5. Management techniques

5.1 Introduction

This section describes the techniques that might be used to manage scrub and gives information to support the selection of the most appropriate technique.
The techniques to be used on a particular site will depend on the objectives for the site, an assessment of the status of scrub on the site and the particular local conditions determining what is the most practical option. Table 5.1 outlines the structure and content of this section.

Table 5.1: Index of management techniques and issues discussed in Section 5.8 & 5.9.

Management Objective		Management Technique	Section
Enhancement:	Increase extent (5.2)	Natural regeneration	5.8.1
		Planting (including watering) and layering	5.8.2
		Protecting from browsing	5.8.3
		Grazing to reduce competition	5.8.4
		Bare earth management/scarification	5.8.10
		Weeding (including suppressing competition)	5.8.12
	Improve quality (5.3)	Livestock grazing & browsing to improve structure	5.8.4
		Coppicing and thinning	5.8.5
		Mowing & flailing	5.8.6
		Controlled burning	5.8.7
		Edge, glade and ride management	5.8.8
		Decaying wood management	5.8.9
		Bare earth management	5.8.10
		Weeding/removal of undesirable species	5.8.12
Maintenance (5.3)		Livestock grazing & browsing	5.8.4
		Edge, glade and ride management	5.8.8
		Coppicing and thinning	5.8.5
		Mowing & flailing	5.8.6
		Controlled burning	5.8.7
		Water level management	5.8.11
Reduction (5.4)		Livestock grazing & browsing	5.8.4
		Mowing & flailing	5.8.6
		Controlled burning	5.8.7
		Water level management	5.8.11
		Weeding	5.8.12
		Cutting	5.8.13
		Stump removal	5.8.14
		Grubbing out	5.8.15
		Herbicide application	5.8.16
Eradication (5.5)		Livestock Browsing	5.8.4
		Cutting	5.8.13
		Stump removal	5.8.14
		Grubbing out	5.8.15
		Herbicide application	5.8.16

Table 5.1: Index of management techniques and issues discussed in Section 5.8 & 5.9 cont...

Management Objective	Management Technique	Section
Generic management issues (5.9)	Disposal of arisings (including litter removal & nutrient stripping) Environmental impacts Design and landscape	5.9.1 5.9.2 5.9.3
Tools (5.9.4)	Non-powered hand tools Powered hand tools Power Take Off & hydraulic powered machines Herbicide applicators	5.9.4.1 5.9.4.2 5.9.4.3 5.9.4.4

5.1.1 Setting Management Objectives

(see Section 3 for the main discussion)

Scrub is likely to be assessed as being in one of the following conditions:

- Under represented – requiring an increase in the extent of scrub.
- Poor condition – requiring an improvement in the quality of scrub.
- Favourable condition – requiring maintenance.
- Over represented – requiring reduction.
- Inappropriate for the location – requiring eradication.

A number of shrub species and scrub types have high conservation value in their own right. Scrub habitats are generally under represented in the UK, and particularly in the uplands because of clearance for agriculture and high grazing pressure from domestic and wild herbivores. Rates of successional change may also be slower in the uplands, limited by factors such as soil fertility and climate. The management objective for scrub in the uplands is often to maintain existing stands, increase the extent and improve quality.

In the lowlands, scrub can be invasive of open habitats such as downland and heathland, particularly in the absence of grazing where rates of successional change can be particularly high. If left unmanaged then this can seriously affect the conservation value of such habitats, but if a mosaic of scrub and open habitats is maintained then the overall biodiversity value will be enhanced. Individual shrub species and scrub habitats, which are of high conservation value in one part of the country and in one habitat, may be invasive in another. The management objective for scrub in the lowlands is often to maintain or reduce cover while improving the quality, but eradication is also a common aim. Site-specific assessment of objectives is essential.

5.1.2 Selecting Management Techniques

Table 5.2 shows the range of techniques that can be used to meet each management objective; some techniques can be used to achieve more than one objective, and some will be used in combination to achieve a single objective. The flow chart in Section 1 which techniques are available to achieve each objective.

There are some key issues to be considered when planning scrub management:

- the conservation of scrub dependent wildlife, avoiding loss or damage to sensitive species (see 5.6).
- impact on the landscape, archaeological and historical interest and public access (see 5.7).
- impacts and effects on the environment as a result of management operations (see 5.9.2).
- accessibility for machinery (see 5.9.4).
- resource costs (see Appendix 8.9).
- aftercare.

Aftercare is particularly important. Scrub management can seldom be achieved with a single operation. Maintaining a dynamic mosaic of scrub and other habitats, or of structure within a stand is an ongoing process. Establishing new areas of scrub involves weeding and potentially fencing to exclude browsing animals, and eradicating or reducing scrub stands by cutting will require some means of preventing re-growth after clearance.

5.2 Increasing the extent of scrub

Where scrub communities are under-represented or absent it may be desirable to establish or to expand scrub. This is particularly likely to be the case where there is high grazing pressure, from either domestic or wild animals, such as in many upland and montane areas. An increase in the deer

Table 5.2: A summary of techniques applicable to the main management objectives.

Management techniques		Applicable to							
		Enhance				Maintain			
		Increase extent	Improve quality	Manage scrub stands	Manage dynamic mosaics	Manage scrub stands	Manage dynamic mosaics	Reduce	Eradicate
Natural regeneration		✓	✓	✓	✓	✓	✓		
Planting		✓	✓						
	Protect from browsing	✓	✓						
	Reduce browsing	✓	✓						
	Grazing - reduce competition	✓			✓		✓		
	Ground scarification	✓							
	Weeding	✓		✓	✓	✓		✓	✓
	Watering	✓							
	Planting	✓							
Browsing - diversify structure			✓	✓		✓			
Browsing - control scrub				✓	✓	✓	✓	✓	✓
Grazing - reduce competition		✓	✓	✓	✓	✓	✓		
Browsing and grazing animals	Goats			✓	✓	✓	✓	✓	✓
	Ponies	✓	✓	✓	✓	✓	✓	✓	✓
	Cattle	✓	✓	✓	✓	✓	✓	✓	✓
	Sheep	✓	✓	✓	✓	✓	✓	✓	✓
	Deer	✓	✓	✓	✓	✓	✓	✓	✓
	Rabbits	✓	✓	✓	✓	✓	✓	✓	✓
(Other foraging livestock)	Pigs (incl wild boar)	✓	✓	✓	✓	✓	✓	✓	✓
Management of scrub and mosaics				✓		✓			
	Coppice		✓	✓		✓			
	Layer		✓	✓		✓			
	Thin		✓	✓		✓			
	Ring bark		✓	✓		✓		✓	✓
	Deadwood management		✓		✓		✓		
	Glade management		✓		✓		✓		
	Edge management		✓		✓		✓		
	Ride management		✓		✓		✓		
	Removal of non-desirable species		✓	✓	✓		✓		
Mowing			✓		✓	✓	✓	✓	✓
	Hand tools	✓	✓	✓	✓	✓	✓	✓	✓
	Power tools (strimmers, etc)		✓	✓	✓	✓	✓	✓	✓
	Mechanical (tractor mounted)		✓	✓	✓	✓	✓	✓	✓
Cutting techniques			✓	✓	✓	✓	✓	✓	✓
	Hand tools (saws, slashers, etc)		✓	✓		✓		✓	✓
	Power tools (Chainsaws, clearing saws)		✓	✓		✓		✓	✓
	Mechanical (Flails, etc)		✓	✓	✓		✓	✓	✓
Stump removal								✓	✓
	Hand tools (mattocks, etc)							✓	✓
	Power tools (chainsaws, etc)							✓	✓
	Mechanical (winches, diggers, etc)							✓	✓
	Horses							✓	✓
Grubbing out	Mechanical (diggers, blades, winches, chains)							✓	✓

Table 5.2: A summary of techniques applicable to the main management objectives cont...

Management techniques		Applicable to: Enhance: Increase extent	Enhance: Improve quality	Enhance: Manage scrub stands	Enhance: Manage dynamic mosaics	Maintain: Manage scrub stands	Maintain: Manage dynamic mosaics	Reduce	Eradicate
Herbicide application		✓			✓		✓	✓	✓
	Foliar spraying				✓	✓	✓	✓	✓
	Stump treatment					✓	✓	✓	✓
Controlled burning	Controlled burn		✓	✓	✓	✓	✓	✓	✓
	Weed burner		✓	✓				✓	✓
Water level management	To manage scrub species composition					✓		✓	✓
Disposal of arisings (inc Brash) and litter removal		✓	✓	✓	✓	✓	✓	✓	✓
	Burning		✓	✓	✓	✓	✓	✓	✓
	Chipping		✓	✓	✓	✓	✓	✓	✓
	Forage harvesting		✓	✓	✓	✓	✓	✓	✓

population is probably having a detrimental impact on lowland scrub communities and is particularly likely in areas where densities are high.

Natural regeneration is the preferred means of establishment or expansion of scrub. However, the absence of an appropriate seed source, suppression of seedling establishment by grazing pressure or a dense mat of rank vegetation may all limit natural regeneration. If there is no appropriate seed source on the site then planting seeds or seedlings imported from the nearest compatible (or ecologically acceptable) site may be the only means of establishing a scrub community. This is often the case for rare scrub communities such as montane scrub and other scrub communities in the uplands. Where a relict scrub community remains, ground preparation may be required to remove a dense mat of rank vegetation that is suppressing natural regeneration. Layering can also be used, for certain shrub species, to increase the extent of scrub from an existing stand. For natural regeneration, planting and layering, success may depend on the reduction of grazing pressure, either by fencing out grazing animals or by reducing their number.

The establishment and expansion of scrub communities can be of particular importance in locations where it provides a buffered edge to woodland habitats or act as a 'nursery' habitat for the development of new woodlands. Techniques for increasing the extent of scrub communities are summarised below.

Techniques for increasing the extent of scrub communities

Management Technique	Outline Description
Natural regeneration (5.8.1)	Where there is a ready source of regeneration seed (or suckers) natural regeneration is generally the best means of expanding scrub communities. It will be necessary to address the issues that prevent or reduce the success of natural regeneration, eg browsing pressure,or excessive competition. Removal of dense vegetation and scarifying the ground can help natural regeneration.
Planting and layering (5.8.2)	If seeding cannot occur naturally (no fruiting shrubs locally), then planting or layering may be needed to regenerate stands, especially for rare species and communities. The causes of failure of the scrub to regenerate will also need to be addressed.
Protection from browsing (5.8.3)	The presence of high densities of grazing or browsing animals, domestic or wild, is likely to limit scrub establishment. For natural regeneration or planting to be successful, the grazing or browsing pressure on seedlings will need to be reduced, either by reducing livestock densities, fencing or tree guards.

5.3 Improving the quality and maintaining scrub communities

Scrub of high nature conservation value should be managed to improve and maintain, and where desirable to improve its quality. This frequently involves rotational management; the period of rotation will depend on the lifecycle of the species involved. Mixed scrub stands on reasonably fertile soils begin to develop towards woodland after about 15 years, so a rotation of around that duration will ensure that all stages of scrub, including open ground are present within a stand or site. The coup size used and the shape of the coup edges will influence structural diversity within the stand; large coups with straight edges will have low structural diversity and vice versa.

The interface between scrub and surrounding vegetation communities is an important ecological feature that can be enhanced by developing sinuous or scalloped edges. This diversifies local microclimates and increases the extent of edge foliage available to invertebrates.

The principal techniques for improving and maintaining scrub are summarised below. The application of a range of techniques applied across a site is important in maintaining a dynamic mosaic of scrub and open habitats.

Techniques for improving and maintaining scrub

Management Technique	Outline Description
Browsing/ Grazing (5.8.4)	• Grazing and browsing create and maintain structural mosaics. • Sheep, ponies, cattle and goats are all useful. • Wild herbivores, Rabbit, deer and Wild Boar grazing/browsing effects need to be assessed and managed at an acceptable level. • Excessive or insufficient grazing pressure can damage the interest.
Coppicing and thinning (5.8.5)	• Coppicing, the cutting of scrub to encourage regeneration from the stump and rootstock, maintains and when used in small coups, enhances scrub stand. • Thinning, or selective removal of individual stems or shrubs, reduces the density of scrub stands, creates dappled light conditions and with regeneration in the gaps creates a fine-scale structural diversity. • Both are usually carried out with either chainsaw or bow saw.
Mowing & flailing (5.8.6)	• Mowing is an alternative to browsing or burning. It suppresses seedling shrubs, so maintaining the balance with open areas.
Controlled burning (5.8.7)	• Periodic use, on flammable scrub species, creates and maintains mosaics of open habitat with scrub.
Edge, glade and ride management (5.8.8)	• The interface between scrub and other habitats is important. • A diverse, long interface provides shelter and a variety of aspects, optimising microhabitat provision. • Interfaces between open habitats and scrub can be maintained using grazing, mowing or flails.
Decaying wood management (5.8.9)	• Decaying wood is important for invertebrates and fungi and may be under represented. • Standing dead wood can be created by ring barking. • A proportion of retained logs or tightly stacked brash may be beneficial.
Bare earth management (5.8.10)	• As a component of the structural mosaic of scrub stands, bare earth is important for invertebrates and pioneer plants. • It can be created and maintained during scrub management.

5.4 Reducing the extent of scrub

Scrub developing onto and, importantly, compromising habitats with a higher conservation priority or archaeological interest will need to be reduced, and then to be kept within acceptable limits. A clear understanding of conservation priorities will be needed at the outset: ie of the relative values of the open habitats, scrub and species interest of each. This will enable scrub reductions to be properly targeted.

The management techniques available for reducing/limiting the extent of scrub, either on their own or in combination are summarised in below. Once the acceptable limits are achieved then maintenance management will be needed to keep the scrub in those limits, involving similar operations repeated periodically during a maintenance phase of management.

Techniques for reducing scrub

Management Technique	Outline Description
Water level management (5.8.11)	• Prolonged inundation of cut scrub prevents re-growth. • Inundating standing scrub kills some species.
Weeding (5.8.12)	• Hand pulling seedlings is labour intensive and can be slow, but it prevents unwanted scrub from establishing and is more cost effective and less disruptive than removing shrubs when they have grown bigger.
Cutting (5.8.13)	• All cutting operations will require follow up treatment to prevent re-growth from stumps. • Small-scale cutting suits light tools, eg loppers, bow saws, billhooks and axes. • A large volunteer labour resource is effective with light tools. • Mechanised cutting with chainsaws or clearing saws suits larger stands. • Tractor powered machinery, eg flails, in large uniform blocks.
Stump removal & grubbing out (5.8.14 & 5.8.15)	• Manual stump removal is slow, mattocks and root cutters can be used for small bushes, winches or heavy horses with chains can be used to remove medium sized stools. • Grinders will destroy stumps in situ with minimal soil disturbance. • Diggers provide a faster work rate and can be used on larger root plates but will produce more ground disturbance and materials for disposal.
Herbicide application (5.8.16)	• Herbicide application is a useful technique for reducing the extent of scrub. • Young or low scrub can be treated directly, whereas taller scrub will require cutting first and herbicide application to the cut stump or next season's re-growth. • Herbicide application should only be used where there is no practical alternative.

5.5 Eradicating scrub

Eradication is the total removal of scrub from inappropriate locations. Invasive non-native species, eg Rhododendron or Sycamore and some native species that are highly invasive in suitable conditions may need to be eradicated.

Eradication will often involve some management after cutting to prevent re-growth. Alternatively, stands might be removed directly by grubbing them out. Aftercare includes preventing seedlings from becoming established. Economies of scale might favour more robust methods that remove the rootstock; these will generally require less follow up treatment. Scrub will grow back if it is cut back without killing or removing the rootstock or suppressing regeneration, increasing management costs. The principal techniques for eradicating scrub are summarised below.

Techniques for eradicating scrub

Management Technique	Outline Description
Cutting (5.8.13)	• Cutting off at ground level will be needed for well-grown stands where grubbing out is not an option. • All cutting operations will require follow-up treatment to prevent re-growth from the stump or seeds. • A range of tools can be used depending on scale and access conditions, including power saws and forest mulchers.
Stump removal (5.8.14)	• Manual stump removal is slow, mattocks and root cutters can be used for small bushes, winches or heavy horses with chains can be used to remove medium sized stools. • Grinders will destroy stumps in situ with minimal soil disturbance. • Diggers provide a faster work rate and can be used on larger root plates.
Herbicide application (5.8.15)	• Herbicides can be used to kill developing scrub or cut stumps. • Young or low scrub can be treated directly, whereas taller scrub will require cutting first and herbicide application to the cut stump or next season's re-growth. • Herbicide application should only be used where there is no practical alternative.
Grubbing out (5.8.16)	• Large scrub stands may be more cost effectively cleared mechanically with 360° excavators or bulldozers. This can have arisings and public perception issues.

5.6 Scrub management for specific wildlife

Earlier sections of this handbook assess the value of scrub for a range of taxa, including plants, birds and invertebrates. Managing scrub to ensure that the biodiversity interest is maintained or enhanced often involves understanding which species are present, their conservation priority, and habitat requirements. A rich and varied mosaic of age and structure to the stand, and a balance between open habitat and the scrub will provide the niches required for most species; others may need specific management. The requirements of flora and fauna in scrub are summarised below.

Surveys should be undertaken to ascertain the presence, distribution and status of rare and vulnerable species before carrying out any management, and the needs of individual species taken into account when planning the management. If rare species are discovered during the management programme, management may need to be changed to ensure their conservation.

Requirements of flora and fauna in scrub

Epiphytes:	Scrub on the western coasts of Britain is richest in epiphytes; high rainfall and humidity, together with sheltered, shady areas, and low levels of atmospheric pollution all contribute. The best communities occur on older, mature trees and shrubs: slow growing scrub in sheltered gullies and ravines provide an ideal microhabitat for epiphytes to flourish. Managing to encourage a continuity of mature shrub should maintain epiphyte populations.
Vascular plants:	Scrub casts shade impacting on the diversity of herbaceous flora. Open short sward plant species are usually intolerant of shade, and species that are shade tolerant are usually adapted to established woodlands. A mosaic of scrub and open habitats can ensure the conservation of an herbaceous flora, and even provide a hot sheltered microclimate that benefits certain species. Restoring species–rich scrub and open habitat mosaics can be difficult: the long-term viability of the seed bank for grassland communities is poor, although characteristic species of heathland will tend to have longer viability. Soils under scrub for any length of time will have their nutrient status changed. This often leads to the growth of different, unwanted plant communities after clearance.

Requirements of flora and fauna in scrub cont...

Invertebrates:	Well-managed mosaics of scrub give continual shelter and warmth and a range of nectar sources, providing many invertebrates with a range of beneficial niches, important to completing their lifecycles. The range of vegetation structure attracts a variety of herbivorous and predatory species as well as providing suitable sites to establish territories and places in which to breed. Flowers of shrub species and forbs provide nectar; a combination of rides and glades will provide both in sheltered sunny locations. Un-shaded, un-vegetated ground provides nest sites and hunting habitat for invertebrates, while sheltered open damp areas will also be important. Deadwood is particularly valuable and can easily be created during management.
Reptiles and amphibians:	Un-managed scrub is usually detrimental to reptile and amphibian species in the UK; succession is cited as a cause of their decline. Natterjack Toad and Sand Lizard are sensitive to scrub encroachment on open heathland and in dune slacks. The encroachment of scrub around ponds is likely to limit their value for a range of amphibians. However, maintaining pioneer scrub with a diverse structure near ponds and on other habitats can benefit both amphibians and reptiles as it provides shelter and a rich source of invertebrate food. Mosaics of scrub with open habitat can provide a hot sheltered microclimate that is beneficial to all reptiles. Brash piles and logs can be important refuges and hibernacula.
Birds:	Scrub is very important for several species of bird, and very high densities of particularly passerine can occur in structurally diverse communities. Hence, management of scrub to provide a mosaic of age and physical structure is important. Structure is a key determinant of the bird assemblages that will occur. Management on a rotation ensures continuity is maintained where birds can find suitable nest sites in the thicker cover, and a range of areas in which they can feed and forage. Berried shrubs are important as a winter food supply for a number of bird species. Mosaics of open habitat and scrub are important for some species including Black Grouse.
Mammals:	Different mammals will use different scrub types depending on the range of species and the structure. Dormice use mature stands along with Shrews and Bank Voles, whereas Harvest Mice use pioneer scrub growth. Many mammal species use scrub as shelter and secure lying-up areas (eg riverside scrub is important as a lying-up area for otters), and from which to hunt and forage in adjacent open habitat (eg Fox predation of Stone Curlew). Many species will dig dens under established scrub. Grazing pressure of rabbits on adjacent grassland can be partially managed by the distribution of scrub cover.

5.7 Scrub management for public access, landscape and archaeological interests

Public access, landscape and archaeology all need to be considered when planning management of scrub, but they can, with care, be accommodated with little impact on the work. Failure to consult could lead to conflict with user groups and the public, or damage to the landscape appeal and archaeology. This section assesses the issues and suggests how conflicts may be avoided.

Scrub is an important component of many landscapes. Equally, however, the character of some landscapes is typically open and extensive areas of scrub would be out of place. It is important, therefore, to consider the typical landscape character of the area when planning expansion or reduction of scrub. There are a number of key sources of information on landscape character:

- English Nature Natural Area profiles (www.english-nature.org.uk/science/natural/na_search.asp) describe characteristic habitats and landscapes in England.
- Countryside Agency's Countryside Character Initiative describes in detail the landscape character of the Natural Areas (www.countryside.gov.uk/cci/).
- Local Authority Landscape Character Areas also describe landscape character at a local level.

Public perception of a local landscape is often influenced by its recently developed character. It is hard for the public to relate to objectives for restoring open habitats from woodland or scrub. Old photographs may assist in showing earlier landscapes before they became colonised by scrub. The openness of many upland areas is assumed to be 'natural', so re-introducing scrub may be seen as being out of character. Conversely, scrub in a landscape can be seen as scruffy and indicative of a lack of care.

Public access requires consideration in management plans of the aesthetic appeal of the area, safe access provision and public safety and the effect of management on the amenity value of the site. Factoring these into management prescriptions will help to ensure that the preferred management is integrated with the wider issues relating to the site.

In order to minimise conflict over scrub management where there is significant visual or public access it is important to explain well in advance what is intended, why it is being done and what the end result will be, including the benefits.

Semi-natural habitats overlay ground that has usually remained undisturbed for long periods. These often have significant surviving archaeological interest, which needs to be fully understood before planning any management. Damage can occur both by active management and by neglect; the encroachment of scrub on areas of archaeological interest can be damaging because of rooting into the feature through the soil, or erosion as the ground covering vegetation is shaded out. Scrub management techniques, involving large machinery, soil compaction or disturbance, can seriously damage the surface or underlying archaeological interest. Scrub management in areas with archaeological interest must be fully consulted in advance.

Implications of scrub management on public access, landscape, archaeological and historic features

The public:	Public access to semi natural habitats is commonplace. The Countryside and Rights of Way Act 2001 (CRoW) will open further areas with scrub, including heaths, downs and commons. People's perception of the landscape and resistance to change can lead to conflict, and there are important considerations for public safety and working practices.
Landscape:	Scrub features in a range of landscapes and can add to their intrinsic, aesthetic feel. Issues occur particularly where scrub requires control or eradication, but may also occur with maintenance management or when establishing new areas. The design of the work can be done to minimise landscape impact, in consultation with experts.
Archaeology & historical features:	Semi natural habitats frequently have associated archaeological interest and historical features. Scrub invasion can damage the interest, as can inappropriate scrub management. Consultation with the relevant authorities is appropriate before management.

5.8 Scrub Management Techniques

The following section gives detailed descriptions of each of the principal management techniques available for scrub management. It describes which management objectives they can be used to meet (enhance, maintain, reduce, eradicate) as well as describing whether the technique can be seen as a one-off solution to a management problem or whether repeated treatments will be required. Each profile discusses the practical implementation of the technique and its advantages and limitations and describes the potential environmental and non-target impact of the use of the technique. A selection of key sites or organisations, with contact details, is listed at the end of each profile, along with recommended further reading specific to the technique. A general reading list applicable to all techniques, appears at the end of the chapter.

5.8.1 Natural regeneration

Summary
Natural regeneration is effective in encouraging the expansion of scrub stands where there is an existing proximate seed source or the desired species have suckering roots, and no constraint on their development. This encourages natural spatial distribution and promotes local genotypes.

Large open areas will be colonised only slowly unless there are species with wind blown seed locally. Where necessary, the ground may need preparation in order to create a seedbed, by either removing or breaking up competing vegetation or scarifying the ground to encourage rooting. This can be through using livestock, manual or mechanical methods. Ground scarification can encourage weed species so precautions may be necessary.

Applications
May be considered for use in delivering objectives aimed at:
- Enhancement
- Maintenance

Is it a long term solution? Yes, subject to successful establishment. May need further recruitment at intervals.

Techniques
Natural regeneration of scrub will mean that only those species that are already locally present will develop, though some may have only been present as buried seeds. Seeding will take place over time, causing a diversity of ages within the new stand, and the species will, in many cases be spatially mixed. The processes are slow, but inherently cheap and where time is not a constraint, this should be the favoured option.

Reduction of grazing pressure:
Grazing suppresses the development of seedlings of the more palatable species, preventing stand regeneration. This is particularly the case in the uplands and mountains. Removing livestock, particularly in spring and summer when seedlings are most palatable allows seedling development, helping to encourage the spread and infill of small, fragmented stands of scrub.

Ground preparation:
Exposing bare soil increases the proportion of seeds that will take root and develop. This can be achieved through a short period of heavy grazing (if too long the seedlings will be browsed); by scarifying to create an open sward with a light harrow; or, where a grass mat or bracken litter impedes seeding, these can be removed by burning or mowing with a cut-and-collect machine.

Natural regeneration of sea buckthorn.
Kev Wilson/Lincolnshire Wildlife Trust

Small-scale ground preparation can be carried out by hand, but machinery such as turf lifters, rotovators, rotoburiers or excavators, can be used to make light of the work.

Aftercare:
Grazing/browsing pressure will need to be low for natural regeneration of palatable species to occur. It may be necessary to exclude grazing animals (see 5.8.3) during establishment. However light grazing should help to suppress competing species. Selective weeding should be used only where necessary to ensure the desired species become established (see 5.8.12).

Non-target impact

- Ensure that areas being colonised are not valuable for other priority objectives.
- The use of heavy cultivating machinery may have a detrimental impact on any archaeological interest as well as on soil profiles at undisturbed sites.
- Ensure that longer term development of shrubs and trees on the extension will not have harmful effects on the next adjacent land i.e. through future shading or seed fall etc.

Environmental

see also Section 5.9.2.

- Avoid creating a soil erosion risk if creating bare ground.

Advantages & limitations of natural regeneration

Method	Advantages	Limitations
Non-intervention	• Natural distribution of species. • Known provenance. • Naturally varied structure.	• May be relatively slow, depending on species and local conditions. • Requires adjacent seed source. • Prone to damage by herbivores. • Prone to suppression by competitors.
Ground preparation	• Removes thatch so seed has direct contact with soil. • Removes cover for small mammals that may damage seedlings. • Temporarily reduces competition from weeds.	• Could provide opportunity for vigorous weeds. • The thatch would retain moisture and insulate the soil from frost.
Exclusion of grazing	• Prevents browsing on seedlings. • Partial exclusion will allow suppression of some competition.	• Seedlings become swamped by grasses. • May need hand weeding instead, if totally excluded.

Key sites and contacts

- Aston Rowant NNR,
  Contact: Graham Steven,
  English Nature, Foxhold House, Crookham Common,
  Thatcham, Berks RG19 8EL,
  tel 01635 268881
  e-mail graham.steven@english-nature.org.uk
- Forest Enterprise [Scotland (North)]
  Contact: John Ogilvie
  West Argyll Forest District,
  Whitegates, Lochgilphead, Argyll PA31
  tel: 01546 602 5188RS,
  email: john.ogilvie@forestry.gov.uk
- Kentish Stour Countryside Project
  Contact: Jon Shelton,
  Sidelands Farm, Wye, Ashford, Kent.
  tel: 01233 813307,
  email: kentishstour@kent.gov.uk
- Kent High Weald Project
  Contact: Keith Rennells,
  Council Offices, High Street, Cranbrook, Kent,
  TN17 3EN.
  tel: 01580 715918,
  email: keith.rennells@kent.gov.uk
- Woodland Trust
  Contact: Geoff Sincomb,
  2 Five Acres, Horbrook, Ipswich, IP9 7QB
  tel: 01473 327771
- Woodland Trust
  Contact: Heather Swift,
  12 Sandy Lane, Leyland, Preston, Lancs PR5 1EB.
  tel: 01772 624726

Further reading and references

James, N. D. G., (1989) 4th edition, *The Foresters Companion*, Blackwell Press, Oxford & Cambridge

5.8.2 Planting and layering

Summary
Seeding and planting may be used where there is no appropriate seed source for natural regeneration. Layering or transplanting is used to assist the expansion of existing scrub stands.

Good preparation and aftercare are critical. Without either, mortality rates will be high.

Applications
May be considered for use in delivering objectives aimed at:
- Enhancement
- Maintenance

Is it a long term solution? Yes, subject to successful establishment. May need further recruitment at intervals.

Techniques
The technique for each follows three basic stages; ground preparation, establishment (seeding, planting out, transplanting or layering) and aftercare.

Preparation:
Preparation may, on open ground, simply require scarifying the ground using a rake to produce a seedbed, direct planting in these conditions would require no ground preparation. Cultivation may be beneficial where ground compaction has occurred, this can be done with either a pedestrian or tractor mounted cultivator or rotovator.

In areas with a low botanical conservation interest, a pre-planting application of an appropriate herbicide might be considered to tackle target species only. Ensure residues will not harm developing seedlings.

Seeding:
Seeds sourced from within the site or locality are normally preferred so long as they are not from previously introduced strains or sub-species. Care will be needed when collecting seed from elsewhere to ensure the species assemblage is appropriate to the communities being created or enhanced.

Small seeds can be sown direct onto the ground (mix with foundry sand to help broadcast the seed thinly). No raking should be needed. Larger seeds will need raking into a cultivated bed, or even planting.

Beech and Oak planting at Hodgemoor wood
Peter Wakely/English Nature

Sowing density will depend on the desired density of the established stand, bearing in mind that a relatively high proportion of seeds will fail to develop.

The seed of some species may have poor germination (part of the reason why they are rare in the first place!) unless they receive special cold treatments to break down the seed coat so reference may need to be made to forestry or horticultural manuals or by seeking specialist advice.

Planting out seedlings:
Planting is mostly used to expand and enhance small, fragmented stands or to infill damaged/failed areas. Work rates are slow relative to sowing but the success of the seedlings is much higher.

Planting out involves either seedlings grown from appropriate seed collected and grown on site, or acquired commercially. Commercial varieties may be of alien stock, unless provenance is guaranteed. Most

commercial nurseries tend to import continental plants, which dilute the local genotype, affecting the balance with dependent wildlife. Nurseries now exist that specialise in native stock, albeit at a higher cost to the consumer and with a more limited supply (see Appendix 8.11).

On site propagation of suitable locally harvested seeds will maintain local provenance. Seeds are usually grown on for a year or two before being planted out.

Size at planting out varies from year old seedlings grown in paper pots (bio-degradable) to 2 or 3 year old bare-rooted (without pot) whips. In Upper Teesdale, pot grown Juniper seedlings fared better than alternative methods. Pot growing is cheap and effective and has low mortality rates.

For best results planting should be carried out between November and March, though a month either side may be effective, with autumn being the best time. Prior to planting, bare rooted stock must not dry out, be kept covered at all times and if left for an extended period, be heeled into the ground in a trench.

Density and pattern of planting varies according to circumstances. Irregular, wide spacing gives a more natural appearance and encourages natural infill and hence diverse stand structure.

Planting method:
Notching (planting into a spade-cut slit) is quick but can result in the plant being lifted from the ground by either frost or drought, and compresses roots, slowing their development. Pit planting (into a spade-dug hole) provides better conditions for root establishment and less chance of lift, but is much slower.

Layering and cuttings:
Layering stems or hardwood cuttings can be used to expand or infill scrub stands and especially hazel coppice. Bramble, Dogwood, Hazel, Roses and Willows are well suited to this. Consult good horticultural or forest manuals for detailed information.

Branches of shrubs and trees are pegged into the soil and a slit is made on the underside of the branch, using a knife or billhook. They then take root and after approximately 3 months, when the layer has set strong roots, cut the stem from the parent close to the layer.

Willow species lend themselves to propagation by cuttings: sections of young growth will take readily if planted in wet soil. Other species, eg Privet, Dogwood and Rose also take but less readily.

Transplanting:
Suckers and crowded saplings can be transplanted to new areas. This should be carried out during dormancy, between November and March, when soil conditions are moist. Dig out the sucker together with substantial amounts of fibrous root and transplant to the new area.

Aftercare:
Aftercare is important to ensure successful and rapid establishment. The most significant threats to successful establishment are from drought, predation from herbivores and suppression by excess growth of competing grasses.

Control excess weed growth during establishment to reduce competition for water and nutrients; otherwise, seeding and planting schemes may fail (but some losses will create gaps and variety). See 5.8.12 for details. Aim to keep approximately one square metre around the tree clear of rank vegetation.

Mulching is effective in suppressing weeds and retaining soil moisture. Wood chips arising from scrub management elsewhere on site can be placed around the base of the sapling. Some aggressive weeds may grow through and need treatment (see 5.8.1).

Alternatively, mulch mats can be used to protect plants from competition and reduce moisture loss around the roots.

Mowing/strimming around trees reduces competition for light and to some degree water, but may increase exposure to drought. Beware of going to close to stems with machinery and damaging bark or soft tissue.

Chemical weed control may be necessary if alternatives (eg hand weeding or mulching) are impractical. Choose an appropriate herbicide that will not affect the planted species. Further information on herbicides is reviewed in Section 5.8.16.

Water is essential. New planting in dry or porous soils will need watering. Where mulching is not possible, plants will need to be watered throughout dry weather in the first growing season. A grass thatch helps to maintain soil moisture, but could suppress saplings; removal could cause drought stress to the roots of saplings. Some level of sapling mortality should be accepted – gaps would naturally be in-filled.

Newly planted trees need protecting from browsing pressure from domestic and wild herbivores. See Section 5.8.3 for details.

Non-target impact

- When planting, always ensure this is not going to affect other ecological or archaeological features of higher value.
- Ensure the provenance of any stock being used.

Environmental (see also Section 5.9.2)

- Avoid creating a soil erosion risk if creating bare ground.

Advantages & Limitations of planting and layering

Method	Advantages	Limitations
Seeding	• Minimal material costs. • Patchy success leads to variation in structure. • Natural spatial distribution and appearance of scrub. • Minimal maintenance.	• Low success rate. • Harder to protect. • Higher risk of predation by herbivores. • Longer establishment period.
Cuttings	• Cheap material costs. • Known provenance. • Minimal effort required to plant for some species.	• Some species are not as easy to propagate. • Longer establishment period.
Layering	• No material costs. • Known provenance. • Infill gaps and expands stands. • Instant effect. • Quick establishment. • Easier to protect.	• Limited amount of stock. • Restricted to immediate area of stands.
Transplanted suckers	• No material costs. • Known provenance. • Can transplant to other parts of site. • Instant effect. • Quick establishment. • Easier to protect.	• Limited amount of stock. • Hard to create a 'natural' appearance.
Nursery raised plants	• Instant effect. • Quick establishment. • Easier to protect.	• High material and labour costs. • Lack of structure. • Hard to create a 'natural' appearance. • Difficult to source local plants / dubious provenance. • Risk of introducing nursery sourced pests and diseases.

Key sites and contacts

- Brighton and Hove Council
  Contact: Matthew Thomas
  Conservation and Regeneration Team, Environmental Services Dept., Town Hall, Norton Road, Hove, BN3 3BQ.
  Tel: 01273 292371
- Kentish Stour Countryside Project
  Contact: Jon Shelton, Sidelands Farm, Wye, Ashford, Kent.
  tel: 01233 813307,
  email: kentishstour@kent.gov.uk
- South Cambridgeshire District Council
  Contact: Milton Country Park,
  Cambridge Road, Milton, Cambridge CB4 6BW.
  tel: 01223 420060

- Sussex Downs Conservation Board
  Contact: Bruce Middleton
  Northern Area Office, Midhurst Depot, Bepton Road,
  Midhurst GU29 9QX
  tel: 01730 817945

- Wildlife Trust West Wales
  Contact: L Gander,
  Welsh Wildlife Centre, Lilgerran, Pembs SA43 2TB.
  tel: 01239 621 600
  email: lin@centre.wildlife-wales.org.uk

- Wiltshire Wildlife Trust
  Contact: Head Office,
  Elm Tree Court, Longstreet, Devizes
  tel: 01380 725 670,
  email: wiltswt@cix.co.uk

- Woodland Trust
  Contact: Heather Swift,
  12 Sandy Lane, Leyland, Preston, Lancs PR5 1EB.
  tel: 01772 624726

- Forestry Research, Alice Holt Lodge, Wrecclesham,
  Surrey GU10 4LH
  tel: 01420 22255,
  email: ahl@forestry.gsi.gov.uk

Further reading and references

Agate, E., (2002), *Tree planting and aftercare*, BTCV.
Ball. M. E, Wormell, P, (1975) *Nursery production of native Scottish trees and shrubs*, Scottish Forestry Journal Vol 29 (2) 102 -110.
Herbert, R.; Samuel, C.J.A. & Patterson, G.S. (1999), *Using local stock for planting native trees and shrubs*. Forestry Commission Practice Note 8; 8pp.
ISBN: 0855385030.
James, N D G, (1989) 4th edition, *The Foresters Companion*, Blackwell Press, Oxford & Cambridge
Kirby, K, (1994) *Where should you put your new woods?* ENACT 2 (3), p 12-14. English Nature.

5.8.3 Protecting from browsing

Summary
Browsing by both wild and domestic herbivores can affect regeneration, survival and development of seedlings. This has a major impact on lowland and particularly upland scrub communities; high numbers of deer prevent regeneration of seedlings and regrowth of coppice stools. Browsing also damages the structure of dense scrub and strips bark.

Where damage is an issue, protective measures are needed. The methods most frequently used are tree guards or tubes, fencing or stock removal and in some instances culling of wild herbivores.

Applications
May be considered for use in delivering objectives aimed at:
- Enhancement
- Maintenance

Is it a long term solution? All preventative methods require either periodic review and assessment or inspection followed by maintenance operations.

Fenced 300 acre plot, Lizard NNR. Peter Wakely/English Nature

Techniques
Tree guards:
Plastic spiral guards suit small areas of planting. They are relatively short and protect the seedling from Rabbit browsing. They are easily installed after planting, and can be supported with a cane or stick. Remove the guard once the plant has become established to prevent constricting the trunk as it grows.

Tree tubes are tougher and taller than spiral guards, but need support by staking. They protect small seedlings or whips from deer, sheep and small mammals, but suppress lateral growth so the shrub tends to be 'lolly-popped'. Remove guards once saplings are established. Fine mesh guards of 60 cm x 10 cm have successfully protected Juniper seedlings.

Fencing:
Fencing is usually used to protect whole stands. The type of fencing required depends on the severity of the problem, the species being managed and the terrain.

Post and strand wire fencing protects established and newly planted scrub that is vulnerable to cattle and ponies; sheep can be kept out with narrowly spaced strand wire or stock net fencing. Deer are kept out only by tall fences, which are expensive, though experiments with shorter fences have proved successful for small exclosures (Robinson 1995). The main types are permanent post and wire, temporary post and wire (to be recycled) and even electrified for some situations.

Rabbits can be kept out with low small mesh fencing that is dug into the ground for 15cms and turned towards the direction of attack to deter them from digging under it. Details of fence design vary according to terrain; consult for example Agate (2002) for options.

Fenced areas can be periodically lightly grazed in order to prevent grass thatch developing and shading out seedlings.

Costs vary greatly, often in response to access and ground conditions; fencing inaccessible montane scrub can be very expensive.

Reduce populations of grazing animals:
Fencing may be impossible; instead removal or reduction of stocking may be needed to conserve scrub communities. However, even temporary removal of stock may be difficult on for example common land. Where stocking levels are controllable, stock should be reduced to remove pressure on the scrub. These levels need to be determined locally, considering what alternative palatable forage is available. Total de-stocking may lead to rank vegetation developing, suppressing seedling scrub.

If fencing is not an option, lethal control of wild animals may need to be considered. Deer will need to be managed, rather than eradicated, by specialists. Rabbits can be controlled by shooting, gassing, trapping or ferreting, and Grey Squirrels by shooting, humane traps or poison (provided in specialist feeders that exclude all other species). Undertake lethal control with care, especially on well-used sites, and explain to users in advance of any operation.

Range of tools and equipment:
Spiral tree guards are cheap and suited to protecting whips and seedlings from Rabbits.

Tree shelters cost more but extend protection to most livestock and wildlife.

Post and wire fencing is frequently used to exclude domestic stock, but depending on design may not be effective against wild animals.

Electric fencing provides temporary protection: only approved fencing materials should be used for safety and effectiveness reasons. Electric netting should be avoided wherever horned stock are involved or where daily inspections cannot take place.

Only legal commercially available traps should be used for small mammals. Rabbits can be caught in single baited traps or multiple catches can be made in drop-traps located on run lines. Lethal control must be carried out by an experienced person, suitably qualified and insured.

Non-target impact

- Excluding grazing encourages sward development, potentially suppressing regeneration.
- High fencing can cause mortality in Black Grouse and Capercaillie. Where fencing is necessary, it should be made highly visible.
- Fencing can affect landscape and should be sited discretely, avoiding skylines.
- Trapping or shooting may cause secondary disturbance to non-target species, or could be publicly unacceptable.

Health and safety

See Appendix 8.12 for a full discussion of Health & Safety issues.

Environmental

see also Section 5.9.2.

- Avoid soil damage and creation of future erosion gullies when erecting fences.
- Remove old tree guards and re-use elsewhere.
- Collect up wire off-cuts when erecting fences. Do not leave old fencing wire to decay near to watercourses.
- Recharge or remove electric fence unit batteries.

Key sites and contacts

- Aston Rowant NNR,
  Contact: Graham Steven,
  English Nature, Foxhold House, Crookham Common,
  Thatcham, Berks RG19 8EL,
  tel 01635 268881
  e-mail graham.steven@english-nature.org.uk
- Ben Lawers NNR
  Contact: David Mardon,
  The National Trust for Scotland (NTS) Lynedoch,
  Main Street, KILLIN, FK21 8UW
- Brecon Beacons National Park Authority
  Contact: 7 Glamorgan Street, Brecon, Powys
  LD3 7DP.
  tel: 01874 624437
- Peak District National Park Authority
  Contact: Rhodri Thomas,
  Ecology Service,
  Aldern House, Baslow Road, Bakewell, Derbyshire
  DE45 1AE.
  tel: 01629 816 330,
  email: archserv@peakdistrict.org
- Upper Teesdale
  Contact: Chris McCarty,
  English Nature
  tel: 01833 622374,
  email: chris.mccarty@english-nature.org.uk

Advantages and limitations of range available

Method	Advantages	Limitations
Spirals and tubes	• Spirals are reasonably cheap and easy to fit. • Tubes offer better protection. • Microclimate created by tree tubes helps promote growth.	• Large numbers look unsightly. • Spirals only effectively protect against rabbits. • Tubes are more expensive and take a little longer to fit. • Once plants are established, protection needs to be removed (but can be reused). • Tops of plants browsed by cattle ponies or deer. • Saplings can become drought stressed and over-heated in hot dry summers.
Fencing	• Protects individual bushes to large stands. • Protects against all livestock subject to design. • Most components are re-useable.	• Costly to install. • Target species become choked with vegetation unless managed. • Deer fencing can be fatal to some bird species e.g. Grouse, Capercaillie. • Impacts on landscape. • Does not exclude small mammals.
Electric fencing	• Requires less labour to put up than permanent fencing. • Flexible. • Effective short-term measure.	• Expensive to purchase and requires regular inspection. • May be a hazard on public sites • Not effective on wild herbivores.
Livestock reduction and or control of wildlife	• Avoids need for capital outlay on fences. • Reduces pressure on other conservation species.	• Rank vegetation suppresses seedlings. • Difficult to reduce the population of wild herbivores and may need repeat operations as territories are refilled. • Emotive issue. • Requires trained, skilled and certificated/licensed person, with insurance and authorisation.

Further reading and references

Agate, E., (2002), *Tree planting and aftercare*, BTCV

Agate, E., (2002), *Fencing*, BTCV

Bacon, J., Barnes, N., Coleshaw, T., Robinson, T., **Tither, J.**, (2001, 2nd ed), *Practical solutions handbook*, (re Rabbit drop-traps Page 9.1) FACT, English Nature

Bullock, D Collis, P (2000) *Managing deer in parklands* ENACT 8 (3), p 11-14. English Nature

Collis, P (1998), *Deer and fences* ENACT 6 (3) pp6, English Nature

Cooke, A, (1995), *Muntjac damage in woodlands*, ENACT 3 (3), pp 12-14, English Nature

De Nahlik, A J, (1995), *Deer density: is there an ideal?* ENACT 3 (3), pp 4-5, English Nature

Falcon, A (2000) *Gengards – guarding the way towards continuous cover.* ENACT 8 (4), p 16-18. English Nature

Gurnell, J (1999), *Grey squirrels in woodlands*, ENACT 7 (1), pp 10-14, English Nature

Henshilwood, D, Lacey, P, Musgrove, M, Wilson, S (1995) *Deer Problems*. ENACT 3 (3), English Nature

James, N. D. G., (1989) 4th edition, *The Foresters Companion*, Blackwell Press, Oxford & Cambridge

McKinley, R. (1995), *Roe management*, ENACT 3 (3), pp20-22, English Nature

Petley-Jones, R (1995), *Deer or butterflies? A woodland dilemma*, ENACT, 3 (3), pp8-10, English Nature

Poore, A, (1995), *Dealing with deer damage* ENACT, 3 (3), pp15-17, English Nature

Robinson, J (1995), *Deer, Wyre – and wire (low cost deer fencing),* ENACT 3 (3) pp18-19, English Nature

Roworth, P (2002) Whats New? ENACT 10 (2), p 20-21. English Nature

5.8.4 Livestock grazing and browsing

Summary
Grazing and browsing will shape scrub stands effect the balance between scrub and open habitats. Poor grazing management can lead to loss or damage to scrub features and prevention of regeneration.

Applications
May be considered for use in delivering objectives aimed at:
- Enhancement
- Maintenance
- Reduction

Is it a long term solution? No. Whilst grazing, browsing and barking may reduce or kill stems most shrub species will produce new growth from remaining stems/stumps once animals are removed.

Livestock can:
- browse accessible and palatable scrub to maintain or alter stand structure at a finer level than can be achieved with machinery,
- limit scrub encroachment by browsing seedlings, re-growth, and accessible scrub,
- assist scrub expansion by opening the sward for seedling establishment, and by suppressing palatable vegetation that is competing with seedlings, and,
- disperse seeds of scrub species via their coat, hooves and the gut.

There are limitations to using livestock as a management tool:
- Certain shrubs are not palatable to some livestock, so may gain a competitive edge (this is beneficial when they are the conservation priority).
- Excessive browsing damages habitat structure and prevents regeneration.
- They require time and skill to manage.
- Rare species may be vulnerable to grazing.
- Public access may be constrained by livestock.
- Archaeological interest may be damaged.

Cattle grazing willow scrub. Peter Wakely/English Nature

Cattle, sheep, goats, ponies and pigs are all used in scrub management. Each has an array of breeds, which have subtly different dietary and behavioural traits. Age, gender, herd history and dam experience all influence behaviour, and hence their impact on scrub.

This section can only be a brief overview of livestock as a scrub management tool. For further information, read the Grazing Animal Project's Breed Profiles Handbook (2001) or contact the Grazing Animals Project (GAP).

A table of livestock breeds and their grazing/browsing ability is included as Appendix 8.6.

Techniques
Grazing and browsing contribute to achieving a range of management objectives. They will significantly reduce the reliance on labour, plant and herbicides. Most importantly, the behaviour and diet of livestock means that they manipulate scrub and its relationship with other habitats in a way that is much closer to natural processes than can be achieved otherwise.

The type and breed is important as impacts will differ, whilst climate, soil type and surface moisture affect the vigour and palatability of the forage. Breed attributes of hardiness and the ability to digest tough vegetation and convert it into usable energy are important factors.

Enhancement – increase extent:
Grazing can open up dense rank swards to allow shrubs to colonise. For palatable shrubs, it will be necessary to withdraw the stock after they have opened the sward, to prevent them browsing off the young seedlings/saplings.

Hoof marks of grazing animals, especially cattle, can provide small areas of bare ground invaluable as a bare ground resource. (See 5.8.10).

Maintenance:
Grazing and browsing contribute to maintaining or enhancing scrub communities, but additional management is often needed. Browsing contributes to preventing spread of scrub and to maintaining structure, particularly of low growing species.

Browsing pressure can help to develop a dynamic between scrub and open habitat that could be an important feature, replicating natural processes.

Reduction or eradication:
Browsing and grazing pressure seldom kills scrub unless it is old or very tender - it will only be effective if all the foliage is consumed or bark is stripped. Prolonged high stocking may damage the ground flora so should only be used to control scrub where there is no other interest.

Stocking rates for scrub control depend on a number of factors including density, age and species of scrub, livestock type, and alternative forage, so need to be judged case by case. Palatable saplings will easily be eaten back with relatively light browsing whereas much higher stocking densities will be required to reduce mature stands of scrub.

Choice of livestock:
Breed selection is important as is the regime they are managed in. All herbivores are selective in their feeding behaviour to some degree, and stocking rate, vegetation structure and physical conditions influence behaviour. The following should be considered:

- Feeding behaviour varies markedly between the livestock types; in general goats habitually browse, sheep preferentially graze (though some breeds eg Hebridean browse freely), ponies graze, browse and strip bark, cattle for the most part graze but will readily browse growth of the current year, whereas pigs do little grazing or browsing, but root in the soil.
- Modern breeds are generally poor at utilising poor quality forage, so are not good at utilising scrub vegetation.
- Older, traditional, hardy, adapted breeds historically grazed on rough forage tend to maintain condition far better than breeds that are more commercial.
- Behaviour is largely learned; young animals that are run with their experienced dams on site will develop similar attributes.
- The ability to convert poor fodder improves with age of the animal, though then declines with tooth loss.
- Metabolic and energy demands of animals vary throughout the year, and for dams with young. Therefore, different vegetation is sought at different times of year.
- The relative palatability of forage varies through the year. To avoid damage to priority species, grazing should be timed to avoid periods when they are most palatable - unless competitors are more palatable.
- Winter grazing removes thatch and promotes good sward conditions for seedling establishment in spring and summer. Note, however, that bark of some species of tree/shrub is taken in winter.
- Summer grazing will maintain swards; reducing competition around seedlings. It is also the time when foliar browsing takes place.

Stocking densities need to be set with care:
- High densities (grazing at densities well in excess of normal carrying capacity of the land), used for short periods, will effect rapid change, eg opening rank stands or browse off unwanted scrub. Rapid change may be harmful to the associated fauna.
- Lower densities used through the year can suppress scrub colonisation: c0.25 LU/ha/annum largely prevents birch establishment on lowland heathland in the New Forest, but is accompanied by periodic burning.
- At low stocking rates there is enough forage for animals to be selective.
- Schemes that start with low densities can have them increased until the desired effect is achieved, avoiding damage to the interest. Allow enough time to evaluate results before changing regime, as effects can be slow to materialise.

- Fencing can be used to keep livestock to a specific area e.g. for controlling specific scrub problems. Free range grazing across the whole site allows a more natural vegetation structures to develop.

- Location and number of watering points influence grazing pressure, usually with higher impact close to the water point.

Grazing & browsing effects of livestock species
The real factor in the effectiveness of grazing and browsing is the length of time animals are grazing an area and the stocking rate. However, whilst it is realised that all grazing animals eat what they like and leave what they don't, the following observations have been made, though they may vary between sites.

Cattle:
Cattle are relatively unselective grazers, and will take palatable leaves of scrub species. They can trample sensitive vegetation, but will also open pathways through tall, dense stands of scrub to open access to other areas.

Preferred woody species are Ash, Sycamore, Elder and oak. Less favoured species are birch, Alder and thorny shrubs (e.g. Hawthorn).

Sheep:
Sheep are relatively selective in their feeding behaviour and will deftly nibble around anything they do not like. They often have a sweat-tooth for flower heads. In scrub habitats, they will control re-growth and saplings of palatable species through browsing, especially any soft, young summer growth.

Preferred woody species are Ash, Elder and Traveller's Joy. Less favoured species are Alder and oak.

Goats:
Goats preferentially browse heavily, climbing and standing on hind legs to access leaves, with minimal impact on herbs and grasses in the ground layer, though some breeds of goat tend to graze more than others. They strip bark on a number of species including Holly, Ash, Rowan, willow, oak, Hazel, Alder and birch, Elder, Blackthorn, Sycamore and Rose, though are reluctant to take the bark of Hawthorn and Field Maple. Bark stripping usually takes place in winter.

Ponies:
Ponies are primarily grass feeders, but will browse evergreen shrubs and buds of deciduous species in winter and spring, helping to reduce the rate of scrub colonisation onto open habitats. Varying amounts of palatable bark and other woody material are also consumed.

Preferred woody species are Blackthorn, gorse and Holly. Less favoured species are Alder and Hawthorn.

Pigs:
Pigs are not widely used in conservation management. They may have some potential to reduce or eradicate scrub with nutritious or starchy roots, or where there is alternative forage that means they expose roots to desiccation. For example, pigs foraging on Bracken rhizomes in the New Forest exposed Gaultheria and Rhododendron roots. Rooting may create seeding conditions, but the pigs will then need to be removed. Pigs will damage surface vegetation so will not be suitable in areas with important flora.

Wild herbivores:
Wild herbivores can play a key role in managing scrub, though both their activity areas and population numbers are less controllable than domestic livestock, which can be a management problem.

Browsing by deer or Rabbits at high densities can dramatically affect the composition and structure of scrub stands. Where scrub is being controlled or eradicated, they can totally prevent re-growth negating the need for herbicide application or stump removal. At lower densities, they can contribute to the maintenance of rides and glades, and to a lesser extent, perhaps the structure of low scrub stands.

The impact of wild herbivores needs to be assessed when considering the use of domestic livestock; stocking levels may need to be lower than anticipated if Rabbits or deer are contributing to the overall impact. Rabbit grazing pressure fluctuates due to disease cycles (Myxomatosis or Rabbit Haemorraghic Disease) and the impact of lush or sparse grass growth seasons, so rapid response to increase or reduce domestic grazing levels may be necessary. Deer can be encouraged into areas by provision of sheltered glades, though note that this could lead to an overall increase in deer numbers that could conflict with neighbours interests.

Animal welfare
Stock welfare is vital. See the GAP Guide to Animal Welfare in Nature Conservation Grazing appended in the Breed Profiles Handbook. Adequate watering and food supplements should be provided where required. Back-up (or lay-back) grazing will be needed for seasonal regimes and for emergencies. Robust and well-managed fencing and stock handling facilities are needed for stock safety. All animal welfare legislation and insurance requirements must be adhered to.

Supplementary feed other than mineral licks, if required, should not be given on inherently nutrient deficient

habitats, eg lowland heathland, as it can cause nutrient enrichment. Instead, hardier breeds should be used or animals should be removed to back-up grazing land, rather than introduce nutrients into the system.

Non-target impact

- Prolonged high stocking rates will damage grass and herbaceous swards, and can damage the invertebrate fauna by loss of food plants and nectar sources.

- Livestock preferentially browse palatable scrub. This can cause less palatable species to spread, whether desirable or not.

- Uncontrolled poaching of wet ground can cause lasting damage, although, light poaching can beneficially create opportunities for scarce annual plants and invertebrates.

- High stocking in summer can disturb or destroy birds' nests and damage reptile interest, in both open habitats and in the scrub itself.

Health and Safety

See Appendix 8.12 for a full discussion of Health & Safety issues.

Some breeds may be temperamental so should only be used with care, especially where there is public access. Only trained or experienced personnel using appropriate equipment should handle livestock to minimise risk to personnel and stress to the animals.

Environmental

see also Section 5.9.2.

- Minimise use of prophylactic animal treatments where these may enter the environment (e.g. anthelmintics through dung). Consider stock management using organic techniques.

- prevent pollution of watercourses from animal herding/treatment/dipping areas.

- comply with legal requirements for the disposal of dead animals.

- Avoid damage to archaeological and biological interest.

Key sites and contacts

- Aston Rowant NNR,
  Contact: Graham Steven,
  English Nature, Foxhold House, Crookham Common,
  Thatcham, Berks RG19 8EL.
  tel 01635 268881
  e-mail graham.steven@english-nature.org.uk

- Beds, Cambs, Northants and P'boro Wildlife Trust
  Contact: Andy Fleckney,
  Priory Country Park, Barkers Lane, Bedford MK41 9SH.
  tel: 01234 364213,
  e-mail: afleckney@bedswt.cix.co.uk

- English Nature
  Contact: Clare Trinder,
  Manor Barn, Overhaddon, Bakewell, DE45 1JE.
  tel: 01629 815 095

- Hampshire Downs & New Forest.
  Contact: Phil Marshall,
  NT Mottisfont, Romsey, Hants. SO5 OLP.
  Tel: 01794 340757.
  email: philip.marshall@nationaltrust.org.uk

- Latterbarrow, Cumbria.
  Contact: John Dunbavin
  e-mail: johnd@cumbriawildlifetrust.org.uk

- Martin Down NNR.
  Contact: David Burton,
  English Nature, Cherry Lodge, Shrewton, Salisbury.
  Wilts. SP3 4ET.
  tel: 01980 620485.
  email: david.burton@english-nature.org.uk

- Mendips & Cheddar,
  Contact: Adrian Woodhall,
  National Trust, Barton Rocks, Winscombe, Somerset
  BS25 1DU.
  tel: 01934 844518.
  email: adrian.woodhal@nationaltrust.org.uk

- Nottinghamshire Wildlife Trust (various reserves),
  Contact: Jeremy Fraser
  The Old Ragged School, Brook Street, Nottingham,
  NG1 1EA.
  tel: 0115-958-8242,
  email: jfraser@nottswt.cix.co.uk

- Peak District National Park Authority
  Contact: Rhodri Thomas, Ecology Service,
  Aldern House, Baslow Road, Bakewell, Derbyshire
  DE45 1AE.
  tel: 01629 816 330,
  email: archserv@peakdistrict.org

- South Devon Coast.
  Contact: Mike Ingram,
  National Trust. Higher Brownstone, Kingswear,
  Dartmouth, Devon. TQ6 OEK.
  tel: 01803 752776.
  email: mike.ingram@nationaltrust.org.uk

Advantages & Limitations of livestock types

Method	Advantages	Limitations
Cattle	• Create varied structure with tussocks. • Light trampling has value for invertebrates. • Create pathways through scrub. • Browse a wide range of woody species. • Mature animals and hardy breeds cope with poor diet. • Random dunging prevents localised nutrification.	• Current 30 months limit of animals destined for human food (may be removed 2003/4), livestock movements restrictions and TB testing. • Grazers rather than browsers. • Excess trampling can damage interest. • Modern breeds do badly on poor forage. • Target more palatable areas. • Damage archaeological features, especially earth banks.
Sheep	• Easy access to open scrub. • Good at controlling re-growth of palatable species. • Good dispersal to all areas of site. • Random dunging in day time prevents localised nutrification – (but see opposite).	• Intensive grazing creates very even sward structure. • Cannot move through dense scrub and get caught by wool on thorny vegetation. • Prefer herbage to foliage. • Varying browse ability between sexes and ages. • Dung accumulates at night-time lying-up places causing localised nutrification.
Goats	• Habitual browsers. • Agile; can access remote areas and browse. • Long lived and age well. • Readily bark strip particularly billies.	• Require dry shelter. • Billies have solitary wandering tendencies. • Bark-strip potentially desirable species. • Prefer drier conditions.
Ponies	• In extensive systems, create a mosaic of structure. • Tend to avoid flowering plants. • Adaptable foragers; readily browse. • Limit scrub encroachment. • Free range so more even targeting of forage.	• Take many grasses with browse. • Feed selectively; may need to combine with other types. • Young and old animals less suited to tough vegetation. • Some breeds not hardy. • May damage archaeological features, especially earth banks.
Pigs	• Eat palatable shrub roots. • Can help to control species with palatable roots e.g. Privet, Dog Wood, Rhododendron, Gaultheria. • Temporary use encourages scrub expansion where acceptable.	• Limited access to foliage. • Rooting can damage desired species. • May damage archaeological features and are rarely suitable.

- The National Trust
  Contact: John Hooson,
  The Hollens, Grasmere, Ambleside, Cumbria.
  tel: 015394 35599,
  email: john.hooson@nationaltrust.org.uk

- Surrey Downs.
  Contact: David Kennington,
  National Trust, Warren Farm Barns, Headley Lane, Micklesham, Dorking, Surrey. RH5 6DG.
  tel: 01372 220640
  email: david.kennington@nationaltrust.org.uk

- Therfield Heath, Hertfordshire
  Contact: Eoin Bell,
  Herts County Council
  tel: 01922 555279,
  email: eion.bell@hertscc.gov.uk

- WDC Countryside Service
  Contact: Andy Glencross,
  Dinton Pastures Country Park, Davis Street, Hurst,
  Reading RG10 OTH.
  tel: 0118 934 2016
  email: andyglencross@wokingham.gov.uk

- Westhay Moor NNR
  Contact: Kiff Hancock,
  Somerset Wildlife Trust.
  tel: 01823 451587
  email: chancock@somwt.cix.co.uk

- Wicken Fen, Cambs,
  Contact: Martin Lester,
  National Trust, Lode Lane, Wicken, Ely, Cambs.
  CB7 5XP.
  tel: 01353 720274.
  email: martin.lester@nationaltrust.org.uk

Further reading and references

Bacon, J, Oates, M, Tolhurst, S (2000) *Getting up close to grazing* ENACT 8 (2), p 13-15. English Nature.

Bowley, A., (1994), *Grazing the flatlands*, ENACT 2 (4) pp15-17, English Nature.

Breeds, J. & Rogers, D., (1998), *Dune management without grazing - a cautionary tale*, ENACT 6 (1), pp 19-22, English Nature.

Bullock, D Collis, P (2000) *Managing deer in parklands* ENACT 8 (3), p 11-14. English Nature.

Bullock, D. J., Kinnear, P.K., (1997), *The use of goats to control scrub in Tentsmuir Point National Nature Reserve, Fife: a pilot study*. Trans. Bot. Sco. Edinb., 45, 131-139.

Bullock, D., (1995), *The feral goat – Conservation and management*. British Wildlife 6 (3) pp152-159.

Elliott, B & Burton, D, (1994) *Longhorns – a natural choice (Parsonage Down)* ENACT 2 (4), p 12-14. English Nature.

Grayson, F W, (1997), *Does conservation farming work?* ENACT 5 (4) pp 19-22, English Nature.

Graham, S; Alexander, I and Nicholson, A, (1997), *Return of the heathcroppers* ENACT 5 (2), pp 4-7 English Nature.

Henshilwood, D, Lacey, P, Musgrove, M, Wilson, S (1994) *The grazing animal*. ENACT 2 (4), English Nature.

Henshilwood, D, Lacey, P, Roworth, P, Wilson, S (eds) (1997) *Special issue*: Rare breeds and conservation management. ENACT 5 (4), English Nature.

Kampf, H., (2000), *The role of large grazing animals in nature conservation – a Dutch perspective*. British Wildlife 12 (1) pp 37-46.

Kennedy, D, (1998), *Rooting for regeneration*, ENACT 6 (4) pp4-7, English Nature.

Lake, S., Bullock, J. M., Hartley, S., (2001) *Impacts of Grazing on Lowland Heathland in the UK – A report to English Nature*. English Nature unpublished report. English Nature, Peterborough.

Oates, M., (1994), *Harness horses for conservation*, ENACT 2 (4) pp9-11, English Nature.

Oates, M and Bullock D (1997), *Browsers and grazers (merits of using goats and ponies)*. ENACT 5 (4) pp15-18, English Nature.

Oates, M., Tolhurst, S., (2000), *Comment – Grazing for nature conservation: rising to the challenge*. British Wildlife 11 (5) pp 348-353.

Offer, D., Edwards, M., Edgar, P., (2003) *Grazing impact assessment for heathland invertebrates and reptiles*. English Nature Research Report no 497. Peterborough.

Oliver, P (1995): *Goats instead of chainsaws: is this the way forward?* The National Trust Views 24,15.

Read, H J, (1994) *Native breeds in Burnham Beeches*, ENACT 2 (4) pp 4-6, English Nature.

Tolhurst, S., (1994), *Flying the flock*, ENACT 2 (4) pp18-20, English Nature.

Tolhurst S. (Ed) (2001), *A Guide to Animal Welfare in Nature Conservation Grazing*. GAP, English Nature.

Tolhurst, S., Oates, M., (2001), *The Breed Profiles Handbook*, GAP, FACT, English Nature.

Tutton, T., (1994), *Goats versus Holm Oak*, ENACT 2 (1) pp 8-9, English Nature.

Wilkinson, B (2000) *From mowing to grazing – the control of scrub at Little Scrubs Meadow*. ENACT 8 (2), p 16-18. English Nature.

5.8.5 Coppicing and thinning

Summary
Coppicing is a traditional method of woodland management that is equally applicable to managing scrub; standing growth is harvested on a rotation over several years, and allowed to regenerate. It can be adopted to manage scrub to rejuvenate stands. Coups or areas are usually coppiced rather than individual stools. Thinning involves either the selective removal of individual trees to create a more open structure to a stand, or the selective cutting of stems from individual stools.

Applications
May be considered for use in delivering objectives aimed at:
- Enhancement
- Maintenance

Is it a long term solution? No. Coppicing needs to be repeated at appropriate intervals. There may be problems with economic sustainability.

Techniques
Coppicing:
Areas or coups of scrub have shrubs cut close to ground level by bow saw, chainsaw or clearing saw (see 5.9). The majority of species regenerate from the stool, sending up multiple new shoots. Some species, for example Beech, are less likely to regenerate after coppicing. Refer to 'Growth Characteristics' in the species profiles (Section 4) for more detail.

Coppicing can be used to:
- rejuvenate old scrub stands,
- diversify homogenous scrub or,
- maintain existing scrub stands,
- generate dense scrub cover (e.g. for birds).

Coppicing long abandoned stands may result in poor stool regeneration. Where this is small scale and patchy it can create a diverse structure; but where it is widespread planting or layering may be needed to infill.

Coppicing is based on cutting blocks annually, or periodically. Advance planning will help achieve a diversity of age and structure: adjacent coups should be cut sequentially to allow movement or colonisation. However,

Coppicing. David Sheppard/English Nature

where the mobility of species is not an issue, it may be preferable to avoid sequential cutting as this may reduce or remove the ecological continuity important to slower growing or colonising species. For example, rare epiphytes may be permanently lost through sequentially cutting, as there would be no old growth to support them.

Stands can be divided into small coups. Smaller coups create hot sheltered microclimates provided shade from trees in adjacent uncut coups does not over-shadow. They are easily re-colonised by less mobile wildlife and contribute to high structural diversity in the stand.

A coppice rotation is often between seven and fifteen years (depending on growth rate of the species involved) and ideally, one or more coups are cut each year.

Consider leaving a few bushes to mature to increase diversity. Too many will increase shading, remove or ring bark bushes if they compromise the interest.

Stands can easily be maintained by coppicing: coups are mapped and given a year in the rotation. Browsing can prevent coppice regeneration in palatable species. Where this is an issue, then consider protective measures (see 5.8.3). Small isolated stands of a few bushes may be vulnerable to browsing so will need monitoring and if necessary be fenced.

Thinning:
Thinning involves cutting selected bushes to ground level; the intention is usually to prevent regeneration so that the stand has a more open structure and or shrubs can grow unimpeded to fill the gap. Selective thinning of stems is useful in managing crowded stands where dappled shade and a humid microclimate are required and for retaining ecological continuity, for example where there is a good epiphyte community. Ring barking is useful as there are no arisings to deal with and it creates standing dead wood (see 5.8.9). The scale of thinning will depend upon the objectives.

Thinning can be used to:
- create diversity in age and structure,
- create open conditions for natural regeneration, eg Juniper or Dwarf Birch,
- create open conditions to suite flora or fauna priorities.

Even aged Elm suckers may be thinned to create a self-sustaining multi-aged structure.

Box may be thinned to reduce humidity. This is a technique currently being trialled at Box Hill to minimise the risk of fungal attack by *Cylindrocladium*.

Disposal of arisings
- Coppicing produces large volumes of arisings. Some, where possible, should be stacked on site to provide dead wood habitat and shelter, the remainder will need to be removed from site or burnt (see 5.9.1). Note that some coppice materials have a market, eg sheep hurdles, horse jumps, pea sticks etc.
- Where browsing is a risk cut material can be placed over cut stools to deter browsing animals.

Non-target impact
- Habitat restructuring will cause temporary displacement of wildlife species. Note that it also provides opportunities for other species, and measures can be taken to offset impact (eg coup shape and width).
- Where certain species or assemblages of species with specialised needs are known to occur, consult with the appropriate authority to ensure correct management.

Environmental
see also Section 5.9.2.
- Time extraction of products to minimise compaction or rutting of soils.
- Avoid coppicing during breeding season (April – August inclusive for most species).

Advantages & limitations of coppicing and thinning

Method	Advantages	Limitations
Coppicing	• Creates and maintains diversity and structure of scrub stands. • Supports a wider range of species. • Supports open glade species where ride management is not achievable. • Prolongs life of individual stools.	• Creates large amount of arisings. • High labour requirement so can be expensive. • Reduced production of large timber.
Thinning	• Creates more open structure of scrub stands. • Suits species requiring some shade and humidity. • Can provide a regular income.	• Creates large amount of arisings. • Access may be difficult amongst standing trees. (But see mini-forwarders). • Less output per man-hour than clear felling.

Key sites and contacts

- Aston Rowant NNR,
  Contact: Graham Steven,
  English Nature, Foxhold House, Crookham Common,
  Thatcham, Berks RG19 8EL,
  tel: 01635 268881
  e-mail: graham.steven@english-nature.org.uk

- Catherington Lith,
  Contact: Martin Healey
  East Hampshire District Council, Penns Place,
  Petersfield. GU31 4EX
  tel: 01730 234386
  e-mail: Martin_Healey@easthants.gov.uk

- Beds, Cambs, Northants and P'boro Wildlife Trust
  Contact: Andy Fleckney,
  Priory Country Park,
  Barkers Lane, Bedford MK41 9SH
  tel: 01234 364213,
  e-mail: afleckney@bedswt.cix.co.uk

- Kent High Weald Project
  Contact: Keith Rennells,
  Council Offices, High Street, Cranbrook, Kent,
  TN17 3EN.
  tel: 01580 715918,
  email: keith.rennells@kent.gov.uk

- Martin Down NNR (Kitts Grave).
  Contact: David Burton,
  English Nature, Cherry Lodge, Shrewton, Salisbury.
  Wilts. SP3 4ET.
  tel: 01980 620485.
  email: david.burton@english-nature.org.uk

- Nottinghamshire Wildlife Trust (various reserves),
  Contact: Jeremy Fraser
  The Old Ragged School, Brook Street, Nottingham,
  NG1 1EA.
  tel: 0115-958-8242,
  email: jfraser@nottswt.cix.co.uk

- Therfield Heath, Hertfordshire
  Contact: Eoin Bell,
  Herts County Council
  tel: 01922 555279,
  email: eion.bell@hertscc.gov.uk

Further reading and references

Bacon, J., Lord, B (1996) *Troublesome trees, taking trees off bogs*. ENACT 4 (3), pp 12-16 English Nature.
Fuller, R. J., Warren, M S., (1990), *Coppiced woodlands: their management for wildlife*, NCC.
Harmer, K., (1999) *Charcoal burning at Combs Wood* ENACT 7 (1), pp 4-6, English Nature.
Howe, J., (1993) *Restoring coppices in Hampshire* ENACT 1 (1), pp 15-16 English Nature.
James, N. D. G., (1989) 4th edition, *The Foresters Companion*, Blackwell Press, Oxford & Cambridge.
Kirby, P., (2001): *Habitat Management for Invertebrates: a practical handbook*. RSPB, Peterborough.
Smith, G., (1996) *Conifers to coppice* ENACT 4 (1), pp 4-5. English Nature.
Warren, M. S., Fuller, R J., (1990) *Woodland rides and glades: their management for wildlife*, NCC.

5.8.6 Mowing & flailing

Summary
Mowing usually refers to the cutting of herbs and grasses; this is likely to include the front edge of colonising scrub. In scrub management terms it can also include mowing of young developing scrub and bramble.

Flailing can remove competing vegetation to allow colonisation; maintain open ground habitats such as rides and glades and perpetuate the building stage of scrub with a short rotation mowing programme; cut down the early stages of scrub colonisation, or to prepare growth for eradication by herbicides.

Mowing can take place at any scale from hand scything to heavy-duty tractor mounted flails and disc mowers.

Applications
May be considered for use in delivering objectives aimed at:
- Enhancement
- Maintenance
- Reduction
- Eradication

Is it a long term solution? No. Operations need to be repeated at least annually and sometimes many times annually as scrub will continue to re-grow.

Techniques
Mowing can be used as a technique to achieve any or a combination of the following objectives:

Enhance:
- To remove competing vegetation to provide conditions that will allow colonisation.

- To diversify young scrub.

Maintain:
The frequency of mowing depends on the management objective:
- Edges, rides and glades may, depending on growth rate of forbs and grasses, need annual mowing, done at the end of summer to ensure that seeds have set. Where growth is less mowing can be done as required in alternate years or less frequently.

- Maintain the grass edges, rides and glades between stands of scrub.

Saw blade maintaining sunny aspect. John Bacon/English Nature

- Pathways may need to be cut several times in the growing season.

- Some species, e.g. Blackthorn increase suckering intensity in response to mowing. Repeated mowing is required throughout the growing season to keep it from extending.

- Arisings should be collected and removed to prevent soil enrichment and smothering.

Reduce:
- To cut down scrub that is encroaching on other habitats.

- To contribute to reduction of scrub that compromises associated priority habitats.

- To contribute to the reduction of undesirable non-native species.

Eradicate:
- mowing can be used to encourage uniform re-growth,

which can then be killed with herbicide application by weed-wipe (see sections 5.8.16 & 5.9.4.4).

- Careful timing of repeat mowing can be used to allow a competitive advantage of desired species; o,r to exhaust re-growth (e.g. bramble has been recorded as vulnerable to repeat mowing in summer).

Range of tools and equipment
The tools used for mowing in and among scrub are reviewed in 5.9.4. Use of an appropriate blade type can be important.

Hand cutting by scythe is practical for smaller areas of herbaceous grassy vegetation. Motorised reciprocating blade mowers have the same effect and so do strimmers but the arisings are less useful as a seed source. Pedestrian mowers can be used to cut smaller areas of grassy sward with a proportion of young regenerating scrub, and to maintain the edges to rides and glades where livestock cannot be used.

Large areas are clearly best done with tractor-mounted mowers that have high work rates.

Older growth is generally too tough for disc mowers, so requires a flail, which is more robust and pulverises stems. Slow passes over the scrub will have most effect. Re-growth from pulverised stems is normally slower than from disc mowers.

Terrain influences the type of flail used. Machines mounted on the front or rear of a tractor suit most conditions. Flails mounted on telescopic arms can reach scrub on very steep banks or on the other side of ditches.

For mature and semi mature stands see 'Cutting' (Section 5.8.13).

Disposal of arisings (see 5.9.1)
Mowing grassy areas will produce moderate volumes of arisings. It may not be necessary to remove them especially if scrub is wanted back. Options for dealing with them where required are:

- Dry grass is easily windrowed by hand or hay-tedding machinery.

- Arisings that lack woody stems can be removed as a hay crop, which could if it contains seed be used to establish or augment herb rich grassland elsewhere.

- Mini-balers can be used to collect up and bale arisings for hay or disposal.

- Burning of windrows or dry heaps may be an option.

- 'Cut and collect' machines or forage harvesters can be very effective.

Non-target impact
- Routine mowing incurs little risk to birds if done after the breeding season (April to August inclusive for most species).

- The impact on other fauna (e.g. invertebrates or small mammals) may be considerable at any time of the year.

Health and safety
See Appendix 8.12 for a full discussion of Health & Safety issues. Those specific to mowing should include:
- Backache and back strain is commonly associated with hand tools or pedestrian mowers.

- Blunt blades and prolonged use without breaks can lead to Raynaud's Disease (white finger).

Environmental
see also Section 5.9.2.
- Ensure arisings do not give rise to harmful leachates.

- Take care with fuels and fuel oils.

- Use low ground pressure equipment where appropriate.

Tools used for mowing in and among scrub

Tool type	Range	Use
Non-powered hand tools	Grass hook. Scythe.	Small areas, where vulnerable species occur.
Powered hand tools	Strimmer. Pedestrian reciprocating blade mowers. Pedestrian rotary mowers. Pedestrian flail mowers.	Small to medium areas of young scrub.
PTO and hydraulic powered tools	Rotary brush cutters. Flails. Cut and collect / forage harvester type flails.	Medium to large areas with young to medium scrub.

Advantages & limitations of mowing

Method	Advantages	Limitations
Non-powered hand tools	• Allows selectivity. • No fuel emissions through machinery use. • Quieter, no machine noise. • Easy access to difficult sites.	• Very slow work rate. • Suitable only on very small areas.
Powered hand tools	• Allows selectivity. • Faster and more efficient. • Can clear large areas with minimal effort. • Easily access difficult sites.	• Noise and fuel emissions. • Many machines require specialised training and certification for use. • May require large labour force to clear arisings?
PTO/hydraulic powered machines	• Fast and efficient. • Can clear large areas with minimal effort. • Usually requires only one operative. • Allow the bulk collection of arisings using 'cut & collect' machines / forage harvesters.	• May be difficult to access some sites. • Noise and fuel emissions. • Many machines require specialised training and certification for use. • May require large labour force to clear arisings? • Risk of compaction and rutting damage from heavy machines.

Key sites and contacts:

- Hampshire Downs & New Forest.
  Contact: Phil Marshall,
  NT Mottisfont, Romsey, Hants. SO5 OLP.
  tel: 01794 340757.
  email: philip.marshall@nationaltrust.org.uk

- Martin Down NNR.
  Contact: David Burton,
  English Nature, Cherry Lodge, Shrewton, Salisbury.
  Wilts. SP3 4ET.
  tel: 01980 620485.
  email: david.burton@english-nature.org.uk

Further reading and references

Bacon J., Harris S., Southwood R., (1997) *Making hay in a small way*. Enact 5 (2) 8-11. English Nature.
Bacon, J., (1996) *Tussling with turves – a review of turf stripping techniques*. Enact (4) 2 pp12-16.
Breeds, J. & **Rogers, D.**, (1998), *Dune management without grazing - a cautionary tale*, ENACT 6 (1), pp 19-22, English Nature.
Dagley, J., Thompson, K., (2000), *Mowing machines for grazing pastures at Epping Forest*. ENACT 8 (1), p 4-6. English Nature.
Nobes, S., (1996) *Flail cutter and collector* ENACT 4 (2) pp 17, English Nature.
Porter, K., (1994), *Seed harvesting – a hay meadow dilemma*. ENACT, 2 (1), pp 4-5, English Nature.
Robinson, T., (2001), *Options for seed harvesting techniques – Part one* ENACT 9 (4) pp 4-8, English Nature.
Robinson, T., (2001), *Options for seed harvesting techniques – Part two* ENACT 10 (1) pp 4-8, English Nature.
Roworth, P., (1998) AEBI Hydrocut HC55 Mower ENACT 6 (3), p 10. English Nature.
Roworth, P., (2002) *Whats New?* ENACT 10 (2), p 20-21. English Nature.
Roworth, P., (2002) *Whats New?* ENACT 10 (4), p 22. English Nature.
Rowarth, P., & **Newlands, C** (2000) *Managing the 'roughs' at Lindrick Golf Course in South Yorkshire* ENACT 8 (1), pp 16-17. English Nature.
Wilkinson, B., (2000) From mowing to grazing – the control of scrub at Little Scrubs Meadow. ENACT 8 (2), p 16-18. English Nature.

5.8.7 Controlled burning

Summary
Fire has been used as a land management tool since pre-history – especially for gorse. Not all scrub is readily flammable by any means – (scrub will only burn if there is enough dry, combustible material particularly close to the ground) - but fire will remove rank vegetation and encourage seed germination, set back successional processes, help remove nutrients or eliminate fire intolerant species. Frequent use of fire will permanently alter the vegetation in favour of fire tolerant species.

Fire is potentially dangerous and should only be used by experienced staff after careful evaluation on site of the risks. The timing and frequency of burning is important. Burning should only take place during the winter when favourable conditions occur after a dry period but while the soil surface is moist.

Applications
May be considered for use in delivering objectives aimed at:
- Enhancement
- Maintenance
- Reduction
- Eradication

Is it a long term solution? No (though there may be exceptions with a very hot burn). Burning needs to be repeated at intervals appropriate to the site to remove re-grown or re-colonised shrubs.

Techniques
Burning can be effective if it is applied carefully. Negative impacts on small mammals, molluscs and invertebrates may be outweighed by longer-term benefits. However, only certain species of shrub are readily flammable, others are therefore not readily managed by fire.

The objective of burning grass or scrub is to remove much – or all - of the standing vegetation and accumulated humus litter, but to leave the rootstock and seed bank intact. A hot burn that moves slowly forward will achieve this as very high temperatures affect a particular area for only a short period (seconds). Making the fire burn against the wind achieves this and gives good control of the fire as there is 'nowhere for the fire to run'. Burning can be used as a technique to achieve any or a combination of the following objectives.

Burning gorse near Hay Tor, Dartmoor. Paul Glendell/English Nature

Enhancement:
By burning off grass thatch, rank vegetation or scrub so creating good conditions for shrub seed germination. Burning mature scrub stands needs to be done with care. Burning readily flammable shrubs has the same effect as coppicing, and, assuming the roots survive will re-invigorate growth.

Maintenance:
Setting back successional processes and removal of nutrients during burning can help restore open habitat and scrub mosaics. The large volume of flammable material will be a risk so careful preparation and management of the fire are needed. Grazing livestock are attracted to recent burns by the flush of new growth, so it may be necessary to remove stock where there is a risk that they will target the scrub.

Growth rates of the shrubs will influence the frequency of burns, which is in turn dependent on the soil conditions and the grazing regime. Hence, the condition of the scrub rather than a timetable, should determine burning frequency.

Too frequent burning can permanently alter the plant community in favour of fire tolerant species. If the intention is to maintain open habitats by controlling succession then less frequent burns are possible especially when the site is maintained by grazing.

Reduction:
Following up burns with grazing and extending the period between burns will slow down or prevent re-colonisation by shrubs.

Eradication:
Burns of fire intolerant shrubs can be used to eradicate them if followed up by management operations to kill any surviving rootstock.

Size of burn:
There is no fast rule: it will depend on purpose and size of the management area. Burning small areas will allow re-colonisation from the edges by species with low mobility as the habitat becomes suitable again. Small burns enhance structural diversity; this is not so important on larger areas though the advantage of mosaics remain for large sites. It is feasible to burn patches in excess of 1 ha but 0.25 ha is more manageable, effective and relatively safe. Very small burns (of a few square metres) will only be successful if the temperature gets high enough for complete combustion. The effort to prepare very small patches is much greater for the area burnt.

Large burns may lead to the future development of extensive areas of even-aged scrub with little structural diversity as happens with 'wild' fires.

Other mechanisms:
Rank vegetation prevents seed germination of priority species such as Juniper, which rely on bare earth for germination. However, Juniper plants are vulnerable to fire, so burning off thatch may damage the interest. If machinery access is difficult it may be possible to carry out very small scale burns to remove thatch from discrete areas, using a flame gun or weed burner.

Avoiding vulnerable species:
Certain shrubs, including Juniper are killed by fire, and less mobile wildlife is vulnerable. Knowing the distribution of vulnerable species is therefore important.

Dormant plants, and invertebrates (and to some extent reptiles), that over winter underground will usually survive a small burn in suitable conditions. Bryophytes and lichens can survive in wet soil surface conditions.

Timing:
Burning between 31 March and 1 November is illegal and damages wildlife interest.

Some reptiles emerge before the end of March and birds can start to nest early.

For good combustion with minimal damage to the soil and dormant species a period of drying weather in late winter (February or early March), which dries the standing vegetation but not the soil surface can be ideal. If weather and ground conditions are suitable, burning can be done in late autumn or early winter instead.

Range of tools and equipment

- Deploy sufficient, trained personnel, equipped with beaters.
- Provide water bowsers with pressure hoses or a fogging/foaming machine for controlling edges and damping down after the burn.
- Knapsacks or lances from a water bowser fitted with special jet nozzles are ideal for damping down hot spots.

Health & Safety
See Appendix 8.12 for a full discussion of Health & Safety issues. Those specific to burning should include:

Safety is paramount; burning large old stands of highly flammable species like gorse can have serious consequences for the safety of public and property, and for the wildlife in and around the scrub. The following should help to minimise risks:

- Cut a firebreak around the burn area. A five-metre break should be adequate, though it may need to be wider downwind.
- Burn in light winds that blow against the direction of the burn, when the vegetation is dry enough to give a clean burn.
- Be prepared for fierce burns creating their own draft and winds.
- Inform the local fire service control centre before the burn and again when finished.
- Inform neighbours well in advance of intended burn periods.
- Prevent public access to the burn locality.
- Deploy sufficient, trained personnel, equipped with beaters; five people should be able to manage a quarter-hectare gorse burn. The burn and personnel should be managed by an experienced person.
- Start at the downwind end of the patch, against a firebreak. Make the fire work into the wind, and prevent lateral creeping. As the fire progresses, the burnt area will buffer the downwind areas from risk.

- Damp down any hot spots.
- Re-visit the burn site before nightfall to check for and extinguish hot spots.
- Do not take risks.

Non-target impact
The following are some examples of vulnerable wildlife likely to be affected by burning:
- Localised populations of animals with low mobility and which depend on mature vegetation, including some invertebrates and reptiles.
- Scarce, localised plants that are intolerant of burning eg: Dwarf Birch, Dwarf Willow and Juniper.
- Seed banks and rootstock when the soil is dry.
- Neighbouring houses and roads.

Environmental
see also Section 5.9.2.
- Burn in good conditions to reduce smoke.
- Obtain 'damping down' water from a source (e.g. mains/fire hydrant) that will not affect the survival of wildlife (i.e. do not drain small ponds).
- Do not burn areas where subsequent erosion may occur.

Advantages and limitations of burning

Advantages	Limitations
• It is cheap and quick relative to other options. • It is efficient at removing the standing crop and at least some of the accumulated litter. • Effective at removing grass thatch for seed germination. • It is effective on rough terrain.	• Difficult to programme work as reliant on suitable weather conditions. • Several shrub species are not flammable. • Many habitats and plants are vulnerable in dry conditions. • Wildlife with limited dispersal ability, such as reptiles, invertebrates, molluscs and small mammals, are at risk. • Requires a team of trained and experienced staff. • Requires availability of fire control and damping down equipment. • May be unpopular with local residents. • In urban locations, it is possible that managed burns can increase the incidence of arson through copycat action.

Key sites and contacts
- Arne, RSPB
  Contact: Neil Gartshore,
  Syldata, Arne, Wareham, Dorset, BH20 5BJ
  tel: 01929 553360,
  email: neil.gartshore@rspb.org.uk
- Mendips & Cheddar,
  Contact: Adrian Woodhall,
  National Trust, Barton Rocks, Winscombe, Somerset BS25 1DU.
  tel: 01934 844518.
  email: adrian.woodhal@nationaltrust.org.uk
- Stiperstones NNR – Contact: Tom Wall, C/o English Nature, Attingham Park, Shrewsbury, Shropshire. SY4 4TW.
  tel: 01743 282000.
  email: tom.wall @english-nature.org.uk
- West Exmoor Coast.
  Contact: Lucy Morton,
  Hunters Lodge, Hunters Inn, Parracombe, Barnstable, Devon. EX31 4PY
  Tel: 01598 763306.
  email: lucy.morton@nationaltrust.org.uk
- We are looking for more examples!

Further reading and references

Breeds, J. & Rogers, D., (1998), *Dune management without grazing - a cautionary tale*, ENACT 6 (1), pp 19-22, English Nature.

MAFF (1992) *The Heather and Grass Burning Code*. MAFF, London.

Rhind, P. & Sandison, W., (1999) *Burning the Warren – management of dune grasslands* ENACT 7 (4) pp 7-9, English Nature.

5.8.8 Edge, glade and ride management

Summary
Rides and glades within scrub stands add diversity and provide opportunities for flora and fauna of both scrub and associated open habitats. Clear objectives need to be set based on survey and monitoring of key species.

They offer shelter with potentially hot microclimates that can support species that cannot survive in open, cooler windswept areas. Graded edges of stands increase the area of foliage, and present flowers often in sheltered sunny situations that suit nectar-feeding insects. Increasing the length of edge increases opportunities for foraging wildlife.

Glades and rides can be created relatively easily and careful planning of rotational management can help to develop edge features to produce rides and glades of varying width and age structure.

Applications
May be considered for use in delivering objectives aimed at:
- Enhancement
- Maintenance

Is it a long term solution? No. Requires continue repeat operations determined by growth rate of shrubs.

Techniques
The interfaces between the edge of stands of scrub and open habitat are often rich in food resources such as flowers and fruits and provide a complex vegetation structure not found within the middle of the stand.

Edge, glade and ride management can be used to achieve any or a combination of the following objectives

Enhancement:
Creation of rides and management of existing rides can enhance the opportunities for wildlife. The shape of rides glades and edges influences the microclimate, while the structure of the vegetation influences the opportunities for wildlife to forage.

Maintenance:
Careful rotational planning of routine maintenance operations will ensure continued availability of a wide range of conditions and niches suitable to maintain the life cycles of the species present.

Managed rides at Monks Wood NNR. Peter Wakely/English Nature

Shade and wind effects:
Sunlight and shelter from wind are important, so minimising the amount of shaded edge is beneficial: shape the route of rides in relation to the direction of sunlight. The south side of east-west rides will always be in shade, whereas both sides of north-south rides will catch the sun for part of the day. Rides that are less than 1.5 times wider than the height of the adjacent scrub will suffer undue shading.

Straight routes can funnel wind affecting the suntrap microclimate as wind reduces temperature and humidity. Open ends to rides also funnel wind, especially when facing prevailing winds. Wind funnelling can be reduced by scalloping edges to rides and making them discontinuous.

Glades can be created anywhere, but being connected with ride systems helps movement of species, especially insects. They can be incorporated at intersections by removing the corners of the rides to open the space. A convoluted edge will add diversity.

Ride edge diversity:
Grassy rides with a simple interface with the scrub edge have a value for wildlife, but a diverse interface can enhance its value. For example, the ride centre could be cut every year or two to maintain grassy or herbaceous vegetation, whereas the edges could be cut on a longer rotation (eg 3-7 years) to encourage a dense thicket to develop. Cutting bramble and shrub vegetation at the edges of rides at varying angles to the vertical can increase the angle to the sun and overall surface area.

It may be inappropriate to cut rides through small scrub stands but these may nonetheless benefit from sensitive management of the edges to create diversity.

Rotational management:
Edges, rides and glades should be maintained in rotation, to create a dynamic continuum of successional stages.

Depending on the size of site and objectives, ride management rotations may range from annually up to 12 years. Herbaceous vegetation may need mowing annually (or every other year). Low marginal scrub will be cut on a rotation of up to 12 years depending on growth rates.

Range of tools and equipment
Rides, glades and edges within scrub can be created in established scrub by cutting or can be incorporated into new areas and maintained by mowing or flailing

The grass and herbaceous elements of rides and glades can be maintained by mowing (and ideally collecting arisings). The edges of these will need to be coppiced with saws or a heavy-duty flail with collector.

Refer to Section 5.9.4 for more detail.

Disposal of arisings
See Section 5.9.1. Creating edges, rides and glades will give rise to a relatively large amount of arisings. Maintenance will only give rise to relatively small volumes. A proportion of these can be left in dappled shade to decay and benefit other wildlife.

Non-target impact
- Survey prior to creating or widening rides and glades for the presence of important epiphytic or invertebrate communities.
- Adhere to management calendar to avoid impact on breeding or hibernating wildlife.
- Do not allow arisings to smother ground vegetation.

Environmental
see also Section 5.9.2.
- Carry out management in weather conditions and with equipment that will not cause unacceptable rutting damage.
- Tale care not to spill fuels and oils.
- Do not leave arisings where leachates may enter water sources.

Key sites and contacts
- Aston Rowant NNR,
  Contact: Graham Steven,
  English Nature, Foxhold House, Crookham Common,
  Thatcham, Berks RG19 8EL,
  tel 01635 268881
  e-mail graham.steven@english-nature.org.uk
- Blean Woods NNR, C/o English Nature, Wye, Ashford, Kent.
  tel: 01233 812525.
- Bentley Wood, Wiltshire, Bentley Wood Trust.
  Contact: David Gore Browne (Trustee),
  Hale Farm, Hale, near Fordingbridge, Hants SP6 2RD
  tel: 01725 512419
  email: gorebrowne@aol.com

  David Lambert (on-site Warden tel: 07968 340717)
- Monks Wood NNR,
  Contact: Chris Gardiner,
  tel: 01780 752939.
  email: chirs.gardiner@english-nature.org.uk
- Nottinghamshire Wildlife Trust (various reserves),
  Contact: Jeremy Fraser
  The Old Ragged School, Brook Street, Nottingham,
  NG1 1EA.
  tel: 0115-958-8242,
  email: jfraser@nottswt.cix.co.uk

Advantages & limitations of edge, glade and ride management

Advantages	Limitations
• Creates warm sheltered microclimates. • Increases interface between scrub and open communities. • Increases the extent of complex structure and features available to wildlife. • Increase the conservation value of the scrub and associated habitats. • Managed rides provide access for management.	• Long rides can isolate scrub stands for some species (eg Dormice). • Add to maintenance effort and costs. • Increases the volume of arisings.

- Westhay Moor NNR
  Contact: Kiff Hancock,
  Somerset Wildlife Trust.
  tel:01823 451587
  email: chancock@somwt.cix.co.uk

Further reading and references

Bodnar, S., (1996) *Rides and small mammals*, ENACT 4 (1), pp 6-8 English Nature.
Bright, P., (1997) *Helping the dormouse*. ENACT 5 (3), pp 12-15 English Nature.
Holmes, M., (1998) *Managing woods for bats* ENACT 6 (4), pp 8-10. English Nature.
Kirby, P., (2001): Habitat Management for Invertebrates: a practical handbook. RSPB, Peterborough.
Porter, K., (1993) *Wide rides for butterflies* ENACT, 1 (1), pp 17-19, English Nature.
Roworth, P., (2002) Whats New? ENACT 10 (2), p 20-21. English Nature.
Roworth, P., (2002) Whats New? ENACT 10 (4), p 22. English Nature.
Sheppard, D., (1997), *Not just neglect: Invertebrates and grassland scrub management*, Unpublished.
Sheppard, D., (2000), *Conservation of Lowland Grassland Scrub Mosaics*, English Nature.
Street, M. & Darke, R., (1996), *Howe Parke Wood – (managing rides for butterflies)* ENACT 4 (1), pp 16-18. English Nature.
Ward,L. K., (1990): *Management of grassland and scrub mosaics*, pp134-139. In: Hillier, S.H., Walton.
D.W.H, & **Wells, D.A.**, (eds) *Calcareous Grassland ecology and Management.*
Warren, M S., Fuller, R J., (1990) *Woodland rides and glades, their management for wildlife*, NCC.

5.8.9 Decaying wood management

Summary
Standing and fallen deadwood are important features within scrub stands. Senescing shrubs have an ecological value, even if just a few isolated bushes are retained beyond the end of their natural life.

Decaying wood is important to invertebrates and fungi. Standing dead wood can be created by ring barking of live trees and shrubs, and fallen dead wood by leaving some arisings from coppicing.

Applications
May be considered for use in delivering objectives aimed at:
- Enhancement

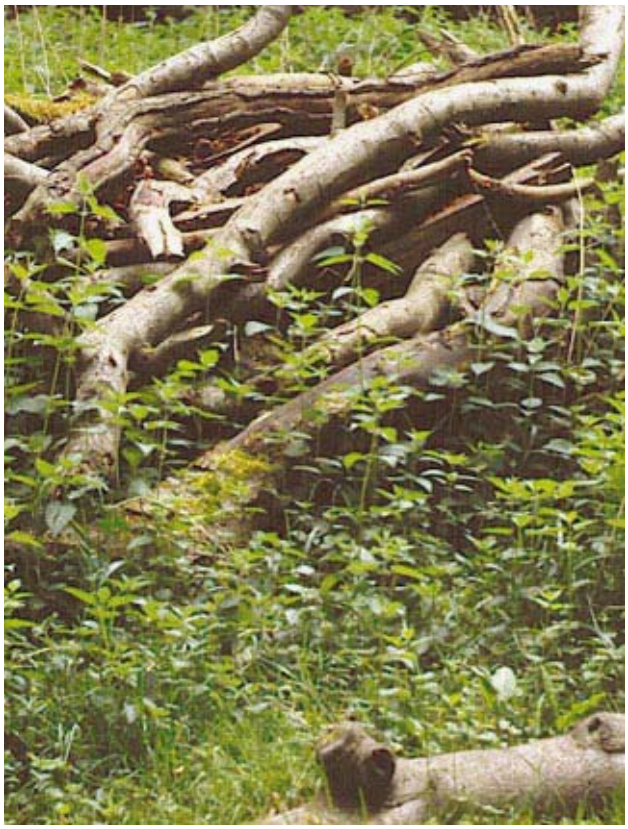
Is it a long term solution? No. The dead wood resource needs continual replenishment to replace earlier material that continues to decay. May need to do planting for future dead wood resource! (see 5.8.2).

Techniques
Decaying wood may be present in scrub stands in a variety of forms, each with its own assemblage of species. Do not remove decaying or damaged shrubs and, where there are no risks to public safety, retain any standing or fallen decayed wood where it lays.

Dead wood supports a large invertebrate and fungal community. It is important to recognise that the long-term recruitment of decaying timber is vital for the survival of these organisms.

Large diameter pieces are likely to be of greater value; where practical avoid cutting any timber into small pieces and stacking. If, for safety or aesthetic reasons, wood has to be cut up then it should be either left in direct contact with the ground or in compact piles to maintain humidity in dappled shade. Full sun will dry and heat the timber and it will support little life, other than 'dead-wood nesting bees which sunny exposed timber. Dense shade is good for fungi but may be too cold for most insects.

Senescent scrub has a high conservation value for its assemblages of insects and epiphytes that value old wood so a proportion can be left when rejuvenating over-mature stands.



Deadwood habitat. Roger Key/English Nature

Only remove stumps if necessary. Leave dead coppice bowls and stumps to decay naturally. Many insects and some fungi require these as part of their life cycles.

Rotten trunks are also important for invertebrates and provide nest sites for birds such as Willow Tit and Lesser Spotted Woodpecker.

Ring barking
This is used to enhance the provision of dead wood in a stand. Using a billhook, axe or chainsaw, cut through the bark and cambium layer to the heart wood right around the trunk.

This kills the standing plant but often leaves the roots alive. It may be necessary to spray or repeatedly cut off any regeneration likely to grow from below the cut.

Ring barking can be used to thin a stand, or for the removal of non-desirable species, leaving some stems to decay instead of removing them altogether.

Health and safety
See Appendix 8.12 for a full discussion of Health & Safety issues.

- Do not over-cut when ring barking risking unexpected tree fall.

Note: avoid leaving decaying wood where it is likely to cause injury.

Environmental
see also Section 5.9.2.

- Nothing obvious.

Advantages & limitations of dead wood management

Method	Advantages	Limitations
Natural decay	• Enhances the wildlife value of the scrub community.	• Slow process, often difficult to maintain continuity. • Dying and fallen stems may impede access for other management.
Ring barking	• Speeds the process of providing decaying wood. • Makes limited use of non-desirable species.	• Stump may need follow-up treatment to prevent regeneration. • Dying and fallen stems may impede access for other management.

Key sites and contacts

- Castor Hanglands
  Contact: Chris Gardiner
  Ham Lane House, Ham Lane, Nene Park,
  Orton Waterville, Peterborough, PE2 5UR
  tel: 01733 405850,
  email: chris.gardiner@english-nature.org.uk

- Coombes and Churnet Valley, RSPB,
  Contact: Nick Chambers,
  Six Oaks Farm, Bradnop,
  Leek, Staffordshire, ST13 7EU
  tel: 01538 384017
  email: nick.chambers@rspb.org.uk

- Hatfield Forest.
  Contact: Adrian Clarke (Headd Warden)
  National Trust Office, Takeley, Bishops Stortford,
  Herts. CM22 6NE.
  tel: 01279 870678.
  email: adrian.clarke@nationaltrust.org.uk

- Martin Down
  Contact: David Burton,
  English Nature, Prince Maurice Court, Hambleton Avenue, Devizes, Wiltshire, SN10 2RT
  tel: 01980 620485 –
  email: david.burton@english -nature.org.uk

- West Midland Parks,
  Contact: Simon Barker,
  National Trust Attingham Park, Shrewsbury,
  Shropshire. SY4 4TW.
  Tel: 01743 708100.
  (NT Regional ecologist and entomologist).
  email: simon.barker@nationaltrust,org,uk

- Wimpole,
  Contact: Simon Damart,
  National Trust Office, Wimpole Hall, Arringdon,
  Royston, Cambs. SG8 OBW
  tel: 01233 207257.
  email: simon.damart@nationaltrust.org.uk

- Winsor Great Park
  Contact: Ted Green,
  22 Reeve Road, Holyport, Maidenhead, SL6 2LS
  tel: 01628 638547
  email: Ted.Green@care4free.net

Further reading and references

Alexander, K. & **Green, T.**, (1993) *Deadwood – eyesore or ecosystem?* ENACT 1 (1), pp 11-14 English Nature.
Curtis, A., Warnock, B. & Green, J., (2000) *Mimicking natural breaks in trees* ENACT 8 (3), pp 19-21, English Nature
Finch, R., (1997) *Winching ancient trees* ENACT 5 (3), pp16-17, English Nature.
Fuller, R. J., Warren, M S., (1990), *Coppiced woodlands: their management for wildlife*, NCC.
Green, T., (1996) *Dead wood for wildlife*. ENACT 4 (1), pp 10-11 English Nature.
Kirby, P., (2001): *Habitat Management for Invertebrates: a practical handbook*. RSPB, Sandy, English Nature, Peterborough.
Warren, M. S., Fuller, R J., (1990) *Woodland rides and glades: their management for wildlife*, NCC.

5.8.10 Bare earth management

Summary
Bare ground can be created as a temporary feature in managing scrub. It provides breeding and hunting habitat for a range of invertebrate and vertebrate species. It also provides opportunities for plants that are unable to tolerate competition.

Bare ground would have been more abundant in times when semi natural habitats were heavily exploited. The cessation of peat and turf cutting on bogs and heaths, caused bare ground to be lost to succession. It now often occurs only on footpaths and tracks or because of erosion, and is frequently overlooked as a desirable feature. Rabbits create bare ground by scratchings.

Applications
May be considered for use in delivering objectives aimed at:
- Enhancement
- Maintenance

Is it a long term solution? No. Natural colonisation and successional processes will lead to covering of bare ground only offset by activities of mammals, notably rabbits. Ground needs to be continually re-exposed, though managers are often very cautious about doing it.

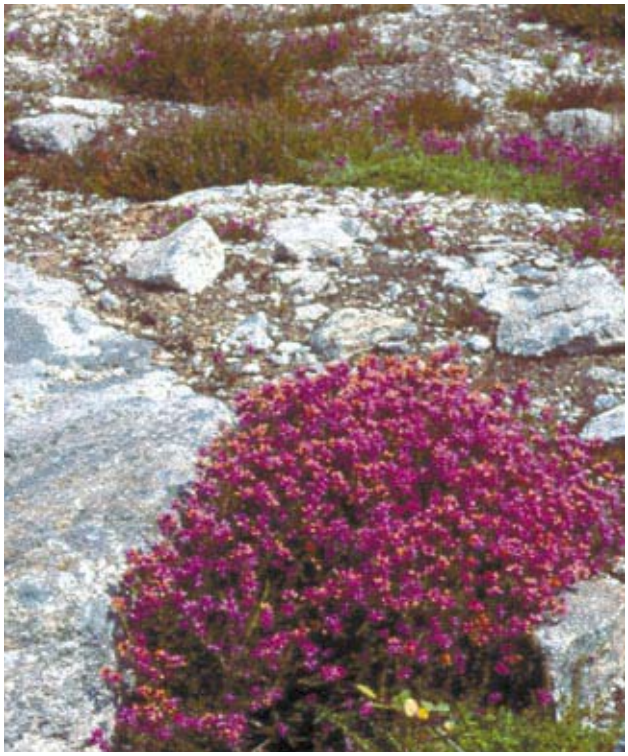
Techniques
Rabbits produce bare ground but the amount can fluctuate widely according to population levels and there is little control over where they produce it.

Hoof effects of grazing animals particularly cattle can produce tiny localised hot spots used by many invertebrates. (See 5.8.4)

Bare earth management can be used as a technique to achieve any or a combination of the following objectives.

Enhancement:
By increasing the amount of bare ground to a level typical for the habitat, where succession has reduced this important component of many habitats.

Bare ground can be a feature on any substrate including bare sand, exposed peat, clay, chalk and gravel. All have some value, though acid or calcareous sands may be of greatest conservation value.



Bell heather growing on bareground.
Paul Glendell/English Nature

Bare ground can be 'unsightly' and this may contribute to its low popularity. However, it can be created in small, scattered patches of just a few square metres or parts of a metre with little visual impact yet have a significant benefit.

The main importance of bared ground is as habitat for basking, burrowing and hunting invertebrates and as a niche for colonisation by pioneer plants. An important association exists for invertebrates with scrub and bare ground: the scrub offers a sheltered microclimate and nectar sources (or food for larvae) and the bare ground is used for nesting or hunting. Mining bees especially use nearby nectar sources provided by scrub.

Maintenance:
Continue to create small areas of bare ground to counter losses caused by succession.

Restoration of old scrub stands back to bare ground effectively restarts primary succession (subject to any

changes in soil chemistry that have occurred during scrub growth phase), allowing the full range of features to occur at least temporarily.

Uprooted scrub leaves a bare substrate, which for a period will be available to dependent species. Eventually the bare ground will be colonised by plants (the rate depends on soil fertility, climate and seed sources). It may be possible to manage scrub cyclically in some situations to provide continuity by periodically taking patches of older scrub back to bare ground.

This is a robust management technique for seral habitats that has been under-used by managers in the past. Provided it is done on an appropriate scale for the habitat concerned then it should maintain and enhance the communities of flora and fauna present.

Rather than maintaining existing bare ground, it may be more beneficial to create new patches. The alternative is to re-expose areas subject to colonisation by plants.

De-turfing has a particular value where there is an accumulation of organic matter as it removes this organic matter, so reducing and maintaining low levels of available nutrients. If appropriate, removed turves may be re-used to repair access paths.

Range of tools and equipment:
- Hand tools including turfing/turbary spades, spades, hoes and rakes.
- Pedestrian or specially designed excavator turfing machines.
- Excavators, rotoburiers and rotovators.

Non-target impact
- Risk of invasion by weeds.
- Risk of blow out in sand dune systems.
- Increase of erosion caused by walkers, cyclists and equestrian users seeing it as a through route.
- Negative impacts on the landscape value of a site are possible.
- Bare ground creation may damage any surface archaeological interest as well as soil profiles at undisturbed sites. A survey will be required, advice and permission sought.

Environmental
see also Section 5.9.2.
- Creation of bare ground or turf removal could lead to soil erosion in high rainfall areas. Overcome by creating strips only and running across any slopes.
- Re-use turves to repair access paths if appropriate.

Key sites and contacts
- Fingeringhoe Wick,
  Contact: Essex Wildlife Trust,
  Visitor Centre, Abbots Hall Farm, Great Wigborough,
  Colchester, Essex, CO5 7RZ.
  tel: 01621 862960
- Surrey Heath Borough Council.
  Contacts: Gordon Voller / Eddie Whalley,
  Ranger Service, Surrey heath House, Knoll Road,
  Camberley. Surrey. GU15 3HD.
  tel: 01276 7007338.
- The Lizard. Cornwall,
  Contact: English Nature / National Trust,
  C/o Ray Lawman,
  tel: 01326 240808.
  email: ray.lawman@english-nature.org.uk
- We are looking for more examples!

Further reading and references
Bacon, J., (1996) *Tussling with turves – a review of turf stripping techniques.* ENACT 4 (2), pp12-16.
Bacon, J, (1999) *A new turf lifter*. Enact 7 (3) 20-21. English Nature.
Bond, W., (2000). *Alaska Environmental. (turf relocating chisel platform on an excavator – lifts about 4sq m a go)* - leaflet Alaska Environmental Contracting.
Edwards, M., Bacon J., Corbett K., et al, (1996), Management of bare ground on dry grasslands and heaths (leaflet) English Nature. (National Lowland Heathland Programme).
Forsyth, L., (1999), *Creating bare ground habitats*, ENACT 7 (1), pp7-9, English Nature.
Key, R.S., & Gent, T., (1993), *Bare but not barren*, ENACT 1 (2), pp 15-16.
Key, R., (2000), *Bare ground and the conservation of invertebrates.* British Wildlife 11 (3), pp183-191.
Kirby, P., (2001): *Habitat Management for Invertebrates: a practical handbook*. RSPB, Sandy & English Nature, Peterborough.
Symes, N., & Day, J., (2003) A practical guide to restoring and managing lowland heathland. RSPB, Sandy.

Advantages and limitations of methods for maintaining bare earth areas

Method	Advantages	Limitations
Hand operations – turfing / turbary spades, digging spades, hoes, rakes, etc	• Suitable to small scale exposures. • Suitable where access is difficult. • Suitable for sensitive areas avoiding damage to other interests. • Permits fine-tuning and design features.	• Labour intensive and slow work rates. • Risk of back injury. • Risk of infestation by weeds. • Check before doing on archaeological sites.
Pedestrian turfing machines	• Faster work rate than manual methods • Reduced risk of injury. • Manoeuvrable and still appropriate to small scale exposures. • Suitable where access is difficult. • Suitable for sensitive areas avoiding damage to other interests.	• Risk of infestation by weeds. • Risk of erosion. • Check before doing on archaeological sites.
Specially designed excavators, JCB digger buckets, bulldozers or other excavators	• Time efficient. • Slower rate of scrub regeneration. • Angled blades create good exposed south facing spoil banks. • Instant compacted sand.	• Encourages trespass by other users. • Risk of infestation by weeds. • Unlikely to be allowed on archaeological sites. • Larger areas risk more soil erosion unless well designed.
Rotoburying	• One pass to bury humus layer/turf and create bare ground surface. • Time efficient. • Slower rate of scrub regeneration.	• Prone to desiccation unless compacted with rear roller. • Risk of infestation by weeds. • Unlikely to be allowed on archaeologically sensitive areas.
Rotovating	• Time efficient. • Slower rate of scrub regeneration.	• May require initial removal of turf. • Re-vegetation more rapid than with rotoburier. • Prone to desiccation until compacted. • May require several passes. • Risk of infestation by weeds. • Unlikely to be allowed on archaeologically sensitive areas.

5.8.11 Water level management

Summary
Wetlands, including grazing marsh, reedbeds, bogs and mires are prone to scrub encroachment especially when they are subject to lowered water levels. In some situations it may be possible to reverse the trend by raising water levels. For example certain species (such as birch) may colonise drained wetlands but are killed when the stump is inundated by re-wetting. Non-target impacts need to be carefully considered and this technique should only be used if ecologically acceptable.

Applications
May be considered for use in delivering objectives aimed at:
- Reduction
- Eradication

Is it a long term solution? Yes. Subject to successful maintenance of water retention devices.

Techniques
In all techniques, the change in water level should be in line with the site objectives and be permanent, rather than temporary changes to specifically control scrub.

Ensure all management requiring access on to the site is completed before water levels are raised!

The effectiveness of this technique varies depending on the sensitivity of the shrub species to flooding.

Water level management can be used as a technique to achieve any or a combination of the following objectives.

Reduction:
Higher water levels can slow down the rate and extent of scrub invasion.

Wet scrub habitats may be valuable in their own right so only growth retardation of shrubs may be required. Where wetland habitats have been drained or dried as a result of succession and scrub has invaded, raising water levels will help to control scrub. Where lowland raised bog or valley mire is being restored, raising water levels by damming drainage cuts frequently leads to die-back of much if not all of the birch (see Fenn's, Whixhall and Bettisfield Mosses NNR case study). Water level management can be used to introduce structural diversity into wetland scrub; low-lying individuals or groups of trees being killed by higher water levels. The trees are then also more vulnerable to wind-throw.


Scrub drowning in raised water levels. J L Daniels/English Nature

Eradication:
If higher water levels are maintained the inundation can kill certain species of scrub.

Where a wetland that has been colonised by scrub is being restored by scrub removal, the stumps of many species can be killed by complete inundation before and during the growing season.

This technique will be limited to situations where there is good control over water levels, an adequate supply of water in the summer, and an extensive restoration programme. This may be where a reedbed is being restored from willow scrub, or water meadows are being restored. The scrub should be cut as low as possible and the water raised to completely cover the stumps for a considerable period; ideally throughout a winter period and into spring.

At Wicken Fen, where wet woodland (carr) has invaded fen habitats as management has ceased and water levels have dropped, raising of water levels alone has caused die-back of a mixed carr of willow alder and buckthorns and a reversion to tall fen and swamp habitat.

Species sensitivity to flooding
To some degree, the extent of die back in all species will be influenced by degree of change in soil water levels: areas with previously dry soils will suffer more die back than those with a relatively high water table. This indicates that species can cope less with rapid change compared to their success at surviving and adapting to slowly changing conditions.

However, complete prolonged inundation of stumps will normally kill all species, including willows. In the case of willows, it is essential to maintain water cover in the critical spring period when seed is dispersed (assuming some seeding trees remain in the area).

On re-wetted grasslands and grazing marsh, self-set Hawthorn will become waterlogged and die.

Table showing examples of species resistance to water logging

Susceptible	Variable	Resistant
Beech	Birch	Alder
Hazel	Buckthorn	Pine
Hawthorn	Oak	Willow

Range of tools and equipment
- Retention of water normally requires installation of dams or sluices. These may be formed from a variety of materials depending on whether they are simply to slow water flow (soft dams) or completely retain water (hard dams).

- Soft materials may be brash, heather bales, peat, soils or gabions filled with stone.

- Hard materials may be plastic, fibre-glass or concrete.

- Provision must be made for the structures to be able to cope with or release storm flows.

- Consult with relevant experts and authorities to secure appropriate designs.

- Installation should be done using appropriate equipment. In wet conditions this will need to be low ground pressure vehicles on balloon tyres, tracks or platforms.

Non-target impact
Re-wetting drained wetlands requires care. Prolonged flooding can have a severe effect on non-target vegetation and wildlife.
- In reedbed restoration it is relatively safe to flood the area as reed and most associated species are tolerant of flooding.

- However in wet grassland prolonged flooding can kill the target vegetation, so this might only be appropriate where the target vegetation has already been lost.

- Drained peat will take several years to recover its water absorption properties, however given time the blocking of ditches to raise the water table will eventually be sufficient to cause die back even of birch.

- It is important not to inundate or waterlog adjacent habitats of high conservation importance that are sensitive to flooding.

- Seek advice at sensitive archaeological sites which may be damaged by fluctuations in water levels.

Health & safety
See Appendix 8.12 for a full discussion of Health & Safety issues. Those specific to water level management should include:
- Any retention of water needs to be done under consultation with relevant authorities to ensure that structures are built to appropriate design specifications and will not fail as water pressure increases.

- No lone working should be carried out on re-wetted areas, staff should be appropriately trained and safety equipment should be available and well maintained.

- Extraction, impoundment and discharge licenses may be required. Contact local Environment Agency Offices.

Environmental
see also Section 5.9.2.
- Any retention of water needs to be done with the consent and under consultation with relevant authorities. Contact local Environment Agency Offices.

- It may be appropriate to analyse the quality of incoming water to ensure it is suitable for the desired vegetation community.

- It may also be appropriate to analyse the quality of water that may later leave the site to ensure it will not have adverse effects on downstream wildlife.

Advantages & limitations of water level management

Method	Advantages	Limitations
Inundation	• Avoids use of chemical or ground disturbance through stump removal. • Contributes to wetland habitat creation.	• Water supply and control are essential for complete inundation. • Limited area where prolonged flooding is acceptable or practical. • Risk of non-target impact to flora and invertebrates. • Seek advice on archaeological sites, as this technique may be damaging.
Water-logging	• Raising water levels is likely to be integral to wetland restoration/creation. • Can be used to introduce structure and variability in scrub blocks. • This may benefit archaeology, but seek advice on sensitive sites.	• Variable kill rates both within and between species, depending on local conditions. • Limited to wetland where raised water levels are practical and acceptable. • Risk of non-target impact to flora and invertebrates.

Key sites and contacts

- Chartley Moss NNR and Wybunbury Moss NNR.
  Contact: T Coleshaw,
  English Nature, Attingham Park, Shrewsbury.
  Shropshire. SY4 4TW.
  tel: 01743 282014.
  email: tim.coleshaw@english-nature.org.uk

- Fenn's, Whixhall and Bettisfield Mosses NNR
  Contact: Joan Daniels,
  English Nature, Manor House, Moss Lane, Whixall.
  tel: 01948 880362,
  email: joan.daniels@english-nature.org.uk.

- Nottinghamshire Wildlife Trust (various reserves),
  Contact: Jeremy Fraser
  The Old Ragged School, Brook Street, Nottingham,
  NG1 1EA.
  tel: 0115-958-8242,
  email: jfraser@nottswt.cix.co.uk

- Westhay Moor NNR
  Contact: Kiff Hancock,
  Somerset Wildlife Trust.
  tel:01823 451587
  email: chancock@somwt.cix.co.uk

- Wicken Fen, Cambs,
  Contact: Martin Lester,
  National Trust, Lode Lane, Wicken, Ely, Cambs.
  CB7 5XP.
  tel:01353 720274.
  email: martin.lester@nationaltrust.org.uk

Further reading and references

Bacon, J., Barnes, N., Coleshaw, T., Robinson, T., Tither, J., (2001, 2nd ed), *Practical solutions handbook*, (re Water level control Pages 7.1, 7.2, 7.3) FACT, English Nature.
Bacon J., Lord, B., (1996) *Troublesome trees, taking trees off bogs*. ENACT 4 (3), pp 12-16 English Nature.
Barnet, H (1997) *Redgrave and Lopham Fens (update on restoration work)* Enact 5 (3), pp8-11, English Nature.
Bedwell, J., (1996) *Sophisticated sluices (on the River Cole)* ENACT 4 (3), pp 21-22 English Nature.
Bowley, A., (1994), *Woodwalton – a model for new fens?*, ENACT 5 (2) pp12-14, English Nature.
Cooch, S. & Morris, D., (2001) *Mending the mires (restoration work in the New Forest)* ENACT 9 (3) pp 19-22, English Nature.
Harding, M., (1994) *Restoring Redgrave and Lopham Fens* ENACT 2 (2), pp 12-15, English Nature.
Warner, P., (1995) *Raised bogs (Ireland)* ENACT 3 (2) pp8-9, English Nature.
Wilson, J., (1994), *Halting succession at Leighton Moss*, ENACT 2 (2) pp7-9, English Nature.

5.8.12 Weeding

Summary
Weeding can be used as an effective means of reducing or eradicating shrub, tree seedlings or competing herbs, or removing competition to seedlings when enhancing scrub through natural regeneration.

This is an under-used technique, the need and advantages of which are not appreciated until shrubs have become more visible, but by then too large to remove by these means. This wastes a real opportunity to act while the problem is still small! Carrying out removal whilst shrubs are still young is enormously less demanding on resources than clearing equivalent areas of mature scrub that will develop if seedlings are allowed to mature.

The operation may be regarded by some as a monotonous task so some means of motivating the work force may be required such as setting half-day or day-targets. The work force should be physically fit to avoid strains and injuries and equipped with appropriate tools especially if removing larger saplings.

Applications
May be considered for use in delivering objectives aimed at:
- Enhancement
- Reduction
- Eradication

Is it a long term solution? No. Seeds will continue to germinate in suitable ground conditions so repeated inspections required at a maximum of two yearly intervals. Beware producing more bare ground on peat/heath soils leading to repeated germination.

Techniques
By moving methodically across the target area, seedlings, saplings or competing herbs can be pulled up by hand, levered out by weed pulling tools or dug out by spade or mattock for appropriate disposal.

The effectiveness of this approach is dependent on several factors:
- The size of area and available labour resource.

- The size and density of the material to be pulled and the extent of the area over which they are to be removed.

Weeding saplings using Lazy Dog tool. John Bacon/English Nature

- The age of seedlings and the extent of their root development, which in turn is dependant on the soil and local growing conditions. Saplings with developed root systems will need to be removed with the help of appropriate equipment.

- The motivation of the work force and ensuring adequate supervision.

Weeding can be used as a technique to achieve any or a combination of the following objectives

Enhancement:
By removing competitors to preferred species on areas where scrub is expanding. Also by the subsequent use of arisings when used in new plantings.

Removing competitors by selective weeding can be used to encourage the expansion of individual shrub species. This can also be achieved by the use of mulching (5.8.2), short spells of light grazing (5.8.4) and by spot treatment with herbicides (5.8.16).

Reduction:
By selectively removing unwanted species or excess seedlings/saplings.

A work force that is skilled in identifying to species level can selectively remove all or a proportion of target seedlings to leave appropriately spaced specimens for the desired number of replacement shrubs.

Eradication:
By removing all seedlings/saplings until germination ceases. If the aim is eradication then grazing or weeding may need to be repeated every one to two years for a number of years until germination of new seedlings ceases. On peaty and heath soils it may be advisable to wait for self-thinning to occur before removing saplings; this will avoid repeat germination on bare soil.

Range of tools and equipment

- Grazing can be used to nip off seedlings in their first year before they establish a root system (e.g. Sycamore). See 5.8.4.
- Hand weeding may require only a pair of gloves with appropriate grips.
- Weed extractors take an element of back bending out of the work by providing leverage. Long handled three-pronged levers are put at the base of the seedling and levered backwards to extract the root.
- Other hand tools, traditionally spades and mattocks, can be used to cut and sever roots of young suckers and seedlings. Displaced turves should be heeled back.
- Biodegradable mulches or mats can be used to suppress the growth of shrub seedlings.
- The root cutting chain saw equipment for severing roots below the surface in suitable soil types.
- 'Tall weed pulling machines' have been observed to pull saplings growing in uncompacted turf during thistle and ragwort pulling operations. It could therefore have application on habitat creation sites or re-verting arable. Needs further trialing.

Other material resources to be considered are:

- Wheelbarrow for carrying away arisings. If arisings are to be replanted elsewhere then keep moist by placing in bags.
- Portable board walks for access across wet areas.
- An open back vehicle or trailer for larger arisings.

Non-target impact

- Ensure that work force is instructed and supervised as to identification of target and non-target species.
- Avoid damaging sensitive areas by trampling and plan extraction routes accordingly.
- Carefully plan and time your access to the site with vehicles to avoid damage to sensitive features, or causing compaction or erosion.
- The use of mulch mats to suppress seedling development will damage other vegetation and potentially also some invertebrate species.
- Ensure any displaced turves are heeled back to reduce risk of later weed seed germination.

Disposal of arisings

- Weeding produces a relatively small amount of material for disposal. By prior arrangement it is often possible to supply seedlings/saplings to sites where planting programmes are underway or for growing on for future planting programmes.
- Depending on the volume of arisings they may be left to dessicate in a suitable area or removed from the site for composting or burning. (5.9.1).

Health and safety

See Appendix 8.12 for a full discussion of Health & Safety issues. Those specific to weeding should include:

- Provide appropriate clothing for the work and conditions.
- Hand weeding can result in back injury. Risk increases when trying to remove older seedlings. Provide suitable tool aids.
- Mattock users need to work at safe distances.
- Root cutting chainsaw users need to check for underground obstructions.

Environmental

see also Section 5.9.2.

- Do not leave arisings to decay where leachates may enter water sources.

Advantages & limitations of weeding

Method	Advantages	Limitations
Grazing	• Removes weed or scrub before it becomes established dramatically reducing future management costs. • Large areas covered with small labour input.	• Unselective. • Only effective in first or second years before rootstock becomes established. After this coppice re-growth may occur.
Hand weeding	• No tools or experience required. • Removes weed or scrub before it becomes established dramatically reducing future management costs. • Low risk of weeding non-target species.	• Slow work rate. • Only effective on smaller or poorly rooted seedlings. • Requires motivated labour force. • Risk of strains or back injury. • Removal may leave bare ground for further germination.
Weed pulling tools.	• The tools are cheap and easy to use. • Removes weed or scrub before it becomes established dramatically reducing future management costs. • Low risk of weeding non-target species.	• Slow work rate. • Only effective on small to medium seedlings. • Requires motivated labour force. • Risk of strains or back injury.
Spades & mattocks	• Minimal resource and experience required. • Removes weed or scrub before it becomes established dramatically reducing future management costs. • Low risk of weeding non-target species. • Can remove larger saplings and those with better developed roots.	• Slow work rate. • Requires motivated labour force. • Risk of injury.
Root cutting chain saw equipment	• Quicker than hand techniques for larger saplings. • Removes weed or scrub before it becomes established dramatically reducing future management costs. • Low risk of weeding non-target species. • Can remove larger saplings and those with better developed roots.	• Need for trained operators. • Only suitable for some soil types. • Check for underground obstructions.
Eco-puller tall weed pulling machine	• Fast work rate over large areas. • May have use on reverting arable or habitat creation sites.	• Cannot grip and pull unless growth has hardened and become woody and is over 30 cms tall. • Limit to the size of sapling that can be pulled. • Unselective. • Not designed specifically for this purpose so further testing required.

Key sites and contacts

- Chartley Moss NNR and Wybunbury Moss NNR.
  Contact: T Coleshaw,
  English Nature, Attingham Park,
  Shrewsbury. Shropshire. SY4 4TW.
  tel: 01743 282014.
  email: tim.coleshaw@english-nature.org.uk

- Fenn's, Whixhall and Bettisfield Mosses NNR.
  Contact: Joan Daniels,
  English Nature, Manor House, Moss Lane, Whixall.
  tel: 01948 880362,
  email: joan.daniels@english-nature.org.uk.

- There must be more sites where weeding is done!?

Further reading and references

Bacon, J., Newman, P., & Overbury, T.,(1998), *Modernising the mattock*, ENACT 6 (4) 15-18, English Nature.

Bacon, J.,(2002) *Modernising the mattock with the root-cutting chain-saw- information Pack* FACT, English Nature.

Bacon J., Overbury T, (1998) *Pulling tall weeds*. Enact 6 (2) 7-9. English Nature.

Bacon, J., (2000) *Weed control… with a lazy dog?!* ENACT 8 (4), p 19-20. English Nature.

James, N. D. G., (1989) 4th edition, *The Foresters Companion*, Blackwell Press, Oxford & Cambridge.

5.8.13 Cutting

Summary
Cutting is probably the most common operation carried out on shrubs to remove unwanted material. It can be carried out using many types of operation and equipment according to the terrain, type of scrub and its condition. It is a technique which gives the impression of real achievement - which hides the fact that re-growth will normally occur very rapidly.

Applications
May be considered for use in helping to deliver objectives aimed at:

- Enhancement
- Maintenance
- Eradication

Is it a long term solution? Cutting to reduce or eradicate scrub will require follow-up treatments in order to achieve these objectives as re-growth will occur from stumps

Techniques
The technique for cutting specific scrub stands will depend on its extent, structure, age, and the availability of labour and or machinery.

Cutting can be used as a technique to achieve any or a combination of the following objectives.

Enhancement:
Cutting scrub is used to enhance the structural diversity of scrub.

Careful cutting or trimming can maintain vigour and thicken subsequent growth especially along scrub edges leading to increased value for a range of species.

Maintain:
Cutting is a way of maintaining existing scrub within agreed size and extent parameters.

See coppicing (5.8.5) for discussion on maintaining scrub stands by cutting. One-off cutting has a role in maintaining the proportion and age class of scrub across a site. Old stands can be cut and treated to prevent re-growth while allowing/encouraging new stands to develop elsewhere. Selective cutting of individual shrubs within a stand, and allowing regeneration from stump or seed, can be used to create diversity within the stand. A balance and continuity of ages may be beneficial as old and senescent scrub often has important assemblages of insects and epiphytes (see Section 5.8.6). Selective cutting can maintain a largely closed canopy with dappled light penetration and humidity that is beneficial to many species.

Cutting scrub using tractor mounted flail.
Pete Boardman/English Nature

Reduce and eradicate:
Cutting can remove all the top growth of shrubs as the first operation of removal prior to killing or removal of stumps.

Cutting deciduous scrub is rarely enough to prevent re-growth. To permanently reduce or eradicate shrubs follow-up management will be necessary to prevent re-growth from stumps or kill the roots eg with browsing (5.8.4), mowing & flailing (5.8.6), water level management (5.8.11), stump removal (5.8.14), grubbing out (5.8.15, herbicide treatment (5.8.16), or, by regularly repeated cutting.

Range of tools and equipment
There are a range of tools and equipment that can be used to cut scrub. These are reviewed in the relevant sections indicated by the table. [See also Coppicing and thinning (5.8.5)]

Stands of light scrub can be tackled with hand tools. Staff working systematically through the stand, cutting and removing the arisings as they go.

Larger scrub may be effectively dealt with using powered hand tools (chainsaws and clearing saws). Teams of saw operators and brash stackers can be effective. Safe working distances need to be maintained.

Extensive stands can be dealt with using a flail provided there is no problem with leaving behind a layer of mulched arisings. Heavy-duty flails are available for dealing with mature scrub.

Tools used for cutting scrub

Tool type	Range	Use
Non-powered hand tools	Bill hook, Slasher Bow saw, Loppers	Small inaccessible areas. Use by volunteers
Powered hand tools	Chainsaw Clearing saw Pedestrian flail mowers	Larger, inaccessible areas
PTO driven power tools	Flails, swipe / bush hogs, forest grinders	Large accessible areas

Cutting of stumps that are later going to be winched or bulldozed out should be left high to provide an anchor or grip. However, if future flailing or mowing of re-growth is planned, stumps need to be cut flush to the ground.

Disposal of arisings
Cutting scrub will produce large volumes of arisings. Removing them may be very time consuming and difficult. See Section 5.9.1 for a full discussion.

- Flailing mature scrub will produce a large volume of arisings. Scarification, or collection and composting, may be the most appropriate option for their disposal (see Section 5.9.1).

Non-target impact
Cutting scrub could affect the shelter, humidity and shade conditions that support important bryophytes and lichens; selective cutting could prevent this.

Health and safety
See Appendix 8.12 for a full discussion of Health & Safety issues. Those specific to cutting should include:

- Backache and back strain is commonly associated with using hand or pedestrian operated tools.
- Blunt blades or prolonged use without taking suitable breaks, can lead to 'white finger' or Raynaud's Disease.
- Maintain a safe area around anyone cutting scrub. Clear the arisings at regular intervals in order to maintain a safe and clear working environment.

Advantages & limitations of cutting

Method	Advantages	Limitations
Non-powered hand tools	• No fuel emissions through machinery use. • Quieter no machine noise. • Easy access to difficult sites.	• Very slow work rate. • Requires motivated labour force.
Powered hand tools	• Faster work rate. • Can access difficult sites.	• Noise and fuel emissions. • Many machines require specialised training and certification for use. • May require large labour force to deal with arisings.
PTO and hydraulically machines	• Suitable for large-scale operations. • Fast work rates.	• May be difficult to access some sites. • Noise and fuel emissions. • Risk of soil damage. • Many machines require specialised training and certification for use. • May require subsequent operations to deal with arisings. • Hire and contractor charges.

Environmental

see also Section 5.9.2.

- Take care not to spill fuels and oils.
- Operate in appropriate weather conditions to minimise soil damage.
- On wet substrates use low ground pressure machines.
- Ensure any leachate from arisings does not cause pollution of any water sources.

Key sites and contacts

- Aston Rowant NNR,
  Contact: Graham Steven,
  English Nature, Foxhold House, Crookham Common,
  Thatcham, Berks RG19 8EL,
  tel 01635 268881
  e-mail graham.steven@english-nature.org.uk
- Beds, Cambs, Northants and P'boro Wildlife Trust
  Contact: Andy Fleckney,
  Priory Country Park,
  Barkers Lane, Bedford MK41 9SH
  tel: 01234 364213,
  e-mail: afleckney@bedswt.cix.co.uk
- Catherington Lith,
  Contact: Martin Healey
  East Hampshire District Council, Penns Place,
  Petersfield. GU31 4EX
  tel: 01730 234386
  e-mail: Martin_Healey@easthants.gov.uk
- Eskmeals, Cumbria.
  Contact: Kerry Milligan,
  Cumbria Wildlife Trust
  e-mail: kerrym@cumbriawilldifetrust.org.uk
- Foulshaw, Cumbria
  Contact: John Dunbavin,
  Cumbria Wildlife Trust,
  e-mail: johnd@cumbriawildlifetrust.org.uk
- Hutton Roof Crags, Cumbria
  Contact: Kerry Milligan,
  Cumbria Wildlife Trust
  e-mail: kerrym@cumbriawilldifetrust.org.uk
- Latterbarrow, Cumbria.
  Contact: John Dunbavin
  email: johnd@cumbriawildlifetrust.org.uk
- Therfield Heath, Hertfordshire
  Contact: Eoin Bell,
  Herts County Council
  tel:01922 555279,
  email eion.bell@hertscc.gov.uk

Further reading and references

See refs under:
- Section 5.8.4 (grazing);
- Section 5.8.6 (Mowing & flailing);
- Section 5.8.5 (Coppicing).

Bacon, J., (1999) *Back to Purple with mean machines* ENACT 7 (2), p 4-6. English Nature.
Nobes, S., (1996) *Flail cutter and collector* ENACT 4 (2) pp 17, English Nature.
Roworth, P., (2002) Whats New? ENACT 10 (2), p 20-21. English Nature.
Roworth, P., (2002) Whats New? ENACT 10 (4), p 22. English Nature.

5.8.14 **Stump removal** (see also: 5.8.15 Grubbing out)

Summary
Stump removal can be used to prevent the regeneration of shrubs or to remove obstructions to allow follow-up operations (e.g. mowing) after scrub removal. Removing stumps is a slow process with low outputs but this needs to be set against time that would be taken to repeatedly deal with re-growth from any untreated stumps. Stumps may be important habitat for insects, fungi and epiphytes and consideration should therefore be given to their conservation value *in situ* before removal.

Stump removal is unlikely to be appropriate on sites of archaeological interest.

Applications
May be considered for use in delivering objectives aimed at:
- Reduction
- Eradication

Is it a long term solution? Yes, except for growth from any remaining roots of species such as willow. Care is also needed to replace turves to avoid germination of shrub seeds on any bare ground.

Techniques
Stump removal can be used as a technique to achieve the following objectives:

Reduction and eradication:
Stump removal eliminates the need to return and repeatedly cut re-growth.

Removing cut stumps from rides and glades will enable mowing to maintain these features. Stump removal may be a suitable follow up to cutting to prevent regeneration of individual bushes.

Removal can be very slow and labour intensive and a drain on resources but this needs to be assessed against time that would be taken to repeatedly deal with re-growth from any untreated stumps or the cost of removing mature scrub.

Rhododendron is a typical species of shrub where stump and root removal is required to prevent repeated regrowth.

Root cutting mattock and chainsaw. John Bacon/English Nature

Range of tools and equipment
There are six main methods used for dealing with unwanted tree stumps:

- Hand tools can tackle small stumps and roots.
- In the right soil conditions, the root cutting chainsaw is capable of cutting and severing through the roots of small stumps as a 'mechanised mattock'.
- Small or large stumps can be tackled with grinders.
- Where access permits tree lifters can lift whole bushes or stumps.
- Winching is another option available and sometimes used when disposing of stumps.
- see also 'Grubbing out' Section 5.8.15

Hand tools:
Small surface rooted suckers can be tackled with either a spade or mattock. Chop through the roots around and under each stump. A mattock can be used to dig around large stumps prior to winching out.

Powered hand tools:
Root-cutting chainsaw equipment can be used to sever roots and suckers on small stumps. Angled cuts are used under the stump to sever roots just below ground level enabling the stump to be rolled out.

Stump grinders can be used to remove small or large stumps. They come in various designs from grinding teeth on fast rotating wheels to large grinding heads mounted on tractors.

Stump lifters:
Where access allows, stumps can be lifted using tree-lifting spades mounted on a tractor. The spades are used to sever through and undercut the roots of large bushes and trees before lifting them out. Root-balling tree lifting machines fitted with small diameter blades can be used to cut the roots and lift out shrubs and tree saplings with minimal ground disturbance (e.g. Holmac).

Winching:
Stump removal by winching is effective especially in situations where alternative machinery is unavailable or where the site is inaccessible. Winching can be potentially dangerous and demands a high level of expertise.

There are three techniques commonly used in winching, depending on the degree of effort needed for removing the stump.

- The straight pull is ideal for small stumps especially in soft ground: the stump is winched directly from a suitable anchor.

- An indirect pull can be used to remove stumps in difficult locations: it relies on two secure anchor points and the cable passes through a pulley block attached to the second anchor.

- The power of a winch can be doubled using a block and tackle pulley. This is a safer method for removing difficult stumps. It gives a greater pulling capacity to the winch at lower cable tensions, though it is fairly complex and time-consuming to set up. It can allow the winch operator to take a position not directly in line with the pull.

Secure anchor points are required for all winching methods. The lack of a safe anchor can be a limiting factor in many situations. If a tractor with anchor-spades is not available, large trees (suitably protected) can make suitable substitutes. Alternatively, horizontal ground anchors can be used. These are drilled steel plates that are secured to the ground with long metal pins, and are used in series to increase anchorage.

Drum winches are usually mounted on a vehicle and either operated electrically or PTO driven.

Hand winches (eg Tirfor winches) are lightweight and capable of up to 5 tonne lateral pull. The cable passes through a hand-operated ratchet, which is attached, between the anchor and target stump. Heavy horses are also successfully used to pull out stumps.

Disposal of arisings
- Stumps can be quite difficult to dispose of. They burn very slowly and most chippers are not suited to deal with them.

- They are bulky and there is a risk of stones and soil debris among the roots, which would cause damage to the blades of the chipper.

- If left to rot they may encourage weed growth around them.

Non-target impact
- Removal of stumps causes loss of potential habitat for insects and epiphytes.

- Removal may not be appropriate on sites of archaeological interest.

- Replace sub-soil, soil and turves to reduce risk of weed seeds germinating on bare ground.

Health and safety
See Appendix 8.12 for a full discussion of health and safety issues. Those specific to stump removal should include:
- Maintain a clear safety escape route behind the operator.

- Blunt blades or prolonged use can lead to 'white finger' or Raynaud's Disease.

- Cabs must always be caged to minimise risk to the operator.

The following should be considered when winching:
- All operators to be certificated in winch use.

- Keep winching area clear of personnel to a minimum of twice the distance of the pull cable.

- Ensure all personnel can be clearly seen.

- Remove anyone not directly involved with the work.

- Ensure all cables are un-frayed, have no snags, kinks or knots.

- Safe working loads (SWL) and breaking strains (BS) should always be observed. These should be stamped on all cables, snatch or pulley blocks and slings.

- If double pulling, the safe working load should be double the estimated load.

Environmental

See also Section 5.9.2.

- If using other trees as anchors ensure they are suitably padded and protected to avoid damage to bark and the trees conductive cells under the bark. Tree death can result if these are damage.
- Take care not to spill fuels and oils.
- Carry out operations in appropriate weather conditions.
- Use appropriate low ground pressure vehicles when operating on soft or wet ground to avoid soil damage.

Advantages and limitations of stump removal

Method	Advantages	Limitations
Hand tools	• Reduces need for follow-up treatment in most species. • Tools are cheap. • Workers need minimal experience and training. • Effective where access for larger equipment is not possible. • Low risk to non-target species. • Suitable for organic sites.	• Slow work rate. • Requires significant labour resources. • Only effective on smaller stumps. • Requires motivated labour force. • Risk of back injury. • Removes decaying wood resource. • Unlikely to be appropriate for archaeologically sensitive areas.
Powered hand tools	• Reduces need for follow-up treatment in most species. • Can access most difficult areas. • Root cutting chainsaw equipment can be comparatively easy to handle and fully portable. • Stump grinders will tackle large stumps. • Suitable for organic sites.	• Need to be trained and certificated in use. • Only suitable for small numbers of stumps. • Not suitable in all substrates. • Chains/blades need to be sharp and balanced. Check for underground obstructions. • Risk of Raynaud's Disease from vibrations. • Risk of back injury. • Stump grinders can be cumbersome to handle. • Removes decaying wood resource. • Unlikely to be appropriate for archaeologically sensitive areas.
Stump lifters	• Reduces need for follow-up treatment in most species. • Suitable for organic sites. • Minimal ground disturbance. • Can remove whole bush in one operation. • Faster work rate.	• Limited access ability. • Need to be trained and certificated in use. • Heavy machines can damage ground. • Soils with rock or stones may damage blades. • Only suitable on fairly level terrain. • Small lifter can only deal with young saplings. • Some species may re-generate from remaining roots. • Removes decaying wood resource. • Unlikely to be appropriate for archaeologically sensitive areas.
Winches	• Reduces need for follow-up treatment in most species. • Hand winches can be used where access is difficult. • Very powerful relative to input required.	• Slow work rate. • Removes decaying wood resource. • Need to be trained and certificated in use. • Safe anchor points often not available. • Unlikely to be appropriate for archaeologically sensitive areas.

Key sites and contacts

- Chartley Moss NNR and Wybunbury Moss NNR.
  Contact: T Coleshaw,
  English Nature, Attingham Park, Shrewsbury.
  Shropshire. SY4 4TW.
  tel: 01743 282014.
  email: tim.coleshaw@english-nature.org.uk

- Kent High Weald Project
  Contact: Keith Rennells,
  Council Offices, High Street, Cranbrook, Kent,
  TN17 3EN.
  tel: 01580 715918,
  email: keith.rennells@kent.gov.uk

- New Forest Heaths
  Contact: Phil Marshall,
  NT Mottisfont, Romsey, Hants. SO5 OLP.
  tel: 01794 340757.
  email: philip.marshall@nationaltrust.org.uk

Further reading and references

Bacon J., Newman P. and Overbury T., (1998) *Modernising the mattock*. Enact 6 (4) 15-18 English Nature.

Bacon J., Newman P., and Overbury T., (1998) *The Holmac* HZC 16-22 *stump lifter in* Modernising the mattock. Enact 6 (4) 15-18 English Nature.

Bacon, J., (2002) Modernising the mattock with the root-cutting chain-saw equipment information pack) FACT, English Nature.

5.8.15 **Grubbing out** (See also Stump removal - 5.8.14)

Summary
Removing scrub with mechanical excavators can be quick and cost effective, for large areas of dense scrub. Success is often determined by the skill of the operator, but a good operator can make a mechanical digger into a subtle tool, and can work around identified interest.

Excavators may not be appropriate where the conservation interest is at a very fine scale, and manual management would be more suitable. Neither would they be appropriate on sites of archaeological interest.

Scrub clearance using excavators takes a site back to bare ground, so if there is relict ground flora to be conserved they are inappropriate, but otherwise they are ideal tools for removing standing scrub together with any litter, leaving the site ready for regeneration of the target habitat.

A wide range of machines are available from very small mini excavators, through tractor-mounted implements and JCB types to large tracked 360∞ long-reach excavators and bulldozers. They all work by removing the entire plant including rootstock, so minimising the need to treat regeneration.

Plant hire or purchase costs can be high but work rates compensate for this, as does the removal of the need for follow-up treatment.

Applications
May be considered for use in delivering objectives aimed at:
- Reduction
- Eradication

Is it a long term solution? Yes, apart from any minimal re-growth from any remaining shrub roots. Management needs to be in place to deal with any seedling re-growth – see 5.8.12.

Techniques
Grubbing out can be used as a technique to achieve the objective of eliminating the need to return to repeatedly cut re-growth.

Grubbing out shrubs on a large scale is heavy work requiring large, powerful machines which tend to be heavy. Use of tracks or other low ground pressure devices may therefore be required on soft ground or where there is a sensitive interest, to spread the weight of machines and prevent them from sinking or rutting the ground. On mires, bogs and fens brash roadways or support (marsh) mats may need to be deployed.

Grubbing out scrub. John Bacon/English Nature

The machine operator needs to be thoroughly briefed on the desired finish and be closely supervised throughout the work. An operator experienced in conservation management is invaluable, he can determine the best machine to use, quote accurately, and most importantly will have a 'feel' for the work.

Where there is a risk of soil erosion excavators need to be used with caution: working along contours, and buffering watercourse with a strip of un-worked ground to prevent soil run-off. Plan work where possible to take place during periods of drier weather.

Range of tools and equipment
The following paragraphs describe the main groups of machines. These are further reviewed in the table.

Excavators and mechanical blades (bulldozers) remove scrub together with its roots. Bulldozers push the scrub up into large piles, and if the blade is set correctly leaves much of the topsoil intact, or if required removes the organic litter to the depth of the mineral soil layer. Because of its design, it is best only at removing large blocks of scrub. It is difficult to manoeuvre, so is unsuited to subtle work.

360° excavators with a root rake bucket clear large-scale scrub efficiently; they can be used very subtly are able to leave specific features untouched with near pinpoint accuracy. The reach of the arm means they can access scrub on small-scale steep or rough terrain, where other machines cannot.

The 360° digger can remove the nutrient rich organic litter that has accumulated beneath the scrub, thereby limiting the risk of nutrient flushes on calcareous grassland or heathland when removing scrub. This provides opportunities for re-establishing species such as Juniper that require bare earth.

Root-rakes (tined buckets) are effective at lifting root mats, causing only low levels of soil disturbance, so the seed bank is then able to develop on the exposed soil. Rhododendron has been removed from humid heathland in this way, allowing heathers to re-colonise from the seed bank.

Non-target impact
- Where an existing conservation, historical or archaeological interest exists, the use of excavators or blades should be very carefully assessed, advice sought and approvals obtained.

- Plants and invertebrates could be eradicated.

- Only experienced operators can use back actors and 360° diggers with great subtlety to work around the interest.

- Soil washed off stripped areas into watercourses will affect aquatic wildlife and needs to be avoided.

Disposal of arisings
- Disposal of arisings must be considered in advance (see 5.9.1). The excavator or blade can build piles of scrub that can be burnt or processed in situ. This may be more cost effective than transporting it off site.

Health and safety
See Appendix 8.12 for a full discussion of health and safety issues. Those specific to stump removal should include:

- On site briefing of operators should be comprehensive and take account of terrain in relation to heavy machinery.

- Proper supervision of works to minimise risk.

Environmental
See also Section 5.9.2.
- Take care not to spill fuels and oils.

- Carry out operations in appropriate weather conditions.

- Use appropriate low ground pressure vehicles when operating on soft or wet ground to avoid soil damage.

- If burning reduce smoke production by ensuring piled material is as soil free and as ‘clean’ as possible.

- Plan work to prevent erosion of soil from bare surfaces into water sources. Install bunds if risk foreseen.

- Ensure machines are maintained to high standard to minimise exhaust emissions and oil loss.

- Instruct operators as to environmental features on the site.

Key sites and contacts
- Avon Heath Country Park, RSPB
  Contact: Roland Hughes,
  Birch Road, St Ives, Ringwood, Hampshire, BH24 2DA
  tel: 01425 472975,
  e-mail: roland.Hughes@rspb.org.uk

- Ainsdale Dunes, Lancashire
  Contact: Rob Wolstenholme, English Nature
  email: robert.wolstenholme@english-nature.org.uk

- Fingringhoe Wick
  Contact: Essex Wildlife Trust,
  Visitor Centre, Abbots Hall Farm, Great Wigborough,
  Colchester, Essex, CO5 7RZ
  tel: 01621 862960,
  email: admin@essexwt.org.uk

- Lullington Heath NNR, Sussex
  Contact: Malcolm Emery,
  English Nature, 32-33 North Street, Lewes,
  East Sussex, BN7 2PH

tel: +44 (0)1273 476595.
E-mail: malcolm.emery@english-nature.org.uk

- Langley Wood NNR, Wiltshire
  Contact: David Burton,
  English Nature, Prince Maurice Court, Hambleton Avenue, Devizes, SN10 2RT
  tel: 01380 726344,
  e-mail: david.burton@english-nature.org.uk

- Therfield Heath, Hertfordshire - Contact: Eoin Bell,
  Herts County Council
  tel:01922 555279,
  email eion.bell@hertscc.gov.uk

- Dersingham NNR, Norfolk
  Contact English Nature,
  The Smithy, Wolferton, Kings Lynn
  Norfolk. PE31 6HA.
  tel: 01485 543044.
  email: phil.holms@english-nature.org.uk,

Further reading and references

Forsyth, L., (1999), *Creating bare ground habitats*, ENACT 7 (1), pp7-9.
Rooney, P., (1998), *A thorny problem*, ENACT 6 (1) pp12-13.
Bowley, A., (1994), *Getting rid of gorse*, ENACT 2 (1), pp6-7.
Burton, D., Carpenter, P., (1999), *Rhododendron – winning the battle*, ENACT 7 (4), pp10-14.
Roworth, P (2002) Whats New? ENACT 10 (2), p 20-21. English Nature.
Searle, S., (1999), *Controlling rhododendron at Windsor*, ENACT 7 (4), pp15-16.

Advantages and limitations of range available

Machine	Advantages	Limitations
Mini Digger & Bobcat	• Stumps will be removed so no need for follow up operations. • Good on medium/small projects. • Light and manoeuvrable. • Easier to transport.	• Lack of power for very bulky work. • Unlikely to be appropriate for archaeologically sensitive areas.
Tractor based back-hoe (180°)	• Stumps will be removed so no need for follow up operations. • Subtle finish achievable. • Good on level terrain. • Manoeuvrable. • Can be self driven to site.	• Limited reach ability. • Slower work rate than 360 machines (hours/hectare). • Unlikely to be appropriate for archaeologically sensitive areas.
Bulldozer	• Stumps will be removed so no need for follow up operations. • Large, powerful. • Good on level terrain. • Graded finish.	• Tight turning can damage sensitive turf. • Not subtle! • Only suited to dry ground. • Needs transport to site. • High hire costs. • Unlikely to be appropriate for archaeologically sensitive areas.
Tracked excavator (360°)	• Stumps will be removed so no need for follow up operations. • Long reach. • All round manoeuvrability. • Fast work rate. • Subtle finish with good operator. • Range of buckets for various jobs. • Low ground pressure versions.	• Expensive to hire. • Needs transport to site. • Difficult to access onto difficult terrain. • May need additional ground support on soft and wet sites. • Unlikely to be appropriate for archaeologically sensitive areas.

5.8.16 Herbicide application
(See *The Herbicide Handbook*)

Summary

To help managers assess situations where the use of herbicides may be appropriate for the management of scrub and other 'weeds' English Nature working with FACT have produced **'The Herbicide Handbook – Guidance on the use of herbicides on nature conservation sites' (2003)** (HH).

Readers are specifically referred to the HH to ensure they properly assess issues relevant to the use of herbicides on nature conservation sites. For this reason the HH is actually supplied at the rear of this Scrub Management Handbook. The two Handbooks need to be used in parallel so that the techniques selected are the most appropriate and best solution for any given site and situation.

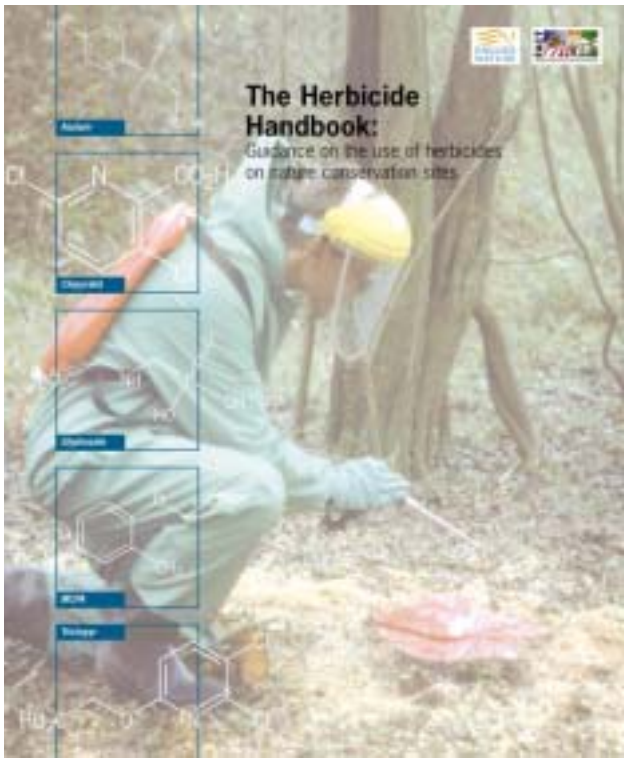
The account that follows is therefore only a very short listing of a few key points extracted from various legal sources and from the HH.

Applications
May be considered for use in delivering objectives aimed at:
- Maintenance
- Reduction
- Eradication

Is it a long term solution? Infrequently! When the correct herbicide is applied to shrubs in the correct growth stage, in appropriate weather conditions and to manufacturers recommendations then good kill rates can be achieved. However the need for repeat operations is evidence that control is not always complete or long lasting. Partial or complete kill of branches is more frequent than killing of the stump and roots.

Pesticide Minimisation Policy:
There is a Government policy within the UK to minimise the use of pesticides. This needs to be taken into account when considering technique choice.

Pesticide legislation:
There is a large volume of information and legislation related to pesticide use. Readers are referred to publications dealing with the law related to the handling and use of pesticides. For convenience only, these are summarised in the Herbicide Handbook – see HH Section 3.1.



The Herbicide Handbook

Using herbicides on nature conservation sites:
The HH provides comprehensive guidance on the selection of appropriate herbicides for use on nature conservation sites for different species and situations. In view of this only brief notes have been included in the 'Species accounts' (Section 4.4. of this Scrub Handbook), followed by references out to relevant sections of the Herbicide Handbook.

A risk assessment approach:
An environmental risk assessment should be undertaken to determine whether herbicide application is the most appropriate technique to achieve control on any given site.

Alternative mechanical methods of preventing scrub regeneration and for killing stumps, as described earlier in this Scrub Handbook, should be considered before using herbicides.

If herbicides are to be applied then the particular risks associated with any approved herbicide should be assessed. (See HH Section 4.1.3 and Table 4).

Techniques
Herbicide application can be used as a technique to achieve any or a combination of the following objectives.

Maintain:
Targeted use of herbicides to colonising shrubs can help prevent spread.

Reduce and eradicate:
Herbicide can be applied direct to regenerating foliage or onto freshly cut stumps to reduce or eradicate unwanted scrub.

Certain scrub species and herbicides may require more than one application in a growing season and some may require follow-up operations the following year to ensure that all regeneration is killed. Mixed scrub may be particularly difficult to kill due to varying susceptibility of the shrub species to a particular herbicide caused by leaf absorption properties.

Choosing a herbicide (See HH Figure 1; Section 4; Table 3):
It is vital that the herbicide is approved for the land classification (habitat) in which it is to be used and that it is applied in approved concentrations and by approved methods. Attention also needs to be paid to timing, calibration, choice of applicator, nozzle, etc. Choose a herbicide that whilst killing the target species is the least environmentally harmful and as selective as possible.

Contamination of non-target species must be avoided. Spray drift occurs in windy conditions and with fine misting nozzles and volatisation/evaporation can occur in warm still-air conditions (above 17 degrees C) – the herbicide later condenses and can affect species well away from the application site. Wet weather reduces effectiveness of uptake. Observe buffer limits when spraying near water. Adher to all label instructions.

Mark out large areas to minimise overlap and increase accuracy of coverage. Use coloured dyes to observe coverage.

Cut stumps:
Treat cut stumps immediately as pores are open and uptake increased, and use a colour dye to show which have been done. Treatment when sap is moving down and less sap is rising may assist in uptake - i.e. in the autumn. Take care when treating stumps in sensitive areas to prevent collateral damage by splash and wash-off.

Foliar spraying the summer following cutting is an alternative option where stump treatment has not been fully successful.

Herbicide choice:
The HH (Section 4.1; Tables 3 & 4) provides information on which herbicides are approved for which shrub species on nature conservation sites, along with much other helpful information.

Adjuvants (including wetting agents) (See HH Section 3.1.1):
Various adjuvants may be added to herbicide mixes to enhance the take-up by the plant subject to being approved for specific uses and with specific herbicides. Adjuvents can be more toxic to wildlife than the herbicide!

Wetting agents increase uptake by breaking down the surface tension on the leaf surface and increases its adhesive properties. This is particularly valuable on shrubs that have thick, shiny or waxy leaves (e.g. Rhododendron, Privet).

Range of tools and equipment
Herbicides should be targeted as precisely as possible. There are a large number of applicators available. Choice should be based on the best method to apply the herbicide to the target shrub with the minimum loss to adjacent non-target foliage. Direct applications (e.g. paint brush, weed-wipers, directed knapsack lances) are generally better than sprays in this respect. The table below shows applicators that may have approvals, the most targeted first. The advantages and limitations of these applicators are discussed in 5.9.4.4 and in the HH Section 3.2.

Non-target impact (See HH Section 6)
- There is a risk to non-target species, which can be minimised by adoption of good practice.

- There is a risk of spray drift and leaching into watercourses, which can be minimised by adoption of good practice.

Health and safety
See Appendix 8.12 for a discussion of health and safety issues and also in the HH Section 3.1.4.

Training and qualifications:
Only suitably trained and certificated operatives can legally carry out herbicide application. They are required to adhere to the Care of Substances Hazardous to Health (CoSHH) and Health and Safety Guidelines and other legal requirements. (See HH Section 3.3):

- Different certification is needed for different applicators (eg hand-held and tractor mounted application). (HH Section 3.3).

- Herbicides may only be used under the terms of their approved use as described on the label by the manufacturer or by any additional off-label approval.

- If more than one person is spraying, ensure a wide safe working area between workers.

- Follow manufacturers manual for care, maintenance and safe use of all mechanised applicators.

- All operatives must maintain appropriate record forms, detailing what and how much chemical has been used.

Environmental

See also Section 5.9.2.

- See The Herbicide Handbook, Section 4.1.3 (Herbicide Information Sheets) and Section 6.

Tool	Use
Stem injection	*Stems – not yet approved for use in UK. (See HH Section 5).*
Paint brush	Targeted application to cut stumps.
Weed wipe – hand held	Hand held for targeted application to stems.
Knapsack, basal bark sprays and crystals.	Targeted application to foliage, stems and stumps over small areas.
Weed wipe – ATV or tractor	Application to tall stems over a larger area.
Hand held lances from Bowser.	Targeted application to foliage over larger areas.
Controlled droplet application (CDA)	Untargeted application using small quantities of water.
Tractor-mounted or other boom sprayer	Non-targeted application to foliage over a large area.

- Due to the potential for environmental harm from pesticides, every effort should be made to minimise the use of herbicides and to prevent application to non-target vegetation or surfaces.

- Splash, drift and volatisation can be reduced by adoption of best practice techniques and application only in suitable weather conditions.

A table listing herbicide applicators along with the advantages & limitations of the different methods is provided in Section 5.9.4.4. (See also HH Section 3.2 for further details).

Key sites and contacts

- Beds, Cambs, Northants and P'boro Wildlife Trust
  Contact: Andy Fleckney,
  Priory Country Park, Barkers Lane, Bedford MK41 9SH
  tel: 01234 364213,
  e-mail: afleckney@bedswt.cix.co.uk

- Eskmeals, Cumbria.
  Contact: Kerry Milligan,
  Cumbria Wildlife Trust
  e-mail: kerrym@cumbriawilldifetrust.org.uk

- Foulshaw, Cumbria
  Contact: John Dunbavin,
  Cumbria Wildlife Trust,
  e-mail: johnd@cumbriawildlifetrust.org.uk

- Hutton Roof Crags, Cumbria
  Contact: Kerry Milligan,
  Cumbria Wildlife Trust,
  e-mail: kerrym@cumbriawilldifetrust.org.uk

- Martin Down NNR.
  Contact: David Burton,
  English Nature, Cherry Lodge, Shrewton, Salisbury.
  Wilts. SP3 4ET.
  tel: 01980 620485.
  email: david.burton@english-nature.org.uk

- Nottinghamshire Wildlife Trust (various reserves),
  Contact: Jeremy Fraser
  The Old Ragged School, Brook Street, Nottingham, NG1 1EA.
  tel: 0115-958-8242,
  email: jfraser@nottswt.cix.co.uk

- Stockbridge Down, Hampshire.
  Contact: Phil Marshall,
  NT Mottisfont, Romsey, Hants. SO5 OLP.
  tel: 01794 340757.
  email: philip.marshall@nationaltrust.org.uk

- Therfield Heath, Hertfordshire
  Contact: Eoin Bell, Herts County Council
  tel:01922 555279,
  email eion.bell@hertscc.gov.uk

- Westhay Moor NNR
  Contact: Kiff Hancock
  Somerset Wildlife Trust.
  tel:01823 451587
  email: chancock@somwt.cix.co.uk

Further reading and references

Bacon, J., (1995) *Removing the prickles* ENACT 3 (2), pp 10-11 English Nature.
Bacon, J. and Overbury, T., (2000) *Pedestrian and*

scrub weed-wipers. ENACT 8 (4), p 16-19. English Nature.
Bacon J., (2002) *How green is your land management*. Enact 10 (2) 7-9. English Nature.
Bacon J., (2003) *Getting the best out of Wipers*. English Nature (unpublished).
Britt, C., Mole, A., Kirkham, F., Terry, A., (2003) The Herbicide Handbook - *Guidance on the use of Herbicides on Nature Conservation Sites* English Nature / FACT, Peterborough.
Cooke, A. S., (1986), *The use of herbicides on nature reserves*, report No 14, NCC, Peterborough.
Cooke, A., (1993), *The use of herbicides*, ENACT 1 (2) pp10, English Nature.
Ferguson, A., (2000) *Chemical control of standing scrub at Rhos Goch National Nature Reserve*, CCW.
Ferguson, A., (2000), *Scrub management by chemical injection into standing stems*, CCW.
Hawkins-Byass, N, (1999) *Aerial bracken control*. Enact 7 (2) 14-17. English Nature.
Roworth, P., (2002) Whats New? ENACT 10 (4), p 22. English Nature.
Whitehead, R., (ed), (2003) *UK Pesticide Guide* (published annually) CABI and British Crop Protection Council.

5.9 Generic management issues

As well as the specific management techniques summarised above, there are a number of generic issues which need to be considered when carrying out any scrub management; how will any arisings be disposed of, what is the most appropriate tool to use and what are the wider environmental impacts of the management. These issues are summarised below and dealt with in more detail in Sections 5.9.1–5.9.4.

The information in these sub-sections is presented to make it clear which techniques prevent re-growth by removal of the stumps and those that do not. There are major cost savings to be made in not having to return in future years to carry out follow up management.

Management Issue	Outline Description
Disposal of arisings (5.9.1)	Disposing of cut scrub is at least as difficult and important a task of scrub management as cutting it down. A variety of techniques are available for the disposal of arisings; leaving as fallen, windrowing, stacking, chipping, mulching, rotoburying, burning or removal.
Environmental impacts (5.9.2)	As well as the impact of scrub management on target habitats and species there will also be an impact on other biodiversity and a wider environmental impact due to the machinery used and its effect on air, soil and water.
Design and landscape (5.9.3)	When establishing or managing new scrub, especially in urban environments and picturesque landscapes, it is important to consider the wider landscape perspective. Management to create a natural look, avoiding regimental blocks and straight edges, achieves a wider aesthetic appeal.
Tools (5.9.4)	There is a very wide range of tools available for the management of scrub. This section gives guidance on selecting and using the right tool for the job.

5.9.1 Disposal of arisings*

Summary
Most techniques for the management of scrub will create arisings*, although the size and volume of the material produced will vary. Dealing effectively with these arisings, if they need to be removed, is an important part of scrub management and can be at least as resource demanding as scrub management itself.

(The word 'arisings' as used in this Handbook may be defined as any organic matter, in any form, resulting from an operation to manage scrub).*

Planning
If arisings are to be removed then pre-planning of operations should aim to minimise the distance arisings are moved and the number of operations required, whilst at the same time fulfilling ecological objectives and minimising environmental damage.

This section reviews the techniques and options to consider when dealing with the disposal of arisings.

Techniques
The main options for disposal of arisings are:

- Leaving as fallen, windrowing, stacking.
- Chipping.
- Flailing, mulching or roto-burying.
- Burning.
- Burying.
- Removal for further processing or sale.

There are legal constraints that relate to the production, storage and disposal of 'biomass arisings' and wastes, which need to be taken into consideration. See 5.9.3 for more details.

Working in dry, firm ground conditions minimises damage.

Retaining arisings on site:
Arisings that are left on site eventually rot and release nutrients, enriching the soil. This may be acceptable in areas of low conservation value, but is to be avoided where trying to restore low nutrient habitats. They can also suppress and change ground flora between clearance and re-growth stages, encourage weed infestations, limit access, create a fire hazard and reduce the landscape value of a site.

Burning coppice arisings. Peter Wakely/English Nature

Leaving as fallen or windrowing:
Unlikely to be acceptable on most sites due to the area of ground affected. One exception is possibly on rehabilitation bog sites as it can act as a substrate over which sphagnum mosses may extend.

Stacking of logs and brash to rot down:
It may be acceptable to leave discrete piles in dappled shade to provide valuable habitat for a range of wildlife. When large-scale projects generate a lot of brash it may not be acceptable to leave it all on site and a judgement has to be made. Nor is it appropriate to leave arisings on habitats where nutrient enrichment is an important issue.

Where opportunities do exist, logs should be stacked in parallel to minimise air gaps and retain humidity, in dappled shade, where they are available to a wide range

of dead wood dependent invertebrates and fungi. Brash should be stacked in as compact piles as practical: branches stacked in parallel and sliced through to reduce piles, which are suitable for nesting birds and small mammals until they rot.

Chipping on site:
Depending on the site management objectives chipping directly onto the ground should only be carried out as a last resort or in areas with no conservation value, ensuring that chip piles will not affect valued vegetation communities.

Chipping on site prior to extraction in bulk or in bags vastly reduces the volume of material making transport off site more efficient.

Chippers are usually either tractor PTO powered or have their own engine. They can process timber diameters up to 23 cm into chips of various sizes. Tracked chippers are now available reducing ground pressure.

Flailing and mulching:
Will leave chopped brash and stump material on the surface. This will need to be removed if the objective is to establish nutrient poor vegetation communities and to prevent enrichment and suppression of seedlings. This can be time consuming if done by hand. Large commercial 'hoovers' are available (for example for horse stables use) that can suck up relatively fine debris. It may be possible to windrow larger material, and pick it up with a buck rake and load into a trailer or onto a fire site. A top loading chipper may be an option, fed from the buck rake.

Roto-burying:
Will incorporate small quantities of arisings into the lower soil horizons. This technique should not be used on low nutrient sites with undisturbed soil profiles.

Burning:
Burn arisings in a safe manner. The fire site should be located to minimise damage to features. Consider burning on sheeting to protect the ground and allow the removal of ash to prevent nutrient enrichment.

When burning, ensure a pressurised water supply is at hand for controlling the fire and damping down. Fires should always be attended, turned in and dampened down before leaving site. Re-visit the fire before nightfall to ensure there are no hot spots.

Small volumes of brash can be burnt on discrete fire sites; on wet ground for example these can be laid on corrugated metal sheets to aid removal of ash and prevent it mixing with soil.

Arisings from lifting with excavators are normally put directly onto a fire. Chipping is not appropriate because of soil in the roots and the tangle of material, unless an industrial top feed chipper with hardened teeth is available. Semi portable incinerators are being developed that may be able to deal with such material.

Burying:
Burying is not likely to be an option on a conservation site, or one with an archaeological interest.

Removal:
Material that cannot be left on site should be removed. The following suggestions can be considered:

Removal for processing or for sale:
Non-woody grassy/weedy arisings may be collected by mini-baler or cut and collect flails.

On wet sites or those with sensitive vegetation communities the arisings may be better taken off site for further processing. Where disposal of arisings is essential any opportunity should be taken to offset costs, as should any opportunity to use the product instead of destroying it.

Brash and chips if suitably processed have a variety of uses off site, for example mulching in landscape or horticultural projects, soil improvers, composts, path surfacing, brash matts, and increasingly as a bio-fuel source. Any commercial value may partly offset the costs of removal.

Where arisings are to be removed as chips or brash, equipment should have as low a ground pressure as possible coupled to a large capacity to firstly reduce risks of rutting and soil compaction and secondly to minimise vehicle movements and labour costs.

Non-target impact

- Removal of potential deadwood with epiphytic interest.
- Soil enrichment from deposited chips or buried scrub.
- Out of control fires damaging sensitive features.

Health and safety

See Appendix 8.12 for a full discussion of Health & Safety issues. Those specific to arisings should include:

- When burning avoid windy days and when the wind takes the smoke onto highways or into habitation.
- Inform the local fire service.
- Plan burning on site, to ensure safety and minimal impact on neighbours.

Environmental

See also Section 5.9.2.

- Ensure that if chips are left on site that any decay leachates will not pollute water sources.
- Only burn when materials and conditions are in a suitable condition to minimise smoke emissions.
- If extracting brash use low ground pressure vehicles and avoid compaction and rutting of soil. Use tracked chippers to reduce ground pressure.
- Consider recycling arisings for other uses subject to logistics.

Key sites and contacts

- Aston Rowant NNR,
  Contact: Graham Steven,
  English Nature, Foxhold House, Crookham Common,
  Thatcham, Berks RG19 8EL,
  tel 01635 268881
  e-mail graham.steven@english-nature.org.uk
- Beds, Cambs, Northants and P'boro Wildlife Trust
  Contact: Andy Fleckney,
  Priory Country Park,
  Barkers Lane, Bedford MK41 9SH
  tel: 01234 364213,
  e-mail: afleckney@bedswt.cix.co.uk

Advantages and limitations for disposal of arisings

Method	Advantages	Limitations
As fallen, windrowing, stacking	• Minimal handling reduces soil damage. • No extraction costs.	• Nutrients remain on site. • Risk of weed infestation. • May affect future vegetation communities.
Chipping on site	• Nutrients concentrated into chip piles. • Clears ground surface for re-colonisation. • Reduces risk of weeds becoming established in brash.	• Leaves dense mulch, increasing nutrients and suppressing regeneration. • Plant hire rates may be expensive. • Risk of leachate as chips decay.
Chipping for removal	• Reduces bulk giving reduced extraction costs. • Usable / saleable product.	• On soft wet ground requires low ground pressure vehicle to extract in bags or bulk.
Flailing and mulching	• Quick. • Grinds stumps so that they do not obstruct future access. • Produces seed bed if required.	• Mulch remains on soil surface. • Cost of removing mulch if necessary. • Cost of operating machinery. • Heavy machinery and risk of ground damage.
Rotoburying	• Buries litter and small quantities of arisings below rooting depth of colonising vegetation. • Produces seed bed for application of seed. • No extraction costs.	• Only possible to incorporate litter layer and small volumes of small diameter arisings. • Creates bare ground surface which may be liable to weed infestation and erosion.
Burning	• Relatively quick in good burning conditions. • Cost effective if material burns well.	• Risk of damage to habitat if fire gets out of control. • Anti-social near houses and roads if smoke produced. • Can damage soil and vegetation (though consider burning on metal sheets or in container). • Pollution from the smoke.
Sale of bi-product	• Helps reduce management costs. • Recycling of material. • Nutrients removed from site.	• Needs a market. • Supply of material needs to meet demand. • Production, marketing and supply costs, may exceed financial gain.

- Nottinghamshire Wildlife Trust (various reserves),
  Contact: Jeremy Fraser
  The Old Ragged School, Brook Street, Nottingham,
  NG1 1EA.
  tel: 0115-958-8242,
  email: jfraser@nottswt.cix.co.uk

- Therfield Heath, Hertfordshire
  Contact: Eoin Bell,
  Herts County Council
  tel:01922 555279,
  email eion.bell@hertscc.gov.uk

- Westhay Moor NNR
  Contact: Kiff Hancock,
  Somerset Wildlife Trust.
  tel:01823 451587
  email: chancock@somwt.cix.co.uk

Further reading and references

Bacon J., Harris S., Southwood R., (1997) *Making hay in a small way*. Enact Vol 5 (2) 8-11. English Nature.
Bacon J., (1996) *Tussling with turves*. Enact 4 (2) 12-16. English Nature (Includes cut and collect machines).
Bacon, J., Lord, B., (1996) *Troublesome trees, taking trees off bogs*. ENACT 4 (3), pp 12-16 English Nature.
Jones, D., Bacon, J., Van Loock, S. *Introducing the self-extracting sledging-trailer*. ENACT 9 (1), p 20-21. English Nature.
McKinley, R., (2001) *Heathland restoration in Dorset: Brash baling as an alternative to burning*. ENACT 9 (1), p 16-19. English Nature.
McKinley, R., (2002) *The problem of arisings*. In: Proceedings of the 6th National Heathland Conference, Underhill-Day, J, Liley, D. eds, RSPB, Sandy. Pp78-80.
Parish, T., (1998) *Aerial runways* ENACT 6 (3), p 15-19. English Nature.
Symes, N., Pickess, B., and **Auld, M.**, (1993), *Machinery for heathland management (product review)*, ENACT 1 (2) English Nature.
Turner, T., (1996), *GreenMech woodchipper* ENACT 4 (3), pp9 English Nature.
Webster P., Ireland D., (2003) *Brash management on habitat restoration sites*, FC Technical Development Branch Report for FACT.

5.9.2 Environmental impacts

Summary
There is a duty in conservation management to employ techniques that minimise environmental impacts and to ensure they are as environmentally sustainable as possible. Increasingly this duty is being enshrined in codes of conduct, law and regulation, but in any case it is important to consider the impact of any techniques on the wider environment.

Some scrub management techniques (involving hand tools for instance) have little impact on the environment. Most, however, have at least some considerable degree of impact. Wider environmental impacts include the use of non-renewable fuels and oils, atmospheric pollution (smoke and engine fumes), introducing toxins into the environment (herbicides, leacheate from arisings dumps, oil or fuel leaks) and noise. Environmental impacts also include issues of public nuisance (smoke, noise, restriction of access). The environmental impact of the management should be assessed by carrying out a 'risk assessment' at the planning stage, and alternative less impacting methods considered. For large-scale projects a full environmental impact assessment (EIA) my be necessary or desirable.

This Handbook aims to raise awareness of these issues being published as it is at a time when attention is being applied to the 'greening' of land management operations. Further information should be sought from the Environment Agency under their best practice Landscaping Guidelines (see below). Liability for failing to comply with regulations is the responsibility of the site-managing organisation.

Techniques
The key areas of likely environmental impact are:

- Storing and handling materials.
- Emissions to water and air.
- Soil impacts.
- Fuel use.
- Noise.
- Biomass arisings and other waste.
- Contaminated land.
- Pesticides.

Water flows and water quality. Joan Daniels/English Nature

Storing and handling materials:
Machines require fuels to run them and oils for lubrication. Large projects will require many machine hours, so this is particularly applicable.

Storage of over 200 litres of fuel must comply with Control of Pollution (Oil Storage) (England) regulations. Even if you store less, you should still consider the implications of the regulation. Fuel and oil containers taken to site should be handled with care to avoid any spillage and should not be left on site, empty or not.

Storage of pesticides is regulated. No more than is necessary for immediate use should be stored, and then in a marked, locked container, capable of retaining spillages in excess of 110% of the volume in store.

Spillages of oil or pesticide should not be hosed down or diluted, but should be cleaned immediately using absorbent material such as sand or fuller's earth. Contaminated material should be disposed of at a permitted facility or through a registered waste processor. Emissions to water and air:

Watercourses should not in any way become contaminated with any fuel or pesticide. Where there is a risk provide an adequate buffer strip. Small spills close to watercourses should be soaked up (see above), for larger spillages contact the local Environmental Regulator.

Avoid allowing soil to enter watercourses, as this may lead to silting and nutrification, and affect aquatic flora and fauna. This risk may occur when carrying out large-scale scrub removal using excavators, or where vehicle tracks rut and wash out in wet weather. It is good practice to strip land in sections to avoid large areas of bare earth. On gradients, try to work across the slope to reduce erosion and plan to carry out work where possible during periods of drier weather.

Burning brash creates smoke and pollution and can cause a public nuisance or hazard where it affects domestic dwellings or roads. Burn only in good burning conditions when the wind will not take smoke towards residences, and aim to generate a hot fire as this produces less, and lighter smoke.

Soil impacts:
Compaction from heavy machinery, or even large numbers of volunteers, can damage soil structure. Where possible, avoid wet ground, provide established access routes across non-sensitive ground, and consider using low-ground pressure tyres/tracks.

Machine use:
The use of fuel-powered machinery for larger scale conservation management is almost unavoidable. All engines produce exhaust, contributing to atmospheric pollution. Modern machinery generally incorporates fuel-efficient engines, and it is important to keep them well maintained. There are alternatives to some machines: many innovative pieces of equipment are becoming available for use using heavy horses, especially for extraction jobs. More sustainable fuels are becoming available; vegetable fuel oil is being trialled as a diesel replacement.

Mineral based lubricants are toxic in the environment. One of the most common and polluting uses is as anti-fling chain oil, however, vegetable based anti-fling oils are readily available. Good maintenance will minimise loss of oil from hydraulic pipes and gear casings.

Noise:
Large machinery use especially near domestic dwellings could be classed as a nuisance, especially during early mornings, evenings or weekends, so should be minimised.

Biomass arisings and waste:
Anything you are going to discard, including all arisings may be classed as waste. Large volumes of chipped, shredded, cut or pulverised arisings intended for further use require a waste management licence. If the quantity is likely to be below 1,000 tonnes per week then you can apply for an exemption licence. This will also allow storage of that quantity on site prior to chipping. A waste management licence may also be required if you are considering burning arisings. Exemption may be given if burning takes place on site and does not exceed 10 tonnes in any 24-hour period, but you must first register with your Environment Regulator.

Composting:
You will need also to register for an exemption if you intend to compost the arisings. To qualify, you must compost at the site where the arisings have been produced, or where it is to be used, or another of your sites or the site of the user. The quantity must not exceed 1,000 tonnes or 10,000 tonnes if being used to cultivate mushrooms. If composting over 1,000 cubic metres per year then a full waste management license is required.

Contaminated land:
This may apply at former industrial sites following a period of dereliction. Such sites often become very good wildlife habitats and may be taken over for management. Identifying and dealing with contaminated land is very difficult and expert advice should be sought.

If the site is identified and defined as contaminated, the local authority or environmental regulator will require remedial action. Work may be required if there is a change in use perhaps likely to un-earth contaminated matter. This may apply to clearing scrub, creating other habitats, re-profiling or any site development such as building a visitor centre.

Pesticides:
There is a Government policy within the UK to minimise the use of pesticides. There is a large volume of information and legislation related to pesticide use and this handbook does not attempt to re-present that information. Readers are referred to publications dealing with the law related to the handling and use of pesticides.

To help managers further assess situations where the use of herbicides may be appropriate for the management of scrub English Nature and FACT have produced: 'The Herbicide Handbook – Guidance on the use of herbicides on nature conservation sites' (2003). This provides further guidance on the selection of appropriate herbicides for use on different species and situations along with environmental information. In view of this only brief notes have been included in the species accounts, followed by references to the Herbicide Handbook. Herbicide application is dealt with in 5.8.16 and applicators are dealt with in 5.9.4.4.

Further reading and references

http://www.environment-agency.gov.uk/netregs/processes/342453/
Bacon, J (2002) *How 'green' is our land management*, ENACT 10 (2), pp 7-9. English Nature.
Britt C, Mole A, Kirkham F & Terry A, (2003) The *Herbicide Handbook – Guidance on the use of herbicides on nature conservation sites*. English Nature.
McKinley, R (2002) *The problem of arisings*. In: Proceedings of the 6th National Heathland Conference, Underhill-Day, J, Liley, D. eds, RSPB, Sandy. Pp78-80.

5.9.3 Design and landscape

Summary
Landscape considerations are important when establishing or managing scrub, particularly in sensitive areas such as National Parks, 'designed' landscapes, AONB's etc.

Attention to landscaping has been important in the past (e.g. 18th Century Parks) and increasingly so in the wider countryside and in urban settings. Management has to take account of historic landscapes. Planting in blocks and straight lines invariably creates harsh, unnatural effects, as does creating straight edges during scrub reduction. In mixed species planting, clumping usually achieves a more natural and aesthetic appearance.

Techniques
When trying to create a landscape that appears natural:
- Avoid planting in straight lines.
- Avoid planting at regular spacings.
- Avoid leaving straight edges.
- Clump the distribution of species into small groups; this creates patches of different hues and growth rates.
- Let natural regeneration replace failures to create a more varied structure.
- Leave some small gaps/glades that will infill over time with natural regeneration.
- Consider softening the edge with more scattered planting, especially scattered bushes or small groupings.

When managing existing scrub stands:
- Avoid creating straight edges.
- Try to create an edge with a varied height, by selecting appropriate specimens.
- Soften edges of stands by retaining small-scattered clumps or individual shrubs.
- Create small glades.

To plant or not to plant in a clearing? Roger Key/English Nature

The visual impact of scrub on flat terrain will be limited to the edge, so designing to fit into the landscape is relatively straightforward.

The complexity of integrating scrub with the landscape is increased with variation in topography, as it will be seen from a greater variety of angles and contexts. Scrub creation will work best where it most closely mimics natural situations, and the natural distribution of the species being planted. It is always very useful to visit sites with, or to refer to photographs of, similar habitats and topography to see how scrub is distributed in that landscape.

Choice of species:
Different species of tree and shrub have different foliage colours, shapes and heights. Species that are native and typical of the locality would give the most natural appearance in the landscape.

Locally appropriate species can be researched on the Natural History Museum website's postcode plant

database or the Flora Locale website, which provide local species lists and plant suppliers (see Appendix 8.11).

Shrubs grown from seed collected locally will flower and leaf at the same time as existing scrub of the same species, and therefore fit into a natural landscape. Plants sourced by nurseries may be from overseas and have different genotype.

Non-target impact
It is possible that a landscape design for scrub could conflict with historic features or conservation priorities. Any planting or management design for landscape should be cross-referenced to historic landscapes, conservation objectives and priority species sensitivity maps to avoid any damage to other interests.

Health and Safety
See Appendix 8.12 for a full discussion of Health & Safety issues. Those specific to design and landscape should include:

- Avoid planting in dangerous localities/situations.

Environment
See also Section 5.9.2.

- Avoid planting that will alter deposition of litter into or shading of watery habitats.
- Avoid planting non-native species or species not of local provenance.
- Avoid planting near or adjacent to priority habitats where the conservation interest will be compromised.
- Do not plant in a way that will damage historic landscapes.
- Be aware particularly of dead-wood community interests in historic parks and ancient woodlands and arrange any plantings to complement the interest.

Key sites
Moccas Park NNR, Herefordshire.
Contact: C/o English Nature, Bronsil House, Eastnor, Nr Ledbury, Herefordshire. HR8 1EP.
Tel: 01531 638501. (Permit required to visit).

(Please let us have some more examples).

Further reading
Anderson, P., (1996) *The wrong trees and what about the shrubs*. ENACT 4 (4), pp 20-22 English Nature.
Harding, P, T & Wall, T, (Eds) (2001) *Moccas: an English Deer Park*. Enact Vol 9 (4) 22.
Kirby, K., (1994) *Where should you put your new woods?* ENACT 2 (3), p 12-14. English Nature.
Poore, A. (2000) *Restoring Melbury Park Enact* Vol 8 (3) 15-18.

Advantages & Limitations of creating various landscape features

Method	Advantages	Limitations
Avoiding straight lines	• Natural appearance • Prevents wind funnelling – providing shelter	• Cannot be easily weeded mechanically.
Creating sinuous and softened edges	• Increased interface • Natural appearance • Sheltered microclimate	• More seeding into open habitats than straight edge. • Increased management effort.
Creating glades	• Diversifies scrub stand • Breaks up otherwise monotonous relief	• Increased management effort.
Local shrub provenance	• Suits local genotype • More invertebrate species adapted • Co-ordinated flowering and leaf break	• Effort required to collect seed. • Native nursery grown stock likely to be more expensive than imported.

5.9.4 Tools

There is a wide range of tools and equipment available for the management of scrub, and some tools can be used for a range of different management techniques. Refer to Table 5.2 (in Section 5.1.2) to consider which tools and equipment have application to which management technique.

As a general principle, starting work early whilst shrub seedlings and tree saplings are small will mean there is less work, which can be done with smaller cheaper equipment and with less arisings to be dealt with.

It is useful to consider a range of factors before deciding on which tools to use:

- Is it possible to use equipment that removes the stumps rather than just cutting off the stems. If so this will reduce the amount and cost of follow-up management in future years.

- Scale of the task: bigger jobs are more likely to lend themselves to mechanical management.

- The age and structure of the scrub: is it single or multi-stemmed?; has it been cut (coppiced) before in which case the stump and root plates will be larger and tougher?

- The species to be controlled: Section 4 details the growth characteristics and suitable control measures for a comprehensive list of shrub species.

- Topography and ground conditions: machinery may not be able to access steep, rough or boggy terrain.

Tools and equipment are discussed under the following categories:

- Non-powered hand tools – 5.9.4.1.

- Powered hand tools – 5.9.4.2.

- Power Take Off (PTO) and hydraulic powered equipment – 5.9.4.3.

- Herbicide application equipment – 5.9.4.4.

5.9.4.1 Non-powered hand tools

Summary
Hand tools are useful for small-scale work on small areas of scrub. They are time inefficient on larger jobs unless a large and willing work force is available.

Carry out operations when shrub seedlings and tree saplings are young and small. They will be easier to remove, work rates will be faster and demoralisation of the work force will be less.

Equipment that removes the stumps rather than just cutting off the stems will reduce the amount and cost of follow-up management in future years.

There is a wide range of hand tools: loppers, bow saws, billhooks and axes are the most common. Recently there have been several new tools arrive on the market. All, if used efficiently and safely, can be effective and have their place.

Conservation team clearing scrub by hand.
Kev Wilson/Lincolnshire Wildlife Trust

Techniques
Effort and hard work will be reduced if shrub seedlings and tree saplings are removed when still very young.

With the exception of the bow saw and mattock, most tools are only effective on scrub with stems up to c50 mm diameter. Wherever possible tools should be selected that will remove or kill the stump. This may take longer but will save repeat operations in future years to cut re-growth when the stump has re-grown.

Where stumps are not being removed then stems should be cut horizontally as close to the ground as possible, especially if it is anticipated that follow-up mowing will be necessary. Angled cuts leave sharp stumps, which can pierce footwear and tyres.

Tool range available
The choice of the appropriate tool will depend upon the nature of the scrub, site conditions and the ability of the user.

Root removal tools:
- Young saplings can be pulled, or levered out using the Lazy Dog tools.

- Small areas of small diameter saplings or surface rooted suckers can be tackled using mattocks.

- Larger stumps can be removed by digging around the roots with a mattock and pulling out with a winch.

Cutting off tools:
- Long-handled slashers can be used to tackle smaller stems, up to 50 mm where there is room to swing at the stems.

- Hand axes and billhooks can be used on larger stems up to 75 mm, and work better than slashers in tight spaces.

Slashers, axes and billhooks, need to be constantly sharpened, as trying to cut stems close to the ground quickly dulls the blades through striking stones.

- Long handled loppers are effective at cutting small shrubs up to 50 mm (with sturdy versions). They are easy to handle and do not require a wide safe working area.

- Bow saws are most effective on stems over 50mm diameter. They are simple and easy to use and, like loppers, can target the base of the stem and do not require a wide safe working area. They can cut very large stems of almost any size, but in practical terms, large areas of scrub containing stems over 150mm diameter are best cut with a power tool.

Non-target impact

- Inexperienced volunteers may be used in this work; supervision is required to ensure that non-target areas are not affected.
- A large group could damage sensitive areas by trampling.
- Brash dragging could damage particularly sensitive vegetation and features and spread shrub seeds.

Health and safety

See Appendix 8.12 for a full discussion of health and safety issues. Those specific to hand tools should include:

- Appropriate levels of training given to volunteers in tool use and safety.
- Long-handled mattocks, slashers, billhooks and hand axes require a wide, safe working area.

Environmental

See also Section 5.9.2.

- Arisings removed to avoid shading and weed infestation.

Key sites and contacts

(We are sure BTCV should be able to provide numerous site examples?).

Further reading and references

Agate, E., (2002), *Tool care*, BTCV.
Bacon, J., (2000) *Weed control… with a lazy dog?!* ENACT 8 (4), p 19-20. English Nature.
Roworth, P., (2002) Whats New? ENACT 10 (4), p 22. English Nature.

Advantages & Limitations of non-powered hand tools

Equipment	Advantages	Limitations
Gloved hands and long-handled weed pullers	• Minimum effort for maximum effect to catch shrubs when they are small. • No stump left to regrow. • Tools are cheap. • Workers need minimal experience and training. • Effective where access for larger equipment is not possible. • Low risk to non-target species. • Allows operator to select which shrubs are removed and which are left.	• Small seedlings/saplings only according to strength of operators and tools. • Motivation of operators required if tackling large areas. • Requires significant labour resources. • Health & Safety - risk of back injury.
Mattock	• Efficient on small stumps. • No stump left to re-grow. • As above.	• Strength and staying power of operators. • As above.
Mattock with winch	• Can tackle larger stumps than mattock alone. • No stump left to re-grow.	• Time consuming. • Requires winch anchor points. • Operators require winch certification.
Long-handled slasher	• Tools are cheap. • Workers need minimal experience and training. • Removes scrub before it becomes established. • Effective where access for larger equipment is not possible. • Low risk to non-target species.	• Stumps remain and will re-grow. • Motivation of operators required if tackling large areas. • Requires significant labour resources. • Only effective on small stems less than 50 mm diameter. • Health & Safety - risk of injury.
Billhook	• As above	• As above
Hand axe	• As above	• As above
Loppers	• As above	• As above • Only effective on stems up to 50 mm.
Bow saw	• As above	• As above • Effective on stems up to 150 mm.

5.9.4.2 Powered hand tools

Summary
Carry out operations when shrubs and tree saplings are young and small. They will be easier to remove, less arisings to dispose resulting in faster work rates and less demoralisation of the work force.

Equipment that removes the stumps rather than just cutting off the stems will reduce the amount and cost of follow-up management in future years.

Powered hand tools are used to cut small to moderate sized stands of scrub. They are quicker and more efficient than non-powered hand tools, with a lower risk of injury.

The machines available make it possible to tackle a range of scrub management tasks, from cutting young stands with clearing saws, regenerating scrub with pedestrian flail mowers, through cutting quite mature stands with chainsaws, to cutting roots or grinding out stumps.

Appropriate training and certification is required with the majority of machines described. All necessary health and safety precautions should be followed as well as the manufacturers instructions for using equipment.

Techniques
Powered hand tools are a quick and efficient way to deal with scrub stands of considerable size, making light of the most tedious of tasks. As with manual weeding and using non-powered tools, a methodical approach is required, systematically working across the stand cutting and removing the arisings.

A safe working area is needed between the machine operator and ground worker for clearing brash. Brash should not be allowed to build up around the operator and should be frequently cleared away.

If stumps are not being removed then it is good practice to cut stems as close to the ground as possible, for both ease of follow-up management and public safety.

Range available:
The range of power tools is wide and their use depends upon the specific task, limitations of site conditions and ability of the user or operator. Many require the operator to be trained and certificated in their use.

Tree felling using chainsaw. Peter Wakely/English Nature

Cutting off tools:
Pedestrian mowers can be used to cut young regenerating scrub and maintain sinuous edges, rides and glades between blocks of scrub, especially where livestock cannot be used. Reciprocating blade and rotary cutter designs are effective at mowing rides and glades and where any re-growth is fresh and succulent of the current years growth. Flail cutters are most appropriate for cutting woodier growth, being able to smash through and pulverise stems more easily.

Clearing saws, and chainsaws may be suitable for small to medium scale work and on sites where access is difficult for larger machinery.

Clearing saws are quick and efficient at cutting stands of small-stemmed shrubs up to 10 cm diameter. It is easy to over work them on thicker stems. Machines with large power units are best, as they will drive a larger, more robust blade. They require training and relevant certification, but unlike other smaller hand tools, have a much lower risk of back injury. (See Appendix 8.12 Health & Safety).

Chainsaws can be used on thicker stemmed bushes but like clearing saws, require a trained operator to carryout the work with the relevant certification (see Health & Safety). There is a risk of back injury if not using the correct posture when cutting.

There is a variety of saw sizes, for most scrub work small professional saws are most efficient and ergonomic.

Stump removal tools:
Root cutting chainsaw equipment is a recent development aimed at 'mechanising the mattock'. The equipment consists of a special hardened cutting chain operating on a special guide bar, within a chain cover that facilitates frequent debris removal. Designed to cut into the ground around small shrubs and previously cut stumps to sever roots and allow removal of the stump. Additional certification is required for use, as well as higher levels of protective clothing for the operator (see Appendix 8.12 Health & Safety).

Use on inappropriate substrates can damage the chain. They are suited to peat soils and those of 'soft' rock derivations. They are not suitable for soils where 'hard' (igneous derived) stones occur near the surface. Maintenance requirements are higher than for normal chain saws.

Stump grinders, can be trolley mounted with their size and power supply determining the size of stump they can grind away. Hardened tungsten teeth are set on a fast rotating wheel. The cutting wheel is passed back and forth across the stump, slowly grinding or chipping through the wood. (NB The Husqvarna trolley grinder is currently not available).

Small enough to be carried or wheeled into awkward areas they should only be used by an experienced operator. Work rates may be slow and the teeth can need frequent sharpening or replacement. Stumps with embedded stones may cause excessive wear.

Non-target impact
Supervision will be necessary to ensure the right areas and species are cut.

- Carefully plan and time access to the site with vehicles. Damage to sensitive features, compaction and erosion could occur.

Disposal of arisings
Before commencing any cutting, always consider first how you are going to deal with the arisings. It is very easy to cut down vast quantities of scrub, but removing it may be very time consuming and difficult (see 5.9.1).

Health and safety
See Appendix 8.12 for a full discussion of health and safety issues. Those specific to powered hand tools should include:

- Ensure a wide safe working area between the machine operator and other workers; a standard distance in excess of two times the height of the trees should be used.

- Badly sharpened or prolonged use of machinery, without taking suitable breaks, can lead to 'white finger' or Raynaud's Disease.

Environment
See also Section 5.9.2.

- Use environmentally approved fuels and oils for machines and chain saw chain lubrication.

Key sites and contacts

- Aston Rowant NNR,
  Contact: Graham Steven,
  English Nature, Foxhold House, Crookham Common,
  Thatcham, Berks RG19 8EL,
  tel 01635 268881
  e-mail graham.steven@english-nature.org.uk

- Beds, Cambs, Northants and P'boro Wildlife Trust
  Contact: Andy Fleckney, Priory Country Park,
  Barkers Lane, Bedford MK41 9SH
  tel: 01234 364213,
  e-mail: afleckney@bedswt.cix.co.uk

- Nottinghamshire Wildlife Trust (various reserves),
  Contact: Jeremy Fraser
  The Old Ragged School, Brook Street, Nottingham,
  NG1 1EA.
  tel: 0115-958-8242,
  email: jfraser@nottswt.cix.co.uk

- Westhay Moor NNR
  Contact: Kiff Hancock,
  Somerset Wildlife Trust.
  tel:01823 451587
  email: chancock@somwt.cix.co.uk

Further reading and references
Bacon, J., Newman, P., & **Overbury, T.**,(1998), *Modernising the mattock*, ENACT 6 (4) 15-18, English Nature.
Bacon, J.,(2002) *Modernising the mattock with the root-cutting chain-saw- information Pack* FACT, English Nature.
Lacey, P.,(1998) A saw for all seasons? A review of the Stihl 026 chainsaw. ENACT 6 (3), p 7-9. English Nature.

Advantages & Limitations of powered hand tools

Method	Advantages	Limitations
Root cutting chain saw equipment	• Removes stump so no re-growth from most shrub species roots. • Allows operator to select shrubs to be removed and those to be left. • Portable to all locations. • Low capital cost.	• Small stumps only. • Limited use on substrates where soil contains (igneous derived) stones occurring near the surface. • Increased maintenance. • Additional certification required. • Risk of Raynaud's Disease from blunt chains.
Pedestrian grinders	• Removes stump so no re-growth from most shrub species roots. • Portable to most locations. • Allows operator to select shrubs to be removed and those to be left. • Low capital cost.	• May not be available currently. • Can only grind small diameter stumps. • Risk of Raynaud's Disease from blunt chains.
Pedestrian mowers and flails	• Can access most difficult areas. • Comparatively easy to handle. • Can cut large areas of regenerating scrub. • Reduced likelihood of back injury. • Fast work rate.	• Re-growth will occur. • Only cuts comparatively young regeneration. • Mulches arisings, which are hard to collect. • Cutters easily replaced and or sharpened. • Less selective.
Clearing saw	• Can access most difficult areas. • Light and easy to handle. • Can cut small areas of young scrub. • Reduced likelihood of back injury. • Fast work rate. • Allows operator to select shrubs to be removed and those to be left.	• Re-growth will occur. • Need to be trained and certificated in use. • Only capable of cutting small diameter stems. • Requires wide safe working area. • Blades need to be kept sharp and balanced. • Risk of Raynaud's Disease from blunt blades. • Moderate risk of back injury.
Chainsaw	• Can access most difficult areas. • Light and easy to handle. • Can cut small areas of varying aged scrub. • Chain can be quickly and easily sharpened • Moderately fast work rate. • Allows operator to select shrubs to be removed and those to be left.	• Re-growth will occur. • Need to be trained and certificated in use. • Requires wide safe working area. • Blades need to be kept sharp and balanced. • Risk of Raynaud's Disease from blunt blades. • Moderate risk of back injury.

5.9.4.3 Power Take Off (PTO) and hydraulic powered machines

Summary
Equipment that removes the stumps rather than just cutting off the stems will reduce the amount and cost of follow-up management in future years.

Tractor driven machinery is powerful and capable of managing large areas of scrub quickly. The decision to use large machinery should be based on the objectives and resources available. Their effectiveness largely depends on site conditions; terrain, scale, ease of access and sensitivity of habitats and features.

Mounted machines are available to do a range of tasks; clearing scrub, mowing rides, and dealing with arisings. The range of machines available can deal with all ages and scales of scrub. Large jobs generally require large machines that are expensive, and it is usually more cost effective to contract hire than to purchase them unless the scale of the project warrants it or a sharing scheme is in use.

Large machines are generally less manoeuvrable than smaller ones. However, in skilled hands they can often be operated with great subtlety and can work around sensitive ecological or archaeological interest.

Techniques
Power Take Off (PTO) and hydraulic powered machines are usually operated from tractors, though some mechanical excavators and 4x4 vehicles may have a PTO or hydraulic take-off fitted. There are increasingly more specialist all-terrain-vehicles (ATVs) that can have PTO or hydraulic drive couplings, both front and rear mounted.

The weight of the tractor and machine need to be considered. Soft ground will be vulnerable to rutting, compaction or churning when turning, if this is localised it may be acceptable. Overall weight may be less important than ground pressure, which can be reduced by use of multiple wheels, cage wheels, balloon tyres, tracks or matts.

Flails and grinders are likely to damage any surface archaeological interest and must not be used where a risk exists.

It is very important that features of importance are clearly marked and the machine operator advised. An experienced operator will readily understand his/her brief, and with the understanding of the machines' capabilities can contribute to problem solving.

Forestry mulcher. John Bacon/English Nature

Machinery range available
There is a wide range of models available of varying size and power of both machine and tractor to run it. Choice of machine should be dictated by suitability of its attributes to the working conditions on site. Large machinery can inherit costly running overheads and may lay idle for long periods. The scale of economics usually makes it a more viable option to employ a contractor, especially where larger specialist machinery is required. Another option is to network through a machinery ring, which share use and are increasingly making specialist machines available.

Cutting machines
Mowers and swipes can be used to manage grass rides, glades and scrub edge where scrub encroachment is very young and succulent. Ride on mowers may be suitable for small areas and where access is difficult and the scrub is young.

Elsewhere larger tractor mounted machines have quicker work rates and are more robust. These are usually mounted on the linkage and run from the PTO. Some can be adapted to fit on a hydraulic arm on a tractor, tracked vehicle, or 'walking' vehicle to give access to steep or inaccessible terrain. The frequency of cut will be dependent on the management objectives. Some species

such as Blackthorn increase suckering intensity and require frequent mowing throughout the growing season. Where grazing is not an option, mowers can also be used to maintain or create rides, glades and sinuous edges between blocks of scrub.

Flails
Flails can be front or rear mounted to tractors, or onto the arms of excavators. They are more robust than rotary mowers with cutters or chains rotating on a high-speed cylinder and able to cope with woody stems and older re-growth.

Those mounted on the tractor linkage can be used wherever the tractor can go. Some small self-propelled machines have been developed that can access very steep ground and steep banks safely. For operating over hedges or ditches the standard hedge trimming flail can be used. A slow pass over the scrub will have most effect at smashing and grinding the stems.

Cut and collect flails and standard agricultural forage harvesters are used to collect cut grass or other crops. There are several specially designed cut and collect machines now available for working on rough terrain grasslands and heaths. Double chop forage harvesters are largely obsolete in agriculture but have a real value in conservation and do a similar job to the cut and collect flails. They cut the grass, heather, etc., and collect in a single operation.

They can be used to remove grass thatch in preparation for scrub regeneration, and to clear pioneer scrub. Some machines have been adapted to deal with older more woody material. Heavy-duty cutter knives are used and the clutch and shear pins are upgraded to cope with the additional pressure. These suit young thicket stage, soft wooded scrub, such as pine, willow or gorse that requires cutting.

Forage harvesters have been successfully operated in rough conditions on lowland heathland and moorland, and are robust.

Most forage harvesters can tow a trailer. It is most efficient to operate with a second tractor, trailer and driver, to shuttle the cuttings to the disposal site. The operation is not as quick as mowing with a swipe or disc, but is more efficient wherever the material is to be collected.

Forest mulchers are the biggest of the flails and are either front or rear mounted to a high-powered tractor. The hammers or teeth are fixed or hinged spirally onto a high-speed, rotating cylinder. The blade guard adjusts for varying effect. They are much more robust than conventional flails, and especially suitable for clearing mature scrub, mulching stems and stumps to ground level. Linkage mounted models can access most terrain, but models are available to run from hydraulic arms of tracked excavators to access steep bluffs or over obstacles.

Working on stony sites will cause wear to the blades; this should always be taken into account when considering the suitability of the machine to do the work. Mulching generates a large volume of arisings left on the ground, which if left may enrich the soil and suppress regeneration.

Stump removing machines
Tree lifters are used in the tree nursery industry for lifting rooted saplings. By using the smallest diameter blades they can be used to lift shrubs. The blade vibrates through small roots severing them and leaving them in the ground allowing the shrub to be lifted out with minimal root and soil around the stump.

Grinders come in various sizes mounted and powered by PTO or hydraulic drives and mounted on large tractors or excavators. This determines the size of stump they can grind. Stones or metal in the stump can cause wear and breakages. Medium to large sizes of stump can be ground down to below the ground surface.

Disposal of arisings
- Flailing and mulching generate a large volume of material that is difficult to handle so disposal is often problematic.

- The arisings from flailing or mulching usually need to be removed as they suppress seedlings and regeneration and can enrich the soil. This can be time consuming and expensive to do, so consideration should be given to cut and collect methods and machinery.

- Chips and mulch can be 'hoovered' using a specialist tractor mounted suction pump (some lighter models are made for the livery industry) and loaded into a trailer for removal or burnt on site.

Non-target impact
- Existing conservation features or surface archaeological interest may be at risk from the use of flails and mulchers. Important plants and invertebrates could be eradicated, and historical features irreparably damaged.

- The combined weight of tractor and machine could damage sensitive ecological and archaeological interest, especially in soft ground.

- Small features may need to be managed by less robust methods and machinery.

Health and safety

See Appendix 8.12 for a full discussion of health and safety issues. Those specific to PTO machines include:

- high risks associated with using heavy plant on nature conservation sites such as working on rough or wet ground, which can create unstable working conditions.
- need for a wide safe working area between the machine and any ground workers.

Environment

See also Section 5.9.2.

All of the entries set out in 5.9.2 apply to this Section.

Advantages & Limitations of PTO driven machines

Method	Advantages	Limitations
Tree lifting machines (e.g. Holmac)	• Removes stumps so no regrowth. • Minimal soil disturbance.	• Can only extract small and medium sized stumps. • Cannot work in soils with large stones or flints. • Expensive machines and may not be readily hireable except out of nursery tree lifting season. • Very heavy and although running on tracks has a high ground pressure. • Cannot navigate slopes greater than 20 degrees.
Grinders	• Grinds stumps away so no re-growth. • Grinds medium, large and very large stumps. • Stumps removed with minimal soil disturbance.	• High wear and tear rates in stoney ground. • Large models require large power unit to drive them.
Ride-on mowers	• Access small site with difficult access. • Manoeuvrability in restricted areas and glades.	• Re-growth will occur. • Limited capacity for cutting woody scrub. • Only suitable for small areas. • Arisings need to be collected.
Swipes and disc mowers	• Fast work rate in managing rides and glades. • Cover larger areas.	• Re-growth will occur. • Limited manoeuvrability in tight corners. • Arisings need to be collected.
Flails	• Fast work rate on light scrub. • Will deal with dense stands. • Capable of cutting large areas of young regenerating scrub and sward between stands.	• Re-growth will occur. • Limited working capacity for cutting woody scrub. • Arisings need to be collected. • Difficult access into small areas.
Cut and collect flails and forage harvesters	• Collect arisings. • Will cut early stage regenerating scrub. • Deal efficiently with large areas of regenerating or establishing scrub.	• Re-growth will occur. • Only able to deal with soft wood species. • Cannot access small areas or very rough terrain. • Need to deal with arisings.
Mulchers	• Capable of dealing with large areas of established scrub. • Fast work rate. • On stone free ground can mulch stumps down to ground level and even 5 cms into the ground so reducing re-growth. • Limited re-growth depending on depth of work.	• Leaves deep bed of arisings that need to be collected. • Cannot access into small awkward areas. • Expensive to hire and high maintenance costs, especially on stoney ground. • Will be re-growth if stumps unaffected.

Key sites and contacts

- Aston Rowant NNR,
  Contact: Graham Steven,
  English Nature, Foxhold House, Crookham Common,
  Thatcham, Berks RG19 8EL,
  tel 01635 268881
  email: graham.steven@english-nature.org.uk

- Martin Down NNR,
  Contact: David Burton,
  English Nature, Cherry Lodge, Shrewton, Salisbury
  Wilts. SP3 4ET.
  tel: 01980 620485
  email: david.burton@english-nature.org.uk

- Nottinghamshire Wildlife Trust (various reserves),
  Contact: Jeremy Fraser
  The Old Ragged School, Brook Street, Nottingham,
  NG1 1EA.
  tel: 0115-958-8242,
  email: jfraser@nottswt.cix.co.uk

Further reading and references

Bacon J., Catling H., (1998) Ringing machines. Enact 6 (2) p 10-11. English Nature.
Bacon J., Newman P., and Overbury T., (1998) *The Holmac* HZC 16-22 *stump lifter* in Modernising the mattock. Enact 6 (4) 15-18 English Nature.
Bacon, J., (1999) *Back to Purple with mean machines* ENACT 7 (2), p 4-6. English Nature.
Henshilwood, D., (1993) *Terratrac at Pagham Harbour*. ENACT 1 (1) p21 English Nature.
Roworth, P., (1998) AEBI Hydrocut HC55 Mower ENACT 6 (3), p 10. English Nature.
Roworth, P., (2002) Whats New? ENACT 10 (2), p 20-21. English Nature.
Roworth, P., (2002) Whats New? ENACT 10 (4), p 22. English Nature.
Symes, N., Pickess, B., and Auld, M., (1993), *Machinery for heathland management (product review)*, ENACT 1 (2) English Nature.

5.9.4.4 Herbicide applicators

Summary
Herbicides should only be used after alternative methods of scrub management have been considered and ruled out in order to comply with the Governments 'pesticide minimisation' policy.

Techniques that enable targeting of the herbicides on the 'weed' to be treated are to be preferred to those that are less precise. Targeted application methods include hand application to individual stumps or bushes by paint brush, hand held weed wipe, lance and knapsack applicator. On rougher terrain ATVs or tractors can use weed–wipes or hand lances fed from a bowser.

Less targeted applicators, include tractor mounted or ATV boom sprayers. Areas of contiguous target species can be treated via Controlled Droplet (CDA) and Ultra Low Volume (ULV) applicators though both have disadvantages.

All of the application techniques have the ability to kill the shrubs and prevent re-growth from the stumps depending on: the choice of herbicide; timing of application; weather conditions at time of application; provided attention is paid to ensuring best practice application procedures, and, weather conditions in the days following application.

Techniques and range of equipment:

Targeted applicators
Paint brushes, hand held weed-wipes, enable precise application to target vegetation and stumps. Both methods are slow and suitable for small-scale treatments only. Hand held weed–wipes are currently only available as wick types.

Knapsack sprayers, are moderately targeted systems depending on the skill of the operator and the use of shields and are commonly used for small scale herbicide application. Reduced pressure and larger droplet size can reduce splash or mist effects on non-target plants. The active chemical is diluted in the knapsack tank, which can have a capacity of up to 30 litres, although for health and safety reasons, 10 or 20 litre versions are more practical. Pressure is derived from a hand lever pump and the chemical is delivered through a spray nozzle specific to the type of application, on a hand lance.

Nozzle size and operator walking pace is used to calculate the calibration and application rate.

Weedwiping birch saplings. Martin Davey/English Nature

ATV or tractor mounted weed wipers, feed the chemical to a rope wick, carpets or rollers mounted on booms, which wipe the foliage of the target species.

Wipes that enable control of the herbicide flow rate reduce risk of dripping. A recent product is a weed wipe where the wick saturation is monitored by a hydrostat electronic control that maintains the correct saturation regardless of speed or target density.

Mounted or trailed weed wipes are height adjustable but require target vegetation to be taller than surrounding non-targets. By planning ahead grazing can be used to produce a height differential where non-target species are more palatable than targets. Where scrub regeneration has overtopped the associated vegetation there is no risk of collateral damage. Wipes are also useful when working near watercourses as they eliminate risk of spray drift.

Bowser and hand held lance applicators, use tanks of diluted chemical carried on tractors or towed behind ATVs, or any vehicle suitable for the access and terrain of the site. These are useful when covering large areas, as follow up spot treatment, or on land inaccessible to a boom sprayer or weed wipe. The chemical is pumped to a lance attached to a long extending hose, removing the need for the operator to carry a heavy knapsack around.

Nozzle size and operator walking pace is used to calculate the calibration and application rate.

Non-targeted applicators
CDA sprayers deliver even sized droplets in the 200-300 microns range which reduces the risk of drift common to smaller droplet size, or the risk of splash experienced by larger droplet size.

ULV sprayers produce a fine mist type spray which is drifted across the target area, using a high-speed spinning disc by the operator walks across the breeze, through the vegetation at appropriate intervals, so the spray drifts onto the target. This is inevitably an indiscriminate method only suitable for areas with total cover of target species, and with no risk of drift onto nearby sensitive species.

Both CDA's and ULV's are usually hand held.

Boom-sprayers, are usually mounted on a tractor or ATV. Tank sizes vary depending on the machine. They are most suitable on even terrain, as boom-bounce that occurs on rough ground will affect spray application. Shorter (6–m) booms minimise this problem. The height the boom is set is dependant on vegetation height.

Nozzles are at set intervals along the boom to provide an even spread of application. Nozzle size and type is governed by the herbicide label, and the dilution rate is calibrated with ground speed and nozzle delivery rate.

Health and Safety
See Appendix 8.12 for a full discussion of Health & Safety issues. Those specific to herbicide applicators include:

- Readers are referred to product labels and legal requirements relating to the use of pesticides.

Environment
See also Section 5.9.2.

- Due to the potential for environmental harm from pesticides every effort should be made to minimise the use of herbicides and to prevent application to non-target vegetation or surfaces.

- Splash, drift and volatisation can be reduced by adoption of best practice techniques and application only in suitable weather conditions.

Key sites
- Beds, Cambs, Northants and P'boro Wildlife Trust
  Contact: Andy Fleckney,
  Priory Country Park, Barkers Lane, Bedford MK41 9SH
  tel: 01234 364213,
  e-mail: afleckney@bedswt.cix.co.uk

- Eskmeals, Cumbria.
  Contact: Kerry Milligan,
  Cumbria Wildlife Trust
  e-mail: kerrym@cumbriawilldifetrust.org.uk

- Foulshaw, Cumbria
  Contact: John Dunbavin,
  Cumbria Wildlife Trust,
  e-mail: johnd@cumbriawildlifetrust.org.uk

- Hutton Roof Crags, Cumbria
  Contact: Kerry Milligan,
  Cumbria Wildlife Trust
  e-mail: kerrym@cumbriawilldifetrust.org.uk

- Nottinghamshire Wildlife Trust (various reserves),
  Contact: Jeremy Fraser
  The Old Ragged School, Brook Street, Nottingham,
  NG1 1EA.
  tel: 0115-958-8242,
  email: jfraser@nottswt.cix.co.uk

- Therfield Heath, Hertfordshire
  Contact: Eoin Bell,
  Herts County Council
  tel:01922 555279,
  email eion.bell@hertscc.gov.uk

- Westhay Moor NNR
  Contact: Kiff Hancock,
  Somerset Wildlife Trust.
  tel:01823 451587
  email: chancock@somwt.cix.co.uk

Further reading
Bacon, J., (1995) *Removing the prickles* ENACT 3 (2), pp 10-11 English Nature.
Bacon, J., and Overbury, T., (2000) *Pedestrian and scrub weed-wipers*. ENACT 8 (4), p 16-19. English Nature.
Bacon, J., Barnes, N., Coleshaw, T., Robinson, T., Tither, J., (2001, 2nd ed), *Practical solutions handbook*, FACT, English Nature (Section 2.3. Weed wipe manufacturers.
Bacon J., (2002) How green is your land management. Enact 10 (2) 7-9. English Nature.
Bacon J., (2003) Getting the best out of Wipers. English Nature (unpublished).
Ferguson, A., (2000) *Chemical control of standing scrub at Rhos Goch National Nature Reserve*, CCW.
Ferguson, A., (2000), *Scrub management by chemical injection into standing stems*, CCW.
Roworth, P., (2002) Whats New? ENACT 10 (4), p 22. English Nature.

Advantages & limitations of herbicide application methods. (See HH Section 3.2 for more detail).

Method	Advantages	Limitations
Stem injection	• *Very targeted and contained.*	*Not yet approved as an application system in the UK. (Application pending).*
Paint brushes, hand held weed wipes and crystals.	• Very targeted so low risk to non-targeted species. • Minimal collateral damage. • Light weight and ergonomic. • Works in tight areas.	• Slow work rate. • Frequent refills needed. • May require more than one application.
ATV and tractor mounted weed wipes	• Can cover large areas. • No spray drift. • Reduced amount of herbicide used.	• Requires height differential of target shrub vegetation over underlying vegetation. • Operators need special certification. • Slow forward speed required to ensure good wiping of weeds.
Knapsack sprays	• Accessible to difficult areas. • Fairly precise application if guarded. • Suitable for follow-up work. • Suitable for small treatments.	• Risk of back injury. • Can affect non-target species. • Slow work rate.
Bowser and lance	• Covers large areas (slowly). • Fairly precise application if guarded. • Suitable for follow-up work. • Can access most areas if ATV mounted.	• Can affect non-target species. • Moderate work rate.
Tractor-mounted and other boom sprayers	• Can cover large areas quickly. • Good foliage coverage.	• Not targeted. • Limited by weather conditions. • Risk of spray drift. • Cannot access rough terrain. • Not suitable for taller growth, although boom height can be raised.
CDA spray	• Accessible to difficult areas. • Droplet size reduces drift. • Droplet size minimises splash.	• Will affect non-target species.
ULV spray	• Accessible to difficult areas.	• Will affect non-target species. • Fine particle size susceptible to drift beyond targets. • Requires buffer strips.

Section 5 Further references and reading

Anderson, P. & Gilbert O L., (1998), *Habitat Creation and Repair*, Oxford University Press.

Anon, (2002), *Soil Association technical guides – Organic livestock management on nature conservation sites.* Soil Association.

Anon, (2002), *Soil Association technical guides – Organic weed and scrub control on nature conservation sites.* Soil Association.

Ash, D., Burton, D., Smith, L., Toynton, P., (2001) *Getting down to scrub management*, ENACT 9 (4), pp15-18, English Nature.

Bacon, J. and Catling, H., (1998) *Ringing machines.* ENACT 6 (2), p 10-11. English Nature.

Bacon, J., Barnes, N., Coleshaw, T., Robinson, T., Tither, J., (2001, 2nd ed), *Practical solutions handbook*, FACT, English Nature.

Kirby, P., (2001): *Habitat Management for Invertebrates: a practical handbook*. RSPB, Peterborough.

Le Bas, B., (2002) *The fellowship of the ring*, ENACT 10 (2), pp 4-6. English Nature.

Sutherland, W. J., & Hill, D. A., (1995), *Managing Habitats for Conservation*, Cambridge University Press, Cambridge.

Toynton, P., Cox, M., (1994), *Scrub management*, ENACT 2 (1), pp10-11, English Nature.

Ward,L. K., (1990): *Management of grassland and scrub mosaics*, pp134-139. In: Hillier, S.H., Walton.