MSc Land and Ecological Restoration

Research Project

The New Beast of Bodmin Moor: Prey Availability for Reintroducing European Wildcats *Felis silvestris* to Cabilla Cornwall

Emma Williams

BSc Zoology

2022

Table of Contents

1. Abstract

Britain's only native feline species, the European wildcat *Felis silvestris,* is now functionally extinct due to persecution, habitat loss and hybridization in the remaining Scottish populations (Breitenmoser et al., 2019). Hope now lies in captive breeding more genetically robust wildcats in zoos and release into suitable habitats throughout the UK, with projects ongoing in the Scottish Cairngorms by Saving Wildcats and in Devon with The England Wildcat Strategy (Breitenmoser et al., 2019; Gow et al., 2019). Macpherson et al., (2019) identified large areas of Cornwall as a further suitable area for wildcat reintroduction through habitat modelling (Macpherson et al*.,* 2019), however, this is yet to be tested. Wildcat prey and shelter are significant factors in habitat suitability (Lozano et al., 2006; Silva, Kilshaw, et al., 2013; Silva, Rosalino, et al., 2013), this paper aimed to explore the feasibility of reintroducing wildcats to Cornwall by researching the available prey base of small rodents and European rabbits *Oryctolagus cuniculus,* estimating how may wildcats these prey populations could support and make recommendations for in-depth habitat suitability surveys. Surveys focused on a wildcat catchment surrounding Cabilla Cornwall, the proposed reintroduction site, in two closed, sheltered habitats of deciduous and coniferous woodland and two open habitats of pastureland and dwarf shrub heathland. Rabbit abundance was higher in open habitat types than in closed, although the results were not powerful enough for a significant finding. The reverse was found in closed habitat types with significantly more small rodents than in open habitats. These results suggest wildcats may focus hunting behaviour in open areas for their preferred rabbit prey but have a diverse range of prey available in the event of a disease outbreak. This study was able to estimate the populations of three out of seven prey species, estimating these could support 22 wildcats. This suggests a viable population of 40 wildcats may be feasible for reintroduction at Cabilla Cornwall, upon determining further prey populations which this study could not complete fully. Recommendations for further in-depth prey base and habitat suitability surveys are made, in addition to land management recommendations to improve wildcat habitat in Cornwall. Finally, further reintroduction considerations are explored, such as mitigating hybridization and road mortality risks and outlining social feasibility study requirements.

Key Words: *European wildcat, European rabbit, small rodent, species reintroduction, ecosystem restoration, rewilding.*

2. Introduction

2.1. Species History & Status

There are five distinct biogeographic populations of wildcats across Europe **(Figure 1)**, which split during the last ice age, with hybridisation being prevalent in Scottish and Hungarian populations (Mattucci et al., 2016). Once widespread across Britain, wildcats have suffered a long history of persecution, starting during the Tudor times with the ‘Vermin Acts’ which rewarded a bounty for their heads (Anderson, 2005), and later by sporting estates and gamekeepers through the 18-19th centuries, causing them to retreat to two distinct populations in Scotland (Langley & Yalden, 1977). Breeding with domestic or feral cats *Felis. silvestris. catus* led to deep hybridization in the remaining Scottish populations (Sainsbury et al., 2019), undermining their genetic integrity. Wildcats are legally protected Europe-wide on Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (Yamaguchi et al., 2015), and acquired protected status on Schedule 5 of the Wildlife and Countryside Act (1981) in 1988 (Breitenmoser et al., 2019). This aids the International Union for the Conservation of Nature (IUCN) reintroduction guideline that their original extinction pressure, persecution, is no longer present (IUCN/SSC, 2013). Although listed by the IUCN Red List as ‘Least Concern’ in Europe (Yamaguchi et al., 2015), populations are declining and a revised status is soon to be published (Langridge, personal communication, 18 February 2022; Monterroso et al., 2009). They have also been a priority species on the UK Biodiversity Action Plan (BAP) since 2007, requiring conservation precedence (Breitenmosser et al., 2019).

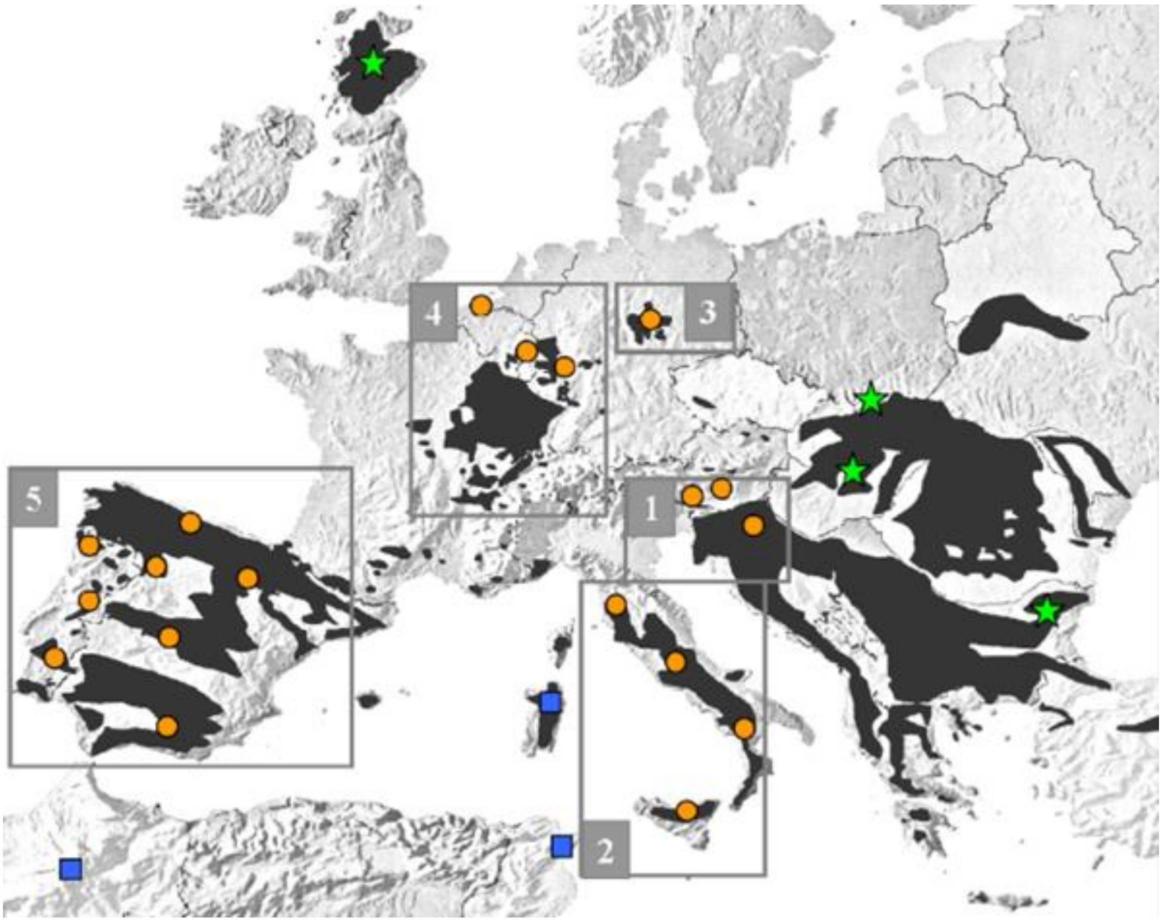


Figure 1. European wildcat *Felis silvestris* distribution, in dark areas: numbered squares and circles show five biogeographic groups; stars show populations with high hybridization with *F. s. catus* in Scotland and Hungary; African wildcats *F. s. libyca* are shown by squares (Mattucci et al., 2016).

2.2. Focal Species

European wildcats *Felis silvestris*, or woodcats as they are also referred as, are not to be confused with the general use of the term 'wildcat' which also refers to all members of the *Felidae* family. They are distinct from domestic cats in their genetics, coat markings **(Figures 2 & 3)** and behaviour, being tabby brown & tan, with black stripes, spots on their underside, no white fur and a distinct bushy banded and blunt tail (Kitchener et al., 2005). They are slightly larger, have longer legs and are more muscular than domestic cats, with males weighing 3.77-7.26kg and females 2.35-4.68kg (Kilshaw, 2011).

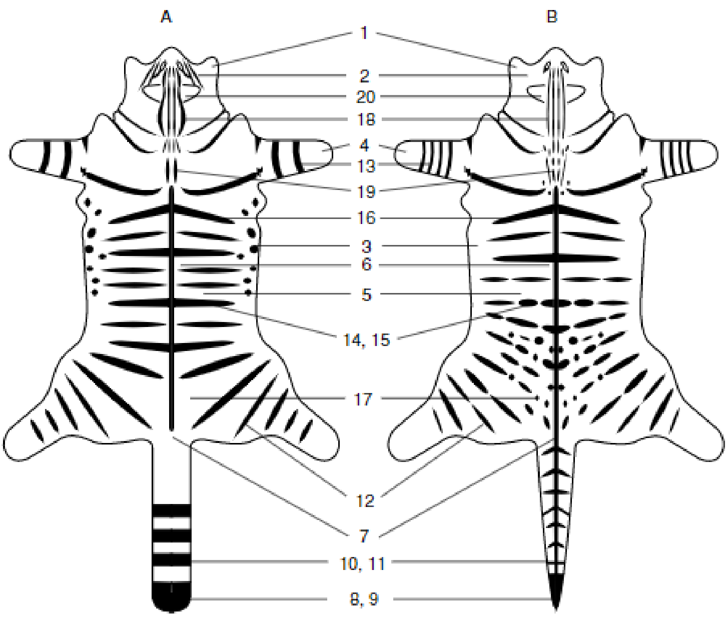


Figure 2. Pelage, or fur characteristics for (A) wildcats and (B) hybrid / domestic cats (Kitchener et al., 2005).

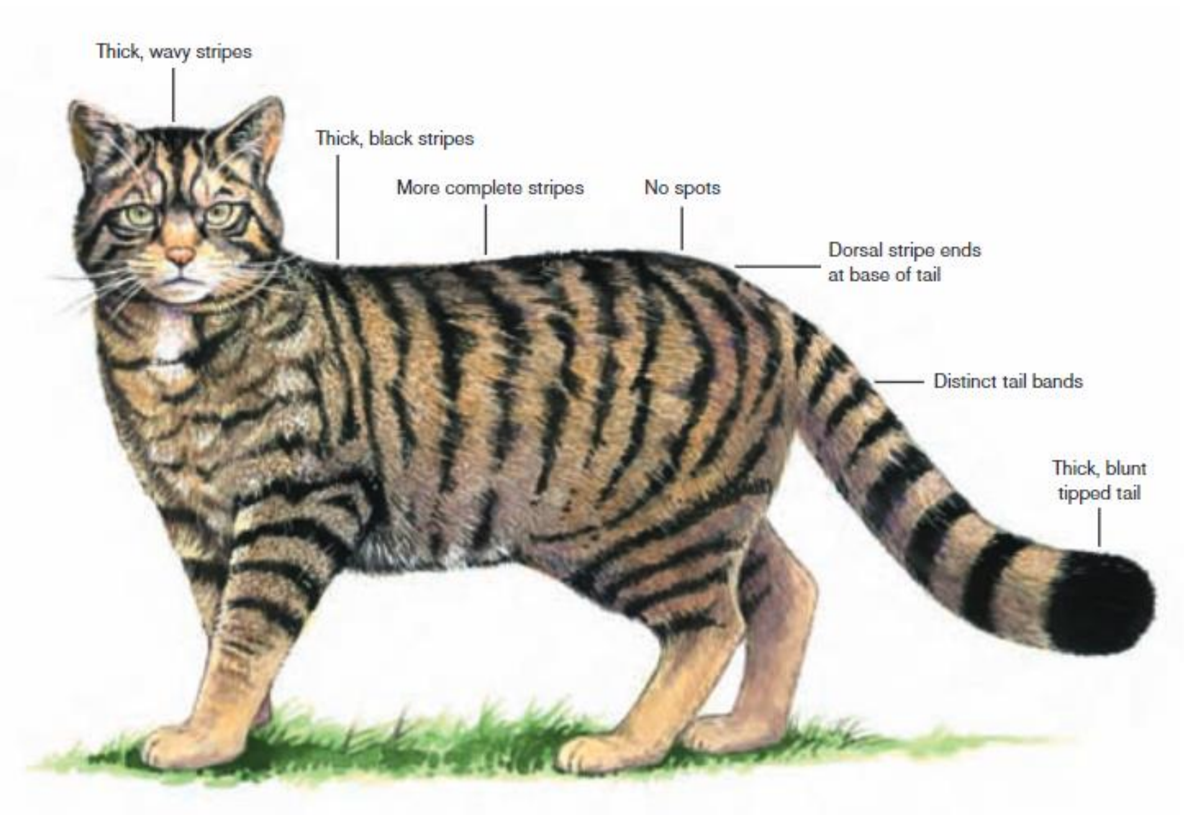


Figure 3. Wildcat pelage characteristics (Kilshaw, 2011).

Within their home range, wildcats utilize a mosaic of habitat (Lozano et al., 2003; Okarma et al., 2002; Silva, Kilshaw, et al., 2013; Wittmer, 2001), dependent on prey and shelter availability (Jerosch et al., 2018; Lozano et al., 2003a; Lozano, 2010; Moleon & Gil-Sanchez, 2003; Silva et al., 2013).

Core, sheltered wildcat habitat is deciduous woodland with dense undergrowth (Wittmer, 2001; Okarma et al., 2002; Lozano et al., 2003), which wildcats have been found to defend with faecal markings when prey resources are rich, to save energy in search of prey and more energy actively hunting (Piñeiro et al., 2015). Priority wildcat habitat in Scotland includes mixed or coniferous woodland (Macpherson et al., 2019), however, they rarely inhabit homogeneous coniferous forests with little understory for prey and shelter (Anile et al., 2019; Okarma et al., 2002; Silva, Rosalino, et al., 2013). This mosaic also includes key open hunting areas such as grassland, meadows, scrubland and heterogeneous agricultural land (Klar et al., 2008; Lozano et al., 2003; Lozano, 2010; Anile et al., 2019).

Wildcats tend to avoid human settlements (Monterroso et al., 2009), with models predicting wildcat occurrence to increase 200m from single houses and 900m from villages (Klar et al., 2008). Riparian areas are also predicted suitable habitat where they can use sheltered vegetation to move through villages (Klar et al., 2008), however, it is not clear if this is due to their unsuitability for farming and thus remnant strongholds of sheltered, prey-rich areas. Larger rivers present a barrier to dispersal (Hartmann et al., 2013), otherwise, they can swim across smaller rivers and use islands as steppingstones, evidenced by high levels of gene flow in populations in the Upper Rhine Valley, Germany (Hartmann et al., 2013; Würstlin et al., 2016).

Females’ affinity to deciduous woodland is linked to raising kittens where secure denning sites in tree cavities increase breeding success (Sarmento et al., 2006). Breeding takes place from January to March, with one litter per year of 1-8 kittens born from April to May (Kilshaw, 2011). Kittens are weaned at 12 weeks and stay with mum for 5 months, oestrus occurs again if they lose the litter, thus can be born up to August (Kilshaw, 2011).

Wildcats prefer introduced European rabbits *Oryctolagus cuniculus* when they’re abundant, forming 70% of their diet in high densities and predicting wildcat occurrence (Moleón and Gil-Sánchez, 2003; Malo et al., 2004; Lozano et al., 2006; Monterroso et al., 2009; Kilshaw, 2011; Silva, Kilshaw, et al., 2013; Silva, Rosalino, et al., 2013). In low rabbit densities, wildcat diets diversify to include rodents and small mammals (Malo et al., 2004; Moleón & Gil-Sánchez, 2003; Silva, Kilshaw, et al., 2013; Silva, Rosalino, et al., 2013). When rabbits are absent and rodents are not abundant, wildcats feed on fish, invertebrates, reptiles, birds and carrion (Kilshaw, 2011; Lozano et al., 2006).

2.3. Reintroduction Rationale

After recognizing in 2019 that Britain's only feline species is functionally extinct, hope now lies in captive breeding of more genetically robust wildcats in zoos and release into the wild (Breitenmoser et al., 2019). Saving Wildcats are an organization that is currently doing this in the Scottish Cairngorms, where hybrid and the risk of hybridization are still present (Breitenmoser et al., 2019; Gow et al., 2019), however, reintroducing wildcats into England and Wales will restore them to their historic range and provide a fresh start for a hybrid free population.

One of the principles and standards for The Society for Ecological Restoration (SER) is to restore ecological processes, which is key to restoring resilient, self-sustaining ecosystems (Gann et al*.,* 2019). This shows the necessity of this species' reintroduction to restore ecological interactions and processes of predation, aiding ecosystem functioning, as it has done with other reintroductions. A famous example of the impact of predator reintroduction is the gray wolf's *Canis lupus* return to Yellowstone National Park which reduced grazing pressure on trees by predating overabundant elk (Ripple and Beschta, 2012). Although Ripple & Beschta (2012) state a trophic cascade, where vegetation regeneration due to wolf reintroduction has benefitted many other species including bison *Bison bison*, beaver *Caster canadensis* and songbird species, care must be taken to consider all evidence and trophic interactions before drawing these conclusions (Fleming, 2019). The same must be done for wildcats, however, last year it was stated that not reintroducing wolves would have been more damaging to ecosystem functioning (Smith and Peterson, 2021).

Reintroducing the process of predation could improve prey population health as predators target sick, old and weak individuals (Carlson et al., 2007; Genovart et al., 2010). Dominant small rodent species compete with subordinate species (Glass et al., 1980; Gutman and Dayan, 2005) and predators may rebalance the ecosystem by opening up resources previously taken up by these dominant herbivores. The landscape of fear effect seen with invasive grey squirrels *Sciurus carolinensis* reaction to pine marten *Martes martes* reintroduction in Wales (McNicol et al., 2020) also raises questions about how wildcats may impact this damaging invasive species. Wildcats do, however, compete with red foxes *Vulpes vulpes* for space which have a similar diet (Rodríguez et al., 2020) and may dampen any ecosystem impacts of reintroducing another mesopredator. There is a lack of direct evidence comparing before and after ecosystem impacts of wildcat reintroduction, therefore, reintroductions provide an immense educational opportunity to learn more about this cryptic species by monitoring reintroduction outcomes.

Reintroductions can have unintended consequences which must be explored in the planning, implementation and monitoring phases of reintroductions (IUCN/SSC, 2013). For wildcats, this includes creating extinction risks for threatened prey species as their mesopredator counterparts, red foxes, do for endangered birds (Moreno-Opo et al., 2015). Conservation decisions post-reintroduction may exclude people from recreational activities in wildcat habitat due to their avoidance of people (Klar et al., 2008), and finally, reintroduction may cause unintended harm to the wildcats themselves through inadequate habitat suitability analysis.

Wildcats may benefit the restoration of further missing native predators to the British landscape, namely Eurasian lynx *Lynx lynx* and pine martens. They are an umbrella species, benefiting these woodland species if conservation measures are put in place to protect and restore core woodland habitat (Soyumert, 2020). In addition, predator reintroductions are a contentious current topic **(Appendix 4),** and successfully reintroducing one predator presents a steppingstone to social acceptance of reintroducing another predator. Lynx hold negative associations such as competition with deer stalkers, conservation of capercaillie *Tetrao urogallus* and sheep predation (Gray et al., 2017). Reintroduction benefits include predating overabundant deer populations which can facilitate woodland regeneration and reduce crop damage, in addition to lynx attracting wildlife tourists (Gray et al., 2017; Hetherington & Gorman, 2007; Vincent Wildlife Trust, 2022). Wildcats, red foxes and feral cats form a small part of the lynx's diet (Jobin et al., 2000). Reintroducing a top predator such as the lynx could, therefore, dampen the impact of these mesopredators on small rodents and vulnerable prey species, or reduce hybridization risks by predating feral cats. There was only one feral cat, one wildcat and 37 red foxes out of 617 kills in this study (Jobin et al., 2000), therefore before and after impacts of lynx reintroduction must be studied to fully understand the reintroduction of this trophic complexity.

Barriers to dispersal, a great dispersal distance and a slow dispersal rate can prevent these species and processes from naturally recolonising an ecosystem (Alakoski et al., 2021; Swinnen et al., 2017; Trakhtenbrot et al., 2005), warranting species reintroduction. In addition, climate change must be accounted for within ecological restoration due to the pressures imposed by changing biotic and abiotic conditions (Simonson et al., 2021). With threatened species covering a wider area, their chances of a sustained population are increased. Therefore, exploring the feasibility of reintroducing wildcats to Cornwall strengthens securing their future in the UK.

2.4. Reintroduction Site & Feasibility

A preliminary feasibility assessment of reintroducing wildcats to England and Wales was conducted by The Vincent Wildlife Trust (VWT) by modelling suitable wildcat habitat at $10km^2$ resolution (Macpherson et al., 2019). This used wildcat presence data in France to identify wildcat habitat predictor variables and then applied these habitat variables to England and Wales to identify potential wildcat habitat. Habitat types contributing to the model were broadleaf and mixed woodland, agricultural land, arable land, scrubland, natural grassland, conifer woodland, wetlands and water **(Table 1).** The study identified large proportions of Devon and Cornwall for further suitability assessment **(Figure 4)**.

Table 1. Contribution of habitat variables to the preliminary feasibility model of suitable wildcat habitat in England and Wales (Macpherson et al., 2019).

Variable	Description	Contribution %
Broadleaf mix	Summed area (ha) of 10km square with broadleaf and mixed woodland	62.1
Mean elevation	Mean elevation per 10km square	13.9
Agri-mosaic	Summed area (ha) of 10km square with heterogeneous agricultural land	5.4
Arable	Summed area (ha) of 10km square with arable and crop cover	4.7
Scrub	Area (ha) of 10km square with transitional woodland scrub cover	4.4
Natural grassland	Area (ha) of 10km square with natural grassland cover	4.1
Conifer	Area (ha) of 10km square with conifer woodland	1.4
Wetland	Area (ha) of 10km square with bogs, marshland and other wetland	1.3
Water	Summed area (ha) of 10km square with water bodies and water courses	0.7
Road density	Summed length (km) of major roads within 10km square	0.7
Population density	Human population density per 10km square	1.0
Moor and heath	Area (ha) of 10km square with moors and heathland	0.3

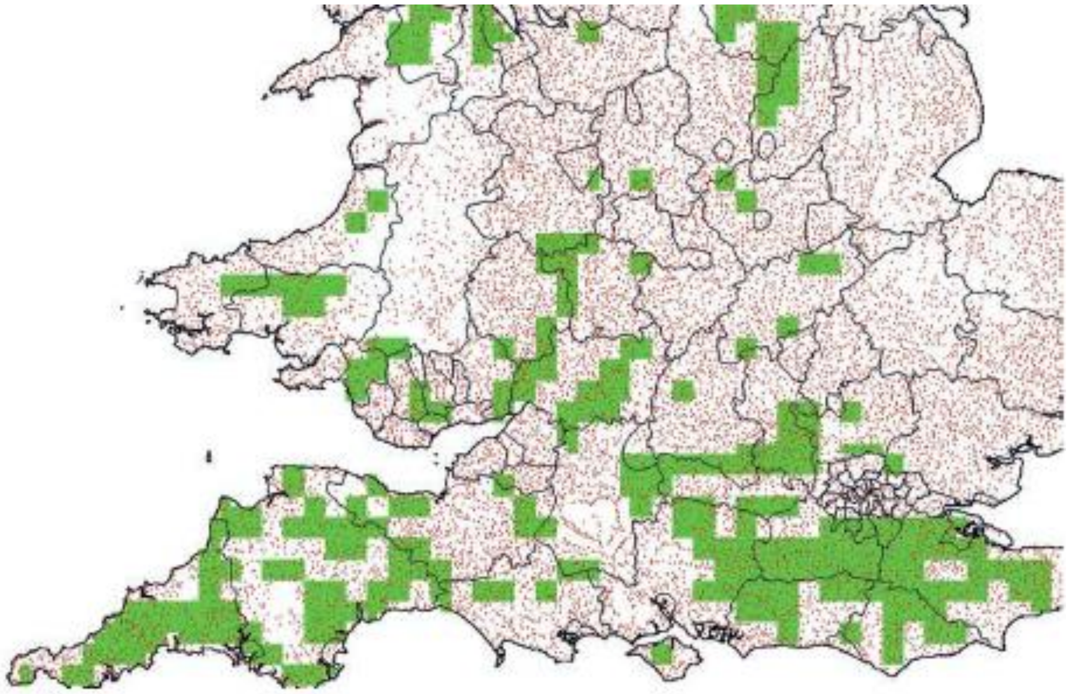


Figure 4. Predicted suitable habitat for European wildcats *Felis silvestris* in England and Wales is shown in green, at 10km^2 resolution, with human settlements shown in red, excluding major towns and cities(Macpherson et al., 2019).

Models of suitable habitat are a way to focus *in-situ* habitat suitability surveys as, in line with IUCN reintroduction guidelines, fine-scale biological suitability assessments are needed to assess the likelihood of reintroduction success (IUCN/SSC, 2013).

Cabilla Cornwall **(Figure 5),** is a traditional 300-acre upland hill farm on Bodmin Moor now in the process of ecological restoration. Cabilla has 30 acres of ancient Atlantic temperate rainforest on site **(Figure 6a),** a rare habitat restricted to a few global locations and designated a Site of Special Scientific Interest (SSSI). Cabilla is part of The England Wildcat Strategy, which exists to explore wildcat reintroduction in suitable areas of England. Along with forest restoration and after the successful reintroduction of European beavers *Caster fiber* in 2020 **(Figure 6b & c),** the site aims to reintroduce further native British species. Cabilla sits within the predicted suitable habitat identified by Macpherson et al., (2019) and is the focus of *in-situ* habitat suitability surveys for this study. The site has been identified by The England Wildcat Strategy, as a suitable reintroduction site due to the core sheltered woodland on site and Cabilla, therefore, aims to extend the UK’s captive wildcat breeding capacity and reintroduce Britain’s remaining feline species on site and to the Cornwall surrounds.

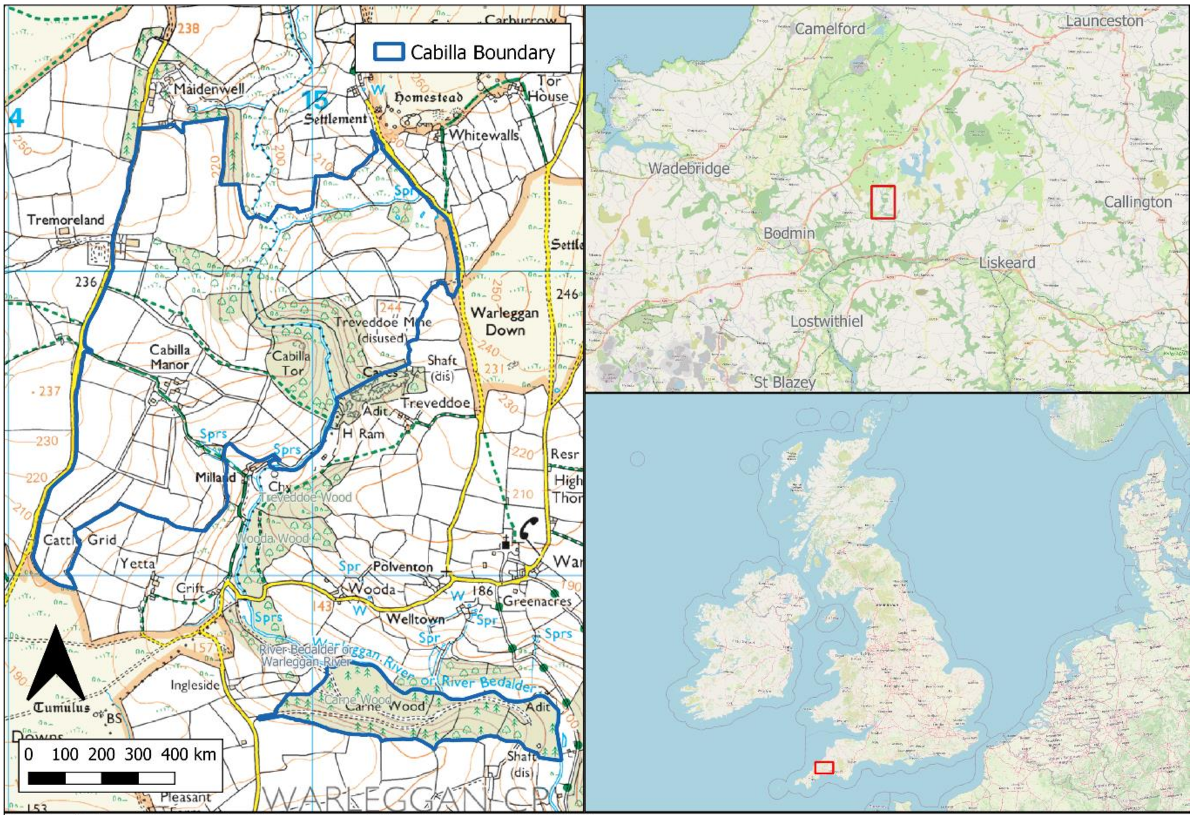
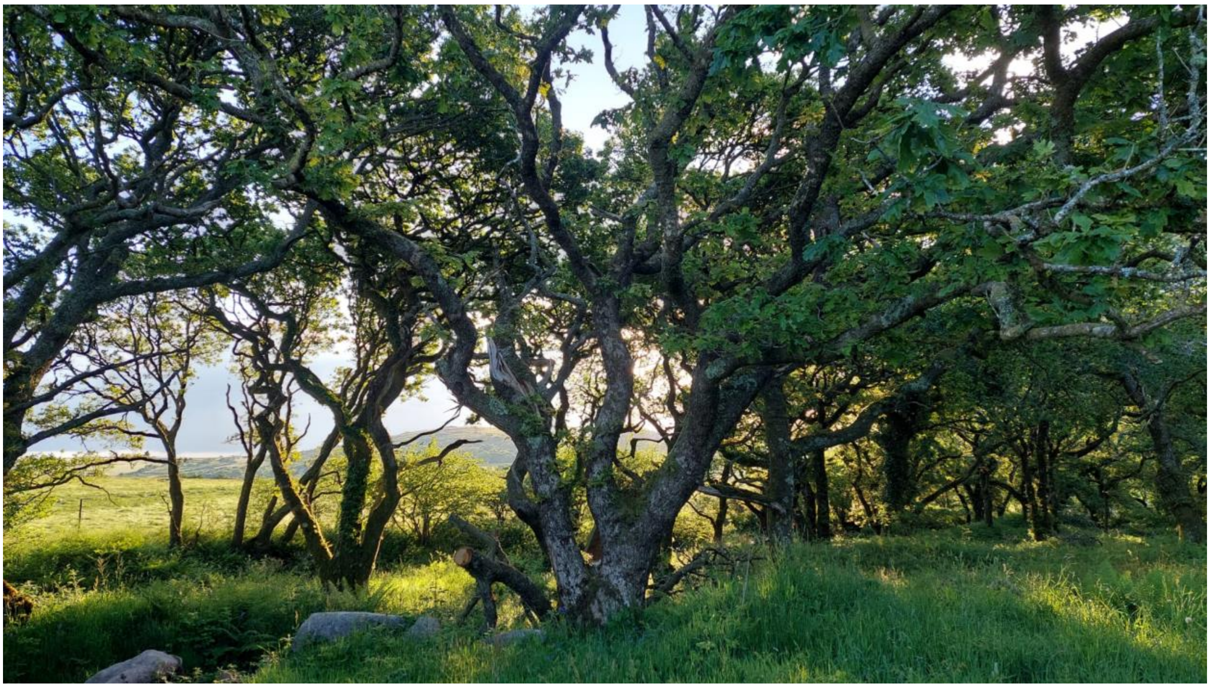


Figure 5. Cabilla Cornwall, a 300-acre upland hill farm on Bodmin Moor, now under the process of ecological restoration.

a)



b)

c)

Figure 6. Cabilla Cornwall a) 30 acres of SSSI Atlantic temperate rainforest on site b) two of the family of four European beavers reintroduced in 2020 and their first dam c) a characteristic felled tree by the beaver family.

My preliminary feasibility study for Cabilla places the species ecology in the context of the Cornwall surrounds by identifying a wildcat catchment and associated habitat composition **(Figure 7).** This catchment is based on the population viability analysis that a group of 40 wildcats (with a sex ratio of 1:1) would stand a 95% chance of surviving for 50 years (Littlewood et al., 2014) and that optimal habitat can support 3-5 wildcats per 10 km^2 (Sunquist and Sunquist, 2002), suggesting a viable population of forty wildcats would encompass an optimal habitat catchment of 80-133 km^2. Reintroduced populations can have substantially larger home ranges until territories are established (Anile et al., 2017), therefore, a generous wildcat catchment area of 150 km^2 for a viable population at Cabilla has been assumed. This catchment forms the basis of Cabilla Cornwall's habitat suitability surveys.

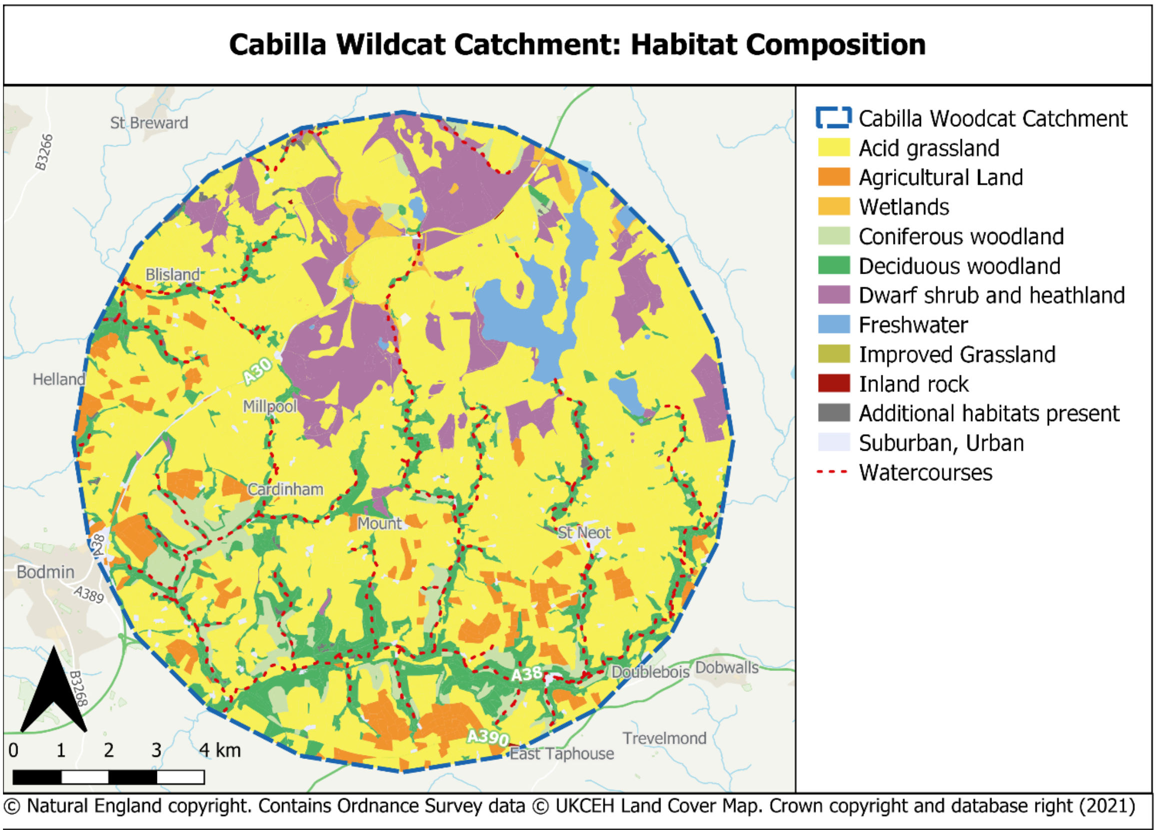


Figure 7. Watercourses and estimated habitat composition in the Cabilla wildcat catchment (150km^2) from UK BAP Priority Habitat and UKCEH Land Cover Map composite data.

As previous studies identify prey availability and shelter as the main determinants of wildcat occurrence (Silva, Kilshaw, et al., 2013; Silva, Rosalino, et al., 2013), assessing populations of their preferred prey, rabbits and small rodents is a key part of habitat suitability surveys and can give insight into reintroduced hunting behaviours. Populations of small rodent prey can be estimated using Longworth trapping, a core tool in Britain (Flowerdew et al., 2004), effective at catching a wide range of small mammals **(Figure 8).** The abundance of wildcat's preferred prey, European rabbits, has previously been estimated using latrine counts, defining rabbit abundance as the number of latrines per 100m (Virgós et al., 2003; Silva, Rosalino, et al., 2013).

	Longworth trapping	Field sign*	Nest counts†	Hair tubes	Owl pellets	Calls	Habitat
Apodemus flavicollis	R	✓	✓	✓	✓		Woodland
Micromys minutus	R‡	R	✓	R	✓		Undisturbed grass, reedbeds
Microtus agrestis	R	R	✓	✓	✓		Undisturbed grass, plantation
Neomys fodiens	R	R	✓	R	✓		River bank, shorelines
Sorex araneus	R§	✓	✓	R	✓	✓	Various
Crocidura suaveolens	R	R					Various in Scilly isles
Microtus arvalis	R	✓					Various in Orkneys
Sorex minutus, *Clethrionomys glareolus*, *Apodemus sylvaticus*	R	✓		✓	✓		Various

R, recommended.
*Feeding sign, faeces, latrines and dropping boards, tracks and prints (including use of tracking boards), runways, artificial refugia; †Including use of bird nest boxes; ‡Traps on bamboo canes above ground if set during the summer; §Use treadle ramps (also for pygmy shrews and other small or light species).

Figure 8. Methods for monitoring small mammals in Britain and the species they are effective at monitoring, showing Longworth trapping as favourable (Flowerdew et al., 2004).

Habitat suitability assessments must incorporate the mosaic of habitats wildcats utilise, such as sheltered, closed woodland types and open rabbit-rich grassland types within the wildcat catchment.

2.5. Aims & Questions

The main aim of this study is to determine prey availability in different habitat types within the Cabilla wildcat catchment, to inform further in-depth habitat suitability surveys prior to wildcat reintroduction. To achieve the main aim, the following questions will be addressed:

1. What is the abundance of small rodents and European rabbits in two open habitats and two closed habitats in the Cabilla wildcat catchment?
    a. Closed habitat types: deciduous & coniferous woodland.
    b. Open habitat types: pastureland and dwarf shrub heathland.
2. How do abundances differ between each habitat type and where are wildcats therefore likely to occur?
3. Where should in-depth habitat suitability surveys focus survey effort?

A second aim is to estimate if the area can support a viable population of forty wildcats (Littlewood et al., 2014) through extrapolation of these prey abundances to the total area of each habitat type in the catchment, by answering:

4. What is the estimated abundance of prey in the wildcat catchment as a whole?
5. How many wildcats can these prey abundances support in the wildcat catchment and does this meet a viable population?

The final aim of the study is to explore potential wildcat prey species which are threatened with extinction in the UK and recommend mitigatory measures for their protection.

6. What threatened small mammals have been recorded in the Cabilla Wildcat Catchment?

These questions will be answered by conducting prey surveys, through examining historical data and supported by vegetation surveys at each habitat type to provide more context to results.

3. Methods

To determine habitat types to survey, this study has taken those contributing to the preliminary feasibility model **(Table 1)** and identified their availability within the Cabilla wildcat catchment, surveying the four most abundant closed and open habitats, those being closed deciduous and coniferous woodland and open acid grassland and dwarf shrub heathland **(Table 2).** The catchment is dominated by acid grassland, identified using spectral imaging by the UKCEH Land Cover Map, however on inspection in the field this is agriculturally improved grassland/ pastureland which was therefore surveyed in this study.

Table 2. Area of habitat types within the wildcat catchment from composite data: UKCEH Land Cover data and UK BAP Priority Habitat.

Cabilla Wildcat Catchment	
Habitat Type	**Area (ha)**
Acid grassland	9085
Deciduous woodland	1889
Heathland	1611
Agricultural Land	816
Coniferous woodland	543
Wetlands	549
Suburban; Urban	193
No main habitat but additional habitats present	55.1
Improved grassland	7.41
Inland rock	3.51

3.1. Prey Surveys

3.1.1. Small Rodents

Longworth trapping and capture-mark-recapture methodology was used to determine small rodent abundance after obtaining a Licence to Take Shrews (GL01) from Natural England (GOV.UK, 2022). Surveys were conducted in June 2022 at Cabilla in four habitat types: coniferous woodland, deciduous woodland, pastureland and dwarf shrub heathland. In each habitat type 30 Longworth traps were placed in a 3 x 5 grid design, with two traps at each trapping point baited with carrot, peanut butter and oat balls and straw bedding **(Figure 9)**, (Gurnell & Flowerdew, 2006).

Figure 9. Small rodent survey equipment: 30 Longworth traps, label tape, straw bedding, bait (peanut butter & oat balls with carrot), bamboo canes, guidebook, plastic bags, methods sheet, fur clippers, Pelosa scale.

Grid points were marked by bamboo canes and each spaced ten meters apart **(Figure 10),** following linear features where possible **(Figure 11).** Traps were set to pre-bait for twenty-four hours, then set to capture for two consecutive nights and checked and re-baited every morning at 07:00 and evening at 19:00, totalling three trapping efforts. Any animals caught were identified, weighed, sexed if adult and marked for identification by clipping fur behind the ear **(Figure 12),** and set free.

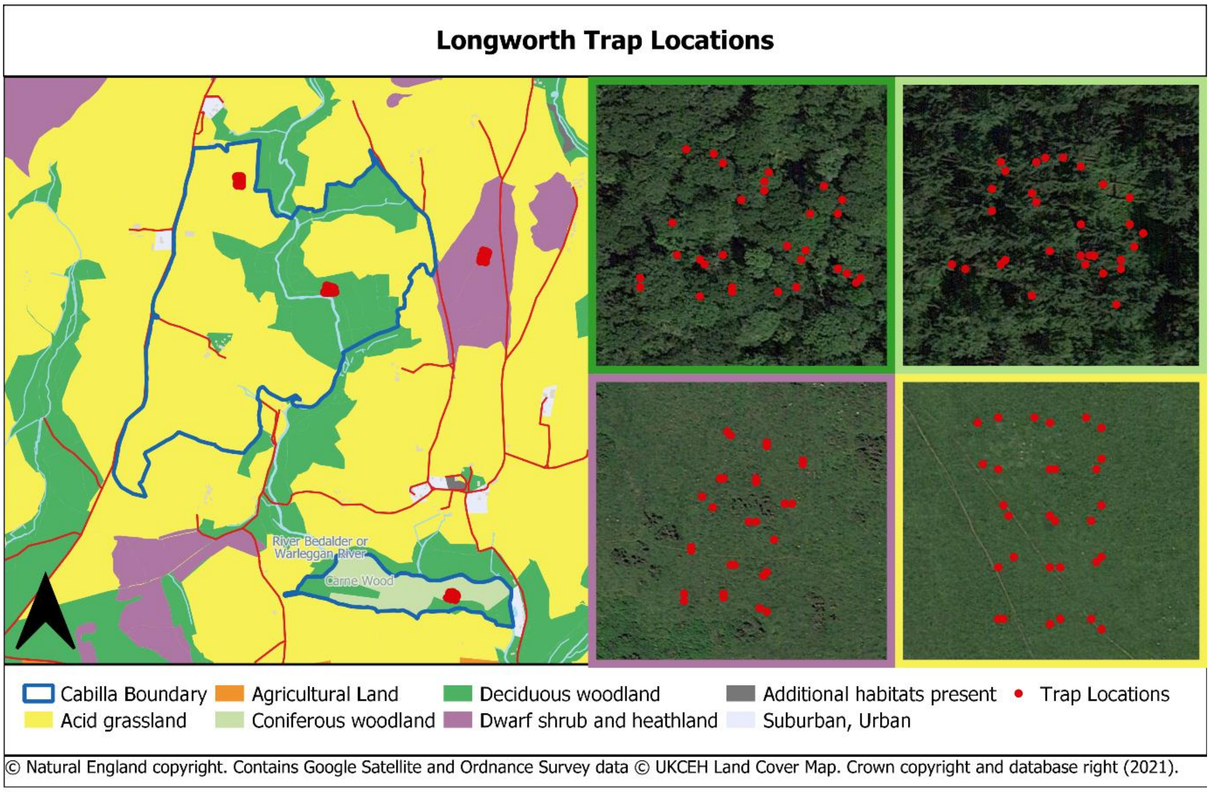


Figure 10. Longworth trap locations, grid arrangement in four habitat types: deciduous woodland, coniferous woodland, dwarf shrub heathland and pastureland.

Figure 11. Trap placement along linear features where present: fallen log in deciduous woodland; gorse patch in dwarf shrub heathland.

Figure 12. Wood mouse with fur clipped behind the ear.

Simpson's Diversity Index (SDI) (Simpson, 1949) was also calculated to compare species diversity at each habitat type.

3.1.2. European Rabbits

In each habitat type two linear belt transects, each 300 metres long were surveyed for rabbit latrines as a proxy for rabbits. Transects were walked along paths through or adjacent to each habitat type as latrines are more visible on clear paths **(Figure 13)** and were scanned three times to reduce the chances of any being missed. Latrines were counted if they made up at least 20 pellets over a surface of 20 x 30 cm.

a) b) c) d)

Figure 13. Start of rabbit latrine belt transects across paths through or adjacent to each habitat type a) coniferous woodland b) deciduous woodland c) pastureland d) dwarf shrub heathland.

3.2. Statistical Analysis

Statistical analysis was conducted using R 4.2.1. A one-way ANOVA was used to determine a significant difference between the habitat types for both the small rodent survey and rabbit latrine survey. Where there was a significant difference with the ANOVA, a Tukey HSD test was performed to determine what habitats were statistically different. Statistical significance was assumed wherever $P<0.05$.

3.3. Habitat Surveys

Vegetation at each habitat type was recorded to inform prey survey results. This consisted of a 2 x 2 metre quadrat of ground flora for all four habitat types and a 10 x 10 m tree canopy survey in the two woodland habitats. One quadrat was surveyed on a homogenous patch of vegetation and all species of plant, moss, lichen and fern and their abundance according to the Domin scale were recorded.

3.4. Population Viability Analysis

The population estimates of small rodents for each habitat type were calculated using the Lincoln Index **(Figure 14)**. Prey has been identified as a determinant of carnivore density, with 10,000 kg of prey supporting 90 kg of a species of carnivore, irrespective of body mass (Carbone and Gittleman, 2002). This was used to estimate how many wildcats prey estimates can support and compared to a viable population of forty wildcats (Littlewood et al., 2019). This was done by using a generous estimate of wildcat weight of 5.96kg, calculated by averaging their largest male and female weight which ranges between 3.77-7.26kg and 2.35-4.68kg respectively (Kilshaw, 2011). Using Carbone & Gittleman (2002)'s estimate, one wildcat would need 666kg of prey. In all habitat types, a 0.15-hectare grid was surveyed, using the mean weight of each species caught, the total prey weight in this area was calculated and extrapolated to the area of the corresponding habitat in the Cabilla wildcat catchment ((total habitat area in the catchment **(Table 2)** / 0.15) x population estimate). The wildcat population estimate was then compared to a viable population of forty wildcats to see if the catchment can be deemed biologically suitable for wildcat reintroduction.

$$\text{Population Size} = \frac{n_1 \text{ X } n_2}{n_3}$$

n_1 = total caught & marked 1st time

n_2 = total caught 2nd time

n_3 = marked animals caught 2nd time

Figure 14. Lincoln index used to estimate small rodent abundance in each habitat type (Lincoln, 1930).

3.5. Threatened Species

Small rodent and rabbit observation data were obtained through Environmental Records Centre for Cornwall and the Isles of Scilly (ERCCIS) between the years 2010 to 2022.

4. <u>Results</u>

4.1. Small Rodents

Small rodent abundance differed significantly between at least two habitat types (ANOVA: $F = 27.4$, $MSE = 85.5$, $p < .01$). Small rodent abundance was highest for coniferous woodland and lowest for dwarf shrub heathland **(Figure 15)** (total species abundance: deciduous woodland: 20, coniferous woodland: 22, pastureland:1, dwarf shrub heathland:0).

Tukey's HSD Test for multiple comparisons found that the mean value of small rodent abundance was significantly different between deciduous woodland and both pastureland ($p < .05$, 95% C.I. = [-17.2, -2.80]) and dwarf shrub heathland ($p < .05$, 95% C.I. = [-18.2, -3.80]).

Tukey's HSD Test for multiple comparisons found that the mean value of small rodent abundance was significantly different between coniferous woodland and both pastureland ($p < .01$, 95% C.I. = [-18.7, -4.30]) and dwarf shrub heathland ($p < .01$, 95% C.I. = [-19.7, -5.30]).
There was no statistically significant difference in mean small rodent abundance between deciduous woodland and coniferous woodland ($p=0.83$) and between pastureland and dwarf shrub heathland ($p=0.94$).

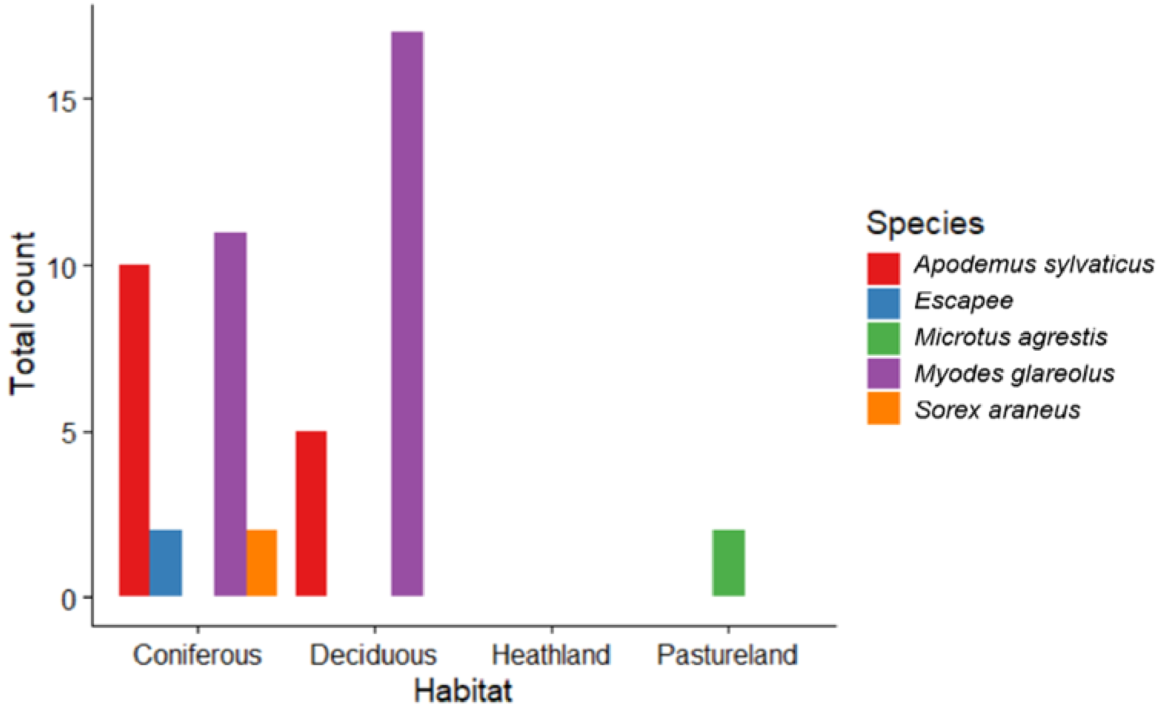


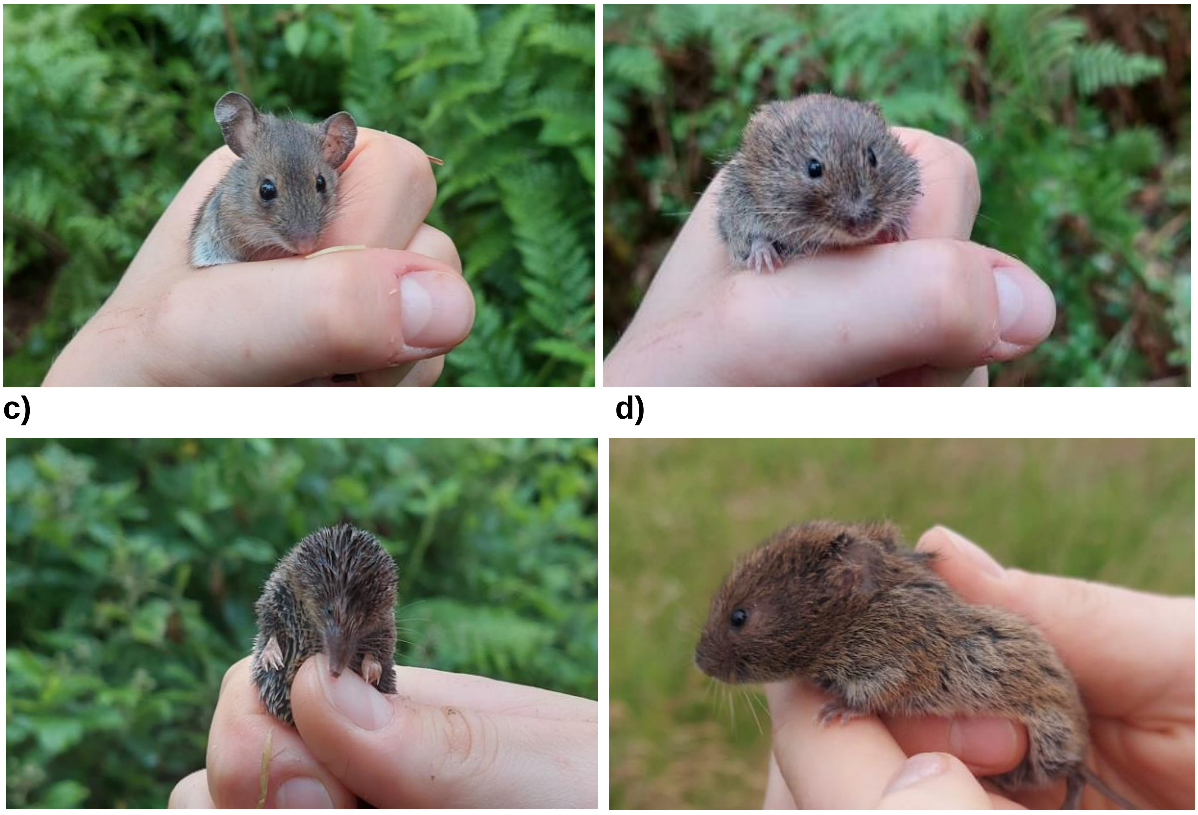
Figure 15. Total abundance of small rodent species in each habitat type surveyed, showing no captures in dwarf shrub heathland. Wood mouse *Apodemus sylvaticus,* field vole *Microtus agrestis,* bank vole *Myodes glareolus,* common shrew *Sorex araneus.*

Species diversity was highest in coniferous woodland where three species were caught: wood mice, bank voles and common shrews (SDI): 2.84), whereas two species were caught in deciduous woodland (SDI: 1.49), one in pastureland (SDI: undefined) and none in dwarf shrub heathland (SDI: undefined) **(Figure 16).**

Table 3. Simpsons Diversity Index (SDI) calculations for deciduous and coniferous woodland. Inconclusive for pastureland and dwarf shrub heathland.

	Deciduous woodland			Coniferous woodland		
Species	Number of organisms (n)	n-1	n(n-1)	Number of organisms (n)	n-1	n(n-1)
Bank vole	9	8	72	7	6	42
Wood mouse	2	1	2	5	4	20
Common shrew				2	1	2
Total	11		74	14		64
SDI			1.49			2.84

a) b)



c) d)

Figure 16. Species caught through Longworth trapping surveys: a) wood mouse b) bank vole c) common shrew d) field vole.

4.2. European Rabbits

Rabbit latrines were found in three habitat types: coniferous woodland, pastureland and dwarf shrub heathland **(Figure 17)**. There was not enough power to make a comparison between sites (ANOVA: $F = 1.44$, $MSE = 70.3$, $p < 0.36$). Rabbit latrine abundance was, however, highest in pastureland and lowest in deciduous woodland **(Table 4)** (total rabbit latrine abundance: deciduous woodland: 0, coniferous woodland: 1, pastureland: 25, dwarf shrub heathland: 14) **(Figure 18).**

a) b) c)

Figure 17. Rabbit latrine observations in a) coniferous woodland b) pastureland and c) dwarf shrub heathland.

Table 4. Rabbit latrine count in two surveys of deciduous and coniferous woodland

Rabbit Latrine Count				
	Closed habitats		Open Habitats	
	Deciduous woodland	Coniferous woodland	Pastureland	Dwarf Scrub Heathland
Survey 1	0	1	21	12
Survey 2	0	0	4	2
Total	1		39	

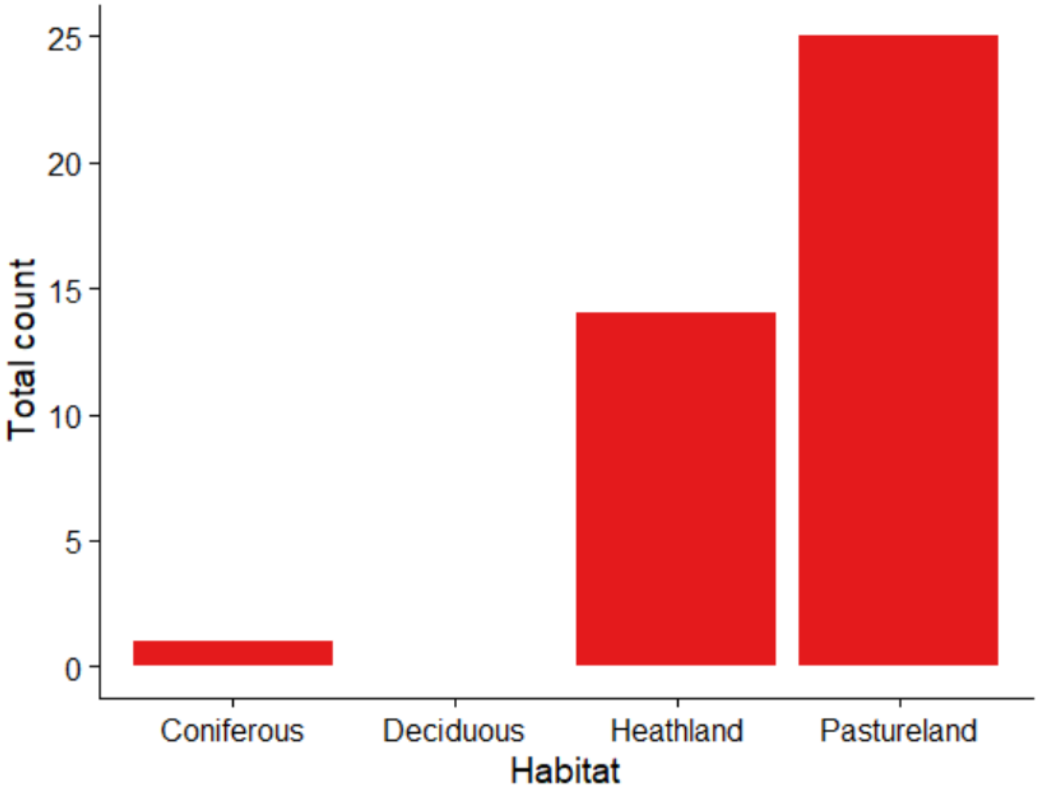


Figure 18. Total abundance of rabbit latrines in each habitat type surveyed.

4.3. Population Viability Analysis

In the deciduous woodland site, the estimated population of bank voles was 36 individuals, whereas the wood mouse population was undefined due to no recaptures **(Table 5).** In coniferous woodland, the estimated population of wood mice was 25 individuals, whereas bank voles and common shrew populations were undefined due to no recaptures. In pastureland, the estimated population of field voles was one individual.

Table 5. The estimated population size of each species caught in deciduous, coniferous and pastureland, using the Lincoln Index.

		N1	N2	R	P
Deciduous woodland	Bank vole	9	8	2	36
	Wood mouse	2	3	0	Undefined
	Total	11	11	20	
Coniferous woodland	Bank vole	7	4	0	Undefined
	Wood mouse	5	5	1	25
	Common shrew	2	0	0	Undefined
	Total	14	9	22	
Pastureland	Field vole	1	1	1	1
	Total	1	1	1	

Extrapolating defined prey populations of bank voles in deciduous woodland, wood mice in coniferous woodland and field voles in pastureland to the catchment as a whole, gives an estimated population of 22 large wildcats supported by these prey populations **(Table 6).**

Table 6. Estimated number of wildcats supported by each defined estimated population of prey species in deciduous woodland, coniferous woodland and pastureland, using predator-prey density estimates from Carbone & Gittleman (2002).

	Average species weight (g)	Estimated population weight (g)	Area surveyed (ha)	Area in catchment	Total prey weight in catchment (g)	Total prey weight in catchment (kg)	Total wildcats supported at weight of 7.26kg
Deciduous woodland: bank voles	26	936	0.15	1889	11788608	11788	17.7
Coniferous woodland: wood mice	28.7	716	0.15	543	2595410	2595	3.89
Pastureland: field vole	27	27	0.15	9085	1635300	1635	2.45

4.4. Threatened Species

Examining data from 2010 to 2022 of small mammals recorded in the Cabilla wildcat catchment identified one threatened species: hazel dormouse *Muscardinus avellanarius* **(Figure 19),** which is listed as vulnerable in the UK (Goodwin *et al.*, 2018).

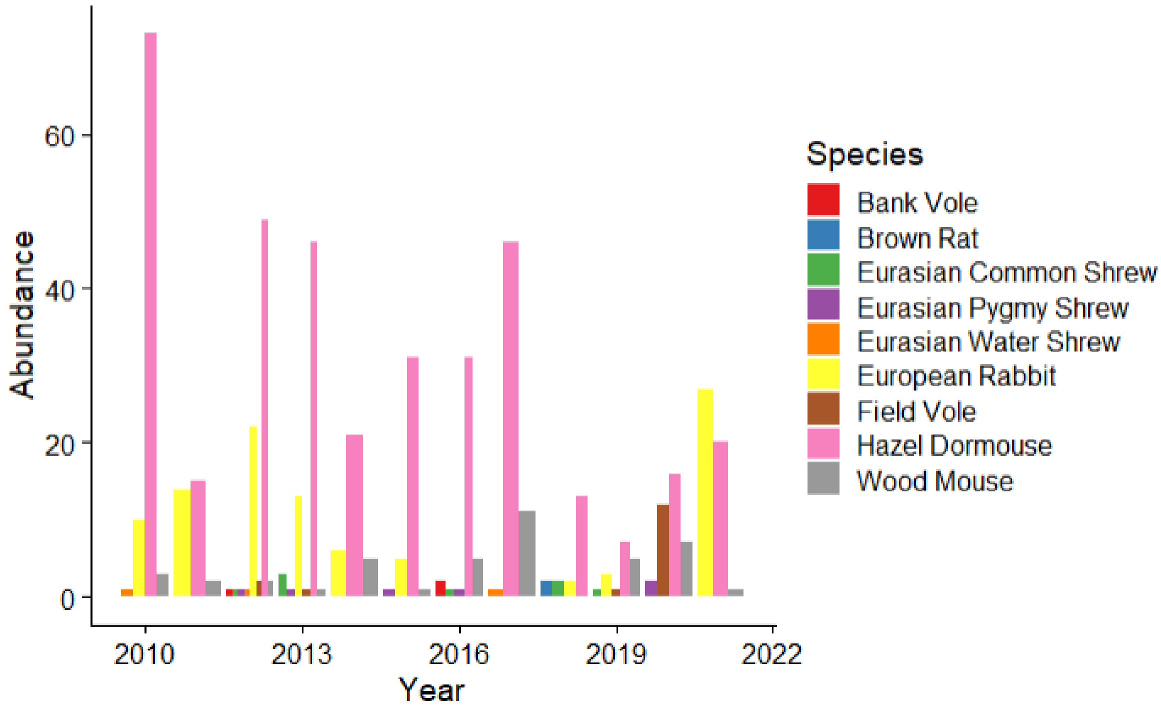


Figure 19. Abundance of small mammal species from 2010 to 2022 recorded in the Cabilla Wildcat Catchment (ERCCIS, 2022).

5. Discussion

5.1. What is the abundance of small rodents and European rabbits in two open habitats and two closed habitats in the Cabilla wildcat catchment, how do abundances differ between each habitat type and where are wildcats therefore likely to occur?

This study highlights the diversity of hunting options available for wildcats in the Cabilla wildcat catchment, varying between open and closed habitat types. The finding that small rodent abundance was higher in coniferous woodland, compared with open pastureland and dwarf shrub heathland, agrees with Silva, Rosalino, et al., (2013). They found rodent abundance was higher in coniferous woodland and lowest in grassland and heathland patches in the Highland and Grampian regions of Scotland where wildcats are present, (Silva, Rosalino, et al., 2013).

Although not significant, there was a higher abundance of rabbit latrines in open habitat types compared with closed habitat types. This disagrees with Silva, Rosalino et al., (2013) and previous studies in Spain which found significantly more rabbit latrines in open Mediterranean scrubland than in coniferous woodland (Palomares, 2001; Virgós et al., 2003) and Pyrenean oak woodland (Virgós et al., 2003). This suggests more repeat surveys are needed to give more power to these results and determine if open and closed habitat types in Spain and England are directly comparable in relation to rabbit abundance.

Where present, rabbits are the preferred prey for wildcats, being energetically profitable (Malo et al., 2004; Lozano et al., 2006). Where rabbits occur in Southern Spain, they make up the bulk of their diet, whereas they switch to small rodents in Northern areas where rabbits are not present (Lozano et al., 2006). Wildcats in Scotland have however been shown to avoid areas of highest rabbit abundance when linked to game hunting and when resting, seeking woodland areas instead (Martín-Díaz et al., 2018). The low rabbit abundance in their study explains how Silva, Rosalino, et al., (2013) found rodent abundance contributed to wildcat occurrence. The results of this study, however, suggest pastureland and dwarf shrub heathland will be important rabbit hunting grounds for wildcats in Cornwall, whereas coniferous and deciduous woodland present resting grounds and alternative hunting areas if rabbit populations are threatened in the future.

Low small mammal and rabbit populations may explain local wildcat scarcity in central Spain (Ferreras et al., 2021) and on Black Isle (Silva, Rosalino et al., 2013). Although a stronghold for wildcats in the 1980s, Silva, Rosalino et al*.,* (2013), found no current evidence of wildcats on Black Isle, no rabbits and a low abundance of small rodents, suggesting food scarcity on the island. Therefore, a diversity of prey found in this study is crucial for wildcat prey base resilience in the inevitable event of prey fluctuations. The introduction of myxomatosis in the 1950s (Bartrip, 2008) and rabbit viral haemorrhagic disease in the 1980s, killed hundreds of thousands of rabbits across Europe, impacting dependent predators such as the Iberian lynx *Lynx pardinus,* among other threats (Fa et al., 1999; Gil-Sánchez and McCain, 2011). Prey populations following reintroductions must be closely monitored and rabbit populations can be boosted or vaccinated if necessary (Ferreira & Delibes-Mateos, 2010), as seen with lynx reintroductions in Europe (LIFE 3.0 - LIFE Project Public Page, 2022). In addition, populations of vole species undergo yearly fluctuations (Ludwig et al., 2020), which may explain low trapping success in open habitats.

Wildcats have been recorded hunting on grassland, close to the forest edge and resting in forest interiors where the abundance of small rodents can be higher in these edge habitats (Klar et al., 2008). Where wildcats do occur in coniferous woodland, patches are small, surrounded by grassland, where they may be used for cover between hunting (Silva, Rosalino, et al., 2013). This highlights how wildcats need habitat heterogeneity and how patches of woodland are important cover and dispersal steppingstones. The size of woodland patches is undetermined (Klar et al., 2008) and therefore a further interesting gap in the literature.

This heterogeneity is also applicable to agricultural land, as agricultural land with hedges, copses and orchards and abundant prey has high wildcat occurrence in Spain (Malo et al., 2004; Jerosch et al., 2017; Jiménez-Albarral et al., 2021), compared with intense arable land in xeric conditions where rabbits and shrubs are absent (Lozano, 2010; Gil-Sánchez et al., 2020). Crops have been shown to provide shelter in the growing season, as females, requiring more shelter, use fallow fields with taller vegetation and young woody species to extend their summer home range (Jerosch et al., 2018). In Greece, the highest wildcat densities occur in a wetland-agricultural mosaic with clustered activity seen in fields during hunting hours (Migli et al., 2021). This suggests pastureland, left fallow for two months in this study may also provide shelter that wildcats need. Research into what features consist of shelter in agricultural land, the parameters wildcats and prey need such as native hedgerows and wide field margins, in conjunction with how seasonal changes to cover such as crop harvest is needed. This can inform agricultural land management in the Cornwall rewilding network, to improve the agricultural habitat for wildcats.

In Scotland, wildcat occurrence is associated with high rodent diversity (Silva, Kilshaw, et al., 2013), which was highest in coniferous woodland in this study, suggesting they will utilise this area for hunting. This may be explained by the dense understory of bracken *Pteridium aquilinum* and brambles *Rubus fruticosus,* in the coniferous site providing ample shelter for prey. Previous studies found wildcat trails in the Polish Carpathian Mountains rarely ran through coniferous forest, instead preferring mixed or deciduous woodland with a dense understorey, linked to prey availability (Okarma et al., 2002). Researching how understorey density in each woodland type may increase small rodent prey abundance and therefore wildcat abundances is a further research area.

5.2. Potential Alternatives to Survey Results

The trapping success in closed habitat types may be influenced by several factors. Woodland habitats have more obvious linear features, which rodents use to travel along (Gurnell & Flowerdew, 2006), therefore trap placement may be more effective in these habitats, compared with dwarf shrub heathland and pastureland. For dwarf shrub heathland, low trapping success may be explained by grazing pressures from highland cattle and sheep resulting in grass swards too short to shelter small rodents. Reducing grazing numbers could therefore improve the habitat for these species and increase wildcat habitat suitability. Pastureland was left fallow for two months prior to the survey and the grass was thick, which may reduce the likelihood of small rodents detecting traps. In addition, Pete Cooper from The England Wildcat Strategy, suggested field voles can generally be more trap shy (Cooper, personal communication, 1 August 2022), which may be a further explanation for low trapping success in pastureland and may require a longer pre-bait period to account for this. For rabbit latrine surveys, the persistence of rabbit latrines is high, except during rainy periods (Palomares, 2001) and the first deciduous and coniferous surveys were after recent rain. Fewer rabbit latrines in closed habitats may also be explained by reduced visibility at the paths of deciduous survey one and coniferous survey two due to dense undergrowth on either side of the path **(Figure 20)**. Despite this, in relation to coniferous and deciduous woodland, these results are expected as there is a low abundance of rabbits in forested areas of Spain, explained by low levels of grazing areas (Virgós et al., 2003). In addition to this, there were direct observations of rabbits in open habitat types, but no direct observations in closed habitat types.

Figure 20. Dense undergrowth on coniferous woodland rabbit latrine survey two.

5.3. Where should in-depth habitat suitability surveys focus survey effort?

Adaptive management is the most holistic framework to strive for best practice when planning and implementing a restoration project and advancing restoration ecology as a science (Palmer et al., 2005). It can be applied widely to review and adapt project strategies whilst incorporating learning from ecological interactions into project plans (Williams & Brown, 2016). This study brings adaptive management into a core aim by informing future in-depth habitat suitability surveys prior to wildcat reintroduction. Firstly, the results of this study are limited to the specific sites surveyed in this study as only one trapping grid in each habitat type was surveyed due to time constraints. Further variables such as neighbouring habitat types, grazing regimes and vegetation matrices will influence abundances on corresponding habitats in different locations. To increase confidence in estimates of abundances in the Cabilla wildcat catchment, further studies should repeat surveys on different sites of each habitat type, whilst also repeating surveys on each site three times to gain an average, totalling nine surveys per habitat type. This will also increase the likelihood of achieving defined population estimates for small rodent abundances, however, care must be taken to mark small mammals in a systematic pattern at each site to avoid double counting recaptures in repeat surveys.

Field signs were not surveyed before trapping and may explain low trapping success in pastureland and dwarf shrub heathland due to random selection of trapping sites. Therefore, future surveys should only take place if field signs such as food caches, droppings, or the presence of their other predators are recorded. Further, trapping occurred before peak rodent season due to time constraints which may explain low trapping success in open habitat types. Future surveys should therefore take place between September and November (Birks et al., 2018).

This study followed trapping guidelines in Gurnell & Flowerdew (2006), which focuses survey grids away from edge habitat. Edge habitats and meadows adjacent to watercourses appear to be more important hunting grounds due to higher prey abundance, as found in previous studies (Klar et al., 2008; Silva, Rosalino, et al., 2013). Further surveys should focus on small rodent abundance at the forest and watercourse edge, adjacent to grassland, pastureland or dwarf shrub heathland.

Although latrine counts are a standard method to compare rabbit abundance between sites (Virgós et al., 2003; Silva, Rosalino, et al., 2013), this study could not determine the population of rabbits as rabbit latrines do not always represent the number of individuals due to their use for territorial marking (Ziege et al., 2016). This method may also underestimate abundance at low rabbit densities, compared with counting individual pellets (Guerrero-Casado et al., 2019). A more suitable method would be to directly count rabbits in a defined plot, using thermal cameras, in line with Saving Wildcats methodology (Saving Wildcats, personal communication, 4 August 2022). Future in-depth surveys should therefore repeat direct counts three times per site to achieve an average, in three areas of each habitat type.

As methodology may explain low trapping success or latrine observations, future surveys should focus on all four habitat types for the first rounds of surveys. If no presence of rabbits is found in deciduous woodland and if no presence of small rodents in dwarf shrub heathland as seen in this study, then further survey efforts can exclude these habitat types to focus survey effort.

5.4. What is the estimated abundance of prey in the wildcat catchment, how many wildcats can these prey abundances support in the wildcat catchment and does this meet a viable population?

This study was unable to estimate the abundance of all prey species due to undefined population estimates and therefore prey in the catchment as a whole. Population estimates of three species could, however, be estimated due to recaptures of these species and are calculated to support 22 wildcats in the Cabilla wildcat catchment. This number is optimistic for wildcat reintroduction as population viability analysis comes out at 40 wildcats (Littlewood et al., 2014), with main prey rabbits and three further prey populations still needing to be determined.

These results, however, are simplistic in predicting wildcat behaviour upon release into the wild. Home range is unlikely to be solely restricted to the Cabilla wildcat catchment, as this is influenced by a variety of factors such as age, gender, breeding season, density, prey and resting site availability (Wittmer, 2001; Biro et al., 2004; Monterroso et al., 2009) and also tend to be higher and unstable upon reintroduction whilst territories are being established (Anile et al., 2017). All reintroduced wildcats must be radio-tracked to monitor territory establishment, with ongoing prey base surveys and wildcat health conditions monitoring to ensure resources are adequate. In line with IUCN reintroduction guidelines, an exit strategy must be put in place to mitigate consequences if unexpected outcomes occur (IUCN/SSC, 2013).

Additionally, trophic complexity matches reintroduction complexity as all species identified in this study also support barn owls *Tyto alba* (Glue, 1974), red foxes (Baker et al., 2006) and species speculated for future reintroduction such as pine marten and wild boar *Sus scrofa* (Birks et al., 2018; Cornwall Council; Hanbury-Tenison, personal communication, 23 March 2022; Herrero et al., 2006). Similarly to wildcats, rabbits can dominate the diet of red foxes, with one male estimated to consume 149kg of prey yearly and one female 132kg (Baker et al., 2006). The impact of wildcat predation on prey species in combination with predators already in the ecosystem warrants further investigation and inclusion in reintroduction monitoring plans.

5.5. What threatened small mammals have been recorded in the Cabilla Wildcat Catchment?

Although wildcats show a preference for rabbits, they are more generalists if preferred prey is not readily available (Lozano et al., 2006). ERCCIS data revealed hazel dormice which are threatened in the UK are present in the catchment. Additionally, ground-nesting birds on Bodmin Moor include Eurasian skylark *Alauda arvensis*, woodcock *Scolopax rusticola*, Eurasian curlew *Numenius arquata*, snipe *Gallinago gallinago* and meadow pipits *Arthus pratensis* (RSPB, 2018). Although these native species evolved alongside native predators such as wildcats, adding predation pressures on top of degraded ecosystems pressures they currently face may push them further to extinction. Therefore, upon reintroduction, scat analysis must determine whether threatened species contribute to wildcat diets and if so, the impact on their population they are having. Although hazel dormice are the most recorded small mammal from ERCCIS data **(Figure 19),** this is likely due to imbalanced survey efforts for this species. Active woodland management by creating areas at varying successional stages with honeysuckle, yew, birch, willow, bramble and hazel trees, can create dormouse habitat which supports all life stages of this vulnerable species (Goodwin et al., 2018). Requiring a licence to train volunteers can further protect this species from inappropriate handling when monitoring populations. Water voles *Arvicola terrestris* have also been reintroduced to Bude river catchment (The Guardian, 2014) and southern Cornwall this year (BBC, 2022). With the potential to be a substantial prey species, if water voles are reintroduced locally, more individuals may need to be established to bolster their likelihood of survival.

5.6. Habitat Management for Wildcats

As a developed understory is important for wildcat prey, managing coniferous woodlands to encourage understory development can improve habitat for small rodents and wildcats, as utilised by Forestry and Land, Scotland (Forestry and Land Scotland, 2009). Firstly, thinning and leaving woody debris can create this understorey and piles of logs for wildcat denning sites. This management decision may however negatively impact rare lichen on felled trees (Marmor et al., 2013) and must only be carried out after rare species surveys. Coniferous woodland can also naturally regenerate to native deciduous woodland if left, as trees have light to grow when shallow-rooted Sitka spruce *Picea sitchensis* fall in storm damage (Harmer and Morgan, 2009). In this study site, the understorey was made up of beech trees *Fagus sylvatica* which are not native to the region, therefore facilitated restoration would be necessary to restore the habitat to native deciduous woodland. In addition, working with Forestry England to clear fell only part of the forest at a time can allow regeneration before further areas are felled.

Wildcats occupy diverse agricultural land with abundant shelter and rabbits, therefore restoring heterogeneity in the landscape with copses, hedgerows and trees in marginal land increase suitability for wildcats (Jerosch et al., 2017; 2018). Cabilla's aims to build a rewilding network of regenerative farmland and restored woodland in marginal land which will further contribute to this mosaic of connected woodland for core sheltered habitat among open hunting grounds. Managing grasslands with light grazing, allowing rough grass to grow and a litter layer to develop, can also provide tunnelling habitat and increased field vole abundance (Ludwig et al., 2020).

5.7. Further Reintroduction Considerations

This study is limited to the species and habitats surveyed, however determining the feasibility of reintroducing wildcats to Cornwall must also consider threats such as human disturbance, persecution, hybridization with feral or domestic cats, roads mortality, and disease, in addition to social feasibility.

5.7.1 Human Disturbance

Wildcat occurrence correlates with low human disturbance (Monterroso et al., 2009), predicted to increase 200m from single houses and 900m from villages (Klar et al., 2008), warranting the focus of habitat surveys to continue outside these buffers **(Figure 21).**

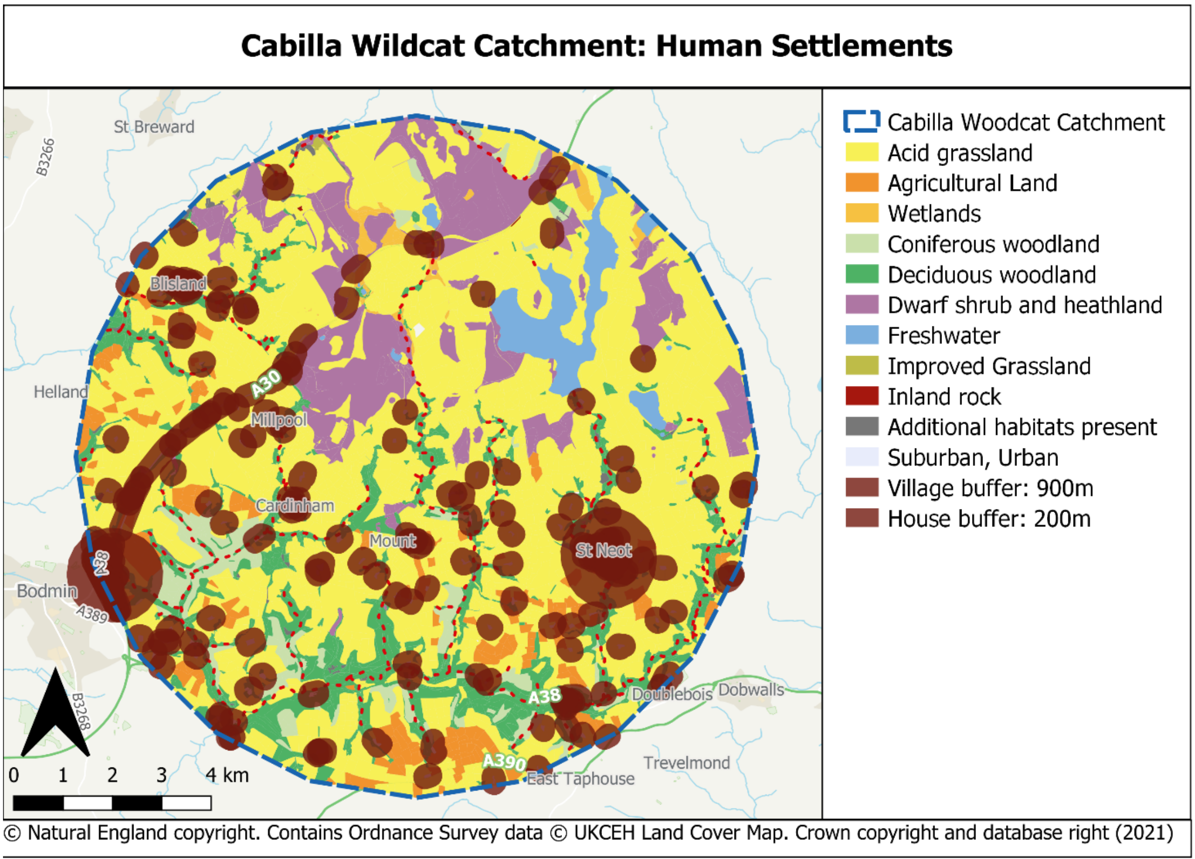


Figure 21. Buffers around human settlements within which wildcat occurrence increases: 200m for houses and 900m for villages (Klar et al., 2008).

Human disturbance includes sporting estates due to persecution threats, their initial extinction pressure, where wildcat occurrence increases in their absence (Silva, Kilshaw, et al., 2013). Keri Langridge from Saving Wildcats stated how illegal persecution still occurs in Scotland as predator control and mistake as feral cats (Langridge, personal communication, 18 Februrary 2022). Reintroduction feasibility depends on the absence of original extinction pressures, therefore persecution risk in the wildcat catchment must be investigated.

5.7.2 Hybridization

Areas close to human settlements are also associated with hybridization where wildcats breed with feral or domestic cats (Biro et al., 2004), currently the wildcat's greatest threat (Oliveira et al., 2008). In the Swiss Jara mountains, when wildcat densities are low, males extend their home range during the breeding season and breed with female farm cats (Nussenberger et al., 2018). This highlights the importance of determining habitat suitability prior to reintroduction as the key to reducing hybridization risk may be ensuring a healthy population of wildcats is supported by quality habitat (Oliviera et al., 2018). Ensuring responsible cat ownership through neutering pets, in combination with capture-neuter-release of feral cats can further reduce hybridization risk. A camera trapping survey within the Cabilla boundary has identified only one neutered domestic cat, however, this effort must be extended across the Cabilla wildcat catchment, whilst working with Cats Protection and the RSPCA to ensure neutered cats and responsible cat ownership in the wider landscape.

5.7.3. Roads

Roads increase stress hormones in wildcats (Piñeiro et al., 2012), create a barrier to dispersal at 100,000 vehicles per day or more (Hartmann et al., 2013) and threaten wildcats with fatalities, with 57% of annual wildcat mortality in Germany being from roadkill (Bastianelli et al., 2021). The A38 and National Rail line run through a large expanse of deciduous and coniferous woodland **(Figure 22)**, warranting investigation into their likely use by wildcats. Introducing wildcat fencing and open-span viaducts to allow wildcats to cross these roads safely can dramatically reduce this threat (Klar et al., 2009).

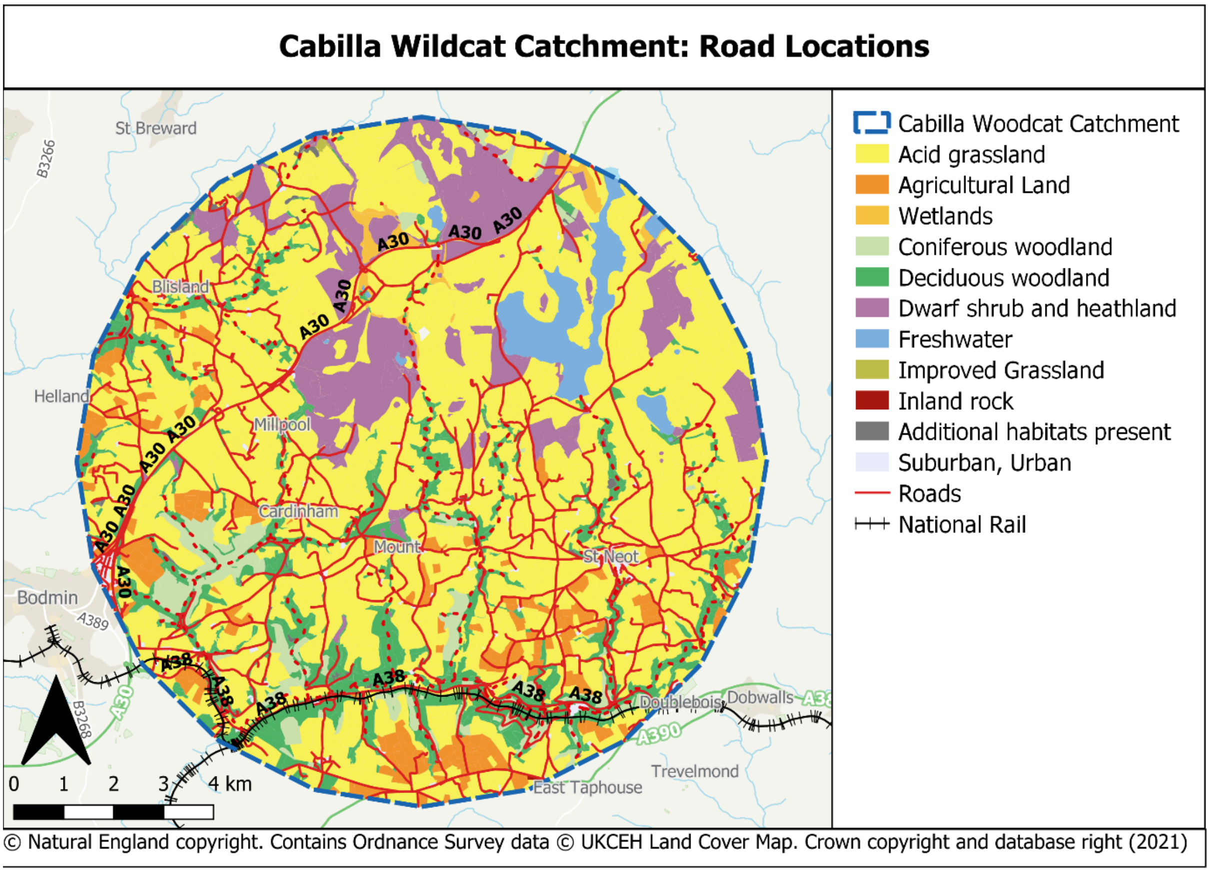


Figure 22. Roads and national rain in the wildcat catchment, highlighting A30 & A38.

5.7.4. Disease

Wildcats are susceptible to feline leukaemia virus (FeLV); feline immunodeficiency virus (FIV); feline coronavirus (FCoV); feline foamy virus (FFV); feline infectious peritonitis (FIPV); feline Panleukopenia; Feline calcivirus (FCV); feline parvovirus (FPV); cat flu (FCV and FHV); feline haemoplasma species, feline herpersvirus, *Mycoplasma felis*, *chlamydophila* species and *Tritichomonas foetus*; common cat roundworm *Toxocara cati* and tapeworm *T. taeniaeformis*. Reintroduced wildcats and feral cats from trap-neuter-vaccinate-release must be fully vaccinated for these.

5.7.5. Social Feasibility

The next vital step in wildcat reintroduction to Cabilla is assessing the social acceptance of wildcats in the local landscape. With lynx reintroductions in Europe, secret releases have resulted in poaching and local opposition, justifying killing lynx as a response to secrecy, whereas public outreach pre-release in later reintroductions cultivated local support and enabled rapid response to human-wildlife conflicts (Wilson, 2018). Effective stakeholder engagement includes shared decisionmaking, proactive engagement and fast responses when dealing with reintroduction conflicts (Auster et al., 2021). Rewilding Britain are interested in funding a Cornwall-wide wildcat social feasibility study (Sara King, personal communication, 18 May 2022), which Cabilla aims to implement through the following objectives:

1. Coordinate with England Wildcat Strategy: aim for cross-sectorial representation to identify and address barriers to wildcat reintroduction through a participatory process.
2. Carry out a Cornwall-wide online stakeholder and public opinion survey.
3. Run wildcat-specific workshops at a range of times and places, being clear about objectives, wildcat benefits and risks, with open participatory discussion.
4. Follow up on workshops addressing everything that has been raised.
5. Set up a wildcat contact line and email so people have a port of call for any wildcat-related concerns.
6. Carry out an information campaign for domestic cat neutering in collaboration with the RSPCA and Cats Protection.
7. Build an online wildcat stakeholder platform so stakeholder engagement can continue beyond workshops.
8. Continually share project progress via email and on the stakeholder platform.
9. Update the Cabilla website on wildcat ecology, importance and reintroduction plans.
10. Build a Cornwall Rewilding Network of interested landowners, stakeholders and locals to continually restore agricultural land and various habitats for nature and people.

The results of this study highlight land management recommendations for coniferous woodland and agricultural land to improve wildcat habitat in the catchment. These recommendations must also be included in workshops, the website and communicated with Cornwall Rewilding Network.

6. Conclusions

An in-depth prey base survey based on recommendations made in this study is warranted, to further assess the feasibility of reintroducing wildcats to Cornwall. Although a lack of data left three prey populations undetermined, including their main prey rabbits, populations of bank voles in deciduous woodland and wood mice in coniferous woodland were estimated to support 22 wildcats. Although this number is optimistic considering 40 wildcats is considered a viable population, further viability assessments must factor in other predators of wildcat prey such as red foxes. This study identified rabbit presence in open habitat types of dwarf shrub heathland, pastureland and very low abundance in coniferous woodland, suggesting wildcats will be found hunting here post-reintroduction. Small rodents in closed habitat types of coniferous and deciduous woodland also present wildcats with a diversity of prey options in the event of prey fluctuations and habitat management by reducing grazing pressures can increase these abundances in pastureland and dwarf shrub heathland. Small rodent abundance was highest in coniferous woodland which may be down to a dense understory which can be increased in other areas by thinning trees. Along with in-depth prey surveys, the next steps to wildcat reintroduction include addressing social feasibility and threats such as hybridization, persecution, disease and road mortality. Upon reintroduction, it is necessary to closely monitor wildcat movements out of the wildcat catchment, their feeding habits, and prey populations including threatened species such as hazel dormice. An exit strategy must also be put in place focusing on population dynamics of threatened species, other predators dependent on rabbits and small rodents and wildcats themselves. Wildcat reintroduction, therefore, presents an exciting educational opportunity to gain direct evidence of before and after ecosystem impacts and learn more about this cryptic species.

7. Acknowledgements

I am extremely grateful to Mark Nason for the opportunities, learning and thorough feedback throughout this year and to Breanna Kaufmann, both of whose comments have greatly improved the quality of this paper. Thank you to Michael Hunt for his statistical wisdom. To John Blackburn and Peter Cooper for helping me with trapping techniques and to Lynda Small from Cornwall Mammals for joining my trapping surveys and teaching me about Hazel dormice. I'm grateful to Merlin and Lizzie Hanbury-Tenison, Samantha Skinner for opportunity to contribute to wildcat reintroduction plans at such a special restoration site, and to Lucy Crump and the Cabilla team for being such a wonderful positive team to work among. I am ever grateful to Tom and Denise for hosting me and for their continued support throughout this year and to my mum, always, all of whom I couldn't have done it without. Of course, thank you to my coursemates who helped me during surveys and who have made it such a fun year with their humour during field trips and post-hand in pub debriefs.

8. Appendices

Appendix 1. Longworth trapping survey results with trap location, species, weather, sex, weight, age and condition a) deciduous woodland night one b) deciduous woodland night two c) coniferous woodland night one d) coniferous woodland night two e) pastureland night one f) pastureland night two.

a)

	Grid Reference		Night One					
Trap Number	**x**	**y**	**Species**	**Weather**	**Sex**	**Weight**	**Age (J/ A)**	**Condition**
1	214998	069844		Sunny				
2	214998	069842		Sunny				
3	215011	069840		Sunny				
4	215018	069842	Bank vole	Sunny	M	23	A	
5	215026	069867	Bank vole	Sunny	Juvenile	9	J	
6	215016	069849		Sunny				
7	215033	069848	Wood mouse	Sunny	F	38	A	
8	215028	069841	Bank vole	Sunny	F	29	A	Lactating
9	215046	069844	Bank vole	Sunny	M	30	A	
10	215032	069842	Bank vole	Sunny	M	29	A	
11	215006	069849		Sunny				
12	215011	069848		Sunny				
13	215012	069847	Bank vole	Sunny	M	23	A	
14	215008	069872		Sunny				
15	215018	069841	Bank vole	Sunny	F	26	A	Lactating
16	215020	069861		Sunny				
17	215030	069851		Sunny				
18	215034	069850		Sunny				
19	215041	069846		Sunny				
20	215043	069845		Sunny				
21	215045	069843		Sunny				
22	215005	069856		Sunny				
23	215016	069869	Wood mouse	Sunny	M	22	A	
24	215014	069871		Sunny				
25	215025	069865	Bank vole	Sunny	F	32	A	Lactating
26	215025	069863	Bank vole	Sunny	F	34	A	Lactating
27	215038	069864		Sunny				
28	215035	069858		Sunny				
29	215041	069858		Sunny				
30	215042	069861		Sunny				

b)

	Grid Reference		Night Two						
Trap Number	**x**	**y**	**Species**	**Weather**	**Recapture**	**Sex**	**Weight**	**Age (J/ A)**	**Condition**
1	215534	068517		Sunny					
2	215531	068518		Sunny					
3	215542	068518	Wood mouse	Sunny		M	24	A	
4	215543	068519		Sunny					
5	215549	068511	Bank vole	Sunny	Recapture	Juvenile	20	J	
6	215553	068521	Bank vole	Sunny		F	23	A	Lactating
7	215565	068516	Wood mouse	Sunny		M	25	A	
8	215560	068520	Wood mouse	Sunny		M	24	A	
9	215568	068509		Sunny					
10	215569	068517	Bank vole	Sunny		F	20	A	
11	215569	068519		Sunny					
12	215572	068522		Sunny					
13	215562	068520		Sunny					
14	215563	068520		Sunny					
15	215560	068527		Sunny					
16	215561	068518		Sunny					
17	215550	068532	Bank vole	Sunny	Recapture	M	23	A	
18	215549	068534		Sunny					
19	215540	068530	Bank vole	Sunny		M	22	A	
20	215540	068535		Sunny					
21	215543	068539	Bank vole	Sunny		F	23	A	Lactating, scar face
22	215542	068541		Sunny					
23	215552	068542		Sunny					
24	215550	068541		Sunny					
25	215560	068540	Bank vole	Sunny		M	24	A	
26	215556	068542		Sunny					
27	215571	068533		Sunny					
28	215565	068536	Bank vole	Sunny		F	27	A	
29	215574	068525		Sunny					
30	215571	068527		Sunny					

c)

	Grid Reference		Night One					
Trap Number	x	y	Species	Weather	Sex	Weight	Age (J/ A)	Condition
1	215534	068517	Escapee	Sunny	M	25	A	
2	215531	068518	Bank vole	Sunny				
3	215542	068518		Sunny				
4	215543	068519	Bank vole	Sunny	M	28	A	
5	215549	068511	Bank vole	Sunny	F	30	A	Lactating
6	215553	068521		Sunny				
7	215565	068516		Sunny				
8	215560	068520		Sunny				
9	215568	068509		Sunny				
10	215569	068517	Wood mouse	Sunny	Juvenile	17	J	
11	215569	068519	Common shrew	Sunny	F	13	A	
12	215572	068522	Bank vole	Sunny	Juvenile	12	M	
13	215562	068520	Bank vole	Sunny	Juvenile	12	J	
14	215563	068520		Sunny				
15	215560	068527		Sunny				
16	215561	068518		Sunny				
17	215550	068532	Bank vole	Sunny	M	36	A	Fleas
18	215549	068534		Sunny				
19	215540	068530	Wood mouse	Sunny	F	32	A	Lactating
20	215540	068535	Wood mouse	Sunny	M	16	A	Orange poo
21	215543	068539		Sunny				
22	215542	068541	Wood mouse	Sunny	M	34	A	
23	215552	068542	Wood mouse	Sunny	F	29	A	
24	215550	068541		Sunny				
25	215560	068540		Sunny				
26	215556	068542	Bank vole	Sunny	Juvenile	12	J	
27	215571	068533		Sunny				
28	215565	068536	Common shrew	Sunny	F	12	F	
29	215574	068525		Sunny				
30	215571	068527		Sunny				

d)

	Grid Reference		Night Two						
Trap Number	**x**	**y**	**Species**	**Weather**	**Recapture**	**Sex**	**Weight**	**Age (J/ A)**	**Condition**
1	215534	068517	Wood mouse	Rainy		M	28	A	
2	215531	068518	Wood mouse	Rainy		F	33	A	Skin tag
3	215542	068518	Bank vole	Rainy		Juvenile	18	J	
4	215543	068519		Rainy					
5	215549	068511		Rainy					
6	215553	068521		Rainy					
7	215565	068516	Bank vole	Rainy		M	28	A	
8	215560	068520		Rainy					
9	215568	068509		Rainy					
10	215569	068517	Bank vole	Rainy		M	18	J	
11	215569	068519		Rainy					
12	215572	068522	Escapee	Rainy					
13	215562	068520		Rainy					
14	215563	068520		Rainy					
15	215560	068527		Rainy					
16	215561	068518		Rainy					
17	215550	068532		Rainy					
18	215549	068534		Rainy					
19	215540	068530		Rainy					
20	215540	068535	Wood mouse	Rainy		M	26	A	
21	215543	068539		Rainy					
22	215542	068541	Wood mouse	Rainy	Recapture	M	32	A	
23	215552	068542		Rainy					
24	215550	068541		Rainy					
25	215560	068540	Bank vole	Rainy		M	25	A	
26	215556	068542		Rainy					
27	215571	068533	Wood mouse	Rainy		F	26	A	
28	215565	068536	Dud	Rainy					
29	215574	068525		Rainy					
30	215571	068527		Rainy					

e)

	Grid Reference		Night One					
Trap Number	**x**	**y**	**Species**	**Weather**	**Sex**	**Weight**	**Age (J/ A)**	**Conditions**
1	214623	070307	Field vole	Clear, rain night before	M	27	A	
2	214620	070307						
3	214620	070317						
4	214623	070319						
5	214621	070329						
6	214622	070327						
7	214617	070337						
8	214620	070336						
9	214616	070345						
10	214620	070346						
11	214630	070306						
12	214632	070307						
13	214630	070317						
14	214632	070317						
15	214631	070326						
16	214630	070327						
17	214630	070336						
18	214631	070336						
19	214627	070346						
20	214630	070345						
21	214640	070305						
22	214638	070307						
23	214640	070319						
24	214639	070318						
25	214638	070326						
26	214640	070329						
27	214639	070336						
28	214640	070338						
29	214637	070346						
30	214640	070433						

f)

	Grid Reference		Night Two						
Trap Number	**x**	**y**	**Species**	**Weather**	**Recapture**	**Sex**	**Weight**	**Age (J/ A)**	**Condition**
1	215534	068517	Field vole	Sunny	Recapture	M	20g	A	
2	215531	068518							
3	215542	068518							
4	215543	068519							
5	215549	068511							
6	215553	068521							
7	215565	068516							
8	215560	068520							
9	215568	068509							
10	215569	068517							
11	215569	068519							
12	215572	068522							
13	215562	068520							
14	215563	068520							
15	215560	068527							
16	215561	068518							
17	215550	068532							
18	215549	068534							
19	215540	068530							
20	215540	068535							
21	215543	068539							
22	215542	068541							
23	215552	068542							
24	215550	068541							
25	215560	068540							
26	215556	068542							
27	215571	068533							
28	215565	068536							
29	215574	068525							
30	215571	068527							

Appendix 2. Rabbit latrine survey results with distance along transect and location a) coniferous woodland b) pastureland c) dwarf shrub heathland.

a)

	Distance (m)	**x**	**y**	**Notes**
Survey one	99	215349	068502	Fresh
Survey two	NA	NA	NA	NA

b)

	Distance (m)	**x**	**y**	**Notes**
Survey one	49	214536	070092	sparse, partially dry, some squished
	165	214650	070069	dry cluster
	192	214668	070052	dry
	205	214680	070049	large fresh
	213	214687	070045	large fresh cluster on rock
	251	214687	070044	squashed cluster
	254	214710	070036	dry cluster
	257	214719	070033	dry cluster
	260	214722	070038	dry cluster
	261	214722	070036	dry cluster
	264	214721	070032	dry cluster
	271	214730	070034	sparse dry
	275	214734	070036	dry cluster
	280	214745	070035	fresh cluster
	283	214742	070039	sparse dry
	285	214743	070039	dry
	287	214740	070040	dry cluster
	288	214743	070039	dry cluster
	289	214747	070038	dry cluster
	292	214747	070038	dry cluster
	297	214754	070045	dry cluster
Survey two	1	214673	070057	dry sparse
	2	214673	070056	dry sparse
	219	214660	070287	dry cluster
	220	214660	070287	3 small clusters

c)

	Distance (m)	x	y	Notes
Survey one	160	215611	069989	Dry, on rock
	182	215589	069989	dry, small, 30 droppings
	183	215590	069985	dry, small, spread out
	187	215588	069985	dry, small, spread out
	190	215587	069985	big, on a rock
	193	215586	069985	dry, old, squished
	196	215574	069983	dry
	203	215573	069984	dry, on a rock
	210	215568	069985	dry, spread out on a rock
	211	215558	069978	dry, on a rock
	213	215559	069979	dry, on a rock
	283	215497	069955	very larger, dry, on a rock, clustered
Survey two	3	215495	069875	large, fresh

Appendix 3. Habitat vegetation survey results with species and abundance a) ground flora (2 x 2 m) deciduous woodland b) tree canopy survey (10 x 10 m) c) d) e) pastureland ground flora f) dwarf shrub heathland ground flora.

a)

Ground Flora (2 x 2 m)		
Species	**Common name**	**Domin Scale Abundance**
Hyacinthoides non-scripta	Bluebells	8
Oxalis acetosella	Wood sorrel	5
Blechnum spicant	Hard fern	1
Dryopteris dilatata	Broad buckler fern	6
Rubus spp.		1
Quercus spp.	Oak sapling	2
Hadera helix	Ivy	1
Thuidium tamariskium	Common tamarisk moss	5
Brachytheciaceae spp.	Feather moss spp.	3

b)

Tree Canopy Survey (10 x 10 m)		
Species	**Common Name**	**Number of Individuals**
Quercus petraea	Sessile oak	1
Coryllus avellana	Hazel	6

c)

Ground Flora (2 x 2 m)		
Species	**Common name**	**Domin Scale Abundance**
Rhytidiadelphus loreus	Lanky moss	5
Thuidium tamariskium	Common tamarisk moss	8
Blechnum spicant	Bracken	4
Dryopteris dilatata	Broad buckler fern	4
Rubus fructicosis	Bramble	7
Polytrichum commune	Common haircap moss	2
Vaccinium myrtillus	Bilberry	3

d)

Tree Canopy (10 x 10 m)		
Species	**Common name**	**Number of Individuals**
Fagus sylvaticus	Beech tree	2
Picea sitchensis	Sitka spruce	6

e)

Ground Flora (2 x 2 m)		
Species	**Common name**	**Domin Scale Abundance**
Holcus lanatus	Yorkshire fog	6
Trifolium repens	White clover	8
Ranunculus repens	Creeping buttercup	6
Stellaria graminea	Lesser stitchwort	3
Cynosurus cristatus	Crested dogstail	1
Agrostis stolonifera	Creeping bent grass	7
Cirsium spp.	Thistle spp.	4
Anthoxanthum odoratum	Sweet vernal grass	4
Lolium spp.	Ryegrass spp.	5
Rumex acetosella	Sheep sorrel	1

f)

Ground Flora (2 x 2 m)		
Species	**Common name**	**Domin Scale Abundance**
Ulex gallii	Western gorse	7
Anthoxanthum odoratum	Sweet vernal grass	4
Carex pilulifera	Pill sedge	9
Potentilla erecta	Tormentil	7
Calluna vulgaris	Common Ling	5
Agrostis stolonifera	Creeping bent grass	3
Brachytheciaceae spp.	Feather moss spp.	1

Appendix 4. Predator reintroduction discussion in the literature and in the media.

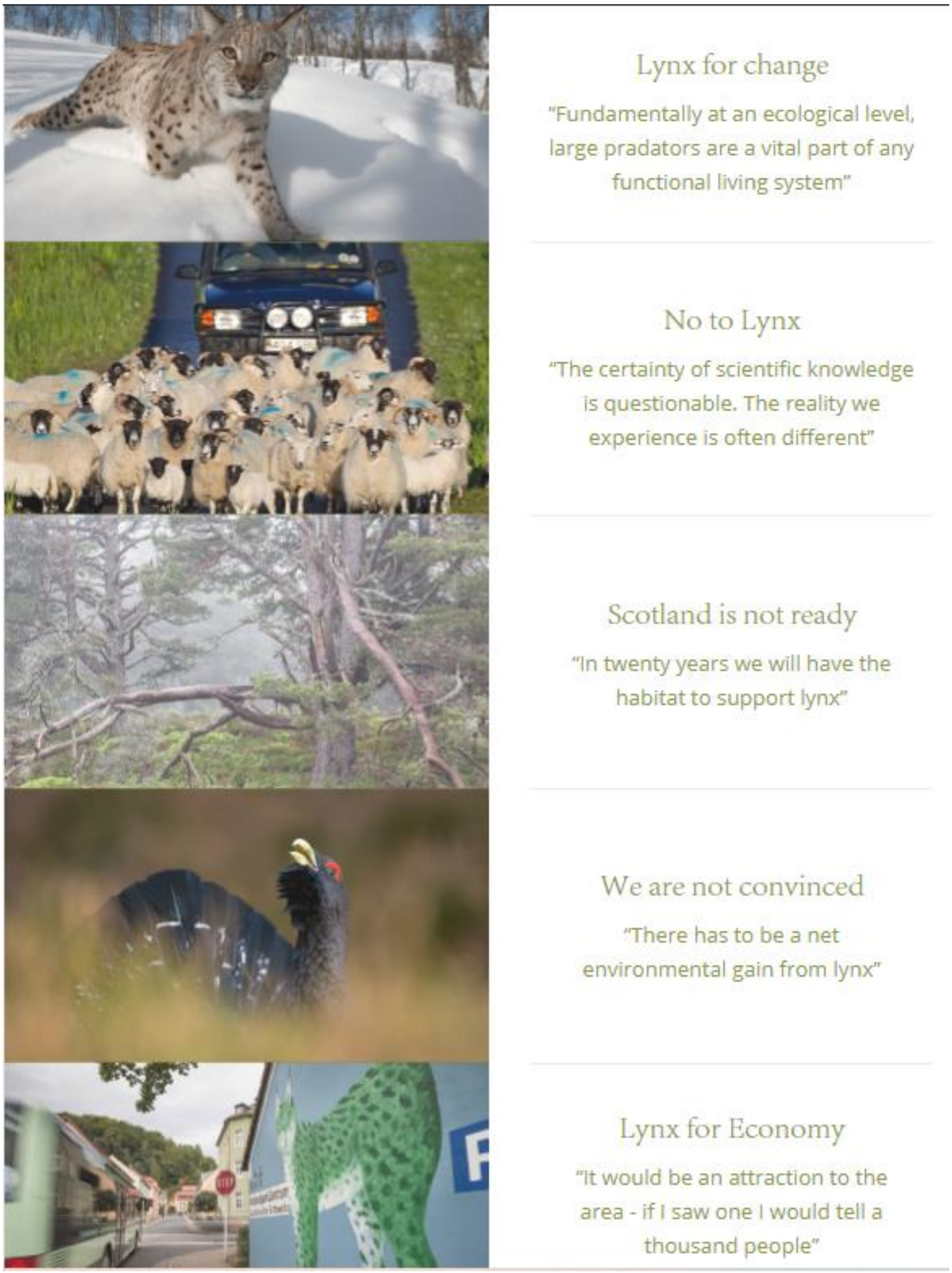


Figure 23. Five varying social attitudes to European lynx reintroduction in Scotland from the 'Lynx to Scotland' social feasibility study (Vincent Wildlife Trust, 2022).

Wildcats could return to England after 200 years

22 April 2021

Wildcats bred in Kent and Devon could be reintroduced to the countryside

Wildcats could return to England for the first time in over 200 years, a wildlife charity has said.

The Wildwood Trust plans to start a breeding project, while researchers look for a suitable release site.

The return of the predators, which have been driven to extinction in England and Wales, could "help restore the balance in ecosystems," the trust said.

Scientists working with the charity are investigating how to manage potential conflicts with farmers and pet owners.

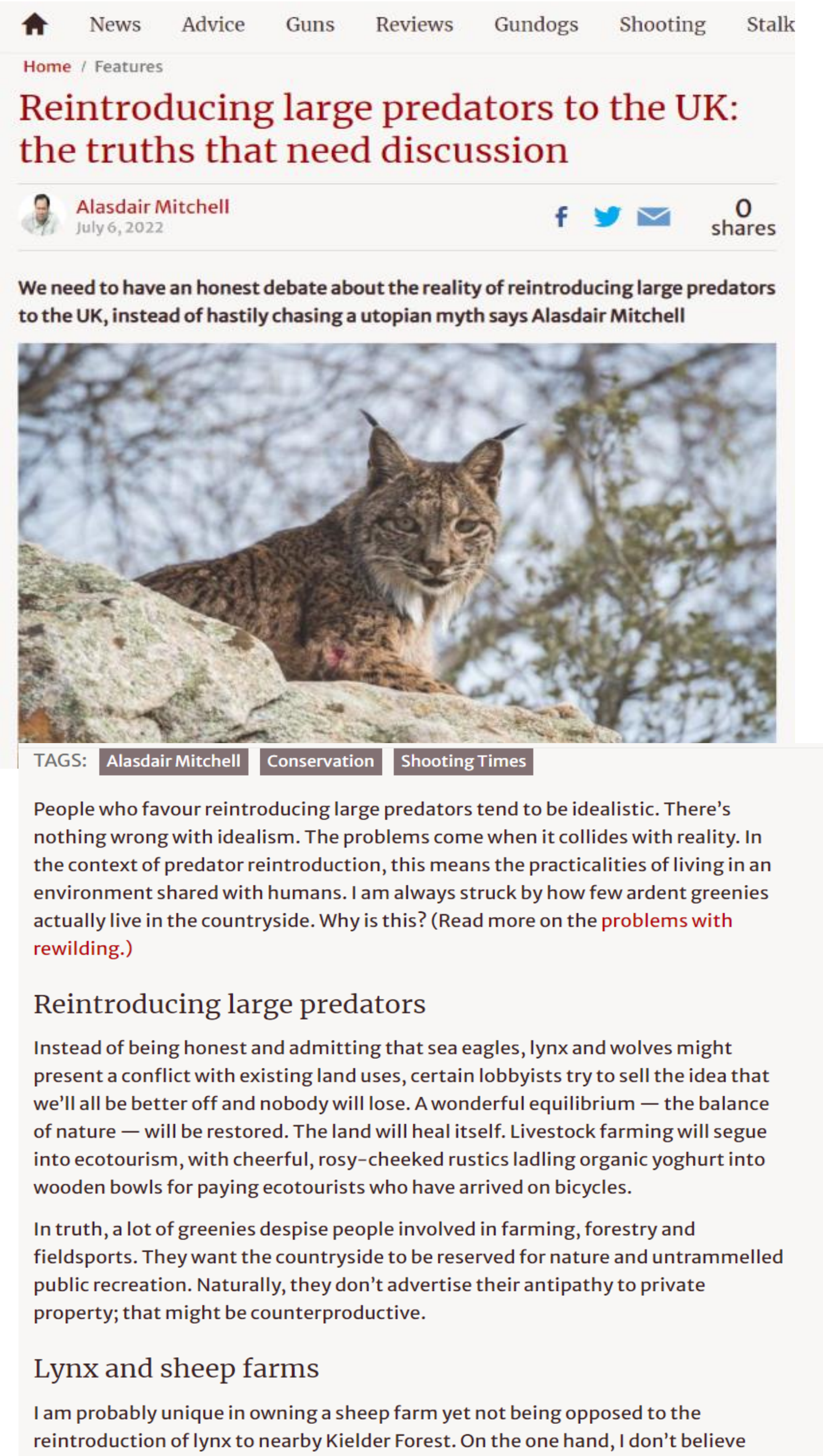
"Our goal is to return a viable and self-sustaining wildcat population to its former range," Laura Gardner, the trust's director of conservation said.

A population of about 300 wildcats remains in Scotland, but it has been called "**functionally extinct**" due to interbreeding with domestic cats.

The European wildcat can be found in habitats across the continent, but it had been "hunted and persecuted to extinction" in England and Wales, the trust said.

It plans to build ten breeding enclosures at its bases in Herne Bay, Kent, and Ottery St Mary, Devon.

Figure 24. BBC News report of European wildcat reintroduction project in Kent highlighting potential conflicts with farmers and pet owners (BBC, 2021).



News Advice Guns Reviews Gundogs Shooting Stalk

Home / Features

Reintroducing large predators to the UK: the truths that need discussion

Alasdair Mitchell
July 6, 2022

0 shares

We need to have an honest debate about the reality of reintroducing large predators to the UK, instead of hastily chasing a utopian myth says Alasdair Mitchell

TAGS: Alasdair Mitchell Conservation Shooting Times

People who favour reintroducing large predators tend to be idealistic. There's nothing wrong with idealism. The problems come when it collides with reality. In the context of predator reintroduction, this means the practicalities of living in an environment shared with humans. I am always struck by how few ardent greenies actually live in the countryside. Why is this? (Read more on the problems with rewilding.)

Reintroducing large predators

Instead of being honest and admitting that sea eagles, lynx and wolves might present a conflict with existing land uses, certain lobbyists try to sell the idea that we'll all be better off and nobody will lose. A wonderful equilibrium — the balance of nature — will be restored. The land will heal itself. Livestock farming will segue into ecotourism, with cheerful, rosy-cheeked rustics ladling organic yoghurt into wooden bowls for paying ecotourists who have arrived on bicycles.

In truth, a lot of greenies despise people involved in farming, forestry and fieldsports. They want the countryside to be reserved for nature and untrammelled public recreation. Naturally, they don't advertise their antipathy to private property; that might be counterproductive.

Lynx and sheep farms

I am probably unique in owning a sheep farm yet not being opposed to the reintroduction of lynx to nearby Kielder Forest. On the one hand, I don't believe

Figure 25. Shooting UK article on large predator reintroduction in the UK highlighting the frequent opposition to European Lynx among sheep farmers (ShootingUK, 2022).

9. References

Anderson, D. (2005) 'Noyfull Fowles and Vermyn: Parish payments for killing wildlife in Hampshire 1533-1863', *Proc. Hampshire Field Club Archaeol. Soc*, 60, pp. 209–228.

Anile, S. *et al.* (2017) 'Home-range size of the European wildcat (Felis silvestris silvestris): A report from two areas in Central Italy', *Mammalia*, 82(1), pp. 1–11. Available at: https://doi.org/10.1515/mammalia-2016-0045.

Auster, R.E., Barr, S.W. and Brazier, R.E. (2021) 'Improving engagement in managing reintroduction conflicts: learning from beaver reintroduction', *Journal of Environmental Planning and Management*, 64(10), pp. 1713–1734. Available at: https://doi.org/10.1080/09640568.2020.1837089.

Baker, P. *et al.* (2006) 'The potential impact of red fox Vulpes vulpes predation in agricultural landscapes in lowland Britain', *Wildlife Biology,* 12(1), pp. 39-50.

Bartrip, P.W.J. (2008) 'Myxomatosis in 1950s Britain', *Twentieth Century British History*, 19(1), pp. 83–105. Available at: https://doi.org/10.1093/tcbh/hwm016.

Bastianelli, M.L. *et al.* (2021) 'Survival and cause-specific mortality of European wildcat (Felis silvestris) across Europe', *Biological Conservation*, 261. Available at: https://doi.org/10.1016/j.biocon.2021.109239.

BBC News. (2021) *Wildcats could return to England after 200 years* [Online] Available at: https://www.bbc.co.uk/news/uk-england-kent-56847548 [Accessed: 30 August 2022].

Birks, J. *et al.* (2018) *The feasibility of reintroducing pine martens (Martes martes) to the Forest of Dean and lower Wye Valley*.

Biro, Z., Szemethy, L. and Heltai, M. (2004) 'Home range sizes of wildcats (Felis silvestris) and feral domestic cats (Felis silvestris f. catus) in a hilly region of Hungary', *Mammalian Biology*, 5, pp. 302–310.

Breitenmoser, U., Lanz, T. and Breitenmoser-Würsten, C. (2019) *Conservation of the wildcat (Felis silvestris) in Scotland: Review of the conservation status and assessment of conservation activities*.

Carbone, C. and Gittleman, J.L. (2002) 'A common rule for the scaling of carnivore density', *Science*, 295(5563), pp. 2273–2276. Available at: https://doi.org/10.1126/science.1067994.

Carlson, S.M. *et al.* (2007) 'Predation by bears drives senescence in natural populations of salmon', *PLoS ONE*, 2(12). Available at: https://doi.org/10.1371/journal.pone.0001286.

Fa, J.E., Sharples, C.M. and Bell, D.J. (1999) 'Habitat correlates of European rabbit (Oryctolagus cuniculus) distribution after the spread of RVHD in Cadiz Province, Spain ', *Journal of Zoology*, 249(1), pp. 83–96. Available at: https://doi.org/10.1111/j.1469-7998.1999.tb01062.x.

Ferreras, P. *et al.* (2021) ‘Integrating multiple datasets into spatially-explicit capture-recapture models to estimate the abundance of a locally scarce felid’, *Biodiversity and Conservation*, 30(14), pp. 4317–4335.

Fleming, P.J.S. (2019) ‘They might be right, but Beschta et al. (2018) give no strong evidence that “trophic cascades shape recovery of young aspen in Yellowstone National Park”: A fundamental critique of methods’, *Forest Ecology and Management*, 454(1).

Flowerdew, J.R. *et al.* (2004) ‘Live trapping to monitor small mammals in Britain’, *Mammal Review*, 32(1), pp. 31-50.

Forestry and Land Scotland (2009) *Forest operations and wildcats in Scotland*. Available at: http://www.brisc.org.uk/Sources.php.

Genovart, M. *et al.* (2010) ‘The young, the weak and the sick: Evidence of natural selection by predation’, *PLoS ONE*, 5(3). Available at: https://doi.org/10.1371/journal.pone.0009774.

Gil-Sánchez, J.M. *et al.* (2020) ‘Fragmentation and low density as major conservation challenges for the southernmost populations of the European wildcat’, *PLoS ONE*, 15(1). Available at: https://doi.org/10.1371/journal.pone.0227708.

Gil-Sánchez, J.M. and McCain, E.B. (2011) ‘Former range and decline of the Iberian lynx (Lynx pardinus) reconstructed using verified records’, *Journal of Mammalogy*, 92(5), pp. 1081–1090. Available at: https://doi.org/10.1644/10-MAMM-A-381.1.

Glass, G.E., Norm, A.D. and Slade, A.A. (1980) ‘The effect of Sigmodon hispidus on spatial and temporal activity of microtus achrogaster: evidence for competition’, *Ecology*, (2), pp. 358–370.

Glue, D.E. (1974) ‘Food of the barn owl in Britain and Ireland’, *Bird Study*, 21(3), pp. 200–210. Available at: https://doi.org/10.1080/00063657409476419.

Goodwin, C.E.D. *et al.* (2018) ‘Climate, landscape, habitat, and woodland management associations with hazel dormouse Muscardinus avellanarius population status’, *Mammal Review*. Blackwell Publishing Ltd, pp. 209–223. Available at: https://doi.org/10.1111/mam.12125.

GOV.UK. (2022) *Licence to take shrews (GL01)* [Online] Available at: https://www.gov.uk/government/publications/shrews-licence-to-take-them/licence-to-take-shrews-gl01 (Accessed: 17 March)

Gow, D., Cooper, P. and Dennis, R. (2019) *A Strategy for the Reintroduction of the Wildcat (Felis silvestris) to England*.

Guerrero-Casado, J. *et al.* (2019) ‘Assessment of the suitability of latrine counts as an indirect method by which to estimate the abundance of European rabbit populations at high and low abundance’, *European Journal of Wildlife Research, 66.*

Gutman, R. and Dayan, T. (2005) ‘Temporal partitioning: an experiment with two species of spiny mice’, *Ecology*, 86(1), pp. 164-173

Harmer, R. and Morgan, G. (2009) ‘Storm damage and the conversion of conifer plantations to native broadleaved woodland’, *Forest Ecology and Management*, 258(5), pp. 879–886. Available at: https://doi.org/10.1016/j.foreco.2009.03.023.

Hartmann, S.A. *et al.* (2013) ‘Potential barriers to gene flow in the endangered European wildcat (Felis silvestris)’, *Conservation Genetics*, 14(2), pp. 413–426. Available at: https://doi.org/10.1007/s10592-013-0468-9.

Herrero, J. *et al.* (2006) ‘Diet of wild boar Sus scrofa L. and crop damage in an intensive agroecosystem’, *European Journal of Wildlife Research*, 52(4), pp. 245–250. Available at: https://doi.org/10.1007/s10344-006-0045-3.

IUCN/SSC (2013) *IUCN Guidelines for Reintroductions and Other Conservation Translocations*, *IUCN Species Survival Commission*. Available at: https://doi.org/10.1016/j.biocon.2015.07.030.

Jerosch, S., Götz, M. and Roth, M. (2017) ‘Spatial organisation of European wildcats (Felis silvestris silvestris) in an agriculturally dominated landscape in Central Europe’, *Mammalian Biology*, 82, pp. 8–16. Available at: https://doi.org/10.1016/j.mambio.2016.10.003.

Jiménez-Albarral, J.J. *et al.* (2021) ‘Abundance and use pattern of wildcats of ancient human-modified cattle pastures in northern Iberian Peninsula’, *European Journal of Wildlife Research*, 67(6). Available at: https://doi.org/10.1007/s10344-021-01533-y.

Jobin, A., Molinari, P. and Breitenmoser, U. (2000) ‘Prey spectrum, prey preference and consumption rates of Eurasian lynx in the Swiss Jura Mountains’, *Acta Theriologica*, 45(2), pp. 243–252. Available at: https://doi.org/10.4098/AT.arch.00-26.

Kilshaw, K. (2011) *Scottish wildcats*.

Klar, N. *et al.* (2008) ‘Habitat selection models for European wildcat conservation’, *Biological Conservation*, 141(1), pp. 308–319. Available at: https://doi.org/10.1016/j.biocon.2007.10.004.

Klar, N., Herrmann, M. and Kramer-Schadt, S. (2009) ‘Effects and Mitigation of Road Impacts on Individual Movement Behavior of Wildcats’, *Journal of Wildlife Management*, 73(5), pp. 631–638. Available at: https://doi.org/10.2193/2007-574.

Lincoln. F. (1930) *Calculating waterfowl abundance on the basis of banding returns*. Washington, DC: U.S. Department of Agriculture.

Lozano, J. *et al.* (2003) ‘Importance of scrub-pastureland mosaics for wild-living cats occurrence in a Mediterranean area: Implications for the conservation of the wildcat (Felis silvestris)’, *Biodiversity and Conservation*, 12(5), pp. 921–935. Available at: https://doi.org/10.1023/A:1022821708594.

Lozano, J. (2010) ‘Habitat use by European wildcats (Felis silvestris) in central Spain: what is the relative importance of forest variables?’, *Animal Biodiversity and Conservation*, 33(2), pp. 143–150.

Lozano, J., Moleón, M. and Virgós, E. (2006) ‘Biogeographical patterns in the diet of the wildcat, Felis silvestris Schreber, in Eurasia: Factors affecting the trophic diversity’, *Journal of Biogeography*, 33(6), pp. 1076–1085. Available at: https://doi.org/10.1111/j.1365-2699.2006.01474.x.

Ludwig, S.C., Roos, S. and Baines, D. (2020) ‘Fluctuations in field vole abundance indirectly influence red grouse productivity via a shared predator guild’, *Wildlife Biology*, 2020(2). Available at: https://doi.org/10.2981/wlb.00642.

Macpherson, J., Carter, S. and Devillard, S. (2019) *A preliminary feasibility assessment for the reintroduction of the European wildcat to England and Wales*. Available at: https://www.gov.uk/government/statistics/great-britain-.

Malo, A.F. *et al.* (2004) ‘A change of diet from rodents to rabbits (Oryctolagus cuniculus). Is the wildcat (Felis silvestris) a specialist predator?’, *Journal of Zoology*, 263(4), pp. 401–407. Available at: https://doi.org/10.1017/S0952836904005448.

Marmor, L. *et al.* (2013) ‘Lichens on Picea abies and Pinus sylvestris - From tree bottom to the top’, *Lichenologist*, 45(1), pp. 51–63. Available at: https://doi.org/10.1017/S0024282912000564.

Martín-Díaz, P. *et al.* (2018) ‘Integrating space and time in predator-prey studies: The case of wildcats and rabbits in SE Spain’, *Mammalian Biology*, 88, pp. 114–122. Available at: https://doi.org/10.1016/j.mambio.2017.10.006.

McNicol, C.M. *et al.* (2020) ‘Translocated native pine martens Martes martes alter short-term space use by invasive non-native grey squirrels Sciurus carolinensis’, *Journal of Applied Ecology*, 57(5), pp. 903–913. Available at: https://doi.org/10.1111/1365-2664.13598.

Migli, D. *et al.* (2021) ‘Spatial ecology and diel activity of European wildcat (Felis silvestris silvestris) in a protected lowland area in northern Greece’, *Animals*, 11(11). Available at: https://doi.org/10.3390/ani11113030.

Moleón, M. and Gil-Sánchez, J.M. (2003) ‘Food habits of the wildcat (Felis silvestris) in a peculiar habitat: The Mediterranean high mountain’, *Journal of Zoology*, 260(1), pp. 17–22. Available at: https://doi.org/10.1017/s0952836902003370.

Monterroso, P. *et al.* (2009) ‘Spatial ecology of the European wildcat in a Mediterranean ecosystem: Dealing with small radio-tracking datasets in species conservation’, *Journal of Zoology*, 279(1), pp. 27–35. Available at: https://doi.org/10.1111/j.1469-7998.2009.00585.x.

Moreno-Opo, R. *et al.* (2015) ‘Is it necessary managing carnivores to reverse the decline of endangered prey species? Insights from a removal experiment of mesocarnivores to benefit demographic parameters of the pyrenean capercaillie’, *PLoS ONE*, 10(10). Available at: https://doi.org/10.1371/journal.pone.0139837.

Okarma, H., Sniezko, S. and Olszańska, A. (2002) ‘The occurrence of wildcat in the Polish Carpathian Mountains’, *Acta Theriologica*, 47(4), pp. 499–504. Available at: https://doi.org/10.1007/BF03192474.

Oliveira, R. *et al.* (2008) ‘Hybridization versus conservation: Are domestic cats threatening the genetic integrity of wildcats (Felis silvestris silvestris) in Iberian Peninsula?’, *Philosophical Transactions of the Royal Society B: Biological Sciences*, 363(1505), pp. 2953–2961. Available at: https://doi.org/10.1098/rstb.2008.0052.

Palmer, M.A. *et al.* (2005) ‘Standards for ecologically successful river restoration’, *Journal of Applied Ecology*, pp. 208–217. Available at: https://doi.org/10.1111/j.1365-2664.2005.01004.x.

Palomares, F. (2001) ‘Comparison of 3 methods to estimate rabbit abundance in a Mediterranean environment’, *Wildlife Society Bulletin*, 29(2), pp. 578–585.

Ripple, W.J. and Beschta, R.L. (2012) 'Trophic cascades in Yellowstone: The first 15 years after wolf reintroduction', *Biological Conservation*, 145(1), pp. 205–213. Available at: https://doi.org/10.1016/j.biocon.2011.11.005.

Rodríguez, A. *et al.* (2020) 'Spatial segregation between red foxes (Vulpes vulpes), European wildcats (Felis silvestris) and Domestic Cats (Felis catus) in Pastures in a Livestock Area of Northern Spain', *Diversity*, 12(7), pp. 1–17. Available at: https://doi.org/10.3390/d12070268.

RSPB (2018) *Birds of Concern 5*.

Shooting UK. (2022) *Reintroducing large predators to the UK - the truth that needs discussing* [Online] Available at: https://www.shootinguk.co.uk/features/reintroducing-large-predators-to-the-uk-133086 [Accessed: 30 August 2022].

Silva, A.P., Rosalino, L.M., *et al.* (2013) 'Local-level determinants of wildcat occupancy in Northeast Scotland', *European Journal of Wildlife Research*, 59(3), pp. 449–453. Available at: https://doi.org/10.1007/s10344-013-0715-x.

Silva, A.P., Kilshaw, K., *et al.* (2013) 'Wildcat occurrence in Scotland: Food really matters', *Diversity and Distributions*, 19(2), pp. 232–243. Available at: https://doi.org/10.1111/ddi.12018.

Simpson, E. (1949) 'Simpsons Diversity Index', *Nature*, 163(1), p. 688.

Smith, D.W. and Peterson, R.O. (2021) 'Intended and unintended consequences of wolf restoration to Yellowstone and Isle Royale National Parks', *Conservation Science and Practice*, 3(4). Available at: https://doi.org/10.1111/csp2.413.

The Guardian. (2014) *Water voles return to Cornwall* [Online] Available at: https://www.theguardian.com/environment/2014/aug/27/water-voles-return-to-cornwall (Accessed: 18 August 2022)

Trakhtenbrot, A. *et al.* (2005) 'The importance of long-distance dispersal in biodiversity conservation, *Diversity and Distributions*, pp. 173–181. Available at: https://doi.org/10.1111/j.1366-9516.2005.00156.x.

Vincent Wildlife Trust (2022) *Lynx to Scotland: Assessing the social feasibility of returning Eurasian lynx to Scotland*. Available at: https://www.vwt.org.uk/download_category/scientific-publications/.

Virgós, E. *et al.* (2003) 'Factors shaping European rabbit abundance in continuous and fragmented populations of central Spain', *Acta Theriologica*, 48(1), pp. 113–122. Available at: https://doi.org/10.1007/BF03194271.

Wilson, S.M. (2018) *Lessons Learned from Past Reintroduction and Translocation Efforts with an Emphasis on Carnivores.*

Wittmer, H. (2001) 'Home range size, movements, and habitat utilization of three male European wildcats (Felis silvestris Schreber, 1777) in Saarland and Rheinland-Pfalz (Germany)', *Mammalian Biology*, 66, pp. 365–370.

Ziege, M. *et al.* (2016) 'Importance of latrine communication in European rabbits shifts along a rural-to-urban gradient', *BMC Ecology*, 16(1). Available at: https://doi.org/10.1186/s12898-016-0083-y.