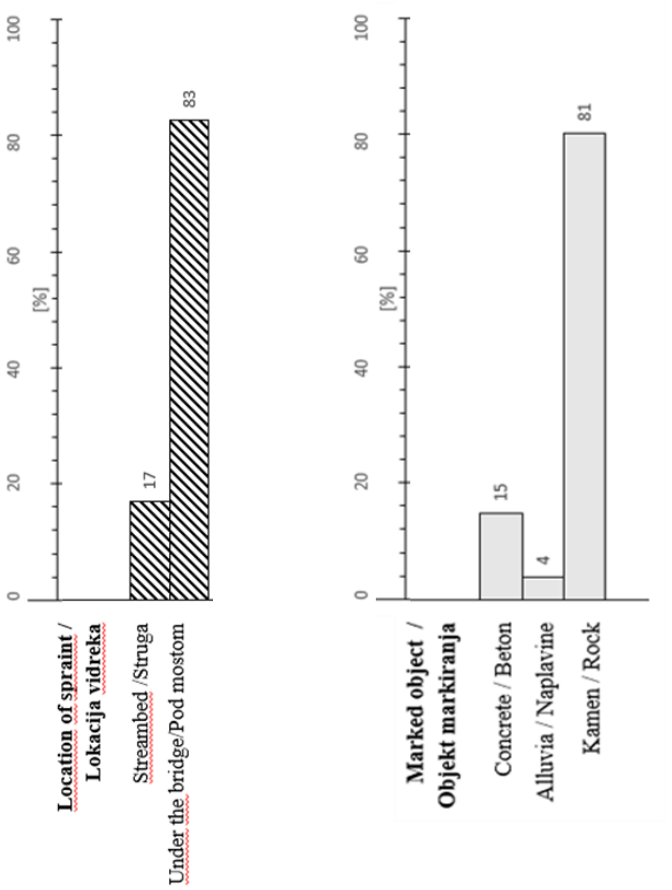

Figure 3. Location of otter spraint (left), and marked objects (right), according to the frequency of occurrence in percentage (%) of occurrence of all spraints (n = 114).
Slika 3. Lokacije vidrinih iztrebkov (levo) in objekti markiranja (desno), izraženi v deležu (%) vseh iztrebkov (n = 114).

In total, we found 114 otter spraints, with 7 ± 5 spraints per sampling site (Tab. 2). The majority of them were located under bridges (83%) or in the streambed nearby (17%). We did not find any spraints outside the streambed. At this point it must be stressed that almost half of the riverbanks were not surveyed because of their inaccessibility for the research team. On the other half, which was surveyed, we did not manage to find any spraints. The ones found in the streambed were mainly deposited on rocks (Fig. 3), but concrete shelves under bridges or other concrete structures and river debris were also used for defecating. Spraints were found individually (70%), or in groups on marking sites (30%), consisting of spraints which were undoubtedly of different age.

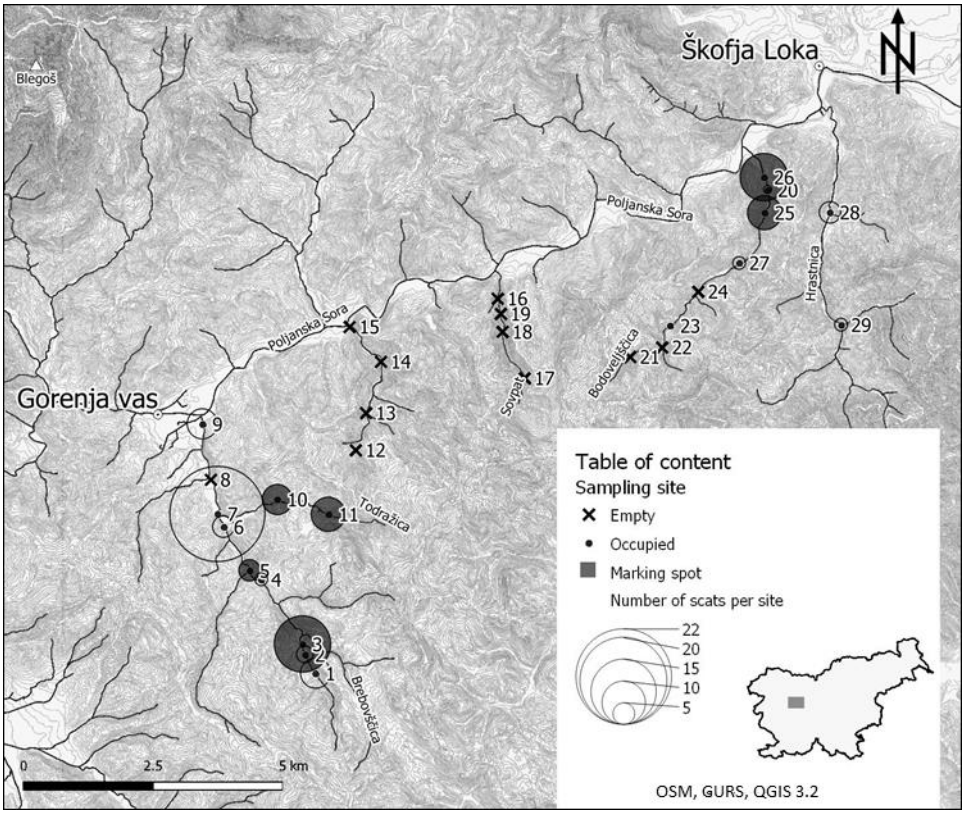

Figure 4. A map showing localities of field sampling sites in the Poljanska Sora River Valley, between Gorenja vas and Škofja Loka. The size of the circles corresponds with the number of otter (*Lutra lutra*) spraint found on the location. The crosses mark sampling sites without any spraint found. Dark colouring indicates the presence of a marking spot. Sampling was carried out under roadway bridges as well as 50 metres upstream and downstream. We set up camera traps on sampling sites 1, 3 and 10.

Slika 4. Zemljevid s prikazom lokacij mest terenskega vzorčenja v Poljanski dolini med Gorenjo vasjo in Škofjo Loko. Velikost točk ponazarja število vidrinih iztrebkov (*Lutra lutra*) na vzorčnem mestu. Križci ponazarjajo prazna vzorčna mesta, brez najdenih iztrebkov. Temna obarvanost označuje markirna mesta. Vzorčenje je potekalo pod cestnimi mostovi in 50 metrov tako dolvodno kot gorvodno. Avtomatske fotopasti smo namestili na vzorčna mesta 1, 3 in 10.

Figure 5. Screenshot from camera trap video, showing two otters present at the same time, probably a mother with her young. Video was recorded 20.7.2020 on the Brebovščica stream.
Slika 5. Zajem zaslona videoposnetka avtomatske foto pasti, na katerem sta vidna dva osebka, najverjetneje samica in njen mladič. Posneto 20. 7. 2021 na potoku Brebovščica.

The vast majority (68.9%) of streambank sampling sites were classified as »Natural«, followed by »Artificial« (19%) and »Moderately modified« (12.1%). The main type of habitat in the surroundings was the »Forest« category (43.1%), followed closely by the categories »Artificial« (30.2%) and »Meadow« (26.7%) (Tab. 1).

Discussion

Despite the short duration of our study, we were able to show that the Eurasian otter is widely present in the Poljanska Sora River Valley. This is also confirmed by the fisherman's occasional observations from the previous year (Križnar 2019). It cannot be assessed whether the otters had been present in the area long before, due to the lack of studies (Kryštufek 1991, 2001). Based on our study, we can confirm their presence via target studies of marking sites on different tributaries, originating in Polhograjsko hribovje, of the Poljanska Sora River.

Due to the fact that our study area lacked information on otter presence (Kryštufek 1991, Kryštufek 2001), the number of streams and sampling sites (Fig. 4) confirming the presence of the species in this alpine valley is encouraging. Our study area is comparable to the habitat in Austria, where otter density studies related to the spraint density, which were done and confirmed with genetics (Sittenthaler et al. 2020).

According to the Austrian studies, we estimate 0.16 – 0.28 otters per km of waterway could inhabit the Poljanska Sora River Valley. This means that regarding the spraint distribution in our study area (35.5 km of waterways), the area could potentially be inhabited by 6 to 10 otters. Video record of two otters confirmed that reproduction already occurs (Kruuk 2006).

Our results of assessment of the habitat around sampling sites indicate a rather well-preserved habitat for the otter (Tab. 1). For otter to be able to colonise an area, it is important that the streambanks and the adjacent areas are natural to at least some extent. Dense and woody streambank vegetation and canopy (shrubs and trees), bare roots and stones that form holes in the riverbanks (potential holts), as well as inaccessibility to humans, are some of the most important factors determining the suitability of habitat for the Eurasian otter (Mason & Macdonald 1987).

Due to the wide distribution of otters in the Poljanska Sora River basin, it could be predicted that the species distribution could soon extend from the Danube River basin and connect with the Adriatic river basin where the species was absent or only occasionally present (Gregorc & Nekrep 2010, Hönigsfeld Adamič et al. 2010, Balestrieri et al. 2015). The connection and extension of the range would significantly improve the species conservation status in Slovenia.

Contrary to some publications stating that otters use mainly grass tufts located on riverbanks and adjacent areas as marking sites (Krofel & Potočnik 2016), our results show that otters living in fast-flowing alpine streams with steep riverbanks exclusively use the streambed area, more accurately, the sections under bridges, as their preferred sprainting sites (Fig. 3). First, the alpine environment is topographically very different from a typical karst or other lowland area where most of the studies were done (Krofel & Potočnik 2016). Otters might not be able to reach the area surrounding the stream because of the steep slope of the streambanks, or because otters mostly use the streambed, sprainting in the streambed could be more successful for effective communication between individuals. Moreover, otters prefer to spraint where their chemical signal can persist for as long as possible (Hutchings and White 2000). Bridges provide cover from precipitation and heat (Hönigsfeld Adamič 2003) and spraints are therefore probably emitting chemical signal for longer periods than those deposited in places with no cover. The use of rocks and concrete structures under the bridges, as the most common, but not exclusive, surface for droppings, can also be confirmed in the variety of other studies (Macdonald 1980, Kruuk 2006, Hönigsfeld Adamič et al. 2011). It must be highlighted, however, that in many cases the streams were followed by nearby roads (not directly quantified, but also categorised as »Artificial« surrounding, Tab. 1), making a part of the area adjacent to the stream completely unsuitable for a typical otter marking site, typical in the lowland slow-flowing water habitats. On the other hand, no spraints were detected even in the meadows representing more than a quarter of the streambanks and often adjacent to a naturally shaped streambed (Tab. 1).

Even though we initially planned to visit more streambanks, they could not be accessed due to dense vegetation or steep slopes of the riverbanks. Consequently, it is possible we might have missed some sprainting sites outside the streambed. We, however, do not expect that otters would choose such areas for marking, as they prefer to spraint in conspicuous areas where their signal will be available, accessible and obvious to other otters (Gorman & Trowbridge 1989).

Further genetic analyses would give a better insight in the detailed demographic parameters of the otter population in the area (Sittenthaler et al. 2020), while further (at least local) scale studies such as ours could help reveal the expansion of otter towards the Adriatic river basin. We suggest that our study offers a good start of otter studies in the area, and that additional surveys of the Eurasian otter should be done in summer, or in winter to early spring. The tendency of otters marking in that time is up to ten times more often (Kruuk 1992) and the river's still unfoliaged vegetation allow us easier access for surveying a larger area of streambanks. To evaluate the status of the otter population on the national scale, extensive national monitoring scheme should be established.

Povzetek

Na območju desnih pritokov Poljanske Sore, ki izvirajo v severnem delu Polhograjskega hribovja (Sl. 1), smo med 20. in 21. julijem 2021 opravili raziskavo ekologije evrazijske vidre (*Lutra lutra*). Namen raziskave je bil potrditi njeno prisotnost, ugotoviti njeno razširjenost ter način markiranja in potencialno zaznati razmnoževanje na območju.

Za kune (Mustelidae), med katere sodijo tudi vidre, je značilen kemičen način markiranja, kjer prek iztrebljanja na zelo očitnih mestih, kot so kamni, štori in ožine, označujejo svoj teritorij. Prav to lastnost velja izkoristiti med številnimi raziskavami vider ob domnevi, da iztrebki v določenem območju pomeni tudi prisotnost vidre (Kruuk 2006). Za zaznavanje vidrinih iztrebkov, t. i. vidrekov, smo uporabili prilagojeno standardizirano metodo za ugotavljanje prisotnosti vidre. Namesto priporočenih 600-metrskih smo opravili zgolj 100 metrov dolge in 12 metrov široke transekte ob mostovih (Sl. 2) (Mason and Macdonald, 1987). Kljub temu to še vedno ustreza več kot 60-odstotni verjetnosti za zaznavo vidrekov, če so le ti na območju opaženi (Mason & Macdonald 1987). Vsak transekt je bil razdeljen na več delov, in sicer most, breg in struga (Sl. 2). Slednja sta bila kategorizirana glede na oceno naravnega stanja posameznega dela vodotoka (Tab. 1). Naše študijsko območje je zajemalo 6 vodotokov, in sicer Brebovščico, Todražico, Hotoveljščico, Sovpat, Bodoveljščico in Hrastnico.

Vidro smo potrdili na 4 od 6 vodotokov oz. na 17 od 29 lokacij (Tab. 2). Vsega skupaj smo zaznali 114 vidrekov, od katerih so bili prav vsi (100 %) v strugi, večinoma (83 %) pod mostovi (Sl. 3). Prav tako smo z uporabo avtomatskih foto pasti v objektiv na lokaciji št. 1 ujeli dve vidri, skoraj zagotovo samico z njenim mladičem (Sl. 5). Evrazijska vidra je namreč samotarska vrsta in opažanje dveh ali več vider hkrati ponavadi pomeni, da gre za samico z njenim mladičem oz. mladiči (Kruuk 2006).

Z našo raziskavo smo potrdili prisotnost ter razmnoževanje evrazijske vidre in zabeležili njeno razširjenost na južnih pritokih Poljanske Sore (Sl. 4). Ugotovili smo veliko preferenco do markiranja v strugi (Sl. 3). Ugotovili smo, da se slednje namreč precej razlikuje od načina markiranja, ki je značilen za nižinske vodne habitate, kjer se vidra približno v dveh tretjinah primerov iztrebija na območju ob vodotokih (breg ali zaledje), kot je prikazano v Krofel & Potočnik (2016). Domnevamo, da gre pri tem za razliko v topografiji območja, saj so v nižinskem območju bregovi bolj dostopni kot v predalpskem. To dejstvo dokazuje, da ob popisu tudi za nas skoraj polovica bregov ni bila dostopna, prav tako najverjetneje tudi za vidre. Takšna gostota iztrebkov in markirnih mest v podobnem habitatu v Avstriji pomeni, da bi na kilometer vodotoka lahko živelo od 0,16 do 0,28 vider (Sittenthaler et al. 2020), zato bi v južnih pritokih Poljanske Sore, ki skupaj tvorijo 35,5 km vodotokov, lahko živelo od 6 do 10 vider.

Genetske analize bi omogočile boljši vpogled v podrobne demografske parametre populacije vidre na tem območju, medtem ko bi nadaljnje (vsaj lokalne) ekološke študije, kot je naša, pomagale razkriti širjenje vidre v jadransko porečje. Za podrobnejšo obravnavo stanja populacije vidre v Sloveniji pa je nujna vzpostavitev nacionalnega monitoringa vrste.

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