12 *Scrub management*

12.1 General principles

12.1.1 Introduction

In the absence of management, most semi-natural UK grasslands would become invaded by shrubs and trees and pass through a phase of scrub before becoming secondary woodland. This would result in the gradual replacement of grassland plants and animals by a range of woodland species. Chapter 2 lists the woody species and scrub types associated with semi-natural grassland. A more detailed description of scrub types can be found in Rodwell (1991a).

Ward (1990) provides an account of the ecological dynamics of this relationship, drawing particular attention to the population of small shrubs present in most pastures, but suppressed by grazing. Morris (1990) provides an analysis of the way in which this successional change in grassland affects invertebrates.

A relaxation or abandonment of grazing, due to a relative decline in the profitability of livestock farming on unimproved grassland (compared with intensively farmed grassland) has resulted in the invasion of many sites with woody shrubs and tree saplings. The myxomatosis epidemic of the 1950s and a general decline in livestock numbers was widely followed by an increase in scrub.

It is usually important to prevent the spread of scrub on most grassland sites and large resources are devoted each year to scrub control and eradication in lowland areas.

However, in certain circumstances scrub vegetation, or more often the vegetation of scrub-grassland margins, can be an important habitat for rare and local species (see Chapter 2, section 2.8, sub-section 2.8.3 and Chapter 12, section 12.1, sub-section 12.1.3). There are also certain rare scrub types such as box *Buxus sempervirens* scrub. In these two cases scrub is a feature to be positively managed.

In the hill farming areas of the UK , intensive grazing has severely reduced the amount of scrub in recent decades, making it a rare and threatened habitat in the north and west.

The rate of scrub invasion depends on a number of factors including:

- Soil depth - scrub develops more quickly on deep fertile soils than on thin nutrient poor soils.
- Proximity to a source of colonisers.
- Tall grasses and herbs (a deep litter layer may inhibit the establishment and growth of scrub).
- Mechanism of dispersal and seed size (Ward 1990).

12.1.2 Landscape context

As a general rule the most important areas of scrub, particularly those with a well-developed marginal zone are to be found in landscapes where ancient woodland adjoins grassland. Here scrub vegetation has existed at the boundary between these habitats for a long time, apparently allowing the diversification of the scrub habitat and its wildlife and perhaps creating conditions for species previously found in natural woodland clearings. (Figure 12.1.)

Scrub of high conservation value often occurs where there is natural rock outcropping, or other inhospitable areas for plant growth, such as screes or flushes. These help to prevent scrub and woodland canopy closure and create natural conditions favoured by a range of rare and local species of the scrub fringe.

Most of the nationally important scrub habitat found in the UK occurs on or around cliff slopes, scarps, or limestone pavements, for example on basalt cliffs in County Antrim, on the North and South Downs, in the Arnside-Silverdale area of Lancashire/Cumbria and in the Derbyshire Dales.

12.1.3 Conservation evaluation

Before taking decisions about scrub management it is important to assess the conservation value of the scrub habitat.

Scrub can be the most important habitat type on the site and be of national scientific interest, alternatively it may have a negative conservation value because, if allowed to develop further by spread or canopy closure, it would exclude important grassland plants and add little of significance to the flora and fauna of the site in return.

Many areas of scrub are of intermediate importance, add to the diversity of the site through the presence of a range of shrub species and other associated plants and animals (see also sections 12.2 and 12.3).

To assist decision making it is possible to characterise the two extreme types of scrub as follows:

Scrub of high conservation value

- Contains a wide range of shrub species with a mixed age structure.
- Has a complex three dimensional structure ie variation in physical structure, age composition and spacing.
- Has many clearings and glades within the scrub giving a high boundary/area ratio.

ZONE A	ZONE B	ZONE C	ZONE D
Woodland lacking grassland plant species	'Mantle' zone of shrubs, many of the Rose (Rosaceae) family. Ground flora consists of woodland and 'Saum' plant species unless grazed where grassland species would predominate	'Saum' zone dominated by tall herbs and grasses including rare species. Many typical grassland plants occur as unusual large forms.	'True' grassland in which low-growing species are more abundant.

Figure 12.1 The woodland-grassland ecotone

- Has a well developed marginal zone which contains a range of tall herbs and other grazing intolerant species which do not occur within the adjoining grassland unless this is also ungrazed. Such vegetation is referred to as 'saum' or 'ourlet' on the continent. Warmth requiring, drought resistant fringe communities are referred to the *Trifolio-geranieta* class of continental phytosociology (Ellenberg 1988). Bloody crane's-bill *Geranium sanguineum* is a characteristic species of these communities. Such vegetation is found in the UK, but is not described as a separate community in the National Vegetation Classification[1]. On acid soils there are tall herb communities with wood sage *Teucrium scorodonia* which may be akin to 'Saum' vegetation. The relationship of these to the NVC is unclear. A list of rare and local plant species characteristic of such scrub margin habitat is given in Table 12.1.

- Supports a range of rare or local invertebrates in the marginal zones where grassland plants, preferred for egg laying, are found eg Duke of Burgundy *Hamearis lucina* on cowslip *Primula veris*, or feeding or sheltering on the shrubs themselves, eg black hairstreak *Strymonidia pruni* on blackthorn *Prunus spinosa*. (See Kirby 1992; Gardiner 1996.)

Scrub of low conservation value

- Is dominated by one species with all individuals about the same size.

- Has simple three dimensional structure with the shrub canopy of even height and bushes rather equally spaced, sometimes providing a closed canopy beneath which little grows.

- Has a scrub margin which is floristically very similar to that of the adjoining grassland and contains no enriching element of tall herb species (see Table 12.1). If tall herbs and grasses are present then they are widespread species of nutrient-rich soils such as hogweed *Heracleum sphondylium*, false oat-grass *Arrhenatherum elatius* etc.

- Has no rare or local invertebrates on the scrub margins or on the scrub itself.

Most scrub will fall between these two extremes. There are some important exceptions to these guidelines for evaluating scrub vegetation (see Duffey *et al* 1974, Ratcliffe 1977). Most notably the rare types of often species-poor scrub dominated by juniper *Juniperus communis* or box *Buxus sempervirens* are of high intrinsic interest. On occasions rare plants and animals are found in rather unexceptional stands of scrub for no apparent reason other than the chance events of dispersal and establishment.

The major structural of scrub types are illustrated in Figure 12.2.

[1] Nitrate and higher humidity requiring fringe communities (class *Artemiseta*) of Europe may have affinities with a rare community in Britain that can occur on scrub margins, the MG2 *Arrhenatherum elatius - Filipendula ulmaria* tall-herb grassland and with other communities described by NVC. The *Pimpinella* variant of the MG1e *Centaurea nigra* sub-community which is characteristic of steep, rocky slopes may be such an example (Rodwell 1992). This variant may well prove to be semi-natural in origin.

Figure 12.1.1

Closed scrub. Canopy closure results in the shading out of nearly all ground flora and conditions for plant growth are made even more difficult due to the build up of a deep litter layer. Even woodland plants find such conditions difficult.

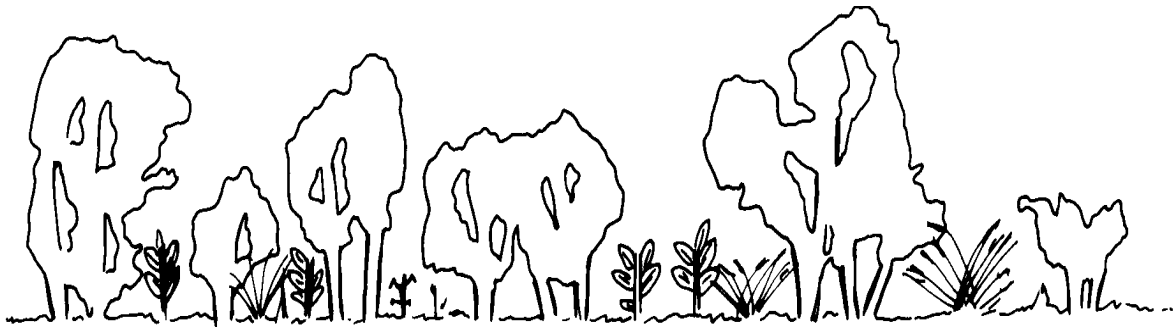

Figure 12.1.2

Scrub of high nature conservation value is characterised by a diverse range of scrub species and a complex canopy structure. There are many gaps allowing the survival of grassland and 'saum' species.

Figure 12.1.3

Scrub of low nature conservation value consists of one or two scrub species and has a uniform canopy. Bushes are often evenly spaced and can close rapidly to shade out grassland species in the gaps. 'Saum' species are likely to be absent.

Figure 12.2 Major structural types of scrub

12.1.4 Effects of scrub on grassland organisms

Scrub species often flower and fruit profusely providing food supplies and shelter from wind exposure and predation for grassland animals. Scattered bushes may also have an associated fauna which is not found in grassland or closed scrub. Indeed there may be a requirement of scattered bushes in a range of age classes to cater for faunistic changes which occur as shrubs mature (Kirby 1992). A moderate amount of scrub and some scattered bushes on a site can be beneficial (see section 12.3).

12.1.5 Prioritising areas for management

The appropriate scrub management regime to be adopted is likely to vary considerably from site to site and even within different parts of the same site, and involve eradication, maintenance or enhancement.

Particular priority should be given to scrub management in situations where the scrub margin has a range of tall 'saum' species or rare invertebrates more or less confined to this type of habitat in Britain.

A second priority is to control or remove invading scrub in areas with an important grassland flora or fauna.

A common mistake is to concentrate on areas which have become closed scrub, and have a dense canopy beneath where there is little plant growth. It may not be possible to restore these areas to species-rich grassland. This is because the surface layers of the soil gradually becomes enriched in organic material as the scrub develops, and there is an associated build up of plant nutrients which is difficult or impossible to reverse. The most important element to build up is phosphorus, an immobile element which is only very slowly lost from soil.

As the grassland flora has disappeared there is no new seed being introduced into the soil seed bank. The seeds of most grassland species of nature conservation interest are short lived in the soil so the seed bank under closed scrub is composed largely of weedy or competitive species of low nature conservation value.

Clearance of closed scrub will often result in growth of common annual and perennial weeds which, if managed by grazing or cutting, will develop into species-poor grassland of negligible nature conservation value.

There may be some benefit in carrying out trial management of closed scrub areas, provided that higher priority areas are being managed successfully. On steep slopes, where the surface soil quickly washes away after vegetation clearance, or where soils are very thin and less nutrient-retentive, clearance of closed scrub can sometimes allow species-rich grassland to redevelop. Physical removal of top soil removes nutrients, but is unlikely to be a practical option where large areas of closed scrub canopy have developed.

Generally it is most sensible to concentrate scrub clearance in those areas where the scrub is very open, and the grassland flora beneath the bushes is still similar to that in areas which have not been invaded by scrub.

12.1.6 Management options and methods

Scrub management will normally involve the cutting and removal of shrubs, although burning or grazing with goats might be considered.

Although most scrub management involves shrub removal at some stage, it can have three objectives requiring different methods. These include:

- Eradication or reduction.
- Maintenance.
- Enhancement.

12.1.7 Eradication or reduction of scrub

This is most appropriate in areas where scrub is of low conservation value and may spread to eradicate grassland of nature conservation interest. Conservation benefit will not result simply by cutting scrub and removing shrubs. The cut stumps will normally regrow very quickly, often into a more closed canopy than existed before the cutting took place and creating multi-stemmed bushes which are more difficult to cut afterwards.

Initial treatment

Before beginning a scrub cutting programme it is important to consider the resources available for follow-up treatment. Scrub cutting without further management can increase the vigour of scrub and stimulate regrowth.

During the winter months cut the stems of unwanted bushes as near to the base as possible. It is best to choose bushes which are more than 1cm thick, as a high percentage of smaller bushes will die naturally. It is more effective to cut small bushes in subsequent years if they become a problem, rather than divert resources to work which is time-consuming and likely to be undertaken by disease, herbivores, weather and competition.

Techniques of scrub cutting and removal

Hand tools

It will probably be impractical to clear a large site using tools such as saws, mattocks and axes. Hand tools are useful on sites where machine access is difficult ie on steep slopes or when scrub is dense.

Table 12.1 Rare and local plant species particularly characteristic of scrub margins and ecologically similar habitats

Actaea spicata	Baneberry
Aquilegia vulgaris	Columbine
Astragalus glycyphyllos	Wild liquorice
Carex depauperata	Starved wood-sedge
Convallaria majalis	Lily-of-the-valley
Epipactis atrorubens	Dark-red helleborine
E. helleborine	Broad-leaved helleborine
Geranium sanguineum	Bloody crane's-bill
Himantoglossum hircinum	Lizard orchid
Hypericum montanum	Pale St John's-wort
Lathyrus nissolia	Grass vetchling
Lithospermum purpureocaeruleum	Purple gromwell
Melica nutans	Mountain Melick
Melittis melissophyllum	Bastard balm
Ophrys insectifera	Fly orchid
Orobanche hederae	Ivy broomrape
O.elatior	Knapweed broomrape
Phyteuma spicatum	Spiked rampion
Polemonium caeruleum	Jacob's-ladder
Scrophularia scorodonia	Balm-leaved figwort
Sedum telephium	Orpine
Thalictrum minus	Lesser meadow-rue
Trollius europaeus	Globeflower
Vicia orobus	Wood bitter-vetch
Vicia lutea	Yellow-vetch

These types of tools can be used to tackle scrub from about 5cm-10cm in diameter. Loppers can be used on growth smaller than this.

Power driven hand tools

Power tools such as chainsaws, clearing saws and brushcutters (if equipped with a suitable heavy duty blade) can tackle bigger growth. Larger areas can be cleared more quickly. Staff and volunteers must be trained in the safe use of such equipment and protective clothing must always be worn.

Large machinery

Larger machinery such as tractor-mounted flails and swipes, sickle-bar mowers and forage harvesters can be used on larger sites (see Chapter 5 for more information). This method is effective for small-stemmed bushes. It is not a good method where species with creeping habits, such as privet *Ligustrum vulgare* and dogwood *Cornus sanguinea* are concerned as they will gradually become dominant in the sward (Toynton & Cox 1994). In some instances scrub can be removed using a JCB with a 'drott' (root fork) or a mini-excavator. Trees and bushes up to about 25cms in diameter can be dealt with but the method is probably best for stems between 2.5cm and 15cm (Toynton & Cox 1994). However, this method can rip the turf leaving bare patches and is only appropriate in areas of low conservation interest. It is important to check for and remove any seedlings or root fragments as scrub can regenerate from these.

At Ainsdale Sandhills Local Nature Reserve, sea buckthorn *Hippophae rhamnoides*, which was introduced 100 years ago has spread with the resultant loss of dune habitat and associated species. Due to the extensive area of scrub, mechanical clearance was considered appropriate (Rooney 1998). This initially involved the use of a 4WD JCB with a four-in-one bucket and back hoe and a Massey Ferguson CAT 931 tracked bulldozer with a four-in-one bucket which proved effective on level ground with easy access. On steeper slopes and where access was more restricted, a 12-tonne Hi-mac excavator fitted with wide pads for low ground pressure and fitted with a specially fabricated rake attachment 1.5mm wide with 11 70cm-long tines has proved effective for grubbing out scrub and roots. This had advantages over the bulldozer and JCB as its long arm and manoeuvrability allowed access to scrub in dune slopes and hollows with minimal movement over the ground thus restricting disturbance to dune topography (see Rooney 1998 for further information).

Important considerations

- Large machinery should not be used on steep slopes, ie greater than 10E.
- Heavy machinery can cause damage to wet soils.
- Removing scrub gradually eg at a rate of 1m-2m a year may reduce the problem of weed colonisation on exposed nutrient enriched soils.
- Cuttings should be removed to avoid smothering grassland and enriching the soil.
- Cut scrub could be sold as firewood or burnt (this should be off-site or on an area of no conservation importance) or chipped. The woodchips can be used to surface footpaths. Tractor-

mounted chippers which can cope with material up to 20cm in diameter can be useful in this context.

" Concentrate on areas of most potential conservation gain initially eg areas of most recently invaded grassland.

Follow-up treatment

Cut stumps should be treated immediately with a suitable herbicide as recommended by the manufacturers. Chemicals should only be applied by a trained and suitably qualified operator (see Ministry of Agriculture, Fisheries and Food & Health and Safety Commission (1998) for details). Notch the cut surface close to the bark with a chainsaw or small axe. This is to enable the chemical to get into the cambium cells so that it will be translocated down to the root.

Certain chemicals can be applied to the stump with a paintbrush, using a wetting agent listed on the pesticide label or in the list of approved adjuvants (see Ministry of Agriculture, Fisheries and Food & Health and Safety Executive 1998; Whitehead 1998). Alternatively, holes can be drilled in the stump and solid chemical crystals, such as Amcide, inserted into the holes. These are then sealed with an earth plug. By including a small amount of oil-based paint in the diesel/herbicide mixture or vegetable dye in a water herbicide mixture it is possible to mark treated stumps.

It is sensible to treat stumps as they are cut, because they can be difficult to find even a few hours later, and if untreated will sprout vigorously. Alternatively, scrub regrowth can be cut every year until the stump is exhausted, but this will take approximately five years depending on scrub species. Repeated mechanical swiping suppresses regrowth but must be carried out regularly, say every two to five years depending upon site conditions. Livestock will graze scrub regrowth especially when it is green and palatable in the spring. Young seedlings can also be killed by grazing animals.

However, the use of most grazing animals alone to control and eradicate scrub is unlikely to be successful other than with feral goats. However, horses and ponies can assist in managing scrub by pushing through and opening up low scrub. They also slow down scrub-edge advancement by browsing tips and they will eat seedlings (Oates & Bullock 1997). Feral goats will preferentially browse and eradicate a large range of shrubs, including gorse *Ulex europaeus*. (See Chapter 5). The National Trust is using feral goats to control evergreen oak *Quercus ilex* on Ventnor Downs, Isle of Wight. Initial monitoring has shown that the goats are thriving and are dramatically reducing the amount of scrub.

A trained operator should return to the site and treat any regrowth from cut stumps with a systemic herbicide. Such regrowth occurs because no herbicide used in stump treatment is 100 per cent effective.

Foliar spraying can also be used as a technique for controlling small scrub and saplings (<1.5m in height) using a knapsack sprayer, drench gun or hand-held weed wiper. This needs to be undertaken with great care to avoid damaging grassland flora. In some situations damage may be unavoidable and consideration needs to be given as to whether it is an appropriate option in such circumstances. Glyphosate and Triclopyr are the two herbicides most commonly used for foliar spraying of regrowth or small scrub. Timing will vary according to the herbicide used (see product label) but in most cases it should be undertaken during the summer months (see Table 12.2). A dye can be mixed with the herbicide to show where treatment has been undertaken. If a dye is being used for spraying or in stump

treatment, operators should ensure that health and safety matters are considered as part of a COSHH assessment (see Chapter 7, sub-section 7.3.5) and the product label is checked for any conditions associated with dye use.

Care should be exercised when spraying shiny-leaved shrubs such as privet *Ligustrum vulgare* as there may be problems with herbicide run-off.

At Barnack Hills and Holes NNR, a CG5 limestone grassland, invasive turkey oak *Quercus cerris* is an ongoing management issue. English Nature controls this species by cutting. The stumps are left untreated and the first years' regrowth is sprayed in late summer (usually August) with Glyphosate at 10% dilution using a hand-held weed wiper. Over 90% kill has been achieved using this method and it does minimise damage to the surrounding limestone grassland (Chris Gardiner, pers comm).

A list of herbicides suitable for use in the treatment of woody weed and invasive tree species is given in Table 12.2. Further useful information is given in Cooke (1986).

Herbicides should always be used according to the manufacturers label or off-label approval notice. These will include information on suitable equipment for application, dilution strengths and timing of application. Note that target species vary in their susceptibility to a given herbicide and so recommended dose rates may differ between species. Consult any appropriate safety instructions before proceeding eg with respect to protective clothing etc. See Chapter 7 for further information on herbicide use.

Root-cutting chainsaw

Bacon *et al* 1998 tested a portable, root-cutting chainsaw and found it to be effective for removing the below-ground stumps of scrub species. This tool may be a better option than using herbicide, in some circumstances.

Use of a weed wiper

Scrub regrowth and small scrub may be controlled using a weed wiper in appropriate situations. Recent trials at Fenns & Whixall National Nature Reserve, a peatland site, used Glyphosate (Roundup Biactive) applied through the Allman Eco-wipe to control 2m high birch scrub. This gave 95 per cent control of this species. Trials with other shrub species are continuing (see Chapter 7 for more information on weed wiping).

Table 12.2 Herbicides for the control of woody weed and invasive tree species[1]

HERBICIDE (Product name in brackets)	How to use (NB: for full conditions of use always read the product label)
AMMONIUM SULFAMATE (Amcide)[2] Particularly useful on hawthorn *Crataegus monogyna* and ash *Fraxinus excelsior*	• Apply as spray to low scrub from April to September in dry weather, wetting agent recommended • Apply as crystals in frills or notches in trunks of standing trees at any time of the year • Apply as concentrated solutions or crystals to stump surfaces within 48 hours of cutting. Wetting agent recommended
GLYPHOSATE (Includes various Roundup products)	• Apply as a spray when leaves actively growing • Rope-wick applicator can be used to control regrowth from woody species • Apply to stumps with a paintbrush • Apply to cuts in the tree
FOSAMINE AMMONIUM (Krenite)[2]	• Apply as overall spray to foliage during August-October when growth has ceased but before leaves have started to change colour. Effects develop in the following spring • Thorough coverage of leaves and stems needed for effective control • Addition for non-ionic wetter recommended. Rain within 24 hours may reduce effectiveness • Most deciduous species controlled or suppressed but evergreens resistant • Little effect on underlying herbaceous vegetation • Appropriate for stump application
TRICLOPYR (Garlon, Timbrel)	• Apply to woody weeds as a summer foliage, winter shoot, basal bark, cut stump or tree injection treatment • Apply foliage spray in water when leaves fully expanded but not senescent • Apply winter shoot, basal bark or cut stump sprays in paraffin or diesel oil. Dose and timing vary with species. See label

[1] There are a limited range of other products based on a combination of active ingredients which may prove effective against woody weeds in particular circumstances, eg dicamba + mecoprop + triclopyr (Fettel). The user should seek sepecialist advice and read the product label.

[2] These are not approved for use in grazed (agricultural) situations. However, in grassland restoration situations with no recent grazing they may be used provided grazing is not introduced for at least a year after treatment.

12.1.8 Special case: invasive cotoneaster *Cotoneaster* species

A particular problem in calcareous grasslands is the establishment and spread of a range of shrubs belonging to the genus *Cotoneaster*. More than 100 species, many of Chinese or Himalayan origin, are widely cultivated in British towns and gardens, and most have the potential to become established in the wild. The prostrate species *C. integrifolius* (often recorded as *C. microphyllus*) and *C. horizonalis* appear to be particularly problematic, erect species such as *C. simonsii* occurring more locally. Infestations have been reported from a variety of substrates in different parts of England and Wales, including chalk as well as harder Jurassic and Carboniferous limestone.

Cotoneaster berries are highly attractive to blackbirds and other thrushes, which readily disperse them to defecation sites. Once established, expansion of local colonies may result in extensive smothering of native communities, greatly altering their structure and composition. Ledge, crevice and scree communities may be affected, as well as a range of calcicolous grassland communities. Among the latter, open *Festuca ovina - Carlina vulgaris* (CG1) swards on summer-parched slopes, as well as *F. ovina - Avenula pratensis* grassland (CG2) and other closed turf communities on deeper soils, are prone to infestation. Root systems are highly pervasive, often penetrating deeply into crevices in the bedrock.

Five methods of control have been trialed (Nile Waller (British Trust for Conservation Volunteers), Frances Cattanach (North Wales Wildlife Trust) and Matthew Oates (National Trust, pers. comm.).

- **Hand excavation and extraction** are possible in some situations but often cause undesirable disturbance to the substrate.

- **Hand cutting at ground level** reduces the vigour of invasive plants but is labour-intensive and does not result in eradication. Repeated cutting on a 3-4 year rotation is required.

- **Herbicide treatment of cut shoot bases** is excessively time-consuming because of the highly divided stems, and is ineffective at preventing regeneration.

- **Herbicide treatment of growing shrubs** uysing glyphosate (30 per cent solution in water), applied either by weed wiper or hand-held spray, is effective at killing plants and controlling regrowth (see Tillotson & Chambers 1996).

- **Burning** is ineffective at controlling regeneration, risks damaging associated vegetation and causing nutrient-enrichment of soils, and is not recommended.

Other woody species causing localised infestations in calcareous grasslands and requiring similar control methods include strawberry tree *Arbutus unedo* and Mrs Wilson's Barberry *Berberis wilsoniae*.

12.1.9 Maintenance management

Where the scrub margin habitat is of intrinsic nature conservation value it should be maintained. A cyclical management regime cutting back a set length each year on a rotation of perhaps five years may maintain the conditions required. This is particularly beneficial if the management creates a series of

scalloped edges to the scrub, to increase the extent of the important scrub-grassland boundary. This provides a more diverse series of microclimates than will exist on a straight boundary.

Such management usually involves the cutting back of bushes and no stump treatment. However, this treatment will favour shrubs which reproduce by rapid vegetative underground spread, such as blackthorn *Prunus spinosa*, dogwood *Cornus sanguinea* and burnet rose *Rosa pimpinellifolia*, in which case some herbicide control may be required to maintain the species balance of the scrub.

Often, the development of important scrub margin is associated with situations where grazing has been relaxed or abandoned. At such sites conservation management may involve the re-introduction or intensification of grazing. Under these conditions significant grazing damage to the scrub boundary can occur, destroying much of the floristic and entomological importance. Sections of the boundary zone should be fenced each year to protect them against grazing, again on a rotational basis. This is most easily achieved with temporary electric fencing.

Rotational management

" It is possible to manage large blocks of scrub on a long rotation. For bushes such as hawthorn and blackthorn, a rotation of about 30 years is suitable. Division of a large scrub block into six compartments, one cut every five years will give good structural variation. Such management is not suitable for most sites but may be useful in the following situations:

- When the scrub is of particular conservation interest
- Where scrub is the major component of the site
- Where scrub is so old and the soil beneath so altered that it is unlikely to be possible to re-establish species-rich grassland if the scrub is cleared (Kirby 1992)

12.1.10 Enhancement

Enhancement management will seldom be a priority in lowland areas, even where scrub margins of importance occur, as the most important scrub vegetation often occurs at sites which are of equal importance for the grasslands they contain.

However, in upland areas scrub vegetation is often reduced to small fragments on rock ledges, river-banks and in other situations where grazing animals cannot reach. Here, fencing off adjoining areas may be of considerable benefit to allow the scrub and its associated species to spread from these refugia.

Such management needs to be introduced with caution, because of deep soils, relaxation or removal of grazing may result in tall grassland or heath which will impede the establishment from seed of those shrubs which do not spread vegetatively such as hazel *Corylus avellana* and juniper *Juniperus communis*.

This is a particular problem with juniper, which is generally present as relict populations, amongs which there is very limited regeneration. Fencing off areas may allow a short-lived spurt of regeneration of juniper, but even a few centimetres height of grass will prevent further juniper seedlings establishing and

some form of scarification or other disturbance may be required to ensure a viable seedling population is established.

Scrub enhancement is likely to be most effective where the ground is relatively broken by rock outcrops, preventing the closure of the grassland sward and leaving open spaces where shrubs can develop.

In general, it is easier to establish new juniper scrub on the edges of existing stands of juniper, than within existing stands. This is due to the shading effects of adult bushes, and could also be because adult populations carry a heavy burden of disease and predators, which kill seedlings or young shrubs growing beneath their canopy.

12.1.11 Grazing animals and scrub

At many sites where scrub occurs grazing is either present or likely to be introduced. It should, therefore, be noted that the presence of scrub will have an effect on grazing animals. Scrub is a potential hazard for grazing animals, particularly sheep, which are easily entangled when they have a full fleece and may die as a result. Although it is not well understood why, the problem of sheep entanglement in scrub varies between seemingly similar sites. This may be related to the lack of knowledge of the sheep; when newly introduced to a site the sheep may have had no previous experience of scrub and do not know it is to be avoided. It is, however, sensible to minimise the risk to sheep by limiting the amount of scrub, especially bramble, to a sensible minimum and cutting scrub blocks to allow easy movement of sheep and clear sight lines for checking stock.

Cattle and horses will not generally be affected by entanglement although injuries caused by scrub, especially to the eyes can be serious and a source of infection. The risk of fly strike (where parasitic flies lay eggs on livestock which develop into maggots and bury into the flesh of the animal) and fly borne disease, is also increased by scrub and trees, particularly in summer, when grazing animals use it for shelter.

12.1.12 Monitoring scrub management

Because shrubs are large structurally complex plants they are easily recorded by photographic means and fixed point photography is a quick method of recording the effects of management. Even aerial photography can be used to monitor the spread and management of scrub on a grassland site, provided it is available at suitable time intervals.

After scrub management has been carried out it is sensible to monitor regrowth to assist planning of follow-up management. This can be achieved by counting a sample of cut stumps in a marked plot and recording for each species the number showing regrowth in the first and subsequent years.

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12.2 Management of grassland scrub for birds

12.2.1 Bird communities on grassland scrub

Scrub associated with semi-natural grassland can support diverse breeding bird communities with high population densities (Morgan 1975; Williamson 1975; Fuller 1982, 1995). However, much grassland scrub supports species-poor bird communities due to its lack of structural and species diversity. The abundant berries on shrubs support large numbers of resident and migrant thrushes *Turdus* spp (and locally starlings *Sturnus vulgaris*) in autumn and the first half of winter (Williamson 1978). Mature scrub can provide important winter roosts for songbirds and other rarer species, such as long-eared owls *Asio otus*. Scrub can also provide food and shelter for large numbers of migrants during the spring and autumn. In particular, scrub habitats can hold large concentrations of breeding warblers, particularly where there is a dense understorey and a complex structural pattern of edges between different growth stages.

A number of these species have suffered from a decline in their numbers and/or range in recent decades and are therefore recognised as birds of conservation concern in the UK (see Table 12.3) (Anon 1996).

The breeding bird communities of scrub are typically composed of 30 or so fairly widespread and abundant species (Fuller 1982), although in addition, several rarer red and amber-listed birds of conservation concern (Anon 1996) can occur locally, such as nightjar *Caprimulgus europaeus,* and, formerly, red-backed shrike *Lanius collurio*, now only an occasional breeder. The varying habitat preferences of these species means that the composition of bird communities changes considerably as scrub ages (Williamson 1975, Duffey *et al* 1974). Different types of scrub, such as hawthorn *Crataegus monogyna*, gorse *Ulex europaeus*, yew *Taxus baccata* and juniper *Juniperus communis* support different bird communities (Williamson & Williamson 1973; Morgan 1975). Hawthorn and mixed chalk scrub tend to support richer bird communities than gorse scrub on lowland grassland. However, it should be noted that gorse scrub can hold large numbers of nesting linnets *Acanthis cannabina*, a species which has declined considerably in the wider countryside over the last 30 years, and as a consequence, is a red-listed birds of conservation concern. The age and structure of the scrub is, however, a major factor determining the numbers and composition of bird communities. Typical changes that occur as scrub invades grassland are summarised below.

Open areas of grassland containing young, pioneer scrub support skylark *Alauda arvensis* and meadow pipit *Anthus pratensis*, although the latter species will tolerate more scrub within its nesting habitat.

As open canopy scrub becomes established, linnet, yellowhammer *Emberiza citrinella*, whitethroat *Sylvia communis*, willow warbler *Phylloscopus trochilus* and dunnock *Prunella modularis* colonise, but the first two species gradually become less common as the scrub thickens. Patchy, open scrub can also support cuckoo *Cuculus canorus* and tree pipit *Anthus trivialis*, with grey partridge *Perdix perdix*, grasshopper warbler *Locustella naevia*, corn bunting *Emberiza calandra* and whinchat *Saxicola rubetra* occurring occasionally.

Table 12.3 Birds of conservation concern in the UK that breed within lowland grassland scrub

Species	Birds of conservation concern listing	Population status
Turtle dove	red	Range contraction and steep decline in numbers on farmland though still widely distributed over much of southern and eastern England.
Nightjar	red	Range has contracted though numbers have increased due to colonization of clear-felled/replanted conifer plantations - very local within grassland scrub.
Song thrush	red	Severe decline in both farmland and woodland habitats though still common and widespread across the country.
Red-backed shrike	red	Occasional breeding species.
Linnet	red	Severe decline in both farmland and woodland habitats though still common and widespread across the country.
Bullfinch	red	Severe decline in both farmland and woodland habitats though still common and widespread across the country.
Cirl bunting	red	Formerly widespread but now restricted to mixed farmland in south Devon where it nests in hedgerows and grassland scrub.
Dunnock	amber	Declining in both farmland and woodland habitats though still common and widespread.
Nightingale	amber	Severe range contraction but remains locally abundant in some parts of south-east England (national survey to be undertaken in 1999 by BTO).
Stonechat	amber	Some range contraction in parts of its range (eg south-west England). A local breeding species in scrub on coastal grassland.
Blackbird	amber	Declining, especially on farmland, but still common and widespread across the country.
Grasshopper warbler	amber	Now thinly distributed across the lowlands following a severe range contraction.

Source: BTO Common Bird Census and Breeding Bird Atlases and the reports of the Rare Breeding Birds Panel and special species surveys by RSPB, BTO and Country Conservation Agencies.

As the scrub matures and the canopy begins to close, additional bird species are supported including blackbird *Turdus merula*, song thrush *Turdus philomelos*, nightingale *Luscinia megarhynchos*, garden warbler *Sylvia borin*, blackcap *Sylvia atricapilla*, lesser whitethroat *Sylvia curruca* and turtle dove *Streptopelia turtur*.

Scrub is especially important for nightingales with a relatively high proportion of the English population dependent on the habitat. In a national nightingale survey undertaken in 1976, Hudson (1979) found that nearly 29 per cent of records were from pioneer scrub; the highest figure from all the habitat types recorded. Extensive thickets of blackthorn *Prunus spinosa* are often preferred (R.J. Fuller pers. comm.). Where substantial populations of nightingales are present, management for this species would be a legitimate objective given its current range contraction and status as an amber-listed species of conservation concern.

Some species which colonise earlier, such as whitethroat, start to disappear at this stage, although others such as willow warbler reach peak numbers as the canopy closes.

Tall, dense scrub with a recently closed or partially open canopy can support the highest densities and diversity of breeding birds, as well as providing good cover for roosting birds and a plentiful supply of fruits in the autumn (Fuller & Peterken 1995). However, once the undergrowth becomes 'leggy', the scrub often loses its value to many breeding birds; for example, many warblers avoid such old stands with little undergrowth. Species which particularly favour nesting in old, closed canopy scrub include robin *Erithacus rubecula*, wren *Troglodytes troglodytes*, greenfinch *Carduelis chloris*, bullfinch *Pyrrhula pyrrhula*, chaffinch *Fringilla coelebs* and hole-nesting species such as tits. Nest sites for hole-nesting species are, however, often limited, even within old scrub, although old elder *Sambucus nigra* bushes can provide more holes than many shrub species.

12.2.2 Management of grassland scrub habitats for birds

The richness of the bird community within an area of scrub largely depends on the variety of successional stages that are present. At most sites, management of scrub for birds should maintain and, where appropriate, enhance the variety of growth stages, although this may need to be adapted according to the conservation priorities for a particular site.

Much grassland scrub occurs on calcareous grassland of high nature conservation interest, supporting a rich grassland flora and invertebrate fauna (see section 12.1). A prime objective of scrub management on such sites is often to reduce or limit its extent, although juniper scrub may be encouraged to regenerate. Removal of scrub from grassland results in decreases in the number and density of breeding birds supported by the `grassland' habitat (Fuller 1984). The most frequent management technique currently used for birds associated with grassland scrub is rotational cutting. Burning is occasionally used to manage gorse on some nature reserves.

Rotational cutting should aim to create a patchwork of scrub at different growth stages, from freshly cut to closed canopy. Where appropriate the mosaic could be managed to provide more recently closed canopy scrub with fairly dense foliage at or near ground level as this supports richer bird communities.

Rates of regrowth and the length of the rotation will be influenced by the intensity of grazing or browsing by deer, and soil type and aspect. The size and number of blocks to be cut in any one year on a site depends on the area and shape of the scrub habitat, as well as practical and financial considerations. An intimate mixture of scrub of differing ages and structures, and grassland can be created by cutting patches of less than 60m x 60m. This increases warmth and shelter and maximises the area of edge habitat favoured by some bird species (Fuller & Peterken 1995). The blocks can be irregularly shaped and arranged to produce glades and rides.

It is essential that the cutting of scrub should not take place during the nesting season for birds, ie between April and July inclusive. Cutting should also be avoided in autumn and the first half of winter to prevent losing the berry crop. Thus the optimum period for cutting is from early December until late March (see section 12.1).

At some sites, extreme browsing pressure from deer can inhibit the regrowth of scrub. In such cases, the creation of rough brash deer fencing using the cut scrub may be appropriate, taking care not to damage

areas of high botanical interest. Fencing will deter roe deer and can also be effective against the larger species, but is labour-intensive (Fuller & Warren 1993).

Fuller & Peterken 1995 have suggested that low intensity livestock grazing may be a better method of producing complex mosaics of grassland and scrub than cutting. However, at present there is a paucity of information on how this might best be achieved. Stock that will preferentially browse scrub such as goats and hardy, primitive sheep breeds are likely to be required.

Goats will preferentially browse scrub and have been used to eradicate scrub. Wild populations of deer will browse scrub and may create a mosaic of structural types of scrub.

The considerable variation in site conditions means that it is difficult to give precise prescriptions for scrub management. Decisions such as whether to use cutting or grazing, or a combination of both, will depend on the overall objectives for the site and the resources that are available. Managing scrub as a patchwork requires experience which has to be developed by site managers through trial and error in many cases.

Grassland scrub can thus provide a valuable habitat for breeding and wintering birds. Where consistent with site management objectives, it should be managed to maintain and, where possible, enhance its ornithological interest.

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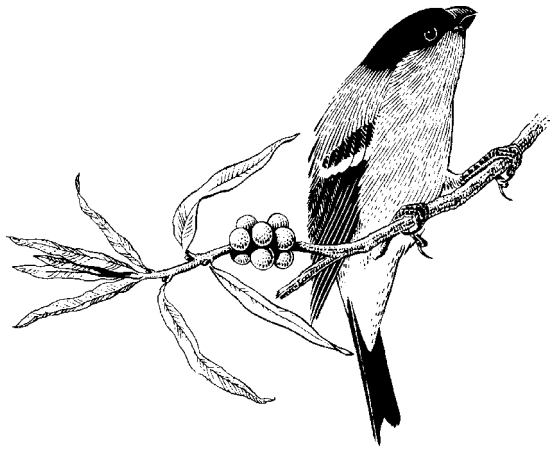

12.3 The management of grassland scrub for invertebrates

12.3.1 Introduction

Scrub provides a warmer and moister environment than open grassland and one that is sheltered from the wind and extremes of temperature. This is important for many invertebrates, not just rare species, which cannot tolerate very high temperatures for very long, but do require warm and moist conditions over longer periods.

Well-managed scrub habitats provide 'dappled' conditions which are essential for the multitude of species which require partial shade during at least part of their life cycle.

A wide range of invertebrates can remain active in scrub areas when the wind would be too strong for flight in open grassland.

12.3.2 Invertebrates and the scrub canopy

There is little detailed information available on the number of invertebrate species associated with tree and shrub species. Table 12.4 gives an outline set of figures.

All the shrubs listed are important for the number of invertebrate species which feed on their leaves, stems, flowers and fruit. Each species also has its associated parasites and predators.

The scrub canopy is in flower from early spring through to early winter. The flowering sequence of nectar and pollen bearing shrubs is vital for the spring insects, such as bees and butterflies emerging from hibernation. Sallow *Salix* spp and blackthorn *Prunus spinosa* flower first, followed by gorse *Ulex europaeus*, hawthorn *Crataegus monogyna*, wayfaring tree *Viburnum lantana*, guelder rose *V. opulus*, crab apple *Malus sylvestris*, dogwood *Cornus sanguinea*, rose *Rosa* spp and privet *Ligustrum vulgare*. This is followed by brambles *Rubus* spp., fermenting fruits of earlier flowering species and finally by ivy *Hedera helix* blossom at the end of the year. The herb layer of the open scrub system similarly provides nectar throughout this period.

The three-dimensional branching of the canopy shrubs creates a dense structural complex essential for invertebrates which cannot survive in the dense growth of the ground flora nor in the more open structure of a tree canopy. Many of these are predators such as spiders. In addition, birds heavily exploit this food source.

12.3.3 Invertebrates and the floor beneath the scrub

The scrub floor is a mosaic of open areas of grassland with patches of partially or totally shaded vegetation. The scrub canopy should never be allowed to become dense enough to eliminate the ground flora, although there may be severe thinning of ground cover during the later phases of scrub development.

Scrub removal after a closed canopy phase may lead to the growth of coarse invasive grasses (see section 12.1). Although not generally desirable, this can provide shelter for both ground dwelling species and for some of the development stages of species that will live on the shrubs at a later stage of their life cycle.

Table 12.4. The approximate number of species of the principal plant feeding insect groups associated with genera of grassland scrub
(Based on information from Ratcliffe 1977 and D Sheppard)

Plant genera	English name	Total no of insect species
Acer	Maples	41
Betula	Birches	229
Buxus	Box	5
Clematis	Traveller's joy	18
Cornus	Dogwood	18
Corylus	Hazel	107
Crataegus	Hawthorns	230
Euonymus	Spindle	19
Fraxinus	Ash	41
Ilex	Holly	13
Juniperus	Juniper	27
Ligustrum	Privet	35
Lonicera	Honeysuckles	48
Malus	Apples	133
Prunus	Cherries	157
Quercus	Oaks	465
Rhamnus	Buckthorns	27
Rosa	Roses	107
Rubus	Brambles	107
Sambucus	Elders	19
Sorbus	Whitebeams	36
Taxus	Yew	6
Ulex	Gorses	52
Viburnum	Viburnums	17

Coarse grasses growing at the margins of scrub patches are a desirable feature for invertebrates (see Section 12.1)

12.3.4 Management objectives and options for management

Wherever possible an invertebrate survey should be carried out prior to undertaking any management.

In general, if scrub is to be managed as a positive feature for invertebrates, management should aim to retain shrubs in all stages of growth and maturity. This is to maximise the range of habitat niches available to invertebrates.

In order to create a predominantly low, open-structured canopy, with a mosaic of partially shaded and exposed ground flora, the following management techniques could be introduced:

- Cut scrub back from the edges (starting with the most recently invaded areas of grassland). A scalloped edge will provide more variations in microclimate and be beneficial to a greater range of invertebrates than a straight edge.

- Cut out glades at intervals.

- Remove large trees (where appropriate).

- Cut scrub back around features of interest eg remnant grassland patches or ponds.

  Remember: this should be achieved over a period of years (the length of time depending on site characteristics). Wholesale felling of scrub will not encourage a suitable ground flora to develop and can lead once again to an even-aged stand of vegetation.

- Some old bushes should be left to die and decay naturally to provide deadwood habitat for invertebrates.

- Some of the scrub canopy will grow into trees. A few large trees are acceptable but should not be allowed to shade out the ground flora.

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