7 The control of grassland weed species

7.1 Introduction

Grassland sites of nature conservation importance will sometimes be subject to infestation by 'weed' species which may compromise agricultural objectives, nature conservation objectives or both[1]. The main problem species in grassland for farmers in order of importance are: creeping thistle *Cirsium arvense*, spear thistle *Cirsium vulgare*, common ragwort *Senecio jacobaea*, broad-leaved dock *Rumex obtusifolius* and curled dock *R. crispus*. Other problem species on unimproved lowland grasslands which may compromise agricultural or conservation objectives include bracken *Pteridium aquilinum*, stinging nettle *Urtica dioica*, marsh ragwort *Senecio aquaticus,* cow parsley *Anthriscus sylvestris* and rushes *Juncus* spp.

Unimproved semi-natural grasslands may contain these plant species, which are regarded as 'weeds'. A weed may be defined as a species which is undesirable to the purpose/objective of the grassland when being managed for agricultural or conservation purposes. The problems caused by weed species are as follows:

- Often unpalatable and reduce amount of available forage.
- can reduce hay yields.
- toxic/unpalatable to livestock in hay.
- may indicate poor pasture/meadow management from agricultural and conservation perspectives (overgrazing/poaching/nutrient enrichment/spoil deposition etc);
- may reduce attractiveness of sites to farmers where grazing/hay management is essential for delivering nature conservation objectives.
- may reduce abundance of desirable species or plant communities (both for conservation and agriculture).

It is important to stress that some of the species may also have positive qualities from a nature conservation perspective in certain situations and these include:

- 'weed' species support diverse invertebrate faunas (see Box 7.1);
- species may contribute to desirable habitat structure for fauna, eg breeding birds (eg rush *Juncus* spp species) or provide a food source, eg seeds for passerine birds;
- may be a normal constituent of semi-natural plant communities which are of high wildlife value.

[1] NB Management and control of grassland scrub and woody sub-shrubs is dealt with in Chapter 12

Box 7.1 Invertebrates and grassland weed species

The plant species which in some circumstances can compromise conservation and agricultural objectives in lowland semi-natural grassland ("weeds") may support diverse invertebrate faunas including a number of Red Data Book and Nationally Scarce species. Thus some of these species are potentially important for the conservation of rare invertebrates. A few grassland examples drawn from beetles (Coleoptera) are listed below to illustrate the point:

- *Liparus coronatus* (Coleoptera: Curculionidae): a weevil associated with species of Umbelliferae but mostly on cow parsley *Anthriscus sylvestris*. Larvae are root-feeders while adults occur at the base of plants. **Nationally Scarce: Notable B*.**

- *Rhinocyllus conicus* (Coleoptera: Curculionidae): a weevil associated with *Cirsium* spp and musk thistle *Carduus nutans* on calcareous soils. **Nationally scarce: Notable A**.

- *Mantura rustica* (Coleoptera: Chrysomelidae): a flea beetle associated with broad-leaved dock. Larvae are leaf miners. **Nationally scarce: Notable B**

- *Longitarsus dorsalis* (Coleoptera: Chrysomelidae): a flea beetle associated with ragwort *Senecio jacobaea*. **Nationally scarce: Notable B**

The reason why species are rare or scarce when their host plant is widespread is often unknown.

Advice

- Check if there are any records of rarer species prior to implementing control measures especially on nature reserves and other protected sites.

- Care is also required when controlling spear/creeping thistle where other related plant species may be present which would be vulnerable to control measures and which themselves may support rare/scarce species. For example the nationally scarce weevil *Ceutorhynchus trimaculatus* is associated with musk thistle *Carduus nutans*.

- If records are discovered seek further advice from an entomologist.

- Many of the target weed species support a varied fauna of more widespread invertebrates which, for example, may be very closely associated and dependent on the plant (eg only larval food plant) or more loosely associated (flowers used as a nectar source). At a site level, it is likely that weed control is being undertaken to ensure the principal interest features are conserved and the conservation of more widespread invertebrates associated with weed species will usually be a lower priority. Some of these weed species will be widespread in the surrounding countryside. However, such species are of interest and provided other objectives are not compromised, control programmes should not normally aim to completely eliminate weed species (and rarely do).

* See Hyman (1992) for an explanation of rarity categories.

Clearly the approach to the control of these species and the methods adopted on sites of wildlife importance will be influenced by a number of factors. These include:

- the nature of the wildlife interest of a particular site and the management objectives;

- the agricultural objectives and the farming system.

Although manual control methods are usually most desirable, **targeted** herbicidal control (spot treatment, weedwiping) of such species will often be acceptable on nature conservation sites particularly where continued grazing/meadow management is essential for meeting nature conservation objectives. Although weed species have their value, in many cases their conservation/persistence on wildlife sites will not often be a priority. Some of these species will be common elsewhere in the wider countryside (eg *Urtica dioica*). In some cases a balance will need to be struck, eg on some Somerset Levels wet grassland sites, too many rushes may be undesirable for farming and wildlife interests. In this example, total eradication, even if possible to achieve, would be damaging from a wildlife perspective. Thus the level of abundance is agreed between farmers and conservation organisations on conservation sites.

7.2 Legal considerations

Cirsium arvense, C. vulgare, Senecio jacobaea, Rumex obtusifolius and *R. crispus* are listed as injurious weeds under the Weeds Act 1959, eg measures to prevent the spread of these species may be required if there is a threat to agricultural production. The Act empowers the Minister for Agriculture, Fisheries and Food or the Secretary of State for Scotland (or approved officials within MAFF, the Welsh Office Agriculture Department or the Scottish Agriculture Environment and Fisheries Department) to require that an occupier of land takes action to prevent the spread of the listed species. Complaints should normally be addressed to the Local Agricultural Department Office.

Set-aside land is not exempt from the provision of the Weeds Act 1959.

Where there is a threat to agricultural land or production from injurious weeds on roadside verges or railways, the Highway Authority or Railtrack should be contacted. On Ministry of Defence land, either the Defence Lands Service or the occupier, if different, may be subject to action. On common land, the occupier is responsible. If the land is unoccupied the person who has a right to occupy may be subject to action.

When Agriculture Departments are notified of injurious weeds on NNRs/SSSIs or ASSIs, the relevant statutory conservation agency will be contacted. On local authority property the local authority needs to be contacted. Appropriate action will then be determined as a result of consultation. The spread of these weeds to domestic gardens, horse paddocks, allotments and land not in agricultural use is primarily a matter for local authority bye-laws or Public Health Acts. Occupiers of such land have recourse to civil action. However, if the source of the problem is on such land and agricultural land is under threat, The Weeds Act 1959 may apply.

In cases of infestation of grassland which has been created under a Nitrate Sensitive Areas (NSA) Scheme agreement, the NSA Project Officer should be consulted on the appropriate control measures to minimise damage to the sward. He/she may also need to provide authorisation for any re-seeding.

Control of weed species by whatever method on Sites of Special Scientific Interest/Areas of Special Scientific Interest will normally require the consent of the relevant Country Agency under the

requirements of the 1981 Wildlife & Countryside Act as amended or the 1985 Nature Conservation & Amenity Lands (Northern Ireland) order as amended.

7.3 Control measures relevant to all species

7.3.1 Introduction

If a weed problem exists on a site it is essential that changes are made to correct the management regime. It should not be assumed that controlling the problem species themselves will maintain the conservation interest of the site or solve the weed problem. It is thus important to consider why the problem arose in the first place.

The most important preventative measure is to avoid damage to the sward where possible (ie creating large areas of bare ground) in the first place. The creation of bare ground will provide opportunities for invasion and spread of many of the more important weed species which cause problems in enclosed grassland.

Avoid damage from the following:

- Overgrazing - inappropriate stock type/numbers/timing of grazing.
- Vehicle movement causing rutting.
- Ditching/river bank maintenance, ie spoil dumping.
- Frequent animal movement (especially in bad weather) as this causes trampling and poaching.
- Animals congregating regularly in one area for feed (unless a deliberate sacrifice area is a practical necessity).
- Feeding weed-infested hay directly onto areas already damaged by poaching.
- Burning or any other operation which can result in bare ground.
- Nutrient enrichment.

There are a number of measures that can be implemented to prevent the spread of problem species once established.

7.3.2 Hand control techniques

- 'Spudding' with a spade or hoe at just below ground level, just before target weed flowers open (not suitable for ragwort).
- Cutting at just below ground level, just before target weed flowers open (not suitable for ragwort).

- Removal with a thistle hoe.

- Hand-pulling just before target weed flowers open. This is only really suitable for ragwort species on small sites (see section 7.4).

If the weeds are uprooted it is preferable to remove and burn them offsite or to remove/exclude stock from the site until the plants are totally decomposed. In the case of ragwort it is essential to remove pulled plants as wilted plants are palatable to stock and are poisonous.

7.3.3 Mechanical pulling

A new machine, the 'Eco-Puller' is now available for the control of grassland weeds. It provides an alternative to other control methods outlined in this chapter and may be particularly useful where use of herbicides is not possible. It was developed and trialed by English Nature, the Royal Agricultural College and Alvan Blanch Development Company for control of tall grassland weeds, but especially for ragwort (Bacon & Overbury 1998). The machine is tractor-trailed and PTO driven and pulls weeds from the ground in a way that mimics hand-pulling. This is achieved by feeding tall plants between a pair of gripping rollers which then provide a good firm vertical pull which is necessary to get the root out of the ground. The weed gripping height is adjustable by a hydraulic pivoting wheeled axle. The pulled plants are then transferred by belt into a collecting hopper for tipping and disposal. The machine is suitable for pulling a range of tall weed species including thistles, nettle, docks, ragworts and bracken (see section 7.8). Weeds should be at least 30 cms tall to be pulled effectively. The machine can be used on level or undulating terrain, ie in situations where a tractor can operate safely.

The Eco-Puller can be used in pastures where a height differential has been created between the target species and the remainder of the sward by grazing from April and May onwards. The machine will be available from Alvan Blanch, Chelworth, Malmsbury, Wiltshire SN16 9SG and the likely indicative cost (1998) will be in the region of £8K.

For thistles and ragworts, pulling should take place after maximum extension of the flower stalk but before seeding. To avoid danger of ragwort poisoning, stock should be removed from the field until all pulled material has been collected and removed from the site.

Stinging nettle should be pulled early in the season as soon as the stems are robust. Docks should be pulled after the seeds have been shed and when the stems have become more woody.

Pulling will be required in successive years to reduce the extent of perennial target species. Bacon & Overbury (1998) report that in trials, the method dramatically reduced the vigour and number of flowering stems of creeping thistle after two years.

7.3.4 Topping

Topping is the repeated cutting of pasture species requiring control. Toppers are tractor-trailed PTO driven machines which spread cut material evenly behind them. The infested areas should be topped just before flowering in the case of thistles and docks when the plants have expended their maximum energy reserves but the flower buds have not opened. Repeat one month later. Topping may prevent seeding and reduce the vigour of thistles and docks but it does not kill the plants and they may re-generate vigorously from the stem base. It is also important to consider the impact such management might have on ground nesting birds which may be present on some sites between April and July. Topping is not appropriate for ragwort control (see ragwort control section 7.4). Toppings should be removed if possible to prevent nutrient enrichment and smothering.

7.3.5 Chemical control

Statutory powers to control pesticides are contained within Part III of the Food and Environment Protection Act 1985. The Control of Pesticides Regulations 1986 (as amended) defined in detail those types of pesticides which are subject to control and prescribed the approvals required before any pesticide may be sold, stored, supplied and used. The majority of products approved for use in Great Britain are also approved for use in Northern Ireland. Pesticide regulations have also been introduced in Great Britain to implement the Plant Protection Products Directive (91/414/EEC) which is intended to harmonise arrangements for authorisation of plant protection products within the Community. The Plant Protection Products 1995 (as amended) and the Plant Protection Products (Basic Conditions) Regulations 1997 implement the Directive in Great Britain and apply control and enforcement conditions.

A wide range of information about pesticides is available. This includes various codes of practice to help those working with pesticides meet the legislative requirements. These include Code of Practice for the Safe Use of Pesticides on Farms and Holdings (MAFF/HSC 1998). It covers the requirements of the Control of Pesticides Regulations 1986 and the Control of Substances Hazardous to Health Regulations 1994 (COSHH). The latter regulations apply to a wide range of pesticides used at work. They lay down essential requirements for the control of exposure to hazardous substances. Under COSHH employers and the self-employed must make a suitable and sufficient COSHH assessment before work commences. All persons involved with storing, using and advising on herbicides must be properly trained (refer to MAFF/HSC 1998 & MAFF 1998b).

For up-to-date information on currently approved products consult MAFF/HSE (1998) and Whitehead (1998).

Other useful guidance relating to the use of herbicides includes Cooke (1986, 1991), the former of which is now out of print, National Rivers Authority (1995) and Simpson (1993).

In general:

- non-chemical methods are preferred whenever possible;
- a herbicide should not be used to deal with the symptom of a problem without tackling the cause, ie poor management.

A variety of sources are available to assist the user in selecting an appropriate herbicide. These include Annexes 2-4 of this Handbook, (Cooke 1986,1991), Simpson (1993), Whitehead (1998) and MAFF/HSE (1998). Then:

- consult a specialist if in any doubt about the following decisions;
- determine which herbicides have approval for the use in question and for users working for English Nature, which of those have been used safely in the past (see Cooke 1991);
- select the most appropriate herbicide for control of the main weeds present - choose the one with the appropriate spectrum of activity for the particular circumstances;
- identify the correct growth stages of the crop and weed and the appropriate dose rate;
- cross-check the cost, hazard rating and ease of application of the alternatives;
- read the product label before spraying;
- avoid disturbance to ground nesting birds during the period April to July.

The text in the Statutory Box on the product label should always be read prior to purchase or use. This will specify the field of use relating to agriculture, eg:

Crop or situation: Newly sown grass leys/established grass leys/permanent pasture. If the herbage is **not** to be utilised by livestock this opens up the possibility of using a range of products which is labelled for use in amenity grassland. **NB**: Some other habitats may be dominated by grasses, eg some types of sand-dune. If this is the case they may be treated as grassland. If not, and they are not grazed, they will come under the category of amenity vegetation. If they are grazed, any product used must have approval for an agricultural situation in addition to amenity vegetation. However, special care will need to be taken to ensure label requirements are met.

The user should comply with the statutory conditions of use and assess the risk to operators and others, as well as to the environment (see Ministry of Agriculture, Fisheries and Food & Health and Safety Commission 1998). The label rates given should not be exceeded but lower rates may be appropriate. In some cases specific off-label use is allowed. Local Agricultural Department offices should be asked to supply the relevant information before such a use is undertaken. Only personnel with appropriate Certificates of Competence should advise on or apply pesticides.

Appropriate application technique

For control of an undesirable species and to avoid environmental damage it is essential that the correct choice of application method and careful application of a herbicide be used.

Application techniques that could be appropriate include:

Knapsack spraying

This is a useful method of restricting the herbicide application to areas of a field or site which require treatment while leaving desirable plants free from contact with the herbicide spray. It is appropriate where small areas require treatment. Sites with irregular topography, anthills or steep slopes are best treated with a knapsack sprayer. Great care must be taken not to affect surrounding non-target vegetation when spot spraying. It is recommended that a buffer zone of at least 2 metres from sensitive plant species/communities is allowed.

There are also a range of other hand-held herbicide application methods including a weed wiper, lance and weed glove for spot treatment which may be appropriate in certain circumstances for use on small-scale weed infestations.

Some herbicides carry details on their labels of how the product may be used through a knapsack sprayer or other hand-held applicator. In other instances, there may be a need to use a product which does not carry knapsack recommendations on the label but which is not specifically prohibited from use in this manner. In these cases, it will first be necessary to carry out a COSHH assessment to ascertain the level of risk involved and if this assessment reaches a satisfactory conclusion the operator may proceed without further reference to the regulatory authorities (see also section below on trailed weed-wipers).

In order to restrict the herbicide application to the smallest possible area, the nozzle tip should either be a narrow (60E or 80E) fan or an equivalent impact jet. Hollow-cone nozzles are frequently encountered as standard equipment on knapsack sprayers but these should be replaced because of the difficulty in achieving precise placement of the spray on the target weed.

Herbicide with label recommendations which include use through a knapsack sprayer:

Dow Shield (Clopyralid)	-	Dow Elanco
Fettel (Dicamba + mecoprop + triclopyr)	-	Zeneca
Roundup Biactive (glyphosate)	-	Monsanto
Grazon 90 (Clopyralid + triclopyr)	-	Dow Elanco
Pastor (Cloyyralid+ fluroxypyr + triclopyr)	-	Dow Elanco

NB: This list is not exhaustive.

Tractor-mounted or trailed weed-wipers

These are machines which deliver a controlled dose of herbicide to the target weed species via a rope-wick, carpet or rotating drum applicator without affecting other components of the sward. These are either mounted or trailed by tractor or ATV. The technique requires a height differential between the target species and other vegetation.

Advantages of wiping

- Targeted application of herbicide without ground contamination (ie herbicide is only wiped on to weeds, whereas spray droplets may reach all the vegetation or ground).

- There is no spray 'drift' because there are no spray droplets (a distinct advantage when operating near to sensitive vegetation or water) - but see comments on vapour drift.

- It may be possible to use the machine in wind conditions that would be borderline for sprayers.

- As a large proportion of the herbicide solution is applied to the underside of the leaves (as a result of the wiping action) this protects it from rain and the risk of 'washing-off'.

- By treating weeds only where they occur, less herbicide is used. This can lead to a cost saving for the land manager.

- A lower volume of water will be needed which is helpful on remote sites.

- Trials have indicated that with improved wiper design of 'second' generation machines, application to the weeds is often improved achieving better herbicide uptake and efficacy. This should lead to reduced dilutions, giving reduced amount of herbicide with related ecological benefits and cost savings. Field trials carried out by English Nature in association with herbicide manufacturers in 1994, 1995 and 1996 have indicated that, over a range of applications, dilutions between 1:2 to 1:20 may produce the best results according to the herbicide being used.

- Wiping has a better public image than spraying.

Limitations of wiping

- **The technique requires a height differential between target weeds and other vegetation**. It is not possible to control target plants in the rosette or recumbent growth stages, unless through translocated effects.

- Producing a height differential may be a problem in some situations. A **temporary** change to grazing prescriptions on grasslands may be necessary, if allowed, for the period of control.

- Application 'windows' may be narrower than with spraying applications. Application when there is a height differential may be after the 'ideal' application time as recommended on the product label, leading to reduced efficacy.

- There is at present a reduced choice of herbicides having label or off-label recommendations for wiper application.

- In some situations tractor wheels may flatten target vegetation so that it does not come into contact with the wiper.

- Traditionally, herbicide dilution rates have always been more concentrated for weed wipers than sprayers. Sprays may typically be 1:150 to 1:400 (active ingredient : water); and wipers have been 1:1 to 1:8. Trials are indicating that weaker dilutions down to 1:10 and 1:20 will produce good control with some herbicides. MAFF/HSC (1998) provides information on the minimum acceptable dilution for use of pesticides when applying them through equipment that is not recommended on the label.

- Availability of a better wiping technique could lead to a tendency to treat the symptoms rather than remedy the causes.

- Under some circumstances vapour drift may still pose a risk to non-target vegetation, eg herbicides containing the active ingredient triclopyr may volatize after application at temperatures of more than 20EC and be carried as fine particles in air currents to non-target or sensitive vegetation nearby. It is recommended that formulations containing triclopyr should not be used if air temperature on the day has or is likely to exceed 20EC. In situations where areas are to be sprayed or treated by weed wiper and where sensitive and important vegetation occurs nearby, then temperatures above 15EC should be avoided where possible. **NB**: Approved proprietary products containing triclopyr are Doxstar, Fettel, Garlon 2 and 4, Grazon 90, Pastor and Timbrel.

Choice of weed wipe machine

There are currently about seven weed wipe machines available with models that are both mounted or trailed. All makes can work on flat fields. Some of the narrower models (up to about 2 metres wide) can operate over rough ground without missing weeds or grounding. The Allman Eco-Wipe Machine, which was specially developed by English Nature and the Royal Agricultural College, is designed to operate for its full 4.6 metre width over the roughest of grassland terrain where it can give good weed control over ridge and furrow, earthworks, embankments, and anthills.

Advantages of the Allman 'Eco-Wipe'

Most weed wipers have the herbicide delivery mechanism mounted on one long straight bar assembly. On uneven terrain this has to be set high to avoid hitting high ground and many weeds go under the bar partially treated or untreated. If set low then ground contamination can occur. The 'Eco-Wipe' overcomes these problems by cutting the bar up into many short sections each on their own 'contour-following' skids. Therefore, particular advantages of this machine are:

- The contour following skids allow delivery of herbicide to all weeds on the roughest of terrain. For example the machine has been trialed on ancient parklands with slopes and anthills (eg Moccas Park, Herefordshire); hill and calcareous grasslands with steep slopes, sarsen stones, ridge and furrow and anthills (eg Bredon Hill, Worcestershire, Fyfield Down, Wiltshire, and Martin Down, Hampshire); and coastal grasslands with dry creeks, runnels and salt mounds (eg Holkham, Norfolk, Old Hall Marshes, Essex, and The Swale, Kent). The machine appears to be able to cope with the roughest of terrains - only the ability of the tractor or vehicle to traverse the ground is a limitation where four-wheel drive is essential. Towing behind all-terrain motorbikes is popular but mini-tractors with normal gears give more control of forward speed through not having centrifugal clutches.

- The variable height control skids enable precise setting of delivery mechanism from 5cms-30cms above ground to cope with varying vegetation heights. Lower settings enable more of the target plants to be wiped enabling more even distribution of herbicide over the target. This in turn should allow weaker dilutions to be used to deliver a lethal dose (application of a more diluted solution to a large surface area is preferable, especially for translocated herbicides, than a more concentrated solution to a small surface area, when localised tissue burning may occur and prevent full translocation). The lowest settings are only possible if a **height differential** between target plants and other herbage is achieved by correct grazing management.

- The carpet delivery units mounted on the skids can be kept optimally saturated with herbicide by correct control of flow rate switches and the pressure pump. These are operated from the driving seat to enable adjustment on the move for low, medium and high infestations of weeds. There is no 'fling-off' of herbicide as found on some other machines because the carpets do not spin. Also, because the carpet is a wool blend with high water retention properties and is fitted with an underlay it enables good saturation to be maintained for long periods without dripping.

- The machine has been assessed for COSHH requirements. Each carpet unit is detachable at times of transport, being carried in an enclosed box from which any leachate can be re-cycled. A clothing box and washing facility are provided on the machine. Operators still need to carry out their own COSHH assessment when planning to use the machine.

- The machine comes in three widths of 2 metres (3 units), 3.3 metres (5 units) and 4.6 metres (7 units including two folding wings) and can be either tractor mounted or trailed [ATV version].

- The machine is rear mounted or trailed so wheels do not pick up herbicide.

The Eco-wipe is available from local Allman distributors and costs (1998) range from *c* £3k-£5k depending on width and number of wicks.

Herbicides with **label recommendations** which include use through a weedwiper: Roundup, and two which have off label approval - Dow Shield and Grazon 90. Table 7.1 provides further details. However, any herbicide can be used in a weed wipe machine **provided it is not specifically prohibited from use by this method on the product label** and as long as other conditions are complied with. Subject to this, reduced volume application via weed wipes of herbicides is acceptable up to 10 times the recommended maximum concentration on the label subject to compliance with carrying out a comprehensive COSHH assessment and that paragraph 146 of the Code of Practice for the safe Use of Pesticides on farms and holdings (MAFF/HSC 1998) is complied with, ie pesticides should not be applied with lower volumes of water than the label recommends for that dose if the label i) prohibits reduced or low volume spraying ii) requires the use of Personal Protective Equipment (PPE) when the pesticide product is diluted to the minimum volume rate recommended on the label for that dose or iii) has one of the following hazard warnings "corrosive", "very toxic" or "toxic" or carries the phrase "risk of serious damage to eyes".

Boom spraying

Non-targeted use of herbicides (eg tractor boom-spraying) used against specific weed species may be acceptable in certain circumstances. This is likely to occur where a herbicide has a narrow spectrum and other desirable species will be unaffected.

The optimum timing for different treatments is likely to vary according to plant growth habit and root system. In general, chemicals are best applied early during the maximum period of growth although Glyphosate is better applied just as senescence commences after the main period of growth. However, always read the label for timing of application, and to ensure that no restriction is placed over the method of application.

Table 7.1. Herbicides with label or off-label approval for use in weed wipe machines

Herbicide	Active ingredient(s)	Target weed(s)	Comment
Dow Shield	Clopyralid	Thistles	Off label nos 0662/92
Grazon 90	Clopyralid + triclopyr	Thistles, nettle and dock	Off label nos 0692/95
Roundup Biactive	Glyphosate	Total weedkiller	On-label use

7.4 Common and marsh ragwort

The significance of ragworts to farmers and conservation managers is due to the fact that they are poisonous to livestock. Ragworts contain various cumulative alkaloid poisons which affect the liver and, when eaten in quantity, can cause death. In general, grazing animals will avoid eating ragwort plants due to its bitter taste. In cut grass, however, stock cannot easily avoid the weed and the bitter taste disappears, therefore it is eaten. Hence its presence in grasslands reduces the value of the herbage for grazing and necessitates control before hay or silage can be safely taken from infested fields.

The list in Cooke (1986) indicates that glyphosate can be used with a weedwiper against ragwort although other herbicides can be effective, eg 2,4-D, Clopyralid/Triclopyr (Grazon 90) (see Annexes 2-4).

For grazed swards the optimum time for spot chemical treatment of ragwort is in late April or May when plants are still at the rosette stage. Treatment with a weedwiper will not be appropriate at this time due to the need to establish a height differential. For fields intended for hay or silage, the best time to treat is in the autumn from mid September to November of the year preceding cutting. This allows the weed to die and so reduces the risk of fodder contamination. A weedwiper can be used in this type of situation. In both cases livestock need to be moved from pastures to be treated to avoid ragwort poisoning from dead plants. They should not return until the ragwort is dead and the foliage has disappeared. Product labels may specify periods for which stock should be removed after herbicide treatment. NB: Close grazing of ragwort may make this weed more difficult to kill chemically.

Cattle and horses are particularly susceptible to poisoning by eating ragwort, fresh or after cutting. Sheep and goats are more resistant but not immune. Young stock of all types are more susceptible than mature animals.

Cutting as a technique to control ragwort

Cutting is not generally recommended as it stimulates the growth of side shoots. Cut plants left lying in the field may still set seed and are a serious poisoning risk. They should be removed and burned.

Hand-pulling as a technique to control ragwort

For heavy infestations or large areas, hand-pulling is not only labourious but impractical.

The problem with this technique is that a proportion of plants may leave some stem fragments behind in the ground. These can produce small new plants which establish readily or allow seeds to germinate in the space left by the parent plant.

If hand-pulling is practised, damp soil favours more complete removal of the roots than dry soil conditions. As with many control methods, hand pulling needs to be undertaken over a period of several years if it is to have any effect.

Grazing as a technique to control ragwort

There are conflicts of opinion regarding sheep grazing as a technique to control ragwort, firstly as to whether it is acceptable, given the risks of poisoning, and secondly the best timing of grazing. Reducing grazing pressure can allow the sward to close up. Prevention of bare ground and disturbance prevents further colonisation.

The following are general guidelines with respect to grazing:

1. Do not allow susceptible animals (eg young stock) access to ragwort-infested swards - graze with the least susceptible type of stock available eg healthy, mature ewes.

2. One option is to graze when plants are young and still in rosette form ie until mid-May. However, another body of opinion suggests that plants are not so easy to graze when they are still in the rosette form and that they have better chemical defences at this time. Sheep may avoid young plants in preference to older ones when they will eat the flowers. The population itself may survive for a number of years from the seed bank, but where control is consistent the population will eventually collapse because of failure to set seed. (Grayson 1993 pers. comm.)

3. Avoid grazing ragwort-infested pastures with heavily worm-burdened animals, particularly when recently dosed with copper compounds or scheduled to be dosed with such compounds in the future. This is in order to prevent cumulative poisoning.

4. Avoid moving hungry animals onto ragwort-infested pastures and ensure that the other components of the sward are fully available as a buffer.

5. After herbicide use, do not graze before the ragwort plants have had a chance to disintegrate and disappear.

6. Never feed ragwort-infested hay or silage. Never pull ragwort without removing it from access to stock. It becomes palatable after wilting and all types of stock are at risk.

7. Never allow stock suffering from vitamin or mineral deficiencies or imbalances to eat ragwort.

8. If grazing ragwort-infested pastures, consider the need to provide additional vitamin and mineral supplementation, particularly vitamin B12 found in bran and other foods and ensure any food supplements contain no copper.

9. Never allow animals which are scouring or show any other signs of digestive upset or illness on to ragwort-infested pastures, remove them immediately they show any such signs.

Table 7.2 provides a summary of the ecology and control of the two ragwort species.

7.5 Thistle control

Mechanical methods of control are covered in sub-sections 7.3.2-7.3.4. For further information see Simpson (1993).

A wide range of herbicides give good control of top growth in the year of treatment and a useful degree of long-term control but no selective herbicide eradicates established creeping thistle by a single treatment. Spraying is best carried out prior to the flower bud stage when the weeds are growing vigorously.

The most specific translocated herbicide currently available for thistle control is Dow Shield which gives good control of next year's shoots through the root system. This has an on-label approval for spot treatment and an off-label approval for use in a weed-wipe. A wide range of herbicides can give good control (Annex 2).

Table 7.3 provides a summary of the ecology and control of thistle (*Cirsium* spp.) species.

7.6 Stinging nettle control

Cutting is generally not an effective method of controlling this species and herbicidal treatment is often necessary.

Nettles are usually avoided by livestock, though they will often eat them after seeding, or when cut and wilted.

Annex 3 of the handbook gives the susceptibility of *Urtica dioica* to different herbicides. The following herbicides all give effective control:

Clopyralid + triclopyr (Grazon 90)
2, 4-D + dicamba + mecoprop (Wood & Brush Killer)
Fluroxypyr (Starane 2)
Mecoprop (eg Campbell's CMPP)
Triclopyr (Garlon 2 or 4)

NB: Glyphosate (Roundup) is not considered to be very effective in the treatment of nettles (MAFF pers. comm.)

Of the above, only Grazon 90 has approval for use in a weed wipe. The remainder are approved for boom spraying or spot treatment but individual approvals for use need to be checked.

Table 7.4 provides a summary of the ecology and control of stinging nettles.

Table 7.2 Common and marsh ragwort

Biology & ecology	Common ragwort is normally a biennial: but it can become perennial, particularly when grazing or cutting prevents flowering or it is disturbed. Damage to the crown can make the plant behave as a perennial through the production of new rosettes. Very unpalatable to cattle and horses when growing, though sheep will eat leaves and flowers of living plants. Marsh ragwort occurs in wet meadows, streamsides and marshes and other seasonally wet habitats and is locally frequent throughout the UK. It is a biennial non-stoloniferous herb but can behave as a perennial.
Problems	Reduces hay yields and forage available to stock. Both species contain various cumulative alkaloid poisons which affect the liver and, when eaten in quantity, can cause death. Sheep less susceptible.
Benefits	More than 200 insect species feed on ragworts.
Factors leading to infestation	Bare ground or gappy swards caused by overgrazing (especially by horses and rabbits), disturbance and poaching. Dumping of spoil. Local seed source. Seldom present on sheep pastures.
Control measures	• Avoid damage to the sward. • Sheep grazing. • Hand and mechanical control techniques (pulling). • Weed wiping or spot spraying.

* see text for further details

Table 7.3 Creeping and spear thistle

Biology & ecology	Creeping thistle is a perennial occurring on most soils in Britain up to an altitude of 640m. It is adapted to withstand grazing by large herbivores and so most abundant in pasture. Height: 30cm-90cm (up to 150cm). Spreads by creeping rhizomes which can rapidly colonise an area. Spear thistle is a biennial with a deep tap root and grows in a rosette form in the first year. It establishes successfully on disturbed and overgrazed swards.
Problems	Reduces hay yields and grass available to stock. Makes hay difficult/painful to handle. Direct competition with herbage in areas of botanical importance.
Benefits	Thistles support a significant range of invertebrates which feed on nectar, leaves, flowers and stems - see Redfern 1983 for an introduction). In addition, seed-eating birds such as goldfinches benefit from the presence of thistles.
Factors leading to infestation	Bare ground and gappy swards caused by overgrazing, disturbance, nutrient enrichment, stock feeding and poaching. Stock will avoid thistles.

Control measures	• Avoid creation of bare ground.
	
	• Hand control techniques
	  • spudding (spear thistle)
	  • cutting low to ground
	  • thistle hoe
	  • hand-pulling
	  (remove weeds and burn them)
	  • mechanical pulling
	
	• Spot treatment with herbicide.
	
	• Weed wipe (especially larger areas).
	
	• Topping before flowers open (remove cuttings).

* see text for further details

Table 7.4 Stinging nettle

Biology and ecology	Tall (up to 1.8m) rhizomatous perennial which can form dense, persistent, clonal patches. An effective colonist of disturbed areas in grassland particularly where fertility is high. Regenerates by seed (it can form a persistent seed bank) or vegetative expansion by rhizome growth. Rhizomes broken by digging or disturbance readily re-root to form new colonies.
Problems	Reduces hay yields and grass available to stock. It is normally avoided by livestock, especially when young.
Benefits	Sustains a rich and diverse invertebrate fauna including some local/uncommon species. (*c*100 insect species are associated with stinging nettle - see for example Davis 1991 for an introduction.)
Factors leading to infestation	Bare nutrient-rich ground caused by overgrazing (poaching) stock feeding, deposition of spoil, old bonfire sites.
Control measures	• Avoid creation of bare ground • Avoid nutrient enrichment • Cutting (can be suppressed by repeated cutting but not an effective control method) • Spot treatment with appropriate herbicide • Weed wipe with herbicide • Mechanical pulling

Table 7.5 Broad-leaved and curled dock

Biology & ecology	These two species of dock are perennials and occur almost anywhere, preferring organically-rich loamy or clay soils, rich in phosphate and nitrogen. Both species grow up to 150cm tall and have a deep tap root.
Problems	Reduce hay yields and grass available to stock. Direct competition with herbage in areas of biological importance.
Benefits	Docks act as host for a variety of insects including moth larvae such as the Ruby Tiger Moth *Phragmatobia fuliginosa*- see Salt & Whittaker 1998 for an introduction.
Factors leading to infestation	Bare ground or gappy swards caused by overgrazing, disturbance and poaching. Nutrient enrichment caused by excessive dunging or dumping of ditch clearings or slurry spraying.
Control measures	• Avoid the creation of bare ground. • Topping before target weed flowers (remove cuttings). • Spot treatment with herbicide. • Weed wipe with herbicide. • Mechanical pulling

* see text for further details

7.7 Dock control

Mechanical methods of control are covered in sub-sections 7.3.2-7.3.4. Further details can be found in Simpson (1993).

The poor performance of herbicides used on the two dock species can frequently be attributed to the shading of seedlings by the large leaves of mature docks. Currently the most selective dock killer available is Starane 2 (fluroxypyr) (Simpson 1993) but there are a number of other effective broad-spectrum herbicides including Grazon 90, Broadshot and Garlon (triclopyr) (see Annex 2).

Cooke (1986) suggests the use of Roundup and Asulox (asulam) on docks. Recent MAFF-funded research on the control of injurious weeds found that asulam gives good control of both species of dock. However, the latter has been known to affect non-target fern species such as adders-tongue *Ophioglossum vulgatum*, but overall it has no detrimental effects on the majority of non-target vascular plant species.

NB: Dock root systems constantly produce new aerial shoots so any reduction in infestation is usually temporary unless killed by herbicide. Repeat treatment may be necessary to give satisfactory control of heavy or long-established infestations.

If early control to prevent seeding is missed, apply herbicide later in the season but while the plant is still green (ie August).

Table 7.5 provides a summary of the ecology and control of docks.

7.8 Bracken control and management

Introduction

Bracken *Pteridium aquilinum* control and management is generally more of an issue on heathland and upland grasslands than lowland semi-natural grasslands. It is generally regarded as an invasive weed, reducing the value of land for both agriculture and conservation. However, bracken can be of nature conservation value especially for mammals, birds and invertebrates in particular circumstances (see for example Backshall *et al* in press). For example threatened fritillary butterflies (high brown fritillary *Argynnis adippe*, pearl-bordered fritillary *Boloria euphrosyne*, small pearl-bordered fritillary *B. selene* and dark green fritillary *Argynnis aglaja*) use bracken stands which are rich in violets *Viola* spp (Warren & Oates 1995, Joy 1998). In many nature reserves and other protected areas, bracken is an invasive 'problem' plant, quickly replacing communities that have a greater conservation value. It can become a problem on lowland acid grasslands, particularly where overstocking has caused damage to the sward structure allowing bracken to establish. Locally it can also invade lowland neutral meadows, particularly on calcium-deficient brown earth soils. Over the last 100 years it has become more widespread, principally due to the reduction or cessation on livestock grazing, overgrazing and the cessation of bracken-cutting to provide winter bedding for animals.

There are several main problems relating to bracken management:

- In long established bracken stands, the rhizomes form an extensive branching system which has the ability to extend rapidly. These are full of food reserves, mainly starch, and there are usually many active and dormant buds present from which new fronds are produced.

- The plant is highly competitive and is able quickly to replace fronds destroyed during growth. Spread of bracken usually takes place by rhizome extension; patches of several hectares may be covered in this way from one original plant.

- Once bracken is established it produces a heavy shade in the growing season which discourages other plant species to establish.

- The dead fronds persist as a ground cover throughout the year, decomposing slowly and building up progressively into a litter layer which can suppress the ground flora.

- Bracken also produces 'allelopathic' chemicals from its rhizome and frond systems. These are naturally occurring toxins which prevent the colonisation, germination and growth of other plant species.

- Bracken is toxic and carcinogenic at various stages in its growth, causing the following problems: acute poisoning, vitamin B deficiency in horses, haemorrhages in cattle and sheep and retina degeneration and carcinomas in sheep.

- Bracken can inadvertently be favoured by autumn/winter/spring burning of the communities in which it occurs. Competing species may be knocked back, but with its food reserves in underground rhizomes, the bracken fronds emerge unscathed and the shade it casts in the summer may enable it to outcompete associated grasses and dwarf shrubs in the early stages of the recovery from burning.

Management options

Brown & Robinson (1997) outline four broad approaches to bracken management. They are:

a. no interference

b. conservation management where the aim is to maintain a relatively low density of bracken by selective control

c. control - the aim is to severely limit the vigour of a bracken stand and

d. eradication

In practice there will be situations where a combination of approaches is required. In a lowland grassland context it is likely that pioneer invading stands of bracken will be the target of control programmes. Complete eradication in any circumstances is seldom likely to be desirable or practical.

Before embarking on any large-scale programme of control it is important to assess the existing wildlife value and evaluate the impact of control.

Long-established bracken monocultures in the lowlands rarely support ground nesting birds. However, areas of bracken can support breeding birds such as whinchat, especially where stands of the plant occur in a mosaic with other habitats. Whinchat, for example, are positively associated with bracken although it is now rare in the lowlands. Thus this issue needs to be considered prior to implementing any of the control methods during the breeding season (April to July).

NB: A COSHH risk assessment should be made before undertaking operations in mature bracken because of the risk to human health of bracken spores.

Methods of control

The following account has drawn extensively from experience gained from bracken control and management at Brettenham Heath NNR in Norfolk (English Nature 1995a) but other sources have also been used (see References and further reading). In many cases any integrated approach to control is necessary involving a combination of the techniques outlined. More detailed information is contained in Backshall *et al* (in press) and Brown & Robinson (1997).

Cutting

This method involves cutting bracken three times a year followed by one cut a year once it has been brought under control. Repeated cutting reduces the energy reserves in the bracken's underground rhizome system and inhibits the production of new fronds.

For best results cutting should commence between early June and mid-July (but see below) to maximise the depletion of rhizome reserves. A second cut is made between late July and August after the fronds have grown back. A final cut is made in September before the first frosts. The timing should ensure the bracken is cut at four to six week intervals throughout its growing season. The density of bracken fronds can increase after the first year of cutting in response to physical attack. Heavy duty powered cutters may be used on lightweight ATV-drawn units.

Cutting operations should be timed to avoid disturbance to ground nesting birds. Species such as nightjar may nest in bracken until late August. At some Breckland sites, eg Weeting Heath NNR, only one cut is made in the season to avoid disturbing nesting stone curlew.

Swiping

Regular 'swiping' of bracken requires special equipment. Staff at Brettenham Heath started with a small tractor and a six-foot rotary swipe. Three years into the programme (1987) English Nature invested in a nine-foot swipe and four-wheel drive tractor to speed up the operation. One person can cover four to six hectares with this equipment in a day. Approximately 80 hectares a month can be cut in this way, provided ground conditions are not too difficult.

Swipes are available in sizes up to 5 metres, but at Brettenham 3 metres was considered the optimum size because of the uneven nature of the ground in parts of the reserve. The height of cut was usually set at about 10cms. The large open areas of the heath were cut first as the equipment was more difficult to manoeuvre among trees and scrub.

Forage harvesters can be used to clear smaller areas of bracken, but are not suitable on large sites because of their slow operating speed, inability to operate on uneven ground and requirement for a second tractor to collect and remove cut material.

Recent advances in equipment design have resulted in a forage harvester that will collect and remove bracken in one operation with a single machine. A flail-cutter collector has been used to cut and remove bracken growth and litter on Thursley NNR, Surrey. This proved effective in controlling bracken on undulating terrain.

Chisel ploughing

Bracken has also been effectively controlled by a method known as chisel ploughing. This deep tine cultivation technique (to a depth of 18 inches) imposes maximum stress on the fern by direct mechanical damage and ensures its rhizomes system is killed off by subsequent frosts and drought.

Ploughing should be preceded by two cuts to pre-stress the rhizomes. Best results can be obtained by ploughing in very hot weather to cause maximum physical damage to the plant's stems and rhizomes. Chisel ploughing damages the soil profile and should therefore only be used in areas where there is an established monoculture of bracken and no risk of damage to buried archaeology. Follow-up management is also necessary. This technique is extremely destructive and is not recommended as a control method within areas of existing nature conservation interest.

Crushing

This can be a useful control technique especially as a follow-up to other treatments. The principle is to flatten, bruise and crush the bracken stems and bleed the sap rather then sever the stems from the root. This reduces vigour and prevents re-charge of next season's storage organs. A variety of machines have been used including a ring roller, a 'bracken crusher' and a 'bracken breaker'.

Two new versions of the 'bracken breaker' machine are now available and can be drawn by ATV quadbikes, mini-tractors or 4 x 4 vehicles. This machine is available from Brian Otterburn, Agricultural & Dairy Engineers, Harome, York, YO6 5JE. As with other mechanical methods, crushing should take place when bracken has expended maximum energy producing this years stem but before re-charge of next years storage organs. This is typically mid-July. Repeating the treatment the same year and in subsequent years is likely to be necessary to provide effective control. Further information on this technique is given in Lewis *et al* (1997).

Pulling

The Eco-puller described in sub-section 7.3.3. has been used on bracken and although little evaluation of its effectiveness has yet been undertaken it is likely to be at least as effective as cutting and bruising. It is advisable to pull early as soon as the croziers lose their brittleness but before full frond extension.

Herbicide control

Bracken can also be controlled with chemicals. Herbicides approved for use on bracken in agricultural situations are asulam, glyphosate and dicamba. Asulam is the only herbicide which has approval for aerial application. Asulam is preferred as it is narrow spectrum in contrast to the others.

At Brettenham Heath NNR a 40 hectare block was treated with the herbicide Asulox (asulam) in 1988 with considerable success. Most of the reserve had already been cleared using the swiping and grazing method so it was decided to try a different technique on the last remaining area of bracken.

Aerial spraying was chosen because this is the most cost-effective method for large, unbroken stands of bracken or where access is difficult. The whole operation was completed in only three hours. This was the total flying and did not include staff time spent mixing chemicals on the ground. Asulox proved very effective killing 95 per cent of bracken fronds. Due to concern over drift, buffers up to 250 metres downwind may be required to protect sensitive rare ferns.

Application through knapsack sprayers has also been found to be generally effective on most heathland NNRs, particularly where accurate work is required near sensitive non-target species. This method is considerably more labour intensive on large areas than aerial application. The latter method has also been found to be more effective and efficient on adverse ground conditions.

Weed wiping trials are underway using asulam and glyphosate with promising early reports of success (see also general section on tractor-mounted weed wiping).

It is unusual for one spray application to eradicate bracken and follow-up treatments are normally necessary.

Timing of applications

One of the main drawbacks of herbicide treatment is the limited opportunity for its use. Asulox must be applied when bracken is in full frond, but before it has started to die-back - usually mid-July to late August depending on season and geographical location.

This timing is critical since it ensures maximum absorption of the chemical and translocation into the rhizome system and is unlikely to be effective at any other time. Application is also very weather dependent and a rain-free period must follow treatment.

Asulox is safe to use in bracken of various densities, ranging from deep litter with no accompanying sward to areas of less vigorous bracken accompanied by ling *Calluna vulgaris* and bilberry *Vaccinium myrtillus* which are not adversely affected by the chemical. Some indigenous grass and forb species may

be checked, but normally recover. However, non-target fern species such as moonwort *Botrychium lunaria* and adder's-tongues *Ophioglossum* spp will be killed and wherever such species of conservation interest occur, care needs to be exercised and application methods carefully selected. A suitable buffer zone should be left around areas containing vulnerable species (see Backshall *et al* in press for further details).

The recommended application rate for Asulox, as shown on the product label, should be followed at all times. Wetting agents (adjuvants) like Agral, are used when spraying to safeguard against adverse weather conditions following application. For best results, the chemical requires a rain-free period of 12 hours to ensure effective treatment. Asulox should not be applied if bracken is affected by droughts as this will severely reduce it effectiveness.

The herbicidal action of Asulox is very slow and apart from a slight yellowing of some bracken fronds there is very little discernible change. The results of the treatment will not be seen until the following season by which time the chemical has been translocated down the stems and into the rhizome system. The plant is so weakened it can produce only a few stunted fronds that can be removed by spot spraying.

Suitable ground application methods for Asulox are by tractor or ATV- mounted sprayer, weed wiper, motorised mist blower, knapsack sprayer and hand-operated knapsack sprayer or hand lance. Buffers may be needed to protect rare ferns. As an example, the Forestry Authority recommends a 100 metre buffer when spraying with a hand-held ULVA (Ultra Low Volume Applicator).

Do not forget that consideration must be given to avoiding contamination of drinking water supplies.

Glyphosate can be used as an alternative to Asulox, but it cannot be sprayed from the air. It is best suited for ground application in areas of dense bracken monoculture as it will kill all non-target grasses and heather. Unlike Asulox, it has the advantage of producing obvious scorch symptoms on bracken soon after application, enabling evenness of application to be judged and, where necessary, follow-up treatment to be carried out.

Some follow-up treatment may be required after spraying. At Brettenham the bracken litter was swiped the following winter to reduce the amount of protection it offered young fronds from late frost.

More detailed advice on the use of asulox can be found in Brown & Robinson (1997).

Grazing

Both undergrazing and overgrazing in the past have contributed to bracken expansion. Thus appropriate stocking levels in pastures should both prevent initial invasion and keep it in check following control measures. Mob stocking by cattle can be used to crush bracken as in mechanical methods but will rarely be a practical solution.

At Brettenham it was found that cattle grazing allied with trampling was most effective as a sustainable management tool in preventing long-term bracken regrowth. It helps suppress bracken by creating a dense, species-rich heathland sward allowing species such as sheep's fescue and wavy hair grass out-

compete bracken for nutrients and space thereby restricting its development. Grazing prevents bracken encroaching into grazing areas that are well grazed but does little to restore dense bracken stands.

In addition to providing sustainable heathland management, grazing helps restrict the growth of young bracken to a limited extent through trampling and physical damage where cattle are present. It also avoids the need to use herbicides to prevent the regrowth of scrub.

Grazing levels are controlled to maintain a stocking rate of between one and two sheep per hectare per year. A flexible system is used because during hot summers the light Breckland soils can quickly become 'parched' and the quality of grazing deteriorate rapidly.

Adequate feed should be provided to prevent stock eating any dead bracken or rhizomes exposed in the surface layer. Bracken contains poisons that can cause illness and even death in some animals if eaten in sufficient quantities. The fronds are most toxic in their newly emerged 'crozier' stage of growth and become progressively less so as they mature. Animals usually avoid bracken because of its bitter taste, but some can develop an appetite for it. Sheep appear more resistant than cattle to acute bracken poisoning.

Removal of the litter layer was not found to be necessary at Brettenham. On other sites it has proved to be essential in order to expose a viable heather seed bank or even to facilitate the introduction of seed.

NB: On sites which have had a long history of bracken infestation there may be very few seeds present in the soil to help recolonisation. It is important to consider this before starting an eradication programme.

It may be possible to use pigs to root up rhizomes and eat them although this method is not suitable for areas where the 'understorey' vegetation needs to be conserved.

On the Morecambe Bay limestone cattle are used to promote patchy bracken stands suitable for fritillary butterflies. Moveable water bowsers and feed blocks are placed at strategic points to encourage animals to enter denser stands and trample down fronds and break up litter. In addition, cutting swathes through stands in June is undertaken to encourage stock access. This encourages a patchy development of sward with violets (*Viola* spp.), the food plant of the high brown and pearl-bordered fritillaries.

Aftercare

With the techniques described it is important to stress that one season's treatment alone is unlikely to give longer-term results.

7.9 Control of rushes

In the lowlands, rushes *Juncus* spp are associated with periodically waterlogged soils. Rushes can quickly increase from the vast numbers of seeds lying dormant in the soil for long periods. There are six species of rush which can dominate lowland damp grasslands; these are: soft rush *J. effusus*, compact rush *J. conglomeratus*, hard rush *J. inflexus*, sharp-flowered rush *J. acutiflorus*, jointed rush *J. articulatus* and blunt-flowered rush *J. subnodulosus.*

Semi-natural fen meadows, rush pastures and wet grasslands are of high value for nature conservation and some of these communities typically contain rush species at high frequency (for example NVC communities M22, 23, 24, 25, 26 & 27).

Rush pasture can provide an important habitat for breeding birds, eg lapwing *Vanellus vanellus*, snipe *Gallinago gallinago* and redshank *Tringa totanus*. Infestations may occur in the absence of sufficient grazing pressure. Although not normally classed as a problem species there are several reasons why rushes can require management. It is important to stress that management regimes are likely to be directed towards control and enhancement rather than towards eradication.

The management objectives will depend on the nature conservation interest of the site. The most likely reasons for management include the following:

- Over dominance by rank growths of rushes can cause a reduction in both species and structural diversity and consequently a loss of nature conservation interest.

- Breeding birds require cover in the form of rushes and patches of open short sward for feeding. These have to be in fairly close proximity.

- Many unimproved lowland damp grasslands of nature conservation interest are utilised for commercial livestock enterprises or mown for hay. Rushes are usually avoided by stock. Farmers will be reluctant to graze their animals if there is insufficient high quality forage, and rushes in hay may reduce forage quality hence control may be required.

Methods of control

The method of control adopted will depend on the nature conservation interest of the site and the management objectives. Where stocking density is low and because of the unpalatable nature of rushes they are best managed by cutting on an annual basis.

Recent work on soft rush (Merchant 1995) has shown that cutting to ground level reduced tussock mass and rush vigour. Two cuts during the growing season are better than one but if only one cut is possible then cutting in August after flowering is most effective To allow for use of machinery, a late cut is more likely to be the practical option on sites with a high soil moisture content. Where sites support breeding birds the timing of cutting should avoid the period April to June inclusive.

Three types of machinery are generally used for cutting rush-infested pasture: a grass mower trailed by a tractor, a pasture topper, or a forage harvester. The latter is particularly useful on uneven ground. Wherever possible, cuttings should be removed to prevent the smothering of low-growing plants.

In the Lower Derwent Valley NNR in Yorkshire, rush pasture is managed on a rotational basis to benefit breeding waders. Strips are mown, on a three year rotation, to provide areas of both short sward for feeding and longer sward to conceal the adults and chicks.

A study by Merchant (1993) showed that goats will readily eat soft rush in grassland and proved to be effective in reducing the cover and vigour of this species. However, high stocking rates were required

(30 per ha) which in turn results in low inter-tussock sward heights. This, coupled with the practical difficulties involved in using goats, may limit the applicability of this method.

Use of Glyphosate in a weed wiper may also be an option for initial control provided a height differential can first be achieved by grazing. Once rushes are reduced to an acceptable level, cutting and possibly grazing can then be used to maintain the 'status quo'.

7.10 Control of cow parsley *Anthriscus sylvestris*

In the lowlands, this biennial or short-lived perennial species can cause problems if it becomes over abundant in enclosed neutral haymeadows. This could potentially threaten the maintenance of species richness and reduce the value of the hay crop for owners and occupiers.

It appears this species may increase in abundance where:

a. nitrogen additions are occurring, either through fertilizer input or atmospheric deposition;

b. cutting occurs infrequently;

c. aftermath grazing of meadows has ceased.

Methods of control

" Ensure the maintenance of aftermath grazing of hay meadows or try to re-establish this practice wherever practicable.

" Prevent inputs of artificial fertilizers or other nutrient inputs with the exception of farmyard manure at agreed levels (see Chapter 8).

" Repeated cutting (three or more cuts per annum - preferably with one cut prior to the onset of May flowering) can apparently reduce the abundance of cow parsley, but this practice may or may not be desirable or practical in most cases. Exceptions to this might include areas where it is locally dominant eg along field margins. For further information on autecology and use of cutting as a means of control, see Hansson & Persson 1994, Parr & Way 1988 and Mierlo & Groenedael 1991.

" As a last resort, spot spraying of small stands could be considered but this would only be acceptable where other broad-leaved species of conservation interest were not affected. It is known to be resistant to grassland herbicides in the mature state but herbicides containing dicamba or dichlorprop can be effective when applied at an early stage of growth.

7.11 Other species

7.11.1 Vascular plants

Occasionally, it is likely that requests will be received to control a range of other vascular plant species that occur as components of semi-natural grasslands where they may be perceived to be a problem. In most cases this will be due to concerns over toxicity. Space does not permit coverage and the provision of advice with regard to other species which may occasionally be cited in this way. However, on receipt of a query regarding a possible problem species, it is recommended that an adviser:

- researches the toxicity and autecology of the particular species;
- considers whether control measures may be legitimate and necessary in relation to the agricultural and conservation context;
- considers what control options there might be (mechanical, changes in management regime, herbicides etc);
- determines whether these can be implemented without damage to the nature conservation value of the particular area or site.

Cooper & Johnson (1998) is a useful source of information on poisonous species and sources of autecological information on particular plant species include the Biological Flora accounts in the *Journal of Ecology*, Grime *et al* (1988) and various floras/identification guides.

7.11.2 Moss

Moss is sometimes a component of amenity grassland such as on golf courses and may be considered undesirable from a sports turf perspective. The usual control method is to spray with herbicide. 2,4-D + mecoprop is approved for use in turf and amenity grass, as are dicamba + dichloroprop + ferrous sulphate + MCPA, dichlorophen + ferrous sulphate and ferrous sulphate which are herbicide/fertiliser combinations for amenity turf.

Occasionally, semi-natural grassland will be managed as part of amenity areas. Species of moss occur as components of most semi-natural grasslands (see Chapter13, Section 13.5) and on no account should the use of herbicide be sanctioned in these situations.

NOTE: It should be stressed that the guidance on chemical weed control contained in the text of Chapter 7 is only a general introduction and no liability is accepted. Operators should always read the product label and comply with any off-label requirements and with all legal requirements and approved Codes of Practice. Details of the products referred to in the text were correct at the time of going to press but reference should always be made to the current label instructions for specific pesticides before use.

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