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Research Article

The efficiency of artificial latrines to detect and describe distribution patterns of the Pyrenean Desman (*Galemys pyrenaicus*)

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Abstract

The traditional methods for detecting the Pyrenean Desman, based on animal trapping or detecting faeces in streams, were logistically cumbersome, and their efficiency varied in space and time. More recently, researchers started using artificial latrines to enhance the detection of faeces, but so far, there is no information on whether their use changes in space and time. To test this, we deployed 51 artificial latrines through the Artikutza Valley (Navarre, North Iberian Peninsula) and surveyed them over 1.5 years to answer the following questions: i) does baiting latrines with Desman faeces from elsewhere affect their use? ii) does latrine use vary over the year and across the valley? Baiting latrines with faeces reduced their use frequency. The use of latrines showed minor variations across time and space and was not affected by extreme weather effects. Comparisons with simultaneous trapping campaigns show latrines to be more efficient than nases at detecting Desmans and suggest that frequency of latrine utilization could be used as an indicator of Desman abundance.

Introduction

Repeated population distribution and density monitoring are essential to assess the trends of wildlife species (Caughley and Sinclair, 1994). In the case of endangered species, researchers try to avoid capturing individuals and, therefore, often rely on indirect detection methods such as camera traps, counting footprints or scats, often linked to baits or other attractants (Orrock and Connolly, 2016; Walters et al., 2013). Nowadays, molecular genetic techniques can identify the species that deposited the scat (Gillet et al., 2015b; Walker et al., 2016). However, these methods are expensive and difficult to carry out in large geographical areas. Nevertheless, the scats of some species, such as the Eurasian otter (*Lutra lutra*), are relatively easy to identify visually, thus allowing routine monitoring (Mason and Macdonald, 1986).

The Pyrenean Desman (*Galemys pyrenaicus*, Geoffroy, 1811; Insectivora, Talpidae) is a 60-70 g semi-aquatic mammal mainly inhabiting clean mountain streams. It is a solitary animal that appears to be territorial. It hides in crevices, roots, and boulder piles on stream banks, whereas it feeds mainly on aquatic macroinvertebrates (Richard, 1986) captured in riffle areas (Esnaola et al., 2021). The distribution of Desmans was traditionally assessed from trapping (González-Esteban et al., 2003) and surveys of faeces along the stream (Nores et al., 1992). Fresh Desman faeces are easy to identify from odour, size, shape and colour (Nores et al., 1992), but as they age, they can be mistaken with those of other small mammals such as *Neomys sp.* or *Rattus sp.* (Gillet et al., 2015a). Desman range has been determined from scat surveys (Bertrand, 1992; Nores et al., 1992; Queiroz et al., 1998), although the efficiency of these surveys is highly variable depending on the region (Charbonnel et al., 2015; González-Esteban and Podra, 2014) as well as on the weather, as scats are washed away during rainfall (Aymerich and Gosálbez, 2014). So far there are no studies on Desman's presence based on camera trapping.

The Pyrenean Desman is protected by the Bern Convention (Annex 2) and the European Habitat Directive (Annexes 2 and 4) (Council of the European Communities, 1992). Its range has decreased dramatically in recent decades (Charbonnel et al., 2016; Quaglietta et al., 2018), which has led to it being downlisted from Vulnerable to Endangered by the International Union for Conservation of Nature (IUCN) (Quaglietta, 2022). Currently, no method exists for estimating the number of Pyrenean Desmans in a territory.

To improve Desman surveys, González-Esteban et al. (2018) built artificial latrines in riffle sections of the stream channels. These consisted of a small mound of boulders where Desmans deposited abundant faeces, covered with a mattress to prevent rain from washing away them. Recently, video recordings (https://www.ehu.eus/streamecology/currentprojects.html) showed that Desmans use latrines mainly as marking posts, not as resting sites. This observation opens the question of whether "baiting" the latrines by imprinting them with scats from other reaches would enhance their performance. It must be noted that, although Desman faeces in a latrine are proof of the presence of this species, their interpretation is still obscure, as it is unclear whether all individuals use latrines, nor whether latrine use changes depending on the site and the season. The current research aims to analyse the efficiency of artificial latrines to detect and describe the Pyrenean Desman distribution patterns. Specifically, we aimed to answer the following questions:

- What is the persistence of latrines in the field?
- Does scat-baiting affect the attractiveness of latrines to Desmans?
- Does latrine use change through space and time across a river network?

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Materials and methods

Study site

Artikutza is a steep mountain valley in the north of the Iberian Peninsula, draining ca. 6500 ha of forested land over granite and shale (Figure 1). The average yearly precipitation is over 2500 mm, and the average air temperature is 12.2 °C (http://meteo.navarra.es/). Streams in the valley are among the best preserved in the region and host a diverse community of invertebrates and a good population of Pyrenean Desman (Esnaola et al., 2018). In 1919, the municipality of San Sebastian built a 42-m-tall dam in Enobieta Stream for water supply, but the reservoir was emptied in 2019 as a first step towards its final decommissioning (Atristain et al., 2022). Desmans were present upstream from the reservoir when the dam was built, but they disappeared in the following decades, apparently as a consequence of genetic isolation. The Desman, though, recolonised the entire Enobieta Stream shortly after the reservoir drawdown (Arturo Elosegi, pers. obs.). The Desman can be captured by multiple predators, including the Eurasian otter and the grey heron, both present in Artikutza. However, there is no information on their effect on Desman populations.

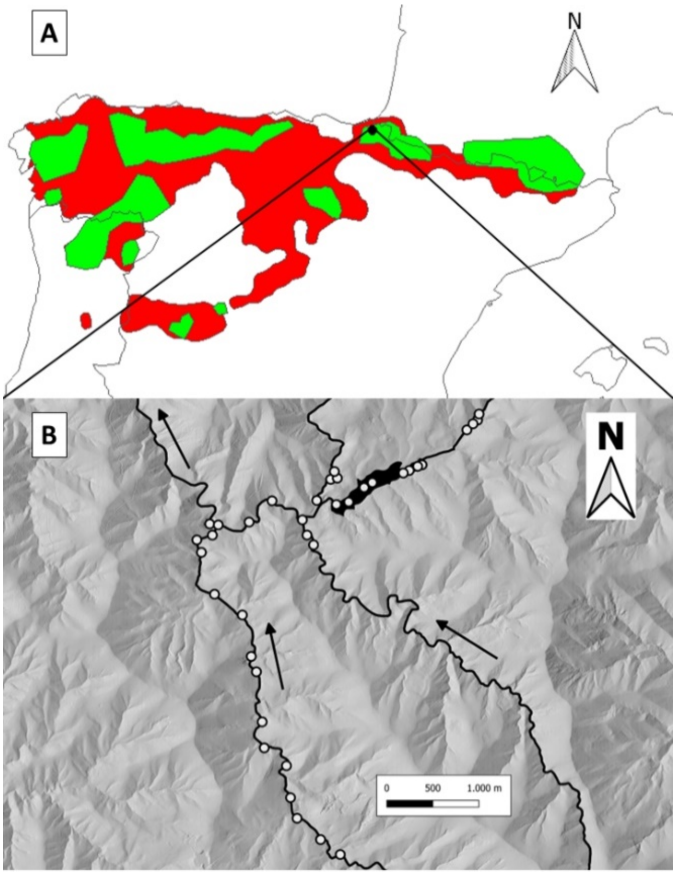

Figure 1 – (A) Historical (in red) and current (in green) distribution of the Pyrenean Desman and location of the study site (black dot). (B) The stream network in Artikutza Valley with the location of artificial latrines (white dots). The black area represents the area formerly drowned by the Enobieta Reservoir, and the black arrows indicate the flow direction.

Field procedure

We surveyed latrine use along 10 km of streams, selected so that a single person could check all of them on a fieldwork day (Fig. 1). The latrines were built according to González-Esteban et al. (2018). First, a mound of stones was built, forming an island in the middle of a shallow riffle (10–30 cm deep) to provide a flat surface and multiple crevices easily accessible to the Desmans. In order to ensure the persistence of droppings, the mound was covered with a high-density ethylene vinyl acetate (EVA) foam mat (630 × 630 × 12 mm), folded onto forming a "roof" that covered a dry platform of ca. 0.25 m^2 (Fig. 2). The mat was secured in place with stones and tied by a string to a nearby branch to avoid losing it during floods. The space between the stones and the "roof" was less than 10 cm to prevent its use by larger animals (e.g., white-throated dippers *Cinclus cinclus*).

To assess the effects of scat-baiting on latrine use, we installed seven pairs of latrines in the study area. In each pair, one latrine was left as a control (unbaited), the other was baited by smearing the underside of the mat with faeces from other sites in the valley (Fig. 2). This was done to avoid mixing the primed and new faeces and to ensure that the effect lasted as long as possible despite changes in streamflow. Once both latrines were in place, they were visited after 2, 5, 10 and 15 days. During each visit, we recorded the number of faeces per latrine and washed them afterwards to avoid double-counting of faeces.

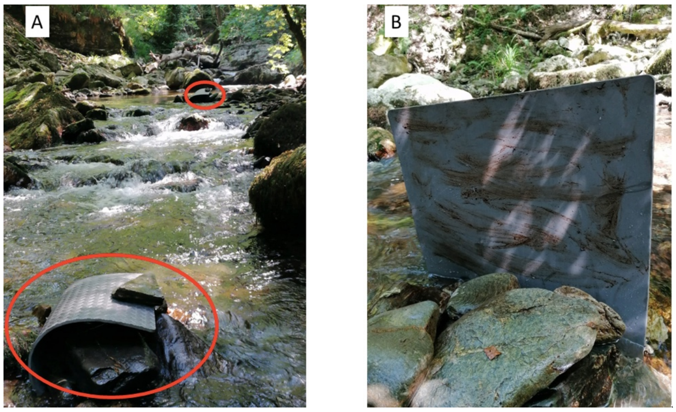

Figure 2 – (A) A pair of latrines in the stream, highlighted with red ellipses. (B) An example of a baited latrine open for revision. Photos: Jon Levy-Otheguy.

To study the change in latrine use over space and time, we deployed 37 latrines across the river network (Fig. 1). The latrines were built by a team of 2 persons in a single day and were monitored at 15-30 day intervals from 1 May 2021 to 1 August 2022, for a total of 26 visits. During each visit, all latrines were checked, the number of scats counted, the scats were removed by gently washing them with water from the stream, and latrines destroyed by flooding or other causes were reconstructed. Only scats with evident Desman characteristics (size, shape and smell) were counted. *Neomys* does not occur in Artikutza, and previous cross-checking with metabarcoding of Desman scats collected by the research team found 100 % correct assignation (González-Esteban et al., 2018; Esnaola et al., 2021).

Statistical analyses

To determine whether baiting affects latrine use, we first compared the use rate —null vs positive— of baited and unbaited latrines utilising a paired t-test. Subsequently, we built locally estimated and smoothed scatterplot (LOESS) models (Cleveland and Devlin, 1988; Fox and Weisberg, 2018) with those data, to assess the values where the use rates reached and asymptote. We set the alpha at 0.49 to obtain an accumulation curve, meaning all local regressions include 49 % of the data to plot the curve (Jacoby, 2000). To test whether baiting affected the number of scats, we performed a Wilcoxon paired test, as the distribution of the number of scats was not normal (Shapiro-Wilk test, $W = 0.74656$; p-value = 0.0012).

We also based on null vs positive data to analyse the latrine use over space and time. The use rate of all the latrines across the study period was plotted using a LOESS with an alpha set at 0.7. Then, using the Kruskal-Wallis test, we determined whether the use rate differed among the four seasons —Autumn, September to November; Winter, December to February; Spring, March to May; Summer, June to August— and the 37 survey sites, by pooling data respectively across sites for each season and seasons for each site.

All data analyses were performed using R software (R Core Team, 2022).

Results

i. Latrine persistence

From May 2021 to July 2022, 144 latrines were found out of order, which amounts to 10.7 ± 22.8 % of the latrines per visit. This number was highly variable: on some visits, all latrines were in working conditions, whereas floods over 5 m^3/s destroyed all latrines. Apart from floods, common causes of latrine dysfunction were changes in discharge (e.g., latrines getting out of the wet channel as the discharge receded), clogging by leaf litter, and disruption by people or animals (most possibly livestock or wild pigs).

ii. Baiting and latrine use

Out of 7 latrine pairs, Desmans used five unbaited but only three baited latrines (Fig. 3A), the difference being statistically significant (Paired t-test t = −3.207, df = 4, p-value = 0.033). On the contrary (Fig. 3B), scat abundance did not differ between baited and unbaited latrines (Wilcoxon paired test W = 2.5, p-value = 0.22).

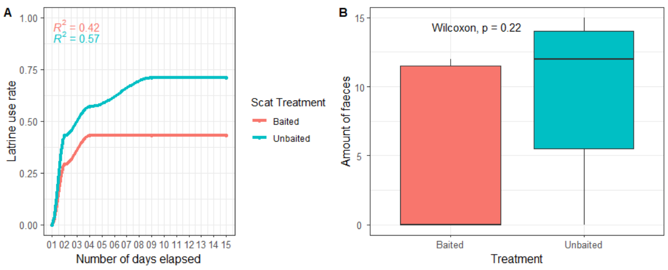

Figure 3 – (A) LOESS models of the use rates of baited vs unbaited latrines from their installation (day 1) to the end of the experiment (day 15). (B) Amount of faeces found in baited vs unbaited latrines.

iii. Latrine use across space and time

The average rate of latrine use during the study period was 54.09 ± 18.52 % (Fig. 4), with a maximum of 81.8 % for two latrines in Elama Stream and a minimum of 8.7 % for two others in Enobieta Stream. The average number of scats per day per latrine was 0.49 ± 0.17. We could not identify any particular environmental characteristic of the most used latrines. In contrast, the least used two were in the old reservoir, where the river infiltrates and tends to dry out during the summer. This is the only stretch of river with these characteristics in the study area. Latrines were used throughout the year. Even if the use rate was somewhat lower in winter and in May-June, the Kruskal-Wallis test showed differences among seasons not to be statistically significant (Season: Chi-square = 6.39, df = 3, p-value = 0.094). Also, the use of latrines did not change after floods, even after large ones, such as that of 09-12-2021 (101.5 m^3/s), which caused large-scale movements of the streambed.

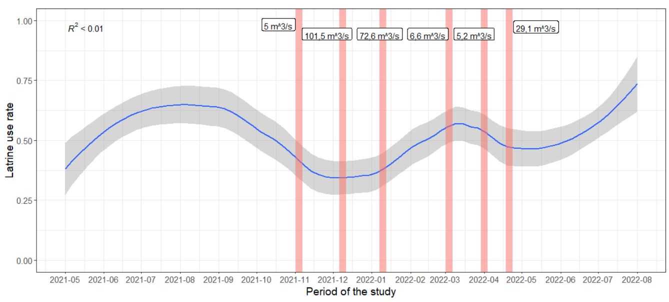

Figure 4 – Latrine use rate during the study period, adjusted by the LOESS model (blue line) with a 95 % confidence interval (grey). Red vertical bars represent periods of latrine disturbance caused by floods (for each bar, peak discharge as measured at the Añarbe gauging site in the lower part of the valley.

In addition, the seasonal use rate of each latrine was analysed (Fig. 5). The Kruskal-Wallis test showed that differences between latrines were not statistically significant (Site: Chi-square = 48.43, df = 36, p-value = 0.081). Spatial patterns of latrine use showed no evidence of major Desman movement across the valley in response to, for example, periods of flooding, as would be reflected in long stream sections devoid of Desman signs in some periods. The only changes detected were minor, as mentioned, due to a stretch in Enobieta Stream drying out during summer.

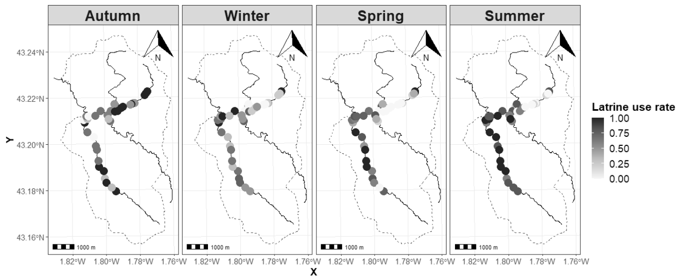

Figure 5 – Seasonal variation of the use rate of individual latrines.

Discussion

González-Esteban et al. (2018) showed latrines to offer a cheap and reliable method to detect the Pyrenean Desman, one that was more efficient than the current standard method described by Queiroz et al. (1998) of searching scats along river reaches. Nevertheless, it remained unclear whether latrines are used throughout the year and whether their use shifts spatially, as a consequence, for instance, of Desmans taking refuge from large floods in the small streams. Our results confirmed the use throughout the year and no marked changes in the spatial distribution of latrines used, which stresses the advantages of the latrine as a method to detect and describe distribution patterns of the Desman. On the other hand, as floods and other agents can destroy latrines, they are better deployed when flooding is not expected, and the mats should be tied to nearby trees or rocks to prevent losing them. Nevertheless, latrines failing was only 10.7 % over more than a year, much lower during low-flow periods, which suggests this can be an efficient routine method for Desman surveys.

Our results showed that baiting with faeces reduced latrine use significantly. Mammals rely on scent – i.e. faecal – marking in various contexts and functions (Eisenberg and Kleiman, 1972; Johnson, 1973). The response to alien marks may vary accordingly. Alien faecal pellets placed in a rabbit's home territory elicit intense marking (Mykytowycz and Hesterman, 1970), whereas, in other species, marks may warn other animals to keep out of the occupied territory (Johnston, 2003; Vlautin, and Ferkin, 2013).

So far, little is known about Desman latrine use behaviour. Although video recordings suggest latrines are primarily used as marking places, it is still unclear whether their use is sexually biased. As latrines are frequently washed away, it is unlikely that the Desman marking behaviour relies too much on the presence of previous scats. Empty caddisfly cases found at times in latrines suggest that, at least occasionally, these are used as places to eat. Additionally, the number of excrements per latrine may inform about their use. In our case, a few latrines, especially the one in the confluence of Artikutza and Elama Streams, usually had more scats than the rest, although we have yet to learn the reasons behind this difference. Also, we have to find out the defecation rate of Desmans and the proportion of defecation in latrines. These questions are relevant as they could open the door to estimating population density using latrines. More information is necessary to understand and correctly interpret latrine use by Desmans entirely.

Our results show that the Pyrenean Desman is detectable throughout the year and that the areas of positive detection differ very little within a valley. Although the spatial distribution of latrines used varied with the seasons, these variations seemed to reflect changes in marking activity or, perhaps, in the availability of natural latrines.

In the longer term, temporal changes in latrine use frequency could be used as an indicator of changes in population density, at least when used consistently in the same area and assuming a relatively constant defecation rate by individuals. Our results amounted to 0.49 ± 0.17 scats per day per latrine, much lower than the 1.38 ± 0.80 per day per latrine we measured six years earlier in the same valley (Amaiur Esnaola's PhD Thesis, unpublished data). It is interesting to note that in 2016, we also had a much higher success trapping Desmans than in 2022 (0.36 Desmans per night per trap in 2016 vs 0.07 Desmans per night per trap in 2022). These changes in trapping frequency are consistent with those on latrine use and seem to reflect fluctuations in the Artikutza Desman numbers. The population dynamics of Desmans are not known. However, given their low density, low reproductive rate and long-life expectancy for an animal of their size, it seems reasonable to assume relatively stable populations over time, as in the case of moles (gen. *Talpa*) (Gorman and Stone, 1990), a taxonomically close group. Our experience, albeit anecdotal, contradicts this belief, as Desman captures in Artikutza have been highly variable over the years, perhaps because it is a population isolated from other nearby ones by the Añarbe reservoir, which disconnects the Artikutza Valley from the rest of the Urumea Valley, to which it belongs. Whatever the case, the fluctuations in population density – as judged from changes in catchability and latrine use – point towards a bleak future for this population.

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