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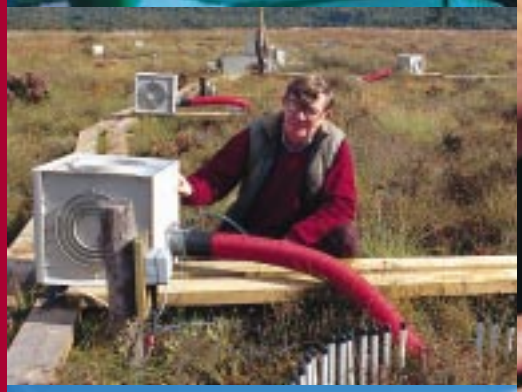

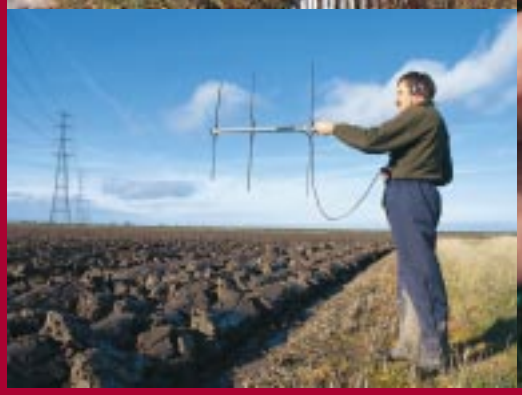

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A judgement-based method to identify overgrazing in English upland native woodland

Richard Thompson, Andrew Peace and Elizabeth Poulsom

Forest Research
An agency of the Forestry Commission

defra
Department for Environment
Food and Rural Affairs

Forestry Commission

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Preface

This report explores a methodology for assessing over-grazing in upland woods in England. The work was funded by MAFF/Defra, the Forestry Commission and English Nature. The report incorporates extracts from: ARMSTRONG, H., CHESTERTON, C., CURRIE, F., KIRBY, K. & LATHAM, J. 2003. *Developing survey methods to assess over-grazing of upland woods*. Unpublished report to the Department for Environment, Food and Rural Affairs.

Acknowledgements

We would like to thank the following individuals for their time and enthusiasm in locating sites for the method assessment: Rupert Lane (Dartmoor National Park), Graeme McVittee (Exmoor National Park), Jim O' Neill and David Atkinson (Forestry Commission, NW Conservancy), Geoff Garrett (Yorkshire Dales National Park), Phil Taylor (Lake District National Park) Ewan Nugent (Rural Development Service (Penrith)). Elaine Rigg and Kit Brown also provided information on sites in Northumberland. We are very grateful to woodland managers and owners for giving us permission to visit their woodlands, all of whom were very welcoming and informative.

We are very grateful to Technical Services staff for their commitment and input in the method assessment survey, particularly Tony Reeves, Barnaby Wylder and Alan Ockenden from Exeter, Lenny Thornton from Kielder and Bo Duff and Harry Watson from Mabie. Kate Fielding and Norman Day are also thanked for their help in developing the initial methodology. We would like to thank Martyn Potton (FC England) for his GIS analysis of site designations and grant aid status.

Ben and Alison Averis are thanked for their information on grazing sensitive plants and Simon Pryor, Chris Chesterton, Sallie Bailey and Helen Armstrong are thanked for their comments on earlier drafts. Thanks also to Robin Gill who helped with training and commented on earlier drafts.

Summary

There is a long tradition of using upland woods shelter and stock-grazing, but at times this conflicts with maintaining the distinctive plant and animal communities associated with upland oakwoods and ashwoods. This has led to concerns that the woods were being over-grazed, in ecological, if not agricultural terms.

The Forestry Commission, Defra (formerly MAFF) and English Nature share a common interest in developing an approach to assessing when the impact of stock grazing within woods is becoming a threat to the interest of the woodland and commissioned Forest Research to test a proposed methodology.

Fifty broadleaved woods spread across Dartmoor, Exmoor, the Yorkshire Dales and the Lake District were visited during 2004. Their condition was scored at 10 points in each wood against a series of possible indicators of over-grazing (type of browse line, damage to saplings, occurrence of browse sensitive species etc).

against a series of possible indicators of over-grazing (type of browse line, damage to saplings, occurrence of browse sensitive species etc).

These data were combined to give an overall score (from A - grazing is not causing a problem in the wood, to D – woodland habitat is severely impacted and this level of grazing is not sustainable). The survey did not pick up as many severely over-grazed woods as might have been expected: however this was in part because the initial selection was biased towards sites that were already within some sort of management scheme. The system was however subsequently tested on severely over-grazed small woods to ensure that it was able to detect such impacts.

The survey approach was generally considered to have worked and to have produced results in line with the surveyors' subjective impressions. However various refinements were made to the proposed methodology to make it more robust for future surveys.

Different approaches to analysing and presenting the results were explored, including the development of a simple 'expert decision tree'.

Contents

1. Introduction

This report presents an evaluation of a judgement based method to assess the level of overgrazing in a sample of English upland native woodlands. The method was initially developed by a working group (Helen Armstrong, Chris Chesterton, Fred Currie, Keith Kirby and Jim Latham). Their recommendations were presented in a report to Defra, English Nature and Forestry Commission (Armstrong and others 2003). Extracts from that report are included here, particularly under sections 1, 2 and 6.

The focus of this report is to make recommendations for refinement of the judgement based method developed in this previous report and to present options for the analysis of data to reach an overall assessment of grazing impact. The method was tested in 50 woods in upland England. It is evaluated in terms of how easy it was to undertake in the field and how successful it was at picking up cases of overgrazing.

1.1 Background

There is a long tradition of using upland woods for shelter and stock grazing, but in the past this would generally have been well-controlled by shepherding and fencing. An increasing tendency to graze sheep in the uplands, rather than cattle, and increasing numbers of sheep overall during the last 30 years lead to concerns amongst nature conservation and forestry interests that many woods were being damaged by over-grazing (eg Coed Cymru 1985). The concern most often expressed was of a lack of regeneration in the woods.

During the 1980s attitudes towards grazing in woodland started to change (Latham 1999). Upland oakwoods may not be wood-pastures in the classic lowland sense (Rackham 1980, Harding and Rose 1986), but grazing does play a key role in maintaining many of their characteristic communities of plants and animals. Mitchell and Kirby (1990) proposed that the highest levels of richness for many woodland species groups would be obtained under a light or variable grazing regime in upland woods, rather than in the predominant very heavy grazing or through complete stock exclusion. Subsequent papers (Kirby and others 1994; Hester and others 1996; Mitchell and others 1996; Mayle 1999) have supported this idea and it has received additional support with the ideas of Vera (2000) on the role of large herbivores in natural systems. An experiment is currently underway at Kirkton Glen (Hulbert and others 1999) to try to demonstrate both forestry and agricultural benefits from a mixed forest grazing system.

There are however both practical and policy obstacles to be overcome in achieving this balance. Practical issues include for example, the need for a water supply and for fencing to control the access of stock, even if they are only using the wood for limited periods. Policy issues have included the effect of headage payments encouraging some farmers to increase the numbers of stock on the hill. Support payments have recently shifted to an area basis which has led to some reductions in overall numbers. Payment mechanisms are about to change again. Under the new system there may be a disincentive to fence stock out of woods because it reduces the allowable forage area. Forestry Commission grants may also work against allowing some grazing in that it is usually a condition that stock are totally excluded from grant-aided woods. There may be further changes as the new Common Agricultural Policy regimes start to operate.

The net effect of the changes has been that in England, large areas of the uplands (not just upland woods) were considered during the 1990s to be over-grazed in nature conservation, if not in agricultural, terms. Consequently MAFF (now Defra), Forestry Commission and English Nature identified common interest in exploring this issue and how it might be assessed. The results described in this report should help address some of the concerns of the recent England Forestry Forum working group on protection of ancient woodland.

1.2 Why do we need survey methods for overgrazing in woodland?

Several agencies and departments have different, but related, reasons for being interested in the level of grazing in semi-natural woods.

- Defra through RDS (formerly FRCA) are responsible for investigating reports of any over-grazing on semi-natural habitat in England, and taking action, for example through restrictions on Single Payment Scheme (SPS) payments and England Rural Development Plan (ERDP) payments, if the overgrazing is causing significant damage. Woodland is one of the habitats that should be considered in assessing damage. However without an agreed system of indicators of overgrazing it has been difficult to apply cross-compliance measures to halt decline in the condition of woodland.
- Forestry Commission are concerned to improve the management and condition of semi-natural woodland. Overgrazing of woodland is a common concern: often this is by deer, rabbits or horses but stock grazing can also be a factor leading to poor condition, lack of regeneration and attrition of upland woods. However it is difficult to quantify the scale of the problem, and hence the resources needed to tackle it nationally, without a system for carrying out surveys of upland woodland condition.
- English Nature is engaged in developing simple methods of condition assessment for Sites of Special Scientific Interest (Kirby & Solly 2000; Kirby and others 2002), part of which involves consideration of grazing/browsing pressures. It needs to improve the way this part of the work is done, particularly if it is to be adopted more widely as part of the monitoring of the condition of priority woodland habitats under the Biodiversity Action Plans.

A simple system of assessing overgrazing in woods would therefore help achieve a range of objectives for all three organisations.

1.3 What is overgrazing?

Grazing by large herbivores is a natural part of woodland ecosystems. Interest in this topic has been increasing throughout the 1990s, partly because of the renewed interests in wood-pasture systems (Hulbert and others 1999; Kirby and others 1995; Kirby & Reid 2000; Watson 2002), but also because of a more general appreciation of the role of grazing animals in promoting woodland diversity (Hester and others 1998; Vera 2000; Kirby 2003).

In very broad terms, as woods go from lightly to heavily grazed, the following changes occur:

a. The understorey tends to be become more open as the lower leaves and branches of trees and shrubs are eaten; a distinct browse line develops; there is a reduction of

regrowth from stools and in the number of seedlings making the transition to saplings and young trees.

b. Changes in the ground flora occur with sensitive species being eliminated or reduced to safe sites (on rock ledges or within exclosures); less palatable species may spread; low-growing species may benefit from the reduced competition from taller-growing but sensitive species.

c. Damage to established trees may occur through bark stripping. As trees die or are felled reduced regeneration in the gaps leads to a rather open canopy developing. Increased light tends to favour grasses and other grazing-tolerant species. If the process is continued long enough there can be a gradual shift from a woodland assemblage to one more typical of open conditions. As more trees die or are removed, so eventually the wood may cease to exist.

At any point in this process there will be differing levels of 'benefit' being delivered in terms of its nature conservation, forest production or agricultural value. Therefore overgrazing as a concept cannot be easily defined in terms of any particular intensity, season or duration of grazing animals present in the wood. Rather it must take account of the impacts that the grazing has in relation to the objectives for a particular wood, taking into account relevant national or local guidance on what are or are not acceptable impact limits.

Thus in terms of grazing value there might be a steady increase with increasing intensity (because of gradual replacement of woodland floras by more tolerant, more productive grassland communities); the long-term result is likely to be that the wood could cease to exist. The shelter value of the wood would peak earlier and start to decline as the shrub layer opens out. The value for birds that depend on the shrub layer starts high and gradually declines; whereas for ground-living bryophytes the peak might come at quite a high grazing intensity because they benefit from higher light levels at the forest floor and reduced competition from grasses. Similarly, in some wet woodland in the Lake District, cattle poaching is required to stimulate growth of Touch-me-not balsam (*Impatiens noli-tangere*) which is the host plant of the endangered netted carpet moth *Eustroma reticulata* (the Lake District contains 11 of the 13 known sites in the UK). From a wood production point of view some grazing may be beneficial in aiding regeneration, but the concern would set in at higher levels where the density of saplings and young trees drops below that sufficient to maintain the canopy, or damage to trees lowers the quality of the timber.

1.4 Sifting grazing from management and site effects

Management includes the impacts of woodland history on current woodland structure and species composition as well as more obvious direct impacts from recent interventions. The characteristics of the site can also affect vegetation composition and woodland structure in the absence of grazing or browsing.

In a landscape heavily influenced by man's past activities, woodlands are frequently isolated and have an artificial, simplified structure. In many upland oakwoods, the whole wood has been heavily influenced by intensive coppicing and there may be few canopy gaps. However, in many cases (particularly in National Vegetation Classification W17 stands), saplings of rowan, holly and birch should still be encountered under the canopy where there are sufficiently low levels of grazing and browsing. Where there is thicket regeneration following lower levels of grazing in the last 2-3 decades), there will be limited light levels,

sparse vegetation and little prospect for recruitment of tree saplings. The same conditions may arise under a well developed understorey of any species but particularly holly and hazel.

Non-site native trees such as Norway spruce, sycamore and beech can limit the development of woodland ground flora due to reductions in light levels under the canopy, change in humus type (build up of leaf litter and organic matter) and consequent reduction of soil fauna.

More obvious impacts from management are where recent operations have taken place and there is damage to established trees or bare ground due to extraction disturbance (whether from the wood in question or from an adjacent plantation). Other damage from machinery may occur where there is access through a wood to adjacent fields. Rearing large numbers of pheasants may cause damage to ground flora through trampling, nutrient enrichment and disturbance (Robertson 1992). In busier tourist areas, there is the possibility of ground disturbance from recreation (eg pony trekking, mountain biking).

Where canopy gaps do occur, these may be occupied by dense stands of bracken, limiting the prospects for tree regeneration and recruitment. Similarly, in lowland NVC W8 woodland, Harmer and Kerr (1994) found that dense stands of dog's mercury inhibited regeneration. This appeared to be the case in some of the Yorkshire Dales woods surveyed as part of this study. Elsewhere, dense stands of greater wood rush have been considered to limit prospects for tree regeneration (pers. comm. Dr S Thomson).

It is difficult to be clear about the impact of grazing animals on very steep slopes where there is a high percentage of scree/bare soil. On one site surveyed as part of this study, a surveyor put the lack of vegetation down to the instability of the slope. Whether this was in part due to overgrazing is difficult to say. However, in similar sites elsewhere within this region, woodland with complex structure has been observed albeit of a very dynamic nature due to the movement of soil and scree. Undoubtedly, the most unstable scree will remain unvegetated although, at a woodland scale, there are usually more stable niches for tree establishment.

1.4.1 Summary

The following may lead to reductions in regeneration capacity and ground flora diversity in the absence of grazing:

- Vegetation competition
- Localised slope instability
- Damage from machinery
- Intensive pheasant rearing
- Intensive recreation use
- Thicket stage regeneration with low light levels reaching the woodland floor
- A dense understorey with low light levels reaching the woodland floor
- Reductions in light levels and build up of litter from non-site native trees

1.5 The Working Group, its terms of reference and methods of working

In autumn 2001 representatives of MAFF, Forestry Commission and English Nature agreed to establish a working group to develop field indicators of over-grazing with the terms of reference set out in Box 1.

Box 1 Terms of reference

The terms of reference for the technical working group are to draft guidelines for:

The assessment of woodland condition with regard to grazing pressure by domestic livestock. The group will consider existing methods of woodland condition assessment and those presently under development, particularly the English Nature vegetation condition assessment for woodlands. Consideration will also need to be given to the practicalities of survey in terms of sampling methods, timing and resources.

The group will:

- identify when the condition of woodland is such that undesirable long term changes in biodiversity, vegetation community and lack of regeneration are taking place because of current grazing by domestic livestock;
- identify the effects of supplementary feeding within woodland. This should distinguish between temporary and more permanent change or damage to the habitat. They should include guidance on when such damage is considered to be defined as unsuitable supplementary feeding practice likely to cause long-term undesirable change to the habitat.

The group developed two methods, a judgement based approach and a quantitative method to confirm observations in more heavily overgrazed sites (The Critical Damage Assessment). This report describes the testing and development of the judgement based approach. The Critical Damage Assessment is not described and still requires further field testing.

2. Judgement based method

The working group considered a range of existing guidance on indicators of grazing impacts for woodland and upland vegetation. From these and discussions in the field, criteria were selected and a form developed (see Appendix 1). This was intended to be used by a surveyor walking round the site in a systematic fashion and stopping at ten points over the wood. The results should provide both a relative assessment of the level of impact and of the animals most likely to be causing the damage. The aim was to make the form as self-explanatory as possible, but it was expected that there would need to be some training in its use to ensure consistency.

Questions were raised about how small woods should be treated and at what time of year the surveys should be undertaken. The working group concluded that small woods should be assessed in the same ways as larger areas except that the number of samples might be reduced if they were effectively overlapping. The significance of the findings would however differ if it was a 2ha or a 20 ha wood. Timing of late winter/early spring (February-March) was

recommended for surveys to be undertaken as this is the point at which the impacts of any grazing activity are likely to be most visible.

A key element is the identification of impacts, not direct densities of animals, because there is not necessarily a direct link between the two (Putman 1994). Where there is some impact, but it is not yet approaching the Critical Damage Threshold, the decision as to whether action to limit grazing is required may depend on the objectives for the wood: for some woods and some objectives a higher level of grazing impacts may be sustainable than in others. The process that is envisaged can be summarised as the series of steps in Box 2.

Box 2 Summary of the stages involved		
Stage	**Outcome**	**Comment**
1. Alert that wood may be over-grazed or agency officer visiting wood suspects this.	Initiation of judgement-based survey using indicators described in later sections.	This could be a Defra, FC or English Nature officer on a routine visit or any member of the public.
2. Judgement-based survey carried out by competent officer.	Level of grazing impact Main animal involved.	Defra, FC, English Nature staff would be competent at this level.
3. Discussion with owner and relevant interested parties.	Impact acceptable/ unacceptable in relation to the objectives for the woodland.	The discussion would take account of the particular interest of the wood and circumstances, eg it may have been a temporary emergency measure to put the stock in the wood.
4a. If unacceptable (ie beyond the agreed threshold), proceed to Critical Damage assessment	The desirable outcome is action to reduce the impact; advice and incentives as appropriate would support this.	WGS, English Nature grants, Defra support might all be involved here.
4b. If judgement-based survey identified that livestock main grazing animals.	If Yes, then Critical Damage Survey based on quantitative approach initiated. If No and the site is an SSSI then English Nature could take action under the CROW Act.	If the answer is no and the site is not an SSSI then the owner would be encouraged to take some action, but there would be no compulsion.
6. Critical Damage survey based on quantitative approach carried out.	If overgrazing confirmed then cross-compliance procedures for achieving a sustainable stocking rate are instigated; if not then further discussion with owners may follow and if an SSSI the CROW Act might be used.	This level of survey will need to be done by someone with previous experience since it could end up being contested.

The following provides a protocol for the judgement based survey:

1. Prior to visiting the woodland, identify ten points systematically spaced throughout the woodland on a site map. This can most accurately be achieved by using the

method described in Pepper (1998) which gives a formula for working out distance between sample points based on the area of woodland.

2. Using the site map, pace to the approximate position of the first survey point. If the point falls on ground which is inaccessible, move to the next safe position along the selected transect. Use a brightly coloured temporary marker peg to show the survey point whilst the plot is being assessed.
3. Estimate the boundaries of a notional 50x50 metre quadrat (with the sample point being in the centre).
4. Record the information asked for in the survey form, referring to qualifying notes if there is any uncertainty about the exact meaning of the question. Whilst answering questions, move within the 50x50m plot to assess conditions over the whole area, unless the qualifying notes specifically ask for observation to be made from only the centre point.
5. Once the questions are completed in a plot, pace the distance to the next point and repeat steps 3 and 4 above on a new form.
6. Where appropriate fill in the supplementary feeding form (see Appendix 2)

2.1 Testing the judgement based method – the method assessment survey

Forest Research were commissioned in March 2004, to test the method described above across 50 woodlands in Dartmoor, Exmoor, the Yorkshire Dales and the Lake District. Field work in the South-west was completed in April and in the north, completed in May. Analysis and report writing was undertaken in August and September.

The specification for research required the following elements to be included within this report:

- The extent and issues affecting woodland overgrazing (in terms of overall area, distribution, relative severities and vulnerable woodland types);
- The key indicators that are the best predictors of overgrazing pressures on woodland (in terms of both understorey vegetation quality and woodland regeneration);
- The key indicators that discriminate between differing grazing pressures and woodland management (in terms of both domesticated livestock and wild animal grazing);
- An evaluation of the method in terms of ease of application, problems encountered and possible areas for development (eg did the results fit with the surveyors' personal subjective views as to whether the sites were heavily grazed).

2.1.1 Additional requirements for project surveyors

Whilst completing the survey forms, project surveyors were asked to undertake the following additional tasks:

1. Makes notes on how the survey form may be improved for that particular quadrat.
2. Make notes on observations within the quadrat not covered by the questions in the form.

3. Take a photograph from the sample point which reflects the amount of grazing in that part of the wood.
4. Give a summary rating for each wood based on your personal subjective assessment of the level of overgrazing (see summary assessment below).

2.1.2 Site selection

The following criteria were used to select the 50 project sites:

1. A range of grazing/browsing intensities
2. A range of different grazing animals (sheep, cattle, deer, ponies/horses or goats).
3. A proportion of woodlands stock fenced but not deer fenced, a proportion unfenced.
4. Woodlands in the Cumbria, Exmoor and Dartmoor areas to be predominantly upland oakwoods (National Vegetation Classification W11 or W17). Woodlands in the Yorkshire Dales to be upland mixed ashwoods (NVC W9 or W8e,g).
5. The area of woodland from 3 – 20 hectares.
6. Each site should be, at least in part, ancient semi-natural woodland.
7. One third to one half of the woodlands surveyed should not be under the Forestry Commission's Woodland Grant Scheme.

How well did the woodlands selected match the above criteria?

The majority of woodlands surveyed fit with the above criteria. However, there were some exceptions. The following list describes how closely selection criteria were achieved:

1. Only a small number of woods were grazed at a heavier intensity. We strongly suspect that this sample is not representative as smaller woods (<3ha) are often the ones which experience the most severe impacts from grazing. Additionally, there was limited time available to select sites and the sample is biased towards those woods which had contact details available (hence, more likely to be under some form of management).
2. It was not possible to find woods which were browsed by goats and met other criteria.
3. Fencing requirements were met. In some cases, stock were excluded (or intended to be excluded) by dry stone walls rather than fences.
4. One woodland in Dartmoor was closer to upland mixed ashwood, otherwise all woods in the south-west were upland oakwood (albeit W16 and W10 rather than W17 and W11 in many cases). The search for upland mixed ashwoods was expanded to the north Pennines to include east and north Cumbria.
5. Exceptionally, small sections of larger woodlands were selected where it was felt that conditions were representative of smaller woodlands. However, 68% of woodlands fell into the required area threshold. 84% of woodlands were below 30ha (see figure 1).
6. Each woodland surveyed was, in part, ancient semi-natural woodland.
7. 32% of woods surveyed were under active Woodland Grant Scheme. This rose to 48% if schemes active within the last 10 years were included. Whilst this fell within

the required limits, it may lead to bias in the result in that woods within schemes are less likely to be over-grazed.

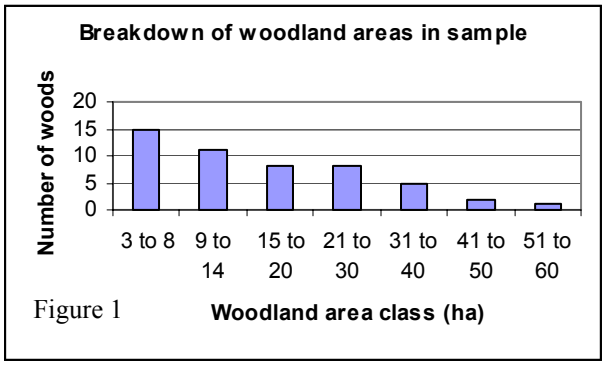


Figure 1

Appendix 3 shows details of sites surveyed.

2.1.3 Summary assessment

The judgement method has been devised to identify a threshold or class of overgrazing for each woodland surveyed. The working group identified two key overgrazing thresholds:

- **When there is concern that continued grazing might, in the long-term cause some key feature of interest to decline.** Heavy grazing is occurring. At present it is not a problem, but it is an issue that will need to be considered in future. The Forestry Commission and other advisors such as English Nature might wish at this stage to approach owners to instigate positive management of the woodland, for example using forestry grants. Action may be needed in the next 10-20 years, but is not necessarily essential in the immediate future.
- **When the grazing pressure is such that it is leading to a decline in the quality of the woodland habitat and is unsustainable**. Action to remedy the situation is likely to be needed within five years or less if the decline in condition is to be halted. This has been referred to as the *Critical Damage Threshold.* We envisage this as the point at which Defra might consider that cross-compliance procedures should be implemented.

The assessment survey method was developed to include four classes of grazing impact. Under the classification below, class C is broadly equivalent to the first threshold above, and D is equivalent to the second threshold. This classification has been expanded in section 5 to include a B/C class. In that classification (see Table 4), class B/C is roughly equivalent to the first class above and C & D are roughly equivalent to the second class.

A	Grazing / browsing is not causing any problems within this woodland.
B	One or two features (eg tree regeneration, ground flora) are showing impact from grazing and/ or browsing. If continued at the present level, this may be unsustainable for the woodland in the long-term.
C	Several features are in decline as a result of grazing and / or browsing but there is not a short-term risk of loss of woodland cover. Grazing or browsing at this level would be unsustainable in the medium-term (ie *c* 20 years). (For some wood-pasture sites this may be an appropriate level of grazing for much of the time.)
D	The woodland habitat is under serious threat from this level of grazing /browsing pressure and such management is unsustainable in the short-term (ie <10 years).

Project surveyors were asked to ascribe one of these classes for each woodland assessed. In practice, this was achieved by reviewing the information collected during the survey but also by discussing the site with the owner, manager or agency contact (eg National Park or Forestry Commission Woodland Officer). Classes A-D have formed the framework for analysis of data collected in the method assessment. Their development is discussed in section 5.

2.2 Quality assurance

Six members of Forest Research's Technical Services team (TS) were employed to carry out the method assessment. All project surveyors are Leading Research Workers and are experienced in the collection of data from designed experiments, and increasingly, from one off field surveys. They have a basic level of botanical knowledge typically to the genus level and to the species level for more common woodland plants. TS research workers are used to collection of data associated with woodland structure and tree health but are less experienced in the recognition of agricultural impacts.

To enable project surveyors to undertake the method assessment, a training course was provided by researchers. Two teams were set up (one in the south-west and one in the north) and a one day course was held in each area. The aim of training was to discuss and clarify the exact meaning of each question and to show examples of features such as browse lines, characteristics of damage caused by x herbivore species. Suggestions were made on each day about how the form could be improved to clarify the meaning of questions and to cope with conditions encountered which were not catered for on the original form.

After each team had completed surveys in a number of woods, a quality assurance exercise was conducted on all project surveyors to assess consistency of results. Method and findings from this task are included in Appendix 4.

2.2.1 QA results summary

As the QA exercise was carried out in three woods and by separate teams, any inference from the results should be made with great care. It is not possible to state whether certain questions were more likely to be misinterpreted or that certain teams were 'better' than others as the three woods were simply chosen to be representative of the population as a whole, and not necessarily that similar. However a simple statistic was obtained. The percentage similarity in response between team members at each wood was averaged over all the questions. For wood 1, surveyors 1 and 2 scored 84% similarity, surveyors 1 and 3 85% and surveyors 2 and 3 78%. In wood 2, surveyors 4 and 5 scored 64% and in wood 3 the similarity score of surveyors 6 and 7 was 81%. These scores indicate a broad level of consistency in plot assessment. The scores for wood 2 are a little low although still showing a significant correlation.

The following issues are identified from this exercise:

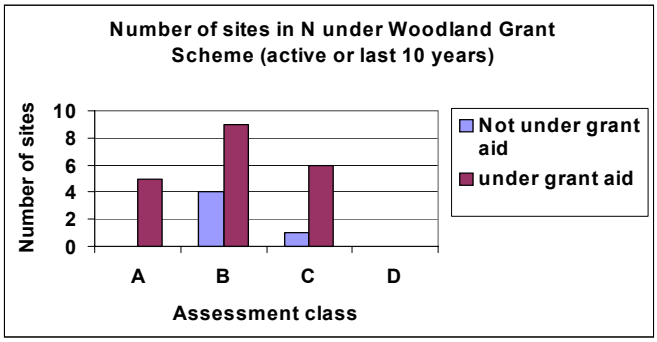
1. More time needs to be spent looking for seedlings and saplings. This is evident largely due to the different species picked up rather than large inconsistencies in the overall answer.
2. More training is needed to identify the browse line and the question (4) needs to be worded more clearly to avoid the confusion over the use of No or Null.

3. Questions on ground flora (7 & 8) need to be clearer and the number of questions need to be reduced.

4. Question 9b on watercourses needs to be changed to make it clear that this should be answered yes where there is >20% animal disturbance to the bank sides of watercourses.

5. More time needs to be spent looking for signs of animals and more input is required on training courses to point out characteristics of each herbivore species.

3. The extent and issues affecting overgrazing in the sampled woodlands



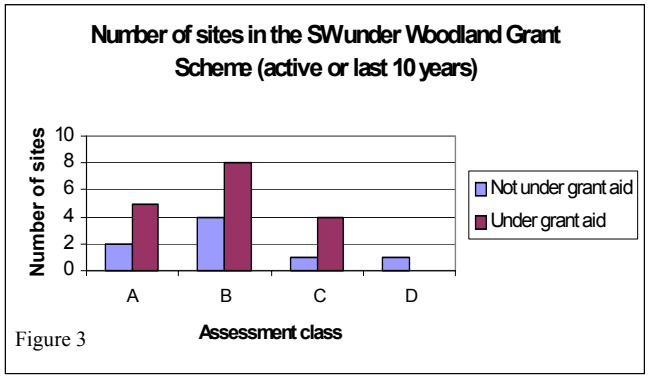


Figure 3

Overall, only 13 sites (ie 26%) were not under some form of grant aid (WGS, ESA or stewardship), or influenced by grant aid in the last 10 years (see Figures 1&2). To some extent, this reflects the amount of native woodlands activity within national parks by government agencies. We suggest that a lower percentage of upland native woodlands outwith national parks are likely to be grant aided. The low number of non-grant aided sites is also likely to be due to the short time available to search for sites and contact owners: those sites with known condition of grazing and contact details were more likely to be under some form of management. The results are therefore likely to be biased towards the less over-grazed sites and cannot be considered to be representative of all English upland oak and upland mixed ashwoods.

Figures 2 and 3 show the assessment classes for the sites under Woodland Grant Scheme (only 2 of the grant aided sites were no longer under active schemes and these were categorised A and B respectively).

Figures 4 and 5 show the proportion of sites in SSSI. 64% of sites in the north and 40% of sites in the south-west are SSSI. Of the woodlands surveyed, there was a bigger difference between SSSI and non-SSSI grazing levels in the north than in the south-west. 64% of sites in the north and 44% of sites in the south-west were in Environmentally Sensitive Area or Countryside Stewardship schemes (see Figures 6 and 7).

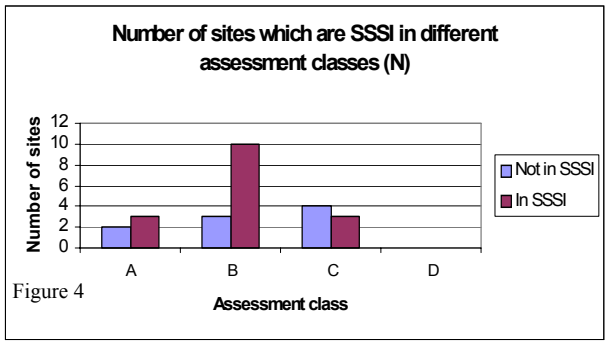


Figure 4

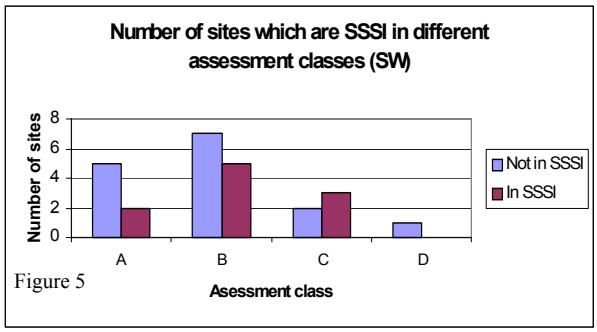


Figure 5

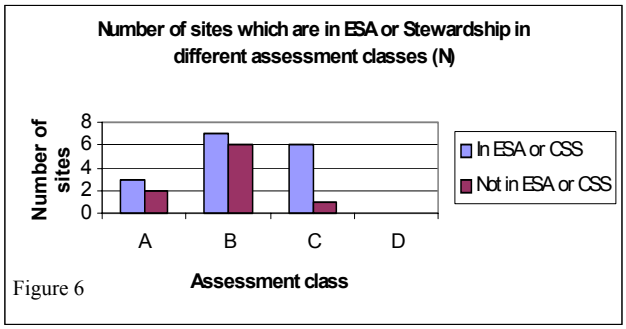


Figure 6

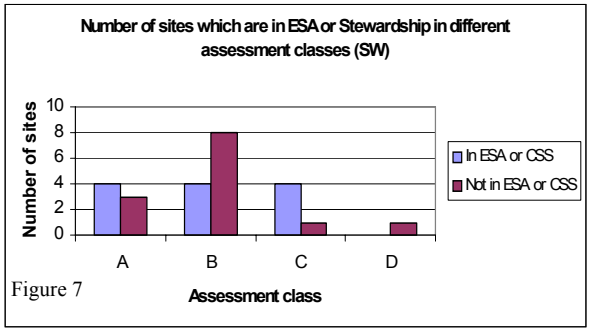


Figure 7

Figures 8 to 11 show the dominant animals in woods in the four areas (data have been added in two woods to include contractor's personal observations where signs have not been picked up by surveyors). It can be seen that there are clear differences between the dominant species in each area with rabbit, sheep and roe deer predominating in the Yorkshire Dales, sheep, roe and red deer in the Lake District, red deer, sheep and ponies on Exmoor and a wide range on Dartmoor including sheep, cattle, roe deer and ponies.

Figure 12 shows the mean number of plots per wood which included evidence of each herbivore species. The number of plots out of ten in each wood which showed signs that a species of herbivore was present in that part of the wood was averaged for all woods within a region. In the Yorkshire Dales 4.8 plots per wood showed signs of sheep, rabbits and roe deer. On Dartmoor, there was a moderate frequency of signs of most animals encountered with sheep predominating (a mean of 4.6 plots). There were frequent signs of sheep in the Lake District (a mean of 7.6 plots / wood) and signs of red deer in a mean of 5.3 plots/wood on Exmoor.

Supplementary feeding was only recorded in three woods (all on Dartmoor). Two of these woods were given an overall assessment of B and the third was classed as C.

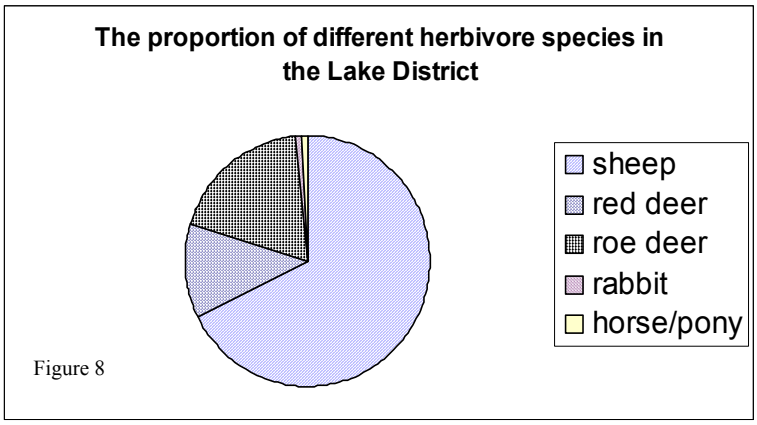


Figure 8

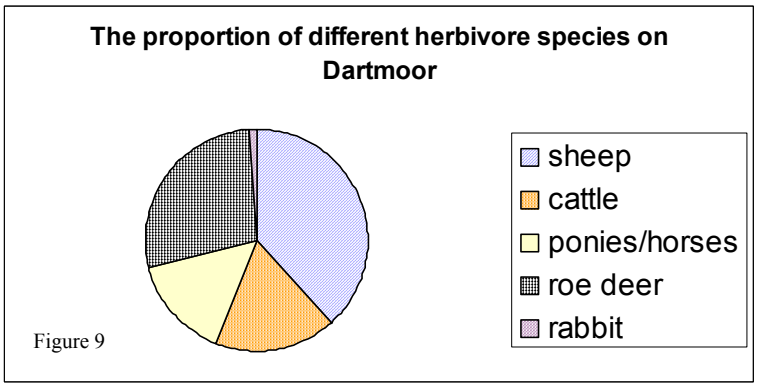


Figure 9

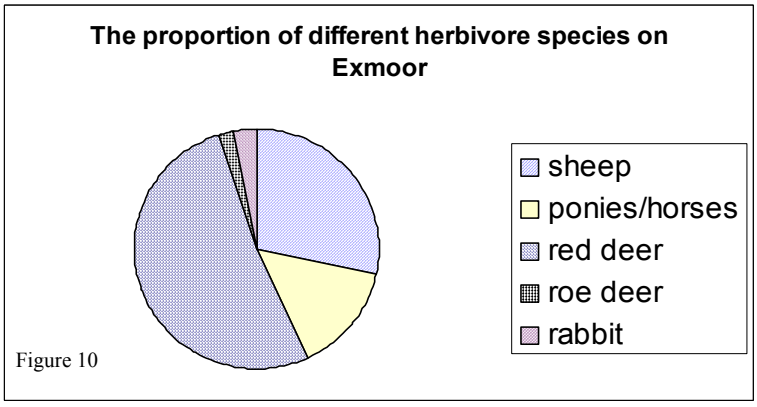


Figure 10

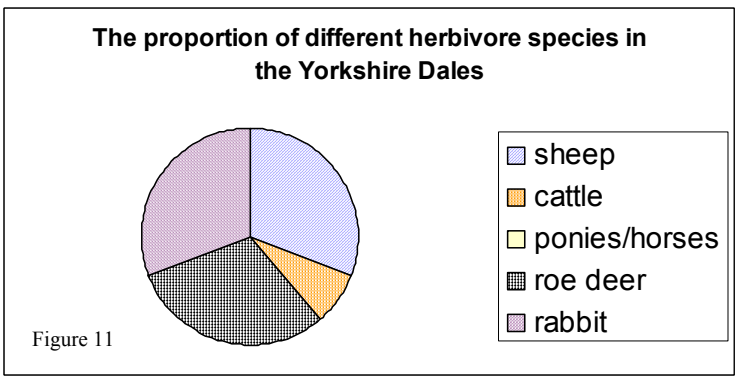


Figure 11

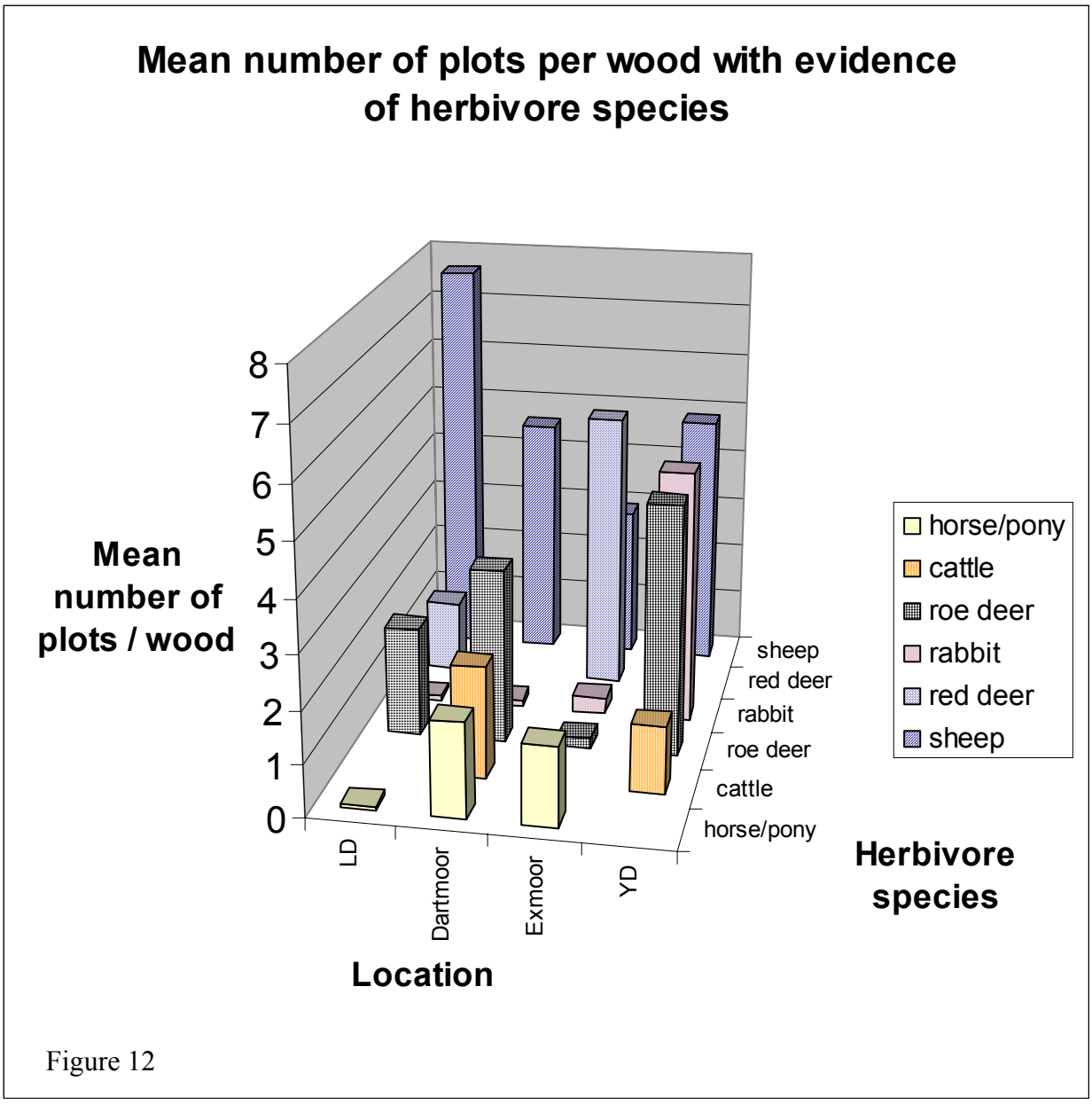


Figure 12

Figure 13 shows the relative proportion of each woodland type in assessment classes. This indicates that upland mixed ashwoods within the sample are in slightly poorer condition than upland oakwoods.

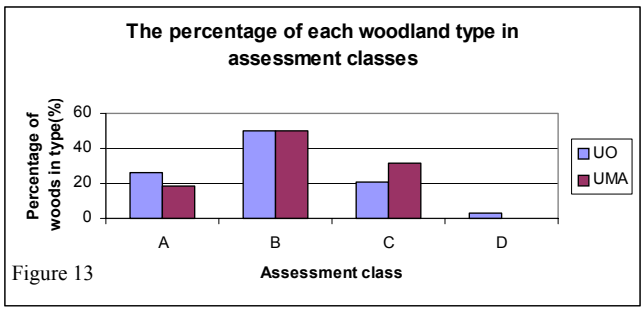


Figure 13

4. Evaluation of the method

4.1 Initial changes to the survey form

The original form included in the contract is shown in Appendix 1. Several modifications were made to this in agreement with members of the steering group and the version used in the method assessment is shown in Appendix 5. The following provides a rationale for changes.

Number refers to the question on the original form, (numbers in brackets refer to order in the pilot form)
- refers to changes made
- ➢ refers to recommendations/ observations

2. (3) Are young trees only very rare or absent below canopy gaps?

- We included two more lines for seedlings/saplings under the canopy as there may be some of these and no canopy gaps in the plot. Alternatively, there may be seedlings as advanced regeneration under the canopy but gaps might be full of bracken.
- We have also included a line to highlight where tree seedlings are restricted to niches.
- ➢ Results indicated that it would be better to ask for presence of seedlings <30cm and seedlings/saplings 30cm – 2m (regardless of canopy cover) which are accessible to browsing animals. In the growing season, it is important to exclude first year seedlings which normally get browsed off before the end of the first winter. These can be recognised (for epigeal germination) by cotyledons and by the lack of a woody lower stem.

3. Is the understorey sparse or absent?

- We included a cover class where the understorey is >10% to cover situations where there may be an open fragmented canopy but a very dense understorey (as in several woods in east of Cumbria). In woods in Exmoor and Dartmoor, there may be a full overstorey but also a dense understorey of holly.
- ➢ It is important to record this where there is a particularly dense cover as light levels may be very low and opportunities for regeneration significantly reduced (ie only holly and ash seedlings that don't get bigger than *c* 2-3cm)

4. Is there a distinct browse line on established trees and shrubs?

- ➢ We added 'put null if understorey is sparse or absent'. This is a useful indicator where it occurs but the absence of one doesn't necessarily indicate low browsing pressure. A *No* answer is more powerful in this case.

5. Is there obvious browsing damage to young trees or shrubs <2.0 m height?

- We have inserted 'that are' <2m in height - to make it obvious that we are talking about tree/shrub height rather than where the damage is.

Previous years' growth

- We changed these to previous year's growth and older growth as these were more appropriate at the start of the growing season.

6. Is there obvious damage (< 2m height) to established trees ?

- Surveyors found this question confusing so we changed it to: 'On trees and shrubs >1.5m tall, is there obvious damage to bark or are stems broken?' We also asked surveyors to state when they thought that damage might be due to squirrels.

7. Is the ground vegetation heavily grazed?

- We made several changes to question 7, mainly due to the onset of the growing season. We felt that a question was needed on the percentage of the plot covered in ground vegetation to cover the scenario where there are only a few stems of vegetation due to factors other than or including animal disturbance (eg a dense canopy of beech or sycamore, rock outcrops/scree). This would then allow for interpretation when there are only a few stems of vegetation but they have all been grazed.

- We asked if there are current signs of heavy grazing (>25% of field layer stems grazed and frequent fresh droppings). We did this to highlight where there is particularly high pressure.

- We then asked about vegetation height (using 5cm from the original question) to gauge the next level of severity, referring to the species which will be recorded lower down to see if they are grass and moss or herbs.

- We asked about the height of last years grass leaf stems to indicate what the pressure was at the end of the previous growing season.

➢ Despite these changes, it was very difficult to pick up the grazing level over the year where there was a new flush of grass and grazing animals hadn't had the chance to make any inroads into it. In other cases, there was no stock in the wood which appeared to be sheep grazed and stock may have been absent due to lambing in inbye fields. Looking at sites in mid June may have been easier than looking at them in early May.

➢ In heavily grazed sites, it *is* possible to have a sward with a modal height less than 5cm in the growing season (June). The percentage of grazed stems proved to be unreliable as even in heavily grazed sites it was often less than 25% of stems grazed. For sheep, frequency of droppings appeared to be a more reliable indicator (where they are *c* <3m apart, although it is understood that use of medicinal insecticides can affect the distribution of droppings so this may not be reliable in all cases).

➢ Last year's grass stems. This may be a useful confirming indicator where they are present in the early spring but it isn't reliable later. May be useful for deciduous species such as *Molinia* in the winter.

8. a. Are sensitive species present?

- We changed this to 'If grazing-sensitive species are present, are they being heavily grazed?' If there were no species present, a null score would be recorded. This change allowed a score of Yes to still have implications of grazing/browsing pressure whereas the original question format worked against the scoring system which normally uses yes to equal grazing impact.

- We added raspberry to the list

➢ In most cases, any sign of grazing/browsing sensitive species was generally a positive thing, particularly in a sheep grazed sward.

➢ The complete absence of grazing sensitive species is likely to be very significant. However, it is not possible to say conclusively that these species are absent because of browsing or grazing. It has therefore not been possible to use the absence of grazing sensitive species as an indicator.

➢ If question 8a was answered 'No' this showed that grazing/browsing pressure was having little impact , if the species concerned were not restricted to niches.

➢ If this survey is to be carried out in the spring/summer, it will need to be modified as some grazing sensitive species (eg bilberry) are not grazed in the spring if there is plenty of grass (E. Nugent – personal communication).

9. Are there obvious signs of animal disturbance in sample area?
Is damage associated with water course?

- We added the damage to water course question as we felt that if stock were causing streamside erosion this would further indicate negative impacts.

10. Identify herbivore species – no change

11 We put a question in here about the health of trees within the plot so that it would be possible to gauge the likelihood of the canopy becoming more fragmented and the need for tree regeneration to retain woodland cover.

➢ It should be possible to establish a lower threshold to simplify the question (eg 'are greater than 30% of trees in poor health?').

4.2 Post survey questionnaire

Surveyors were asked for their opinions about how they found the method. The following summarises their observations and views:

- The average site took 4 hours to complete (not including travelling time).

- Most of the questions were clear and unambiguous. However, as some have been constructed as negative rather than positive questions, the answers sometimes needed more consideration (for example, in question 3, it is easy to write 'No' where there are

no seedling or saplings. Despite completing several woods using this method, it is still necessary to check some of the questions occasionally to reaffirm the precise meaning.

- The option to use 'Null' caused considerable confusion. It would have been better to use 'Not Applicable' and to design the form so that this is used as little as possible.

- Most of the tasks were considered to be straight forward but locating seedlings was difficult in some circumstances (particularly in upland mixed ashwoods during the growing season).

- Most surveyors said that it was easier to do the work as an individual rather than as a team of two although on steep rough sites, it was safer to work in teams of two.

- Most questions were easy to find answers for. In some cases though, site conditions may have been due to a combination of factors and it was difficult to say which (eg the reason for unvegetated ground).

- It was sometimes difficult to identify which animal was responsible for grazing/browsing. This usually became evident before completing the wood but it was hard to judge when there were several species present. The surveyors felt that more training would have been useful.

- The table for animal damage was generally considered to be useful. The only suggestion for improvement is to look at the height of the browse line (in this survey, a very high line indicated red deer, we suggest that this would be similar for horses).

- For the final subjective assessment (ie A, B, C or D), it was usually straightforward to decide which category to select. However, in some cases, the conditions varied substantially within a single wood and some thought was needed to reach a balanced assessment.

- On some sites it was difficult to distinguish between B and C. The majority of surveyors thought that four categories were sufficient. However, one thought that a B/C category would have been useful. There was support for a decision tree to help determine which category to select.

- All surveyors thought that the survey had been undertaken too late in the year. Early April is the latest recommended time in the north. The intended period of February to March would be more appropriate in the south-west.

- The method became physically difficult to undertake on very steep slopes and where there was extensive cattle poaching.

- The layout of the form made it difficult to use on very wet days, even when using a 'weather writer' clip board.

- In smaller woods, fewer plots were recommended unless there was a lot of variation in habitat type and grazing intensity.

- There was insufficient space on the form to write (eg the area for ground flora on question 7).

4.3 Overall site assessment

Figure 14 shows the comparison between regions and assessors for the overall site assessment. The most consistent trend is for B to be the most frequently selected rating. However, the surveyor's ratings for Dartmoor showed C to be more frequent and the surveyor's ratings for the Yorkshire Dales were heavily skewed towards A (>70% of sites).

An independent rating of sites was undertaken by staff from the Northern Research Station (NRS), in many cases by carrying out assessments in the field but where this was not done, by reviewing field sheets, notes and photographs. In the majority of cases, there was a strong similarity between the surveyor assessments and NRS assessments. Only in the Yorkshire Dales did this differ significantly (see Figure 15).

As the NRS assessment for the Yorkshire Dales showed a similar distribution between classes to that of other areas, it was decided to use this for analysis.

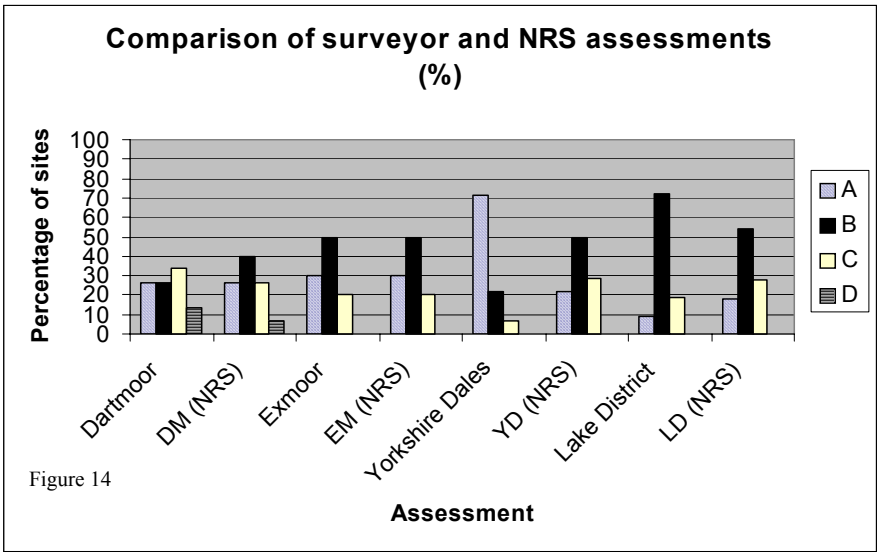


Figure 14

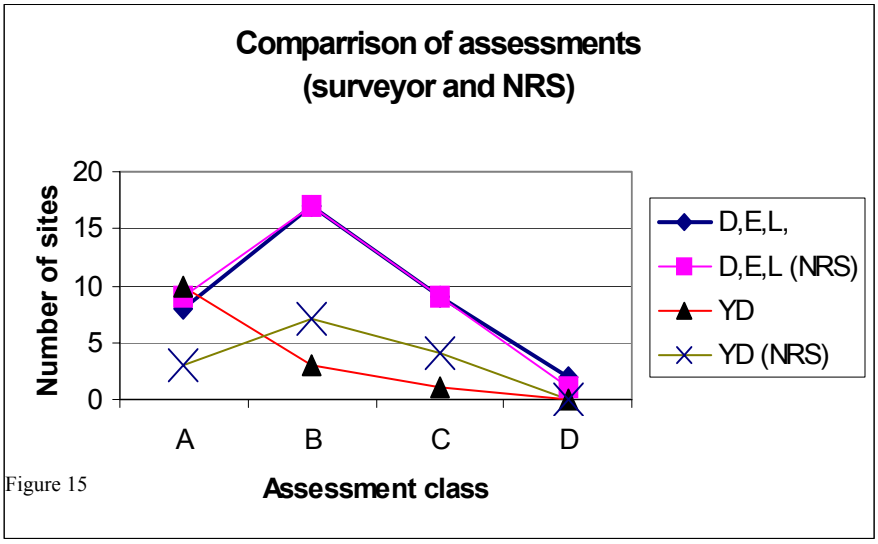


Figure 15

4.4 Timing of the method assessment survey

The working group recommended that the judgement based survey should be carried out in February or March. Unfortunately, due to the timing of the contract for this study, field work was not carried out until April - May. As identified above, this created a number of problems, particularly to do with changes in ground flora as the growing season began. However, it also raised a number of opportunities, allowing certain features to be observed that would not be visible at the end of the winter. Advantages and disadvantages of surveying in the two periods are presented below together with recommendations on timing for future surveys. A fuller account of the consequences of surveying at different times of year is presented in the discussion.

Spring survey – advantages

- A wider potential range of grazing sensitive species (including vernal dominants) is evident.
- Recovery of vegetation from winter shelter can be seen.
- It is possible to see if plants are able to flower.
- It is easier to see if somewhere is being heavily grazed as pressure has to be fairly intense in the spring to create a sward that is less than 5cm.
- Tree seedlings in leaf are easier to see in grassy swards.
- It is easier to see a browse line on deciduous species.

Spring survey – disadvantages

- Stock may be absent because of lambing or because there is better forage in adjacent fields.
- It is difficult to see seedlings in a sward dominated by vernal dominant herbs such as meadow sweet and wood avens.
- It appears to take a while for stock to have an impact on a new flush of grass at the beginning of the growing season.
- It is easy to mistake annual regrowth for the beginning of successful establishment (the converse is also possible).
- Towards the end of the spring, seedlings <1 year old become less easy to identify (these were not recorded in the survey as there is a high mortality rate in the first year – Miles and Kinnaird 1979).

Winter survey – advantages

- Stock are present if the wood is used for shelter.
- Seedlings are not obscured by vegetation and are browsed back in winter.
- Browsing sensitive species (eg wood rush and bilberry), basal shoots and seedlings are browsed back in winter.

- The full extent and impact of poaching can be seen easily.
- The cumulative impact of grazing and browsing throughout the year can be assessed.

Winter survey – disadvantages

- It is not easy to assess the site's capacity to recover in the growing season.
- Seedlings are not easy to see when they are not in leaf.

Recommendations

- Carry out the main survey in the winter (February to March) and follow up any potential C/D woods in the spring to see if features show signs of recovery.

If spring/summer surveying is the only option, a number of additional observations need to be made:

- Are seedlings > one year old (presence of woody stem above rootstock not new growth from woody rootstock)?
- Are epicormic and basal shoots > one year old?
- Is the ground poached below the field layer?
- Are grazing sensitive species vernal dominants only?
- Is the growth of grazing sensitive species (eg bilberry) > one year old (presence of woody stem)?

4.5 Application of the method to wood pasture

The method was developed for grazed woodland. Its applicability to wood-pasture needs to allow for the fact that desirable attributes of wood pasture include an open canopy, a grassland flora, and invertebrates such as meadow ants or detritivore species which feed on animal dung. One of the woodlands surveyed is considered to be a good example of upland wood pasture containing many notable veteran trees and a variety of habitats. It is known to be important for bryophytes, lichens and black grouse. The judgement method gave this site an overall rating of C as there was an open canopy, little regeneration, a short grass sward and bare ground caused by poaching. The need for tree regeneration is recognised by the managers of this wood although, if mechanisms exist, there is a preference for managed grazing by a low stocking of cattle to achieve this without compromising desirable features associated with the pasture.

4.6 Training needs

Having assessed the method and surveyors interpretations of questions together with their comments on the methodology, future training needs have been identified:

- A range of woodland types should be visited on any course and each site should include at least one effective exclosure which demonstrates the potential for ground

flora and tree regeneration development in the absence of grazing (or if only stock fenced, lack of domestic stock where deer still have access).

- The training course should comprise: a half day inside given by two to three presenters on woodland dynamics, grazing impacts and recognition of features (eg browse line, bark stripping by x species) and characteristics of historically managed wood-pasture; the first afternoon in the field discussing issues raised in the morning and getting delegates views (visiting two contrasting sites). The second day should involve small teams carrying out a survey in a wood contrasting with those visited on the first day, followed by a joint evaluation and discussion. Over the two days, woods in categories A, B, C and D should be visited or illustrated and examples of all features to be observed should be available for discussion including signs of a number of different grazing/browsing animals. It is recognised that there are fundamental problems in trying to identify which species of animal is responsible for most forms of damage. However, the characteristics identified in Appendix 6 should provide a basis for this aspect of the training.

Summary

Time	Venue	Subject	Notes
Day one AM	Indoors	Talks on woodland dynamics, grazing impacts and recognition of features (eg browse line, bark stripping by x species) and characteristics of wood-pastures	Given by 2-3 presenters from FC/EN/RDS
PM	2 contrasting sites with exclosures	General discussion of method, delegates views and identifying details discussed in morning	Sites should be A and C or D
Day two AM	One site with range of features and marginal grazing pressure	Exercise in field in small groups	Site should contrast with those of the previous day
PM	Indoors	Sum up, evaluation from trainers and from delegates. Slot for officers from contrasting regions to raise issues not covered over the two days.	Examples of a B site not seen on the course

5. Development of the method

This section re-evaluates criteria used in the method assessment survey, uses statistical and 'expert' techniques to analyse the data and formulate models for future analysis. New survey forms have been devised, with a rationale presented for the selection of recommended criteria.

5.1 Key indicators to predict grazing pressure

As identified in section 1 there are a number of factors which affect vegetation and woodland structure apart from grazing and browsing. Therefore, a number of criteria in the judgement-

based method cannot be used in isolation without some assessment of the site conditions and how these may affect potential for tree regeneration and vegetation development. The list below identifies key variables to sift grazing and browsing from other factors (some of the following variables may indicate higher levels of grazing impact than others):

- Browse line. This is a useful variable where there is sufficient vegetation in the understorey to allow a browse line to develop.
- Recent browsing on seedlings and saplings.
- Recent animal damage to overstorey trees.
- Browsing on sensitive species where these are present.
- Animal disturbance.

All other variables addressed in the judgement method are considered to be influenced by current or past management or site characteristics and their use requires some clarification to ensure that grazing is the primary cause of observations.

The following sections review the criteria used in the method assessment survey and assess their use in future surveys.

5.1.1 The overstorey

The overstorey is an artefact of past management. Recording its condition does not in itself indicate the current level of grazing pressure. Its condition should, however, be considered as there is a lot more urgency to control grazing impacts in a woodland with a very open canopy and a number of other negative characteristics compared to a wood with an intact canopy and a closely grazed sward, few seedlings.

5.1.2 The value of the understorey as an indicator

The value of the understorey as an indicator is open to question as, in a similar way to the overstorey, it is an artefact of past management rather than an indicator of current grazing/browsing pressure. Whilst it is recognised that the understorey provides an important element of the woodland ecosystem, unlike the overstorey, it does not provide clear indication about the future long-term sustainability of a wood.

An understorey is useful in providing evidence of a browse line and, where it covers much of the site, it is useful in indicating where there may be insufficient light levels for sapling and ground flora development. However, in many cases the understorey has all but disappeared (eg ex coppice upland oakwoods) and a range of grazing regimes may exist in a woodland with such a simple structure (eg from very intensive grazing to woodland which has been effectively fenced for >5 years).

Results from the survey suggest that basal shoots should not be included in the same question as the understorey as basal shoots on their own can be very useful indicators of the current regime but it is difficult for them to cover more than 10% of the area in the short term. As with bilberry, in the growing season, it would be necessary to assess whether there are basal shoots with woody growth from the previous growing season as new growth may be unbrowsed in the spring and early summer (particularly in unpalatable species such as alder).

Basal shoots have been grouped with epicormic shoots in the recommended version of the form (see section 5.2).

The browse line does appear to be a useful indicator where there is sufficient vegetation in the shrub layer for it to be identified. In one wood, this became increasingly obvious as an area used for supplementary feeding was approached. However, on the method assessment version of the form, the lack of a browsing line does not indicate low browsing pressure unless there is a clear split when choosing between 'Null' (no understorey to see a line on) and *No* which should indicate that there is sufficient vegetation at the appropriate height but insufficient browsing pressure to result in a zone of depleted vegetation. The question in the method assessment form is ambiguous and there was a tendency to think "question 4 is about the browse line, can't see one so I'll answer 'No' ", despite the small print advising on the use of 'Null'.

5.1.3 Ground flora

The condition of ground flora is a useful indicator of grazing pressure as long as consideration is given to factors other than grazing which may lead to low growth and poor coverage of the site (ie a dense canopy (eg beech trees, holly understorey) unstable scree or boulders). The easiest question to evaluate on the method assessment form is: 'Is the typical (most frequently occurring) height of ground vegetation 5cm or less?' The implications of a 'Yes' answer to this would have been clearer if the species had been restricted to predominantly grass and moss.

The sward in sheep grazed areas is generally very tight (as in a frequently mown lawn). There is a tendency for grass and moss to predominate although, in upland mixed ashwoods, herbs of a range of species survive under moderate grazing pressure (eg meadowsweet, wood cranesbill, water avens and wood avens) usually short in stature and without flowering (a notable exception being pignut).

In areas used to shelter stock in the winter and ungrazed in the growing season, vernal dominants appear almost unaffected unless the ground is heavily poached causing the seed bank of ruderal species (eg dock, buttercup and thistle) to out-compete woodland herbs.

The question 'Are there current signs of heavy grazing' in the method assessment version of the form asks for signs of animal droppings as well as percentage of grazed stems. The presence of animal droppings is not considered to be a reliable indicator (H. Armstrong, pers. comm.) as droppings decay at different rates and may have been deposited by a large number of animals being driven through the wood or by a smaller number, present for a longer period.

5.1.4 Grazing sensitive species

The only species added in the survey to those in original list provided by the working group, was raspberry as this was obviously restricted to crevices in several of the woods observed in the initial stages of the pilot exercise. However, three other species are recommended for inclusion when surveys are carried out in the growing season. These are valerian *Valeriana officinalis*, angelica *Angelica sylvestris* and wood cranesbill *Geranium sylvaticum*. There are several other species which could have been included, however, there is a lot of uncertainty about the reliability of grazing sensitive species and even the species included should be used

with caution. We considered broadening question 8 to include assessing whether any species of vascular plant is restricted to unreachable crevices. However, this wasn't adopted as such crevices can provide edaphic conditions which are restricted elsewhere within the plot (eg base rich groundwater associated with rock outcrops). Additionally, only a small proportion of plots actually contained such micro-sites.

The presence of grazing sensitive species needs to be treated with caution in the growing season. Some species show impacts from browsing throughout the year (eg greater woodrush) although other species such as bilberry only appear to be grazed when there is little alternative vegetation (ie grass) (pers. comm. E. Nugent). Suggestions for dealing with this are given below. Additionally, as discussed, if a woodland is being used to shelter stock in the winter and is only lightly grazed/browsed in the growing season, sensitive vernal dominant species may show few signs of impact. This is unlikely to be the case for species that persist above ground through the winter.

5.1.5 Seedlings and saplings

The absence of seedlings or saplings does not necessarily indicate that a woodland is being grazed (see section 1). In the winter, their presence is a positive indication that grazing pressure is not significant, particularly where they are not being heavily browsed. In the summer, presence of seedlings can be misleading as they often survive in moderately grazed swards as new growth from old root stocks or newly germinated seedlings which either succumb due to climatic stress over the winter or are browsed back before the next growing season. Any saplings observed in the growing season above sward height are, however, a good indication that herbivore impacts are low.

5.1.6 Damage to trees>1.5m tall

This is a useful indicator and the only misinterpretation possible is where damage is the result of grey squirrel activity. Damage may be very patchily distributed and it is likely to be more significant in smaller, more isolated woodlands. Particular tree species may be targeted (eg red deer stripping bark off rowan, fell ponies stripping ash) or size classes of stem (eg smaller coppice/sapling stems selected by roe deer for fraying).

5.1.7 Ground disturbance caused by animals

If woodlands are used to shelter livestock in the winter, and the site is surveyed in the winter, the resulting ground disturbance typically appears to be having a severe long-term impact on the site. The actual impact depends on the grazing management of that area throughout the rest of the year.

Damage to watercourse banks can be restricted to a small proportion of a woodland (eg where cattle access a stream to drink). Nevertheless, this type of damage is a good indication of the sustainability of a grazing regime when the effect is balanced out over the whole woodland (ie if it only occurs in one or two plots, it should not influence the overall assessment - see Appendix 11 for thresholds). The effect of diffuse pollution is not considered here, only the effect of poaching and subsequent bank-side erosion.

5.1.8 Tree health

Whilst this gives us some indication of the longevity of woodland cover in the absence of regeneration, any tree health assessment is very subjective unless the surveyor is very experienced and given specific training (ie by forest pathologists). It was therefore decided to exclude this question.

5.2 Rationale for the selection of questions and wording on the recommended survey forms

Appendices 7 & 8 show recommended survey forms, notes for February – March surveying and notes for growing season surveying.

The new approach asks a mixture of positive and negative questions where only 'Yes' answers are of interest. Some questions will not be applicable in all cases (indeed, in one case, two questions are mutually exclusive). Each question is specific and reference will need to be made to accompanying notes on a regular basis to clarify exactly what is being asked. Although it may take a little more time and training to understand exactly what information is required, both questions and answers should be less ambiguous, providing good quality data and allowing an overall assessment to be reached successfully.

The following provides a rationale for changes made (new question number refers to the recommended forms, old question number refers to that in the method assessment form):

New question	Reason for change
1 (old 1)	We have added potential canopy trees as one of the sample woodlands had an open canopy but frequent birch trees (>2m) in the understorey. Simply recording an open canopy in this case would have given an overly pessimistic view of the long-term sustainability of this woodland. This situation has arisen in several woodlands visited following the survey.
2 (old 4)	As discussed previously, a stand with an obvious browse line may be subject to similar levels of grazing as a stand with no understorey and therefore, less possibility of seeing a browse line. The 'expert' decision tree (p.30) has therefore been designed to avoid increasing the probability of assessing the wood as being overgrazed where insufficient vegetation exists to see a browse line. Where the shrub layer is missing, evidence of a browse line may still be observable but closer examination of individual trees may be required. This question now includes three elements: A. identify whether there is the possibility of seeing a browse line (ie where there are epicormic and/or basal shoots and/or a shrub layer). B. identify where there are no signs of browsing, with branches well within reach of browsing animals– a very clear sign that there is low pressure, and C. identify where there is an obvious browse line, visible either at the plot scale (where a clear line can be seen on a shrub layer) or at a tree scale where there is an absence of a shrub layer and closer inspection of epicormic and basal shoots is required. These specific questions should avoid ambiguous answers.
3 (old 3)	We have removed the canopy and gap categories as analysis of data showed that there were no significant differences between the classes. In the growing season version, we have restricted seedlings and saplings to one class as seedlings at or below sward height are frequently encountered at this time of year and are typically either less than one year old or annual regrowth from winter browsed root stocks. To reduce the number of questions and make analysis easier, this question is only answered YES where seedlings/saplings are within the reach of herbivores. We have made this a positive question so that presence of seedlings/saplings shows clearly that the level of

New question	Reason for change
	grazing is not heavy. In the original version, the absence of seedlings could have been due to a range of factors including management and site characteristics not directly attributable to grazing.
4 (old 5)	This question only asks about browsing within the last year as older browsing damage may not reflect the current grazing regime. A YES answer applies where seedlings are frequent or rare (ie whether you have answered YES or NO in question 3).
5 (old 6)	We have restricted this to recent damage as older damage may not reflect the current grazing regime.
6 (old 7)	This question aims to identify a heavily grazed sward, hence the qualifying notes about scree/boulders or dense canopy cover. The implication for the summer is higher as it is still possible to get a sward <5cm at this time of year but the intensity of grazing has to be much greater. Other questions about ground flora put into the method assessment survey form were not included here as there were difficulties when interpreting the meaning of the question, and answers were too subjective.
7 (old 8)	This question now includes two elements. A. are there frequent grazing sensitive species accessible to grazing and B. are they being heavily grazed. The 'expert' decision tree has been designed to avoid increasing the probability of assessing the wood as being overgrazed where there are no grazing sensitive species or they are present but restricted to crevices. The question can be ignored if this is the case. As is the case with the browse line and saplings, unbrowsed or lightly browsed sensitive species are a very positive indication of low grazing pressure. In the growing season version of the form, we have included three vernal dominants and emphasised that species which are present throughout the year should show woody growth from the previous growing season. This avoids misinterpreting this season's growth which may be browsed back during the winter.
8 (old 9)	We have amalgamated the questions about general poaching and poaching/erosion of watercourse banks as the version in the method assessment survey caused confusion. We have worked on the basis that damage to streamside banks is more serious than general poaching. Where appropriate therefore, the 20% threshold applies to the watercourse margins rather than the whole plot.
9	This question aims to identify where there are site factors which may be limiting the prospects for vegetation development or tree regeneration. The three elements included are dense canopy (ie where there is insufficient light for seedling establishment), boulders (ie where there is a lack of soil – the Lake District includes some examples of this but they are unlikely to occur over many plots otherwise the 20% canopy threshold required to define the site as woodland is unlikely to be achievable) unstable scree (the comment for boulders applies) or dense stands of bracken (conceivably, other species could provide similar vegetation competition although bracken is the typical one likely to be encountered in upland woods).
10	In the growing season version, we have added a question to identify cattle poaching in the winter, followed by stock exclusion in the spring/summer. Two woods have been observed where this has taken place and similar conditions resulted.

5.3 Statistical analysis of data from the method assessment survey

Statistical methods have been used in an attempt to identify key set of variables that can be used to accurately estimate the overgrazing state of a woodland. The following analysis uses questions from the method assessment survey. Models have been recalculated to work with the recommended version of the form (February – March) and these are presented in Appendices 9 &10. Note that the analysis used 5 assessment classes (including B/C - see Table 4). Three methods of analysis were chosen. Appendix 12 (p. 85) provides a worked

example which includes the demonstration of Ordinal Logistic Regression and the Classification Tree

Question numbers discussed in this section refer to the method assessment version of the form. Question numbers in Appendix 12 refer to the recommended February – March version.

5.3.1 Ordination analyses

a) Survey questions

As there were large numbers of survey questions, there was a distinct possibility that some of them would either be highly correlated, and hence redundant, or have little or no influence on the observed grazing class. Principal component analysis (PCA) was used to identify such questions. Results of the biplot that accounted for 40% of the total variation are given in Figure 17. This figure clearly shows a gradient on the x-axis from unsustainable to acceptable grazing classes whilst the y-axis separates the northern and southern sites. It also shows the high level of correlation between certain questions (vectors that form acute angles such as Q1yes and Q7a) but also highlights a good range of uncorrelated and partially correlated questions that appear to separate out poor sites from good ones.

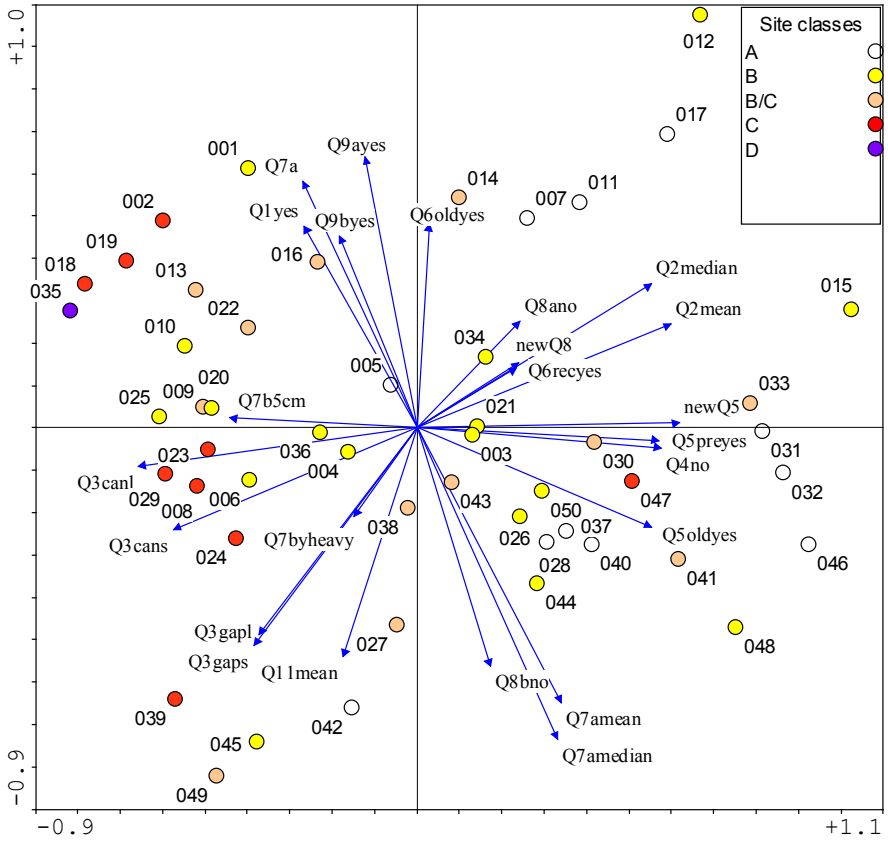


Figure 17 . Biplot based on a PCA of the Survey questions

b) Vegetation /animal species

Principal component analysis (PCA) was used to look at the ground flora of the 50 assessment sites to see if overgrazing class could be linked to a change in community composition and the animal species present within the site. A biplot of the results is given in Figure 18. The two axes account for 60% of the total variation in the data with the x-axis clearly a 'spatial gradient', separating northern sites from southern ones. Of more interest is the y-axis which appears to separate out the grazing classes for the southern sites (sites 026 - 050). Southern sites with larger quantities of ericoids and bilberry tend to have grazing classes A and B whilst those sites with high levels of fine grasses used by ponies and horses have a greater chance of being classified as B/C, C or D. There was no obvious relationship for northern sites.

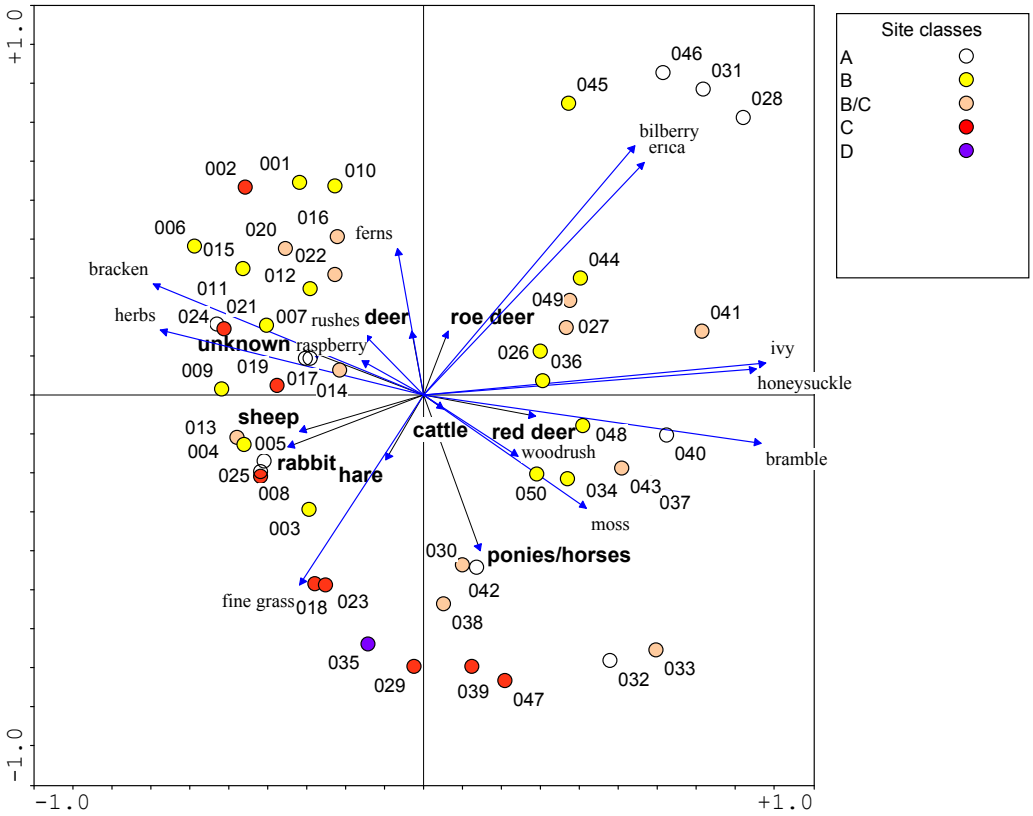


Figure 18. Biplot based on PCA of site vegetation data.

5.3.2 Ordinal logistic regression

An ordinal logistic regression model was considered the best 'regression method' as the response variable, overgrazing class (A, B, B/C, C, D - see table 4), could take one of 5 classes scored on an interval scale. Desirable properties of this model were twofold. Firstly, the model estimates probabilities for each of the overgrazing classes. The class with the highest probability becomes the predicted class for that site but one can also assess the likelihood of the site belonging to a different class. Secondly, parameter coefficients of the model can be simplified into a scoring table which allows a simple summation of integer numbers to predict the overgrazing class.

Indicator variables were chosen for this model using a backward selection algorithm. Variables that were not significantly associated with grazing class were systematically removed until no other effect in the model met the $p<0.05$ level of significance.

Four variables, Questions 1, 3, 5 and 7, were selected using the above process and Table 1a gives the estimated probabilities, Table 1b gives a scoring system for these variables. A site scoring 0-18 is classified as an A, 19-24 as B, 25-28 as B/C, 29-35 as C and 36 as a D. 60% of sites were correctly identified and 98% of sites correctly identified to +/- 1 overgrazing class.

Table 1a

Score	Grazing class probability				
	A	B	B/C	C	D
0	0.9999	0.0001	0.0000	0.0000	0.0000
1	0.9998	0.0001	0.0000	0.0000	0.0000
2	0.9997	0.0002	0.0000	0.0000	0.0000
3	0.9996	0.0004	0.0000	0.0000	0.0000
4	0.9993	0.0006	0.0000	0.0000	0.0000
5	0.9989	0.0011	0.0001	0.0000	0.0000
6	0.9981	0.0017	0.0001	0.0000	0.0000
7	0.9969	0.0029	0.0002	0.0000	0.0000
8	0.9950	0.0047	0.0003	0.0000	0.0000
9	0.9917	0.0078	0.0004	0.0001	0.0000
10	0.9864	0.0128	0.0007	0.0001	0.0000
11	0.9778	0.0208	0.0012	0.0001	0.0000
12	0.9640	0.0338	0.0019	0.0002	0.0000
13	0.9420	0.0545	0.0032	0.0004	0.0000
14	0.9078	0.0863	0.0052	0.0007	0.0000
15	0.8565	0.1338	0.0086	0.0011	0.0000
16	0.7836	0.2005	0.0140	0.0018	0.0001
17	0.6871	0.2870	0.0229	0.0029	0.0001
18	0.5712	0.3868	0.0370	0.0048	0.0002
19	0.4469	0.4857	0.0592	0.0079	0.0003
20	0.3289	0.5647	0.0931	0.0129	0.0005
21	0.2291	0.6067	0.1423	0.0211	0.0008
22	0.1527	0.6026	0.2090	0.0342	0.0014
23	0.0986	0.5534	0.2907	0.0551	0.0023
24	0.0622	0.4696	0.3770	0.0875	0.0037
25	0.0387	0.3693	0.4501	0.1358	0.0061
26	0.0238	0.2709	0.4909	0.2042	0.0101
27	0.0146	0.1876	0.4876	0.2937	0.0165
28	0.0089	0.1244	0.4410	0.3988	0.0270
29	0.0054	0.0799	0.3646	0.5064	0.0437
30	0.0033	0.0502	0.2781	0.5983	0.0701
31	0.0020	0.0312	0.1981	0.6582	0.1105
32	0.0012	0.0192	0.1340	0.6757	0.1700
33	0.0007	0.0117	0.0872	0.6479	0.2524
34	0.0004	0.0071	0.0553	0.5795	0.3576
35	0.0003	0.0044	0.0345	0.4823	0.4785
36	0.0002	0.0026	0.0213	0.3738	0.6021

Table 1b Classification score

Assessment score	Q3comb/4	Q5preyes	Q7b5cm	Q1yes
0	0	0	0	0
1	2	1	1	0
2	4	1	1	1
3	6	2	2	1
4	8	2	3	1
5	10	3	4	2
6	12	3	4	2
7	14	4	5	2
8	16	5	6	3
9	18	5	7	3
10	20	6	7	3

Q3comb/4 – is the sum of Question 3 scores for small and large trees both under canopy and canopy gap divided by 4 (to provide an assessment score 0-10).

Q5preyes – browsing damage to previous years growth.

Q7b5cm - ground vegetation 5cm or less.

Q1yes – open tree canopy

Example. Site 013 has a Q3comb assessment score of 10 , a Q5preyes of 0, a Q7b5cm of 7 and a Q1yes of 7 would score 20+0+5+2 = 27 and would be classified as B/C (the class with the highest probability for a score of 27). This was the correct classification for site 013.

Appendix 9 gives a revised version of Table 1b based on the new questions in the recommended February March survey form.

5.3.3 Classification tree model

Although a dataset of 50 sites is far too few to form a complex decision tree a simple model was built to allow a comparison with the 'expert' built decision tree. The classification tree was formed using entropy reduction (ie a formula to maximise the number of woods in the same class at any point on the tree) as the splitting criteria and used 80% of the data to build the model and 20% for validation and pruning. Questions 1, 3 and 7b were selected as significantly important to the classification process. 62% of sites were correctly classified and 94% correctly identified to +/-1 class. Appendix 10 gives a revised version of the Classification tree model based on the new questions in the recommended February March survey form.

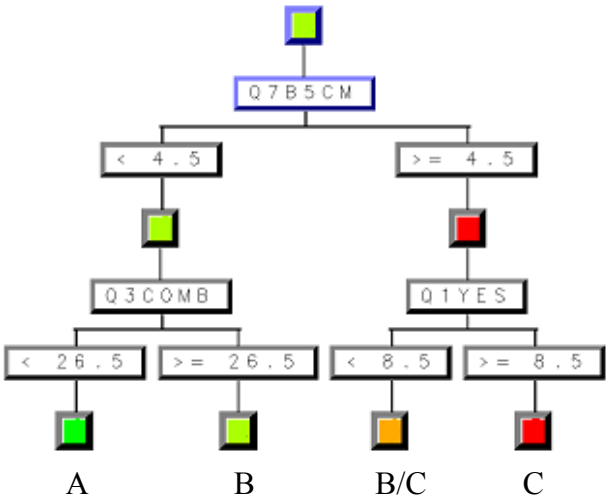


Table 2. Ability of the Classification Tree to predict overall assessment class

		Predicted				
		A	B	B/C	C	**D**
Actual	**A**	6	4	1	0	0
	B	1	13	3	0	0
	B/C	0	5	7	0	0
	C	0	1	3	5	0
	D	0	0	1	0	0

5.3.4 'Expert' decision tree

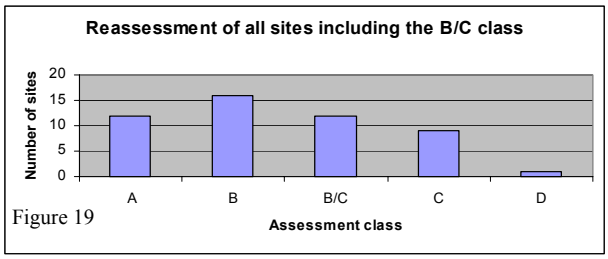


Figure 19

Appendix 11 shows an 'expert' decision tree which has been designed to identify the overall assessment class from data collected on the February – March recommended version of the form. This tree is based on observations made during the pilot exercise and subsequent field visits. When producing this, it was not possible to restrict overall assessment classes to four, hence the addition of the B/C class. It is interesting to note that, in preparation of the statistically derived tree, it was also difficult to produce a satisfactory version when only using four classes. The assessment class for each woodland was reassessed using the 5 point scale (see figure 19).

Threshold values for YES answers have been calculated for this decision tree through observations of data from the method assessment survey. Criteria were evaluated in terms of which assessment class they most frequently influence (eg an open canopy typically moves the assessment beyond a B/C where other elements such as saplings and grazing sensitive species are missing). Mean wood values (ie number of plots out of 10) were then assessed for all woods that fell into separate classes and the mean value selected for the relevant threshold (for example, all woods with an assessment of C were grouped and their mean plot value was used for open canopy). It was not possible to automate the calculation of thresholds as questions used in the survey have changed in the recommended version and

some interpretation was required. As the 'expert' tree has been written to accompany the February – March version of the recommended form, its use in the growing season will require some interpretation to take account of factors such as current years growth which is likely to be browsed off during the subsequent winter. Table 3 shows the classification of overall grazing assessment for sites using the 'expert' tree. 62% of sites were correctly classified and 96% correctly identified to +/-1 class (ie only two woods out of fifty were predicted to be two classes poorer or better than the actual assessment).

Table 3. Ability of the 'Expert' tree to predict overall assessment class

		Predicted				
Actual		**A**	**B**	**B/C**	**C**	**D**
	A	4	6	1		
	B	1	12	4		
	B/C		1	9	2	
	C		1	2	5	1
	D					1

Table 4. New definition of the assessment classes (including class B/C).

Level	**Description of typical characteristics**	**Implication**
A	Frequent saplings, well developed ground and field layer vegetation. Branches in understorey well within reach of grazing animals	Grazing / browsing is not causing any problems within this woodland.
B	The sward is not being heavily grazed but woody plants are being moderately to heavily browsed	Not a grazing management issue. May become necessary to control browsing animals in the long-term.
B/C	There are moderate to heavy levels of grazing and browsing under a full canopy	Survival of the woodland is not threatened in the short-term but there is limited structural diversity. May become unsustainable in the medium-term
C	There are moderate to heavy levels of grazing and browsing under a fragmented canopy or animal disturbance under a full canopy	Grazing or browsing at this level would be unsustainable in the short-term (i.e. c.10-15 years).
D	The woodland habitat is under serious threat from this level of grazing/browsing pressure (e.g. heavy poaching and/or bark stripping together with an absence of tree seedlings and heavily grazed sward), under an open canopy	Such management is currently unsustainable.

6. Discussion

6.1 The surveyed woodlands

The method assessment survey did not pick up as many excessively grazed sites as had been expected. However, few small woods (<3ha) were surveyed and, due to time constraints, the sample was biased towards those woods which had contact details available (hence, they were more likely to be under some form of management). Several woods have been visited following the main survey to validate new versions of the forms and the 'expert tree'. More severely overgrazed woodlands were sought and those recommended by government agency staff all proved to be less than three hectares. Woodlands included in the method assessment survey are to some degree unrepresentative as they are skewed towards less intensively grazed sites.

Supplementary feeding was only recorded in three woods (with two woods in assessment class B and one in C). Observations from these and other sites (Pennine Dales and Northumberland) suggest that the effect of feeding can be localised, having less relative impact in larger woods. However, substantial ground disturbance and a very prominent browse line have been seen within the vicinity of feeding rings (*c* 2ha) and it is suggested that, where the amount of forage available is artificially increased, the carrying capacity of components of the woodland ecosystem (particularly soil structure) are likely to be exceeded.

The large presence of rabbits in the Pennine Dales was recognised by Trout and others (2000) and is likely to be due to drier soils as well as the prominence of sporting estates (pheasant and grouse shoots) and therefore higher predator control. The high presence of red deer on Exmoor is largely due to sporting interests. Some woodlands were owned by sporting societies for the purpose of holding and hunting animals.

The slightly poorer condition of upland mixed ashwoods compared to upland oakwoods (see Figure 13) may, to some extent, be due to an inherent difference in vulnerability between woodland types. In theory, upland mixed ashwoods should be less vulnerable as there is generally more forage available and therefore less overall impact (in terms of biomass) to ground flora and tree seedlings. However, as pointed out above, rabbit numbers are higher in the Pennine Dales where the majority of surveyed upland mixed ashwoods were located. It was suspected that one reason for the difference in vulnerability of woodland types within this sample was the average size of the woods in each type. However, this does not appear to be the case (the average size of upland mixed ashwoods was 13ha and the average for upland oakwoods was 18ha).

6.2 Quality assurance conclusions

As the QA exercise was carried out in three woods, it is difficult to make comparisons between surveyors on separate teams. However, comparisons within teams can be made and trends in the consistency of all surveyors can be seen for each question.

The results indicate a broad level of consistency in plot assessment within the survey teams and an acceptable accuracy in plot size estimation and location. Inconsistencies may be due to two factors:

A genuine difference of opinion. This may be due to the feature (eg canopy cover) being on the threshold between two classes, insufficient time and effort put into looking for evidence or insufficient knowledge about what signs to look for.

Misinterpretation of the question. By the time this exercise was carried out, any misinterpretation should have been dealt with. However, the main issue still causing problems was the use of Null (ie Not Applicable instead of using Yes or No as an answer).

There was a substantial difference between the frequency and number of grazing sensitive species present in the north and the south. This is not thought to be due to inconsistencies between survey teams but to higher growth rates and quicker recovery of grazing sensitive species as a result of a more favourable climate in the south-west.

6.2.1 Dealing with woodland objectives where higher levels of grazing may be appropriate

The procedure outlined by the working group is to carry out the survey initially and then discuss finding with the woodland owner/manager in relation to their objectives. This seems a sensible approach as it allows an assessment to be made objectively. However, as the person undertaking the survey is likely to have some knowledge about the owner/manager's objectives before the survey commences, this is likely to bias the way in which questions are answered (eg Is the canopy open?, Is the ground vegetation heavily grazed?). In order to assess how sustainable the existing management regime is in terms of favourable woodland condition, the survey should be carried out independently of the surveyor's knowledge of the owner's objectives. Once the survey is complete, consideration should be given to how the condition of woodland components suffering from the existing regime can be improved in line with other objectives for the site (see Box 2).

The issue of what are the conservation objectives for a site is particularly important with former wood-pastures. In these sites relatively high impact grazing (category C) may be desirable. Wood-pastures can be recognised by the presence of veteran trees with broad, open grown crowns and features such as basal swelling, evidence of pollarding (Quelch 2001, Stiven and Holl 2004). Canopy cover is typically very open although there are some examples where widely spaced veteran trees have sufficiently large crowns to form a closed canopy.

There are a number of regeneration strategies for wood pasture, from extensive grazing regimes which allow patch mosaics of grassland and scrub, with occasional high forest trees, to periodic exclosure of livestock.

Training on the identification of wood pasture is recommended (see section 4.6) as the occurrence of this upland woodland structure type has only recently been recognised and it is anticipated that there are still unrecorded examples.

6.2.2 What time of year should the survey be carried out?

When we are considering current grazing pressure, are we looking at the pressure observed on the day or the current grazing regime and it's likely impact over a year? The latter appears to be most appropriate. There are two considerations, the ability of the site to recover during the growing season and the condition that the site is in towards the end of winter.

For sites which appear to fall into category C or D and where action under cross-compliance is being considered, it is suggested that the site should be visited in the winter **and** the growing season to understand the full impact that a site is under. In some cases, particularly in Upland mixed ashwoods, even with significant amounts of winter poaching, summer recovery can alter the overall assessment, moving the wood into a B category where it would have been rated as a D in the winter.

Figure 20 Site A, Northumberland – December (left) and June (right) *photos Kit Brown*

Figure 21 Site B, Northumberland - November (left) June (right) *photos Kit Brown*

Figure 20 shows the contrasting conditions on a site in Northumberland in two different seasons. The contrast is significant on site and, it is suspected that the judgement survey would have rated this site as a D in the winter whereas its ability to recover in the spring meant that an overall assessment of C was given.

In Figure 21, a similar scenario exists. However, inspecting the site in the spring, it was clear that heavy grazing is still taking place at that time of year, there is little opportunity for features to recover and the overall assessment remains as a D in both seasons.

By recovery of features, what are we considering? Light grazing in the spring should allow some revegetation of poached areas and flowering of plants to replenish seedbanks, provide nectar sources for invertebrates. It may also allow occasional tree seedlings to establish and provide advanced regeneration (which will be held in check at sward height in successive winters until the pressure from grazing is reduced).

Several elements need to be considered if carrying out the survey in the spring. The structure of the woodland remains as it was in the previous winter but a number of elements change as the growing season begins: flush of grasses and emergence of vernal dominants, regrowth of basal shoots, regrowth of browsed back rootstocks of seedlings held in check at sward height in the winter, regrowth of species which are mainly targeted in the winter (eg bilberry) and germination of tree seedlings.

In the spring, it is possible to significantly underestimate the impact of grazing throughout the year by mistaking this year's regrowth and new seedlings for regeneration which has survived greater than one year. It is also possible that a new flush of vegetation is not heavily grazed initially due to livestock grazing elsewhere in the early spring (eg lambing in lower fields). However, in swards **very** heavily grazed by sheep, the 5cm rule appears to still be valid in the growing season. This does not necessarily appear to be the case where there is moderate pressure at the beginning of the growing season as this intensity of grazing seems incapable of reducing the height of the newly flushed sward below 5cm. It is suspected that with the same number of animals in the winter, the sward would be well below 5cm although this has not been tested.

Rapid breakdown of organic matter can take place on neutral to base rich soils with mull humus, due to abundant soil fauna. Additionally, ground flora may be dominated by vernal species, with little vegetation evident in the winter. Therefore, even in lightly grazed upland mixed ashwoods and NVC W7 wet woodlands in the winter, the typical height of vegetation may be <5cm and there may be bare soil.

A MSc dissertation will be undertaken 2004-6 in Northumberland by Dave Moore, a mature student from Birkbeck college, University of London. He plans to look at the application of the judgement method in four woodlands (to fit broadly into the A-D ratings), over four seasons. We hope that this study will help to identify the influence that time of year has on survey results.

6.2.3 Key indicators

The condition of indicators can be misinterpreted and absence of features such as a shrub layer, grazing sensitive species, seedlings or saplings cannot confidently be put down to current over-grazing. The 'expert tree' has been devised to allow management and site factors to be taken into account and to bypass absent criteria, focusing instead on the condition of existing features. An alternative approach using qualitative indicators is being developed (Smith 2004) which looks at the long-term as well as current impacts. We consider that some elements of this method could be combined with that put forward in this report to develop a more sensitive and complete system for identifying differences in less intensively grazed sites and to allow this method to be used more effectively for condition monitoring.

Selected criteria are generally observable from the plot centre and do not require a great deal of searching. The two areas which would benefit from more time input and wider coverage of the plot are assessment of seedlings/saplings and identification of browsing levels on epicormic/basal shoots. There was some debate whether epicormic and basal shoots should be considered as separate criteria to the browse line on shrubs. It was decided to retain this as one question as both aspects are looking at the same grazing impact on different features. The assessment of epicormics normally requires closer observation than the browse line on

shrubs as epicormic growth may be limited by the physiology of the tree as well as browsing and therefore growth above browsing height may not provide an obvious contrast from a distance.

When compiling questions, there are tradeoffs between reducing complexity and ensuring that questions and answers are unambiguous. Experience from the method assessment survey has shown that the exact meaning of the question has to be very precise. The recommended version has therefore opted for more of a specific approach. Each question has a number of qualifying notes which are more complex than those used in the original version. This has implications for training but we believe that the quality of data and the reduction in time spent wondering how to deal with unusual circumstances in the field should make extra training input worthwhile and lead to greater overall efficiency.

As data were collected in April and May, and statistical models presented are based on a relatively small number of sites (classification trees usually requiring in excess of 100 sites), some validation of recommended forms and analysis models would be beneficial. As field staff survey new woodlands, it should be possible to feed in data into existing models and refine the method. The eventual aim would be to reduce the number of parameters that need to be recorded.

If we compare the statistically derived Classification tree and the 'expert' tree, the overall accuracy of the two is the almost identical (ie 62% correctly predicted and 94/96% + or – one class). However, the Classification tree appears to more accurately predict the sites with little grazing and the 'expert' tree, the more severe sites. The 'expert' tree appears very complex but in practice it is straight forward to apply. It should be possible write a simple programme for this tree so that answers could be reached by entering raw data into an Excel version of the recommended February/March form. As more surveys are completed, new data should allow refinement of the threshold values. Appendix 12 (p. 85) provides a worked example of the use of Ordinal Logistic Regression, the classification tree and 'expert' tree to reach a summary assessment.

It will be necessary to consider what constitute Good Agricultural and Environmental Condition (GAEC) for woodland. In their consultation paper, The Woodland Trust suggested that there should be some form of cyclical exclusion (10% at any one time is suggested) to allow regeneration (see: www.woodland-trust.org.uk/campaigns/consultationmore/proposed_and_possible_measures_cross_compliance_in_England140604)

Whilst this aim would substantially improve many upland wood, GAEC uses a risk-based approach to cross compliance. Hence the method outlined here looks at grazing impacts rather than management requirements. However, where the overall assessment for a wood falls below the acceptable threshold set by Defra, this will indicate that management such as fencing is required. All forms of analysis used in this report identify an open canopy as one of the triggers that puts a woodland into a lower assessment class and this should link well with any management to encourage regeneration. Regeneration is possible under all but the densest of canopies but recruitment into the canopy is unlikely unless there are sufficient canopy gaps.

Training of surveyors may require more input than initially envisaged. However training farmers to recognise woodlands according to GAEC should not correspondingly become

more complex because more emphasis is put on the presence of positive features, with less attention paid to recognising impacts.

7. Conclusions

a. Grazing is a critical factor in determining the structure and composition of upland woods. While we have focussed on overgrazing, there are some circumstances where too little grazing may be the issue. The general approach developed may, with some modification, be applicable to under grazing and to the lowlands.

b. The level of desirable/acceptable grazing must be related to the objectives for the particular wood. Some woods may be able to sustain higher impact levels than others. Nevertheless high sustained levels of stock grazing are damaging, are against general forestry and nature conservation guidelines and may be deemed against good farming practice.

c. The method-assessment survey considered grazing levels in woodlands subject to a range of different grazing levels and herbivore species. There were some geographic differences, particularly the main herbivore species, but the methods put forward should be applicable to all upland areas within England. The two drawbacks to the survey were that it was completed after the period that the methodology was designed for (April–May instead of February–March) and there were insufficient heavily grazed sites to be representative. However, data collected have allowed validation and development of the method and achieved the aim of the project.

d. Revised survey forms are presented together with accompanying notes (Appendices 7 & 8). The February–March form is recommended for normal use although an indication of grazing impact should be obtainable through use of the second version of the form (appendix 8) in the growing season. Questions are more specific than those put forward by the working group and more training will be required to ensure that the surveyor understands the precise requirements for each question. However, data recorded should be open to less interpretation and should therefore provide more accurate results.

e. The criteria selected should indicate **current** grazing pressure rather than conditions resulting from historic overgrazing. Questions have been included on the recommended form to identify where conditions are due to site factors and management rather than grazing impacts.

f. This method may give some examples of historically-managed wood-pasture an overall classification of C. In such cases, it may be appropriate to continue the existing grazing regime in the short- to medium-term but with some future provision to encourage low densities of tree regeneration. However, in such woodlands, animal damage to overstorey trees and animal disturbance (eg poaching) would remain an important criteria to evaluate overgrazing.

g. Use of analysis tools provided should allow an overall assessment of grazing impact to be reached (in terms of whether the woodland is in class A, B, B/C, C or D). Appendix 12 provides a worked example of how these models should be used. Decisions will need to be made by members of the steering group as to which class

the threshold is for Good Agricultural and Environmental Condition and where cross compliance rules may apply.

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Appendix 1. Original form

General Grazing Impact Assessment

Section 1: General information

Site name: Grid reference:

Surveyors Site code: Date:

Woodland type (see notes) Major component: Minor component:

Supplementary feeding form completed: yes / no Map attached: yes / no

Photos taken (include brief details, eg sample point):

Section 2: Grazing indicators

yes =1, no = 0, null = \

1. Is the tree canopy open (light)?										
	1	2	3	4	5	6	7	8	9	10
2. Are young trees only very rare or absent below canopy gaps?										
	1	2	3	4	5	6	7	8	9	10
Trees 30 cm – 2.0 m										
Trees < 30 cm										
Notes: (eg species of tree.)										
3. Is the understorey sparse or absent?										
	1	2	3	4	5	6	7	8	9	10
4. Is there a distinct browse line on established trees and shrubs?										
	1	2	3	4	5	6	7	8	9	10
5. Is there obvious browsing damage to young trees or shrubs <2.0 m height?										
	1	2	3	4	5	6	7	8	9	10
Previous years' growth										
Current year's growth										
6. Is there obvious damage (< 2m height) to established trees ?										
	1	2	3	4	5	6	7	8	9	10
Old damage										
Recent damage										

7. Is the ground vegetation heavily grazed?										
	1	2	3	4	5	6	7	8	9	10
Heavily grazed?										
Main ground vegetation (spp)										
8. Are grazing sensitive species present?										
	1	2	3	4	5	6	7	8	9	10
a. Are sensitive species present?										
b. Are grazing sensitive species confined to niches?										
List species										
9. Are there obvious signs of animal disturbance in sample area?										
	1	2	3	4	5	6	7	8	9	10

10. Which species of herbivore are present? (refer to guidance table for help with identification).										
	1	2	3	4	5	6	7	8	9	10
Sheep										
Cattle										
Goats										
Ponies / horses										
Deer (specify if known)										
Rabbit / hare										
Unknown										

11. Any additional comments:	1	2	3	4	5	6	7	8	9	10

Appendix 2. Unsuitable supplementary feeding form

Surveyor(s) _____ **Date** _____

Location name _____ **Size of woodland** _____ **ha**

Name and address of grazier _____

Is this the first visit to this site? ☐ **Yes** ☐ **No**

Foddering site

Grid Ref _____

Distance from nearest woodland edge _____ m

Distance from other foddering sites _____ m

Foddering damage

Area of foddering site _____ m^2

Area of associated damage _____ m^2

Area of other impact (plastic, string etc) _____ m^2

Is there evidence of the area\ getting bigger ☐ **Yes** ☐ **No**

Feeds

	Hay	Silage	Straw	Concs
Big bale				
Small bale				
Loose				
Racks / troughs / rings (specify)				

Block fed ☐ **Yes** ☐ **No**

Number of blocks fed in wood _____

Method of transporting fodder _____

Length of tracking within woodland _____ m

Approx depth of ruts _____ cm

Other track damage (eg width of tracks) _____

Photographs taken ☐ **Yes** ☐ **No**

Appendix 3. Site details

	Area	Active WGS	WGS (10 yrs)	LEAP	LEAP (10 yrs)	SSSI	ESA	CSS
Dartmoor sites								
1	10	N	N	N	N	N	N	N
2	10	N	N	N	N	N	N	N
3	11	N	Y	N	N	Y	Y	N
4	4	N	Y	N	Y	N	Y	N
5	8.5	N	N	N	N	N	Y	N
6	4.5	N	N	N	N	N	Y	N
7	3.5	N	Y	N	N	Y	Y	N
8	9	N	N	N	N	N	N	N
9	6	N	N	N	N	N	N	N
10	32	Y	N	N	N	N	N	N
11	3.5	N	N	N	N	N	Y	N
12	22	Y	N	N	N	Y	Y	N
13	16	Y	N	Y	N	Y	N	N
14	5.5	N	N	N	N	N	N	N
15	3	N	N	N	N	Y	Y	N
Exmoor sites								
1	7.3	N	N	N	N	Y	Y	N
2	3.5	N	N	N	N	Y	Y	N
3	21.4	N	N	N	N	Y	N	N
4	11.5	N	N	N	N	Y	N	N
5	25	Y	N	N	N	Y	N	N
6	16	Y	N	N	N	Y	Y	N
7	14	Y	Y	N	N	N	N	N
8	7	N	N	N	N	N	N	N
9	29	Y	N	N	N	N	N	N
10	8	N	Y	N	N	N	N	N
North Pennine sites								
1	22	N	N	N	N	Y	N	N
2	8	Y	N	Y	N	Y	N	N
3	9.5	N	N	N	N	Y	N	N
4	7.5	N	N	N	N	N	N	N
5	16	N	N	N	N	Y	N	N
6	12	Y	N	N	N	Y	N	N
Lake District sites								
1	28	Y	N	N	N	Y	N	N
2	20	N	N	N	N	Y	Y	N
3	21	N	N	N	N	N	N	Y
4	56	Y	Y	N	N	N	Y	N
5	35	Y	N	N	N	Y	Y	N
6	39	N	Y	N	N	Y	Y	N
7	47	N	Y	N	N	Y	Y	N
8	16	Y	N	Y	N	N	Y	N

	Area	Active WGS	WGS (10 yrs)	LEAP	LEAP (10 yrs)	SSSI	ESA	CSS
9	45	N	N	N	N	Y	Y	N
10	20	N	N	N	N	Y	Y	N
11	32	N	Y	N	N	N	N	N
Yorkshire Dales sites								
1	34	N	Y	N	Y	N	Y	N
2	5.3	Y	N	N	N	N	Y	Y
3	4.7	N	N	N	N	Y	Y	N
4	22	N	N	N	N	N	Y	N
5	9	Y	N	Y	N	N	Y	N
6	11	N	N	N	N	Y	N	N
7	15	N	N	N	N	Y	part	part
8	16	N	N	N	N	Y	Y	N

Appendix 4. Findings from the Quality Assurance Assessment

For the woodland assessment in Exmoor and Dartmoor, an unsurveyed woodland was selected and each of the three surveyors were asked to analyse the first three plots within that woodland. The assessment was carried out by an individual surveyor in the absence of other team members. The first task was to state the dimensions of the notional 50m x 50m plot by estimating 25m from the centre of the plot in four directions and then measuring out to that point using a tape measure. At each plot, the surveyor conducted the full qualitative survey as normal (completing questions 1-11 for each plot). The surveyor was also asked to walk the estimated distance between the plots as per the nearest neighbour calculation, and then this distance was measured and compared to the actual distance to be walked.

For the surveys of woodlands in northern England, two of the surveyors were assessed on the same wood, using the method outlined above. The third surveyor was assessed on a separate wood (also using the method described above), with the quality assurance trainer carrying out the same survey and comparisons made between the two.

South-west

The following tables outline the responses to each question for the three plots assessed.

Question 1. Tree canopy open

Surveyor	Plot 1	Plot 2	Plot 3
1	No	No	No
2	No	No	Yes
3	No	No	No

Question 2. Understorey sparse or absent

Surveyor	Plot 1	Plot 2	Plot 3
1	25-50%	Yes	Yes
2	15-20%	Yes	Yes
3	25-50%	10-25%	Null

Question 3. Young trees rare or absent

Surveyor	Plot 1				Plot 2				Plot 3			
	UC 30cm –2m	UC <30cm	CG 30cm – 2m	CG <30cm	UC 30cm –2m	UC <30cm	CG 30cm – 2m	CG <30cm	UC 30cm –2m	UC <30cm	CG 30cm – 2m	CG <30cm
1	No	Y	nu	nu	No	No	nu	nu	No	No	nu	nu
2	No	No	nu	nu	No	No	nu	nu	Y	Y	Y	Y
3	No	Y	nu	nu	No	No	nu	nu	No	No	nu	nu

Species present

Surveyor	Plot 1	Plot 2	Plot 3
1	Ha, Be	Holly, Be	Ha, Holly, Be
2	Holly, Be	Be, Ha, Row	Ok, Be, Ha, Wthn
3	Be, Sy	Be, Ok	Be, Ok

Confined to niches

Surveyor	Plot 1	Plot 2	Plot 3
1	No	No	No
2	No	No	No
3	No	No	No

Question 4. Distinct Browse line

Surveyor	Plot 1	Plot 2	Plot 3
1	No	No	No
2	No	No	No
3	No	No	nu

Question 5. Obvious damage to young trees or shrubs

Surveyor	Plot 1		Plot 2		Plot 3	
	Previous	Older	Previous	Older	Previous	Older
1	No	No	No	No	No	No
2	No	No	No	No	No	No
3	No	No	No	No	No	No

Question 6. Trees and shrubs >1.5m, damage to bark

Surveyor	Plot 1		Plot 2		Plot 3	
	Old	Recent	Old	Recent	Old	Recent
1	No	No	No	No	No	No
2	Yes	Yes	No	No	No	No
3	No	No	No	No	No	No

Question 7a. Ground vegetation cover

Surveyor	Plot 1	Plot 2	Plot 3
1	95%	95%	95%
2	90%	90%	95%
3	>75%	>75%	>75%

Question 7b. Ground vegetation grazing

	Plot 1			Plot 2			Plot 3		
	S1	**S2**	**S3**	**S1**	**S2**	**S3**	**S1**	**S2**	**S3**
Heavy grazing	No	No	NO	No	No	No	No	Y on bil	No
Stem height	No	No	Y	No	No	Y	No	nO	No
Dead stems	No	No	No	No	No	No	No	No	No
Species	Gr, Mo	Gr, Mo, Ox	Gr, Fe, BBL, HS	Gr, Mo, Bluebell	Mo, Gr, HS, Ox	Mo, Gr, Fe, Bluebell, Ox	Gr, Mo, HS, Bil	Gr, Mo, BBL, Bil, HS	Bil, Hs, Wrush, Gr, Mo

Question 8. Grazing sensitive species

	Plot 1			Plot 2			Plot 3		
	S1	**S2**	**S3**	**S1**	**S2**	**S3**	**S1**	**S2**	**S3**
Heavy grazing	Y	Y	Y	Y	Y	No	Y	Y	No
Confined to niches	No	No	No	No	No	No	No	No	No
Species	BBL, HS, Wrush	BBl, HS	BBL. HS	BBL, HS, Ivy	BBL, HS	BBL, HS, Ivy	BBL, HS, Wrush, Bil	BBL, HS, Bil	BBL, Ivy, Wrush, HS, Bil

Question 9. Animal disturbance in the sample area

Surveyor	Plot 1	Plot 2	Plot 3
1	No	No	No
2	No	No	No
3	No	No	No

Damage associated with water course

Surveyor	Plot 1	Plot 2	Plot 3
1	No	No	No
2	No	No	No
3	nu	nu	nu

Question 10. Species present

Surveyor 1: Red deer in three plots
Surveyor 2: Red deer in three plots
Surveyor 3: Deer in one plot (species unknown)

Question 11. Trees in poor health

Surveyor	Plot 1	Plot 2	Plot 3
1	6%	12%	6%
2	10%	10%	40%
3	0-10%	25-50%	11-25%

Overall category

All three surveyors classed the wood as an A.

There was a marked consistency between the three surveyors, although there were some discrepancies in questions regarding understorey cover, absence of young trees and presence and grazing on grazing sensitive species. The most marked variation was seen in the question regarding trees in poor health, although some of this may have been accounted for accidental inclusion of standing dead trees in their assessment by one surveyor. Overall analysis of the results indicated an acceptable level of consistency in the surveyors assessment of the woodland.

North

Surveyors 4 and 5 were assessed in one wood and their results compared. Surveyor 6 was assessed in a separate wood and compared with the QA instructor (7) who conducted the same survey independently.

Question 1. Tree canopy open

Surveyor	Plot 1	Plot 2	Plot 3
4	No	No	No
5	No	Y	No
6	Y	Y	Y
7	No	No	Y

Question 2. Understorey sparse or absent

Surveyor	Plot 1	Plot 2	Plot 3
4	50-75%	50-75%	25-50%
5	25-50%	25-50%	10-25%
6	25-50%	25-50%	25-50%
7	25-50%	50-75%	25-50%

Question 3. Young trees rare or absent

Surveyor	Plot 1				Plot 2				Plot 3			
	UC 30cm –2m	UC <30cm	CG 30cm – 2m	CG <30cm	UC 30cm –2m	UC <30cm	CG 30cm – 2m	CG <30cm	UC 30cm –2m	UC <30cm	CG 30cm – 2m	CG <30cm
4	No	Y	Y	Y	No	Y	No	Y	No	No	Y	No
5	No	No	Y	Y	No	Y	No	Y	No	No	Y	Y
6	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
7	Y	Y	nu	nu	Y	Y	No	Y	Y	Y	Y	No

Species

Surveyor	Plot 1	Plot 2	Plot 3
4	Ash, Sy	Ash, Sy	Ash, Sy
5	Birch, Ash	Oak, Birch	Birch, Ash
6	nu	nu	nu
7	Syc	nu	Birch

Niches

Surveyor	Plot 1	Plot 2	Plot 3
4	No	No	No
5	No	No	No
6	No	No	No
7	No	No	No

Question 4. Browse line

Surveyor	Plot 1	Plot 2	Plot 3
4	Y	Y	Y
5	nu	nu	nu
6	No	No	No
7	No	No	No

Question 5. Obvious damage to young trees or shrubs

Surveyor	Plot 1		Plot 2		Plot 3	
	Previous	**Older**	**Previous**	**Older**	**Previous**	**Older**
4	Y	Y	Y	Y	Y	Y
5	No	No	No	No	No	No
6	No	Y	No	Y	No	Y
7	No	Y	No	Y	No	Y

Question 6. Trees and shrubs >1.5m, damage to bark

Surveyor	Plot 1		Plot 2		Plot 3	
	Old	Recent	Old	Recent	Old	Recent
4	Y	No	Y	No	Y	No
5	No	No	No	No	No	No
6	y	Y	Y	NO	No	No
7	Y	No	Y	No	Y	No

Question 7a. Ground vegetation cover

Surveyor	Plot 1	Plot 2	Plot 3
4	>75%	>75%	51-75% (c,o)
5	51-75% (c,o)	51-75% (o)	51-75% (c,a,o)
6	25-50% (s)	>75%	>75%
7	>75%	>75%	>75%

Question 7b. Ground vegetation grazing

	Plot 1				Plot 2				Plot 3			
	S4	**S5**	**S6**	**S7**	**S4**	**S5**	**S6**	**S7**	**S4**	**S5**	**S6**	**S7**
Heavy grazing	NO	No	No	No	NO	No	No	No	No	No	No	No
Stem height	NO	NO	No	No	NO	NO	No	No	No	No	No	No
Dead stems	NU	NO	No	No	nu	NO	No	No	nu	NO	No	No
Species	Fe He	Fe He Gra	Gra Mo He	Gra He Mo Fe	Gra Fe He	Gra Fe He	Gra Mo He	Gra He Mo Fe	Gra Fe He	Mo Fe He	Gra Mo He	Gra Mo He

Question 8. Grazing sensitive species

	Plot 1				Plot 2				Plot 3			
	S4	**S5**	**S6**	**S7**	**S4**	**S5**	**S6**	**S7**	**S4**	**S5**	**S6**	**S7**
heavy grazing	NU	NO	NU	NO	NO	NO	NU	NU	NU	NO	NU	NU
confined to niches	NU	NU	NU	NO	NO	NU	NU	NU	NU	NU	NU	NU
species	NU	RASP	NU	RASP	RASP	RASP	NU	NU	NU	RASP	NU	NU

Question 9. Animal disturbance in the sample area

Surveyor	Plot 1	Plot 2	Plot 3
4	No	No	No
5	No	No	Y
6	No	No	No
7	No	No	No

Damage associated with water course

Surveyor	Plot 1	Plot 2	Plot 3
4	No	No	No
5	nu	Y	nu
6	Y	No	No
7	nu	nu	nu

Question 10. Species present

Surveyor 4: Deer in 3 plots (species unknown)
Surveyor 5: Animal presence in 3 plots (species unknown)

Surveyor 6: Sheep, deer (species unknown) and rabbits present in all three plots
Surveyor 7: Deer (species unknown) and rabbit present in all three plots

Question 11. Trees in poor health

Surveyor	Plot 1	Plot 2	Plot 3
4	0-10%	0-10%	0-10%
5	0-10%	0-10%	0-10%
6	0-10%	0-10%	0-10%
7	0-10%	0-10%	0-10%

Surveyors 4 and 5 both classed their wood as an A
Surveyor 6 classed wood as an A
Surveyor 7 classed wood as a B

Comparison of the results between surveyors 4 and 5 indicates that the main areas where variation in interpretation occurred were on questions concerning damage to trees and the presence of a browse line, with surveyor 4 consistently recording obvious damage compared to surveyor 5. In all other aspects of the survey, there was strong consistency, with only occasional variations in interpretation.

Comparisons of results between surveyors 6 and 7, shows strong consistency between the two, the main variation occurring in the final categorisation of the woodland.

Estimating plot size and distance between plots

50m plot estimation

For the purposes of this assessment, the surveyors will be known as 1- 6. The accuracy of the plot size estimations are shown below:

Surveyor	No of estimates within % accuracy of 25m			
	<5%	**5-10%**	**10-20%**	**>20%**
1	2	5	5	0
2	3	5	4	0
3	6	1	5	0
4	4	4	3	1
5	6	5	0	1
6	6	2	4	0
Total	27	22	21	2

Analysis of these results indicate that in most situations the surveyors were underestimating the size of the plots but in most situations this was less than 2.5m out. On only two occasions were the surveyors more than 5 metres wide of the mark.

The possibility of consistent underestimation of plot size, particularly in areas of uneven terrain is something to be highlighted in further training.

Distance between plots

The results of the distance between plot estimations are shown below:

Surveyor	Calculated distance between plots	Actual distance walked between plot		Mean error (%)
		Plot 1-2	Plot 2-3	
1	100	94	118	12
2	100	102	87	7.5
3	100	90	87	11.5
4	87	98	91.5	8.9
5	87	87.3	96	5.4
6	55	55.30	58.30	3.27

As expected, the smaller the distance between the plots, the more accurately the surveyors were able to pace between the plots. Terrain was seen to have a major impact on the accuracy of estimates and this should be stressed in further training.

Appendix 5. Method assessment survey form

General Grazing Impact Assessment										
Section 1: General Information										
Site Name:		Grid Reference:		Surveyors:						
Site Code:		Date:								
Woodland Type:		Major Component:		Minor component:						
Supplementary feeding form completed yes/no:				Photos taken (include brief details eg sample point)						
Map attached: yes/no										
Section 2: Grazing Indicators			**Answer all questions yes, no or null**							
1. Is the tree canopy open (light)?			Open (light) canopy is a tree canopy <75% by aerial projection if tree is in leaf							
	1	2	3	4	5	6	7	8	9	10
2. Is the understorey sparse or absent? If no state cover class	The understorey includes basal shoots from established trees. Record yes if understorey vegetation covers < 10% of sample area. Cover classes are 10- 25%, 25-50%, 50-75% and >75%									
	1	2	3	4	5	6	7	8	9	10
3. Are young trees very rare or absent?										
	1	2	3	4	5	6	7	8	9	10
Trees 30cm – 2.0m under canopy										
Trees < 30cm under canopy										
Trees 30cm – 2.0m under canopy gap										
Trees < 30cm under canopy gap										
Notes: (eg species of tree)										
Are tree seedlings and saplings restricted to niches eg rock crevices (note species)										

4. Is there a distinct browse line on trees and shrubs in the understorey?
This question only applies if there are sufficient trees and shrubs with potentially low-growing leaves for a browse line to develop. Browse line should be visible from a single vantage point selected near the centre of the sample area (most obvious from crouching position). Put null if understorey is sparse or absent.

	1	2	3	4	5	6	7	8	9	10

5. Is there obvious browsing damage to young trees or shrubs that are < 2.0m high?
Obvious browsing damage is >50% of the number of growing shoots of young trees and low shrubs (seedlings or saplings 30cm – 2.0m high, in gaps or under canopy) damaged by browsing. (Put null if seedlings/saplings absent)

	1	2	3	4	5	6	7	8	9	10
Previous years growth										
Older growth										

6. On trees and shrubs >1.5m tall, is there obvious damage to bark or are stems broken?
Obvious damage is usually gnawing, stripping or rubbing of bark on trunks or branches, more rarely breakage of branches. Record yes if >10% of trees >1.5m high are damaged below 2m height. Distinguish between old damage (partly or fully healed over) and recent damage (still fresh). If in doubt, record as old damage. Note when you think damage below 2m may be due to squirrels. Don't record any damage above 2m high.

	1	2	3	4	5	6	7	8	9	10
Old Damage										
Recent damage										

7a What percentage of the plot is covered in ground vegetation? (classes <10%, 10-25%, 26-50%, 51-75% and >75%)

	1	2	3	4	5	6	7	8	9	10
If less than 75%, say why – dense canopy (c), animal disturbance (a), unstable slope (s) or other (o)……										

7b Grazing level of ground vegetation

	1	2	3	4	5	6	7	8	9	10
Are there current signs of heavy grazing? (record yes if > 25% of stems are grazed and there are frequent animal droppings).										
Is the typical (most frequently occurring) height of ground vegetation 5cm or less?										

If grass, is the typical height of dead stems from the previous growing season 5cm or less?										
Main ground vegetation species										
8. Presence of grazing sensitive species Woodrush.	Grazing sensitive species include Bramble, Bilberry, Raspberry, Ivy, Honeysuckle, Greater									
	1	2	3	4	5	6	7	8	9	10
a. If grazing sensitive species are present, are they being heavily grazed? Heavily grazed =>50% of stems browsed). Put null if grazing sensitive species are absent)										
b. Are grazing sensitive species confined to niches eg crevices?										
c. Species present										
9. Are there obvious signs of animal disturbance in the sample area? Signs of animal disturbance should be clearly visible from a single vantage point selected near the centre of the sample area. Extensive poaching is >20% of the sample area with bare soil visible, caused by animal activity.										
	1	2	3	4	5	6	7	8	9	10
a. Animal disturbance in the sample area										
b. Is damage associated with water course?										
10. Which species of herbivore are present? (refer to guidance table for help with identification).										
	1	2	3	4	5	6	7	8	9	10
Sheep										
Cattle										
Goats										
Ponies/horses										
Deer (specify if known)										
Rabbit										
Hare										
Unknown										

11. What % of the trees are in poor health? Signs of poor health include rot holes, loose bark, bracket fungi, significant deadwood in the canopy										
Classes are: 0-10%, 11-25%, 25-50%, >50%	1	2	3	4	5	6	7	8	9	10

Level	Description	(✔)
A	Grazing / browsing is not causing any problems within this woodland.	
B	One or two features (eg tree regeneration, ground flora) are showing impact from grazing and/ or browsing. If continued at the present level, this may be unsustainable in the long-term.	
C	Several features are in decline as a result of grazing and / or browsing but there is not short-term risk of loss of woodland cover. Grazing or browsing at this level would be unsustainable in the medium-term (ie *c* 20 years).	
D	The woodland habitat is under serious threat from this level of grazing /browsing pressure and such management is unsustainable in the short-term (ie <10 years).	

Appendix 6. Guidance table for determining species of grazing animal present

NB It will be relatively easy to determine the species responsible for the impact in a particular woodland if only one species is present. However, up to 4 species may commonly be impacting, albeit in different seasons. Determining the relative contribution of sheep/deer to the impact will be difficult and may be not possible in some instances.

Animal (plus code)	Signs	Dung (droppings)	Tracks and Pathways	Minimum height of grazed sward	Browsing characteristics (a)	Bark stripping characteristics (b)	Maximum height of (a) and (b)	Comments
Sheep (S)	White wool snagged on fences/shrubs.	Roundish but angular and irregular shape. Smooth surface, shiny when fresh.	Slots rounded at tips. Broader and more rectangular than for deer.	3cm	Ragged ends to bitten-off shoots which are always eaten.	Occasionally. Young to pole stage trees. Can be severe in seriously over-grazed woods. Diagonal incisor marks.	1.5m	Avoids less palatable species in spring (eg rushes). Impact can be uniformly spread over large areas in most regions.
Goats (G)	Black and white wool snagged on fences.	As for sheep.	As for sheep.	6cm	As for sheep.	Can be severe with small/ medium sized trees/shrubs killed. Diagonal incisor marks.	1.5m	Confined to very few areas. Rocky outcrops/ledges are required for shelter and foraging. Can negotiate most fencing with ease.
Cattle (C)	Trampled tall vegetation. Rubbed trees. Poaching.	Large round pats.	Widely splayed deep slots. Pathways 0.3m wide.	6cm	Roughly torn and pulled up vegetation. Trampled standing areas for ruminating.	Rubbed trees only	2.0m	Are often sheltered in woodlands in winter where poaching of soil surface around supplementary feeding stations can occur.
Ponies/ horses (P)	Trampled vegetation. Rubbed trees. Barked stripped trees.	Coarse fibrous heaps.	Rounded hoof marks. Pathways 0.3m wide.	2cm	Nipped favoured vegetation close to ground. Less woody growth.	Individual trees of any age can be stripped in patches.	2.0m	Rarely found or sheltered in close-canopied woodland.

Animal (plus code)	Signs	Dung (droppings)	Tracks and Pathways	Minimum height of grazed sward	Browsing characteristics (a)	Bark stripping characteristics (b)	Maximum height of (a) and (b)	Comments
Roe deer (RO)	Frayed young trees. Hair in barbed wire fencing.	Short blackish cylindrical and pointed at one end. Smooth surface, shiny when fresh.	Well used narrow pathways. Slots pointed and together at tips.	4cm	As for sheep. New bramble and birch shoots favoured.	Rarely strips but frayed stems (ie young bendy trees with bark rubbed off by antlers) frequent on edges.	1.1m	Most likely deer species in the uplands. Impacts may be acceptable where other herbivores absent, due to social spacing.
Fallow deer (F)	As for roe, and chewed/ thrashed plastic tree shelters.	As for roe, but larger with striations and less uniform shape for older males.	As for roe, but pointed tips more splayed (seen at wet muddy crossings).	4cm	As for sheep. Bramble leaves in winter, shoots in spring. Ash also favoured.	Young pole sized trees or stools of favoured species. Bark eaten. Vertical incisor marks. Some frayed young trees.	1.8m	Less likely than red or roe in the uplands. Impact may be heavy but variable due to social spacing, use of favoured traditional areas and degree of disturbance.
Red deer (RE)	As for roe and wallows in wet hollows.	As for fallow, but larger and more fibrous and brownish.	As for fallow but more poached pathways in places.	4cm	As for sheep/roe.	As for fallow.	1.8m	Common in some upland regions. Impacts may be uniformly heavy over large areas. Favours wet, boggy woodlands.
Rabbits (R) and hares (H)	Holes, dunging tumps. Very short vegetation in patches.	Roundish and fibrous. Deposited in favoured areas.	Narrow vegetated pathways. Pad marks evident in snow/frost.	1cm	Sharp angled, knife-like cut ends to bitten shoots which can be left uneaten (NB always left uneaten in hares).	Areas of young/medium aged smooth barked trees and shrubs. 3-4mm wide diagonal incisor marks in pairs. Bark patches removed often not eaten.	0.5m	Locally at very high densities on dry, calcareous free draining slopes mostly on the east side of the Pennines.

Appendix 7. Recommended version - February–March

General Grazing Impact Assessment										
Section 1: General Information										
Site Name:		Grid Reference:		Surveyors:						
Site Code:		Date:								
Woodland Type:		Major Component:		Minor component:						
Supplementary feeding form completed yes/no:				Photos taken (include brief details eg sample point)						
Map attached: yes/no										
Section 2: Grazing Indicators			**Answer all relevant questions yes or no**							
1. Is there an open canopy and a lack of potential canopy trees in the understorey to occupy canopy gaps?										
	1	2	3	4	5	6	7	8	9	10
2. Browse line										
	1	2	3	4	5	6	7	8	9	10
A. Are there basal shoots, epicormic shoots or a shrub layer?										
B. If yes to 2a, is there an absence of browsing on these features?										
C. If yes to 2a, is there an obvious browse line or browsing to shoots lower than 2m ?										
3. Are seedlings or saplings frequent?										
	1	2	3	4	5	6	7	8	9	10
Seedlings (<30cm)										
Saplings (30cm – 2m)										
4. Is the level of browsing on seedlings or saplings heavy?										
	1	2	3	4	5	6	7	8	9	10
5. On trees and shrubs >1.5m tall, is there obvious recent damage to bark below 2m or are stems broken?										
	1	2	3	4	5	6	7	8	9	10

6. Is the typical height of ground vegetation 5cm or less and dominated by grass and moss?										
	1	2	3	4	5	6	7	8	9	10
7. Grazing sensitive species										
	1	2	3	4	5	6	7	8	9	10
A. Are there frequent grazing sensitive species accessible to grazing?										
B. Are they being heavily grazed?										
8. Are there obvious signs of animal disturbance within the sample area?										
	1	2	3	4	5	6	7	8	9	10
9. Site factors										
	1	2	3	4	5	6	7	8	9	10
Is >75% of plot occupied by dense canopy, boulders/unstable scree or dense bracken										
10. Which species of herbivore are present? (refer to guidance table for help with identification).										
	1	2	3	4	5	6	7	8	9	10
Sheep										
Cattle										
Goats										
Ponies/horses										
Deer (specify if known)										
Rabbit										
Hare										

Appendix 8. Recommended version - Growing season

General Grazing Impact Assessment										
Section 1: General Information										
Site Name:		Grid Reference:		Surveyors:						
Site Code:		Date:								
Woodland Type:		Major Component:		Minor component:						
Supplementary feeding form completed yes/no:				Photos taken (include brief details eg sample point)						
Map attached: yes/no										
Section 2: Grazing Indicators			**Answer all relevant questions yes or no**							
1. Is there an open canopy and a lack of potential canopy trees in the understorey to occupy canopy gaps?										
	1	2	3	4	5	6	7	8	9	10
2. Browse line										
	1	2	3	4	5	6	7	8	9	10
A. Are there basal shoots, epicormic shoots or a shrub layer?										
B. If yes to 2a, is there an absence of browsing on these features?										
C. If yes to 2a, is there an obvious browse line or browsing to shoots – only this year's growth of shoots – lower than 2m?										
3. Are seedlings or saplings frequent?										
	1	2	3	4	5	6	7	8	9	10
Above sward height to 2m										
4. Has the level of browsing on seedlings or saplings been heavy within the last year?										
	1	2	3	4	5	6	7	8	9	10
5. On trees and shrubs >1.5m tall, is there obvious recent damage to bark below 2m or are stems broken?										
	1	2	3	4	5	6	7	8	9	10

6. Is the typical height of ground vegetation 5cm or less and dominated by grass and moss?										
	1	2	3	4	5	6	7	8	9	10
7. Grazing sensitive species										
	1	2	3	4	5	6	7	8	9	10
A. Are there frequent grazing sensitive species accessible to grazing?										
B. Have they been heavily grazed? (Note: bramble, bilberry, ivy, honeysuckle and raspberry may have been heavily browsed the previous winter and current year's growth may be unaffected in the growing season)										
8. Are there obvious signs of animal disturbance within the sample area?										
	1	2	3	4	5	6	7	8	9	10
9. Site factors										
	1	2	3	4	5	6	7	8	9	10
Is >75% of plot occupied by dense canopy, boulders/unstable scree or dense bracken										
10. Is there evidence of poaching under a sward of species such as cock's foot, thistle, buttercup and dock over >20% of the plot?										
	1	2	3	4	5	6	7	8	9	10

11. Which species of herbivore are present? (refer to guidance table for help with identification).										
	1	2	3	4	5	6	7	8	9	10
Sheep										
Cattle										
Goats										
Ponies/horses										
Deer (specify if known)										

Rabbit										
Hare										

Accompanying notes for the February to March survey

1. An open canopy is <75% by aerial projection if tree is in leaf. Potential canopy trees include birch, oak, ash, rowan, beech, sycamore, cherry (ie species other than those normally restricted to the understorey) >2m tall.
2. If you have answered *No* to 2A, ignore 2B and C. 2B will apply only where signs are obvious (ie there are no signs of browsing, with branches well within reach of browsing animals). 2C will apply where signs of browsing are obvious on existing shoots (ie where inspection of trees with epicormic shoots reveals a clear difference between those shoots growing above the reach of browsing animals (typically showing >2 years growth and those below (browsed shoots of this year's growth) or where a shrub layer exists and there is a marked browse line visible from a single vantage point selected near the centre of the sample area (most obvious from crouching position). Note that 2B and C are mutually exclusive.
3. Frequent equals closer than 7m. Do not record YES if seedlings or saplings are restricted to crevices beyond the reach of grazing animals (eg on rock outcrops or within piles of deadwood etc.).
4. Heavy browsing is >50% of growing shoots browsed. Record YES even if seedlings are rare.
5. Obvious damage is usually gnawing, stripping or rubbing of bark on trunks or branches, more rarely breakage of branches. Record yes if >10% of trees >1.5m high are damaged below 2m. Ignore old callused over damage.
6. If >75% of the plot is occupied by unstable scree, boulders or a very dense canopy (whether under- or overstorey – eg beech canopy or holly understorey), record NO, even if the ground vegetation is dominated by moss.
7. Grazing sensitive species include: bramble, bilberry, raspberry, ivy, honeysuckle, greater woodrush. Ignore the question if there are grazing sensitive species which are restricted to crevices beyond the reach of browsing animals. If you have answered *No* to 7A, ignore 7B.
8. Signs of animal disturbance should be clearly visible from a single vantage point selected near the centre of the sample area. Answer YES if either:

→ extensive poaching with bare soil visible occupies >20% of the plot area

→ there is a water course within the plot and >20% of watercourse margins have bare soil visible, caused by animal activity.

9. Dense canopy equals closed canopy of beech (possibly sycamore) or a dense understorey of shrubs such as holly or hazel (ie where, in the growing season, there would be insufficient light for seedlings to survive). Only record *Yes* for boulders or unstable scree where they are acting as a barrier to tree seedling or vegetation establishment. Only record *Yes* for dense bracken where bracken litter has excluded other vegetation over >75% of the site.
10. Refer to guidance table for help with identification.

Accompanying notes for the growing season survey

1. An open canopy is <75% by aerial projection if tree is in leaf. Potential canopy trees include birch, oak, ash, rowan, beech, sycamore, cherry (ie species other than those normally restricted to the understorey) >2m tall.

2. If you have answered *No* to 2A, ignore 2B and C. 2B will apply only where signs are obvious (ie there are no signs of browsing, with branches/ shoots well within reach of browsing animals). 2C will apply where signs of browsing are obvious on existing shoots (ie where inspection of trees with epicormic shoots reveals a clear difference between those shoots growing above the reach of browsing animals (typically showing >2 years growth and those below (browsed shoots of this year's growth or only this year's shoots present, unbrowsed) or where a shrub layer exists and there is a marked browse line visible from a single vantage point selected near the centre of the sample area (most obvious from crouching position). Note that 2B and C are mutually exclusive.
3. In the growing season, do not include seedlings at or below sward height as these may have regrown from browsed root stocks the previous winter. Frequent equals closer than 7m. Do not record YES if seedlings/saplings are restricted to crevices beyond the reach of grazing animals (eg on rock outcrops or within piles of deadwood etc.).
4. Heavy browsing is >50% of the number of last year's growing shoots browsed. Record YES even if seedlings are rare.
5. Obvious damage is usually gnawing, stripping or rubbing of bark on trunks or branches, more rarely breakage of branches. Record yes if >10% of trees >1.5m high are damaged below 2m height. Ignore old callused over damage.
6. If >75% of the plot is occupied by unstable scree, boulders or a very dense canopy (whether under- or overstorey – eg beech canopy or holly understorey), record NO, even if the ground vegetation is dominated by moss.
7. Grazing sensitive species include: bramble, bilberry, raspberry, ivy, honeysuckle, greater woodrush. In the growing season, species include wood cranesbill, valerian and angelica. Answer *NO* if there are grazing sensitive species which are restricted to crevices beyond the reach of browsing animals. If you have answered *No* to 7A, ignore 7B. Note: bramble, bilberry, ivy, honeysuckle and raspberry may have been heavily browsed the previous winter and current year's growth may be unaffected in the growing season. Record *Yes* if current year's growth is unbrowsed and there are either signs of browsing on previous year's (woody) growth or there is an absence of previous year's growth.
8. Signs of animal disturbance should be clearly visible from a single vantage point selected near the centre of the sample area. Answer *Yes* if either:

→ extensive poaching with bare soil visible occupies >20% of the plot area

→ there is a water course within the plot and >20% of watercourse margins have bare soil visible, caused by animal activity.

9. These conditions indicate that the wood is used to shelter cattle in the winter. Usually associated with supplementary feeding. In the summer, vegetation can be >1m height.
10. Dense canopy equals closed canopy of beech (possibly sycamore) or a dense understorey of shrubs such as holly or hazel (ie where there is insufficient light for seedlings to survive). Only record *Yes* for boulders or unstable scree where they are acting as a barrier to tree seedling or vegetation establishment. Only record *Yes* for dense bracken where bracken litter has excluded other vegetation over >75% of the site.
11. Refer to guidance table for help with identification.

Appendix 9. Ordinal Logistic Regression

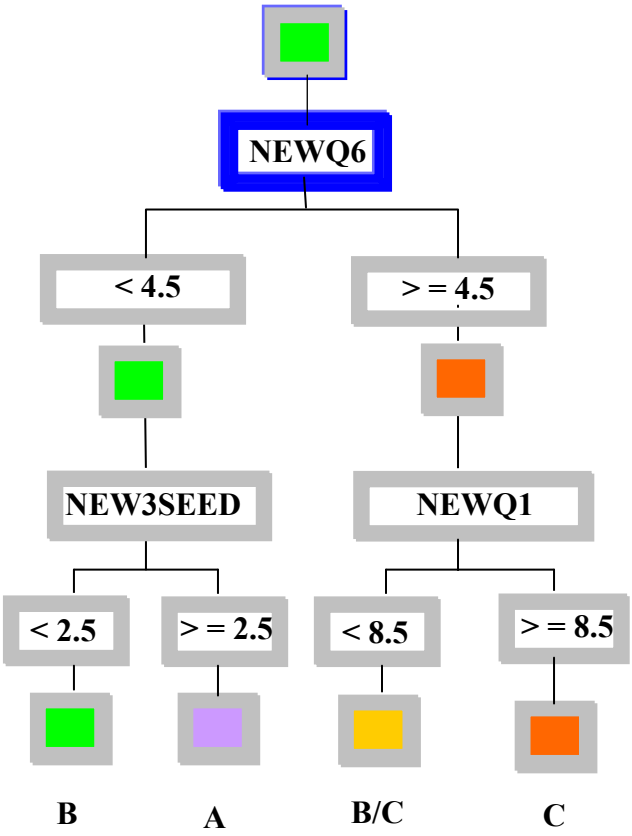
Ordinal Logistic Regression Table using New Assessment Form. Note that the scores shown are different to those on p. 38 due to the re-configuration of the questions used (ie the change of wording from the method assessment survey form to the February March form).

Assessment score	newQ3comb /2	newQ4	newQ6	newQ1
0	17	0	0	0
1	16	0	1	0
2	14	0	2	1
3	12	1	2	1
4	10	1	3	2
5	9	1	4	2
6	7	1	5	3
7	5	2	5	3
8	3	2	6	3
9	2	2	7	4
10	0	2	8	4

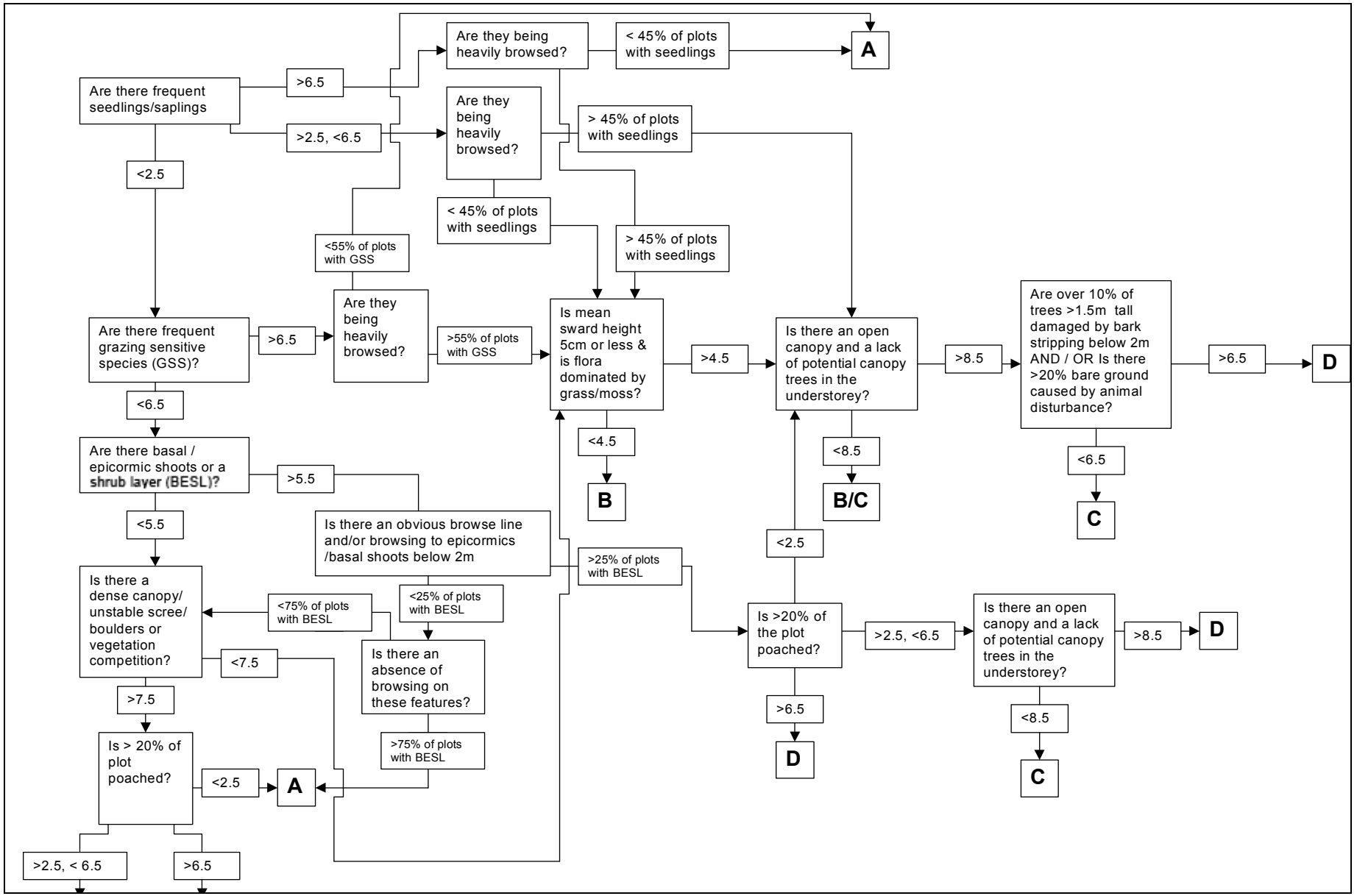
Score	Class
0-18	A
19-23	B
24-26	B/C
27-31	C

Appendix 10 Classification tree using the New Assessment Form

Note that some of the threshold values have changed from those on page 29 due to the re-configuration of the questions on the February – March version of the form.



Appendix 11. 'Expert' Decision Tree



Appendix 12 Worked example using three methods of analysis

This report presents three models to help surveyors reach a summary assessment of the level of grazing impact (ie whether the wood is classed A, B, B/C, C or D). The approaches to using the Classification tree and 'expert' tree are very similar. To reach a summary assessment, the following steps should be completed:

1. Assess the woodland using the protocol identified on page 14 of this report, using the recommended February – March version of the form (appendix 7, p.71). To use the threshold values directly, ten plots will be required (ie the standard amount for woodlands above 2.5 hectares).
2. Once the ten plots have been completed, add up all the YES answers for each question.
3. Using these values, work your way through the decision tree to reach a summary assessment. Descriptions of what these classes mean can be found in Table 4, on page 31.
4. A quick answer should be obtainable using the classification tree as only a limited number of steps are included. For the 'expert' tree, an answer can be obtained quickly (eg where there are frequent seedlings which are not being heavily browsed). In more heavily grazed cases though, a greater number of steps will need to be worked through to reach an answer.
5. Each threshold value refers to the proportion of the ten plots with YES answers (ie >6.5 means that 7 or more plots had a YES answer for that question).
6. Where the wood is too small to fit in ten plots, it is possible to reach a separate summary assessment for each plot by substituting > (ie more than) values for Yes and < (ie less than) values for No or Not Applicable. A balanced decision would then need to be made about what overall assessment is given to a wood with widely differing results for each plot (eg a wood only has room for 5 plots and 3 are A, one is B and the fifth is a C).

To use the Ordinal Logistic Regression Model, steps 1-2 above should be followed and then:

3. For each of the selected questions (3, 4, 6 and 1) , identify the number of YES answers in the left hand column and read across to look up the score. Note, for question three, the number of YES answers will need to be divided by 2 as there is a possible total of 20 for YES answers for this question.
4. Add all scores up from the four questions to determine the class (using the separate table on the right hand side).

The following pages provide a worked example using Ordinal Logistic Regression (p. 38 and appendix 9) the Classification decision Tree (p. 39 and appendix 10) and the 'expert' decision tree (p. 40 and appendix 11).

Summary of worked example

In the example provided, the tree models both predicted a B/C classification. The ordinal Logistic regression model predicted a C. In all three cases, the result was on the threshold between B/C and C, canopy cover being less than 75% in 8 plots and the threshold being 8.5 plots. To summarise the three results from the worked example, it could be said that the site was classed as a B/C but very nearly fell into the C class.

At this stage of the method's development, we recommend using all three models to reach a summary assessment. As more data become available, it should be possible to refine the models and recommend the most accurate option.

February – March

General Grazing Impact Assessment

Section 1: General Information

Site Name:		Grid Reference:		Surveyors:	
Site Code:		Date:			
Woodland Type:		Major Component:		Minor component:	
Supplementary feeding form completed yes/no:				Photos taken (include brief details eg sample point)	
Map attached: yes/no					

Section 2: Grazing Indicators	**Answer all relevant questions yes or no**									
1. Is there an open canopy and a lack of potential canopy trees in the understorey to occupy canopy gaps?										
	1	2	3	4	5	6	7	8	9	10
	YES	No	YES	YES	No	YES	YES	YES	YES	YES
2. Browse line										
	1	2	3	4	5	6	7	8	9	10
A. Are there basal shoots, epicormic shoots or a shrub layer?	No	No	No	No	No	No	No	YES	YES	No
B. If yes to 2a, is there an absence of browsing on these features?	———	———	———	———	———	———	———	No	No	
C. If yes to 2a, is there an obvious browse line or browsing to shoots lower than 2m ?	———	———	———	———	———	———	———	YES	YES	
3. Are seedlings or saplings frequent?										
	1	2	3	4	5	6	7	8	9	10
Seedlings (<30cm)	No	No	No	No	No	No	No	No	No	No
Saplings (30cm – 2m)	No	No	No	No	No	No	No	No	No	No
4. Is the level of browsing on seedlings or saplings heavy?										
	1	2	3	4	5	6	7	8	9	10
	No	No	No	No	No	No	No	No	No	No

8

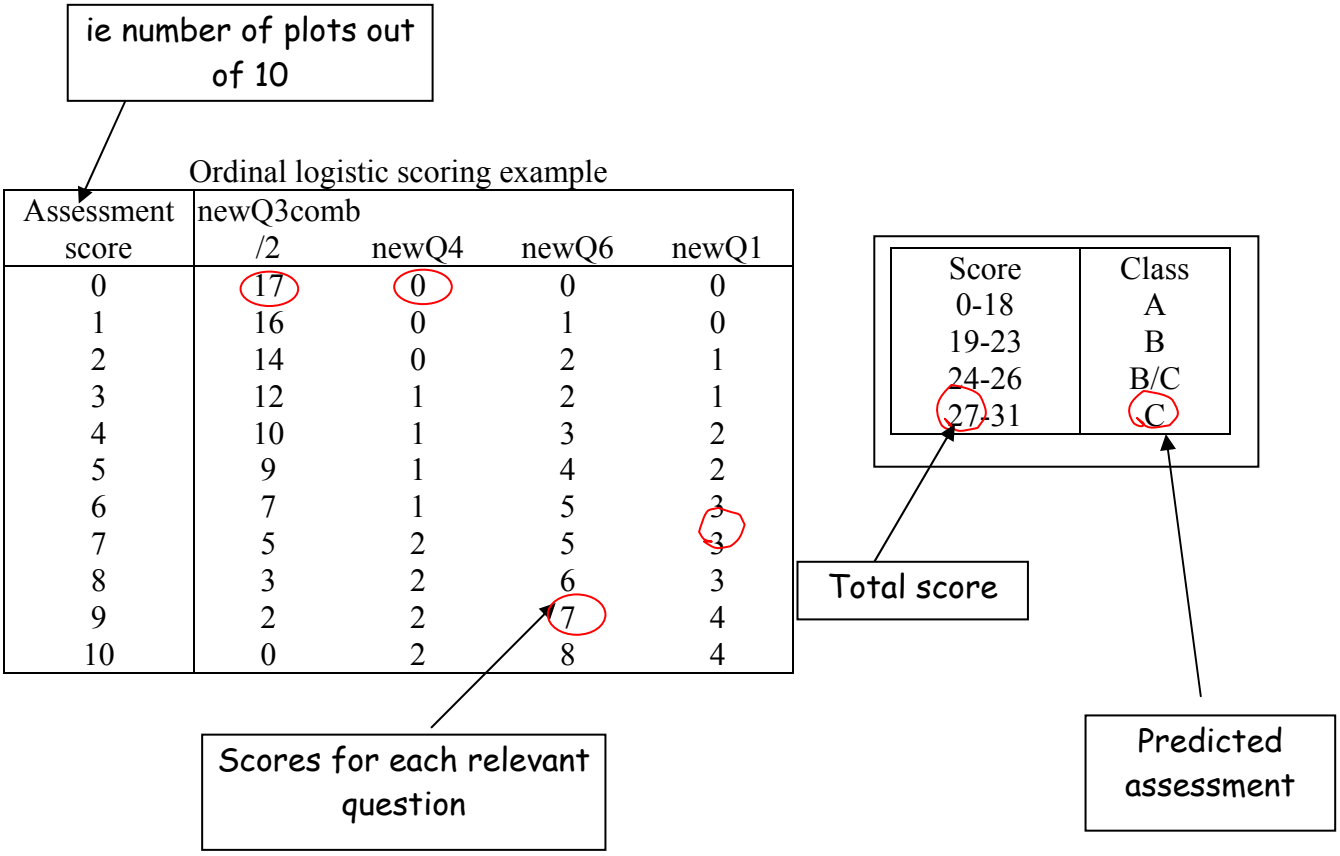
2

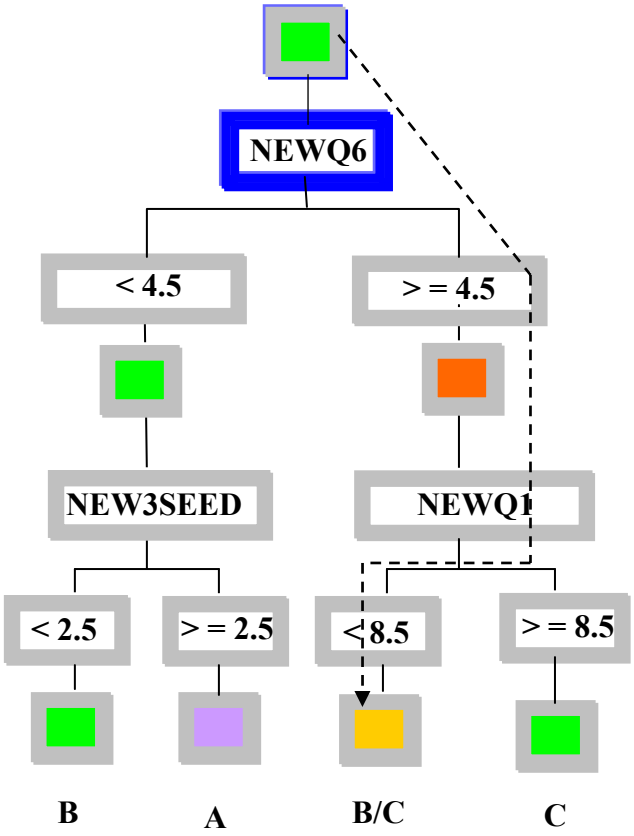
2

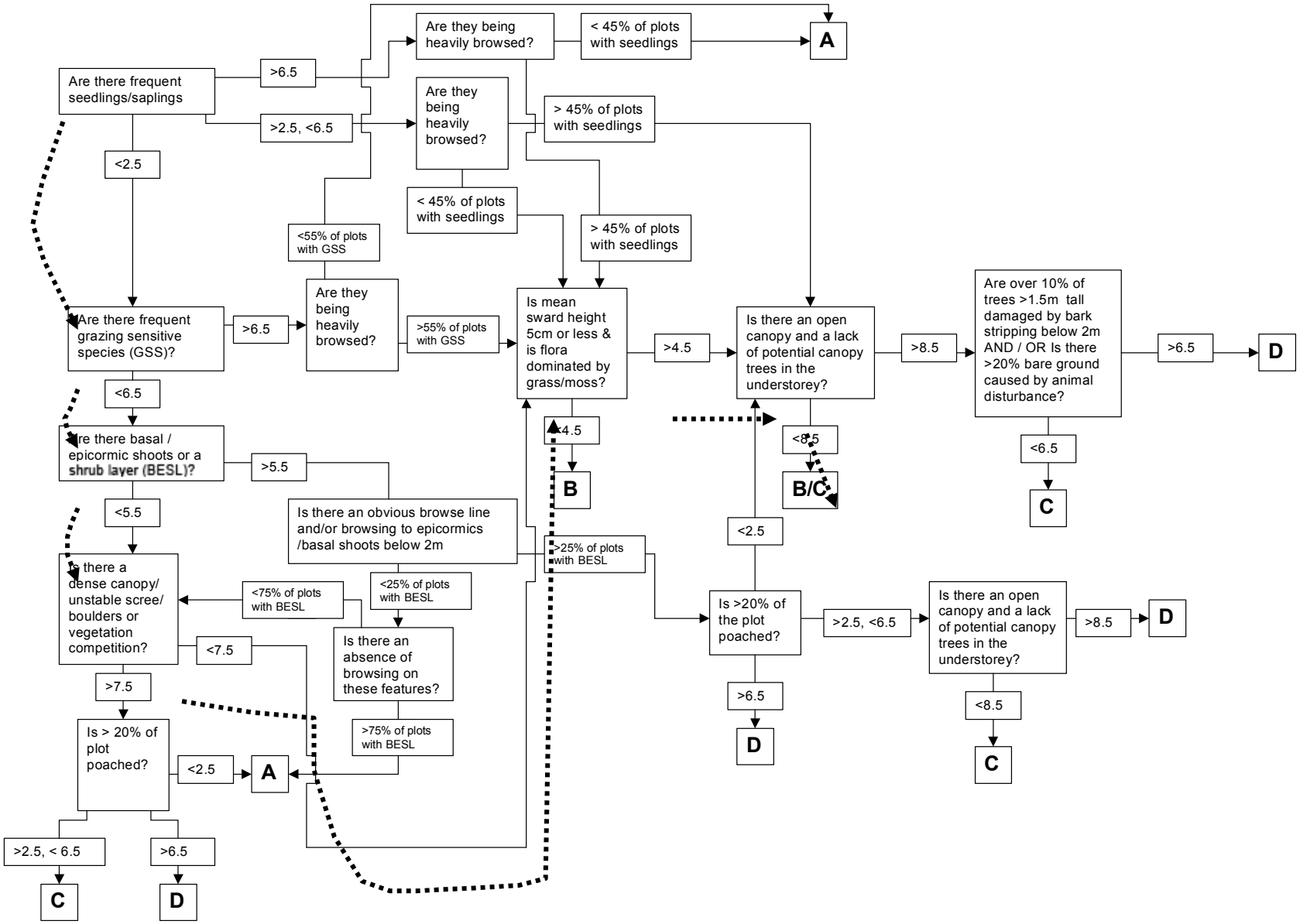
5. On trees and shrubs >1.5m tall, is there obvious recent damage to bark below 2m or are stems broken?											
	1	2	3	4	5	6	7	8	9	10	
	No	No	No	YES	No	YES	YES	No	YES	No	4
6. Is the typical height of ground vegetation 5cm or less and dominated by grass and moss?											
	1	2	3	4	5	6	7	8	9	10	
	YES	YES	YES	YES	YES	YES	YES	YES	YES	No	9
7. Grazing sensitive species											
	1	2	3	4	5	6	7	8	9	10	
A. Are there frequent grazing sensitive species accessible to grazing?	No	No	No	No	No	No	No	No	No	No	
B. Are they being heavily grazed?	———	———	———	———	———	———	———	———	———	———	
8. Are there obvious signs of animal disturbance within the sample area?											
	1	2	3	4	5	6	7	8	9	10	
	Yes	No	No	Yes	No	No	No	No	No	No	2
9. Site factors											
	1	2	3	4	5	6	7	8	9	10	
Is >75% of plot occupied by dense canopy, boulders/unstable scree or dense bracken	No	No	No	No	No	No	No	No	No	No	

10. Which species of herbivore are present? (refer to guidance table for help with identification).										
	1	2	3	4	5	6	7	8	9	10
Sheep	✔	✔		✔		✔	✔	✔	✔	✔
Cattle										
Goats										
Ponies/horses										
Deer (specify if known)	✔			✔	✔		✔		✔	
Rabbit										
Hare										

Ordinal Logistic Regression




NEWQ6
< 4.5
> = 4.5
NEW3SEED
NEWQ1
< 2.5
> = 2.5
< 8.5
> = 8.5
B
A
B/C
C


Are there frequent seedlings/saplings
>6.5
>2.5, <6.5
<2.5
Are they being heavily browsed?
< 45% of plots with seedlings
A
Are they being heavily browsed?
> 45% of plots with seedlings
< 45% of plots with seedlings
> 45% of plots with seedlings
<55% of plots with GSS
Are they being heavily browsed?
>55% of plots with GSS
Are there frequent grazing sensitive species (GSS)?
>6.5
<6.5
Are there basal / epicormic shoots or a shrub layer (BESL)?
>5.5
<5.5
Is there a dense canopy/ unstable scree/ boulders or vegetation competition?
<75% of plots with BESL
<25% of plots with BESL
<7.5
>7.5
Is there an absence of browsing on these features?
>75% of plots with BESL
Is > 20% of plot poached?
<2.5
A
>2.5, < 6.5
>6.5
C
D
Is there an obvious browse line and/or browsing to epicormics /basal shoots below 2m
Is mean sward height 5cm or less & is flora dominated by grass/moss?
>4.5
<4.5
B
>25% of plots with BESL
Is there an open canopy and a lack of potential canopy trees in the understorey?
>8.5
<8.5
B/C
<2.5
Is >20% of the plot poached?
>2.5, <6.5
>6.5
D
Are over 10% of trees >1.5m tall damaged by bark stripping below 2m AND / OR Is there >20% bare ground caused by animal disturbance?
>6.5
D
<6.5
C
Is there an open canopy and a lack of potential canopy trees in the understorey?
>8.5
D
<8.5
C

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Peter Wakely/English Nature 17,396
Middle left: Co_2 experiment at Roudsea Wood and Mosses NNR, Lancashire.
Peter Wakely/English Nature 21,792
Bottom left: Radio tracking a hare on Pawlett Hams, Somerset.
Paul Glendell/English Nature 23,020
Main: Identifying moths caught in a moth trap at Ham Wall NNR, Somerset.
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