Shifting Sands

Securing a Future for the Brecks

Techniques to encourage European rabbit recovery

A Toolkit for Landowners

BACK FROM THE BRINK

NATURAL ENGLAND

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Abstract

Contrary to an often negative perception of the European rabbit's ecological value, the species plays an essential role as a landscape engineer in many UK ecosystems. Their population has, however, been declining drastically since 1953. The Shifting Sands project has trialled different habitat management techniques, designed to boost rabbit numbers in areas where they are promoting biodiversity. The results of this project support the use of brush piles as a cost-effective tool to encourage rabbit burrowing and other activity. The effectiveness varied across study sites. This document has been advised by specialists and the results of the field trials to provide practical conservation techniques for local implementation, designed to encourage rabbit recovery.

Introduction

Background

European rabbits (*Oryctolagus cuniculus*) are a keystone species in certain UK grass and heathland habitats due to their impact on ecosystem structure and biodiversity [1-3]. It is the action of ground disturbance through grazing, pawscraping, burrowing, and nutrient input via defaecation/urination at latrines that engineers landscapes to benefits open swards, bare ground, and varied micro-topography [2,4,5].

The European rabbit is a highly selective grazer producing mosaics of differing vegetation thereby increasing floral and faunal richness [6,7]. In comparison, grazing by livestock creates a less disturbed and more homogeneous sward and does not achieve the same increase in species richness [8].

This ecological benefits of rabbit disturbance in this way typically benefits lowland grassland [9,10], heath [11,12] and dune habitats [13,14]. In these landscapes, rabbits are able to manage and maintain favourable conditions for an abundance of moss, lichen, plant, insect and bird species [2,15]. Breckland in Norfolk and Suffolk is an example of a predominantly lowland grass and heath habitat where rabbits are a keystone species due to this ability to promote biodiversity [2,15].

UK Rabbit decline

Following the national trend, rabbit numbers in the East Anglian region of Breckland have shown a drastic decline due to a combination of disease, persecution, predation, and habitat degradation. The introduction of myxomatosis to the UK in 1953 decimated wild rabbit populations, reducing numbers by >99% [16]. Whilst there was some recovery in the following decades, the disease is still prevalent and rabbit numbers have never returned to pre-myxomatosis levels [2]. Most recently a UK wide population decline of 64% was reported by the BTO Breeding Bird Survey between 1996 and 2018 [17,18]. These declines are evident in all regions with the greatest recorded in the East Midlands (88% between 1996 and 2018) and Scotland (83% during the same period). A major cause has been the emergence of new introduced rabbit haemorrhagic disease viruses (RHDV1 first discovered in domestic rabbits in the 1990s and RHDV2 similarly in 2010) [17,19]. This rabbit decline threatens Brecks habitats; without intensive grazing, coarse grasses and shrubs encroach on heathland sites, reducing overall biodiversity.

Timing and placement of works

The timing of works should be in winter, to avoid disturbance to breeding birds and to have works in place before the rabbit breeding season. The placements of works should be strategic, designed to attract rabbits from nearby active warrens to areas where they are needed. This can be done effectively by placing works <40m from existing warrens.

If undertaking ground disturbance work, special consideration should be given to the risk of disturbing sensitive archaeology or unexploded ordnance. This can be a barrier to works in archeologically rich areas such as Breckland, particularly on pristine grass-heath sites where previous mechanical disturbance has been limited. Ex-arable sites with a history of ground disturbance may be less problematic, but the choice of location should ultimately be informed by where rabbits are most needed ecologically. Our advice would be to collaborate with county archaeologists from the outset, to ensure historical heritage is conserved alongside ecological.

The impact of rabbits on crop yields has been a historical concern [2,20], however, due to the combined impact of novel diseases in addition to endemic myxomatosis, population recovery from this viral cocktail is unlikely in the short term [17]. Conservation efforts are focused on maintaining rabbit populations in the areas where they are promoting biodiversity. It is unlikely that rabbit numbers will return to a level at which they are an economic issue.

Rabbit behaviour and social structure

Rabbits live in territorial social groups containing one to three adult males and one to six adult females which defend underground warren systems. Separate age-related linear dominance hierarchies occur in male and female adults with reproductive success biased towards the high-ranking individuals [21-23]. Management techniques that encourage younger rabbits to disperse and establish new social groups earlier could increase individual lifetime productivity, thereby increasing the rate of population recovery and the area of positive ecosystem impact of the species. Increased distribution might also help to reduce the transmission rate of circulating pathogens. For this reason, the conservation techniques trialled during this project were focused on encouraging the expansion of rabbit home ranges and new warren building as mechanisms to promote rabbit population recovery.

This toolkit focuses on habitat management as a tool for rabbit restoration. Predator control measures are not discussed in this toolkit but may promote rabbit recovery.

Habitat management options to aid rabbit recovery

Brush piles

Previous research at different East Anglian sites has demonstrated that brush piles, made of felled branches or uprooted trees/bushes, encourage burrowing and provide important cover for rabbits which helps protect against predation [24]. The impact of vegetation cover on rabbit mortality is well-documented [25-27]. Brush piles vary in their effectiveness as suggested in the results section.

Brush piles are an appropriate management strategy for implementation in grass-heath habitats as a simple, low-cost option that utilises tree and scrub material which is otherwise routinely removed during heathland management.

The positioning of brush piles needs to be carefully planned to maximise their efficacy as cover 'stepping stones' encouraging rabbits to expand their home range around existing warrens and maximising reproductive success of all adult females within social groups. They therefore need to be located at strategic distances from spread from active warrens into areas where rabbit ecosystem engineering activity is required. Their distribution will therefore be bespoke to the site in question. Placing nearest brush piles <40m of warrens could increase the likelihood of them being utilised. Finally, in areas of long grass typically avoided by rabbits, it is recommended that tracks are mown between warrens and brush piles and between the additional network of brush piles to encourage brush pile discovery.

It has been suggested that nutrient leaching from brush piles may be a conservation concern in low nutrient ecosystems. However, there is currently no scientific evidence for this, and future studies are required to compare nutrient input from brush piles with that from commonly used additional management techniques such as livestock grazing. Impacts on vegetative growth are likely to be negligible and should be counteracted by the removal of biomass by grazing rabbits [5,9]. Brush piles may act as physical barriers to management in areas that are mown or managed mechanically. Where this is a concern, some brush could be removed once burrows have been established, however, the impact of this has not yet been trialled.

Brush pile design criteria:

I. Cover an area between 2 m^2 and 4 m^2 at the base.
II. Sufficient numbers of rabbit-sized spaces (a) inside the brush pile for the animals to shelter (25cm high), and (b) around the periphery to gain unobstructed entry. Wide entrances should be avoided to increase protection from predators.
III. <1m in height to mitigate the risk of acting as perches for predatory birds.
IV. Provide good cover so any rabbit occupants cannot be seen from above.
V. The brush pile design will depend on the type of brush material and the time available.

Method

Brush piles are a low-cost option. The construction would require equipment that most landowners already have access to, e.g. hand saws for felling brush and a trailer for transportation. If option one is being followed a digger would also be required to uproot shrubs.

The brush pile design will depend on the type of brush material and the time available. Several potential designs are described below.

Example design I.

Figure 1: *Brush pile formed by uprooting two Hawthorn trees, now containing active warrens.*

If the available brush materials are complex in structure, with horizontal branching such as Hawthorn, it can be felled or uprooted and simply piled up. This method should only be used when sufficient space can be created within the pile for rabbits to shelter. As with all felling/management work, the ecological importance of the plant species should be assessed before uprooting it for this purpose.

Example design II.

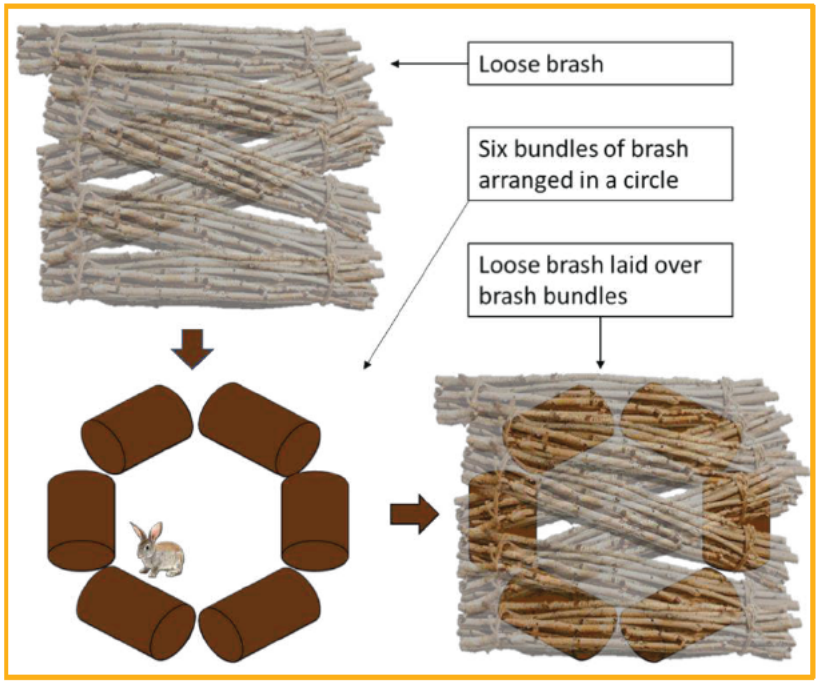

Figure 2: *Six smaller brush bundles are arranged in a rough hexagon and covered in loose brush. This will provide six small entrances.*

When the available brush has less horizontal branching, such as ash or birch, a refuge should be constructed to ensure the structure allows space for rabbits to shelter. In Figure 2 brush has been tied into bundles to create a base with additional brush laid over the top.

I. Each bundle is tied into approximate 0.25-0.5 m cylinders using a natural fibre (e.g. hemp rope), to withstand interference from livestock and adverse weather conditions such as high winds.

II. At least six bundles should form the base, to create adequate numbers of small entrances for rabbits and allowing a good surface level of cover from predators and multiple escape routes.

III. Branches and brush are laid across the top, creating a covered area where rabbits can shelter and burrow. Enough brush should be placed on top to provide good cover from aerial predators.

Figure 3: *Completed brush pile with supporting bundles and loose brash on top.*

Example design III.

Figure 4: *brush pile created by piling larger or more complex brush types*

This option is less structured than the previous examples and requires simply piling brush in a loose structure. Creating rabbit sized space can also be challenging; if complex brash types with horizontal branching are available this may help to create space underneath the pile. Larger brash can also be placed underneath smaller brash to create a structure (similar to the role of brash bundles in example 2).

Banks and turf strips

Banks of soil were first used by UK warreners several hundred years ago to encourage rabbits to proliferate by providing a suitable substrate to burrow into [28]. These rabbits were regularly harvested for their meat/fur. A south-facing bank encourages burrowing as rabbits like to bask in the sunshine when resting above ground: they also find a sloping surface and penetrable soil more attractive/easier to dig into than flat ground (D.Bell personal observation); [24,29].

In this instance, we recommend a that non-stony soil is piled in a south-facing bank and compacted several times with a digger. Longer, broad banks are likely to be most effective, matching the methods used by the early warreners.

This may be a higher-cost option unless paired with other ground management works for example where spoil clearance and turf stripping is conducted for alternative conservation purposes such as providing suitable nesting areas for Stone Curlew (*Burhinus oedicnemus)* or to encourage rare early successional plant species. Finally, shallow, and wide banks may be easiest to manage, and best suited to withstand livestock interference.

When undertaking ground disturbance landowners should consider the biological and archaeological sensitivity of the area.

Translocations/reintroductions

European rabbit reintroductions have been trialled in Spain and Portugal where the European rabbit evolved and is a keystone prey item for >40 vertebrate predator species [30]. Due to high mortality rates recorded after translocation, and their greater conservation effort and cost, they are not considered an effective management strategy. Mean post-release survival rates in these translocations have been estimated at as low as 3% after 10 days [31]. These low survival rates are a product of the stress involved in the capture, transport and release of these animals into an unfamiliar environment as well as an increased vulnerability to predation and disease [25,31,32]. Such translocations also threaten remnant populations of a species now listed by the IUCN Red List as Endangered in Iberia [33].

In the UK where there is no conservation alternative (i.e. where rabbits have been extirpated from key sites), translocations can be considered but will require expert guidance. Professor Diana Bell at the University of East Anglia has successfully translocated rabbits [2]. There are also legislative complexities that need to be considered in the UK. This would be a higher cost option.

Warren census monitoring method

Various techniques have been used to monitor trends in rabbit population size include counting a) animals from standard locations, b) numbers of fresh faecal pellets and c) burrow number. We recommend the latter and describe a standard method here.

Warren census monitoring method:

I. Mark the boundary of the survey area if necessary (e.g. if not already defined by a fenceline). Record/map the boundary of the survey area for future surveys.
II. Split the survey area into 20 m sections. Walk slowly in a zigzag pattern to cover each section, searching for warrens.
III. Count and record every warren. A warren is defined as a single burrow or a group of burrows at a distance equal to or less than 5 m apart.
IV. Count and record the total number of active and inactive burrow entrances for each warren. To distinguish between active and inactive burrows, signs of rabbit activity are used. A typical inactive burrow is identified by the absence of footprints, presence of cobwebs and absence of fresh faecal pellets (old pellets are pale brown, whereas fresh pellets are dark) (see Figure 5).
V. In the notes section, record any extra observations or notes (e.g. dead rabbits or bones near warrens, predators seen on site, whether the warren is in a management area such as in a brush pile or bank).
VI. Repeat this method until the entire survey area has been covered.

Notes: if available, marker flags (in two colours) are a useful tool to keep track of active and inactive burrow counts in large warrens. A burrow within 5m of another burrow is classified as the same warren, so some warrens can end up sprawling across large areas and contain many burrows.

A more advanced method includes recording the GPS location of the centre of each warren, which is a useful tool to map density and changes in distribution. This method is preferable but more time consuming and requires access to GIS mapping software and skills.

Figure 5: *active warren (left), inactive warren (right).*

Results of the Shifting Sands field trial

We include the results from a two-year project conducted as part of Shifting Sands, which was based at five Breckland study sites within Norfolk and Suffolk. 36 trial plots were surveyed monthly. Each plot contained two brush piles on either side of a bank created by stripping turf to a depth of 5 cm plus 18 unmodified control plots. The design of our banks was constrained by not being allowed to a) import soil into SSSIs and b) draw turf beyond a shallow depth of 5 cm due to archaeological restrictions, however they were still effective. Rabbit pawscrapes and burrows were recorded as measures of rabbit activity within entire plot areas ($25m^2$) and separately on banks and around brush piles within these. Biosecurity measures were followed to reduce pathogen transmission between sites (for example, footwear was sprayed with anti-viral disinfectant). Detailed statistical analysis of the data was conducted, and the main results are summarised here:

I. There were significantly higher numbers of pawscrapes in managed plots compared to control plots.
II. There were significantly higher numbers of brush piles containing burrows in managed plots compared to control plots.
III. The success of the management techniques varied across sites and years.
IV. At the end of the trial period 91% had signs of rabbit activity and 41% of brash piles contained visible burrows.

These findings show that both management interventions, brush piles and banks, increased rabbit activity, supporting the findings of our previous research at other lowland heath sites [24]. Point IV indicates that even when burrows did not form the brush piles expanded the range of rabbit activity. Importantly, our project found that there was no 'one size fits all' management approach, because sites vary considerably (e.g. species of brush available, soil type, and baseline rabbit population size). Brush piles encouraged burrowing, which should promote breeding and restoration of rabbit populations.

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