5 *Grazing*

5.1 Introduction

Grazed grasslands are usually referred to as pasture whereas grasslands which are cut for hay are called meadows. Most meadows in the UK have stock put on them to graze the regrowth after a haycut (aftermath grazing) while some upland meadows are spring grazed and then 'shut up' for a subsequent hay or silage cut and then aftermath grazed (see Chapter 6).

Grazing of pastures can take place at any time of year including periods when plants are growing, flowering or setting seed. As a result, some species found in hay meadows are generally absent or reduced in dominance in grazed swards owing to their intolerance to grazing (Hopkins 1990) (see sub section 5.2.2).

All of the five broad types of semi-natural lowland grassland ie calcareous, neutral (or mesotrophic) acidic, fen meadows/rush pastures and Calaminarian (metaliferous) grassland are used for either grazing or hay cutting or a combination of both (see Chapter 2, section 2.3). Mesotrophic grasslands tend to be most easily improved from an agricultural point of view. Acid and calcareous grasslands tend to be less productive and are usually grazed rather than mown. They are less easily improved by re-seeding and are more likely to suffer from abandonment. Many areas of species-rich chalk downland in Dorset have been abandoned in this way.

Since 1945, three factors have led to dramatic changes in the extent and wildlife interest of the remaining areas of semi-natural grassland (Stoate 1996) :

Specialisation

Farmers have increasingly moved to specialising in either arable or stock farming (notably dairying). There has been a decline in the traditional mixed farming methods practised before 1945. Improvements in agricultural technology along with the introduction of financial incentives have led to an increase in the proportion of arable to grassland. On lowland arable farms the value of semi-natural habitats is likely to be peripheral to farm activities.

Intensification

Drainage, the change from hay making to silage, reseeding with ryegrass, increases in stocking rates and above all the greatly increased use of inorganic fertilisers have led to a loss of semi-natural grasslands and the associated flora and fauna previously maintained by extensive grazing systems (see Chapters 2 and 4).

Abandonment

A reduction or cessation of grazing on unimproved grassland due to the relative decline in profitability of livestock farming on such land has led to further habitat loss. Many areas of land which are inaccessible to machinery, ie steep escarpments, have been colonised by rank grass and scrub. In chalk and limestone areas, species previously kept in check by grazing such as tor-grass *Brachypodium pinnatum* have become dominant over large areas (see Chapter 10).

Neglect has been exacerbated by the decline in rabbit grazing following the myxamotosis epidemic of the 1950s. The decline of species associated with short swards such as the burnt tip orchid *Orchis ustulata* and the late spider orchid *Ophrys fuciflora* may be as much a result of the process of agricultural abandonment as absolute habitat destruction. Undergrazing is certainly believed to be the main factor leading to the extinction of the large blue butterfly *Maculinea arion*, the decline of the silver spotted skipper *Hesperia comma* and the decline in wheatears *Oenanthe oenanthe* which favour short, tightly grazed swards (Hopkins 1990).

Certain species of butterfly such as the Duke of Burgundy fritillary *Hamearis lucina* and the dark green fritillary *Argynnis aglaja* have benefited from an increase in taller swards.

5.2 The ecological perspective of grazing

There are three major components of the grazing process: defoliation, trampling and manuring.

5.2.1 The impact of grazing

Defoliation

This is the removal by animals of some or all of the above ground parts of plants (ie leaves, stems and flowers) which may be alive or dead.

Except at very high stocking densities, grazing removes plant material more gradually than cutting. This can give more mobile invertebrates a chance to move to other areas within the grassland.

The selection of certain plant species in preference to others by grazers can be an important factor determining the structure and floristic composition of the sward. In general, animals select leaf material rather than stems and prefer young green leaves to old, dry herbage. Younger material is easier to digest as it contains less lignin and higher levels of nutrients (soluble sugars and proteins).

Grazing selectivity may influence plant species composition/abundance in grassland and can lead to community change. Grazing limits the ability of competetive species to achieve dominance by continually removing their additional biomass.

At higher stocking rates animals are generally forced by hunger to be less selective and eat both the older, tougher plant material and the coarser plant species. This can be a useful way of restoring neglected grasslands or controlling unpalatable species (see Chapter 10).

Food intake and possibly diet choice of female animals will vary according to stock type reproductive condition and age. Diet choice may also vary seasonally, according to changes in species composition of the sward and the phenology of its different components (see also Section 5.3).

Trampling

Trampling by livestock can affect both the structure and botanical composition of the grassland. The effects of trampling will depend on a number of factors including: stocking density, stock type, soil type, topography, length of grazing period, season of year and rainfall

Hay meadow management by cutting alone can very quickly result in a less species-rich community. Aftermath grazing is essential, partly to control competetive coarse grasses, and partly, via trampling which creates gaps in the sward for germinating seedlings to exploit.

Moderate trampling can be beneficial especially in neglected grassland. The hoof action of heavy animals, such as cattle, breaks up the litter layer and tramples and crushes the coarse vegetation. In addition, it creates bare ground which enables seedlings to establish. Bare soil is also essential for the life-cycle of many invertebrates (see Chapter 13, section 13.3). The effects of trampling depend on the livestock species. The physical pressure exerted on a grassland by sheep is estimated to be 0.8 to 0.95 kg per cm^2 and by cattle to be 1.2 - 1.6 kg per cm^2 (Spedding 1971).

Although a certain amount of bare ground is desirable, heavy poaching can destroy soil structure through compaction leading to soil erosion, excessive bare ground and invasion by problem weed species (see Chapter 7). Poaching occurs when hoof damage combines with high soil moisture levels to destroy the structure of the soil profile impeding its natural drainage properties. It is unusual for stock grazing naturally to produce trampled vegetation types. However, if grazing and/or lying-up is concentrated along footpaths there can be a significant effect on vegetation. (Generally, a marked reduction in species, introduction of a small number of ruderal or weed species and creation of a short, open sward.)

Cattle create their own access into scrub and this is a very important means of controlling scrub through trampling and mechanical damage, rather than grazing.

Manuring and nutrient cycling

Grazing animals promote the recycling of nutrients in the grassland ecosystem. Nutrients are added in the form of dung and urine, and removed via grazing through the export of carcasses, milk and wool.

Traditionally, sheep were transferred or 'folded' at night from chalk grassland downland onto arable land where their dung and urine acted as a fertiliser for arable crops. This type of management may have helped the transfer of nutrients off the downland. A decline in this practice could have led to an increase in nutrients, particularly in areas where sheep lie up at night, eg against walls, fences and scrub. Horses can dung in the same areas forming 'latrines' which can become dominated by nutrient demanding species (see Chapter 5, Section 5.3, sub section 5.3.3).

Nutrients are cycled faster in grazed areas than ungrazed and are more quickly made available to plants via dung and urine. Production of fresh green material, rich in nutrients (especially nitrogen) is enhanced, stimulated by the removal of older leaves and other plant material during grazing. Overall

the total amount of nutrients locked up in the vegetation of grazed systems will be lower than in the ungrazed systems. The biomass of green plants is less, due to regular removal by animals.

Unless the grazing animals die and decompose *in situ* there is a net loss of nutrients to the system when animal carcasses are exported for sale.

Much of the ingested material is recycled in dung and urine. Urine contains much nitrogen, sulphur and potassium and this is made available for recycling when voided. Dung contains phosphorous, magnesium and calcium. Eighty per cent of the nitrogen taken up by plants is recycled in urine. However, the nutrients returned in dung and urine do not all become available for plant uptake due to losses by leaching and to the atmosphere. Overall, in semi-natural vegetation there is no evidence that long-term dunging has a net enrichment effect beyond localised latrines. However, this may not be the case if stock are grazing fertilised and semi-natural sites within one grazing unit. This can result in a net import of nutrients and can cause problems when animals are moved from improved pasture to grasslands of conservation interest which usually have a much lower nutrient budget.

Production of new plant material is enhanced by the improved availability of nutrients (especially nitrogen) from dung and urine. Microbial decomposition in the soil liberates the nutrients present in dung and urine more quickly than those in dead plant material and nutrients are thus recycled more rapidly for uptake by plant root systems.

Areas that have received dung and urine may be avoided by livestock for some time. This can result in patches of taller vegetation which may benefit some invertebrates. This rejection by grazers is a behavioural defence to limit the spread of gastro-intestinal parasites which are present in faeces. When livestock are overstocked this avoidance behaviour is reduced by hunger and the parasite burden is likely to increase within the grazing animals. On dry sites 'scorch' or death of grasses can occur in patches receiving urine deposits followed by invasion of other species.

Dung itself provides an important habitat for dung dwelling invertebrates and fungi. There are 56 British Red Data Book species of beetle associated with various types of dung (16 with cattle, 15 horse, 13 sheep) (McCracken 1993).

5.2.2 Grazing interactions and ecological adaptations

The aim of this section is to provide a theoretical framework upon which to base assessments of grazing situations (ie ascertaining past management and setting objectives for future management). This section should be read in conjunction with Chapters 3 and 15 on monitoring.

Grazing plays a key role in maintaining species richness by limiting the ability of competitive species to achieve dominance. When considered in relation to soils, topography, vegetation, site size etc, an assessment of the proportion of stress tolerators to competitors/ruderals can be partly used to assess past management and, in conjunction with clear achievable objectives, to determine the future grazing requirements of the site. This is a more conceptual approach to grassland management, based on Grime's model of plant life history strategies.

A high proportion of competitive species indicates a cessation of either grazing or cutting leading to successional development towards later seral stages. Monitoring of the proportion of a range of stress tolerant species compared to ruderals and competitors, through time can be used as a guide to help adjust grazing regimes (see Chapter 15). This approach relies on identifying how different adaptations and responses fit Grime's model of plant life history strategies.

The response of plants to grazing

Position of the growing point

The position of the growing point is a very important determinant of whether a plant can tolerate close defoliation. Grasses are generally tolerant of grazing as they grow continuously from the base. Plants with their growing tips higher up, eg great burnet *Sanguisorba officinalis* and many umbellifers, can be much suppressed or eliminated by grazing. If plants have a creeping or prostrate form or grow as low flat rosettes, they will have an advantage in a heavily grazed sward, eg wild thyme *Thymus polytrichus*, plantains *Plantago* spp, and stemless thistle *Cirsium acaule*. Some erect plants can form rosettes when heavily grazed, eg ragworts *Senecio* spp and knapweeds *Centaurea* spp. Communities with a history of regular grazing, therefore often have an abundance of laterally spreading, stoloniferous, rhizomatous and rosette species with fewer tufted or tussock forming plants.

Palatability

Palatability is very important in determining whether or not plants are readily grazed. Palatability is a function of smell, digestibility and nutrient content, taste, texture and leafiness. The following will influence these attributes:

- Chemical composition. The amounts of soluble protein and carbohydrate are important feeding stimulants (eg false oat-grass *Arrhenatherum elatius*, a palatable grass has high amounts of phosphorous and calcium in its tissues. Alkaloids, resins and terpenes will also reduce palatability due to their bitter taste (Launchbaugh 1996).

- Hairiness, spines, stinging hairs and thorns are important. Stinging nettle, for example is unpalatable to most stock.

- A high leaf: shoot ratio contributes to palatability – ie leafy plants as opposed to stemmy ones are more palatable; woody parts of plants are less palatable.

Plants which are palatable to most herbivores include most grasses and most legumes. Species which are unpalatable to most herbivores include St John's-worts *Hypericum* spp (which contain the alkaloid hypericin), nettles, aromatic herbs such as wild basil *Clinopodium vugare,* marjoram *Origanum vulgare* and wild thyme *Thymus praecox*.

Species which are palatable are often competitors – fast growing, with a high leaf turnover and high nitrogen content in the tissues eg perennial rye-grass *Lolium perenne*. Conversely, unpalatable species are often stress tolerators - slow growing leathery, woody, spiny and without juicy leafy tissue. These may also include ruderals such as ragwort *Senecio jacobaea.*

Tillering of grasses

The production of new shoots takes place from the base of the plant throughout the growing season. It is stimulated by defoliation and increased light penetration to the lower parts of the plants; therefore, under regular defoliation, more tillering will take place. However, severe defoliation right into the base of the plant can kill the tiller buds. At some point during the growing season (depending on species), production of leafy tillers switches to production of tillers which bear flowering stems and ultimately seed heads. Once this starts, new leaf production is limited or negligible. New vegetative tiller production is blocked until the flowering stem is cut off or dies. To keep swards leafy and thick (often undesirable for nature conservation), regular or continual grazing and/or cutting/topping is necessary.

Allowing the grasses to flower will decrease the density and leafiness of the sward, although the total bulk, with stems and flowers, will probably be greater. Grasses vary in their tillering capacity, ie number of tiller buds, and hence their response to defoliation. Plants which produce many tillers include red fescue *Festuca rubra*, perennial rye-grass *Lolium perenne*, creeping bent *Agrostis stolonifera*, common bent *Agrostis capillaris*, wavy hair-grass *Deschampsia flexuosa*, sheep's fescue *Festuca ovina* and mat-grass *Nardus stricta*. Relatively poor tillerers include false oat-grass (a grazing intolerant species), sweet vernal grass *Anthoxanthum odoratum*, yellow oat-grass *Trisetum flavescens*, meadow foxtail *Alopecurus pratensis* and crested dog's-tail *Cynosurus cristatus*.

Storage organs

Types of storage organs include rhizomes, tap roots, stolons, bulbs and corms. These provide food reserves for regrowth. Many grass species have rhizomes which are storage organs, eg bent grasses *Agrostis* spp, tor-grass and red fescue. Some grasses have very fibrous roots systems and/or stem bases which store food, eg purple moor-grass *Molinia caerulea*.

Grazing will have most effect:

- in spring – when photosynthetic (leaf) area should be rapidly expanding and physiologically very active, but is reduced by grazing;

- in early autumn – when manufacture and translocation of food for winter storage are prevented by defoliation; and

- in later autumn – when plants are weakened and made more prone to winter frost and drought.

If the aim of management is to control species which have storage organs, these plants need to be cut or grazed hard when the food reserves have been drawn from these organs ie while the plant is at the peak of its growth (usually May/June) and before fresh supplies have been manufactured.

Reproductive and regeneration strategy

Plants with rhizomes and stolons often recover quickly after heavy grazing or damage. Plants which only reproduce by seed, eg annuals, need to set seed to be able to survive. If grazing is continuous and heavy these species may gradually die out if they are susceptible to being eaten. Annuals need bare

ground (to a greater or lesser extent and in varying seasons, depending on the species) to allow re-establishment from seedlings, something which is favoured by heavy grazing. This is why most annuals have effective defences against grazing (see sub section 5.2.3).

Seed of some species will germinate in deep shade underneath a tall sward, eg buttercups *Ranunculus* spp, umbellifers, meadow sweet *Filipendula ulmaria* and cuckoo flower *Cardamine pratensis*. Others, eg violets *Viola* spp, lady's-mantles *Alchemilla* spp and harebell *Campanula rotundifolia* need high light intensity for germination. This strategy is correlated to the successional stages occupied by each species.

Most grassland species have light seeds which need gaps in which to germinate; however, heavy seeded species with a large food reserve in the seed such as tor grass, upright brome *Bromopsis erectus* and false oat-grass (and many shrubs and trees) can grow up through litter and vegetation.

Creation of bare ground in spring will favour spring-germinating species and creation of bare ground in autumn will favour autumn germinating ones.

Longevity

If a plant is long-lived, it will not need to produce seed every year. Many grassland perennials are very long-lived, eg upright brome cocks-foot *Dactylis glomerata*, Timothy *Phleum pratense*, perennial rye-grass and tufted hair-grass *Deschampsia cespitosa*. A high proportion of grassland species are perennials.

Conversely, some perennials are short lived, eg false oat-grass and sweet vernal-grass . Annuals need to flower and seed every year unless they have a persistent seed bank. Problems can arise (ie species may be lost from the sward) if changes are made to the management regime when annual species are present. Continuous spring grazing or a switch from a hay cutting to a grazing regime can cause a decline in the number of annual species present, eg yellow-rattle *Rhinanthus minor*.

5.2.3 The grazing resistance model

Introduction

The previous section illustrates how Grime's life history theory establishes a conceptual framework which can consolidate our understanding of and approach to management issues.

Considerable research effort has been devoted to plant-herbivore relationships during the last 50 years. It has provided a powerful theoretical framework for understanding the fundamental ecological processes which shape plant-animal interactions. It has also produced a significant body of more applied knowledge that has greatly assisted the development of agriculture (Illius and Hodgson 1996).

Although conservation management has also benefited from ecological advances, this has been almost entirely empirically derived using research findings that relate directly to species or habitats of immediate concern. Relatively little progress has been made towards applying the wider ecological theory to conservation grazing management. This section therefore sets out to explain a model of plant-animal interaction that can assist the process of interpreting and designing appropriate grazing regimes for conservation and should be read in conjunction with Chapter 3.

Grazing resistance

Grazing resistance (Briske 1996) is a concept that describes how grazing by animals (herbivory) affect plants at both population and community level, providing important insights into the ecological processes which control grazing-induced change. The concept of grazing resistance is defined by a plant's relative ability to survive and grow within a community subjected to grazing pressure. Grazing resistance comprises two complementary types of strategy by which plants seek to withstand herbivory:

Avoidance: These are adaptations enabling plants to minimise the damaging effects which grazing directly inflicts on them. Avoidance mechanisms therefore correspond to active-means of plant defence or escape.

Examples include:

- mechanical defences; prickles, stings, hairs, spines, leaf texture and toughness;
- chemical defences; unpalatable smell and taste or toxicity due to the presence of specific chemicals;
- escape mechanisms; prostrate habit, dormancy, species associations, frequency and distribution.

Tolerance: These are adaptations which enable plants having survived the damaging impact of herbivory, to secure and utilise the resources needed for replacing lost tissue as quickly as possible. Tolerance is therefore the means of plant recovery.

Examples include:

- meristems; the number and location of growing points from which to replace grazing damage (eg tiller buds on grasses);
- seeds; the number and viability of seeds from which to replace mortality losses from the population;
- physiology; compensating mechanisms for restoring levels of production (eg photosynthetic ability, uptake of nutrients via roots).

There is a close parallel here between Briske's grazing resistance concept and Grime's theory of life history strategies (See Chapter 2) since avoidance mechanisms represent adaptation to a form of disturbance (ie grazing) and tolerance mechanisms are adaptations for overcoming stress. Such 'meshing' of complementary theoretical concepts may lend additional credence to their wider use and application, since together they permit a fuller and more coherent interpretation of the ecological principles which must inform management decisions.

Each plant's grazing resistance strategy represents a compromise between two primary biological goals: the need to survive grazing on one hand, and the requirement for maintaining adequate levels of growth and reproductive output on the other. Hence there is a strategic trade-off between tolerance and

avoidance mechanisms which determines the overall effects of grazing on different populations and communities.

Late-successional dominants must maintain high levels of biomass production in order to retain their competitive status. Tolerance mechanisms are therefore more appropriate components of late successional grazing resistance strategies because they are designed to enhance productivity and will therefore complement the plant's more generalised competitive adaptations. Avoidance mechanisms are adaptations which are divorced from growth so investment in them constitutes a drain on competitive ability. High costs of defending against grazing obviously cannot be justified if the population subsequently declines as a result of competition.

Avoidance mechanisms are much more prominent components of early and mid-successional grazing resistance strategies because the competitive pressures within these communities are considerably lower than in later stages. The main requirement here is to escape damage by herbivores since in general the effects of grazing will be more prevalent in the early seral stages.

Briske provides a diagram, reproduced here (Figure 5.1) to illustrate the fundamental relationship between grazing resistance strategy and competitive status. It summarises the main points of the grazing resistance concept and highlights the contrast between early and late successional strategies.

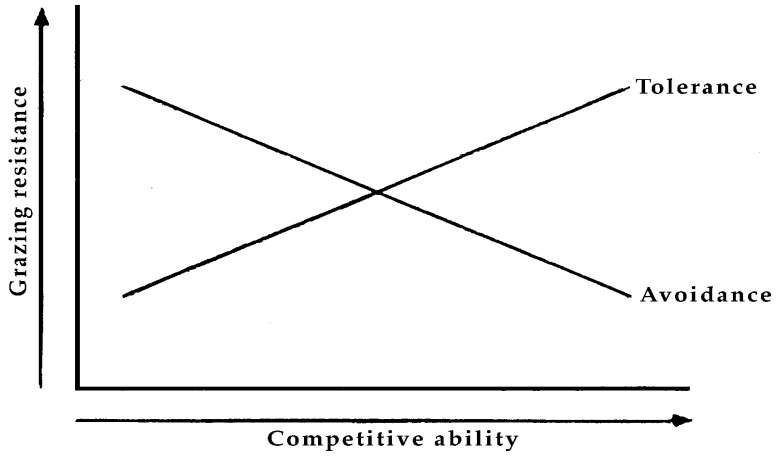

Figure 5.1

Hypothesized relative contributions of tolerance and avoidance strategies to grazing resistance in plants possessing a range of competitive abilities. Avoidance mechanisms are assumed to represent a greater trade-off with competitive ability than tolerance mechanisms because they divert resources from plant growth. Therefore, late-successional dominants are proposed to rely on the tolerance strategy to a greater extent than early- or mid-successional species.

Reproduced from Briske, D.D. 1996. Strategies of plant survival in grazed systems: a functional interpretation: *In:* J. Hodgson & A.W. Illius, eds. *The ecology and management of grazing systems*. Reproduced with kind permission of CABI Publishing.

Application of the grazing resistance concept

The interactive complexity of plant-animal relationships, combined with the effects of the physical environment, makes it difficult to fully understand the detailed functioning of grazing systems and creates much of the uncertainty regarding management decisions. A theoretical model of plant-herbivore interaction may help to guide management of conservation grazing regimes if it helps to clarify the true nature of the various relationships and identify causes and effects

Site managers often have to make decisions on the basis of quite superficial knowledge of the composition, structure and functioning of the grassland ecosystems being managed. The information used is often anecdotal in origin, and although factually it may be correct, conceptually it may sometimes be misguided. The risks associated with a tightly-focussed site-based approach are that objectives can become too narrowly defined and prescriptions be implemented too rigidly, resulting in missed opportunities for nature conservation. Theoretical concepts like grazing resistance strategy, which is based on fundamental principles and key processes may help to prevent the larger perspective being obscured by a mass of tiny detail. By modelling the principles of grazing interaction accurately it can help to organise existing information, clarify and consolidate perceptions and direct further investigations and research.

One of the most frequent concerns of reserve managers is to identify the potential effect of any grazing prescription on the relative abundance of the particular plant species that are selected as targets for positive management. In the absence of detailed information about a particular plant's ability to withstand the effects of grazing, the management process has to be based on guesswork and the resulting compromise is usually a grazing regime that is deliberately lax. This, however, may not achieve the desired effect in the long run since plants can be adversely affected by under-grazing as well as over-grazing. Consideration of the target plant's successional status and probable strategy for resisting grazing may indicate how it will respond to a given regime.

Where factual details of plant adaptations are known, the grazing resistance model can be used to explain the different strategies of plants with contrasting lifestyles. Ragwort *Senecio jacobaea* for example, is a short-lived, composite herb characteristic of the more disturbed situations associated with early successional communities. It is strongly endowed with avoidance mechanisms, in particular chemicals which make it unpalatable and highly toxic to most herbivores. Common knapweed *Centaurea nigra* on the other hand, although a composite of similar form and stature, is a long-lived perennial more typical of later successional communities. It is eaten fairly readily by most grazers and seems to invest few resources in active defence as a means of avoiding grazing. However, it reduces damage by adopting a rosette growth form from which it is quickly able to resume an upright habitat when grazing is removed.

Similar differences in grazing resistance strategies are evident among grasses. Wood false brome *Brachypodium sylvaticum*, for example, is a highly unpalatable species which quickly colonises bare ground on thin limestone soils, thereby demonstrating a strong emphasis on avoidance strategy in association with early successional tendencies. Perennial rye-grass *Lolium perenne,* is strongly dominant in later successional grasslands in mesotrophic situations (MG6 and MG7) and is one of the most palatable and nutritious species of grass. It demonstrates no avoidance strategy whatsoever, at least in the vegetative phases of its lifecycle. However, its tolerance mechanisms are so effective that it is able to increase its dominance of swards as grazing intensity increases.

The grazing resistance model can also be used to predict community-based change. This is a much stiffer test because it must include the effects of plant to plant interactions (ie competition) as well as plant to herbivore interactions. The relationship between grazing resistance strategy and successional development of a community (Figure 5.1) suggests that later successional communities favour assemblages of plants with greater reliance on tolerance rather than avoidance strategies. Grazing in these more developed situations should therefore be 'easier' since most of the component plants will be relatively defenceless and hence more palatable to a wide range of grazing species. It is likely therefore that choice of grazing animal would have relatively small impact, and the main part of any grazing-induced change within the community would be due to overall grazing intensity, rather than type of grazer.

This prediction is supported by the results of an extensive study by Gibson (1997) in which he assessed vegetational differences across a range of mesotrophic grasslands. He discovered that, as predicted by Briske's model, most of the differences were due to overall grazing pressure rather than choice of grazer. It was only at higher grazing intensities that species of grazing animal began to exert an obvious effect on vegetational change, since this forces the community into an earlier successional stage in which the constituent species rely more on avoidance mechanism. The effectiveness of these defences depends very much on the grazing species.

5.2.4 Grazing behaviour

Grazing is a crucial activity for large herbivores. Their objective is to ingest all their nutritional requirements using only the minimum investment of time and energy. Grazing behaviour is controlled and directed by a number of different senses working in sequence throughout all stages of the process (Phillips 1993).

Selection and rejection of different food items are controlled via:

- sight – distant detection of best areas for grazing;
- smell - closer detection of particular food items;
- taste - contact detection of particular food items.

Initiation and cessation of grazing are controlled voluntarily but the underlying drive to feed is controlled by hunger. The primary factor controlling all aspects of feeding behaviour is energy. The animal attempts to maintain an overall balance between energy intake and energy output (activity, growth and reproduction). Other nutritional parameters, protein for example, may assume temporary dominance and direct feeding behaviour towards meeting a specific shortfall, but only when the need for energy is fully supplied. This is why greater selectivity is exercised when the grazing animal is at or near to satiation.

Voluntary control of intake and food availability

Although nutritional requirements are of paramount importance, feeding does not take universal precedence over other behaviour. Grazing animals possess an upper limit for time spent grazing. In cattle it is 12-13hrs per day. Beyond this point other activities assume priority: rest, cudding, socialisation, sleep etc. If an animal doesn't eat sufficient food during a 24hr period it will have to draw upon its body reserves to make good the shortfall. Modern livestock farming has reduced the need for nutritional efficiency through the use of supplementary feeding and selective breeding of other traits. Availability of food is not just a function of overall quantity – the nutritional quality is of fundamental importance because of the constraints of feeding and digesting time. This restriction means that grazers cannot always respond to poorer quality feed by eating more of it, in fact intake may decrease on poor quality vegetation. When restricted to feeds of inferior quality, voluntary intake is reduced because animals cannot digest the food material quickly enough and the overall passage through the gut declines. Each animal therefore has a food quality threshold, which the diet must exceed for it to be capable of achieving energy balance (Bourne and Orr 1988). It is this nutritional threshold that determines an animal's suitability for grazing a particular sward.

Choice of grazing animal

It is important that choice of grazing animal for conservation management should be based on an assessment of its nutritional adaptations and abilities. Poorer quality pasture will require grazers which are physiologically capable of achieving energy balance from a low value feed diet. Various factors will determine an animal's nutritional efficiency, but the one that is most widely recognised is breed. In particular native breeds of livestock will usually be better equipped to use poor quality vegetation than imported lowland-derived breeds (see Section 5.4).

Other parameters also affect nutritional efficiency:

- Young animals have a smaller and less efficient rumen than mature individuals. They also have a larger surface area-volume ratio and need relatively more energy intake for maintenance because of higher rates of heat loss and the energy required for growth.

- Animals reared on forage-based diets develop larger rumen capacity than ones receiving high density feeds and cereals.

- The energy requirements of an individual depend on its productive status. Pregnant and lactating dams may need double their maintenance levels of energy intake. At the same time a growing foetus can reduce the functional capacity of the rumen. Late pregnancy is an especially vulnerable phase of the grazers reproductive cycle in terms of dietary factors.

In most grazing situations, grazers are able to select material that is nutritionally better for them. They are only able to do this because the sward itself is not of uniform quality. Those parts that have been kept short and actively growing by the activities of the grazers themselves will continue to be selected in preference to the patches that have escaped being grazed and have become senescent as a result. Sheep are able to feed more selectively than cattle because their mouth is narrower and their lips are better able to manipulate plants prior to ingestion.

The height of a grazed sward will normally decline during the grazing period. The direct consequence of this for the grazing animal is a reduced bite size. However, total intake can be largely maintained by grazing for longer periods of time and by increasing the biting rate. The grazers' ability to compensate for sub-optimal food supply is not absolute so there is a responsibility on the stock person to ensure that the welfare of the animals is not excessively compromised by reductions in its quantity or quality.

5.3 The grazing attributes of different species of grazing animal

All animals, both wild and domesticated, graze selectively. Favoured elements of the vegetation are eaten first while less desirable plants are left until last, or not grazed at all. There is considerable variation between different types of animals regarding which plant species they favour Grazing selectivity often varies acutely and even contradicts itself from site to site. A certain plant may be selected in some situations yet avoided in others. In addition, there are major differences between the grazing preferences of young, mature and old animals, especially in sheep (Matthew Oates, National Trust, pers. comm.).

The correct type of animal and the right timing and intensity of grazing are essential in order to overcome the problems of selective grazing. In this instance 'type' refers to breed, age, sex, background (ie what it has learnt from its social group), whether it has been wintered in or out and temperament. Where grazer selectivity is felt to be a significant problem, the best general approach is to use as many different species and types of animal as possible. This section concentrates on the physical differences between the grazing actions of different herbivores including sheep, cattle and ponies. Section 5.4 concentrates on the grazing attributes of different breeds of grazing animal. Table 5.1 summarises the grazing characteristics of the main animals used for grazing semi-natural grasslands; namely sheep, cattle and ponies.

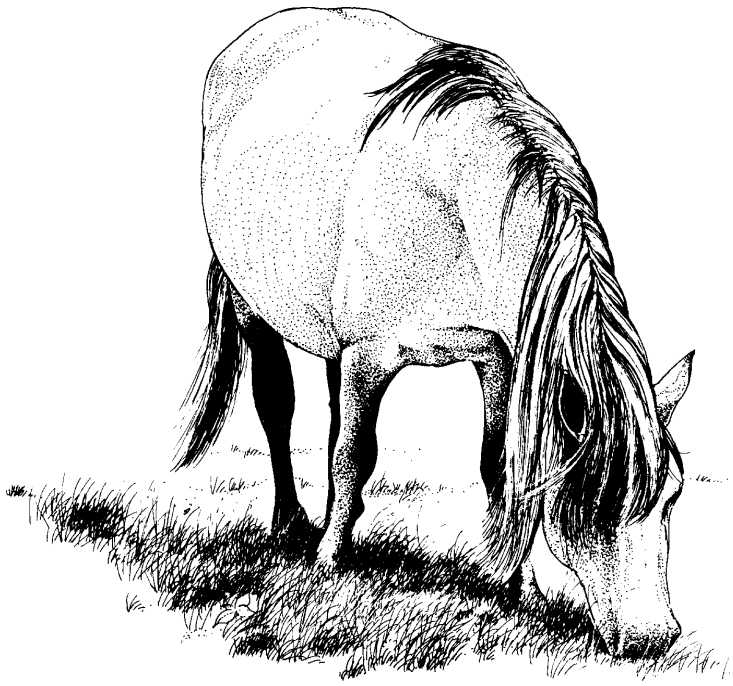

Table 5.1 Grazing characteristics of sheep, cattle and ponies in unimproved grasslands

Sheep	Cattle	Ponies
Bite the vegetation. Have lower incisors only. Graze right down to close to ground level; produce very short swards	Bite, pull and tear the vegetation, wrapping it in protractile tongue. Have lower incisors only. Cannot graze as close to ground level; graze and maintain longer swards	Bite the vegetation, with upper and lower incisors. Graze right down to ground level, even closer than sheep; produce very short swards
3cm is minimum sward height grazed	5–6 cm is minimum sward height grazed	2cm is minimum sward height grazed
Have thin, mobile lips; manipulate the herbage with lips and jaws before biting. Can push plants aside and take other from underneath	Have thick, wide immobile lips and cannot manipulate the vegetation with lips and jaws effectively	Do not manipulate the vegetation
Can 'weed' the vegetation by uprooting plants and dropping them, or biting and then spitting out	Such selection not possible	Very selective, but do not weed
Have a variable diet at the individual level and with variation between individuals	Have a less variable diet than sheep	Variable diet
Can select items from very low in the grassland profile	Cannot select items from low in the profile	Can select items from very low
Can select a species growing in a fine admixture with other species	Cattle cannot select from fine mixtures	As sheep
Avoid tall plants in the sward	Take tall plants	Take tall plants
Grass stems left	Grass stems taken	Grass stems taken
Flowers selected and eaten	Flowers not selected (although may be eaten)	Some flowers selected and eaten, others avoided and left
Dead material and litter left	Dead material and litter taken	Dead material and litter taken
Rough, tall sward and tussocky areas often avoided and left ungrazed	Rough, tall sward and tussocky areas utilised	Rough, tall sward and tussocky areas utilised (but see dunging below)
Graze preferentially in small patches; select the most palatable patches available	As sheep. Cattle swards often particularly patchy	In comparison with cattle, ponies may produce a more even sward, inefficient digesters and consume a great quantity and bulk of herbage (twice as much as cattle)

Source: K.A Hearn National Trust (1998)

5.3.1 Sheep grazing

Sheep are the most frequently used grazing stock on grasslands of nature conservation importance. This is due to their widespread availability and relative inexpensiveness. They have thin mobile lips and move slowly over the sward nibbling the grass. At high stocking densities this might be right back to the root stocks. Their narrow mouth enables them to eat very selectively when circumstances dictate. Often they will ingest single leaves or shoots from a sward, biting them off close to the ground level (Phillips 1993). They are efficient browsers of low scrub, able to remove leaf material completely from selected bushes.

The choice of stock is further complicated by the fact that sheep develop a full set of broad front teeth after three years and then steadily lose them as they age. Consequently, young and old sheep may not graze as efficiently as middle-aged sheep, although this depends to some extent on the type of sward and the state of the individual's teeth as some retain a good set of teeth into old age (6-10yrs).

There is evidence to suggest that the sex of the animal can be important in some situations. A study of the feeding behaviour of the free ranging Soay sheep in the Cheddar Gorge, found significant differences in feeding preferences between ewes and rams in both summer and winter. Ewes, in summer, ate significantly more tree leaves and less grasses than rams. (Bullock and Oates 1998).

Sheep are lighter and more agile than cattle and may be more appropriate for grazing on steep slopes. However, on heavy wet soils even sheep are capable of causing trampling damage, although this will be less severe than with the heavier grazers. They usually deposit dung randomly and do not reject the grazing around it. They can therefore graze swards to a uniformly low height.

There are many situations where it may be more appropriate to use cattle or ponies for grazing. Sheep do not tackle areas of long grass as readily as cattle or ponies and are not generally the best animals for restoration grazing. The presence of large amounts of bramble create problems for smaller types of sheep which easily become trapped by their fleeces (see Chapter 12). In addition, sheep are not generally suitable for wet sites because of problems of foot rot. However, they can be useful in the control of ragwort since they are more tolerant of the toxins it contains (Owen 1976) (see Chapter 7). The grazing attributes of different sheep breeds are detailed in Table 5.2

5.3.2 Cattle grazing

Cattle differ greatly from sheep in that they prefer to eat longer grass using their tongue to pull material into the mouth before its bitten off using the incisors. They can eat short grass using the tongue but intake is less efficient. The greater width of mouth means that cattle cannot graze as selectively as sheep. Like sheep, cattle acquire four pairs of adult incisors in annual stages, although having obtained the full set, they seem less prone to losing them until they wear down with use which can take 20 years or more. Cattle are generally better than sheep at creating and maintaining a structurally diverse sward of benefit to invertebrates. They also trample the ground more significantly which, in moderation, is beneficial as it opens up the sward allowing the establishment of short-lived species. Hoofprints can provide the hot microclimate conditions that specialised invertebrates such as the adonis blue butterfly *Lysandra bellargus* require for oviposition. However, overstocking during the autumn and winter period can lead to

infestations of docks *Rumex* spp, ragwort *Senecio* spp and thistles *Cirsium* spp and can also damage archaeological features.

Cattle are particularly good at knocking down and opening up tall coarse vegetation such as bracken and scrub and therefore have a useful role in restoration management (see Chapter 10). However, they can also maintain short turf (< 5cm) if stocked at a high enough rate, although they may not perform well in terms of production. Again, cattle of different breed and age may behave differently and produce different results (see Table 5.3).

Cattle need more water than sheep and their grazing coverage of a larger site is greatly influenced by the location of water troughs. Localised problems with over-grazing and under-grazing can often be resolved by installing a new trough or moveable bowser. Mineral licks can also draw cattle into poorly grazed areas.

It is more difficult to acquire commercially-farmed cattle for conservation grazing than sheep as they are more expensive to buy and keep. Farmers are less likely to be willing to graze cattle on conservation grassland because of their value and requirements for them to put on weight. Recent BSE restrictions have imposed additional pressure as the majority of cattle now entering the food-chain must be killed before 30 months of age. The economic consequences of this crisis have greatly reduced the price of cattle, so that in terms of their grazing potential they may now represent better value than sheep.

The dunging behaviour of cattle is often an important consideration. Pats are usually scattered randomly over the sward, each one creating a zone of avoidance where the animals will not graze around it. The rejected vegetation continues to grow and mature creating a series of tall sward 'islands' among shorter turf. This can be a valuable feature for insect communities.

The excreta is an important habitat in its own right, providing food for many insects, mainly beetles and flies. It has been estimated that each beast generates 20 per cent of its own body weight in insect biomass every year (Lawrence 1954), which for an adult cow would be 0. 1t of larvae. This can represent a critically-timed food resource for pasture feeding birds like the chough *Pyrrhocorax pyrrhocorax.* (McCracken and Foster 1993).

5.3.3 Grazing with horses and ponies (See also Section 5.4.3)

Horses and ponies generally have had a poor reputation as grazers among nature conservationists. This is largely as a result of the many examples of overstocked small horse paddocks where overgrazing of the more palatable grasses can lead to bare patches with areas of uneaten coarse grass.

Horses and ponies have teeth which point slightly forward and can graze as close to the ground as rabbits. Grazing preferences and efficiency varies from site to site, and from season to season. Horses preferentially take grass but will also take a wide range of sedges and rushes. Selective overgrazing and undergrazing can occur side by side. Sites grazed by horses and ponies can be structurally varied and valuable for invertebrate diversity. Hardy ponies can take a surprising amount of live bracken, especially in late summer and early autumn when grass is low and bracken toxicity has declined (Oates and Bullock 1997).

Horses and ponies do not preferentially select flowers as do sheep and rabbits. They will avoid buttercup *Ranunculus* spp, knapweed *Centaurea* spp, ragwort *Senecio jacobaea*, orchid spikes and aromatic herbs such as marjoram *Origanum vulgare*. Rushes *Juncus* spp and sedges *Carex* spp are taken mainly in spring.

In small fields some observations point to the fact that horses tend to defecate and urinate in specific latrine areas which can cause localised high nutrient levels. These areas can become colonised by nutrient-demanding competitive species resulting in a lessening of the conservation value of the sward. Steeply sloping sites on chalk and limestone appear to be less susceptible because latrine sites are established on upper or lower level parts of the site which are frequently of less nature conservation interest (J. Hopkins pers. comm.). However, observations on National Trust at Memorial Down, St Margarets Bay, Kent highlight that there is no set pattern to dunging by ponies (Oates 1997).

The management objectives for the site will determine the suitability of horses and ponies as grazers, eg horse-grazed sites can support unusually diverse invertebrate faunas due to the patchy effect created by grazing. The grazing attributes of different breeds of horse and pony are outlined in Table 5.4.

A study of the effects of horse grazing on species rich grassland, specifically neutral MG5 *Cynosurus cristatus-Centaurea nigra* grassland was carried out by Bioscan UK Ltd for English Nature (Gibson 1996 and 1997).

The results showed:

- the species of livestock has a minor effect compared to the grazing intensity eg damage was found in sites heavily grazed by both horses and cattle;
- damage was manifest by an overall reduction in plant species richness, notably those indicator species of mesotrophic grassland eg heavy grazing may turn MG5 into MG6 grassland;
- there appears to be no long-term detrimental effects on sites with light or moderate grazing levels by horses, although the richest sites are almost always cattle grazed;
- light grazing by horses is preferable to no management. A sward that has had no cutting for at least three years had species richness lowered by as much as the heavily grazed swards;
- fields that have only recently suffered from over-grazing may have retained most plant species of nature conservation interest and will recover quickly if stocking levels are reduced;
- simply removing stock for a rest period in winter or summer will not mitigate the effect of heavy grazing pressure.

Management recommendations

- If it is a choice between no management or grazing solely grazed by horses, opt for the latter at light stocking densities, or shorter duration.
- Remove animals, when wet conditions prevail.

- On small areas, to help prevent the build up of worms and the development of latrines, dung should be picked up on a daily basis or twice weekly in summer and once weekly in winter. Selling manure might be an option.

- Longer swards in incipient latrine areas should be "topped" to promote grazing in these patches. Cuttings should be removed to prevent nutritional enrichment.

- Any ragwort or thistle present should be treated by spot herbicide or mechanical removal, or grazing by sheep (see also Chapter 7).

- It may be possible to control the development of latrine sites by grazing with other stock such as cattle. Sheep may be useful where ragwort is a problem.

- supplementary feeding should not be allowed in the field.

Box 5.1 Satisfactory management by grazing horses in lowland neutral grasslands can be indicated by the following:

- Sward height should not be reduced below 2cm at anytime (outside latrine areas) and should be at least 5cm in the growing season. Aim for a target height of between 2cm-5cm at the end of the growing season.

- Bare ground should only be present very locally, eg around gateways and troughs.

- Latrine areas should be few in number or absent.

NB horse grazing will need well drafted agreements and continuous supervision

5.3.4 Goat grazing

Goats can either graze or browse, but most types of goat are by preference browsers, eating, and sometimes killing, both trees and shrubs. Goats may browse more when mixed with sheep and are potentially very useful for restoration management. In semi-natural habitat where they is plenty of browse and grass, free ranging goats should browse for at least 50 per cent of their feeding time (Oates and Bullock 1997).

Goats prefer willow *Salix* spp, gorse *Ulex spp* (especially if crushed by rolling), ash *Fraxinus excelsior* and guelder-rose *Viburnum opulus* and will tolerate hazel *Corylus avellana*, oak *Quercus* spp, alder *Alnus glutinosa*, hawthorn *Crataegus monogyna* and wayfaring-tree *Viburnum lantana*.

Goats dislike birch and conifers, and will avoid herbaceous legumes.

At high stocking densities goats will eat thistles, rushes, tufted hair-grass and mat-grass (David Bullock, National Trust, pers. comm.). Rush infested pastures have been restored after three years of grazing by goats at Bronydd Mawr Research Station (Davies, undated).

Practical considerations

It is possible to use either feral or domesticated goats. Domesticated breeds such as Angoras and Anglo-Nubians are more grazers than browsers. Goats will also strip bark, particularly during the late winter. Goats form strong social groups. Like sheep, goats in extensive grazing regimes have hefts (group home ranges) which are maintained by females and their offspring. However, containment and husbandry requirements rarely make 'grazing' by domesticated goats a viable proposition. It is not necessary to dip or provide water for feral goats. Water should be provided in all compartments, especially if a mineral lick or nuts are provided, and all goats need some kind of shelter.

The simplest way to start a goat scheme is to use wethers (castrates). They are fairly long-lived and tolerant of dogs.

Feral goats can be contained within normal fencing providing the compartments are large and there is no shortage of browsing material. Horned goats need daily inspection for entanglement among denser scrub.

The National Trust has recently introduced feral goats to the short turf slopes of Ventnor Downs, Isle of Wight, to counter evergreen oak *Quercus ilex* invasion. The sward there scarcely needs grazing, the essential requirement is for browsing.

5.3.5 Rabbit grazing

See Chapter 8 for rabbit control measures.

The rabbit is the most significant non-domestic grazer. This species was introduced to Britain in the 12th century and initially farmed in warrens on the Southern chalk downs, the Brecklands and Dartmoor (among other places). They escaped and became a major agricultural pest until myxomatosis almost wiped out the wild population in 1954.

The decline of rabbit grazing has had a dramatic impact on acid, chalk and limestone grassland. Where the effects of myxomatosis have been severe, some sites have become invaded by long grass and scrub. In some areas, rabbits have returned to pre-myxomatosis levels and overgrazing is the main problem. In addition their populations can fluctuate greatly year to year in response to outbreaks of disease and weather conditions. This should be taken into account when considering stocking rates of managed grazing regimes. It may be necessary to suspend grazing by cattle and sheep if rabbit population densities are too high.

The main problem faced by conservationists is that rabbits are hard to control and rabbit grazing difficult to direct. Rabbits will not graze tall swards, consequently the shorter areas tend to become overgrazed, especially where grazing is already taking place by sheep or ponies.

On areas with unreliable winter grazing such as many of the Mendip scarp grasslands, the sward and conservation interest is maintained by rabbit grazing. Problems can occur during the population highs, but during the lows (usually brought on by myxomatosis), the heavily grazed plants succeed in flowering and seeding. In addition rabbit grazing can maintain an interesting lichen and bryophyte flora

Rabbits are highly selective grazers and at moderate densities they produce a patchy mosaic of small areas nibbled to different heights, whilst their scrapes provide patches of bare ground favoured by ovipositing females of species such as the adonis blue *Lysandra bellargus* butterfly. In addition these small sheltered hollows provide areas where seeds of annual species such as fairy flax *Linum catharticum* can germinate. This bare ground also favours prolific germination of scrub, if and when grazing pressure declines. Rabbits are not usually effective as browsers and generally avoid leaves of woody plants, although they will strip bark from saplings in winter.

Heavy rabbit grazing on the other hand only benefits a narrow range of plants, eg rock-rose *Helianthemum nummularium*, and invertebrates, eg silver-spotted skipper *Hesperia comma*, which requires very short turf. Continuous rabbit grazing can be damaging through the removal of orchid spikes and cowslip *Primula veris* and the destruction of breeding areas for the Duke of Burgundy fritillary *Hamearis lucina* and dark green fritillary *Argynnis aglaja*. Eventually, continual heavy rabbit grazing causes destruction of the turf and invasion of undesirable plant species due to the creation of large areas of bare ground. In exceptional circumstances this may be desirable, for example, for nesting stone curlews on Weeting Heath, Norfolk.

The combination of heavy rabbit grazing, drought and overstocking can be particularly damaging to the nature conservation interest of grasslands developed on thin soils. Sometimes rabbits will colonise new areas whose managed grazing has recently been restored. Rabbit control is becoming an increasingly important issue in nature conservation and should be considered in any grazing strategy (see Section 5.6).

Despite the negative attributes of rabbit grazing, it has undoubtedly slowed the decline of many sites where farm economics have led to the cessation of grazing and it still maintains the conservation interest in some sites.

Rabbit Viral Haemorrhagic Disease (RVHD).

RVHD is a disease of the rabbit which affects both wild and domestic rabbits. Rabbits with the disease die within 72 hours. The disease first appeared in UK commercial rabbit stocks in 1992, and the first cases were recorded in Devon in August 1994. Although there have been several outbreaks since then, there is no evidence for large scale kills over a wide area. This may be due to varying levels of natural immunity in rabbits in the UK. It is no longer a notifiable disease and so it is difficult to derive data on its extent and spread.

Until the likely level of mortality in UK wild populations is known, it is impossible to predict the impact that the disease will have on nature conservation interest. It might be worth instigating rabbit monitoring on particularly sensitive sites that rely on them for grazing management so that alternative arrangements can be made if a high proportion of rabbits are killed by this disease.

5.3.6 Deer grazing

Deer are ruminant herbivorous ungulates. Deer were originally primarily animals of woodland habitats but adaptability has led to them exploiting a wide range of environments including open grassland. Six species occur in the wild in the UK, namely roe deer *Capreolus capreolus*, red deer *Cervus elaphus*, fallow

deer *Dama dama*, Reeves muntjac *Muntiacus reevesi*, sika deer *Cervus nippon*, Chinese water deer *Hydropotes inermis*. Only the first two species are native, the remainder are established introductions.

Over the last 30 years in the UK there has been an increasing interest in commercial deer farming for the production of venison. Red and fallow deer are the two species which are most commonly reared commercially although the latter more rarely as it is more difficult to husband.

Diet varies seasonally and between species. The fallow deer is a relatively selective grazer and in the wild >60 per cent of its diet consists of grasses, although herbaceous species and woody browse also make a significant contribution as do tree fruits in mast years. The red deer is an adaptable opportunistic feeder and is less selective than fallow deer. Its diet varies depending on the availability of plants in the different habitats it utilises. Within the upland part of its range in the UK, its diet consists mostly of grasses, sedges and rushes, although in winter it preferentially feeds on dwarf shrubs. The roe deer is a versatile species which uses a range of habitats including agricultural land. Its diet again varies according to food availability in different habitats but compared with red and fallow deer, it selects herbs, woody browse and other highly nutritious foods to a greater extent.

Use for nature conservation management.

Communities of large wild herbivores including red and roe deer are being managed in conservation areas within the Netherlands and elsewhere in continental Europe to achieve specific conservation objectives (Kampf 1998).

Fallow and red deer, in particular, are adaptable and able to survive on grassland. Despite this, the potential for using deer as grazers on many semi-natural lowland grasslands by conservation organisations in the UK is probably limited by factors such as the small size of many sites, capital and husbandry costs, lack of markets due to competition with farmed deer enterprises and the availability of more suitable grazing animals. The problem is that deer are not domestic animals and handling and husbandry is much more complex and expensive. Hence, in the majority of situations, sheep, cattle or equines are likely to be preferred tools for conservation grazing.

However, in deer parks, which support areas of semi-natural grassland (normally lowland acid or neutral grassland), deer grazing may be suitable for the maintenance of such grassland although information and data on the topic are limited. The most common parkland species is fallow deer; relatively few parks hold red or sika deer. In many parks, wild roe and muntjac also occur.

General advice

The advice is similar to that for other grazing animals as provided elsewhere in this chapter:

- Avoid overgrazing (ie swards less than 2cms) and poaching.

- Avoid supplementary feeding or feed in an area of low nature conservation value.

In parklands, the typical deer density is 2-3/ha which is far higher than the carrying capacity densities of wild populations and can only be sustained by supplementary feeding in winter. Thus, unless there

is any scope for reducing numbers of deer, supplementary feeding is usually unavoidable as part of the successful management of park deer (Bullock & Vernon 1992).

The scope for using deer to manage and sustain the nature conservation value of semi-natural grassland within commercial deer rearing enterprises is likely to be limited. This is due to the intensive nature of commercial deer farming which demands nutritious high quality pasture and winter supplementary feed.

5.3.7 Grazing with donkeys

Little is known about the effects of donkey grazing, both because it is relatively uncommon and because donkeys are often grazed together with other stock, which makes it difficult to separate the effects of the different animals. The following is a summary of anecdotal information from conservation practitioners.

Donkeys are similar to ponies in that they graze selectively and can tend to dung in latrine areas. They can browse, providing useful scrub control, but will not always do so. They are small animals, much lighter than ponies of equivalent height and they are not shod, so can have an advantage over horses and ponies where the hooves of these animals are thought to be damaging. However, they tend to suffer from foot problems so are not suitable for grazing wet sites. They are generally more likely to have health problems than other types of stock and can lose condition easily.

There is general agreement among practitioners that the grazing habits of donkeys in general are less significant than the individual circumstances of particular animals, their owners and the sites. Donkeys which have been stabled and fed hay and nuts will not cope well with rough vegetation and will not browse. On the other hand, hardy donkeys which are used to being outwintered and being self-sufficient on semi-natural vegetation can be useful for nature conservation management; they will probably not graze as tightly as ponies, they will cope with rough grassland and they may browse encroaching scrub.

5.4 The grazing attributes of different livestock breeds

5.4.1 Grazing with different breeds of sheep

With around 50 native breeds of sheep in Britain, and several more from continental Europe, together with a multiplicity of crosses that are routinely bred from them, there is no shortage of overall choice and something to suit almost any lowland situation will be available (see Table 5.2).

Table 5.2 Sheep breeds most suited to grazing semi-natural swards

Breed type	General characteristics	Sample breeds
Mountain	Small to medium size Hardy Can survive on low quality diet - will browse scrub and coarse grasses Often difficult to contain, less prolific Need minimal care	Scottish blackface (horned) Herdwick (hornless females) Rough fell - docile, (horned) Swaledale Welsh Mountain (hornless females) White-faced woodland (horned)(rare breed status)
Hill	Medium size Less hardy than mountain breeds Survive on low quality diet - will browse scrub and coarse grasses Usually more docile and easier to contain More prolific lambers and milkier	Beulah Cheviot Gritstone Kerry Hill Hill Radnor
Primitive	Small size Hardy Good browsers of scrub and coarse grasses Strong bonds between flock members Can be difficult to contain	Hebridean Soay – loses fleece naturally Manx Loughton Shetland (widespread and easier to obtain)
Down/ Closewool (lowland)	Larger size Not hardy - needs regular attention Need good quality diet. Will not perform well on coarse grasses or scrub	Suffolk – terminal sire for carcase quality Oxford Down – largest native breed Ryeland – minority breed foot-rot resistant Wiltshire horn (rare breed status, no wool) Texel – terminal sire (Dutch breed)
Cross breeds.	Large size, prolific and milky therefore profitable. Large appetite. Intermediate degree of thrift and hardiness. Excitable and more expensive to buy than the pure hill breeds.	Masham, Mule and half-bred

The three main categories of commercial sheep breeds reflect the relative altitudes that each is adapted to: hill (or mountain), upland and lowland. There are others which are less numerous but may have economic importance: the Long Wool breeds which provide rams for breeding commercial cross-bred ewes and the Primitive breeds which as yet have only minor commercial significance, being kept mainly for aesthetic reasons by devotees of rare breeds. The exception to this last statement is the Shetland which is still popular with sheep farmers in its place of origin.

The key point about sheep is that there are marked differences in grazing ability between animals of different breeds. These have been developed to cope with contrasting conditions and, consequently, show different grazing preferences. The primitive breeds such as Hebrideans and mountain breeds such as Herdwicks, Swaledale and Scottish blackface graze less selectively than lowland breeds such as Suffolks and Dorset Horns; because they have 'harder' mouths and will eat coarser grasses. In addition, they are hardier and reputedly less prone to diseases and problems such as foot-rot.

Hill sheep

Hill sheep are smaller than breeds from lower altitudes, ranging from the tiny Welsh Mountain, (less than 40 kg mature ewe live weight), to the Scottish Blackface ewe (at 50 -70kg) (National Sheep Association 1992). Their frame is light and even when kept on good pasture these sheep do not carry much weight so the carcass is of only moderate quality.

They are physiologically adapted to utilising the poor quality vegetation found on mountains, moors and bogs, and have not been selected for prolificacy or milkiness, since these qualities cannot be sustained on a poor diet. They would, in their original environment, be expected to rear just one lamb apiece, although when moved to kinder situations all of the breeds can achieve much better lambing percentages. Their lighter build and keen foraging instincts make them agile and determined escapologists if held in enclosed fields once the food supply becomes sparse. Larger breeds like the Swaledale and the Blackface can be athletic jumpers of walls, while the little Welsh Mountain is adept at getting under fences, given just a small gap. All of them are quite able to eat their way through unfenced hedges given sufficient time. Most hill sheep will respond to grazing by moving into new areas in search of better supply.

However, they can be contained in enclosed fields if the boundaries are properly maintained and adequate grazing or supplementary feed is available. It is not always simply a wild temperament, developed from their harsh environment which makes them difficult to confine: the Rough Fell, one of the hardiest breeds is in fact one of the most placid when kept in lowland conditions (conversely, the Mule which is probably the most numerous lowland ewe, is renowned for its excitable and unpredictable disposition).

For breeding purposes all the hill sheep are unsurpassed for mothering abilities. Their instinct to take the lamb is always strong and problems with mis-mothering are very rare when lambing in the open. The newborn lambs too are equipped with a much stronger instinct to find the ewe's udder than is the case with many lowland breeds. These are key attributes for hill flocks which are still, in most cases, lambed outside.

These commercial hill breeds are usually easy to obtain even in lowland situations since many are sold off the hills each autumn as store lambs, mainly wethers to be finished for slaughter. Most ewes are drafted from the original flock after three or four years of breeding. If still sound, with two functional teats and a good set of incisor teeth in the middle of the gum, such ewe can continue breeding for another two years or more when moved to the kinder conditions of a lowland farm. Most will be bought for breeding eg crossing with a longwool ram to produce a mule halfbred or Masham ewe.

The main disadvantages of most hill breeds for conservation grazing are a long, heavy fleece which can get caught up in thorny scrub, and horns which create difficulties when tangled with electric fences.

However, breeds like the Derbyshire Gritstone (southern end of the Pennines), the Cheviot (Scottish Borders and further north), the Beulah and the Welsh Mountain (from mid-Wales) all lack horns in the ewe and have relatively short fleeces. The Hill Radnor possesses similar favourable characteristics and is listed as a rare breed, which may enhance its appeal.

Lowland sheep

In the lowlands, lowland breeds are more readily available than upland or primitive breeds. They are genetically more productive when kept in the improved conditions. In addition, they are usually easier to contain and more docile. However, they are frequently unable to control coarse unpalatable grasses due to their 'soft-mouthed' nature and are less effective at browsing but may 'tip' some scrub species. Lowland breeds may need more care, eg help with lambing, dipping, foot treatment, etc., and are more likely to experience health problems when kept on low grade pasture.

Lowland breeds have been selected mainly for the quality of the carcass. They are larger, more heavily muscled sheep; the Suffolk weighs about twice as much as the Welsh Mountain. Most of them lack horns and the wool is short and dense. They have not been bred to survive on low quality pasture, and do not have the same digestive efficiency as the hill breeds, although they do not always require the lush grazing of improved grassland. Most of them could probably perform perfectly well on calcareous grasslands where these have not deteriorated through neglect, and provided they are not stocked too densely. In some situations particular lowland breeds may also have important attributes for conservation grazing eg:

- The Wiltshire Horn x Welsh Mountain (crossed with a Welsh Mountain to produce the easy care sheep) has no proper fleece and hence does not require shearing. It is therefore not at risk of getting entangled in thorn-scrub and is much less vulnerable to fly strike.

- The Romney and the Ryeland are noted for their resistance to foot-rot. This makes them better suited to grazing wetter grasslands.

- The Portland and the Norfolk Horn, both rare breeds, have been developed for grazing lowland heath, and may still retain important attributes which suit them for this type of situation eg Breckland grass heaths. The Norfolk Horn was one of the breeds from which the Suffolk was originally developed, although all its modern representatives, original breed having become extinct, have now been bred back from the latter.

Other types of commercial sheep

Intermediate between hill and lowland breeds of sheep are the upland and the Longwool breeds. The longwools and especially the Blue-faced Leicester and the Border Leicester, have a special importance for the whole commercial sheep sector. Their main function is to provide a crossing ram for putting onto draft hill ewes - Blackface, Swaledale and Welsh Mountain, to produce mule ewes and half-bred ewes respectively (of Scottish, Northern and Welsh extraction according to the type of ewe they have been bred from). These cross-bred ewes between them account for more than half of the total lowland flock, since the hybrid vigour generated by their mixed genetics makes them very productive.

There are also a number of upland breeds like the Clun Forest from the Welsh Borders which are not hardy enough for true hill-farming situations, nor productive enough for the best lowland pastures, but represent a very good compromise for intermediate environments.

Primitive sheep breeds

There is a number of much older breeds that are physically and behaviourally different to all the modern breeds. They are not usually kept commercially apart from the Shetland, which is still popular on the islands that it originates from. Of the others, the Hebridean is probably the most widely kept, although the Soay, perhaps the oldest breed of all, also deserves a mention as well.

These primitive breeds can be observed to graze in an altogether different manner. The individuals of a flock usually stay close together and move as a group, grazing their way round a site, probably an instinctive behaviour to help protect them from predators. When threatened, for example by a dog, the group will split up very readily while a flock of modern sheep in the same predicament will bunch up tightly. This type of behaviour clearly has implications for ease of management.

Along with these differences in flock behaviour, primitives also exhibit contrasting dietary preferences to those of improved breeds. Controlled trials established by The Game Conservancy Trust (Braithwaite *et al* 1997) have shown that Hebridean sheep graze purple moor-grass *Molinia caerulea* more effectively than Swaledales while at the same time eating comparatively less heather *Calluna vulgaris* . These differences between the breeds were significant and enabled the Hebrideans to achieve an increase in percentage cover of heather at the expense of purple moor grass, while the converse was true for Swaledales. This experiment highlights the value of controlled comparative trials in determining the real dietary differences between breeds.

The primitive and hill breeds often browse scrub in preference to grazing the sward. They are therefore more appropriate for scrub-invaded grassland where the sward does not need heavy grazing. In winter, these breeds will tackle largely unpalatable shrubs such as bramble *Rubus* spp and dogwood *Cornus sanguinea*. They may prefer large expanses of grassland rather than small paddocks, although they are often kept as small flocks in the latter situation.

All of the primitive sheep breeds would probably be well suited to conservation grazing, especially on the poorer quality swards. They are enthusiastic browsers and seem to thrive in scrubby situations (although all sheep will nibble the tender regrowth from cut stumps). On Aston Rowant National Nature Reserve they control hawthorn which is invading calcareous grassland. Anecdotal evidence from a range of habitats indicates that Soay sheep are not as effective at controlling scrub invading grasslands or heathlands as Hebridean sheep (D. Bullock & M. Oates pers. comm.). However, they have been effective at grazing scrub on the Cheddar Gorge. They have a good reputation for general health and resistance to disease, although this may be because many of the flocks are fairly isolated from contact with other sheep. They are certainly affected by all the main sheep ailments and should therefore receive a similar degree of husbandry.

The main disadvantage with the primitive breeds is their comparative lack of commercial value. This makes them more difficult to buy and sell, other than through special livestock sales or directly between breeders. The Rare Breeds Survival Trust produces a quarterly magazine, *The Ark*, the classified section of which is a good way of locating or advertising rare breed livestock for sale. The fat lambs from pure-

bred primitive breeds are generally too small to be marketed in the conventional ways. So most flocks therefore use a terminal sire ram. (eg Suffolk or Texel) on part of their ewe flock to obtain bigger and more marketable lambs. The pure-bred lambs can achieve a better size if kept for longer, usually 12-18 months. (Braithwaite *et al* 1997).

There is a continuing lack of data to demonstrate the different grazing impact of animals of different breeds, sex, age and background (ie past behavioural and physiological experience) in determining the most appropriate choice of animal. (Bullock and Oates 1997.)

5.4.2 Grazing with different breeds of cattle

There is not quite the same degree of choice in breeds of cattle as there is for sheep, but the variety can be divided up in broadly similar ways between hill and lowland types. The hill breeds are mainly devoted to beef production, while those from the lowlands are divided between specialised beef and dairy breeds, with a few dual purpose types that have been able to survive the commercial trend for specialisation. In general, all of the native British breeds have lost popularity over the last 10-20 years with the importation of breeds from continental Europe.

There are comparatively few specialised breeds of cattle from the Uplands but those that do exist are very well adapted to a harsh climate and low quality grazing. The Highland and the Galloway, both from Scotland, are shaggy coated, compactly built animals with a reputation for producing premium quality beef. The Highland, despite its fearsome looking horns, usually has a quiet disposition, although that of the naturally polled Galloway is reputedly less reliable.

The main hill breed from Wales is the Welsh black, which although normally horned, does have polled strains. The same is true of the Devon, the English breed that is best suited to upland situations. Both of these breeds are easy to manage and produce top quality beef.

In recent decades the emphasis for stocking the hills has been very much in favour of sheep and in general, cattle numbers have declined on land above 300m. Representatives of many breeds have now been brought down to the lowlands where they are being selected for a different set of production criteria – growth rate, conformation and size, rather than hardiness, thriftiness and longevity. Care should therefore be exercised in selecting animals from these lowland herds if the original breed characteristics are required for conservation grazing.

However, for many less challenging lowland grasslands, the extreme qualities of true hill breeds are probably not required, and most of the normally available commercial beef cattle would perform adequately (see Table 5.3).

Table 5.3 Cattle breeds most suited to grazing semi-natural swards

Breed type	General characteristics	Sample breeds and characteristics
Upland beef	Smaller - medium size, hardy, thrifty constitution, performs adequately on lower quality diet. Strong maternal instincts (caution needed when calves are young) Slow growing and late maturing Many can be outwintered	Highland, - shaggy coat and very long horns - true hill breed Beef Shorthorn Welsh black – horned and polled lines can be outwintered. Still available from native location Galloway – dense coat and polled. Includes belted variety with rare breed status. True hill breed Belted Galloway – rare breed status Devon. Horned and polled lines. Noted for docility. Still available from native location
Lowland beef	Less hardy, less able to tolerate coarse vegetation/lower quality forage. Medium-large size, better conformation Native breeds early maturing, continental breeds, late maturing	Hereford – fairly hardy and will tolerate 'low quality' herbage. Native breed Angus - Native breed Sussex South Devon – largest native beef breed Limousin, Charolais, Simmental & Belgian blue (all continental) - Large body size. Fast growth on better quality diet. Poor performance without concentrates. May be temperamental
Ancientbreeds		White park – medium/small size with horns very hardy and thrifty Vaynol.
Lowland dual purpose	Small to medium sized Mixture of beef and dairy characteristics often with marked variation between individuals Usually thrifty and fairly hardy Most are rare of minority breeds due to commercial emphasis on specialization	Red Poll – Medium size, no horns, rare breed, good temperament Dexter - small and light which reduces the propensity to poaching in wet weather - minority breed British white - no horns, minority breed Shetland – small size, rare breed, very hardy Simmental - large continental breed with good beef characteristics. Very milky too and often needs a dairy animal in mainland European countries

On the other hand, it would probably be wise to avoid most of the popular continental breeds and their crosses; Limousin, Charolais, Belgian blue. Research has shown that these breeds are not as good at converting lower quality forage as our native breeds (Webster 1988) and they tend to be much more excitable than the traditional breeds which they have largely replaced, eg Hereford, Aberdeen Angus. Another disadvantage is that they are more expensive to buy initially.

Most breeds of cattle (and sheep too) are promoted by a breed society which can be used to source animals of that breed. It is often a good idea to buy animals direct from a farm in order to assess them in a more appropriate setting prior to purchase. Buying cattle in an auction market, or through a dealer are the other alternatives, but the purchaser must know what they want and how much they are prepared to pay.

The most readily available types of cattle are cross-bred animals that have been born to dairy cows and have been reared artificially on milk replacers. They account for more than half of all beef production in the UK (Meat and Livestock Commission 1996). For the first six months of their lives, such calves need to be kept on a high plane of nutrition to compensate for the lack of milk. However, after about three months an increasing proportion of their daily intake can usually come from grazing. Their small initial size can be an advantage where poaching is a problem, but at this stage they should not be restricted to low quality pasture without supplementation.

Normally such cross-bred animals are born to a Freisian dairy cow (or the more extreme Holstein dairy type) and provided that the sire is a beef breed they will have commercial value at almost any stage up to being ready for slaughter ("finished"). If being reared on semi-natural grassland they will usually perform better if the sire breed is of British origin. (Hereford and Angus crosses are still generally available though much scarcer than before.)

In situations where large size is a problem there are small breeds of cattle such as the Dexter or the Shetland. They are neither of them commonly seen but stock can be obtained through the respective breed societies.

5.4.3 Grazing with native breeds of horse and pony

Native breeds of pony, eg Exmoor, Dartmoor, New Forest, Welsh Mountain and Shetland, are tolerant of quite poor grazing unlike thorough and half breeds. In addition, as they are not reared for milk or meat production, their exact levels of nutrient input are not critically important. Hardy native breeds such as these can be a particularly useful management tool in both managing established swards and reclaiming neglected grasslands (see Chapter 10). They trample down and eat coarse grasses, including tor-grass. They will only browse significantly when there is inadequate grass. However, horses and ponies can assist in managing scrub by pushing through and opening up low scrub that is in the process of closing over. They slow down scrub-edge advancement by browsing tips such as gorse, holly and sloe. Native breeds will eat bracken (Oates and Bullock 1997) but this can cause poisoning if there is insufficient grass to feed on. At light densities they produce a useful degree of poaching and trampling. Table 5.4 summarises the grazing attributes of ponies suitable for conservation grazing.

Table 5.4 Some grazing attributes of ponies suitable for grazing semi-natural swards

Horse/pony	Positive attributes	Negative attributes
Exmoor	Extremely hardy Needs minimal attention Not prone to foot problems Strongly resistant to equine influenza Efficient grazers and moderately browsers will even ring-bark trees and shrubs Tolerant of people and dogs Supplementary feeding only needed in very severe weather, provided animals are being extensively grazed	Rare, therefore only small numbers available Difficult to approach unless broken Need very secure handling pens Difficult to handle when ill/injured
New Forest pony	Not in short supply Cheap (unbroken) Easier to handle than Exmoors Good grazing and browsing abilities Adept at controlling gorse, bracken, purple moor-grass and thistles	In late winter ponies can become skeletal in appearance – can cause public outcry Pester visitors for food Prone to foot problems
Dartmoor	Some proven ability in regulating bracken and gorse encroachment Can maintain acid grassland swards	Can congregate in car parks and gateways seeking titbits from visitors
Shetland	Efficient grazers of bramble Agile on steep slopes. Small size less poaching	Prone to laminitis
Konik (or Tarpan)	Very adaptable in dietary terms and so when grazed extensively all year round, require supplementary hay in only very severe weather conditions Placid sensible temperament Foot problems rare Tolerant to biting insects. Thick skinned	Not known
Welsh Mountain	Good for wet pasture Excellent feet. Resistant to fly problems Numerous and cheap	Not known

There are significant differences between the grass preferences of hardy and domestic horses and ponies, eg domesticated animals tend to avoid false oat-grass while at some sites it is heavily suppressed by hardy ponies.

The domesticated horse and native breed ponies, readily, though not always preferentially, graze tor-grass, at all times of the year. Short tor-grass swards (2-5cm) can be very floristically rich (see Chapter 2). On Purbeck, the NT has used a herd of Exmoor ponies to regulate tor-grass swards with much success. Upright brome and cocksfoot are also taken by horses and ponies. In calcareous grasslands, patches of shorter, more neutral grassland will be favoured.

Some practical considerations

On rich pasture, hardy ponies will be prone to laminitis (see sub-section 5.9.5) and obesity therefore it is unwise to use improved or high quality pasture as lay back land for ponies which are being run intermittently on nature conservation sites. In general, hardy breeds are not as prone as domestic ponies to ailments such as laminitis, sweet itch and equine influenza. However, they need checking regularly and their management requires a range of husbandry skills. Many problems can be avoided by having non-breeding animals (especially geldings).

For containment, standard fencing for cattle is suitable. Do not use temporary electric fencing unless ponies have already learned to respect it. The location of water will influence grazing patterns in extensive grazing systems.

Handling units on site need to be constructed of strong wood (ideally 1.5m in height). Metal crushes can be used with tame animals, For more information on veterinary care see section 5.9.5.

The price of native breeds may vary depending on age, sex, condition and breed eg £30 - £200. Fillies and mares are more expensive. Younger horses and ponies are cheaper. The costs of the gelding operation are £50-£100 and should be taken into account. Parasitic worm cycles may be broken, and worm burden build-up reduced by moving animals between compartments on at least an eight week rotation.

5.5 Conservation grazing using farm stock (see also chapter 4)

It is important to understand how farming systems operate in the UK if local farming operations are to be used in providing conservation grazing.

5.5.1 Cattle production in the UK

In general, pastoral farming with cattle is based on two types of enterprise:

Dairying

Milk production is the largest financial enterprise in UK agriculture contributing 19 per cent of the total value of all agricultural output. Such production targets can only be met by top quality feed, which requires improved grassland. High yielding Freisian-Holstein dairy cows are not suitable for conservation grazing systems.

In the UK there are close links between milk and beef production. Dairy herds commonly use beef bulls for crossing to improve the value of the calves being sold. These cross-bred calves, together with most of the dairy pure-bred bull calves, are fattened for beef. One of the BSE measures is a scheme that pays farmers to have surplus calves slaughtered rather than to be sold for rearing. This has reduced the supply of dairy-bred calves to the beef sector.

Beef

Since the BSE crisis began in March 1996 there have been a number of political and administrative changes which affect the conservation grazing of semi-natural grasslands. The key factor has been the introduction of the 30 month beef ban which prevents animals older than this from entering the food-chain. The slower rates of growth achieved on semi-natural grassland due to the poorer quality of forage may not allow cattle to finish properly in the time available. The prices obtained for poorly finished animals is only about 60-70 per cent of the average on a unit weight basis which represents a severe financial loss on top of the general downturn in beef wholesale prices (see Chapter 4). BSE appears to have affected the ability of some farmers in ESAs to graze pastures and meadows. One solution might be a certification scheme for herds which graze conservation grasslands such as the Beef Assurance Scheme. This applies to herds which can establish BSE-free status and allows farmers to finish cattle as old as 42 months. The producer has to pay an annual subscription for this privilege but being part of such a scheme may enable them to achieve a market advantage.

Beef breeds were historically Aberdeen Angus and Hereford types, now beef cattle are dominated by continental breeds such as Limousin, Charolais and Simmental, often crossed with dairy breeds. These generally fetch a better price.

Beef enterprises can generally be split into rearing and fattening systems.

" **Rearing systems**

Single suckling is the most popular method of production in which the calf remains with the dam until weaning at about six-10 months of age. Calves are traditionally born in the early spring but latterly autumn calving has become more popular. Suckler calf production usually produces weaned calves for sale in the autumn as 'stores', these are animals sometimes kept on a low level of growth over the first winter for fattening later. Usually though they are finished by 18 months of age.

Another approach is multiple suckling, the cow rears her own calf plus several purchased calves which are fostered on in successional batches. This has little role in conservation.

Artificial rearing of calves from the dairy herd that are fed on milk substitutes for six-12 weeks and concentrates subsequently. These are the main source of beef animals. In 1996 (latest year for which statistics are available) 49 per cent of UK beef came from dairy crossbred cattle and 43 per cent from specialist beef herds. More than half a million calves processed under the Calf Processing Aid Scheme were mainly pure-bred dairy bull calves that would have previously gone for export (Meat and Livestock Commission 1997). Calves from native breeds such as Hereford and Angus crosses can provide excellent conservation grazing from the age of about six months but will still need reasonably good grazing, at least initially.

" **Fattening systems**

Indoor intensive. Cattle are fed on high quality silage and are fed indoors until ready for slaughter at 12-14 months of age.

Longer period, low intensity fattening for meat. These are extensive systems of production where stock are raised on grass outdoors, and a longer period is allowed for fattening than in intensive livestock production systems. A period of enhanced feeding often takes place prior to slaughter to increase the market value. This is known as 'finishing'.

The most common system is referred to as 18 month beef. Autumn calves are housed over winter then grazed, followed by finishing in yards the following winter.

5.5.2 Sheep production in the UK

Under UK conditions, the main output from sheep production today is in the form of lambs which may be sold either `finished' (lambs fattened up ready for slaughter) or 'store'. At one time wool was a major source of income for the sheep farmer. This now accounts for less than 5 per cent of gross returns.

Sheep production systems in the UK are linked by a substantial crossbreeding programme known as 'stratification' (Cooper 1988). Under the extreme conditions of hill farms, a ewe, eg a Swaledale, generally produces lambs for only four years. After this time hill farm ewes are usually 'drafted' (sent) to upland farms where the better conditions allow for further lambing.

Upland breeds are often crossed with a long wool ram to produce a vigorous crossbreed or half-breed such as a mule (eg Swaledale or Scottish blackface ewe x blue faced Leicester ram) or Scotch halfbred (North Country Cheviot x Border Leicester). These crossbreeds can then be sold at six months of age to lowland breeding flocks where they are crossed with a terminal sire, eg Suffolk, or Texels to produce prime lamb.

Box 5.2 Farming systems suited for adaptation to conservation grazing – key points

Most conservation organisations rely on farm stock to graze their grasslands. However, by comparison with high productivity improved grasslands created by modern intensive agriculture, lowland semi-natural grasslands are, for the most-part low productivity systems which produce lower yields of digestible herbage. Because of the high production targets set by modern agriculture, not all farming systems can be sustained by utilisation of semi-natural vegetation.

The agricultural systems most suited to conservation management of semi-natural grasslands are outlined as follows:

Extensive cattle systems

- Suckler calf production. The nutrients required for the growth of the calf are supplied by the cows milk. The calves are normally sold off as stores after weaning.
- Non-lactating cows or 'dry' cows, replacement heifers .
- Beef store cattle including dairy/beef crosses and pure beef. This should be a 50:50 mix of bulls and heifers.

Extensive sheep systems

- Ewe or wether lambs (store lambs or hoggs) may be winter grazed on unimproved semi-natural vegetation and then finished on better quality grassland. Some unimproved mesotrophic grasslands are productive enough to be used for finishing. Replacement ewe lambs are available throughout the year from weaning until shortly before the autumn tupping season. Wethers are castrated males which have a lower maintenance requirement.
- In some situations it is possible to use dry ewes ie ewes not put to tup after the lambs have weaned although these are usually only available for a short period before the tupping season (August-October). Cull ewes are often not fit enough.
- Mature wethers (see below).
- Hill ewes with single lambs at foot can perform adequately on marginal land. Any with twins will need more fertile situations or supplementary feeding.

Important considerations

- In some situations ie especially on unmanaged grasslands with invading scrub, the use of lambs can be inappropriate because they are not physically strong enough to pull themselves out of the scrub if they get entangled
- Cattle of about three-eight years old are more suited to restoration grazing as by this age they have more adult teeth and have become suitably `hard mouthed' to be able to tackle coarser grasses and scrub. The efficiency of the rumen increases as the animal matures.
- In most instances hardy breeds are the most appropriate for grazing semi-natural grassland because of their ability to utilise poor quality vegetation .

5.5.3 Grazing case studies

Two contrasting approaches to using sheep on chalk grassland nature reserves are provided below. These give an idea of the timing of operations over a typical year.

A typical sheep year at Aston Rowant National Nature Reserve

66 Beulah ewes, 51 Beulah wethers and one Beulah ram

1 April	Commence lambing. Usually until end of April. Dependent on how successful tupping has been.
	As soon as possible after lambing, each ewe and lamb(s) are penned up to ensure they are bonded and lamb navels are treated with iodine to prevent infection entering the umbilical cord. If lambs have not had colostrum from ewes within six hours, a substitute milk formula is administered.
	Within 24-48 hours of birth, castrate lambs and dock tails of all lambs using rubber rings. Ewes are foot trimmed, wormed and checked for milk supply before being released into the holding paddock.
May	Lambs are checked closely for signs of Orf. All ewes are dagged (by contractor) to help prevent fly-strike problems. Whole flocks are treated with Vetrazin (a fly repellant).
	At six weeks of age, and every six-eight weeks thereafter throughout the summer months, all lambs are wormed. Adult sheep are usually wormed in the spring and autumn.
Early June	Shear all adults. Contractor should have been booked in January/February.
June	Vaccinate lambs with Heptavac P+.
	Spray with Vetrazin two-three weeks after shearing.
July	Vaccinate lambs with a booster dose of Heptavac P+ six weeks after first dose. All non-breeding sheep to have their annual booster dose.
August	Wean lambs off ewes.

September/October	Select breeding ewes for tupping in November. Treat whole flock with Vetrazin if flies are still a problem.
	Feed ram on high protein concentrate for two weeks prior to tupping.
November	Put ram in with ewes usually on 4/5 November for lambing 1 April. Keep in for 34 days in order to cover two gestation periods.
November/March	Make Rumevite blocks available to whole flock throughout winter period, especially if grazing is of poor quality. Ensure there is a stock of hay for feeding in bad weather ie where snow cover is deep and lies for more than one day
March	Vaccinate breeding ewes with Heptavac P and worm them three-four weeks prior to lambing.
All year	Daily checks should be carried out to monitor the welfare of the sheep, and ensure all animal welfare concerns are met ie water is available at all times, there is sufficient grazing fodder and all sheep are fit and healthy.
	The whole flock are foot trimmed at least twice a year, and any individual sheep showing signs of lameness are checked as necessary.
Sales	Any cull ewes are usually selected in September/October and sent to the local market.
	If there are fat lambs they will go to market after weaning.
	Store lambs can go anytime after weaning up to April.
Costs	For this operation, £1000-1200 per annum.
Labour	Approximately two hours per day averaged throughout the year, to allow for all sheep tasks, sheep movements and general reactive work eg sorting out problems like sheep worrying by dogs.

Addendum

1. Heptavac P+ is a trade name for a Clostridal vaccine. Vetrazin is a trade name for a treatment for head fly and blow fly (see also Section 5.9.5 and Chapter 8).

2. Panacur and Cydectin are used alternatively to help reduce worm resistance within the flock (see also Section 5.9.5 and Chapter 8).

3. Rumevite is a trade name for a high energy molasses block.

4. The breed of sheep at Aston Rowant are Beulah speckled face from mid-Wales. All replacement stock are bred on site. Only the ram is brought in new to the reserve and he is quarantined for a month to be sure he has no disease or health problems.

Old Winchester Hill National Nature Reserve, Hampshire

The Old Winchester Hill's stock comprises of two flocks:

1. Twenty beulah ewes, a hardy Welsh hill breed brought in as ewe lambs now full mouthed.

2. Thirty easy care ewes, a crossbreed (Wiltshire horn x Welsh mountain). The ram (Wiltshire horn) imparts the short fleece while the ewe keeps the hardiness of the Welsh Mountain. They were purchased as two tooths and are now also full mouthed.

All ewes will be kept until they become broken mouthed when they will be culled and replacements purchased. A health check is conducted annually by a local vet.

April	Worm if necessary and trim feet of both breeds.
May/June	Check beulahs for flystrike. Dagg and shear and then spray with Vetrazin two-three weeks later. Spray easy cares with Vetrazin in early May if necessary, otherwise treat as with beulahs.
October	Inject all ewes with Heptavac P+, trim feet and worm if necessary.
November	Annual health check by local vet. Make Rumevite blocks standard available throughout the winter. Hay is supplied only in very harsh winters.

All ewes are checked daily (Animal Welfare Regulations) and any signs of scouring is treated on an individual basis.

Costings based on 1994 data.

Replacement ewes; beulah ewe lambs *c*£30, breeding ewes £45. Easy care ewe lambs c£45 breeding ewes *c*£60.

Drugs and animal health products; 12 Rumevite blocks (£85) Levacure sheep wormer 2.5ltr. (£30) Heptavac P 100 mil (£27) Vetrazin spray on fly repellant 10lt (£135) Annual health check (£40).

Staff time per year: Site manager = 15 man days and estate worker = 80 man days. NB this figure includes *c*2 hours per day undertaking checks.

5.6 Setting objectives for grazing

5.6.1 Introduction

The biological features of a grassland are profoundly influenced by, and in many cases fundamentally determined by, the grazing regime imposed on it. This includes a number of different parameters.

This section aims to set out some broad guidelines which will assist site managers in making the best decisions regarding the objectives for grazing regimes. The format conforms to the 'management by objectives' model described in Chapter 3.

Decisions about what to aim for with a particular grazing regime on a particular site need to be based on as much information as possible. This information can come from two main sources.

Biological records: Detailed records of the plant and animal species which occur or have been recorded in the past. Information about distribution and abundance and how these parameters have altered through time for particularly important or representative species is especially helpful.

For many sites biological information will be quite limited, confined to descriptive records rather than quantitative data and it may need to be supplemented by additional survey work. Wherever such surveys are required they should be based on well-defined protocols and targeted towards community-based assessments to obtain the fullest assessment possible. The NVC methodology provides a good botanical standard (Rodwell 1992) with which to evaluate the importance of a site using well understood authoritative criteria (Ratcliffe 1977).

Management history: The current biological features of a site will broadly reflect the ecological consequences of human intervention, and non-intervention during the preceding years. However, the relationship is usually a complex one, with layers of events and consequences superimposed on each other and merging into each other so that the precise cause and effect connections are not always easy to determine.

This problem is particularly acute for grasslands of lower fertility that have experienced an extended period of neglect due to agricultural abandonment. In many cases this cessation of grazing started in the 1950s when myxomatosis decimated rabbit populations quickly and comprehensively. Prior to this such sites were likely to have been so intensively grazed by the rabbits that stocking them with cattle or sheep would have been a waste of time. Teasing out the determining management influence in such situations

will therefore not be easy since they are likely to comprise a mixture of short sward and tall sward elements.

Remember the following:

- Any change in management should record stocking rates, stock type and grazing periods.

- Where there is an existing grazing regime, continue this if it appears to be maintaining the conservation value of the site. It may be necessary to introduce some fine tuning of management in the light of monitoring (see Chapter 15).

- Unless obvious damage is occurring under existing management, introduce changes gradually to lessen the impact on flora and fauna.

5.6.2 Principles of grazing management

In most cases the objective for grazing management will specify a particular type of sward, either maintaining one in its existing state or changing it in terms of height and/or structure. The objectives will usually be expected to deliver certain biological outcomes, in terms of the plant and animal communities associated with the desired sward type (see Chapter 2).

The essence of maintenance grazing lies in ensuring that each years' production has all been removed before the start of the next growing season. The relationship between sward biomass, grazing intensity and time of year is generally straightforward and well understood. However, managing it to achieve particular outcomes is made difficult by knock-on effects which reinforce and amplify the original management effect. To achieve this, most of the live plant biomass will need to be consumed by grazing animals, although some of it, having senesced, will spend some time attached to the plant as standing-dead material. Very little of this standing-dead component is removed by grazing, although the presence of large animals does facilitate its eventual removal by mechanical damage as they move through the sward. It then becomes part of the litter-layer which comprises fallen-dead material in contact with the soil, degrading over time into soil organic matter.

Simply altering the amount of plant material in the sward by altering grazing pressure can have a knock on effect. For example in trying to reduce a tall, rank sward, the removal of excess plant material promotes better penetration of sunlight into sward profile, stimulating shoot growth, and mobilization of plant nutrients. The resulting flush of fresh, nutritious and very palatable leaf material itself provides a further stimulus to the grazing process by promoting higher levels of intake amongst domestic grazers. At the same time wild grazers, especially rabbits, are quick to exploit sites with enhanced feeding opportunities, and once established cannot always be readily controlled.

Managing grazing regimes requires effective methods of control so that grazing pressure can be adjusted to determine the amount of plant material left in the standing sward at the end of the year, more if grazing is light, less if it is heavy. It is important therefore to have a clear vision of the sward that such

changes are designed to achieve and to be able to monitor progress effectively. Controlling the process of change may be made more difficult if the initial disturbance of the existing sward has been excessive - it is advisable to introduce adjustments gradually so that the intensity of the response can be properly assessed at the outset.

In order to achieve proper control of grazing it is important that effective means for monitoring habitat change are established. These are dealt with in fuller detail in Chapter 15 but it is appropriate to outline the principles here:

- Assessments need to be made frequently to give advance warning of undesirable trends.

- Assessments of grazing effects should extend throughout the whole site or compartment. Often the intrinsic heterogeneity within even quite small areas of semi-natural vegetation creates variation in grazing pressure (eg soil type, moisture content, terrain and species composition) which can create a false impression of the situation if the assessments are not sufficiently widespread.

- Assessments should be based on as wide a range of habitat criteria as possible: sward height, sward structure, damage to components of the sward, browsing and scrub-edge effects, condition and health of grazing animals and extent of bare ground. If the assessments are too narrowly based, because perhaps the management objectives have been defined too precisely, some important habitat changes may be overlooked or ignored, causing damage to aspects of biological interest lying outside the grazing remit.

- Different sources of grazing need to be identified and assessed separately so that only the most appropriate adjustments are made. This is of particular importance where rabbit grazing is a significant factor.

5.7 Establishing a grazing regime

5.7.1 Introduction

The following factors all need to be taken into account when designing a grazing regime that will achieve the management objectives:

- Physiography: deeper, more fertile soils can support higher stocking levels, rock outcrops and steep cliffs can be a hazard for livestock.

- Climatic fluctuations: wet or dry years lead to a marked change in tolerance of vegetation to grazing, warmer and wetter regions, eg south-west England, may support higher stocking levels.

- Water supply: domestic livestock must have access to water supplies.

- Type of boundaries: they must be intact and suitable for the type of livestock.

- Accessibility: inaccessible areas may remain undergrazed. Cattle numbers need to be carefully controlled on steep slopes, especially wetter north facing slopes.

- Presence of problem weeds/scrub: may cause husbandry problems eg inspection, entanglement, poisoning etc.

- Vegetation: palatability of vegetation to different livestock types - selective grazing of some species of plant can lead to overgrazed areas.

- Productivity: competitive grasses are highly productive and some are able to withstand or even benefit from higher grazing intensities.

- Non-domestic grazing: grazing of a particular site by animals such as rabbits or deer may already comprise an important grazing element.

- Local Farm Systems: on lowland arable farms the value of semi-natural grassland habitat is likely to be peripheral to farm activities. The type of production system is critical (ie stock type/age, year round or seasonal stocking regimes) if reliance is being placed on local graziers.

- Management history of the site.

Having determined the objectives for grazing management, a suite of decisions must be made concerning the best means for achieving them. Deciding an appropriate grazing regime often starts as a fairly intuitive process but develops as experience is gained. Not all of the options will be practicable or acceptable and real life constraints will often require considerable flexibility and compromise in order to implement conservation grazing regimes. One of the key aims of this section therefore is to try to show where compromises can be made without significantly undermining the objectives of grazing. See also Chapter 3.

The options for establishing a grazing regime are based on five criteria:

- Species of grazing animal - cattle, sheep, ponies.

- Stocking density - number and size of grazing animals.

- Duration of grazing - time for which grazing is allowed.

- Season of grazing - months during which grazing is allowed.

" Grazing system – sequence and pattern of grazing events.

The way in which these parameters interact with each other to affect the sward is often complex, making accurate predictions of outcome more difficult. However this also means that a desired result can often be achieved using a variety of regimes. The process of establishing an appropriate grazing regime is therefore usually an empirical one based on 'best-guess' and 'guess-test', and it is often difficult to decide what is appropriate until something has been tried. The key to success is having tried something, being able to decide if it is working and when it is not, being able to identify and correct the problem.

The following sections deal in some detail with these grazing regime parameters.

5.7.2 Grazing season

Grazing season is a crucial factor dictating all other aspects of the grazing regime since it has a primary influence on the nutritional characteristics of a sward. For this reason it should be decided first.

The advantages and disadvantages of restricting grazing to particular times of the year are summarised in Tables 5.5 and 5.6. Delaying the onset of grazing until sometime after the end of the growing season will allow plants in the sward to flower, seed and start senescing. The winter herbage which the stock then have to deal with will be less palatable, and of lower nutritive quality, which may severely restrict intake. It can be difficult to achieve sufficient use of such swards, and even with prolonged periods of high stocking density, the bulk of dead plant material can remain uneaten, although much of it may have been trodden down to ground level. Such grazing presents significant problems for livestock welfare, and may not be possible without supplementary feeding or rotating different batches of animals through the site to reduce the time that any individual is exposed to an inadequate diet.

Choice of grazing season presents the manager with a conundrum, since often the attractive elements of semi-natural grassland are most visible in the absence of summer grazing when plants and animals are able to complete their life cycles undisturbed by large herbivores. However, the successional changes which are triggered by undergrazing (taller thicker sward, more standing dead material, thicker litter layer, dominance by tall grasses and herbs, encroachment of woody species) are usually deleterious if unchecked. Winter grazing may, however, provide more effective maintenance for grasslands of lower productivity, where the residual biomass is not excessive and can be largely removed in most years by a combination of grazing and/or cutting. Even in grasslands of low fertility however, winter grazing will usually still allow scrub to encroach. This is because woody plants soon consolidate their summer growth by laying down secondary deposits of lignin, which makes the stems inedible to stock from midsummer onwards. A regime based on winter grazing will therefore usually need to include provision for regularly repeated scrub clearance to remove the gradual accretion of woody plants throughout the site.

Table 5.5 The seasonal effects of grazing in spring/summer

Timing	Advantages	Disadvantages
Spring April/May	Useful where the dominant species is particularly unpalatable, eg tor-grass, mat-grass *Nardus stricta*, rushes *Juncus* spp. Checks growth of scrub seedlings and in some cases can be used to check growth of ragwort *Senecio* spp. NB This is the most likely time that a farmer will require grazing eg when plant growth is at its maximum. Grazing in spring is a good time to control purple moor-grass *Molinia caerulea* as is at this time that draw-off of phosphorous is at its greatest (Goodwin 1995).	Repeated heavy spring grazing on meadow sites with early flowering plants such as fritillary *Fritillaria meleagris* and green-winged orchid *Orchis morio* can cause local extinctions. Hay rattle *Rhinanthus minor* is an annual which is susceptible to heavy grazing during this time. Heavy or repeated grazing at this time can damage or eliminate a significant range of invertebrates. Trampling of eggs and chicks can be a problem where waders and wildfowl use lowland wet meadows and pastures, especially at high stocking densities.
Summer May/September	Sward productivity is high. Grazing at this time can help control tall herb species such as great willowherb *Epilobium hirsutum* and meadowsweet, *Filipendula ulmaria.* Helps check development of woody scrub. Fresh leaves and shoots of many species are highly palatable to domestic stock, eg sycamore *Acer pseudoplatanus*, oak *Quercus* spp, ash *Fraxinus excelsior*. Stump regeneration is particularly sought after. Less nutrient build up from animal dung due to greater microbial processes. Soil moisture is generally low so there is less chance of poaching.	At high stocking rates grazing removes flowers, and lessens aesthetic appeal for visitors. Reduction in feeding sites for flower feeding invertebrates. Heavy grazing pressure can prevent flowers from setting seed. Although perennials will be able to persist in a vegetative form, continual summer grazing may affect annual and biennial species. Heavy or repeated grazing at this time can damage or eliminate a significant range of invertebrates and will result in a simple specialist short turf fauna (which may be of significance in its own right). Some insects rely on seed-heads to complete their life cycle, eg small blue butterfly *Cupido minimus.* Drought in some years can disrupt planned grazing regimes by reducing plant growth rates to almost zero. This may neccessitate removal of livestock.

Table 5.6 The seasonal effects of grazing in autumn/winter

Timing	Advantages	Disadvantages
Autumn September/October	Least damaging time for sensitive invertebrates. Has little effect on most plant species which finish flowering and set seed before this time. May help seeds to disperse and establish through trampling.	Sward palatability declines markedly and much standing crop is rejected allowing more competitive species to dominate the sward. Tough woody species will not be effectively checked. Heavy grazing may result in the removal of flowers/leaves of certain species, eg devil's bit scabious *Succisa pratensis* which may have a detrimental impact on plant feeding invertebrates.
Winter October/April	Most grassland herbs are not directly affected by winter grazing as they are generally dormant (depending on weather to some extent). More vigorous grasses can be weakened. Less damaging to invertebrates which are usually overwintering in the base of tussocks. Moderate trampling breaks up the litter layer exposing ground for colonising by annuals the next spring.	Heavy trampling can lead to poaching and infestation by weed species. Poaching damage may be irreversible. Does not remove as many nutrients by grazing Stock may lose condition. Hard winter grazing which removes all plant litter can destroy the habitat of many overwintering invertebrates. Less likely to control tall grasses and creates the need for supplementary feeding.

Winter only grazing may therefore not be the most appropriate option for maintaining grasslands, despite its intrinsic aesthetic appeal. It is difficult to think of a situation in nature where it would be the norm since herbivore life cycles are geared to exploiting the benefits of optimal food quality by producing young in the spring. They are thus able to utilize the early season grass to boost the production of milk for the offspring.

There are, however, some cultural traditions where suitable grasslands were largely reserved for winter use by domestic livestock, and in such situations the historical antecedent may still bear relevance to the management of existing semi-natural swards. One example is the western escarpment of the Mendip Hills in Somerset, which were customarily stocked most intensively with cattle in the winter months when the adjoining Levels were inundated. Similarly the Great Orme in North Wales is sheep grazed in winter.

In many mesotrophic situations, however, the sward is unlikely to be properly maintained by winter grazing alone and livestock will need to be present on the site for at least part of the summer if increasing

rankness and scrub encroachment are to be avoided. There is some element of flexibility in the start date of grazing, from a habitat manager's perspective at least although the needs of a grazier may be more restricted. However, the longer that the start of grazing is deferred after the beginning of June, the greater will be the resistance of the livestock to eating the herbage back to its pre-season level since the loss of nutritional value begins as soon as flowers start to develop. On the other hand, if late summer grazing can be continued into the winter as well, the sward will usually have recovered its original pre-season condition before the next spring. In fact one study indicates that winter grazing increases overall plant species-richness when applied to pastures also grazed in the summer (Treweek and Watt 1994), although this may have negative implications for invertebrate populations, through loss of habitat structure.

Some situations may require a degree of flexibility regarding their grazing season because of physical factors. Prolonged summer drought can suppress swards on shallow soils, while excessively wet winters can make low-lying grasslands ungrazeable in that season because of poaching. When grazing in the prescribed season is prevented, for whatever reason, it is advisable to reinstate livestock as soon as conditions permit rather than abandon the regime altogether for that year, although adjustments may need to be made regarding stocking rate and duration.

There are also ways in which the grazing season interacts with other parameters to produce a range of options for achieving a specific outcome; here are some examples:

- The damage done to swards in winter is related to the size of the grazing animals. Sheep are therefore a better option than cattle or ponies where winter grazing is needed on damper soils. However, there are husbandry implications if the site is very scrubby or if the animals are prone to foot infections.

- Sheep are the only domestic livestock that habitually eat ragwort, generally without any adverse effects. However, they usually only do this either in the late winter/early spring when the plant is in rosette stage, or in the late summer when it is flowering (some flocks develop a taste for the flowers though others will target the leaves - this has also been observed in New Zealand).

- Cattle or ponies grazing in summer help to break up stands of bracken *Pteridium aquilinum.* Good results are obtained if the animals are introduced soon after the young shoots have begun to emerge, and can be kept on the site at least until the fronds begin to senesce. However, even winter-only grazing helps to break down the thatch of bracken litter which usually accumulates. Selecting them as sites for supplementary feeding can assist this process.

- Stock availability often determines when grazing can be undertaken, especially when site managers rely on local farmers to provide grazing. In commercial sheep and beef systems, stock may only be available to graze at certain times of the year when they can get by on lower levels of nutrition at non productive stages of their breeding cycle, eg dry suckler cows and breeding ewes, mid-pregnancy ewes, replacement heifers and ewe-hoggs. This will depend to some extent on the features of the breed (see Section 5.4).

5.7.3 Grazing animals

The grazing characteristics of the main types of wild and domestic grazers have already been described and the aim here is to indicate how these interact with site-based parameters, this will help site managers to select the most appropriate grazing animal.

Although great importance is usually attached to choice of stock, there is probably more potential for flexibility than is generally accepted which is all to the good because there are often serious constraints on the availability of preferred stock. The reason for this wider choice is that all large herbivores, regardless of their particular feeding behaviour and food preferences, follow the same basic strategy in sequentially exploiting the grazing resource, eating the tastiest and most nutritious food first and only then moving on to the lower quality items. It has been shown for instance that cattle and horses, despite their contrasting grazing behaviours, are similarly adept at maintaining MG5 grassland (Gibson 1996). Briske's model of grazing resistance suggests that the choice of grazer will have greater impact in grasslands of earlier successional status (see sub-section 5.3.2).

The overall result will depend on the other aspects of the grazing regime but as long as supply exceeds consumption, the less palatable parts of the sward will be able to develop phenologically without significant check. It is only when consumption gets ahead of production that the grazers begin to catch up with the sward and are forced to eat larger quantities of less preferred, lower quality food. (Milne & Fisher 1993.) Cattle, sheep, ponies and rabbits will all, at low stocking densities, produce the kind of patchy structure and mixed height swards that form the conservation objective for many grazing regimes, at least to start with. It is the pattern and scale of the vegetation mosaic which are most likely to differ according to choice of stock.

Other site-based criteria besides sward characteristics are also likely to influence the choice of grazing animal (eg water supply, boundary type and quality, degree and type of scrub cover, level of visitor access). The best strategy therefore is to initially opt for the most suitable type of grazer, in terms of ecological outcome, but to keep other alternatives in mind if the preferred choice proves to be impracticable or unavailable.

Mixed grazing can be beneficial since it may create different sward structures depending on the grazing preferences of different animals. It provides scope too for more effective control of unpalatable species of plant as the food preferences of the different grazers are unlikely to coincide. In managing mixed grazing it is important to be able to distinguish the impacts of the different grazing animals so that when adjustments are made to the regime, they are applied to the correct species. It is often helpful therefore to have tested the effects of each type of grazing animal separately from the others, in advance of them being grazed together. On the other hand, the regime may require them to be grazed separately anyway if this will assist in achieving objectives. Cattle, for example, can be used to graze off tall late season swards initially, to be followed by sheep or ponies once the sward height has been reduced to a level that these other grazers can cope with more effectively. In many, if not in most situations, the presence of significant numbers of rabbits means that in any case, the managed grazing regime has to take account of more than one grazing species.

Sometimes a precise conservation objective can only be achieved by using one particular species of grazer. The beetle and fly larvae which feed on cattle dung are an important food resource for different birds, including the chough *Pyrrhocorax pyrrhocorax*. Cattle are therefore an important component of the grazing regimes that maintain the grassland foraging areas of this species where it is still found on the western coasts of Britain.

5.7.4 Grazing pressure

Grazing pressure is a measure of the amount of vegetation that a given number of grazing animals of given species and size are expected to obtain from an area of grassland during the time for which they are grazing it. When grazing pressure is allowed to exceed the carrying capacity of the grassland it would normally result in damage to the sward's ecological and productive character and this is equivalent to the concept of overgrazing.

Inappropriate stocking rates can be seen as one of the main factors leading to poor management of semi-natural grasslands. Continuous overgrazing eliminates certain species as it prevents flowering and seeding. In addition, it can destroy soil structure leading to erosion and invasion by weed species (Chapter 7). Undergrazing can result in tall rank swards and a loss of biological diversity (see Chapter 10).

Grazing pressure is thus very important in determining the ecological outcome of grazing regimes (Gibson 1996 and 1997). The type of grazer and the time of year for grazing need to be decided well in advance of implementing the grazing regime. Once the animals have been released on the site it is the day to day decisions regarding numbers of grazers and the length of time for which they remain that will determine the outcome for that year. These adjustments will usually be made according to the observed impact of grazing at any particular time, in order to maintain sward height and structure at the required level. Occasionally they may be made in anticipation of other factors, eg a spell of dry weather, or for reasons connected with animal husbandry, eg reduce parasite infestations. The manager therefore usually controls overall grazing pressure by altering these two parameters.

5.7.5 Grazing systems

Farmers customarily use a variety of grazing systems; routine, organised sequences for moving grazing stock over an area of pasture. These systems are designed to achieve the best levels of utilisation of the grassland for the least cost and effort. In high-output situations (eg dairying) the extra income that can be generated by the enterprise justifies a more intensively managed system, which usually requires higher capital investment (fences, water supply, access tracks) and extra labour costs (monitoring the sward, moving animals). The extra effort and expense is paid for by the more efficient utilisation of the grassland's productive potential. Enterprises with lower output (eg sheep and beef), usually operating in a less productive context, cannot generate sufficient income to justify these extra costs. They therefore tend to be organised around much simpler grazing systems which, although being cheaper to run, are generally less efficient in capturing the productive potential of the grassland.

The various grazing systems can, in essence, be simplified down to two fundamental strategies:

Set stocking

This is the most common system on marginal semi-natural vegetation and is where the stock are present on the whole pasture area throughout the nominated grazing season. At lower stocking rates it allows the ungrazed parts of sward to develop phenologically thus providing many more ecological niches for animal species to exploit (flowers, seeds, standing and fallen dead material). The other main agricultural benefits of set stocking are that it is relatively cheap to set up and maintain, with just one boundary to retain stock and often only one trough or other water supply. It is also easy to operate and requires very little manpower to see to its day to day functioning, although on large, physically complex sites finding and checking stock can be time consuming. Stocking density can be adjusted as required, usually being reduced as the season progresses and sward productivity declines.

Rotational grazing

Rotational grazing is where the area for grazing is divided up into compartments (fields, paddocks or strips) and the stock are moved to fresh grazing units at appropriate intervals. By the time they have grazed off the last unit, the pasture in the first one is ready to be grazed again.

The most productive grazing systems are usually based on rotational grazing (Farmers Weekly 7.3.97.) with animals stocked very tightly on each grazing area, but only for a short time (as little as one day). They are moved to new areas at regular and frequent intervals, progressing around the whole grazing area in a structured sequence. They return to graze the initial area after an interval of three-four weeks, by which time the sward will have recovered its full productive capacity, but not yet started to flower (Brockman 1988).

Rotations of longer than this will allow the vegetation to gradually progress into the flowering and seeding stages of the life cycle, and the sward will decline in productivity and palatability as a result. Rotational grazing may be less sympathetic to invertebrates since it results in relatively sudden changes in sward structure.

The chief disadvantage of these more complex grazing systems is that they are costly to operate both in terms of labour (moving livestock on a frequent basis) and facilities (many paddocks require lots of fencing and numerous watering points). They can also be difficult to organise if access between the separate grazing areas is not straightforward. So while these guidelines represent the ideal approach to maximising grassland utilisation they do not apply universally and there are still many farmers operating more extensive systems of grazing, especially for beef and lamb production, which are lower-output operations.

Rotational grazing can be used to achieve conservation management goals, particularly when short swards are required to maintain the more specialised communities which depend on their continuing availability. Dividing a site up into separate compartments and moving livestock between them may provide a more effective method for controlling sward height. There is scope too for designing a

sequence of grazing that will generate different sward types within the separate compartments, by varying the grazing regimes appropriately.

Several Wildlife Trust conservation grazing projects have been established using the rotational grazing approach (Tolhurst 1994). These usually attempt to provide grazing for a large area of grassland scattered over many separate sites. The grazing animals are nearly always sheep, for ease of transport from one site to another. It can be an expensive and cumbersome system to operate and, in conservation terms, is often less than ideal. This is because limitations on stock numbers and manpower may mean that grazing is applied in short intense pulses and is timed to fit in with the overall logistics of flock management rather than conservation priorities.

This approach often works best on sites requiring winter grazing, since the objective is simply for the animals to graze as much as possible of the past seasons growth. Once this is done the sward is ready for the onset of the new seasons production. On separate sites requiring rotational grazing in summer it may be difficult to get the grazers back again at the required stage of sward recovery once they have been moved to another location. Such problems can be overcome by developing a well organised system for integrating the grazing needs of different sites.

One particular rotational technique associated with intensive grassland management can be an effective means for grazing off rank winter swards. This uses an electric fence to confine the animals to a portion of the site until they have eaten it down to the required level after which they are moved into a fresh area contained by the portable electric fence. This system is used a lot by dairy farmers who can give the cows a fresh strip of grass twice a day, just enough for them to sustain full production while utilising all the available grass. In most conservation situations strip grazing is probably too labour intensive to be operated at such a short interval. A five to seven day interval is usually more appropriate. A movable supply of water and, where necessary, a source of supplementary feed (trough, feedblock or hayrack) can easily be incorporated into the design of such a system.

Rotational grazing systems can also be used to provide benefits for livestock welfare when animals are required to graze pastures of low nutritional value, especially if supplementary feeding is not permissable. Such pastures can be grazed by successive batches of animals, each group spending limited time on the poorer pasture before being moved to better grazing. In this way, although the animals may experience nutritional shortfalls, they do not have to endure them for dangerous lengths of time. This system does rely on having access to better quality grazings and sufficient numbers of grazing animals to maintain a viable rota.

5.7.6 Stocking levels

The annual yield of plant biomass sets the upper limit for the grazing pressure that can be sustained by a particular sward. This fact leads to the concept of 'stocking level', which is the grazing pressure needed for achieving a desired outcome. Agricultural stocking levels for example, with the emphasis placed on maximising utilisation are usually high, set at or close to the productive limits of the sward. Conservation objectives on the other hand generally require stocking levels that are lower than the carrying capacity of the grassland. This allows a significant proportion of the sward's annual production

to escape being grazed by livestock so that it can enter other foodchains (eg invertebrate herbivores or decomposer communities) or enhances the structured diversity of the habitat.

Stocking levels are also strongly influenced by the characteristics of the vegetation, especially the species composition and community type. Table 5.7 provides examples of stocking levels that have been found to be effective in conserving the four main types of lowland semi-natural grassland. It shows how longer duration with cattle or sheep compensate for lower numbers of animals in achieving the same overall level of stocking.

The purpose of this is to provide general guidelines for stocking levels on semi-natural swards that are being managed to achieve conservation objectives. It is not intended to be prescriptive and the values it offers may be expected to differ, possibly by a significant margin, from those observed in the particular circumstances which prevail in real situations. The following points should be borne in mind when referring to it:

1. **Number of animals.** The ratio of four sheep to one beast is represented by four adult hill ewes (each 60kg liveweight) and one yearling beef store (240kg liveweight). Each beef animal is therefore equivalent to approximately 0.5 LU and each sheep to 0.125LU (see table 5.8).

2. **Annual stocking rate.** The number of animals that can theoretically graze throughout the 52 weeks of the year is equivalent to the annual stocking rate when converted to LU/ha. These values are given at the bottom of the table and can be used for wider comparison.

   For example, the annual stocking rate for neutral grassland in the table is 0.5 LU/ha which can be compared with the 2.0 LU/ha average stocking rate for sheep and beef production on improved grassland (see Chapter 4). This means that in conservation terms the overall stocking level on unimproved mesotrophic grassland may only need to be a quarter of that found in commercial systems.

   This is not surprising since available data indicates that annual yields of unimproved grassland may at best only represent 60 per cent of improved yields (Tallowin 1997). Furthermore it is quite likely that specific management objectives for conserving particular species will require deliberately lower levels of utilisation of the available production. This would heed stocking levels to be reduced well below the theoretical carrying capacity of the sward in order to ensure that sufficient vegetation remained ungrazed during the growing season for meeting conservation objectives.

3. **Grazing duration**. For the purposes of the table it is assumed that the inverse relationship between stock numbers and duration of grazing is directly proportional. However, this is only true as long as the rate of sward production remains constant (see Chapter 4). This means that in terms of the sward's carrying capacity the potential stocking levels will be higher in summer than in winter because the vegetation continues replacing itself while it is being grazed.

Provided that these considerations are taken into account Table 5.7 can be used to establish the initial stocking levels for a new site, based on its plant community. Adjustments can then be made to the regime on the basis of actual experience and recorded results.

Calcareous grassland

The stocking levels given in Table 5.7 are for maintenance management of an existing sward on shallow soils, eg CG2. It may be necessary to increase stocking rates on sites with deeper soils such as in valley bottoms.

Neutral grassland (pasture)

The stocking levels given are suitable for maintaining botanical interest, eg on MG5, but should be adjusted downward slightly if there is invertebrate interest, particularly if grazing is carried out in summer.

Acid grassland

This grassland type is defined here as grassland which is dominated by sheep's-fescue, *Festuca ovina* or wavy hair-grass, *Deschampsia flexuosa* and/or mat-grass *Nardus stricta*. In NVC terms this equates to U1, U2, U3, and U4 (see Chapter 2).

Wet/marshy grassland (pasture)

This is defined as grassland which is dominated by tall sedges and/or sharp-flowered flowering rush, *Juncus acutiflorus*, meadowsweet *Filipendula ulmaria*, yellow loosestrife *Lysimachia vulgaris*, purple loosestrife *Lythrum salicaria* etc. In NVC terms this equates to M22, 23, 24 and 25 (see Chapter 2). Cattle grazing is needed to check the growth of vigorous species in spring and early summer or to remove vegetation in late summer and autumn. Marsh orchids benefit from a late summer/autumn grazing regime. The grazing is based on the likelihood of significant invertebrate interest. If a generally short sward is required, or on grassland that is less wet (damp) stocking levels should be nearer to those for neutral grassland. On more productive wet grasslands such as M23 a higher stocking rate may be more appropriate.

Table 5.7 A guide to stocking levels for lowland grassland (Number of animals per hectare)

No of grazing weeks per year	Calcareous grassland		Neutral grassland		Acidic grassland		Wet/marshy grassland	
	S	C	S	C	S	C	S	C
2	60	15	100	25	50	12	50	12
4	30	8	50	12.5	25	6	25	6
6	20	5	33	8	16	4	16	4
8	15	4	25	6	12	3	12	3
10	12	3	20	5	10	2.5	10	2.5
12	10	2.5	17	4	8	2	8	2
14	8.5	2	14	3.5	7	1.5	7	2
16	7.5	2	12.5	3	6	1.5	6	1.5
20	6	1.5	10	2.5	5	1	5	1
24	5	1	8	2	4	1	4	
36	3.5	1	5.5	1.5	3	0.5	3	
52	2.5	0.5	4	0.5	2	0.4	2	
Annual Stocking Rate LU/ha/yr	0.25		0.5		0.2		0.2	

S=sheep C=cattle

(*c*60kg LW) (*c*250kg LW)

Source: Nature Conservancy Council 1986 and Maurice Massey (pers. comm.)

Table 5.8 Livestock units for adult grazing animals of different breeds/types

Live weight KG	**10**	**20**	**30**	**40**	**60**	**80**	**100**	**150**	**200**	**250**	**300**	**350**	**400**	**450**	**500**	**550**	**600**	**650**
Livestock units LU	**0.04**	**0.06**	**0.08**	**0.10**	**0.13**	**0.17**	**0.20**	**0.29**	**0.38**	**0.47**	**0.56**	**0.64**	**0.73**	**0.82**	**0.91**	**1.00**	**1.09**	**1.18**
SHEEP																		
		LAMBS			EWES RAMS													
Hebridean																		
Cheviot																		
Mule																		
Suffolk																		
BEEF CATTLE/ SUCKLER COWS INCLUDING CALF																		
		CALVES						STORES					FINISHERS				ADULTS	
Dexter																		
Galloway																		
Hereford																		
Limousin																		
IN MILK DAIRY COWS																		
Guernsey																		
Ayrshire																		
Freisian																		
Holstein																		

Adapted from: Halley and Soffe, eds (1988)

5.7.7 Grazing duration

The length of time for which a group of animals is allowed to graze an area represents the other parameter which determines grazing pressure. The relationship is a fairly direct one, at least while the rate of production of the sward remains unchanged, and in principle, half the number of livestock units can be grazed for twice as long on a particular area, provided that the vegetation continues to grow at the same rate. Caution must be used in extrapolating the relationship from summer into the winter season, since by then the sward has ceased production. In general, the shorter more intense periods of grazing are potentially more damaging and the annual requirement is better spread out over 12-16 weeks.

Short periods of intense grazing may be appropriate in situations where problem species such as tor-grass exist (see Chapter 10) or where grazing at other times would be detrimental from a nature conservation point of view. It may simply be the case that it is not possible to obtain grazing at any other time. However, the effect of short periods of heavy grazing on grassland in general is likely to be catastrophic for some invertebrate species that are dependent on continuity of sward structure over their entire life cycle. It will be least harmful in winter when most above ground insects are in a dormant phase of their life cycle.

The same annual grazing pressure can still be achieved by using a lower stocking rate but only if it is intensity maintained over a longer period of time; the desired sward structure is still achieved but more time is given for invertebrates to re-distribute. This is also the best technique for carrying out reclamation grazing on pastures which have not been managed for many years (Bacon 1990).

Lightly stocked grazing may not be able to keep up with grass growth during peak growing times (especially on more fertile soils), but as productivity declines through the growing season, stock are generally able to 'catch up' and produce a suitable sward height by the end of the next growing season. Ideally, the bulk of the season's growth needs to be removed before the winter (subject to achieving target sward height). This is because stock are less willing to graze rank growth and their welfare will often be compromised if grazing continues for too long under these circumstances.

Flexibility is needed to match the grazing intensity to grass production and the conservation objectives of the site. Flexibility could be achieved either by the use of lay back land (an area of grassland set aside for non-conservation grazing); or by buying and selling stock as necessary. Alternatively, it may be possible to lease stock or rent out land.

5.8 Financial aspects of conservation grazing (see also Chapter 4)

5.8.1 Introduction

While the rationale underpinning conservation grazing contrasts strongly with that which informs commercial livestock farming, both are subject to similar sets of financial constraints. The success and sustainability of both depend in part upon their ability to keep operational costs to a minimum, or at least

to a level which is commensurate with the ends they are pursuing. The latter assessment is made easier for farming businesses because for them the basic aim is to make a profit (ie financial output must exceed total costs) consistently, sustainably and if possible, increasingly. Activities which detract from this objective are promptly recognised in a well-run commercial operation and they can be modified or ceased accordingly (Chapter 4).

Conservation objectives on the other hand are seldom measured in terms of financial output so it can be difficult to assess how well any component activity is working within the overall remit of the organisation concerned. Consequently, it is often difficult to know whether the associated costs of running a project are fully justified or not.

To be successful, conservation livestock enterprises have to steer a middle path between two contrasting financial approaches:

- Over-emphasising commercial gains; there is a risk that pursuit of profit can compromise primary conservation objectives.

- Under utilising commercial potential; in which opportunities for achieving financial gain from livestock are wasted, and management costs may not be sustainable.

5.8.2 Income from livestock

Financial income from livestock is based on the animals' inherent productive ability, the main aspects of which are:

a. Growth

Cattle and sheep can be bought-in as 'stores', ie part-grown younger animals with potential for increasing in size and value. Autumn and spring are popular times for buying and selling store cattle, while store lambs are traded from the autumn onwards through the winter.

Prices vary according to size, sex, breed and condition of the animals and are influenced by seasonal and annual changes in the market. Typically, one might expect to buy a store lamb for about £20-£30 in the autumn and sell it for slaughter worth about £40-£50. However, lambs are unlikely to fatten successfully on the kind of winter grazing that is provided on most nature reserves. The exception to this might be some neutral haymeadows (eg the Derwent Ings, North Yorkshire) on the aftermath grazing. Lambs would also do very well in the spring and summer on new season grass of some of the better quality limestone or acid grassland pastures.

Another enterprise is based purchase of ewe lambs (hoggs) in the autumn when they are six months old, (about £30), to keep them for a year and sell them in the following autumn as shearling ewes ready to be put to the ram. Depending on the actual market fluctuations in the general value of breeding sheep, they could have appreciated by between £10 and £40 per head at the point of sale

Cattle cost more to buy initially (£200-£300 each at six-12 months old) but increase in value more quickly and it is usually possible to sell them at any stage up to the point of slaughter. Prior to the BSE crisis (March 1996) suitable cross-bred finished cattle of native beef breeds would have been worth £500-600 each depending on size and quality. These values had generally fallen by about £100 per animal two years later.

Typically on unimproved semi-natural pastures of marginal quality, cattle of native breeds and their crosses can put on about 0.5 kg per day of bodyweight (Grayson 1997). This is sufficient for a typical Hereford x or Angus x beast to achieve a live weight of around 500kg by the 30 month deadline for slaughtering which BSE regulations impose. The present liveweight price (1998) is about £0.80-£0.90p per kg which means that such cattle are only increasing in value at the rate of £0.40-£0.50p a day, which for small groups of animals in remote situations may not even cover the costs of daily inspection, let alone the associated costs of feed, transport and vetinary care.

Selling for slaughter does require some knowledge and experience because price is usually worked out on a per kg basis with reductions made for animals that are too fat or too thin. It is important therefore to know when each animal is ready - fit but not fat.

b. Reproduction

Many flocks and herds are used for breeding young stock to sell. The progeny are kept at least until weaned, after which they can be sold as stores or kept on for 'finishing'. Cattle usually have single calves (5 per cent will have twin) although sheep can be more prolific if the situation is favourable.

c. Other products

Milk is one sector of farming which has managed to remain relatively profitable in recent years and has been able to justify the extra costs associated with intensification. Stocking rates are maintained at considerable higher levels than in most beef and sheep enterprises by using large amounts of fertiliser to grow more grass. Calves are sold as a by-product of dairy herds, usually at two weeks. They are mostly reared artificially on milk replacers until 8-12 weeks old when they are weaned onto solid feed and are able to continue growing on a grass and/or cereal based diet. This is not often an enterprise that fits well with the management of semi-natural swards, at least in its early stages.

Wool is much less profitable, the price per kg having fallen considerably in recent years. It is a bulky material requiring significant amounts of manpower to handle and transport. Shearing by contractors normally costs 50-80p per sheep, the higher price being charged for smaller flocks. Most wool from commercial flocks must by law be sold to the British Wool Marketing Board for £1-£4 a fleece, depending on weight, quality and the general market situation at the time. Rare breed flocks are exempt from the above requirement but the price for coloured wool offered by the wool board is much less than for white fleeces.

In addition to the animals productive output there is a significant additional slice of income for many livestock enterprises through the various forms of headage-based subsidy payments. These are a vital financial component of all beef and sheep systems and without them there would be litte prospect of economic viability (see Chapter 4).

- Suckler Cow Premium Scheme (SCPS)
- Sheep Annual Premium Scheme (SAPS)
- Beef Special Premium Scheme (BSPS)
- Hill Livestock Compensatory Allowance (HCLA).

Full details of these subsidies are given in Chapter 16. Since 1992 however, claiming them has been complicated by the introduction of two new sets of rules.

a. Livestock quotas. Anyone wanting to claim under the SCPS or SAPS must own or lease the appropriate number of units of the relevant type of quota (suckler cow or sheep). Quota can be bought on permanent transfer or leased in on an annual basis, though either method of acquisition represents a significant extra cost (*c* 50 per cent of the actual subsidy to lease in each unit of quota). It can also be obtained without payment by applying to a central "pool", from where it is allocated according to a strictly prioritised list of criteria.

b. Stocking density rules. Stocking densities are calculated by the relevant Agricultural Department. According to the details of each farmer's forage area, (amount of pasture, meadow, and forage crop) as disclosed on the annual IACS (Integrated Administration and Control System) return. Stock numbers are assessed from the claims submitted for the various livestock headage payments. If the stocking rate is excessive the subsidies are withheld or only partly paid. Converesly, if the number of animals claimed reduces stocking rate to below a set threshold, the farmer receives an additional subsidy known as the extensification premium (for further details on livestock subsidies, see Chapter 16).

   Both farmers and conservation bodies looking to establish grazing initiatives are likely to find that these two mechanisms systems involve a considerable administrative burden which must be dealt with if they need these subsidies in order to make the project financially viable. Most commercial sheep and beef enterprises rely on these subsidies to establish a financial profit. Some Wildlife Trusts have been able to attract sponsorship for livestock, usually on a headage basis. This can increase income very significantly (Tolhurst 1994).

5.8.3 Costs of managing livestock

The previous section indicates how livestock enterprises can generate income which can contribute to the costs of grazing for conservation. The financial output per animal should be broadly comparable with commercial farming since stock prices are usually fairly standardised. Although on a per hectare basis, it is likely to be significantly less because of the lower stocking rates that most conservation objectives usually requires.

However, the lower stocking rates often have financial benefits which compensate to some extent for lower levels of income. This is due to savings in variable costs, those items of expenditure which are directly associated with the means of livestock production eg:

- Feed - conservation grazing will generally place limits on the use of bought in feedstuffs (since its main objective is to get the grass on site eaten). However, some purchased feed will be needed for most breeding enterprises will certainly be needed for breeding enterprises.

- Forage costs - seed, sprays and fertilisers. Commercial farmers spend considerable sums of money to promote the growth of grass and other forage crops. Conservation managers would normally expect to spend very little on these items.

- Vets fees and medicines - lower stocking rates generally mean healthier stock due to reduced rates of infection by disease and lower parasite burdens. Many routine treatments which add significantly to the cost of commercial farming can therefore be reduced to a minimum.

- Replacement costs - the breeding females are usually retained for several years until ill-health or old age makes them unfit for reproduction. This is generally after four-eight years for ewes 10-15 years for suckler cows. When this happens, the females are culled (sold for meat) and replaced by younger ones at the start of their breeding life. The difference in value between culls sold and replacements bought represents the net costs of replacement. Even when replacement females are retained from within the group and do not actually have to be bought in they still represent a notional cost because they could otherwise have been sold for a profit. Generalised figures for net replacement costs would be in the order of £20-£30 per ewe and £100-£200 per suckler cow. Averaging out these costs for the whole herd or flock gives a value for depreciation of the breeding group as a whole. Healthy, well-managed enterprises tend to have lower livestock depreciation because the members of the breeding group live longer, productive lives and fewer replacements are needed each year (eg where life span is 10 years, 10 per cent of the herd must be replaced annually, where it is 15 years, replacement rate is down to below 7 per cent). It is generally accepted that breeding life is extended by the extensive systems of management so the depreciation costs of conservation-based livestock may be less.

In addition to variable costs, it is important to consider 'fixed costs' or those items of expenditure which do not contribute directly to the production process and which have to be met to some extent even when nothing is being produced. Fixed costs are the background costs which are difficult to assign to given enterprises because they relate to shared basic resources of the entire organisation or business. The main ones to consider are below:

- Labour - often the most costly expense, for conservation as well as commercial enterprises. Extensive systems of husbandry by their very nature can be less demanding in their use of labour, provided that sites are well fenced and watered and stock are not having to be moved frequently between sites. Where sites are large with uneven terrain, difficult access and considerable amounts of dense scrub or woodland, the time required to find and inspect the grazing livestock can make this a very expensive item. The costs are compounded if several sites of this type are being grazed concurrently.

- Machinery - in intensive systems, reduction of labour costs is usually associated with higher machinery costs (fuel, repairs, depreciation etc). Extensive grazing involves little use of machinery except to transport livestock and for routine checking. However, the actual costs of operating a suitable vehicle can be high when large distances separate the different sites and the terrain is difficult.

- Rent and/or interest changes. In conservation land is often acquired by gift, grant, donation, covenant, management agreement or similar means which provides tenure at minimal actual cost. However, the initial establishment costs capital may be high (scrub clearance, boundary restoration etc)

Nix's *Farm Management Pocket book*, published annually by Wye College (Nix 1998), provides up-to-date forecasts of financial performance along with other useful information regarding the main fixed costs including conservation work. (For information on livestock subsidies see Chapter 16.) The SAC *Farm Management Handbook* is relevant to Scotland and northern England. See also the Organic Farm Management Handbook (Lampkin and Measures 1995).

5.8.4 Overall financial performance

Unfortunately, very little information is available regarding the physical and financial performance of specific conservation grazing projects. This is probably because they are not operated for financial objectives, even though some are run within a straightforward farming context (eg Parsonage Down NNR). Output from semi-natural grassland will necessarily be lower than its agriculturally improved equivalent would sustain because of a combination of reduced stocking rates, lower yields of biomass and inferior forage quality (Tallowin 1997).

Many semi-natural grasslands found in locations economically marginal to the farming operations have been abandoned by agriculture during the last 40 years. The pace of modernisation and intensification of farming has probably only increased during this period of neglect, so it would be unrealistic to suppose that restoration grazing would be achieved on a commercially viable basis. However, the advent of the various land management schemes (see Chapter 16) has introduced a new perspective which could improve the financial viability of restoration projects and this is already having some effect. (Grayson 1997).

The Organic Aid Scheme (see Chapter 4 section 4.6) can also help the situation by providing a source of additional funding for the would-be grazier if they happen to be a registered organic producer. Where the land in question can be managed without the use of artificial chemicals (herbicides and fertilisers) it can be registered by the producer for conversion to organic status over a five year period. It has to be inspected by one of the organic bodies (eg the Soil Association), along with the producer's own premises before qualifying for entry to the scheme. Inspections are repeated on an annual basis thereafter. Once this is done the grazier can apply for Organic Aid payments. These were increased from September 1998 so that mesotrophic pasture and meadow now qualify for £350/ha spread over five years and rough grazing for £50/ha, again over five years. Payments are scheduled to provide most assistance in the first two years of conversion.

This payment, made directly to the organic grazier and independently of other management schemes provides a basis for developing positive grazing management even on the most difficult sites. It also affords an ideal opportunity for nature conservation and organic farming to achieve an effective working partnership. Organic livestock are also attracting significant price premia at the moment, which further enhances the financial advantages of this system (see Chapter 4).

5.9 Livestock management

5.9.1 Introduction

Livestock husbandry calls for considerable knowledge, practical experience and commitment in its practitioners, if the animals in their care are to remain healthy and functionally effective. It is too large a subject to be dealt either here in anything more than a superficial manner. This section aims only to highlight those elements which are especially relevant to conservation grazing management. There are numerous general texts which describe routine management and care of all the major livestock species and these should be referred to for detailed explanations and accounts of topics mentioned here.

Wherever possible it is worth employing an experienced stock person on a full- or part-time basis.

Help, advice and training is essential personnel who are required to take on responsibility for stock management as an extra duty. Sufficient experience should be gained in managing the relevant types of animals prior to embarking on conservation grazing projects. Ideally the level of competence attained would be tested and certificated through the current National Proficiency Test Scheme.

Help, advice and general information regarding husbandry is generally available from farmers, vets and MAFF officers. The Grazing Forum (part of the Grazing Animals Project) now exists to enable conservation grazing practitioners to meet and exchange information and ideas concerning their use of livestock formal training courses in animal husbandry from:

- Agricultural Training Board (ATB) Groups (usually one or two day courses).
- Agricultural colleges (full-time, block release and day courses).
- ADAS and SAC.
- National Proficiency Test Council (NPTC) can test and certificate competency for a range of livestock tasks.
- Some of the larger conservation organisations have begun to run their own in house training courses (eg National Trust).

Livestock being used for reserve management must be healthy and injury free if they are to graze effectively and provide proper site-management. Their welfare will be an important issue for public relations because they will usually be noticed by visitors (see also annex 6 on animal welfare). The principles for good husbandry are set out in MAFF Welfare codes (one for each species of livestock). These are produced as free pamphlets available from Regional Service Centres and these comprise a series of recommendations for achieving minimum standards of health and welfare. They are based on five basic provisions:

- Freedom from hunger, malnutrition and thirst.
- Freedom from pain, injury and physical discomfort.

- Freedom from disease.
- Freedom from stress and fear (as far as possible).
- Freedom to display the most natural behaviour patterns.

Good stock management involves an ability to recognise the signs of a healthy, stress-free and otherwise normal animal. These can be summarised thus:

- General appearance (eyes, skin, coat, body condition).
- Behaviour (ease of movement, alertness, responsiveness).
- Bodily function (extremes of appetite and thirst, colour and consistency of faeces/urine, cudding, breathing and temperature.

Individuals which fail to show the normal signs of well-being must be checked as soon as possible to determine if there is a problem and its cause. This may require:

- Handling and catching facilities (hurdles, pens, cattle crush, etc).
- Assistance (from suitable helpers).
- Planning and patience.

5.9.2 Nutrition

Patterns of grass growth

Feeding requirements and grazing abilities represent the single most important aspect of managing livestock for nature conservation. The person responsible for animal husbandry must therefore have a good grasp of nutritional principles and their practical applications.

Grazing

Grazing livestock can normally obtain all their nutritional requirements from green leaves, provided they have access to sufficient quantities of adequate quality herbage. Stock actively select green succulent material which has a high nutritional content. Ruminants (cattle, sheep, goats) have symbiotic micro-organisms in their stomachs (Rumen) which digest fibrous plant material (cellulose). These same bacteria also manufacture proteins and vitamins which are absorbed further along the gut of the animal. Horses do not possess this facility and are therefore less efficient grazers, spending much more of their time feeding alone.

The ability of any particular animal to sustain itself by grazing is affected by a number of factors:

- **Age and condition**

  Front teeth wear out or are lost with age which impairs the grazing ability of older stock (mainly sheep), especially on coarser pastures. Young animals and pregnant or lactating mothers need nutritionally better pasture to sustain growth and production at commercially viable levels.

- **Breed and type**

  Upland and primitive breeds of stock have been developed by selecting for ability to thrive on poorer quality grazing. They are normally smaller and are inherently less productive, but can survive on vegetation that will not sustain breeds typical of the lowlands. Most breeds of cattle native to the UK are more effective converters of poor quality forage than the imported continental ones that have largely replaced them for commercial beef production.

Method of rearing

The efficiency of the adult digestive system is influenced by diet during development. Young animals reared mainly on concentrates (cereals) do not develop the large rumen capacity required to digest large amounts of cellulose fibre. Calves and lambs reared outdoors suckling their mothers will be stronger and healthier than ones reared artificially.

It is dangerous to allow livestock to experience nutritional shortage for too long since even a brief period of negative energy balance can produce life-threatening metabolic disorders, especially in sheep. There are particular risks associated with winter grazing on remote sites where poor quality forage and harsh weather conditions combine to make subsistence difficult on grazing alone. In such adverse situations the stocksperson must decide whether the animals should be allowed to continue grazing without the provision of dietry supplements

Supplementary feeding

The use of supplements may be necessary where continued grazing is desirable ecologically but entails significant risks for animal welfare.

Supplementary feeding should normally be avoided on sites of nature conservation value as it can have detrimental effects on the site in the following ways:

- Stock eat the more palatable supplementary feed rather than removing the herbage on site, which can lead to undergrazing. In the more distant parts of the site together with overgrazing around the feeding stations.

- Poaching can occur around feeders. The sward may be destroyed and bare ground created.

- Weed seeds may be introduced with hay and easily establish on the bare ground created.

Supplementary feeding may be unavoidable if heavy snowfall covers the pasture too deeply or during intense frost. General guidance for feeding on grassland is as follows:

- Feed hay in small quantities at widely scattered sites, avoiding using the same areas repeatedly and making sure that all the food is eaten. Works best with cattle which will clean up hay very thoroughly from small scattered piles on the ground if it is reasonable quality. Sheep tend to be more wasteful unless a hayrack is used. This should be moved on at every feeding.

- Locate a permanent feeder in a place that has no conservation value and treat this as a sacrificial area.

- Feed blocks and mineral licks should normally be moved to fresh ground at frequent intervals to minimise poaching damage. Concentrates can be given in moveable troughs or on fresh clean ground as necessary.

Although traditionally unpopular with reserve managers, the need for moderate levels of supplementation is being more widely discussed now as a means of allowing cattle to be finished within the 30 month deadline when restricted to lower quality unimproved pasture. The BSE regulations do pose considerable problems for conservation in this regard (English Nature 1998) because semi-natural grasslands are usually less productive and less palatable than improved leys (Tallowin 1997).

It is known that small amounts of protein-rich supplements (eg cereals, distillary bi-products, grass nuts etc) enhance rumen function by stimulating microbial activity. This promotes higher levels of intake of low quality forage because the rumen is able to process it more quickly (Dove 1996) (see section 5.2.4). In this case supplementary feeding will enhance grazing ability rather than constrain it through substitution. Most feed blocks contain urea as a ruminal stimulant. This is prohibited for use by organic farmers because it is an industrial by-product rather than a feedstuff. It is also used as a fertilizer.

The manner in which supplements are given is important and may sometimes even help to achieve positive ecological outcomes. The concentration of trampling and dunging around dense stands of bracken or scrub can help to create valuable glades for butterflies like the high brown fritillary *Argynnis adippe* (Grayson 1997).

5.9.3 Water

All livestock must have access to adequate supplies of clean fresh water, preferably whenever they need it. Their requirements vary tremendously. In winter, small hardy sheep will often get all their requirements from their grazing activities and not drink at all while a lactating cow on a warm summer day may need to drink 50 litres or more.

For small flocks of sheep (10-20 animals) a single bucket (20-50 litres), topped up regularly as required, is sufficient in most circumstances. The bucket should be tied securely to prevent it being knocked over. Topping-up will need to be more frequent in warmer weather.

Cattle will require a mains-fed trough or access to a large pond or stream. Where neither is available, a self-filling trough can easily be connected to a bowser (water tank on wheels) which can be refilled and returned to site as often as required, provided that vehicular access is good.

The ball-cock in a self-filling trough should be protected by a cover when cattle are using it to prevent them damaging it.

In very cold weather, access to water for stock can be a serious problem - ice crusts must be regularly broken up (at least twice daily) and above-ground pipes thawed out where they are not lagged. Young lambs can drown in water troughs without a ramp of large stones to allow them to climb out. Where large numbers of cattle come to drink at a pond, the water can become heavily fouled by their faeces; this may inhibit their intake, causing thirst-induced stress.

If stock have access to a large pond or stream, ensure any conservation interest is not damaged by poaching or enrichment (Summers 1994). Steep sided ponds or ditches can lead to drowning of livestock and may require fencing or grading.

Water provides a useful medium for administering some veterinary treatments. Certain homeopathic remedies are simply introduced into the water supply, while mineral supplements can also be given this way.

5.9.4 Containment

Effective management of livestock relies on their being adequately confined to a specific area. This will:

- allow grazing to be directed and controlled so that desired results may be achieved;
- permit most efficient use of time in locating and checking stock;
- provide protection from external dangers (eg cliffs, traffic, dogs);
- prevent nuisance or harm to neighbours and the public.

In enclosed grasslands, stock are confined by permanent field boundaries which may be:

- walls/dykes;
- hedges and hedge banks;
- water filled ditches;
- fences.

Each type of boundary must be checked and maintained to ensure that it remains proof against the particular type of stock it is required to contain. Cattle will rub against the upper courses of walls and dislodge the stones, while sheep will nibble away at the new growth in hedge bottoms, creating gaps.

Where ditches are the only barrier, they must be inspected frequently to ensure that livestock have not fallen in. There must be provision of safe, accessible drinking places. Cattle are more difficult to contain by this means than sheep, especially once the grazing becomes sub-optimal. Ditches may cease to be stockproof during periods of drought which allow the water level to drop significantly.

Maintenance of traditional boundaries is expensive and time consuming but, because of their importance as landscape and wildlife features, grant aid can be available from various sources (Countryside Commission, Local Authority, MAFF, SOAFED, WOAD and DANI etc) (see Annex 5).

Fences are quicker and cheaper to erect and require less maintenance than other types of boundaries. They can provide permanent field boundaries or temporary enclosures of open ground. Wherever possible, fence lines should follow natural features such as breaks in slope or beside water courses and avoid visually intrusive locations such as on skylines.

Permanent fencing

Most permanent stock fencing comprises strained sections of galvanised wire supported by intermediate posts. Permanent fences need checking and maintenance to ensure they remain stock-proof.

Each type of fence is suited to a particular type of livestock.

- **Barbed wire**. Anything from two or three horizontal strands are needed to contain cattle. The top one must be high enough to prevent stock jumping over; the bottom one must be low enough to prevent them ducking under. Barbed wire can be used to supplement the stock proofing function of hedges and walls, as well as affording them protection from stock. It is relatively cheap to buy and quick to erect, functional but unsightly. It may provoke an adverse reaction from members of the public if sites are near to footpaths.

- **Stock fence or net**. A rectangular grid of interlocking wire is the standard type of fence for sheep. More expensive and more time consuming to erect than barbed wire, it can be visually intrusive - but nothing else works as effectively. Where cattle are contained as well there must be a strand of barbed wire about 10-15cm above the stock net to prevent them pushing it down with their necks. Lambs and horned sheep can get caught in stock netting and need to be released within 24 hours, so frequent and regular checking is necessary, especially if managing for a short sward.

- **Wire mesh netting**. A hexagonal grid of various sizes with smaller mesh used for rabbits, larger ones for sheep and deer. It can be used as a temporary fence, supported on lightweight posts at 2-3m intervals. It does not need to be mechanically strained, unlike the other type of wire fence.

Temporary fencing

" **Electric fencing.** Normally this is some form of electrified wire delivering frequent pulses of high voltage (up to 10,000 v) charge along its length. The pulse is produced by an energiser, which may be powered from the mains, a battery, or a solar panel (if powered by a battery this can be kept in a locked box). The animals must first learn to avoid it for it to work reliably. When naive stock are introduced to electric fencing for the first time, they should be monitored carefully or there should be an outer permanent-stock proof barrier, as back-up. For all types of electric fence the power source must be checked and maintained regularly because stock can soon discover when the fence is no longer operational. On sites with public access, it is advisable to put up warning signs to inform the public of the electric fence and is a legal requirement when sited next to a footpath. There are a number of different systems:

- **Line systems**. Horizontal strands of electrified wire supported by movable vertical posts. One strand at about 3 feet high can contain adult cows, three strands or more are needed for sheep, the lowest about 6 inches from the ground. It is cheap, quick to erect and very versatile, especially on steep rough or uneven ground. However, it can be less than 100 per cent effective if the food supply is inadequate inside the fence.

- **Net system**. Rectangular mesh, with only the horizontal wires electrified. It is more expensive to buy, and sometimes more time consuming to put up, especially on rough or steep terrain and where the vegetation is coarse or scrubby. However, it is more reliable than a line system because it is physically denser. It also provides a better defence against dogs and other predators (eg foxes at lambing).

  NB this type of fencing is not recommended for horned sheep, because there is a risk of entanglement.

5.9.5 Health care

For animals which have a sound diet and are properly contained within a safe and suitable environment with effective supervision, the risks of ill health will be kept to a minimum.

There are, however, a number of general points to consider:

i. Sourcing livestock

Bought-in livestock can bring with them undetected diseases and infections which can spread to the rest of the herd or flock. It is often best to buy stock from a known local source where information concerning their health status can be sought and the risks minimised. New animals can be quarantined for a week or two to detect ailments which are possibly being incubated at the time of purchase.

It is usually much better therefore to breed all ones own replacement animals, since they will possess higher levels of immunity to the diseases prevalent in the locality. They will also be able to learn how best to cope with the various grazing situations that confront them from their mothers.

ii. Vaccination

Prevention of a range of infectious diseases which may be either life-threatening for individuals (eg clostridia, soil-borne bacteria including tetanus) or debilitating for whole flocks or herds (eg foot rot, and orf in sheep). Vaccine is injected into the animal, usually just below the skin, and stimulates the immune system to manufacture antibodies against the pathogen and is often used to provide passive immunity via colostrum (first milk, rich in anti-bodies) to new born animals. The dam is injected 4-6 weeks prior to giving birth to stimulate production of appropriate anti bodies in her colostrum, which are absorbed into the infant's blood stream via its first feed which it must obtain within the first 12 hours after birth. They protect it against infection for several weeks until the young animal's own immune system has developed.

iii. Worming

All grazing livestock are subject to infestation by a range of gastro–intestinal parasites (roundworm, tapeworm and fluke). These invertebrates have complex lifecycles based on transfer to new hosts via the pasture. Most adult animals have considerable immunity and tend not to develop pathogical levels of parasite burden. Over-reliance on routine preventative doses of anthelmintic drugs can undermine the host animals genetic resistance to parasites by allowing animals with lower levels of immune response to be retained for breeding.

A variety of drugs (anthelmintics) control gastro-intestinal and other internal parasites. They can be administered in a number of different ways :

- Drenching/dosing (liquid poured down throat).
- Injection.
- Pour on (liquid applied along mid-line of back).
- Bolus (slow or pulse release pellets which provide longer-term protection). They are administered orally.

There are three main classes of anthelmintics which should be interchanged on a routine annual basis to minimise the risk of resistant strains of parasites developing. One of the classes of products, Ivermectin, has residual insecticidal activity within the voided faeces of the host animal, and this may have adverse implications for conservation of dung-dwelling invertebrates, together with vertebrates that rely on them as a food source (see Chapter 8) (McCracken 1993).

There is increasing concern in the livestock sector regarding the routine use of anthelmintics leading to drug resistance in the targeted parasites. More emphasis is now being given to breeding livestock with genetic immunity. This can only be achieved by avoiding routine use of the drugs as a means of prevention. There are a variety of management techniques which can help to restrict parasite burdens to levels to which animals can cope with.

- Avoid overstocking to minimise build-up of worm populations.

- Introduce mixed grazing (eg cattle and sheep) either together or in sequence (cattle ingest infective stages of sheep worms without being themselves affected and vice versa).

- Move stock regularly to fresh 'clean' grazing.

- Grazing with healthy adult stock which have developed good immunity. Cattle show more resistance than sheep and should not need worming even when young if grazed extensively. Sheep in their first year are more susceptible and 'wormy' lambs are at risk of permanent impairment or death without treatment. Adult sheep have greater resistance unless under stress.

- Liverfluke is a localised problem associated with wet pastures. It infests both cattle and sheep and cannot be controlled by mixed grazing. It can be very debilitating and will always require use of drugs to cure it where it is a clinical problem.

iv. Minerals and trace elements

Some soils are deficient in specific minerals and trace elements which can cause health problems in grazing stock.

Semi-natural grasslands, not subjected to routine treatment with artificial fertiliser, should provide adequate levels of most nutritionally important minerals, although some semi-natural grasslands appear to be deficient in certain major mineral nutrients eg P,K, Mg and S (Tallowin 1997). Many herbs have richer mineral content than grassess (Newton 1993) which may help to compensate for overall deficiencies. Some mineral deficiencies are a persistent problem among commercially farmed livestock and seem to be associated with improved fertilised swards. Milk fever (calcium deficiency) and staggers (magnesium shortage) are the main ones, but they are seldom encountered in extensive systems based on unimproved pastures.

Some soils may produce localised problems of mineral toxicity (eg lead-mining areas) and these can be detected beforehand by discussion with local farmers or vets. Lead toxicity can be a problem in certain limestone regions (eg Peak District, Mendip Hills) but is usually associated more with ingestion of soil, or contaminated water, than with higher concentrations in vegetation.

Where the lead poisoning risk to livestock is high it can be reduced by:

- Grazing in winter.

- Using older stock.

- Keep stocking rates low.

- Routinely swapping numbers of animals back to uncontaminated pastures.

Ruminants obtain most of their vitamins indirectly from their gut microflora, those that have to be ingested directly (eg vitamin C) are all associated with fresh green food sources. Vitamin supplements are only necessary when livestock are confined on a diet of low quality preserved fodder (hay or silage) for any extended period, although animals outwintered on rough pasture may experience problems.

v. External parasites and insect pests

On hot, calm summer days most grazing animals are troubled by flies such as head-fly *Haematoba irritans* which irritate and make them restless. A few species of fly can cause severe nuisance, torment and even physical wounding. In particular, the green bottle flies *Lucilia* spp causes 'strike' in sheep when the larvae infest faecal contaminated or damp wool and eat into the skin. Lambs are particularly susceptible but adult sheep can suffer also. Heavy burdens of gastro-intestinal worms can cause scouring which will attract *Lucilia* spp and encourage fly strike. Other flies are implicated as vectors of disease such as New Forest Eye. This is a bacterial infection of the eye, which if left untreated can cause permanent blindness in cattle and sheep. It is thought to be more prevalent in scrubby and wooded areas because of likely transmission by flies which are attracted to the lachrymal secretions of grazing livestock. These in turn may be excessively stimulated by the irritating effects of rough vegetation as animals graze. Rapid diagnosis and treatment with antibiotic ointment is essential for a good recovery. There is no direct preventative treatment, only the indirect benefits of fly control which can be partly achieved in cattle with pour-on treatment (eg spot-on).

In some places ticks *Ixodes ricinus* and *Haemaphysalis punctata* are prevalent in areas of rough grassland, bracken and scrub, mainly in the north and west (Blowery 1988). Although the majority of mesotrophic lowland grassland Britain is free from infestation, where they do occur ticks are capable of acting as vectors for certain diseases, and preventative measures may need to be taken to protect livestock. Traditionally, this would be with organophosphate based dips but pour on synthetic pyrethroid dips are effective in both treatment and prevention depending on the nature of the infestation

The diseases spread by ticks include redwater fever and tick- bourne fever in cattle and sheep and louping-ill in sheep.

By far the most serious ectoparasite condition is sheep scab caused by the mite *Psoroptes communis ovis*, which presents a major hazard to the welfare of sheep, and potential loss to the farmer (Bates 1998). Sheep affected by scab perform less well, and the infection which causes severe distress to the animals, damages both the fleece and the hide (Corke 1997). It is estimated that an infection can cause a 10 per cent drop in flock performance (lamb and wool sales), costing in the order of £4-£5 per ewe (Stubbings 1998).

In 1992 the statutory requirement to dip was removed. Since then scab has returned as an intermittent problem that is considered endemic among the sheep flock. The Sheep Scab Order of 1997 makes it a criminal offence to fail to treat scab or to move sheep visibly affected by scab.

Sheep treatment options (see also Chapter 8)

There are three major methods of administering medicine for treating ectoparasites and a wide variety of product. Application methods include dips, pour-ons and direct injections. The major compounds are: organophosphate products (OPs), synthetic pyrethroids (SPs) and injectable macrocyclic lactones. The traditional method of controlling ectoparasites of sheep has been to dip the animals in a suitable OP insecticide. However, in the last five years, alternative methods have been developed. Pour-on preparations are generally applied directly onto the animal, sprayed along the back and flanks and around the rump using a specially designed applicator. Two injectable products are also available for the treatment of scab.

The market for pour-on type products and SP dips has expanded rapidly over the past five years, largely in response to the perceived human health hazards of OPs and the withdrawal of compulsory dipping for scab. The endectocides (injectables - Ivermectin and Doramectin and Moxidectin) have only recently beeen authorised for use in sheep. OPs remain the preferred treatment for the control of scab. Although pour-ons are probably the method of choice for tick control, no pour on solutions or injectable solutions are effective in *preventing* sheep scab.

Environmental impacts of the various methods of treatment

Chemicals applied to sheep in the process of dipping are powerful pesticides with the potential to cause environmental problems if allowed to reach non-target organisms. Chemicals may enter the environment by splashing spillage or runoff from drying areas, or may be carried into water courses on the fleeces of freshly dipped animals. At the end of a dipping operation, the dipping bath may contain as much as a 1,000 litres of a hazardous chemical. Organophosphates generally have a higher mammalian toxicity than SPs (but as persistent as the now un-licenced, banned, organochlorine pesticides). However SPs are far more toxic to aquatic fauna (100-1,000 times) than OPs. Small amounts of SP dip entering a watercourse can cause great damage to aquatic fauna, recent incidents have involved rare priority species such as crayfish *Austropotamobius pallipes* and freshwater pearl mussel *Margaritifera margaritifera*.

One of the recommended methods of disposal of spent dip is to land provided this does not result in leaching or run-off to a watercourse or to groundwater (see Environment Agency 1997). However, there is little detailed information on the effects of application of spent sheep dip on terrestrial invertebrates and more research is needed. No spent dip product should ever be spread on land of ecological interest.

The impact of injectable solutions to treat scab is likely to be similar to that of the effect of chemicals used to treat intestinal parasites ie the impact of the faeces on the population of dung beetles etc (see Chapter 8).

Which method of control to use

The safety and well-being of the sheep flock is a major concern, and control of parasites is an essential component of good flock management. However, this may not necessarily require the use of frequent dipping (see below). If dips are to be used, guidance on best practice on use and disposal has been produced by HSE and the EA and should be strictly followed. If organophosphate sheep dips are to be used the person responsible for dipping must have an appropriate certificate of competence from the National Proficiency Test Council (NPTC). Currently only a certificate of competence for purchase (not use) is required. This is to be extended to the purchase of SPs in the near future. The implementation of the 1998 Groundwater Regulations will involve authorisation by the Environment Agency of dip disposal sites to ensure that ground water is protected. At the same time it will be important to ensure that the dipping and disposal operation pose no unacceptable risk to aquatic or terrestrial life.

The need to dip could be considerably reduced by strategic planning of ectoparasite control to utilise all the benefits of the available products in combination with good flock management. Only dipping, showering or jetting produce a significant amount of waste insecticide for disposal at the end of the operation.

In the first instance it is important to establish the nature of the parasitic problem (eg scab, blow-fly etc) and then choose the most appropriate and effective method of treatment.

Flock management

It is important to remember that in all cases prevention is better than cure. When new stock are brought in, a quarantine period of about three weeks would allow time for sheep scab to develop and clinical symptoms to be apparent (however, this may take longer). If replacements develop scab they could be treated by injection, pour on or dipping. The new stock should be added to the rest of the flock only when treatment is complete. The provision of good, secure boundary fences helps reduce the spread of disease by stray animals. Sheep scab can be introduced to a farm by transport lorries, shearing equipment, clothing etc; hence good hygene should be practised by all contractors. Treatment on site is required by law to prevent the spread of the disease.

Injectables

The currently available systemic injectable treatments may prevent the introduction of scab into a flock provided they are used in conjunction with 'quarantine' management of flock imports. None protect against blow-fly strike. There are fewer disposal problems and welfare issues both human and animal. There are, however, environmental considerations such as the impact of faeces on the population of dung beetles. Injectables are particularly useful for the protection of lambs too young for dipping or for pregnant ewes. There are, however, long withdrawal periods (up to 70 days for Doramectin) during which the animals may not be slaughtered for meat or the milk used for human consumption. Injectables do not give protection against reinfection of sheep scab and treated animals have to be kept away from the site where they had been previously held for 16 days minimum (the period of time that a mite can live away from the sheep's body).

Pour on solutions

These products are applied by pouring a measures dose onto the sheep or spraying on via an applicator gun. They are administered in small volumes, typically 10-50ml of relatively concentrated insecticide. The products are non systemic and their effects persist for six-eight weeks. High cis-cypermethrin is also effective against blowfly, lice ticks and keds. No pour-ons or sprays are currently authorised for use against sheep scab.

Cattle occasionally suffer from skin parasites, though these are usually associated with housing in the winter. Ringworm in cattle (a fungus) and orf in sheep (a virus) are two skin infections which are readily transmitted to humans. Care should be taken when handling stock with these conditions, and gloves should be worn.

vi. Foot care

Sheep often need the horny outer part of their feet trimmed back with a sharp knife or special shears. Foot trimming removes overgrowth, maintains correct proportions and alignment, and helps control infections. It is time consuming, but easily learnt and essential to the well-being of the sheep and their continued effectiveness as a grazing tool. The frequency with which foot care is required depends on:

- Type of ground - more often on soft deep soils.
- Type of weather - more often in damp warm conditions.
- Type of vegetation - long grass can cause sores between the toes.
- Type of sheep - some breeds are less susceptible, eg Romney and Ryland.

Most foot problems are caused by small wounds becoming infected. Routine use of zinc sulphate footbaths can help to reduce the problem of bad feet on a flock basis. Foot-rot is a specific bacterial infection for which a vaccine is available (Foot-Vax), although its efficiency is variable. Foot-rot only survives in an infective state on the ground for 10-20 days, so regular movement of flocks to clean pasture is a good method of control.

Cattle, particularly non-dairy ones subsisting primarily on pasture, are seldom affected by foot problems. When they are, treatment will require special handling facilities and trained personnel. Specialist contractors are available in most areas who can undertake this work. Horses and ponies are susceptible to laminitis, a form of lameness in which the horny outer layers of the hoof begin to split and separate from the tissues underneath causing inflamation and leading to infection. The condition is associated with lush pasture and also occurs in sheep, though seldom in cattle. Breeds adapted to a poorer diet may be more disposed to this complaint when kept on grass of better quality. Treatment involves paring away the damaged outer hoof to admit air and light and allowing pus to drain. Healing will be facilitated by spraying with antibiotic.

If sheep are confined on poached and muddy pasture in winter they may become lame when balls of mud harden between the two claws of the feet and abrade the skin.

vii. Redwater disease

An infection of cattle (transmitted by ticks), lethal if initially contracted when the animals are older, although young animals quickly develop immunity. Advice should be sought from local farmers about the risk it poses in a particular area, and if it is a problem, care should be taken before bringing in adult cattle from outside the locality. It is characterised by fever, weakness and red urine due to bleeding in the urinary tract

viii. Care of sick or injured animals

Occasionally animals will suffer injury or illness so severe that they cannot sustain themselves in their normal social environment. Provision should be made in advance of such emergencies for removal of the affected individual and its accommodation in a suitable place of shelter where it can be given the best treatment. Although isolation from its social group can cause considerable stress for a healthy animal, sick and injured ones often choose to separate themselves. It is only when they are in controlled and protected conditions that their state of health (and especially their appetite) can be monitored properly.)

5.9.6 Transportation

Effective conservation grazing will often require animals to be moved some distance by road in order to meet the requirement for grazing a number of different sites. Good planning and preparation are important elements of this process which will normally involve catching, sorting, loading, transporting and off-loading numbers of sheep, cattle or other stock. It requires specialist equipment:

- A livestock trailer of suitable dimensions (8, 10 or 12 ft long). It must be big enough to carry sufficient number of animals, but not so big that it makes access to the sites difficult. Most stock trailers can be equipped with a set of removable decks which allow a second tier of small stock such as sheep to be transported when required. Some stock trailers also can be used as flat-bed trailers and the box canopy is removable.

- A towing vehicle sufficiently powerful to pull the trailer, when fully loaded, off and on the grazing sites (eg a Land Rover or equivalent with high ground clearance, a low range gearbox and 4 wheel drive. A front mounted winch may also be required where access is consistently difficult).

- Portable handling system for catching and sorting the stock. There are purpose made ones available for both sheep and cattle but they are expensive and cumbersome, requiring an extra journey to tow them to the site. For most situations a set of ordinary hurdles or gates can provide a cheaper, but equally effective, alternative which can be carried inside the trailer, or fastened to its exterior. Their lower cost makes them less susceptible to theft and they can be left on site throughout the period that it is occupied by livestock.

Catching and loading the animals can be made easier by careful siting of the pen, using existing features and fences to funnel them into the opening. Temporary fencing such as Flexinet is invaluable, but the stock must have learned to respect it. The best angle for funnelling stock into the pen is reputed to be 30E - less than this and they get too crowded at the entrance, more and they can double back around the handler. An experienced stock person can easily catch most moderate sizes of sheep flock unassisted using this system. Dogs can be a useful aid, but must be worked regularly and often to be fully effective. A fully trained working dog can cost between £500-£1,000.

Livestock which are moved frequently soon adapt to any given routine for transporting them and can even learn to cooperate with the procedures, especially once they have begun to exhaust their current food supply. Moving cattle usually requires more manpower because they can be more resistant to being herded and driven than sheep, and the equipment needed for penning them must be more robust. Cattle and ponies grow used to handling by particular persons using an accustomed routine. On large sites with rough terrain and quantities of scrub a good working dog is invaluable for locating

and moving cattle or sheep. Alternatively, supplementary feeding routines can easily be adapted to assist in the penning of animals.

Journey time must be kept to a minimum since stock cannot feed or drink during transit, and are usually in a somewhat stressed condition. They need sufficient space to afford some freedom of movement but not so much that they can be thrown about by the movement of the trailer. Ventilation is important, especially on longer journeys or in warm weather. Sheep should not be transported back to their grazing site immediately after dipping because the fumes of the dip are toxic within confined spaces for extended periods.

Vehicle and trailer maintenance is important since breakdown recovery, when stock are in transit could prove difficult and expensive. Spare wheels for both trailer and towing vehicle should be carried.

Before any animals arrive on the new site it is important to check that the boundaries are stock proof. It is advisable to stay long enough after off-loading the stock to ensure that they all travelled safely - almost always the first thing they do when released is to start grazing.

5.9.7 Disposal

Ideally all animals used for conservation grazing would be disposed of by means of profitable sale either for further rearing, breeding or human consumption. There are adverse welfare implications associated with selling livestock though auction markets, and some indication that the animal welfare lobby is concerned with the fate of animals used by conservation charities. The National Trust has recently been confronted with this issue at its 1996 AGM.

Stock sold privately to the purchaser avoids the livestock market (and saves the cost of the auctioneers commission) but may require more involvement and more patience. The national farming press, local papers or specialist periodicals (eg The Ark published quarterly by the Rare Breed Survival Trust) are all possible ways of advertising stock. The Grazing Animals Project (GAP) aims to establish a networking system for supplying animals suitable for conservation projects.

Occasionally an animal will be critically injured and provision must be made for its humane destruction. This can be done by a vet, a knackerman, or even by the stocks person if suitably equipped and trained with firearms. Disposal of the carcass can be by burial, although it must be covered by at least 1m depth of soil. It is easier and safer to request removal by a specialist knacker service although there may be a charge to pay (eg £5 per sheep £30 per beast).

5.10 Legal aspects of owning stock

The bulk of legislation on farm livestock concerns farmers obligations towards the animals in his care, the environment and the general public.

Animal welfare

See also Annex 6

Cruelty to animals is an offence under the Protection of Animals Acts 1911-1988 while the Agriculture (miscellaneous provisions) Act 1968 prohibits the cause of unnessessary pain or distress to livestock on agricultural land. This applies to all animals, not just farmstock. However, good husbandry is not directly subject to legislation because much of it is still very subjective. It is now a requirement for all farmers to have copies of MAFF Welfare Codes relevant to the type of stock they keep. However, the Codes themselves are only recommendations and it is not a specific offence to be in breach of them, apart from specific provisions for certain intensive systems based on permanently housed stock. The legal situation has been summarised in a freely available MAFF publication (MAFF 1992a).

There are specific laws which govern the welfare of animals in transit, at auction-markets and at slaughter. Vets and RSPCA inspectors are the main agents for policing these laws. Under the Welfare of animals during Transport Order 1992 no animal may be transported in a way which causes it undue suffering. Special rules apply to sick and injured animals that need to be taken to a vet or slaughterhouse

Pollution

Where animals are housed in large intensively run units there are serious risks of pollution of air and watercourses. Legislation brought in progressively over the last five years has tightened controls on existing units and imposed restrictions and conditions on new and refurbished ones.

The main statutes governing disposal of farm waste to land, water and air are: The Water Act 1989; The Environment Protection Act 1990 and The Environment Act 1995 which created The Environment Agency for England and Wales. The main provisions are incorporated into the Codes of Good Agricultural Practice for Air, Soil and Water (MAFF 1998a, 1998b, 1998c). These are available free of charge from MAFF and are recommended reading.

The Food and Environment Protection Act (1986) controls the purchase, use and disposal of all pesticides.

Burning of vegetation as an aid to management of grassland or moorland is also subject to legal controls and cannot be carried out after March (April in the Highlands) without a special licence from the relevant Agriculture Department (see Chapter 9).

Food quality

A record must be kept of drugs and medicines used to treat animals that are to be slaughtered for food. Stock managers must adhere to the instructions on product labels, particularly with regard to stated withdrawal periods (time which must elapse before a treated animal can be sent for slaughter). Routine

checks are carried out on milk and meat to test for residues of drugs. Cattle keepers must comply with a compulsory system of stock identification. Each animal has a unique number on ear tags fixed in both ears, by which it can be traced back to its farm of origin. Passports are required for all cattle born after 31 July 1996, a registration document issued by MAFF, showing the animal's identity, breed, date and place of birth. It must accompany the animal whenever it changes ownership.

Disease control

Some diseases can spread from farm to farm very quickly causing serious losses of livestock over a wide area. Such diseases have been made compulsorily notifiable - anyone who suspects that an animal in their care has such a disease must inform either their own vet, the Local Authority's Animal Health Department or the nearest Agriculture Department office as soon as possible. Examples of notifiable disease include foot and mouth disease, anthrax and BSE. Sheep scab is no longer notifiable and dipping is no longer compulsory, although many continue to do it as a precaution or for control of other parasites. However, it is a legal requirement to treat sheep affected by scab on a whole flock basis, and to retain them on the farm until cured.

Stock managers are required by law to maintain accurate records of animal movements. An entry must be made in the record book whenever any cattle, sheep or pigs are moved from one set of premises to another. This will normally include situations where stock are taken from one reserve to another if the movement requires a road journey. Such records allow disease outbreaks to be traced back to source. A new system for recording cattle movements is being established from September 1998 based on individual passports. The cattle tracing system (CTS) is being established and run by the British Cattle Movement Service (BCMS) based in Wokington, Cumbria. It will monitor an anticipated 20 million cattle movements annually using a computerised system. Inclusion in the system will be compulsory for all cattle and a charge will be made for the issue of passports (MAFF 1998a).

Public liability

Owners or managers of stock are liable for damage or injury done to third parties by their animals. They are generally responsible for preventing their animals from straying and it is nearly always the owner's obligation to fence his or her own stock in. When animals escape and cause damage to property (eg in gardens) or physical injury to people (eg causing road accidents) their owner can be sued in court for reparation or compensation. The main exception to this is on common land where it is generally the adjoining landowner's responsibility to fence out stock grazing on the common. Insurance is available to cover such situations.

Owners of bulls must take steps to protect members of the public. It is an offence (under The Wildlife and Countryside Act 1981) to keep a bull of a dairy breed at large in a field crossed by a public right of way. A beef bull in this situation is permitted provided that it is in the company of cows. A warning sign is not a legal requirement although it is often an advisable precaution against liability claims if an incident occurs.

Conversely, the dog-owning public must take care that their pets do not worry livestock. The farmer is allowed to protect stock by seizing or shooting a dog that is attacking them.

The legal regulations which govern livestock farming are becoming increasingly complex under the influence of the EEC. New entrants to the industry should contact their Local Animal Health Officer (County Council) and the nearest Agriculture Department office to ensure they comply with existing requirements and are advised of any new ones as they are introduced. The NFU have produced a series of leaflets providing outline guidance on various legal aspects of farming and land use and members have access to a free legal help-line.

Grazing licences and agreements

This has been the preferred option for leasing out most conservation grasslands, requiring minimum input of resources and usually achieving management objectives quite satisfactorily. The key to success is in finding a good grazier. This is usually a local farmer with sufficient numbers of suitable stock, enough flexibility in his farming system to be able to adjust stocking rates appropriately, and who is prepared to cooperate to help achieve conservation objectives. Finding good graziers is not always easy or straightforward. It must be borne in mind that their objectives will be different to those of the site manager and they will not necessarily understand the conditions imposed on them. It is important to try to establish good communications, starting with the licence or agreement. Many of the potential pitfalls can be avoided by a carefully drafted agreement which sets out clearly and comprehensively the terms under which the grazier can utilise the site.

It is important to get written agreement with respect to the following animal welfare considerations:

- Make sure it is clear that the responsibility for the health and welfare of grazing stock lies with the grazier and not the landowner/site manager.

- A named person who is adequately trained and easily contactable should be responsible for the stock and this should be clearly stated in the agreement.

- There needs to be written confirmation that the grazier is aware of any public access to the site, eg gates/footpaths.

- Refer the grazier to the relevant MAFF Animal Welfare Codes. It should be stated in the agreement that they must possess a copy, be familiar with its provisions and adhere to them.

The period of occupation has until recently been an important legal point, since agreements which involve any renting of land for farming have been subject to the laws governing agricultural tenancies. These stated that anyone who occupied farm land for a period of 365 days or more could apply to MAFF to have their agreement converted to a full agricultural tenancy. The site manager should still ensure that the licensee removes all stock and equipment promptly at the end of the occupancy, if still letting on an annual licence.

Although annual grazing licences continue to be legally valid they have been largely superceded by Farm Business Tenancy agreements, established under the Agricultural Tenancies Act 1995. These allow for complete flexibility of terms and conditions so long as both parties are in agreement.

When the services of a good grazier are secured, it may be worth thinking about a longer-term arrangement for managing the site which will allow both parties to plan ahead. The period of letting can

be extended without creating risk of full (ie lifetime) tenancy. Professional advice from a land agent or surveyor would be required. The question of rent paid is also important. Conservation grasslands seldom attract high rents because of the restrictions imposed on how they are used; in many cases the income that licences generate is of secondary importance to meeting the management need. Where land is difficult to let commercially, it may be possible to find a grazier only if it is rent-free.

Where no rent is paid the arrangement falls outside agricultural tenancy legislation. However, it may still be important to have a written agreement to refer to in the event of misunderstandings and disputes. Some agreements stipulate a token peppercorn rent (eg £1) or an optional rent (if requested) as a means of validating their agricultural character.

Where rents are very low there is some danger that licences will be bought as cheap insurance against a poor growing season. Then, if the farmer in question finds that he has sufficient grazing and hay from his own land, they could simply do nothing with the licensed land. It is not possible to compel a grazier to put stock on - they have bought the right to graze do so and are perfectly free to choose not to exercise that right if they wish. Such problems may be resolved by negotiation on the part of the site manager but, when it becomes clear that the grazier is not going to use the licence, there needs to be a let-out clause for the licensor. Usually, this is achieved by refunding some or all of the fee, terminating the licence and attempting to find another grazier.

Usually graziers are found by chance - the more contacts that can be made with local farmers the more probable it will be that one will be found. Sometimes advertising can be a useful method; local newspapers or notice-boards in livestock markets, farm suppliers and feed merchants. It may be possible to secure interest from organic livestock farmers for land that does not require the use of artificial chemicals because they can benefit from payments under the Organic Aid Scheme if they can guarantee their occupancy for at least five years

The legal considerations of grazing on commons

The legal issues surrounding grazing rights on commons are complex and can be a further obstacle to management. DETR (1998) provides useful advice and information on practical solutions to management issues on common land.

Many commons are unmanaged because no individual or organisation assumes responsibility for management. This is true particularly when there is no registered owner or rights, as set out in the Commons Registration Act 1965.

There are complicated procedures for application to the Secretary of State for the Environment for permission to fence even temporary enclosures on commons, plus opposition to fencing from the public and organisations such as the Open Spaces Society.

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