

Safeguarding Orkney's native wildlife from non-native invasive stoats

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Abstract The Orkney Islands, off the north-east coast of Scotland, support highly significant cultural and natural heritage. The combined land area of the 70 islands is 990 km² (380 sq mi), <1% of the UK, but they host over 20% of the UK's breeding hen harriers (*Circus cyaneus*) (declining over much of its mainland range), 8% of breeding curlews (*Numenius arquata*) (one of only two UK populations not in decline) and an internationally important assemblage of breeding seabirds. The Orkney Islands are naturally free of mammalian predators, and all bird species, including raptors, are ground-nesting in the largely treeless landscape. Rats (*Rattus spp.*), hedgehogs (*Erinaceus europaeus*) and feral cats (*Felis catus*) are present across the archipelago. Stoats (*Mustela erminea*) are native to mainland UK but not Orkney, yet were detected on Orkney Mainland in 2010. Orkney Mainland has an area of 523 km² (202 sq mi). Early attempts at removing them were not successful. By 2013 stoats were present across the Orkney Mainland and connected isles. In 2016, SNH and RSPB formed a partnership to eradicate stoats to protect the native wildlife and designated sites of the Orkney islands, and to secure the wider socio-economic and cultural benefits of thriving native wildlife. Difficulties faced in developing the project include predicting the effort required to remove stoats at a rate faster than they can reproduce, securing community support and access to private land and, in particular, funding large scale biodiversity restoration projects. A feasibility study determined that stoat eradication would be possible using DOC200 kill traps, and search dogs in later stages of the eradication. There are no legally available poisons that could be used on stoats in the UK. A Biosecurity Plan has been produced for the archipelago, with a current focus on preventing the spread of stoats to the un-invaded isles. The partnership is working to secure funds and community support for what will be the world's largest stoat eradication attempted to date. We present the findings of the feasibility study and our proposed methodology.

Keywords: biosecurity, feasibility, hen harrier, Orkney vole, predator eradication, Scotland, short-eared owl

INTRODUCTION

The Orkney Islands are situated 10 km from the north-east coast of Caithness, at the northernmost point of mainland Scotland. The archipelago is made up of around 70 islands, of which 20 are inhabited with a total population of around 21,000 residents (National Records of Scotland, 2016). The largest island, Orkney Mainland, is some 523 km² and is home to 75% of the human population. The islands of Burry and South Ronaldsay are connected to the Orkney Mainland by causeways carrying road infrastructure. The remaining islands are not physically linked, and are reachable via air or inter-island ferry.

Orkney supports a wide range of natural and cultural heritage for which it is world-famous. There is abundant native wildlife with seabirds, ground-nesting and wading birds, corncrake and sea mammals – all important parts of the ecosystem. Although the islands represent only 0.4% of the UK land area, they are home to a significant proportion of native UK seabirds and terrestrial species. About 14% of the UK breeding kittiwake (*Rissa tridactyla*) population, 34% of arctic skua (*Stercorarius parasiticus*), 10% of puffin (*Fratercula arctica*), 25% of arctic tern (*Sterna paradisaea*) and 14% of the global population of breeding great skuas (*Catharacta skua*) are found in Orkney. Orkney is a UK stronghold for hen harrier (*Circus cyaneus*) and short-eared owl (*Asio flammeus*). Over 20% of the UK population of hen harrier is known to breed in Orkney. The islands are one of the few remaining core areas for breeding corncrake (*Crex crex*) and a stronghold for breeding waders and especially the curlew (*Numenius arquata*) – the UK's highest conservation priority bird species. At a time of large-scale decline across the UK, wader populations in the lowlands of Orkney are thought to be stable or increasing, bucking the national and global trends. Densities in these areas are amongst the highest recorded in Europe.

The quality and importance of Orkney's natural heritage is recognised through the number of nationally and internationally designated sites across the islands.

These cover approximately 30% of the islands' land area. There are 13 Special Protection Areas (SPAs), strictly protected sites for rare and vulnerable birds, and for regularly occurring migratory species, under the EU Birds Directive, as well as five Special Areas for Conservation (SACs) which offer strict protection for threatened habitats under the EU Habitats Directive. Orkney also has 36 Sites of Special Scientific Interest (SSSIs), a designation for sites which best represent Scottish natural heritage and are designated under the Nature Conservation (Scotland) Act 2004; one National Scenic Area (NSA), a designation representing Scotland's finest landscapes; two nature conservation Marine Protected Areas (NC MPAs), nature conservation sites in the marine environment designated under the Marine (Scotland) Act 2010; and three proposed marine SPAs. The unique natural and historic heritage of the islands underpins Orkney's distinctive culture and economy and supports a thriving tourism industry.

Although stoats (*Mustela erminea*) are native, widespread and common throughout mainland Britain and Ireland they are not native to the Orkney archipelago. The first confirmed sighting of a stoat in Orkney was reported in August 2010, following verbal reports of possible sightings in June and July of the same year. It is not known how stoats arrived in Orkney; possible vectors include accidental release from imported hay or straw, shipping, or deliberate release (e.g. to control rabbits). Sightings of stoats reported to Scottish Natural Heritage (SNH) have increased in frequency and stoats are now considered to be present across the entire Mainland and linked isles.

This paper examines the risks to Orkney's native wildlife from the impact of predation by stoats and describes efforts to date to deal with the problem. We present the findings of the feasibility study into eradication, our proposed methodology for eradication and outline some of the major challenges to what will be the largest removal of stoats anywhere in the world.

MATERIALS AND METHODS

This paper summarises the results and discussions arising from stoat sightings across the islands, a desk study conducted to predict the likely impact of stoats on native wildlife, an independent technical feasibility study of stoat eradication (Harper, 2017a), and a Biosecurity Plan (Harper, 2017b) which identifies measures to prevent increase in range and re-colonisation post-eradication.

RESULTS

Likely impact of stoats

When stoats are introduced into ecosystems that have no native mammalian predators, such as those of the Orkney islands, they can have a devastating impact on the native species present. In New Zealand, the stoat is thought to be the main driver of declines and some local extirpations of many native bird populations (Dowding & Murphy, 2001). A desk study that was conducted predicts that the ecological consequences of stoat introduction to Orkney are likely to be devastating (Fraser, et al., 2015). It is highly likely that the presence of stoats on Orkney will have a catastrophic effect on ground nesting birds and mammals on Orkney due to the absence of other mammalian predators including the red fox (*Vulpes vulpes*) "... it is highly likely that the introduction of stoats will profoundly change the ecology of Orkney and its value for birds of prey and the SPAs that have been designated for protecting these species." (Fraser, et al., 2015). Stoats have never been part of the ecosystem in Orkney and therefore many native species, cannot respond rapidly enough to the introduction of this predator. The potential scale and range of the impact of this non-native predator is such that little wildlife in Orkney is currently safe. Impact will be of national and international significance due to the proportion of populations living on the islands.

One critical linkage within the Orkney ecosystem is the predator-prey relationship of the Orkney vole with the hen harrier and short-eared owl. Fraser, et al. (2015) suggest that a decline in Orkney voles will have direct consequences on the hen harrier and short-eared owl populations because both of these species rely to varying extents on the Orkney vole as a component of their diet. The short-eared owl has developed a specialist hunting behaviour to match Orkney vole activity (Reynolds & Gorman, 1999). A range of evidence suggests that the abundance of Orkney voles (which do not display the cyclical population abundance observed in other *Microtus* species) is directly linked to the breeding success of the hen harrier and short-eared owl. It is therefore suggested that significant depredation of voles by introduced stoats will have an indirect detrimental impact on these species. The RSPB Orkney reserves data on numbers of hen harriers fledging suggests a sustained decline which started in 2011 (RSPB 2016, unpublished data). In relation to other species, Fraser, et al. (2015) raise concerns over a range of ground-nesting birds including curlew (another bird on the UK Red list of conservation concern), as stoats are well known to be significant predators, especially where other terrestrial mammalian predators such as foxes are absent, as is the case in Orkney – and so curlew and similar birds are now under severe risk.

Whilst there are other threats to Orkney's native wildlife, including climate change and changes in land management practices, the stoat is considered to be the most pressing and widespread current threat.

Decline in the native wildlife populations is predicted to have a significant effect on socio-economic benefits that Orkney's nature and landscapes provide in terms of tourism and farming. The 2012–2013 (the most recently

completed) Islands Visitor Survey (Visit Scotland, 2013) shows that just over 142,800 people visited Orkney, spending over £31 million in the local economy over the period of a year. The main influence on visitors deciding to come to Orkney was an interest in the archaeology and history of Orkney, followed by the scenery and landscape. Given the importance of wildlife tourism to the overall tourism market in Orkney, the predicted declines of many native species caused by stoat predation is a cause for concern amongst tourism businesses.

Stoats are also predicted to affect free-range poultry operations. Free-range poultry farming is common practice in Orkney, where the absence of mammalian predators makes this an economically viable management option for poultry. If stoats continue to persist on the archipelago, future impacts on this industry are expected to include loss of stock to stoat predation as well as the financial impact of implementing predator control and mitigation measures.

Population expansion

No population estimates are available for the stoat population in Orkney, and the available information on their range comes from sightings reported by members of the public. Sightings (both those reported directly and through the 'Stoats in Orkney' Facebook page, maintained by interested local volunteers) have increased steadily since 2010, with a marked increase in sightings since 2016. However, caution must be used when correlating this to any indication of abundance of stoats. Press activity and awareness-raising campaigns by SNH and RSPB Scotland (including posters designed to increase recording of sightings – see Fig. 2) may have increased peoples' awareness of stoats. This could partially lie behind the recent increases in the rate of sightings, although no particular spikes in sightings have been recorded after media activity in the past (Fraser, et al., 2015). The overall distribution map of all sightings (Fig. 1) tends to reflect where people live, work and travel, rather than any accurate estimate of the distribution of stoats per se.

Stoats were first reported in two areas, one on Orkney Mainland and one on South Ronaldsay in 2010. Since this time their numbers and range have increased rapidly and they are now known to be distributed across Mainland

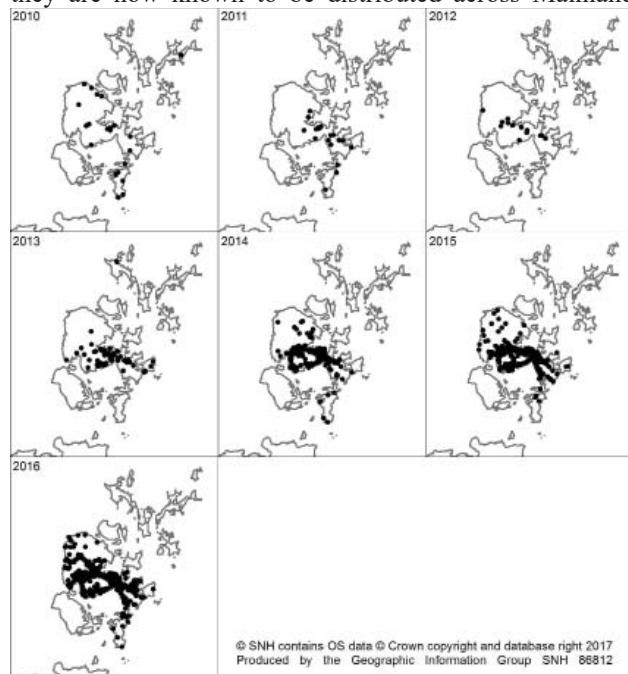


Fig. 1 Distribution of all sightings of stoats in Orkney as reported to SNH (Scottish Natural Heritage) – 2010 to 2016.



Have you spotted a stoat?

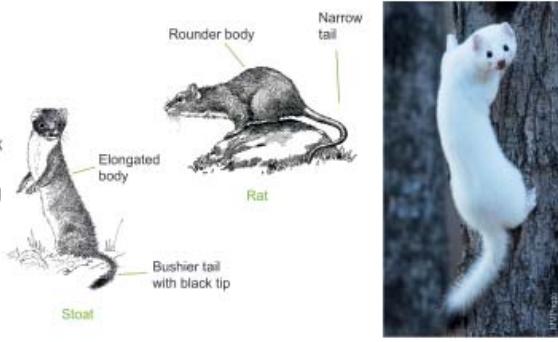
Stoats are a serious threat to Orkney's wildlife.

Stoats will probably have a negative impact on the native Orkney vole, hen harrier, short-eared owl and ground-nesting birds. Find out more at www.snh.gov.uk/land-and-sea/managing-wildlife/orkney-stoats/



Is it a stoat or a rat?

They're very similar in size. Look out for the stoat's bounding gait rather than the rat's low scurrying as well as its other special features. Stoats moult twice a year, with some turning white or partially white during winter, known as ermine.



Report a stoat sighting



All stoat sightings are important to us. They give us an insight into the distribution of stoats across Orkney. If you have seen a stoat either dead or alive we would really like to hear from you. It is important that you record the date and location – if possible the six figure OS grid reference. Contact SNH on 01856 886163 or email north@snh.gov.uk

Fig. 2 Poster to raise awareness of stoats and their potential impact – and encourage sightings to be reported to SNH (Scottish Natural Heritage).

Orkney and the linked isles of Burray and South Ronaldsay (Fig. 1). Figure 3 shows the clear increase in sightings from 2010–2016. There are obvious seasonal peaks in stoat sightings which would correlate with seasonal activity of the animals (Fig. 4).

Although a number of live and lethal trapping efforts were implemented, they were unsuccessful in completely removing the species or controlling range and population growth. When stoats were first confirmed in 2010 an early 'rapid response' was put in place with volunteers using live traps to remove stoats from the two sites in South Ronaldsay and the west Mainland. Any stoats caught were relocated to mainland Scotland. This was most successful in South Ronaldsay where sightings decreased to two in 2011 and none at all in 2012 and 2013. However, it clearly did not remove the problem on West Mainland where sightings continued to be reported, and eventually increased in numbers and over a wider area.

In 2011–2013, SNH employed a contractor to remove stoats using kill traps mainly on the west Mainland,

across an area of some 300 km² (115 sq mi). This was unfortunately unsuccessful, possibly due to inexperience of the contractor and/or an inadequate methodology. Fewer than five stoats were caught – nowhere near the numbers required to contain or remove the problem. In 2014, SNH recruited a relatively large number of volunteers from the local community following an awareness raising campaign and increasing concern from interested parties. Over 50 volunteers were trained in the use of kill traps and a trapping project was launched to remove stoats. The purpose of this project was three-fold; in addition to attempting to remove or control the spread of stoats, it was to test whether a large scale volunteer effort was feasible and sustainable in Orkney, and finally to trial approaches to data handling and management for an eradication project.

The volunteering project was ultimately scaled down in 2016 as it had been shown that sustaining a large volunteer force of this size was very resource intensive, few stoats (under 10) were trapped and keeping volunteers motivated when stoats were not being caught was very difficult.

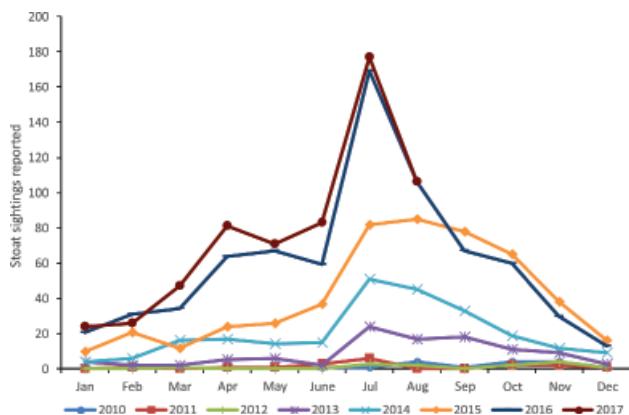


Fig. 3 Number of stoat sightings reported each month on Orkney between June 2010 and June 2017.

Feasibility of stoat eradication

A proposed methodology for eradicating stoats was initially developed by SNH following their experience gained during the Hebridean Mink Project (HMP) and the Uist Wader Project (UWP) which carries out live trapping and translocation of hedgehogs. It was revised following advice from the project's Technical Advisory Group (TAG).

This methodology and the technical, political and environmental feasibility of stoat eradication was assessed independently in an independent Technical Feasibility Study commissioned by RSPB Scotland and completed by Grant Harper of Biodiversity Restoration (Harper, 2017a) following best practice guidelines.

The feasibility study determined that an eradication project was feasible given the current range, but that a new methodology should be adopted. Draft costings were developed for this methodology to determine capacity to eradicate. This methodology has now been assessed by the TAG and adopted by the partnership.

The only legal method to remove stoats in the UK is humane trapping. There are no approved viruses or poisons available for use at present, nor are any likely to be approved within the time frame of eradication. The feasibility study identifies only NZ Department of Conservation (DOC) and Goodnature A24 self-setting traps as AIHTS (Agreement on the International Humane Trapping Standard) compliant in the UK. In Scotland only DOC traps are currently legally compliant. Dogs can be used to locate but not harm or kill an animal.

The legal circumstances surrounding land access are simplified as SNH has the power to issue a Species Control Order which allows them to compulsorily access land in order to control invasive species in the event that landowner permission is withheld. This is of course a last resort, and

landowner permission, and the inclusion of landowning interests in the partnership, is of paramount importance.

Environmental acceptability was assessed to determine if the impact of the project on native wildlife can be reduced to an acceptably low level and ensure eradication will not lead to permanent negative changes impact on non-target species. It is accepted that there is always a short-term risk to non-target species, and the project is designed so that this balances out to give a positive long-term change. Harper shows that the species most at risk are rats (which are also non-native to Orkney), but a smaller number of Orkney vole, mice and (potentially) small feral cats are also at risk (Harper, 2017a). However, based on New Zealand data, none of these bycatches are predicted to be of big enough volume to impact population size or stability of non-target species or will be anywhere near the estimated impact of stoats on their long-term populations (Harper, 2017a).

Setting and inspecting traps will inevitably create disturbance in areas of high breeding density for native wildlife. This risk will be minimised in the eradication phase by sensitive placing and minimising disturbance through remote monitoring of trap triggers. The effect of this is also asserted to be much less than the effect of stoats on the native wildlife.

To achieve eradication, a methodology must be implemented that removes animals at a rate faster than they can reproduce and target all of the animals within the population. Stoats in the UK can have home range sizes from 2–254 ha but average about 40 ha. Their home range in Orkney is unknown but a home-range analysis now, when the stoats still have room for expansion, would delay the project unacceptably. A precautionary approach is proposed that works on the assumption of the smallest home range size. This is considered to be required due to the year round food supply, density of food supply and novelty of the predator.

A methodology is proposed that uses a uniform trapping density of 16 traps per km² in the first instance. Baited DOC200 kill-traps in standard housing will be used and it is proposed that Goodnature A24 self-resetting traps are also deployed, to target trap-shy individuals that may avoid the DOC traps if these traps are made legal in Scotland. Dogs are also an option to locate trap shy individuals. Within the currently affected area, all land is considered easily accessible and well provisioned with access routes.

This density of trapping gives a total number of traps of 9270, each will be roughly 250 m apart based on a square grid. It is expected to take roughly two months to set these traps, based on 10 trappers setting 20–30 traps per day. Utilisation of habitats is likely to vary and it is expected that, in the largely open farmland habitat, stoats will use field margins that provide both cover and more food. In these habitats, traps will be set according to linear features including fences, walls, ditches, roads and tracks. The proposed grid will be used as a guide for the placement of the traps but trappers will have the discretion to move the traps up to 50 m from the proposed position to the best location on the ground for the interception of stoats.

Trap density and distribution in each habitat type will be reviewed as the project develops using an adaptive management approach.

Draft costings were developed to determine the financial feasibility and the capacity of the relevant organisations to deliver the project in a timely manner. These figures have been further developed by the partnership to ensure social feasibility through community support and involvement. The cost of the project is around £4.5 million. This resource is not available through government so external funding will need to be sourced.

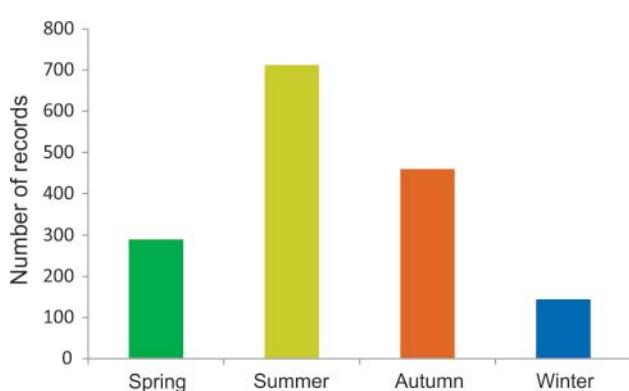


Fig. 4 Seasonality of reported stoat sightings on Orkney.

The feasibility study did identify some aspects unique to this project and in particular interaction with the man-made environment. To date stoat eradication have been carried out in largely uninhabited areas so association and behaviour of stoats with areas such as gardens, and farmyards is not known. It is also worth noting that, whilst effectiveness of traps, baits and lures is well documented in New Zealand, this is less well known in the UK and there have been no trials on Orkney.

Biosecurity plan

Finally, the sustainability of the proposed project has been assessed through an RSPB commissioned independent biosecurity plan (Harper, 2017b) to determine if the likelihood of reinvasion is suitably low, or the risks of re-invasion can be reduced sufficiently, through affordable biosecurity measures. All potential invasion and re-invasion risks have been assessed. Two main pathways have been identified for the re-introduction of stoats to Orkney, firstly through intentional introduction and secondly accidentally through haulage of fodder and bedding. A high level of community engagement in an eradication and increased vigilance is considered to reduce the risk of intentional introduction and on-going use of sniffer dogs and an isolation and trapping method for cargoes to sufficiently reduce the risk of accidental re-introduction. It should be noted that this risk is considered small. For decades Orkney has had a high volume of bedding and fodder imported each year, but only the 2010 incident of stoat introduction. Measures can also be taken to reduce the source risk by wrapping and timely movement of bales.

The Biosecurity plan does identify a major risk of expansion to new islands. While no comprehensive survey of stoat population on Orkney has been carried out, the distribution and extent of stoat sightings across the whole of the Mainland and linked isles suggests that the stoat population has ended the invasion phase and it is suggested (Harper, 2017b) that they are at or near carrying capacity within the current range. There are over 60 islands that are still thought to be stoat-free. This means that the situation for stoats on Orkney is at a critical stage, as dispersal to other islands is highly likely. Stoats are thought to be good swimmers, and written accounts exist of stoats swimming 400 m in Ireland, and much further between islands in New Zealand (Veale, 2013), although this has not yet been observed on Orkney. There are many islands within theoretical swimming distance for stoats which could act as staging-posts for dispersing animals onto non-linked isles which are currently biological refuges. Whilst the plan clearly identifies eradication of stoats from the current range as the most effective biosecurity measure to prevent dispersal to new islands it is suggested that trapping on the Orkney Mainland can reduce the risk of spread until eradication can begin. There are five areas of Orkney Mainland coast that have been identified where stoat-free islands are within swimming distance. Immediate deployment of DOC traps in these areas will reduce risk of dispersal. Whilst eradication is considered currently feasible a successful eradication would already be three times greater in area than the largest successful eradication to date. Any extension of range, particularly to islands with less accessible land could make an eradication no longer technically or financially feasible.

DISCUSSION

Due to the native status of the stoat through most of the UK, there is little direct evidence of impact of stoat predation. However, due to the importance of the Orkney islands in a national and international context for wildlife, the SNH commissioned a report, assessing likely impacts

of stoats on Orkney's native wildlife through comparison with impacts in other areas of the globe where they are not native. This report clearly demonstrates an ecological imperative to eradicate (Fraser, et al., 2015).

Our learning from early unsuccessful attempts to remove and contain stoats through volunteer response and small contracts has been put to good use in demonstrating that a full scale professional eradication project is required to deal with this issue.

An independent feasibility study (Harper, 2017a) has clearly shown that it is possible to eradicate stoats given the current range of presence across the Mainland and connected isles (as shown in Fig. 1). An assessment of sustainability has shown that we can sufficiently reduce the risk of re-invasion but that we must act now to prevent spread to other islands which could threaten feasibility of eradication (Harper, 2017b).

Since this work has been completed the SNH and RSPB Partnership have focused on developing a costed project, applying for funding for both the eradication and ongoing biosecurity measures, developing community support and implementing immediate biosecurity measures to prevent spread to more islands in Orkney.

We have developed a fully-costed plan, called the Orkney Native Wildlife Project, costing £4.5 million. We have applied to the Heritage Lottery Fund for support and are also in the process of developing and submitting two further grant applications for the eradication and supporting ongoing biosecurity measures. RSPB Scotland is about to commence biosecurity trapping measures on the Orkney Mainland, in accordance with the biosecurity plan. These measures will be kept in place until we start eradication. We also have developed a trial trapping phase within project development that will investigate success of traps, lures and baits in different habitats and will fill gaps in knowledge and be used to fine tune our trapping methodology.

The Orkney Native Wildlife Project is unique. It will be the first eradication of stoats in Europe, and also the first project to consider stoat eradication in areas which include urban and rural settlements.

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