

Domestic Stock Grazing to Enhance Woodland Biodiversity

INFORMATION NOTE

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SUMMARY



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Within ancient and semi-natural woodlands the range of habitats, resulting in part from a history of grazing management, encourages biodiversity. However, recent changes in agriculture and forestry have led to a loss of these habitats through neglect and overgrazing. Concern about this continuing loss has led to government initiatives aimed at encouraging better management and stemming further losses. This Note describes the influence of domestic stock on woodland habitats and their associated flora and fauna and provides guidance on the use of domestic stock to re-create, maintain and enhance the characteristics of semi-natural woodlands.

INTRODUCTION

- Ancient, semi-natural woodlands provide a range of habitats supporting a rich diversity of plants and animals, many of which depend on the continued existence of these habitats for their survival. The ecological character of these woodlands owes much to their historical management¹, including grazing by domestic stock².
- 2. Changes within forestry and agriculture since the latter half of the 19th century have led to the decline of 'managed' domestic stock grazing in woodlands³. Where stock (particularly sheep) still have access to woods for shelter, high stocking levels have led to over-browsing and limited natural regeneration causing a reduction in the structural diversity of woodlands. At sites where stock have been removed the more vigorous plant species shade out less competitive species and reduce diversity.
- Concern about the felling of ancient woods and the loss of character of those remaining through overgrazing or neglect led to the introduction of the 'Broadleaves Policy' in 1985⁴. This policy is targeted at semi-natural woodlands and aims to:
 - maintain and wherever suitable restore the natural ecological diversity;
 - maintain and where appropriate improve their aesthetic value;
 - maintain the genetic integrity of populations of native species, so far as is practicable;



Grazed (left of fence) and ungrazed (right of fence) areas at Coed-y-Brenin.

- take appropriate opportunities to produce utilisable wood;
- enlarge the woods where possible.
- 4. Woodland grazing systems are still in limited use within other parts of Europe and new systems are under trial. Few formal trials of the use of domestic stock in the management of woodlands have been carried out in Great Britain. This Information Note draws together the available information to provide guidance on how and where domestic stock can be used to recreate, maintain and enhance the characteristics of semi-natural woodlands. Where possible, stocking densities to achieve specific aims are given. As wild herbivores (deer and rabbits) will also influence woodland structure and species diversity their impact should also be considered where grazing is being managed to enhance biodiversity⁵.

DOMESTIC STOCK

5. Grazing by large herbivores helps to create and maintain structural and species diversity within the ground flora, shrub layers and tree canopy, thereby influencing dependent invertebrate and vertebrate communities. Differences in the resultant structural and species diversity are due to variation in feeding preferences (influenced by plant species composition and grazing pressure), feeding and dunging behaviour, and trampling by their hooves.

Feeding preferences and behaviour

- 6. Figure 1⁶ shows the broad variation in diet for domestic stock. Cattle and horses are generally classed as grazing species, being low selective herbaceous feeders (taking mainly grasses and other ground vegetation) whilst sheep and goats are more selective and tend to browse more on the shoots and leaves of trees and shrubs³.
- 7. Feeding pressures of domestic species are usually compared by referring to livestock units (LSU). This generally refers to grazing pressure where a cow = 1 LSU and a sheep = 0.15 LSU. However, equivalent grazing units of 1 pony : 3 cattle : 5 sheep have been suggested³, alternatively one pony is considered equivalent to 2.5 cows. Some studies consider cow-calf pairs as animal units (AUs) and express grazing pressure as AUs relative to available forage (AU Mg⁻¹ ha⁻¹). This describes the ratio of animal demand per unit mass of forage at any instant in time. Stock browsing pressure is also referred to by browsing units where 1 cow = 1 unit, a pony = 5 units and deer = 3 units⁷. Table 1 describes differences in feeding behaviour and preferences and the resultant effects on the habitats.
- 8. Within a species there may be variation in feeding preferences and behaviour between breeds, sex and age classes. Hardier breeds tend to be less selective, taking poorer quality forage, and animals with incomplete dentition (youngest and oldest age classes) tend to graze less efficiently and therefore be more selective¹¹. Males and females may graze similar habitat for a part of the year but separate areas for the rest⁷.
- 9. The dung of all species may increase soil fertility in the grazed area. However, where animals tend to dung in latrines, or lie-up together at night, dung may become concentrated in local patches, and cattle dung, in particular, may smother plants. Most species avoid grazing near dung patches, allowing patches of taller vegetation to develop.

Table 1

Species	Feeding method	Selectivity
Cattle	Bulk grazer Tear-off long vegetation by wrapping tongue around and pulling. Grasp short vegetation between lower incisors and horny upper pad. Ruminants feeding for 60% of the day.	Low
Horses & ponies	Bulk grazer Nip herbage close to ground with upper and lower incisors. Non- ruminant. Feeds for 75-88% of the day.	High
Sheep	Selective grazer Nip herbage close to ground. Vegetation grasped between lower incisor and horny upper pad.	Very high Native and hardy breeds less selective.
Goats	Selective browsers Narrow incisor width enables high selectivity.	High
Pigs	Omnivorous Take invertebrates, tubers, fungi, fruits seeds, grasses and carrion, much of which is obtained by rooting in the leaf litter.	Low

Figure 1

Variation in the diet of domestic stock



Method of feeding, dietary preferences and habitat effects of domestic stock species

Diet preference Major /minor species	Seasonal variation	Effects on habitat	References
High quality grasses, bent/fescue Low quality communities: bog-rush fen, mat grass/purple moor-grass, heather (ling).	Low Broadleaves bark stripped when forage availability low (winter), or in response to mineral deficiency (summer).	 Uneven tussocky sward, with tall vegetation around dung patches which are avoided. High grazing pressures produce short swards. Winter grazing of mat/purple moor-grass breaks-up deep litter and increases quality of spring growth. Summer grazing of heather and wavy hair-grass reduces coarse and woody material, encourages herb species and improves forage quality. 	3, 5, 7, 8, 9
Bent/fescue grasses Purple moor-grass, heather, gorse and holly. Sedges/rushes and ferns. Native breeds take more coarse grasses.	High Bent/fescue grasses preferred. Purple moor-grass, sedges, rushes and ferns taken late spring and summer. Bark stripped when forage availability low.	 Varied sward structure, patches of closely grazed and tussocky ground. Native breeds particularly useful at controlling coarse grasses (e.g. tor grass) and producing open, herb-rich swards. 	7, 9, 10
High quality grasses and forbs Heather and coarse grasses.	High Ash, holly, oak and birch browsed in summer. Fir, spruce, yew, juniper and bramble in winter. Bark stripped in severe winters.	 Short, tight sward, except where tussocky grass is present. Commercial hill breeds avoid coarse grasses. Browse hardwood seedlings for a greater proportion of year and more selectively than cattle, preventing natural regeneration. Saplings browsed in winter especially during snow cover. Seek woodland shelter during inclement weather causing particularly high impact to ground flora and natural regeneration. 	3, 11, 12
High quality grasses, sedges, rushes and dwarf shrubs Mat grass, rushes, bracken, bog mirtle.	High Grasses, sedges and rushes in summer, dwarf shrubs, gorse and browse in winter. Norway and Sitka spruce browsed in winter. Winter stripping of smooth barked broadleaf species (40–35 cm girth) and conifers (5–15 cm girth).	 Graze/browse tall vegetation leaving uneven, tussocky swards. Hardwood seedlings browsed more than by cattle and sheep, preventing natural regeneration. Brambles and other thorny species may be controlled by browsing. 	7, 13, 14, 15
Anything tasty	Low Fruits and seeds (particularly acorns) taken in autumn.	 Dense ground vegetation (bracken, couch grass, brambles, roses) reduced/cleared by rooting behaviour. Seed beds created for natural regeneration. Seedlings, saplings and roots of larger trees may be uprooted or damaged unless pigs are ringed (4–5 rings in snout) and removed following pannage period (3–4 weeks). Continual pig rooting prevents natural regeneration. 	16





An Aberdeen Angus cow eating cotton grass.

Trampling

- 10. The hooves of domestic stock, in particular cattle and ponies, can cause trampling of vegetation and the soil surface (poaching). Trampling may be particularly important in limiting or reducing the spread of invasive species such as bracken in grassland¹, and in knocking down other tall vegetation, creating pathways (approximately 30 cm wide even through rank vegetation) which may be used by other mammal and bird species⁹. Trampling can also break up thick turves and mats of vegetation, helping to create seedling establishment sites.
- 11. The pressure of a sheep hoof (1.5 kg cm⁻²) is only 44% that of a cattle hoof (3.4 kg cm⁻²) and so sheep may be more suited to wet habitats for winter grazing³, although sphagnum species in bogs and

Cattle path through blaeberry and heather at Abernethy Forest.



lichens are vulnerable to even light sheep trampling. Sheep appear to have no trampling effect on bracken on the open hill (unlike cattle)⁸. However, Adams¹⁷ concluded that poaching by sheep (2.5–6.4 ha⁻¹) was the main reason why trees failed to respond to the grazing of understorey in an agroforestry trial in Northern Ireland. On light or peaty soils or bare ground sheep may initiate or exacerbate erosive processes by making 'scrapes' and lying up in peathags for shelter.

- 12. Trampling (particularly by cattle) on wet sites can be damaging to soil structure causing compaction (up to 15 cm in depth¹⁸) and increasing the bulk density of the soil surface (to 8 cm depth). This may lead to reduced soil pore space, poor aeration, reduced soil infiltration rates, soil seepage and low microfaunal densities¹². However, in upland woods the benefits of trampling in creating seedling establishment sites should outweigh any detrimental effects of soil compaction³.
- 13. The rooting activity of pigs is particularly useful for clearing dense ground vegetation (bracken, brambles, couch grass and wild roses), improving access for silvicultural operations, reducing the need for weed control and creating seed beds for natural regeneration¹⁶. Stocking density should be low (< 0.5 ha⁻¹) for a short period (up to 3 months) during spring and summer. High pig densities (up to 100 ha⁻¹) on restock sites may cause soil compaction and burrowing leading to raising of stumps from the previous crop, making subsequent vehicle access difficult (Guest, unpublished). Unless removed from the site, pigs will eventually root up any seedlings which have established, preventing natural regeneration.

IMPACT ON WOODLAND HABITAT

- 14. The impact of domestic stock on woodland ecosystems is broadly similar to that of wild herbivores⁵. There is, however, variation between species and even between breeds of the same species (Table 1). Cattle and goats tend to graze taller vegetation and leave an uneven tussocky sward. Sheep and horses graze closely, leaving a short sward of even height at moderate to high grazing pressures and a more varied sward at lower grazing pressures. Table 2³ summarises the impact of different grazing intensities in woodlands. Specific impacts by the domestic stock species to particular parts of the woodland ecosystem are described below.
- 15. Generally the greater the grazing or browsing pressure then the greater the impact to the ground, shrub and canopy layers of the site. However, not all impact levels will be detrimental to the objectives of the site. For example relatively high grazing and browsing levels are necessary to restore woodland pastures and ensure that ancient trees are not shaded out by natural regeneration. However, on sites where domestic stock have prevented natural regeneration and reduced structural diversity, exclusion of grazing for a few years followed by extensive cattle grazing may be most beneficial (Table 4).

Effect on ground flora

16. Where grazing pressure is completely removed the more aggressive plant species (e.g. bluebell and wood anemone) will become dominant, shading out smaller herbaceous species and less competitive species, such as violet and wood pimpernel¹⁹.



A pig rooting in lowland woodland.

Table 2 Grazing level indicators (after Mitchell & Kirby)³

Grazing level	Indicators
Low	Saplings frequent in canopy gaps, well developed shrub layer, no obvious browse line. Ivy present, ground vegetation dominated by grazing sensitive species (blackberry, honeysuckle) or limited by dense shrub layer, mats of wavy hair-grass may develop in base poor sites.
Moderate	Saplings present although localised, shrub layer developed in parts, signs of grazing/browsing, few bare soil patches. Ground vegetation >30 cm high, mixture of grass/herbaceous/dwarf heath vegetation.
High	No tree regeneration >20 cm, generally no shrub layer, pronounced browse line on shrubs and trees, ground vegetation up to 20 cm, dominated by less palatable grasses, bryophytes and bracken, some bare patches, palatable and grazing sensitive species (blackberry, bilberry, honeysuckle) confined to inaccessible areas.
Excessive	No tree regeneration, barking of mature trees and of branches on the ground, no shrub layer, extensive bare ground and soil disturbance, invasion of weed species (docks, annual meadow-grass).

- 17. At low grazing levels sward structure may be more varied but species richness is reduced by the dominance of a few competitive plant species. Some species such as dogs mercury are exceptionally sensitive to grazing and may only survive in the shelter of bushes even at relatively low grazing intensities¹⁹.
- 18. At moderate grazing levels the more aggressive and dominant plant species may be kept in check enabling smaller, common, less competitive species to become established and create a more species-rich and structurally diverse habitat.
- 19. Heavy grazing pressure can cause dramatic changes in plant species composition and abundance, with preferred species being grazed out, and unpalatable, such as bracken and tufted hair-grass, becoming dominant. Heavily grazed grasslands generally become species poor and may become dominated by bryophytes as other vegetation is grazed out.

- 20. Grazing (and rooting) by domestic stock is particularly useful to reduce the spread of most unwanted (coarse grass and shrub) species, for maintaining 'open swards' with patches of bare ground for ground nesting species, and for reducing competition between weeds and young trees, hence reducing the need for herbicide application during the establishment phase. However, grazing may accentuate the competitive advantage of tufted hair-grass on poorly drained lowland soils, as it is unpalatable and avoided by domestic stock unless little else is available. Heavy trampling may damage and flatten small tussocks.
- 21. Where dunging is concentrated in latrines or other areas, plant species composition may be affected by the concentrations of nitrogen and potassium and the introduction of 'alien' plant species through seeds in supplementary feed.

Effect on tree regeneration

- 22. Where grazing pressure is completely removed the more aggressive plant species shade out seedlings of some tree species²⁰. Where there is a 'mat' of ground vegetation, seeds may be prevented from reaching the ground, or from establishing once they have germinated.
- 23. A reduction of grazing in upland woodland sites may encourage oak seedlings/sapling recruitment but reduce birch and rowan recruitment. Ground disturbance to reduce competition and create niches for seedling establishment is particularly important for the regeneration of birch²¹. This disturbance may be achieved through trampling, close cropping of the vegetation, which creates short swards with shallow moss and litter layers and bare soil. However, unless removed from the site, pigs will eventually root up any seedlings which have established, preventing natural regeneration.
- 24. There are clear differences between tree species in their susceptibility to browsing, even at the seedling stage²⁰, although this will also be influenced by the presence of alternative forage and grazing/browsing pressure. Birch, oak and hawthorn are considered to be least susceptible and sycamore most susceptible to grazing^{20, 22}. Moderate grazing favours alder regeneration whilst high or none prevents it. Simulated grazing experiments³ have shown that oak seedlings are particularly resilient to browsing, and only die when subjected to sustained defoliation. Seasonal differences in the responses of seedlings to grazing/browsing suggest that for birch,

rowan and ash, winter browsing is less detrimental than summer browsing²⁰. Selective browsing and grazing can dramatically alter woodland composition³, with browsing of holly by sheep (and deer) being considered to be responsible for its scarcity in the shrub layer in western British oakwoods.

- 25. Controlled grazing/browsing plays an important role in preventing unwanted scrub development in open heathland habitats¹⁸ which support populations of a number of rare reptiles and amphibians (smooth snake, sand lizard and natteriack toad). Goats are particularly effective at controlling invasive weed/shrub species as they have the ability to detoxify secondary plant compounds such as tannins¹⁴. They have been used to maintain fire breaks in the Pacific south-west forests of USA, to improve upland pasture by grazing out rushes²³ and to remove birch and willow from dune systems and lowland heath. High densities (32 goats ha⁻¹) are required and for maximum impact on birch and willow, browsing should commence as early as possible (May) and continue through to July¹⁴.
- 26. Trampling by cattle may cause damage to seedlings^{7, 8} particularly within the first few years of establishment. As seedlings grow taller they become more visible to the cattle and levels of basal scarring decrease. A threshold grazing pressure of 12 AU Mg⁻¹ ha⁻¹ has been suggested above which a high percentage of trees would be scarred. Species which are able to resprout (e.g. birch and rowan) are more likely to recover from trampling damage than others which cannot (e.g. Scots pine)⁷.
- 27. Where regeneration is protected against browsing by the use of individual tree shelters, the stakes supporting the treeshelters/guards must be substantial enough to withstand ponies and cattle rubbing against them, otherwise they can be knocked over and trees within the shelters broken off.

Effect on vegetation structure

28. At high grazing pressures structural diversity is reduced dramatically with very little, if any, vegetation present below the 'browse line'. Generally domestic stock browsing of evergreens is higher during winter whilst on deciduous species it is highest during summer¹⁵. High levels of browsing will prevent natural regeneration leading to a very open woodland structure¹⁷.

- 29. All domestic stock will strip the bark from trees although sheep and goats may be more prone to this¹⁸. Bark stripping may be more severe during severe weather or when forage availability is low. It may also occur in response to mineral deficiencies and the provision of mineral supplements (salt licks) may prevent or reduce it. Any trees which are ring barked will be killed, and where some tree species are stripped preferentially, the species composition of the woodland may be altered. Continuous high browsing and stripping damage levels by sheep and goats can lead to complete degradation of woodland habitats with juniper heathland developing in areas which were once acid oak forests¹⁸.
- **30.** Where pigs are kept within woodland all year without the provision of supplementary feed they will quickly eradicate most ground vegetation and strip tree stems and spur roots leading to eventual death of the trees. However, if provided a full diet they may be used to control invasive species such as bracken and rhododendron, which will be used as bedding litter by sows.



Tree guard damaged by ponies/cattle because of insufficient height of stake.



Bark stripping of sweet chestnut by sheep.

Impacts on invertebrates

- 31. A reduction in ground flora and shrubby growth will reduce food plants and nectar sources available to invertebrates, other than those in the tree canopy. This will be accompanied by a loss in invertebrate species, particularly butterflies²⁴. Many woodland butterfly species depend on open areas such as glades, rides or recently coppiced areas, and require a temporarily continuous mosaic of these 'open' habitats as they have low dispersive powers²⁵. Grazing can help maintain these habitats by limiting the spread of grasses which outcompete important herbaceous nectar plant species such as viola. Some invertebrates, such as the wood ant, may benefit from increased grazing/browsing as they build their nests in locations to obtain direct sunlight and so a reduction in ground vegetation will enhance their habitat²⁴. Putman²⁶ also found a greater abundance of spiders in grazed compared to ungrazed woodland.
- 32. The dung of domestic stock, in particular of cattle, is an important invertebrate habitat, with large numbers of beetles (particularly Geotrupes) and some 60 species of fly associated with it, as well as earthworms, nematodes, mites and springtails9. Current research suggests exceptionally high levels of Geotrupes in oak woodland in the New Forest (grazed by ponies and cattle) whilst none have been found in oak of the same age class in Alice Holt Forest (ungrazed). Spots favoured by cattle to rest at night or shelter from rain or heat may be heavily covered in dung and urine, attracting large numbers of dung beetles and their predators. However, the use of antihelminth drugs (in particular Avermectin based endectocides) to control internal parasites can dramatically reduce the invertebrates associated with dung⁹.

Impact on birds and mammals

Birds

33. Generally speaking bird species diversity will be highest in more structurally diverse woodlands²⁷. At low to moderate grazing levels woodland structural diversity will be enhanced (Table 2), providing a range of feeding niches and shelter for birds. Certain bird species (woodwarblers, pied flycatchers, redstarts, thrushes and tree pipits) prefer sites with less than 30–40% shrub cover, for feeding and nesting, and low ground vegetation (15–20 cm). Low to moderate



Silver washed fritillary (Argynnis paphia L.).

grazing levels provide these conditions. Where grazing levels are reduced and shrub cover increases, commoner species such as blue tits will compete with pied flycatchers for nesting sites. Trampling by large stock or pigs may be a risk to ground nesting birds. On sensitive sites grazing should therefore be limited to summer/autumn, after young birds have fledged (i.e. after May). Game birds also rely on ground cover to avoid predation.

34. Cattle create pathways through ground vegetation which are used by other mammals and birds (in particular woodland grouse)⁹. During the winter cattle movement through snow helps to expose feeding sites for small birds and break up the ice at loch edges. Cattle dung in particular, attracts birds (jackdaws, waders, chough, starlings and woodland grouse) which feed on the associated invertebrates and their larvae, and other species which feed on adult flies attracted to the dung⁹.

Mammals

35. In woodlands the highest abundance and diversity of small mammals is associated with establishment, restock and prethicket crop stages, where there is an abundance of ground vegetation, in particular grasses²⁸. Studies have shown that heavily grazed woodlands such as the New Forest, with short ground vegetation, have reduced small mammal populations^{24, 26}. Woodmice are the only small mammal species which appear to achieve healthy populations in heavily grazed habitat. Burrowing species such as field voles may be limited due to trampling and disturbance of leaf litter as well as the reduced ground and shrub vegetation.

- 36. As rabbits are morphologically adapted to use closecropped vegetation, heavy grazing may be expected to have less impact on their populations. However, where grazing is high rabbit populations are relatively low, with breeding groups most frequently occurring in areas of dense gorse or other cover²⁴. Predatory mammals (weasels, stoats and foxes) relying on small mammals and rabbits are indirectly affected by grazing in woodlands and are either rare or occur at lower densities than in other ungrazed woodlands²⁴.
- 37. Small mammals (particularly voles) are one of the main food items of 50% of the raptors found in British forests and the only main prey item for all four owl species and kestrels²⁸. In years of low vole density most species take other prey (songbirds, other birds, lagomorphs, reptiles and invertebrates)^{24, 28} but species density and breeding success will be reduced. However, short-eared owls (a highly mobile species) may be completely absent from an area except in peak vole years²⁸. Tawny, barn and little owls, kestrels and buzzards all occur at lower densities in the heavily grazed New Forest compared to other similar habitats²⁴.
- 38. In semi-natural woodlands, low grazing intensities, which encourage a diverse ground and shrub flora, are likely to create suitable habitats for the widest range of small mammals and their predators. The dung from domestic stock also has high numbers of invertebrates associated with it on which badgers, foxes, shrews, hedgehogs and bats will forage.

CONCLUSIONS

39. Low intensity grazing by domestic stock should benefit a range of ancient and semi-natural woodland types by increasing structural and species diversity. Some habitats, such as lowland wood pasture, may benefit from higher grazing intensity (Table 4). Although it is possible to provide general guidance on the use of domestic stock there is very little detailed information available on specific impacts of different breeds to woodland flora and fauna. It is therefore recommended that grazing regimes should start at low intensity, should not encompass all of sensitive or priority habitats and should be monitored. Grazing regimes to meet general objectives are given in Table 3 whilst Table 4 provides specific recommendations for a range of NVC woodland types.

Table 3 Grazing recommendations

Objective	Recommendation	
Maintain parkland communities	Increase grazing levels where shrubs and regeneration are shading out parkland communities. Extensive grazing should continue to maintain a short sward, reduce shading and overtopping of veteran trees. Regeneration can be protected in small exclosures or individually, until above browsing height ²⁹ .	
Manipulate ground flora	Coarse grasses and dominant species will be reduced by grazing and trampling. Extensive grazing (continuous low density) preferred. The bulk of old coarse grasses should be removed first by burning or mowing.	
Improve tree regeneration	Reduce grazing levels. Enclose newly felled or glade areas. Use individual tree protection ²⁹ . Where regeneration is limited by a dense understorey use pigs, cattle or ponies at relatively high density for a short period of time to create bare patches and break up any mats of vegetation.	
Increase shrub cover	Keep grazing levels low. Cattle and ponies will browse less than sheep or goats.	
Coppice management	Very low densities for first 5 years or exclusion until regrowth is above browse height.	



Staverton Park, a typical grazed wood pasture.

PRACTICALITIES OF STOCK GRAZING

- **40.** For those woodland owners who have limited experience of dealing with domestic stock the following practicalities should be considered:
 - Hardy and/or ancient breeds are most suitable (e.g. Belted Galloway or Highland cattle; Hebridean, Herdwick, Swaledale or Rough Fell sheep¹¹; Saddleback or Gloucester pigs) as they are hardier and less prone to disease, thrive better on relatively poor forage and are likely to require little supplementary feeding. Horses survive better on poor quality year-round grazing than cattle.
 - Cattle require daily inspection of animals and fences, particularly breeding stock with young. Nonbreeding (fattening) cattle, sheep or hardy ponies require less stockmanship. Water must be supplied daily for lactating cattle, horses and goats, regularly for sheep and pigs. Inspection should be more frequent during periods of inclement weather.
 - Keep stock in herds/flocks of sizes found naturally e.g. 10–30 adult cows. This may limit the application of extensive cattle grazing to areas of ≥30 ha.
 - Manage stock 'organically', with no/minimal use of antibiotics or worming compounds which remain active in the dung and are toxic to invertebrates and fungi. Fenbendazole products are recommended.
 - Suitable fencing will need to be used. On small areas electric fencing may be adequate, particularly for pigs. Suitable (self-closing) gateways will need to be provided where footpaths and bridleways cross the site. Vehicle access will be required to move stock to and from the site. Hardy/ancient breeds (particularly of sheep) require higher fencing.
 - Where there is public access choice of stock must consider risks to the public and stock:
 - entire males and cows with calves can be particularly aggressive towards people and dogs
 - dogs walked off lead may 'worry' sheep and cows.
 - Conflicts may occur where the area is shot for gamebirds, or is used by ground nesting species. Grazing will tend to reduce shrub and ground flora and hence gamebird cover, and nests may be trampled. Where ground nesting birds are a priority grazing should be limited to late summer/autumn.

- Domestic stock may interfere with the culling of deer, both by disturbing the deer and concerns about shooting them. Where deer culling is an important objective domestic stock should be removed during the doe cull season (November–March). This will also reduce the likelihood of the ground becoming 'poached' over the winter.
- Noxious weeds may need to be removed from sites (ragwort should be removed by hand as dead plants become more palatable after cutting or herbicide treatment³⁰), or stock kept away whilst the plant is in leaf (e.g. March–June for meadow saffron, found in wood pastures in Savernake). Cattle and sheep (less likely) may suffer from bracken poisoning in areas where other forage is particularly limited³¹.
- Risks of redwater disease (caused by a tick-borne protozoan parasite, particularly in south-west England) and the presence of Johne's disease (spread through contaminated water, particularly drinking ponds) may limit the use of cattle³¹.

PROPOSALS FOR THE FUTURE

- **41.** Currently the use of domestic stock to enhance/restore habitats is mainly limited to open heath and grassland areas. Few sites have investigated or monitored the use of domestic stock in woodlands. Formal trials should be initiated to consider:
 - Impacts of grazing and trampling on sensitive plant communities.
 - The impact of grazing by different stock species and breeds on invertebrate, bird and small mammal populations.
 - The influence of domestic stock grazing on soil compaction, regeneration and tree survival.
 - Minimum/maximum flock/herd sizes to achieve specific objectives.
- **42.** Where stock are to be grazed in woodland habitats it is recommended that sensitive plant communities are identified, current structural and species diversity is recorded (including point photographs) and the effects of the grazing regime are monitored at regular (1, 3, 5, 10 year) intervals. Details of the grazing regime (numbers of animals, breed, sex, age-class and weight, area grazed and over how long) should also be recorded.

Table 4 Recommendations for the grazing of domestic stock in ancient and semi-natural woodlands, by NVC woodland type

Woodland type	Grazing issues	Objectives
Wet woodlands NVC W1-7	Shrub, coppice, high forest mixes. Generally not regularly grazed. May be grazed locally.	 Coppice regeneration over 5–40 years. Improve groundflora and structure.
Upland mixed ashwoods NVC W8 (e–g) W9	Most former coppice displaced by grazing. Sycamore naturalised in many.	 Coppice regeneration and high forest. Improve groundflora and structure.
Upland oakwoods NVC W11, W17 (oak dominated)	Mainly former coppice or high forest. Most now neglected and heavily grazed. Others dominated by birch, ash, holly, hawthorn	 Reduce shading by scrub. Improve groundflora and structure.
(Oak dominated)	and rowan.	 High forest regeneration. Coppice regeneration.
Upland birchwood NVC W11, W17 (birch dominated)	Woods dominated by birch, sometimes with hazel, sallow, rowan and holly. Most heavily grazed by sheep and deer limiting development into native pine or oak woods.	 Reduce grazing to encourage increased natural regeneration and succession. Maintain as high forest (grazed).
Lowland mixed broadleaf woodlands NVC W8 (a–d) W10	The main lowland woodland type; mainly oak, ash and hazel. Historically coppiced with oak standards. Some still worked. Often intricate mosaics of various stand types. Regeneration limited by deer grazing and browsing.	1. Coppice regeneration.
		 Regeneration of standards. Improved flora and structure.
		4. High forest regeneration.5. Maintain open and ride habitats.
Lowland beech-ash woods NVC W12–14	Beech and yew high forest. Most historically coppiced with limited wood pasture. Many now high forest with extreme beech dominance.	 Recoppice areas coppiced within the last 50 years. Regeneration of standards. Re-establish wood pasture areas. Reduce shading and overcrowding of ancient trees.
Lowland acid, beech and oakwoods NVC W15 and 16	Often formally managed as wood pasture. Reduction in grazing has led to changes in structure. W16 often found on lowland heaths, reducing conservation value of heath. Many planted with chestnut and worked as coppice.	 Manage beech dominated areas as uneven age high forest 0.2–0.5 ha coupes. Oak dominated areas coupes >0.5 ha Recoppice areas coppiced within last 50 years, especially chestnut, oak or birch areas. Maintain and improve wood pasture areas.
Lowland wood pasture	A reduction in grazing has generally led to shading out and overcrowding of trees, particularly pollards. Scrub encroachment has reduced the amount and distribution of open space.	 Stock grazing and shelter. Conserve habitat for breeding birds, saproxylic specialist invertebrates, and epiphytic lichens. Open up structure, reduce regeneration and shrub layers (e.g. Savernake).
Native pinewoods NVC W18	Pine high forest, often very open due to heavy grazing by deer and sheep. Very little regeneration, some birch and other broadleaves associated.	 Regeneration and extension of woodland (some grazing). Regeneration of associated shrub layer (especially juniper).

Maximum grazing density ha ⁻¹ (either/or)				
Cattle	Horses	Sheep	Timing	Reference
0.07 0.1	-	0.5 0.7	1st 5–10 years 10 years onwards	32
0.07 0.1	-	0.5 0.7	1st 5–10 years 10 years onwards	
0.2–0.5 0.05	-	- 0.33	Summer grazing Continuous	33 32
0.07 0.1	-	0.5 0.7	1st 5–10 years 10 years onwards	32 32
0.1			Summer grazing	
0.05	-	0.33	Continuous	32
0.1	-		Once coppice above browse height	32
0.2–1			Summer grazing	33
0.05		0.33	Continuous	32
0.1		-	Continuous, extensive grazing	33
see below				
0.07 0.01 see below		0.5 0.7	1st 5–10 years 10 years onwards	
0.05	-	0.33	For 15 continuous	32 32
0.6	-	4.0	Other years	52
0.3	-	-	Remove Nov–Feb	34 34
0.05–0.1	-	-	Continuous	9

italic = best estimation

43. The Grazing Animals Project (GAP) provides a useful forum for exchange of ideas and information and facilitates the use of native domestic stock breeds.

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44. Grazing by domestic stock has the potential to improve structural and species diversity of woodland habitats whilst at the same time improving their aesthetic value and encouraging the conservation of genetic diversity within domestic stock species.

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