

TECHNICAL  
ADVICE  
NOTE

BURROWING  
ANIMALS  
AND  
ARCHAEOLOGY

ANCIENT  
MONUMENTS  
DIVISION



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EDINBURGH  
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Tel 0131 668 8668

Fax 0131 668 8669

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BURROWING  
ANIMALS  
AND  
ARCHAEOLOGY

by  
Andrew J Dunwell  
&  
Roger C Trout

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## Authors

This document has been researched and written by

Andrew J Dunwell,  
Centre for Field Archaeology,  
University of Edinburgh, Old High School,  
12 Infirmery St, Edinburgh EH1 1LT

&

Dr Roger C Trout,  
"Rabbit-wise", Holtside, Batts Corner, Dockenfield, Farnham,  
Surrey GU10 4EX

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Historic Scotland is also grateful to H R Arnold, J S Bone, Jane Downes and the Royal Commission on the Ancient and Historical Monuments of Scotland for permission to reproduce their illustrations.

### *Cover illustration*

*Bronze Age burials at Linga Fiold, Orkney, during the course of excavation to explore the problems being caused by the combination of ploughing, rabbit burrowing and cattle poaching. The archaeological integrity of the surviving remains was found to have been damaged, particularly those parts of the site which were upstanding earthen barrows. Copyright: Jane Downes.*

# PREFACE

Historic Scotland is the Government Agency charged with the task of protecting the built heritage. Ancient monuments and archaeological sites and landscapes form an important part of Scotland's built heritage. They can be protected by law through the process of scheduling under the Ancient Monuments and Archaeological Areas Act 1979, but unfortunately that particular piece of legislation is not widely understood in Scotland's rabbit warrens.

Any visitor to Scotland's ancient monuments will be familiar with the sight of white tails disappearing as he or she examines the remains of ancient earthworks. Clearly, rabbits burrow into and create homes within these earthworks, but unfortunately archaeologists cannot see beneath the surface of the ground and readily understand the damage being done to the underlying archaeological deposits, although the visual impact on the surface features is all too obvious.

In order to try to understand better the damage caused by rabbits and other burrowing animals, Historic Scotland has commissioned over the years a series of surveys and excavations. As a result of this work we now have a much clearer indication of the considerable damage which is done by burrowing animals, particularly rabbits on archaeological sites. Over time, archaeological deposits are completely churned up and our ability to understand the history of a particular site is destroyed. This Technical Advice Note, which draws upon the skills and expertise of both archaeologists and a mammal ecologist, was commissioned to draw together our present knowledge and understanding of this problem. The authors, the Centre for Field Archaeology and Roger Trout, also outline a methodology for recording and monitoring changes in

burrowing animal activity and damage, without which the condition of a monument and the risk of further damage occurring are difficult to assess.

Much of Scotland's early history can only be learnt through the excavation of archaeological sites. These ancient monuments are the repository of all our history from about 8000 BC to the arrival of the Romans in the first century AD. Thereafter, although some written records exist, archaeological sites are still a most important source of information in order to help us understand the lives - and deaths - of our ancestors. In order to gain the best appreciation of Scotland's history, it is essential that we preserve in the best possible condition as many ancient monuments as we can for present and future generations to examine and excavate.

All burrowing animals can cause damage to archaeological sites for the soft archaeological deposits offer an attractive home to them. Their presence would appear to be one of the greatest active threats to our archaeological heritage. I welcome this Technical Advice Note, the first in this series to be commissioned by the Ancient Monuments Division, as an important step forward in bringing the concerns of archaeologists to a wider audience and offering encouragement and advice to the many colleagues involved in countryside management, without whose help we cannot begin to address the problem.

**David J Breeze**  
**Chief Inspector of Ancient Monuments**  
December 1998

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*Fig 1. The large Iron Age hillfort of Brown Caterthun, near Brechin in Angus, here shown from the air, has recently become infested with rabbits. Historic Scotland commissioned a programme of survey and excavation to obtain further information about the effects of burrowing at the site. Copyright: J S Bone.*



# BURROWING ANIMALS AND ARCHAEOLOGY

## 1. INTRODUCTION

Archaeological sites, monuments and landscapes are important to the study of past societies because they contain unique, irreplaceable information about the past. Many archaeological remains are fragile and vulnerable to various forms of damage which, if unchecked, lead to information being lost forever. Burrowing animals represent one such cause of damage to archaeological remains.

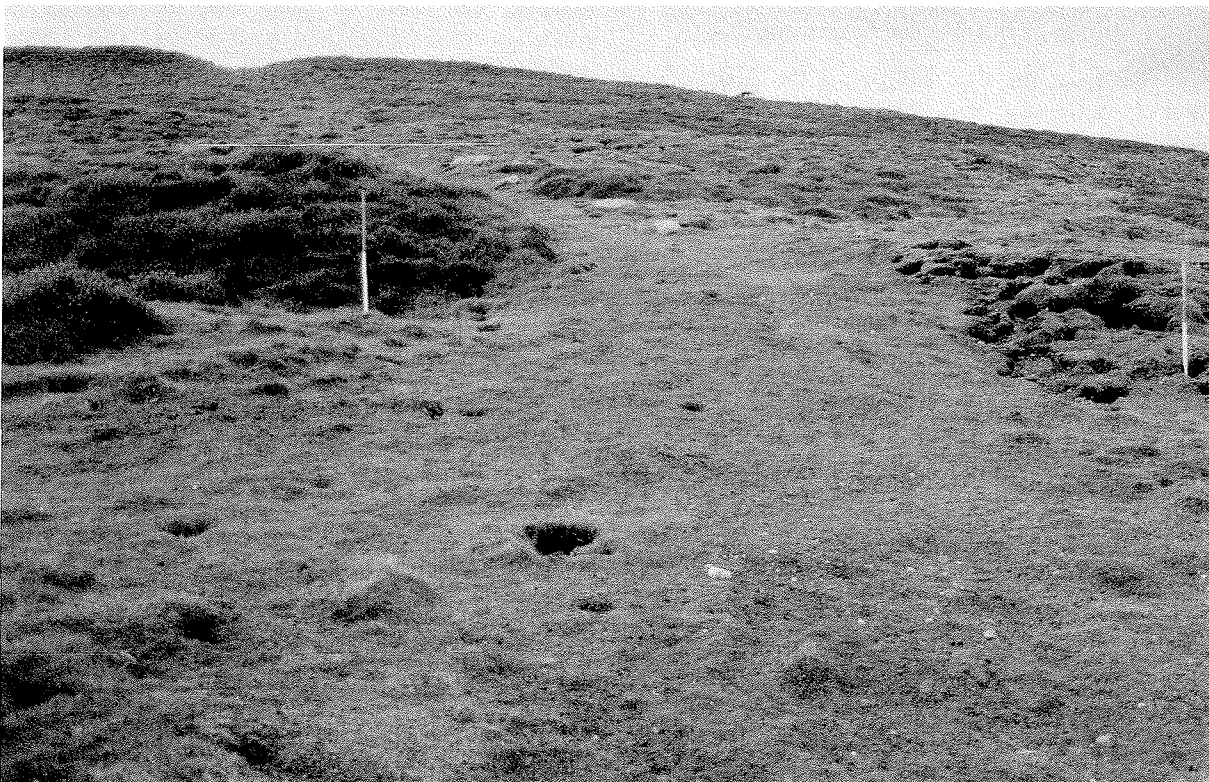
This document is targeted at a wide audience: it explains why burrowing animals are a problem for archaeologists; gives practical guidance for recording or monitoring of archaeological sites undergoing such damage by those without specialist vertebrate expertise or archaeological knowledge of what is likely to be buried beneath the ground; and provides guidelines for the management of such sites. Examples of burrowing damage are illustrated from recent projects funded by Historic Scotland, principally the Brown Caterthun project<sup>1</sup> and Orkney Barrows Project.<sup>2</sup>

## 2. WHY ARE BURROWING ANIMALS A PROBLEM TO ARCHAEOLOGISTS?

Species that either use or make underground tunnels include rabbit, rat, mole, badger, fox, puffin, and shearwater. Often tunnels will be excavated preferentially by these species (excepting moles) into soft and slightly sloping ground, both for ease of digging and to create well-drained refuges.

Archaeological sites and monuments often include upstanding material in earthen banks (referred to as earthworks), which can thus form attractive habitats for burrowing animals: unfortunately their tunnelling may damage sensitive archaeological information preserved within them.

*Fig 2. The damaging effects of burrowing at Brown Caterthun can be seen by comparing a length of one of its ramparts to either side of an entrance break. The difference is striking - to the left, the rampart is not infested and appears as a distinct heather-covered mound; whereas to the right a burrowed length of rampart has become disfigured, slumped and unstable. Much archaeological information has been lost. Crown Copyright: Historic Scotland.*



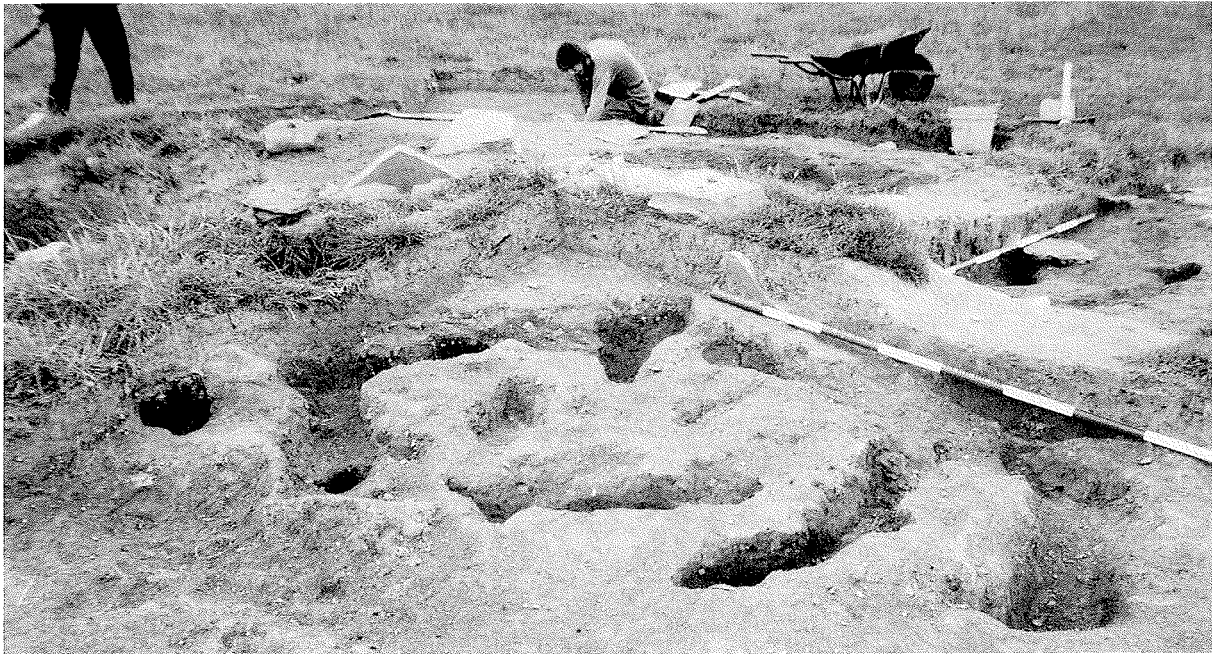


Fig 3. Excavation in progress at a Bronze Age barrow at Linga Fiold, Orkney: the surface of the barrow shows evidence of dense burrowing. Copyright: Jane Downes.

The damage caused by burrowing animals, particularly rabbits, has recently been recognised as one of the greatest threats to earthwork conservation in eastern Scotland.<sup>3</sup> In response, Historic Scotland has funded investigations of several archaeological sites in order to assess the ways in which their remains are damaged by rabbit burrowing.<sup>4</sup> These surveys and excavations have demonstrated that the principal negative effects of burrowing into earthworks can be classified as:

- **Disfigurement** - a reduction in the clarity of the field characteristics of a site by the alteration of its earthwork profiles; the monument can become unsightly, which detracts from visitor appreciation.
- **Destabilisation** - leaving the monument open to further degradation by other agencies, such as poaching by cattle, scarring by sheep rubbing, and wind and water erosion; destabilised earthworks can become a health and safety hazard to visitors and livestock, with potential legal implications.
- **Irretrievable information loss** - disturbance and, in extreme cases, destruction of buried remains; the loss of field characteristics also entails information loss.

The necessity to excavate a site as a response to the problem is expensive, often destroys the feature and is the ultimate failure of archaeological conservation. Sites need protection from this eventuality but, since each is unique, management strategies must be considered individually.

### 3. RELEVANT FEATURES OF BURROWING SPECIES<sup>5</sup>

#### 3.1 Rabbit

Rabbits can form dense permanent colonies, unlike the other burrowing mammals, and so increases in population are usually mirrored by many more excavated holes in the vicinity. Rabbit numbers are continuing to rise, following the population collapse due to myxomatosis in the 1950s, and the (re)invasion of suitable areas is likely where soft ground for digging burrows lies close to food sources. Digging is concentrated in softer and well-drained soil where possible, such as archaeological earthworks; east- and south-facing slopes appear favoured. Rabbits create burrows for breeding (February to August) and for refuge during the day, often under bushes and trees for preference but also in open flat or sloping ground. Short breeding burrows (stops) may be made by subordinate rabbits emigrating from the original focus of the local population; these then become enlarged (with a greater entrance diameter) and more elaborate. Finally the density of warrens reaches a honeycomb.

The warren structure is variable according to soil/subsoil characteristics but may have 5-250m of tunnel, typically 0.1-0.15m in diameter and reaching 0.75-4.5m below the ground surface. Estimates of the volume of warrens also vary widely; perhaps 2.5-8m of burrow per hole and 0.02-0.14 cubic metres of soil removed per hole (greater in soft soils than on rocky or clay ground). Incremental digging over the years involves both spoil removed to the surface and its redistribution underground. A guide to the extent of excavation can be determined roughly from the frequency of burrows and the amount of spoil outside,

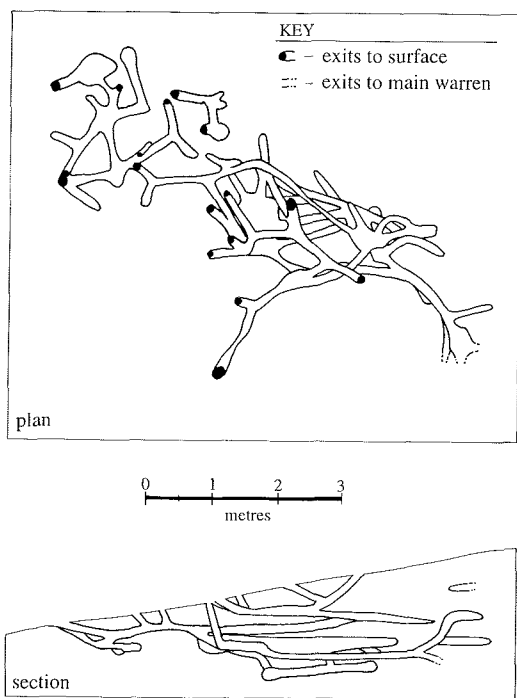


Fig 4. Plan and elevation of a hillside warren (after Kolb 1985).<sup>6</sup>

(except where rabbits live in cracks in very hard ground and cannot excavate further, eg rock).

Signs of rabbits include grazing of crops and pasture leading to increased weed growth, droppings, scrapes, breeding stops (single entrance), individual small warrens, runways with distinct hopmarks, furrowed runways that indicate more traffic, large warrens, barked and undermined trees, rabbit 'lawns' and bare ground at risk from erosion. Initial usage starts with grazing (with scattered droppings). As grazing pressure increases scrapes are seen and the piles of droppings are closer and closer together. The normal home range is 0.5-3.5ha but rabbits can easily travel 800m to feed or explore. Rabbits can survive on upland grasses, herbs and heather but may move daily or migrate to lower levels in (mid)winter for food. Favoured foods include young cereals, sweet grasses, herbs and root crops (except potatoes).

**3.2 Mole**

The mole is a widespread species, living all year round underground singly in territories consisting of a complex tunnel system, often over 100m long with sometimes several hundred characteristic mole heaps above; tunnels are about 0.06m in diameter and normally penetrate no further than 0.25m beneath the ground surface (but can extend as deep as 1.5m). Mole heaps indicate the approximate course of tunnels. New digging clears out damaged tunnels, makes a larger catchment area for its food source (invertebrate food falls into the tunnel system), and is needed for

constructing deeper nest chambers. Almost all digging occurs close to surface in the soil zone where invertebrate food lives. The home range of a mole is a defended territory with a density of about 2-10 per ha. Infestations usually start with just one or two animals in an area, followed by a territory-sized incremental increase in the tunnelled area as the population grows. Mole heaps are produced each season of the year.

**3.3 Badger**

Badgers have a discontinuous distribution in Scotland. They live year round in isolated setts with three to twenty large holes about 0.25-0.4m in diameter at the entrance and 1-4m deep. There may be very large soil excavations, produced over many years, with the volume removed often measurable in tons; sett size may reach 15m by 20m in area. Spoil is often raked out as a furrow, principally during February to April, and also August to October (when new setts may be created - often in rabbit warrens). Traces of new or old hay/bracken bedding may be found outside the entrances to tunnels. Characteristic banded white/black/white/black hairs may be found at the sett entrance or on nearby fencing where their paths pass. Other characteristic signs include small pits (latrines) with often very soft droppings in (often grey, smooth and containing earthworms); worn pathways for long distances in a range of 50-150ha. Badgers are not a colonial species and so new setts are not adjacent, as with rabbits, but are spaced well apart such that only very large archaeological sites would be likely to have more than one active sett.

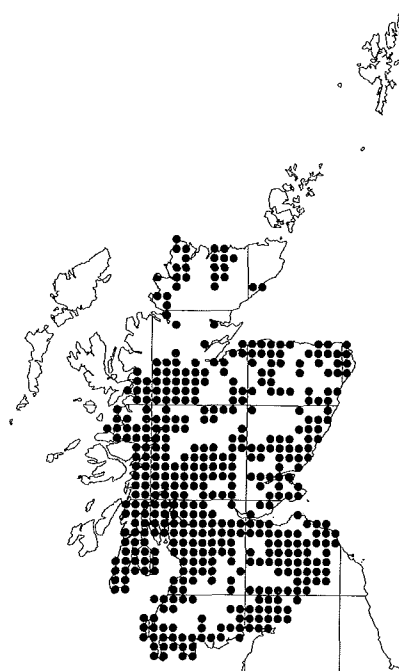


Fig 5. Map showing distribution of badgers in Scotland. Reproduced by permission of H R Arnold, Institute of Terrestrial Ecology, Huntingdon.

### 3.4 Fox

Foxes are widespread in Scotland. They have an isolated den for refuge and breeding, and may dig or enlarge usually one to three large holes about 0.3m in diameter, often in an active or old rabbit warren. Earth is excavated as a fan. Inhabited dens often have a pungent smell; visible and rotting prey remains lie outside the breeding den in April to August. No nest material is used. Grey/orange fur may be found on nearby fences. Fox droppings are often grey with a distinct smell and fur or bones visible; they are often deposited on raised features. The family group range is about 100-1000ha and so only one den would be likely on an archaeological site.

### 3.5 Rat

Rats are present on many farms and offshore islands. They are weak diggers, with tunnels rarely 0.5m deep, and prefer burrowing in farm dumps, old rabbit burrows in or under farm stores or hedgerows as refuge near to a food supply (eg picnic sites, maize or root crops, bird colony). Rat tunnels are unusual in open ground. A rat hole is usually 0.06-0.09m diameter with a narrow polished soil heap outside its entrance and with tracks (especially under obstacles) running between holes. Rat droppings are about 12mm long, cylindrical, and often with pointed ends. Characteristic polished runs can be detected in and around the base of walls and buildings, with smear marks on obstacles.

### 3.6 Puffin

Puffins are primarily open-sea-dwelling birds with a restricted distribution on land. They create colonies on sloping land near the sea and on stacks or islands, sometimes so densely packed as to destroy the vegetation, but will be seen on shore only during April to August while breeding. A puffin will use old or active rabbit holes, but can dig its own tunnel, which is rarely more than 2m long or 0.5m deep, and can create warren-like structures over time. It is not possible to distinguish these latter from rabbit holes outside the

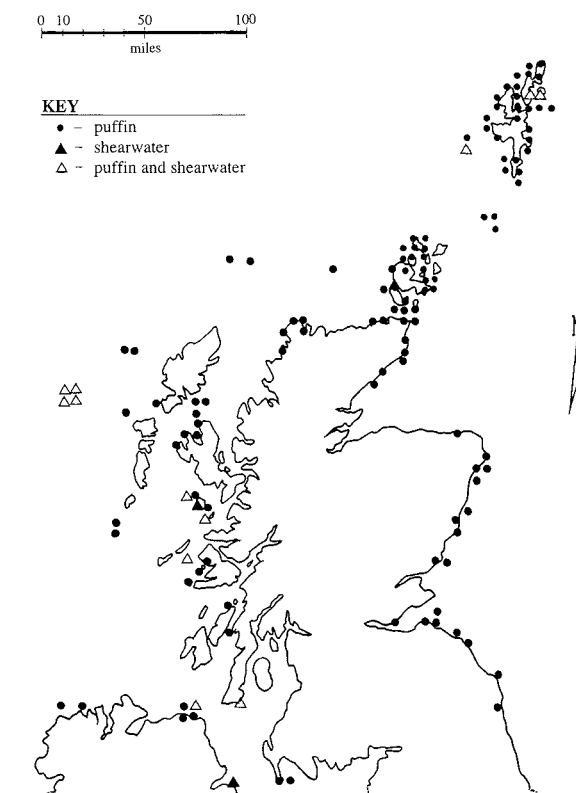


Fig 6. Map showing distribution of puffins and shearwaters in Scotland: after Gibbons et al 1995.<sup>7</sup>

breeding season (rabbits often live in them too) but sometimes a tiny lawn and the presence of fishy bird droppings are apparent in front of an entrance occupied by puffins.

### 3.7 Shearwater

Shearwaters are open-sea-living birds with a restricted onshore range, confined to the breeding season from the end of March to September. The adult visits the burrow at night so they are almost never seen. They use old or active rabbit burrows, or dig their own, but burrows cannot be distinguished from those of rabbit or puffin. Colonies are usually on clifftops but may also be some way inshore on hilltops.

Table 1 - Summary of general burrowing characteristics of species

	Rate of incremental digging	Likelihood of deep digging	Rate of increase in area affected	Risk of new burrowing causing extensive, severe damage within 5 years
<b>Rabbit</b>	High	High	High	High
<b>Rat</b>	Low	Low	Low	Low
<b>Mole</b>	High	Low	Medium	Medium
<b>Badger</b>	Medium	High	Low	Medium
<b>Fox</b>	Low	Low	Low	Low
<b>Puffin</b>	Low	Low	Low	Low
<b>Shearwater</b>	Low	Low	Low	Low

#### 4. WHAT MAKES AN ARCHAEOLOGICAL SITE VULNERABLE TO DAMAGE?

The principal ways in which archaeological remains can be damaged by burrowing animals have been outlined above - by *disfigurement* and *destabilisation* of earthworks, and by the *loss of information* buried within them. Of the species considered, rabbits represent the greatest threat. However, not all archaeological remains are equally susceptible to damage: assuming the presence of a burrowing animal, the following list considers the principal factors which influence the vulnerability of a site to damage.

- **Earthwork composition** - 'soft' deposits, such as earth and turf, are more vulnerable to exploitation than features composed largely of stone. Monuments

located on soft (eg sandy) subsoils can be particularly badly affected, as burrowing can run beneath and undermine archaeological remains. On small earthworks, it is likely that burrows will penetrate throughout the feature.

- **Soil depth** - areas of deeper penetrable soil (greater than about 0.3-0.4m), such as earthworks are often composed of, are more vulnerable to penetration than areas without artificial mounding of soil (moles generally tunnel less deeply and thus may occur in these latter areas). This can be relevant for example on enclosed sites, such as hillforts or Roman forts, where the enclosing ramparts are prone to warrenning, whereas between earthworks there may be insufficient soil depth for burrowing.

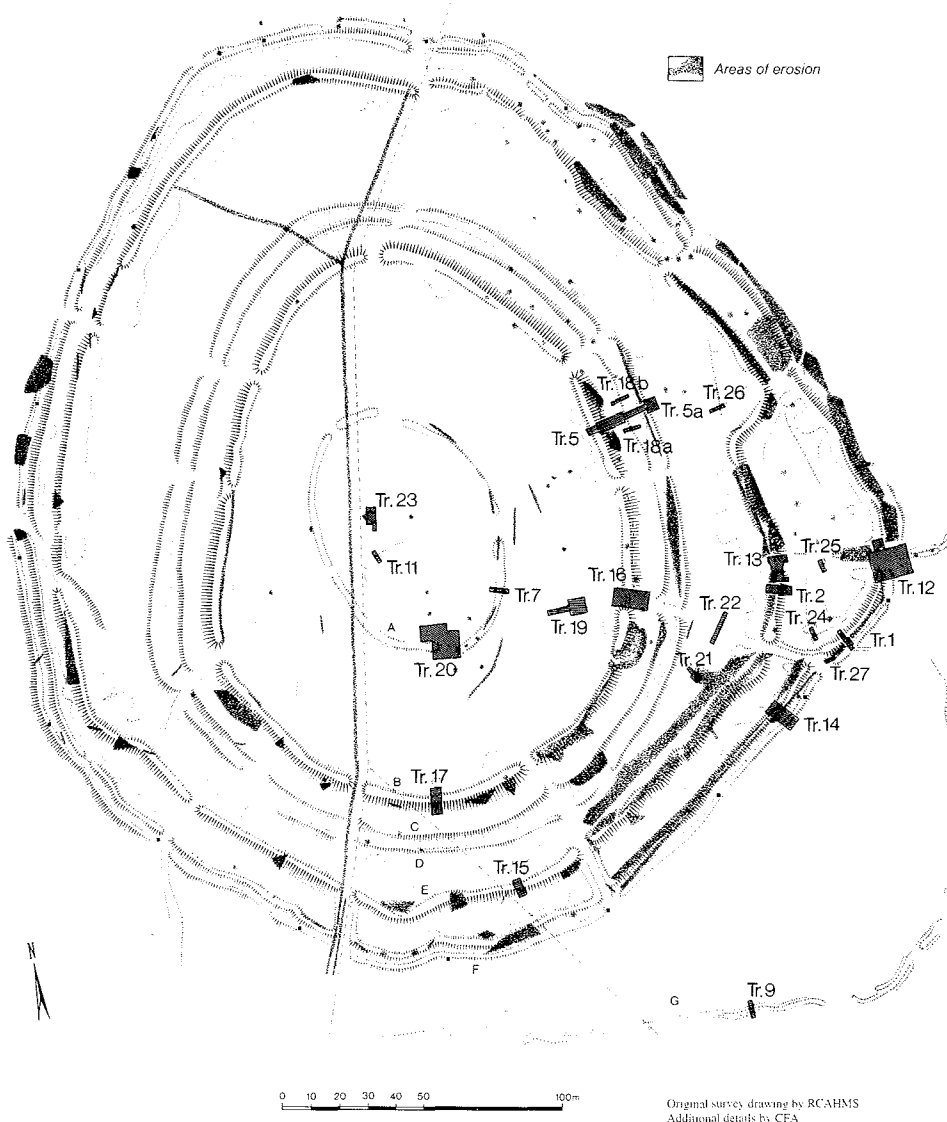


Fig 7. Brown Caterthun, Angus: site plan showing distribution of rabbit damage across the site. The earthen ramparts on the lower eastern slopes of the hill have provided the most propitious habitat and refuge for rabbits and are thus most heavily damaged. The lack of soil depth between ramparts has precluded burrowing. Crown Copyright: Royal Commission on the Ancient and Historical Monuments of Scotland / Historic Scotland.

- **Aspect** - rabbits prefer to feed on warm and sheltered slopes of hills or earthworks - east- and south-facing slopes are preferentially selected. Evidence of rabbit warrens on all sides of a hill may be taken as evidence of high colonisation pressure.

- **Previously disturbed areas** - such as backfilled trenches from previous excavations, or infilled quarries, provide areas of softer soil which provide a more readily penetrable entry point for colonising species.

- **Waterlogged areas** - these tend to be avoided by burrowing animals.

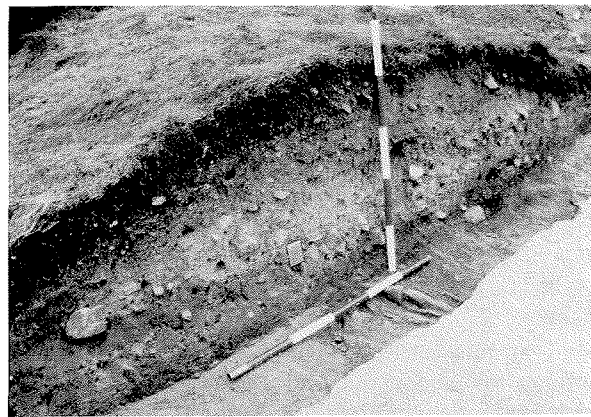
- **Nature of vegetation cover** - the presence of trees and scrub on earthworks provide more secure cover for burrowing mammals and protect against attack by predators.

**5. SOME RECORDED TYPES OF BURROWING DAMAGE WITHIN EARTHWORKS**

The types of damage caused by burrowing animals will largely depend upon the character and content of the archaeological remains burrowed into. The following effects have been recorded at sites infested by rabbits - but most probably can be extended to sites affected by other species.

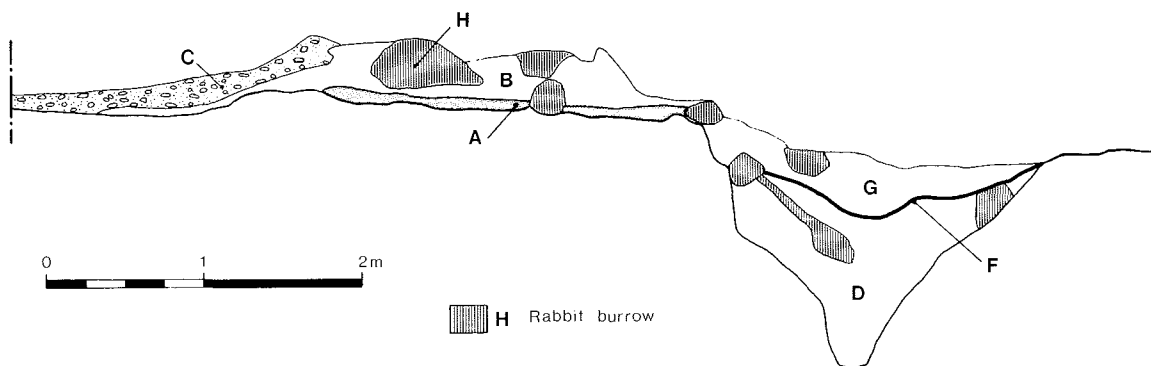
- Patterns of damage are not random and are influenced by the factors listed in the previous section. However, the continued digging and spreading of warrens, by rabbits in particular, will cause more widespread damage in time.

- Displacement and removal of material from earthworks. The riddling of the earthwork with holes leaves it prone to further collapse and loss of information from other agents.



*Figs 8 & 9. Brown Caterthun, Angus: two excavated sections of the same rampart (also shown on Fig 2) - above an intact profile, below a slumped and unstable profile caused by burrowing. Crown Copyright: Historic Scotland*

- Removal of stratigraphic clarity and stratigraphic relationships between archaeological features and deposits - archaeologists look for sequences of buried remains in order to chart the development of sites. Burrows punch holes in these sequences and make them less interpretable.



*Fig 10. Drawn cross-section of the rampart in Fig 9: B represents the surviving material within the rampart, G material cast into an adjacent ditch by burrowing. Here, over 50% of the material present before rabbit infestation has been displaced. What evidence is available suggests that this has occurred within the last 15 years. Crown Copyright: Historic Scotland.*



Fig 11. Brown Caterthun, Angus: a rabbit burrow runs through a bed of burnt timbers present within a rampart. Such timbers can help us to understand how the rampart was constructed, provide information on past woodland management practices and also supply material for radiocarbon dating to determine when the rampart was built. Crown Copyright: Historic Scotland.

- Disturbance of artefacts, which are important aids to understanding the functions and dates of sites. It is important for interpretations of past activity for the precise locations where finds were deposited to be recorded.
- Disturbance of the soil surrounding buried stone walls, souterrains, burial cists, which may become destabilised and prone to collapse.
- Damage to sensitive archaeological deposits which contain particularly important information, such as burnt timber features; and to old ground surfaces buried beneath earthworks which can preserve important information on the nature of past landscape and land use.
- Exacerbation of damage to unstable earthworks by other agencies, principally cattle poaching and sheep rubbing.

## 6. RECORDING AND MONITORING INFESTATIONS AND DAMAGE

A simple but objective and repeatable method is needed for recording, and monitoring changes in, burrowing animal *activity* and *damage*. This information is required in order to provide baseline information for evaluating the *condition* of a

Fig 12. A Bronze Age barrow at West Puldrite, Mainland Orkney: the stone-lined cist has been exposed by previous excavations, visible as a depression on the surface of the mound which has been penetrated by rabbit burrows. Livestock trampling on the surface of the mound may lead to a collapse of the rabbit warren, causing further damage to the barrow. Copyright: Jane Downes.



monument and the *risk* of further damage occurring, and thus to trigger management decision-making. A checklist of important criteria for such recording is presented in the Appendix.

## 7. MANAGEMENT OF BURROWING ANIMALS

There are four basic management responses to deal with an archaeological site undergoing burrowing damage:

1. Conserve through active management
2. Archaeological recording through fieldwork - survey, excavation (total or partial)
3. Regular monitoring of damage (if only minor impact observed)
4. No further action (abandonment)

Professional archaeological and land management advice is required in assessing which of these four options is most appropriate in the circumstances. In particular cases, where impending problems can be envisaged, the proactive protection of a monument before damage occurs may be preferable to waiting for inevitable damage to occur. The remainder of this section considers ways to actively manage infested sites to ensure their preservation.

### 7.1 Conservation through active management

If an archaeological monument is deemed to be worthy of conservation by preventing its further deterioration by burrowing then the objective of management must be, wherever practical and legally permissible, to both remove the cause and reduce recolonisation pressure permanently. A committed, long-term strategy is needed. However, more temporary holding measures may be appropriate in limited cases. The detail of the strategy should be dependent upon the landowner's agreement and ability, cost, the size and remoteness of the site, availability of grants, and the current appropriate methods. Unfortunately annual (one-off) operations – poorly planned, haphazard and unmonitored – are often implemented to no long-term benefit.

Methods employed will be site specific, each applied correctly to the circumstances and including novel methods as they become available. Methods should be legal; not cause unnecessary damage to the monument; should seek to balance the needs of nature conservation where possible (remember to seek advice from Scottish Natural Heritage in areas designated for nature conservation reasons); and should be consistent with public access and health and safety considerations. Specifications for all operations should be carefully but simply drawn up to ensure that all landowners and contractors know what is expected, including that inspections are going to be carried out and the results recorded. If landowners are accepting responsibility as part of a management grant, they should not only be aware of the objective but also be encouraged to place it as part of a wider management effort (especially for rabbits).

### 7.2 Rabbit management

Total removal of rabbits from an archaeological site, combined with reducing recolonisation pressure, is not an easy task to achieve, especially over decades. Rabbits must be killed faster than recruitment; immigration must be zero; monitoring at low densities must be maintained; the socio-political will must be favourable; and the cost be sustained and less than the long-term loss (including political and excavation costs) from failure. If rabbits are actively reduced to a very low level by a planned high initial input, continued management (including monitoring) is less than if a weak initial effort and success is followed by repeated expensive treatments – still allowing deterioration of the archaeological site.

#### 7.2.1 Reducing recolonisation pressure

This may be achieved by changes in local land management practice to reduce the suitability of surrounding land to hold high rabbit numbers and the consequent immigration pressure on the archaeological site. Appropriate measures may be:

- the use of 'sacrificial feeding areas' where rabbits may be drawn to be killed;
- erecting rabbit-proof perimeter fencing with wire mesh to normal specification, to isolate adjacent infestations (or the archaeological site itself). This can last 10-15 years and excludes about 80% of rabbits after removal of animals within the fence (except when snow bridges the fence).<sup>8</sup> Improved specifications can add greatly to the effectiveness, if maintained properly, but add eg 15% to the cost for a cantilevered fence top. Electric fencing is not yet a viable long-term option;
- the netting (in winter) of the entire ground surface of small sites, including a substantial perimeter and after having removed the residents. The mesh is lost to view soon after the vegetation grows in spring. Wire netting has been used but the use of hard geotextiles may be an alternative.

#### 7.2.2 Removal of rabbits

Removing rabbits from an area should involve more than one method, usually during the winter period when rabbit numbers are lowest. Many methods, including shooting, live/killing trapping, snaring, fumigating, netting, fencing, warren destruction are legal and can be combined with the methods described above.

- Fumigation. Careful, thorough fumigation (after using dogs to drive rabbits underground). Entrances to tunnels may be blocked by turf, earth or sand - but this material must be brought from off site, as digging up ground adjacent to the tunnels will cause further damage to the archaeological site itself. At least one





*Figs 13 & 14. Addinston hillfort, Lauder, Scottish Borders: before and after the beneficial effects of rabbit and stock control. Crown copyright: Historic Scotland.*

repeat fumigation operation is necessary four to seven days later.

- **Traps.** Effective use of killing or multicapture traps in fences or walls surrounding other nearby rabbit hotspots may reduce the pressure to dig more tunnels. Tunnel traps in fences containing one-way gates have been used as an adjunct to other operations as has even the rabbit version of a deer leap to assist the clearance of an area. The use of live capture cage traps may be effective within a small area but takes considerable manpower since traps must be visited twice per day. Spring traps must be set well within a tunnel and visited daily. Snares should not be used where livestock are present.

- **Other methods.** In many situations there are 'preferred' methods eg snares or ferrets, offered by locals often for free; these may be admirable in putting additional pressure on a rabbit population but should not replace a properly planned strategy since such cropping will rarely achieve the 95-100% reduction

required. The use of ferrets to bolt rabbits to nets, guns or dogs is normally discouraged because of the damage likely in digging out lost animals. The destruction of warrens by ripping with a tractor-mounted subsoiler has been used - its use on an archaeological site will rarely be appropriate, and such operations are illegal on Scheduled Ancient Monuments without prior permission of the Secretary of State for Scotland.

The disadvantage of leaving rabbit burrows intact following a clearance is that other burrowing species may use them eg rat, fox, badger and any future immigrant rabbit immediately will have cover (unless burrows have collapsed or filled in as happened after the myxomatosis epidemic in the 1950s). When rabbits have been removed, the vegetation should regrow to cover surface scars but will need some future management to prevent too much cover and the risk of scrub development. Earthwork reinstatement may be archaeologically desirable and archaeological advice will be required beforehand.

### 7.3 Mole

Removal of moles can be achieved by either excavating small holes to position killing traps, or placing poisoned worms down 0.02m diameter holes made into the tunnel by licenced professionals. Archaeological advice should be sought before attempting such measures.

### 7.4 Badger

The provision of badger gates in rabbit fences is allowed to prevent damage to the fence, but it is illegal to interfere with a sett or animal. A licence is required from Scottish Natural Heritage for the removal of a sett or the translocation of animals.<sup>9</sup> Seek advice from Scottish Natural Heritage about experienced contractors and methods.

### 7.5 Fox

Foxes may be removed by snaring, hunting or shooting.

### 7.6 Rat

Rat problems can be removed by poisoning with anticoagulant baits, trapping, proofing, shooting or fumigation. Some sites may already have management for the protection of seabird colonies on islands or for reducing public health risk at picnic sites by eliminating accessible food sources.

### 7.7 Puffin and Shearwater

Disturbance of nesting birds /nests /eggs is illegal. Management of a site outside the breeding season is legal, although not encouraged, so long as there is no designated conservation status for the site.

## 8. MONITORING MANAGEMENT MEASURES

Monitoring a management regime has four functions:

1. assesses how effective management techniques have been;
2. detects whether further action is needed now- eg repairing fences - and doing it;
3. records when the effectiveness against the objective is declining and another focussed input of resource is required;
4. gives an indication of the suitability of that regime for other similar types of site elsewhere.

## 9. COSTS OF MANAGEMENT

The costs of individual management operations (planning time, construction of specifications, contractor estimates and execution and monitoring visits) are highly variable and managers should be aware that only thorough management and maintenance is acceptable: the cheapest option may well turn out to be wasted money. The actual cost of rabbit-proof fencing (typically c.£3.50/m for a 1km run) will depend upon the specification and quality of materials, as well as the required length, the remoteness of the site and labour rates. For example, cheap wire netting does not reach the BS 1722 specifications and rabbits may get through within a few days of erection, wasting the entire cost! This cost is also wasted if the erection procedure is poor or if regular (at least monthly) maintenance is not carried out, including attending to badger gates and the proper patching of holes and digs. A day's fumigation may be quoted at £200-£600 but this reflects the machinery used (spoon, applicator, hand pump, motorised pump), the active ingredient chosen (cyanide or phosphine) and extent of an infestation that can be covered to a high quality. The fumigation of only active holes is unacceptable and a repeat operation must be carried out within a week.

Grants to assist with the overall costs of management of archaeological sites, including rabbit control, may be available from the SOAEFD (through the agri-environment programme) or Historic Scotland (Section 17 Management Agreements or Section 24 Ancient Monuments Grants). As of 1998, the relevant grant levels for rabbit control works associated with archaeological sites are listed in Table 2.

## 10. LEGAL ASPECTS

Approximately 6700 archaeological and historical sites and monuments are currently protected in Scotland as scheduled ancient monuments under Section 2 of the

*Ancient Monuments and Archaeological Areas Act 1979*.<sup>10</sup> It is a criminal offence to carry out certain types of works affecting such sites without the prior written consent of the Secretary of State for Scotland (referred to as 'scheduled monument consent'). Erection of rabbit-proof fencing, removal of fencing, digging in wire netting, ripping warrens, digging out, filling in holes, digging in traps, and any other ground-breaking works on a scheduled monument will require scheduled monument consent. Historic Scotland must be consulted at an early stage of planning any management response to animal infestation at scheduled ancient monuments; for unscheduled archaeological sites, most local authorities have archaeological officers or advisors.

There are many Acts and regulations restricting the control of vertebrates but only those of relevance to burrowing animals on archaeological sites are mentioned here. Pest control companies and landowners should operate within these laws and follow other regulations (eg Health and Safety at Work Act 1974; COSHH 1994).

- *Protection of Animals (Scotland) Act (1912)* - Poisoning of ground vermin allowed - but no products cleared for use on burrowing animals except for rat and mole.
- *Prevention of Damage by Rabbits Act (1939)* - Permits the use of fumigants in rabbit holes.
- *Pests Act (1949)* - Requires notification to the local authority of substantial populations of rats.
- *The Pests Act (1954)* - Places an obligation on the occupier to undertake rabbit management (except in the Outer Hebrides). It also covers the use of approved spring traps and their placement underground (or in a tunnel).
- *Animal (Cruel Poisons) Act (1962)* - Regulates the use of strychnine for moles.
- *Wildlife & Countryside Act (1981)* - It is an offence to kill or harm occupied puffin and shearwater nests or eggs, but neither are on Schedule 1.

It is an offence to kill a badger or disturb a sett, but is allowed under licence on scheduled ancient monuments. Always contact Scottish Natural Heritage for advice on licencing and appropriate contractors, and Historic Scotland in the case of scheduled ancient monuments.

Prohibits the use of self-locking snares, but allows the use of free-running snares.

- *Control of Pesticides Regulations (1986)* - Pesticides including repellants must be approved and used according to labelled instructions.

- *Control of Substances Hazardous to Health Regulations (1994)* - Covers use of poisons and fumigants. Updated information and guidance sheets available from the Health and Safety Executive.
- *Protection of Badgers Act (1992)* - The legislation on badgers is still complex, and advice must be sought.

**TABLE 2: Typical grant types and levels (1998)**

	<b>Environmentally Sensitive Areas (rates depend on which ESA)</b>	<b>Countryside Premium Scheme</b>	<b>HS Management Agreement</b>	<b>HS Ancient Monument Grant</b>
Capital costs for stock fence	£2.75-3.20/m	£2.50/m	£2.70/m (at cost where special circumstances apply)	at cost
Capital costs for rabbit-proofing	£1.25-1.60/m	£1.25/m	£1.25/m (where special circumstances apply)	at cost
Rabbit eradication	Machairs of the Uists, Benbecula, Barra & Vatersay only: payment of £290/ha/ annum for dune control including rabbit control programme.		Infestation under 75%: £3.30 x %/ha/annum Infestation over 75%: £250/ha/year	at cost
Annual area payment	Tier 2 payment, for managing archaeological site, including rabbit control where needed.  Areas up to 1.5 ha: £80/0.25 ha.	Areas up to 1.5ha: £80/0.25 ha.  Areas over 1.5 ha: £20/0.25 ha	Areas up to 1.5 ha: £75 per annum  Areas over 1.5 ha: £150 per annum ha.	Not applicable
Points to note	Tier 1 requirement: where rabbit control is carried out on an area of archaeological or historic interest, avoid ground disturbance.	General Environmental Conditions require that where rabbit control is carried out on an area of archaeological or historic interest, that ground disturbance is avoided.		One-off payments; unlikely to be suitable for rabbit control programme, but may be able to assist with capital costs. Several quotes are required and SOAEFD rates are used for guidance.

Note:

- problems which rabbits create can be exacerbated by other factors, which will need addressing by management works;
- the table only singles out those capital payments relevant to rabbit control; area payments may relate to additional works as well.

## 11. USEFUL CONTACTS

Council for Scottish Archaeology (CSA):  
c/o National Museums of Scotland, Chambers Street,  
Edinburgh, EH1 1JF.

Farming & Wildlife Advisory Group (FWAG):  
The Rural Centre, West Mains, Ingliston, Edinburgh,  
EH28 8NZ.

Historic Scotland (HS): Longmore House, Salisbury  
Place, Edinburgh EH9 1SH.

Local Authorities - most have archaeological and pest  
advisory services.

RSPB: Dunedin House, 25 Ravelston Terrace,  
Edinburgh, EH4 3TP.

Scottish Agricultural College (SAC): The Rural  
Centre, West Mains, Ingliston, Edinburgh.

Scottish Natural Heritage: 2 Anderson Place,  
Edinburgh EH6 5NP.

Scottish Office Agriculture Environment and  
Fisheries Department (SOAEFD): Pentland House,  
47 Robb's Loan, Edinburgh EH14 1TW.

## 12. REFERENCES.

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### 13. APPENDIX - GUIDELINES FOR RECORDING INFESTATIONS AND DAMAGE

Many archaeological sites are sufficiently small that they can be recorded as a single unit; for large or complex sites, however, it may be appropriate to divide the site into sectors. It is important that records of damage are supplemented by a sketch and photographs. The following refer to rabbits, but can be adapted to other animals.

#### 13.1 Recording and monitoring activity

Evaluation of severity of damage should be based upon a combination of the factors listed below.

- *Identity of burrowing species* - the animal responsible for damage will affect the level of risk, the type of management and may have legal implications.
- *Intensity of activity* - a) no sign b) droppings c) surface scrapes d) individual holes e) few warrens (holes close together) f) holes and warrens scattered g) warrens dense / continuous.
- *Distribution of signs on site* - a) surface damage only - no burrows; b) all burrows away from earthwork / outside site; c) burrows near earthworks; d) burrows into features.
- *Distribution of signs up to 250m off site* - a) holes absent; b) cover, animals present; c) no cover, animals present.

#### 13.2 Evaluation of damage from surface survey

##### 13.2.1 Factors for assessing damage caused by burrowing animals

- *Estimated number of holes on site* - scale order (eg 1-10, 10-50, 50-100, 100+): combined with knowledge of site area, this can provide a loose quantitative index of density of activity.
- *Extent of surface traces* - rapid visual assessment of the surface extent of burrowing, without need for detailed measuring: % of earthwork - 0-25%, 25-50%, 50-75%, 75%+. Note whether certain elements of complex sites are being preferentially exploited.
- *Estimate lengths of tunnels within earthworks* - estimate number of barrowloads of soil displaced from a warren, and divide by the number of holes evident to give an average soil displacement per tunnel (1 barrowload approximates to 5m of tunnel where tunnel diameter is about 0.15m). This is a coarse guide only.
- *Disfigurement of earthwork profiles* - yes / no.
- *Destabilisation of earthwork profiles* - yes / no.
- *Information loss.*

Note presence of archaeological material in spoil from burrows, eg disturbed artefacts, charcoal, variations in soil matrix colour and texture (indicating disturbed stratification).

Note exposure of structural features visible (walling etc) resulting from soil falling away.

Note variations in character of earthworks, as this may affect future levels of infestation if no management methods are adopted - ie are undamaged areas liable to burrowing through incremental increase of population.

##### 13.2.2 Additional factors

Several factors may exacerbate the problems caused by burrowing, and should be recorded - the landowner or estate factor will be a valuable source of information in this regard.

- *Presence of livestock* - may cause further deformation by poaching and rubbing.
- *Presence of cover* - rank vegetation, shrubs, trees; providing cover from predators.
- *Land use conducive to attracting populations of animals* - eg uncultivated land; designated nature conservation area; local food sources.
- *Predator control* - can have significant effects on populations of burrowing creatures; eg removal of predators can result in rabbit population being more than doubled.
- *Human intervention* - uneducated / unauthorised attempts to control burrowing animals eg fencing rabbits into monuments (and thus away from cultivated land); ferreting and trapping, which may involve disturbance to earthworks; previous archaeological excavations / quarrying etc.





