Research Report No. 1190

Observer Variation in the Use of a Method of Assessing Current Herbivore Impacts in Woodland

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Summary

Observer Variation in the Use of a Method of Assessing Current Herbivore Impacts in Woodland

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Background

The Woodland Herbivore Impact Assessment Method (WHIA) was developed as a means of assessing the impact of all species of large herbivore on woodlands. The method provides a standard range of indicators, and standard ways of assessing herbivore impacts on those indicators. The method is based on observations, rather than measurements, of impact levels on seven indicators at ten roughly 25-m radius 'stops' located throughout a woodland. Due to the relative simplicity, low cost and speed of the method it is suitable for use by woodland, deer and stock managers as well as by professional surveyors. Although the WHIA has become increasingly used for a range of purposes, its reliability for formal impact assessment is currently unknown due to a lack of information on observer variation. This study sought to address this lack by comparing the results obtained by fifteen surveyors assessing the same four sites with High, Medium-High and Medium impact levels on the browsing /grazing indicators. Comparing sites with Low and Medium impacts may yield different results. It is, however, difficult to find such sites.

Main findings

- On average across all four sites, the percentage of surveyors who recorded an impact level that was within half a category of the overall median impact was 85, 73, 82, 72, 88, 72 and 85 for each of the seven indicators; basal shoots, epicormic and lower shoots, seedlings and saplings, preferentially browsed plants, bark stripping, fraying and stem breakage and ground disturbance, respectively. The equivalent percentage who recorded an impact level within one full category of the overall median impact was 98, 95, 100, 100, 95, 93 and 100.

- Between 20% and 47% of surveyors (depending on the indicator) showed a consistent bias in their assessment of impact on individual indicators.
- A detailed analysis of the results for the seedlings and saplings indicator showed high variation in the stop-level impacts recorded by the surveyors.
- Most of the between-surveyor variation in stop- and also in site-level impacts on seedlings and saplings was due to differences between surveyors in the assessment of browsing rates (percentage of shoot biomass removed by browsing) on seedlings and saplings.
- Consistency in assessing browsing rates might be improved by:
  - Telling surveyors to ignore very short shoots since these may often be the result of late summer growth after summer browsing.
  - Improving the guidance on the conditions under which a seedling /sapling is likely to be 'unavailable' to browsing animals.
  - Improved guidance on assessing browsing rates on holly seedlings and saplings.

The first two of these issues have been addressed in an updated version of the methodology (Armstrong *et al.* 2020).

- There were large differences in the numbers of seedlings and saplings found by different surveyors at individual stops, and overall across a site
- No surveyor recorded total numbers of seedling and sapling species at all four sites that were consistently above, or below, the average.

Conclusions

- The level of variation in results obtained by different surveyors using the method, as it was specified in this study (Annex 1), means that a WHIA carried out by one surveyor, though sufficiently reliable for many purposes, may not be accurate enough for all situations where a WHIA is needed.
- Two surveyors working together on an impact assessment, at least for the initial stop or stops, may produce results that are more accurate as might the use of the updated version of the methodology (Armstrong *et al*. 2020). The effect of these on observer variation has not yet been tested.
- For sites where a more robust assessment is needed, several independent assessments could be obtained.

Recommendations for further work

- Further testing of updates to the methodology should focus on assessing the consistency with which surveyors assess browsing /grazing rates.
- Where the method is to be used to determine merely whether a site has a Low impact or not, assessing browsing on basal shoots, epicormic and lower shoots and seedlings and saplings by estimating the 'percentage of shoots browsed' rather than the 'percentage of shoot biomass removed' may be adequate and likely to give better inter-surveyor consistency as it is an easier quantity to estimate. This change would be less useful where clear distinction needs to be made between Medium, High or Very High impact levels.
- A field handbook with diagrams of different browsing /grazing rates on different tree /plant species may improve inter-observer consistency in assessing browsing /grazing rates although this would need to be tested.
- Analysis of the data on the six indicators that were not analysed in this study may yield further insights into methods of improving inter-surveyor variation.

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1 INTRODUCTION

The Woodland Herbivore Impact Assessment Method (WHIA) is an observation-based method of assessing the impact of large herbivores on woodlands. The method was developed with funding from NatureScot and Scottish Forestry (SF), as part of the Woodland Grazing Toolbox (an online guide to writing woodland grazing management plans; https://forestry.gov.scot/woodland-grazing-toolbox. Although originally developed to monitor the impact of domestic stock used to achieve nature conservation objectives in woodlands it has, over time, become more frequently used to assess the impact of wild deer on woodlands. The near ubiquitous presence of deer in Scottish woods, coupled with the relatively simple, and low cost, approach used in the method, has led to it becoming increasingly used for this purpose. Although the method was not intended to provide proof of a given level of impact nor to provide hard evidence of a given change in impact over time, its increasing use for these purposes prompted NatureScot and SF to fund the current study. The results will inform the guidance that these organisations provide to deer and woodland managers on the appropriate use of the method. They may also point to changes to the method, or to the documentation, that will reduce observer variation.

Although the WHIA provides guidance on assessing medium- and long-term, as well as current, impacts on woodlands, this study has focussed solely on the assessment of current impacts i.e. those that have taken place since the start of the previous growing season. This is the component of the WHIA that is most useful for deer managers. Similarly, although the WHIA provides guidance on two 'levels' at which the assessment can be carried out, this study focussed solely on the 'level 2' assessment which includes the collection of detailed field information (see Annex 1 for more details). This information was thought likely to be of use in explaining any observer variation.

2 METHODS

2.1 Study sites

In February 2018, six potential woodlands to be included in the study were visited by the author and, of these, four were chosen. All four were upland, broadleaved woodlands designated as Sites of Special Scientific Interest and located within the Loch Lomond and the Trossachs National Park (Figure 1). All were judged to have between Medium and Very High current deer impact levels on browsing /grazing indicators. The sites chosen were: Pass of Leny Falls, Fairy Knowe (the more southerly part of Fairy Knowe and Doon Hill SSSI), Beinglas (the most southerly part of Glen Falloch SSSI) and Glen Loin (Figure 1; Table 1). Beinglas is privately owned whilst the other three sites are owned by Forestry and Land Scotland.

Figure 1. Location of the four woodland SSSIs used in the study.

Table 1. Descriptions of the four woodland SSSIs used in the study. (taken from NatureScot site management statements).

Site	Woodland description
Pass of Leny Flushes 36.23 ha	Pass of Leny Flushes lies on a north facing slope on the south bank of the River Teith. The SSSI consists of a series of nutrient-rich upland flushes set in acidic moorland and native deciduous woodland. The upland oak woodland, set within this mosaic of wet woodland and flushed open ground, is of ancient and long-established origin. It is dominated by sessile oak and downy birch, with a field layer of blaeberry, grasses and bracken. The wet birch woodland with willow and alder is also an important aspect of the site. Calcareous flushes form where groundwater percolates up through lime-rich soils, picking up nutrients on the way to form an area of enriched wet grassland. These flushes form a mosaic throughout the site and are characterised by plants such as broad-leaved cottongrass, fragrant orchid and butterwort, as well as sharp-flowered rush, globeflower and marsh violet. Calcareous flushes such as these are uncommon in the Stirling Council area.
Fairy Knowe 42.84 ha	Situated on steeply undulating rocky knolls, the woodlands comprise a dominant canopy of oak with birch on the higher slopes and ash, rowan and hazel over pockets of base rich soils. Additional tree and shrub species represented include; Scots pine, beech, aspen, holly and hawthorn. Clumps of bracken and bramble occur in localised areas. In a number of locations, the bedrock reaches the surface creating treeless rocky clearings. There is a mixed carpet of associated ground flora, dominated by blaeberry and heather with locally rare species such as alternate-leaved golden saxifrage.
Beinglas 30.6 ha	The canopy at Beinglas Wood, which is on a steep west facing slope, is a mixture of oak, birch, ash and hazel. Beinglas Wood was under a Woodland Grant Scheme agreement (1999-2004) as part of the Atlantic Oakwoods LIFE Project. Deer fencing has been erected around the perimeter and dense bracken areas have been sprayed with Asulox.
Glen Loin 65.19 ha	The natural features of the site are upland oak woodland on higher ground and upland mixed ashwood on the lower ground. The oak woodland is diverse and open in part, with broad tree canopies and a rich understorey of bryophytes and extensive expanses of wood hyacinth. The sessile oak is mostly an infrequent component of the wood except on the middle north slopes of the SSSI. Here there are a few older specimen trees of good size. The oak woodland shows evidence of coppicing and pollarding in the distant past. The upland ash woodland occurs on the lowest slopes where the ground is mineral enriched from a band of base-rich Rhyolite rocks. It has a richly diverse and regenerating understorey dominated by ash with some alder, rowan and sessile oak. Unlike the rest of the SSSI, the lowest slopes have low grazing pressure. Consequently there is a rich ground flora including grass-of-Parnassus, dog's mercury, wood avens, bromes and many species of ferns. This feature has not been monitored since it has recently been assigned to the site as a reassessment of the original feature. There is much more regeneration in this section of the wood due to the proximity of a well-used path and road that probably makes the area less attractive to deer.

2.2 Field surveys

The WHIA documentation current at the time (version 29 December 2017; Annex 1) was used as the basis for the field surveys. Level 2 surveys were carried out as described in the documentation with the exception that photographs were not taken at each stop. Surveyors were also asked to provide notes on the weather on each field day and an estimate of the time spent in the field on each survey.

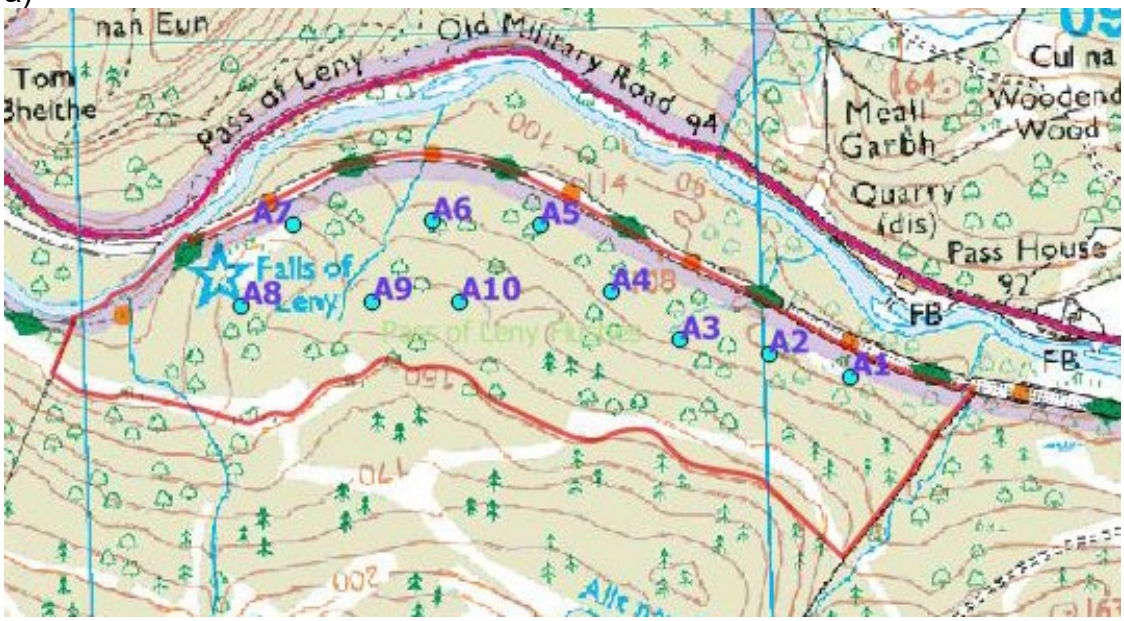
The author carried out a WHIA at each site in February 2018 (Table 2). Fourteen other surveyors, all experienced in the use of the WHIA, took part in the study. Of these, five worked for NatureScot, three for Forestry and Land Scotland, two for Woodland Trust Scotland and four were independent consultants. All surveyors attended a one-day refresher /standardisation course prior to carrying out the WHIA surveys. They then all carried out a WHIA at all four of the sites between 12 and 27 March 2018 (Table 2). Surveyors were allowed to visit the stops together but were instructed not to discuss their observations or findings with other surveyors. Surveyors were asked to spend one day at each site and to focus on accuracy rather than speed even if this meant that results were recorded for fewer than the ten stops recommended in the guidance. In four cases, surveyors returned to sites on a second day to complete their surveys (Table 2). In another eleven cases, surveyors were not able to assess all ten stops in the single day allocated. In all but one of these cases, at least seven stops were visited but in one case, due to injury, only five stops were visited (Table 2).

Table 2. Day of the month on which WHIA surveys were carried out at each site by the author (surveyor 1) and by each of the other surveyors. All surveys were undertaken in March 2018 except for those undertaken by the author that were carried out in February 2018. Also shown in brackets is the number of stops assessed where this was fewer than ten.

	Site			
Surveyor	Pass of Leny	Fairy Knowe	Beinglas	Glen Loin
1	1	2	7	8
2	16	12	20	19
3	16	12	26	22
4	13	12 (8 stops)	23 (8 stops)	22
5	16	15	23 (8 stops)	21 (7 stops)
6	26	27	13	10 (9 stops)
7	13	14	22 (5 stops)	21 (8 stops)
8	16	15	20 /23	21 /22
9	15	14	22	24
10	15	16	21	22
11	15	12	26	22
12	14 (8 stops)	12	21 (8 stops)	19 /20
13	14 (8 stops)	12	21 (8 stops)	19 /20
14	17	16	24	23
15	15	14	26	26

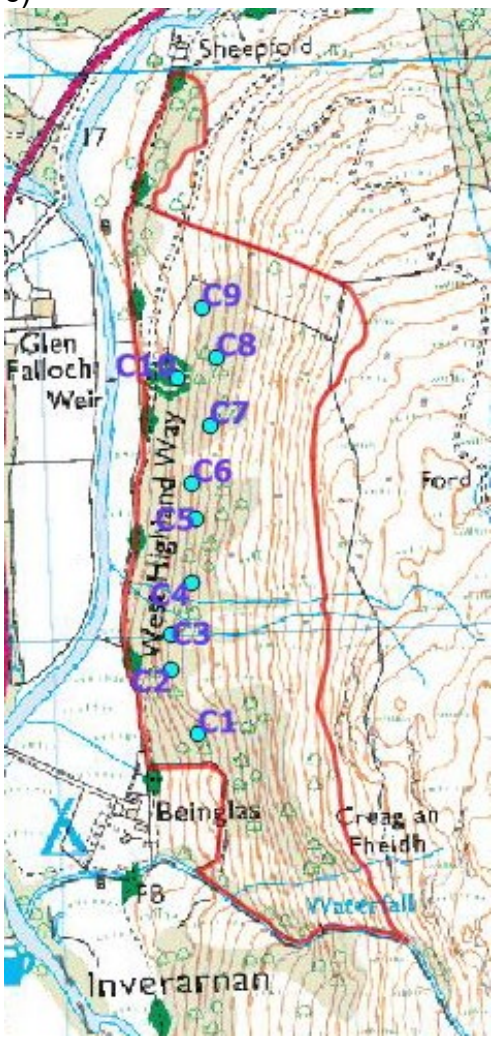
In February 2018, whilst carrying out the WHIAs, the author recorded the location of each stop at each site using a GPS (Figures 2a-d). The GPS files were provided to the other 14 surveyors so that they could make their assessments at the same stops. Where necessary, surveyors were given training in the use of a GPS on the training day. At Pass of Leny, surveyor 5 did not have a GPS and had to rely on estimating the stop locations from a printed map.

a)



b)

c)



d)

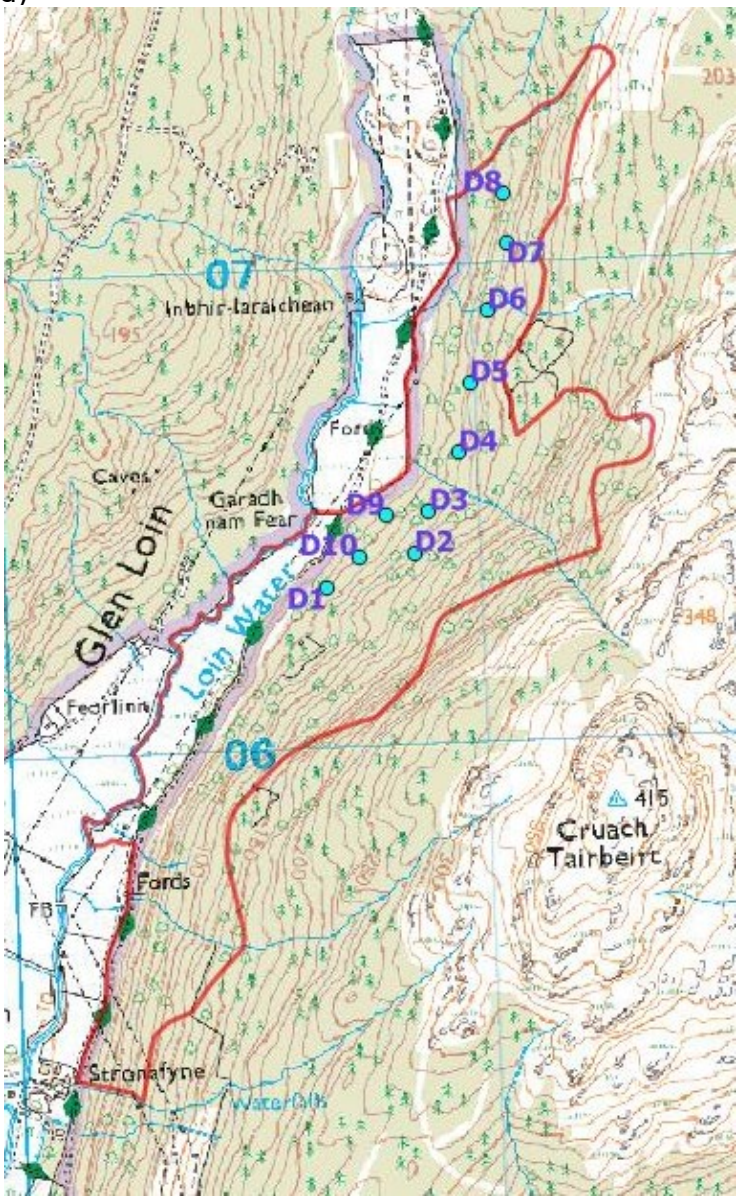


Figure 2 Maps of SSSI boundaries (red line) and the location of the stops (blue circles labelled with the stop name) at a) Pass of Leny, b) Fairy Knowe, c) Beinglas and d) Glen Loin.

Surveyors followed the guidance provided (Annex 1), together with further explanation and standardisation provided on the training day, to make their assessments. In particular, surveyors were asked to record the number of instances of each tree/plant species in each browsing/grazing category but, where this was a large number, to record instead e.g. >10, >20, >50. In two cases surveyors mis-interpreted the guidance in minor ways. Surveyor 10 used the wrong method of assessing browsing offtake at Pass of Leny and Fairy Knowe. Instead of estimating the percentage of the growth of all of the previous summer's growth that had been removed by browsing, surveyor 10 estimated the percentage of the biomass removed from only the browsed shoots. This may have led to an over-estimate of browsing levels, and so of impact levels, on basal shoots, epicormic and lower shoots and seedlings and saplings. Surveyor 15 included unbrowsed trees and plants in the 'Lightly browsed' category rather than recording them as 'Unbrowsed'.

This may have resulted in the impact for some indicators at some sites being assessed by this surveyor as ‘Low’ rather than as ‘No impact’. All other surveyors used the correct method.

Surveyors returned scanned copies, or photos, of all completed field sheets to the author. They also provided their assessment of the overall impact on each indicator at each site based on the results for all stops assessed. This was usually the mode or median result although the guidance allowed surveyors to give more weight to stops where there were more examples of the indicator present than to those where there were fewer present. Thus, for example, the result for a stop with twenty seedlings or saplings present would carry more weight than one where only one seedling or sapling was present.

2.3 Data summary and analysis

The degree of variation between surveyors in their assessment of current herbivore impact on each indicator was assessed at both the site and the stop level. Given that the ‘correct’ impact level was unknown, the median impact level was taken as the standard against which the recorded results were compared. The exception is where a numerical mean method was used. In this case, the overall mean was used as the standard.

Four potential sources of variation may have contributed to the variation between surveyors in the assessment of impact at each site on each indicator.

1. Different approaches to converting stop results into an overall site result for each indicator.
2. Different approaches to the conversion of impacts on different examples of each indicator at a stop into an overall result for the stop. This applies only to indicators for which there could be numerous examples at one stop. These were: basal shoots, epicormic and lower shoots, seedlings and saplings and preferentially browsed /grazed plant species. In theory, this could also apply to bark damage and sward impacts however, in this study, very little bark damage or sward impact was found so this was not relevant to these indicators.
3. Differences in the number, or type, of examples of indicators found at each stop.
4. Differences in the assessment of browsing /grazing levels on individual examples of an indicator (applies to basal shoots, epicormic and lower shoots, seedlings and saplings and preferentially browsed /grazed plant species) or of bark damage, ground disturbance or sward impact at individual stops.

The effects of factor 1 on the variation between surveyors in the site-level impact results were investigated using data for all seven indicators. Due to time constraints, the results for only one indicator (seedlings and saplings) were analysed for the effects of factors 2-4. The ‘seedlings and saplings’ indicator was chosen because of the large amount of data collected on this indicator.

3 RESULTS

3.1 Methodological issues

3.1.1 Comparison between the author's, and the other surveyors', assessments

The author surveyed the four sites several weeks before the other fourteen surveyors carried out their assessments (Table 1). In theory, since deer impacts are cumulative over the winter, this may have resulted in lower impacts being recorded at this time. Had this been the case, the author's results would not have been included in the analysis of observer variation. In practice, all of the author's results relating to four of the indicators were either above, or equal to, the median result (Table 3). Only at one site for each of the 'Sward' and 'Ground disturbance' indicators was the author's result below the median and, in both cases, it was lower by only half a category. The author's results at three of the sites for the indicator 'Bark stripping, fraying and stem breakage' were, however, lower than the median; at two sites by half a category and at one site by one category (Table 3). The results were, however, within the range of the other surveyors' results. Overall, there was no clear evidence that any increase in deer impact between the times of the author's, and the other surveyors', assessments resulted in the author's assessments being lower than those of the other surveyors. The author's results were, therefore, combined with those of the other surveyors for subsequent analyses.

Table 3. The median herbivore impact level recorded by all 15 surveyors, together with the result recorded by the author at each site for each indicator. NI = No impact, L = Low, M = Medium, H = High, VH = Very High. Intermediate levels are shown with a hyphen between the two levels. Also shown is whether the author's result was above (A; green background), equal to (E; yellow background) or below (B; pink background) the median.

	Site											
	Pass of Leny			Fairy Knowe			Beinglas			Glen Loin		
Indicator	Median	Result	A, E, B	Median	Result	A, E, B	Median	Result	A, E, B	Median	Result	A, E, B
Basal shoots	M-H	H	A	H	H	E	L-M	M	A	H	VH	A
Epicormic and lower shoots	M	H	A	M-H	H	A	L	M	A	H	VH	A
Seedlings and saplings	H	VH	A	H	H	E	M-H	H-VH	A	H	VH	A
Preferentially browsed or grazed plants	H	VH	A	H	H-VH	A	M	H	A	H	VH	A
Bark stripping fraying and stem breakage	NI-L	L	A	L	NI	B	NI-L	NI	B	NI-L	NI	B
Sward	L-M	L	B	L	L	E	L	L	E	L-M	L	B
Ground disturbance	L	L	E	L	L	E	L	NI-L	B	M	M	E

3.1.2 Inconsistencies in the application of the method

For the three indicators that require the assessment of browsing rates on tree shoots, Surveyor 10 assessed browsing rates at Pass of Leny and Fairy Knowe according to the percentage of the biomass removed from only the browsed shoots rather than from all shoots, This may have resulted in a higher browsing rate being recorded than would have been the case had the correct method been used. Surveyor 10's results for these sites, however, tend to be lower than are those of the

other surveyors (Annex 2) hence it appears unlikely that this error made a significant difference to the result.

Surveyor 15 recorded unbrowsed shoots, or leaf tips, as lightly browsed rather than as unbrowsed. This may have resulted in some of the four indicators affected (basal shoots, epicormic and lower shoots, seedlings and saplings and preferentially browsed or grazed plants) being recorded as 'Low' when they should have been 'No Impact' or 'No Impact – Low'. However surveyor 15 only recorded 'Low' impacts for any of these indicators at Beinglass and since 'No Impact – Low' and 'No Impact' were recorded by other surveyors at Beinglass for these indicators at only fifteen stop /surveyor /indicator combinations out of a possible 524 (Annex 2), the effect of this methodological error is likely to be negligible. Occasions where it may have influenced the variation in browsing /grazing rate assessments are discussed in the relevant Results section below.

A few surveyors were not able to complete all ten stops in the time available at all sites (Table 2). In all cases, except one, seven or more stops were completed (Table 2) however, due to injury, surveyor 7 assessed only five stops at Beinglas. This may have resulted in higher variation and /or a skewed result if the plots surveyor 7 assessed were in one part of the site and that part had higher, or lower, impacts than the rest of the site. To test this, the median impacts recorded by each of the other surveyors for the five stops assessed by surveyor 7 (stops 1-5) were compared with the median impacts assessed for the remaining five stops (stops 6-10). There was no clear evidence that the impact on any of the indicators differed between the two sets of stops (Table 4).

Table 4. Number of surveyors whose median impact assessment for Beinglas for stops 1 to 5 was higher, equal to, or lower than their median impact assessment for stops 6-10, for each indicator. Also shown is an assessment of whether there is clear (Yes), possible (?) or no (No) evidence that the impact at stops 1-5 differed from that at stops 6-10.

Indicator	1-5 higher	Equal	6-10 higher	1-5 different from 6-10
Basal shoots	3	6	5	No
Epicormic and lower shoots	5	6	3	No
Seedlings and saplings	1	7	6	?
Preferentially browsed or grazed plants	4	4	6	No
Bark stripping, fraying and stem breakage	1	5	8	?
Sward	2	8	4	No
Ground disturbance	0	9	4	No

Surveyor 5 located the stops at Pass of Leny by comparing an estimate of their current location with the location of the stops marked on a paper map rather than by using a GPS. This is unlikely to have affected the overall result since the stops would have been in approximately the right location. Surveyor 5's overall site results are, therefore, unlikely to have been affected by this methodological anomaly, however it may have contributed to any differences between the results recorded by surveyor 5 at individual stops at Pass of Leny compared to those recorded by other surveyors.

Ground disturbance caused by fifteen surveyors assessing the same stops at each site may have increased the amount of ground disturbance over time and this may not have been distinguishable from ground disturbance caused by deer. This may have led to later assessments of ground disturbance being higher than those carried out earlier. The ground disturbance results, however, do not show any indication of an increase in recorded ground disturbance over time (Table 5).

Table 5. Ground disturbance impact levels recorded by each surveyor at each site, ordered by date with the earliest date at the top.

Pass of Leny	Fairy Knowe	Beinglas	Glen Loin
L	L	NI-L	M
L	L-M	L	L
L	M	L	L-M
L	L	L	L
L-M	L	L	L-M
L	L-M	L	M-H
L	M	NI-L	L
L	L	NI	H
L	L-M	NI-L	H
L	L	L	M
M	L-M	L-M	M-H
M	M	L	L-M
M	L	L	L
L	NI	L	M
L	L	L	M

3.2 Site-level results

3.2.1 Overall impacts on each indicator

The median herbivore impact recorded by the fifteen surveyors on each indicator at each site can be assumed to be the best measure of actual impact levels (Table 6). Impact levels on basal shoots, epicormic and lower shoots, seedlings and saplings and preferentially browsed plants were generally High at Glen Loin and Fairy Knowe, Medium – High at Pass of Leny and Medium at Beinglas (Table 6). Bark stripping, fraying and stem breakage were recorded as No Impact – Low at all sites except Fairy Knowe where it was Low (Table 6). Sward impacts were not recorded above Low-Medium at any site but were slightly higher at Pass of Leny and Glen Loin than at Fairy Knowe and Beinglas (Table 6). Ground disturbance was Low at all sites except Glen Loin where it was Medium (Table 6).

Table 6. Median herbivore impact levels on each indicator at each site (median of the impacts recorded by all fifteen surveyors). NI = No impact, L = Low, M = Medium, H = High, VH = Very High. Intermediate levels are shown with a hyphen between the two levels.

	Site			
Indicator	Pass of Leny	Fairy Knowe	Beinglas	Glen Loin
Basal shoots	M-H	H	L-M	H
Epicormic and lower shoots	M	M-H	L	H
Seedlings and saplings	H	H	M-H	H
Preferentially browsed or grazed plants	H	H	M	H
Bark stripping, fraying and stem breakage	NI-L	L	NI-L	NI-L
Sward	L-M	L	L	L-M
Ground disturbance	L	L	L	M

3.2.2 Variation between surveyors in the assessment of overall impacts on each indicator

There was a high level of variation between surveyors in the level of herbivore impact reported for most indicators at most sites (Tables 7, 8, Annex 4). For only seven of the twenty-eight indicator /site combinations did 90%, or more, of surveyors record impacts that were within half a category of the median (Table 7). For the other twenty-one indicator /site combinations the equivalent percentages lay between 53% and 87% (Table 7). For most indicator /site combinations, a high percentage of surveyors did, however, record impacts that were within one full category of the median (Table 7).

Table 7. The percentage of surveyors recording results for each indicator at each site that were within half (Half) or a full (Full) impact category of the median.

Indicator	Pass of Leny		Fairy Knowe		Beinglas		Glen Loin		Average	
	Half (%)	Full (%)	Half (%)	Full (%)	Half (%)	Full (%)	Half (%)	Full (%)	Half (%)	Full (%)
Basal shoots	93	100	67	100	100	100	80	93	85	98
Epicormic and lower shoots	73	100	93	100	67	93	60	87	73	95
Seedlings and saplings	67	100	100	100	80	100	80	100	82	100
Preferentially browsed or grazed plants	73	100	100	100	53	100	60	100	72	100
Bark stripping, fraying and stem breakage	87	87	73	100	93	93	100	100	88	95
Sward	67	93	73	100	73	93	73	87	72	93
Ground disturbance	80	100	73	100	87	100	60	100	75	100
Average	77	97	83	100	79	97	73	95	77	97

Table 8. Number of surveyors recording each level of herbivore impact on each indicator at each site. N/A = Not Applicable, NI = No impact, L = Low, M = Medium, H = High, VH = Very High. Intermediate levels are shown with a hyphen between the two levels. Median values are highlighted in green.

Site	Indicator	Impact level									
		N/A	NI	Ni-L	L	L-M	M	M-H	H	H-VH	VH
Pass of Leny	Basal shoots					1	5	4	5		
	Epicormic and lower shoots				1	2	8	1	3		
	Seedlings and saplings						2	3	7		3
	Preferentially browsed or grazed plants						1	2	6	3	3
	Bark stripping fraying and stem breakage	2	5	3	5						
	Sward			1	6	1	3	3	1		
	Ground disturbance				11	1	3				
Fairy Knowe	Basal shoots						5	2	8		
	Epicormic and lower shoots					1	6	4	4		
	Seedlings and saplings							3	10	2	
	Preferentially browsed or grazed plants							2	9	4	
	Bark stripping fraying and stem breakage		3	4	5	2	1				
	Sward				8	3	4				
	Ground disturbance		1		7	4	3				
Bein-glass	Basal shoots				4	5	6				
	Epicormic and lower shoots				9	1	4	1			
	Seedlings and saplings					2	4	4	4	1	
	Preferentially browsed or grazed plants				3	3	5		4		
	Bark stripping fraying and stem breakage		5	3	6		1				
	Sward		1	1	10		2	1			
	Ground disturbance		1	3	10	1					
Glen Loin	Basal shoots					1	1	4	4	4	1
	Epicormic and lower shoots				1	1	3	2	6	1	1
	Seedlings and saplings							3	5	4	3
	Preferentially browsed or grazed plants						3	2	5	2	3
	Bark stripping fraying and stem breakage		7	5	3						
	Sward			1	5	4	2	1	1	1	
	Ground disturbance				4	3	4	2	2		

3.2.3 Consistency of surveyors' assessments relative to the median

A few surveyors consistently recorded impacts that were above or below the median for some indicators. The number of surveyors who consistently recorded impacts on individual indicators that were higher than the median (between two and four) was similar to the number that consistently recorded impacts that were lower (between zero and four; Table 9, Annex 4). In total, between three (20%) and seven (47%) of

the fifteen surveyors consistently recorded *either* higher or lower impacts on individual indicators (Table 9, right hand column). Thus between 20% and 47% of surveyors (depending on indicator) may have been consistently 'biased' in one direction or the other in their assessment of impact on any one indicator. Most apparent bias occurred with the 'seedlings and saplings' indicator and least with the 'preferentially browsed /grazed plant species' and 'ground disturbance' indicators (Table 9).

No surveyors recorded consistently high or low impacts on all indicators (Table 9, Annex 4). Four surveyors (1, 3, 4, 5) did, however, record consistently high impacts and two surveyors (2, 10) consistently low impacts, on three or more indicators (Table 9, Annex 4). In total, therefore, six surveyors (40%) may have been 'biased' in the same direction in their assessment of several indicators.

Table 9. Identification numbers of individual surveyors who recorded impact levels for each indicator that were consistently higher or lower than the median. 'Consistently' is defined as recording higher or lower impact levels at three or more of the four study sites and, where this occurred at only three sites, recording the median at the fourth. Also shown is the total number of surveyors recording either a consistently higher or lower impact on each indicator.

Indicator	Higher	Lower	Total number
Basal shoots	1,3	2,10,13	5
Epicormic and lower shoots	1,3	10,13	4
Seedlings and saplings	1,3,4	2,5,6,10	7
Preferentially browsed /grazed plant species	1,5	2	3
Bark stripping, fraying and stem breakage	4,15	12,14	4
Sward	4,5,6,8	3	5
Ground disturbance	3,5,8	None	3

3.2.4 Variation between surveyors in the relative ranking of impacts on sites

Most surveyors identified Beinglas as having the lowest impacts on most of the indicators (see the comparisons between sites that include Beinglas in Table 10). The agreement on relative impact levels between the other sites was less good, probably because the impact levels at the other three sites were similar to each other (Tables 6, 10).

Table 10. A comparison between pairs of sites in the herbivore impact level recorded by surveyors on each indicator. Numbers of surveyors ranking the first site in the comparison higher, equal to, or lower than the second site are shown, together with the percentage of surveyors whose ranking agreed with the median (%). The median values are shown with a green background.

Site comparison	Indicator	Higher	Equal	Lower	%
Pass of Leny v. Fairy Knowe	Basal shoots	3	5	7	47
	Epicormic and lower shoots	2	6	7	47
	Seedlings and saplings	5	5	5	33
	Preferentially grazed /browsed plants	6	6	3	40
	Bark stripping, fraying and stem breakage	2	4	7	54
	Sward	7	5	3	47
	Ground disturbance	2	9	4	60
Pass of Leny v. Beinglas	Basal shoots	12	3	0	80
	Epicormic and lower shoots	12	3	0	80
	Seedlings and saplings	13	3	1	73
	Preferentially grazed /browsed plants	13	1	1	87
	Bark stripping, fraying and stem breakage	2	7	4	54
	Sward	8	7	0	53
	Ground disturbance	7	8	0	53
Pass of Leny v. Glen Loin	Basal shoots	0	5	10	67
	Epicormic and lower shoots	1	3	11	73
	Seedlings and saplings	2	8	5	53
	Preferentially grazed /browsed plants	4	9	2	60
	Bark stripping, fraying and stem breakage	3	8	2	62
	Sward	5	6	4	40
	Ground disturbance	0	5	10	67
Fairy Knowe v. Beinglas	Basal shoots	12	3	0	80
	Epicormic and lower shoots	14	1	0	93
	Seedlings and saplings	9	5	1	60
	Preferentially grazed /browsed plants	14	1	0	93
	Bark stripping, fraying and stem breakage	7	6	2	47
	Sward	6	7	2	47
	Ground disturbance	8	6	1	40
Fairy Knowe v. Glen Loin	Basal shoots	3	4	8	27
	Epicormic and lower shoots	3	4	8	53
	Seedlings and saplings	1	6	8	40
	Preferentially grazed /browsed plants	5	6	4	40
	Bark stripping, fraying and stem breakage	8	7	0	53
	Sward	3	6	6	40
	Ground disturbance	2	3	10	67
Beinglas v. Glen Loin	Basal shoots	0	1	14	93
	Epicormic and lower shoots	0	1	14	93
	Seedlings and saplings	0	2	13	87
	Preferentially grazed /browsed plants	2	1	12	80
	Bark stripping, fraying and stem breakage	5	10	0	67
	Sward	0	6	9	60
	Ground disturbance	0	3	12	80

3.3 Variation between surveyors in the conversion of stop-level results to site-level results

Surveyors were asked to determine an overall impact level for each indicator at each site based on the most common impact level (the mode) (Annex 1) or the median if they thought that the median represented the results better. They were, however, asked to give more weight to stops where there were more examples of a particular indicator than to those where there were fewer. There is, therefore, a degree of subjectivity involved in determining the overall results for each indicator at each site. To investigate the effect of this subjectivity, the site-level results recorded by each surveyor for each site were compared with the mode and median of the stop-level results.

A comparison of the overall impact assessment for each indicator by each surveyor at each site with the mode and the median showed that surveyors were not consistently using the mode, nor the median, to obtain their overall site assessment (Annex 5, Table A5.1). There are several likely reasons why the surveyors did not consistently use the mode:

1. The mode can often mis-represent the results. If, for example, the results for the ten stops are four Medium, two High, two High-Very High and two Very High then the mode is Medium but most results are High or above. In situations such as this, surveyors often used the median rather than the mode or made some other adjustment to better reflect the results.
2. Where the results for the ten stops were split between very different impact levels, for example, with six Lows and four Highs, surveyors often did not record the overall result as either the mode or the median (both Low in this example) but recorded something between the two extremes, for example Medium or Low-Medium.
3. Where there were, for example, four stops where the impact was recorded as High and six where it was recorded as Very High, some surveyors gave the overall score as High-Very High, rather than Very High, which was both the mode and the median. This is a logical response since the site, overall, is between High and Very High.
4. Where the results were a combination of Low and No Impact assessments, surveyors often went for Low, or No Impact-Low, even if there were more No Impact scores since, logically, it does not make sense to record a result of No Impact if there is an impact at some stops. This is especially true if there is a stop where a Medium impact was recorded as well as some with a Low impact. In these cases, some surveyors followed the guidance and recorded No Impact and others recorded a No Impact – Low or a Low impact.
5. The guidance says that all stops where no examples of an indicator are found should be recorded as Not Applicable and those stops should be excluded from the assessment of the overall score, which should be assessed on the results from stops where an impact was recorded. This should apply even if an indicator is found at only one stop. In this situation, however, some surveyors recorded the overall assessment as Not Applicable rather than using the impact recorded at the one stop where an example of the indicator was found.

All of these factors will have led to different surveyors producing overall assessments for an indicator at a site in different ways and this will have increased the variance

between surveyors. Clearly specifying a method of summarizing the individual stop results would help to reduce this variation.

There are issues with using both the mode and the median of the stop results to produce a site impact result (see bullet points 1 and 2 above) and a solution might be instead to convert the impact results to numeric values i.e. No Impact = 0, No Impact-Low = 2, Low = 3 etc., calculate the mean value over all the stops at a site for each surveyor, then convert this back to an impact level. To test whether this would significantly reduce the variance between surveyors, this was done (Annex 5, Table A5.1).

Using this method of summarizing the stop-level results to produce an overall impact assessment for each surveyor at each site did, generally, reduce the variance between surveyors (Table 11 c.f. Table 7) however the reduction was relatively small (Table 12). Differences in the method used to summarise their stop-level results is therefore not the major cause of the differences between surveyors in their assessment of the impact at a site. Although using the arithmetic mean would increase surveyor consistency to some extent, the disadvantage is that it adds complexity to the method. It would also not allow surveyors to give more weight to stops where there were more examples of an indicator than were present at others. However, since this is a subjective judgement, it may, in itself, reduce consistency between surveyors and, as such, should perhaps not be included in the guidance.

Table 11. The percentage of surveyors whose arithmetic mean results for each indicator at each site were within half (Half) or a full (Full) impact category of the mean result of all surveyors (Annex 5).

Indicator	Pass of Leny		Fairy Knowe		Beinglas		Glen Loin	
	Half (%)	Full (%)	Half (%)	Full (%)	Half (%)	Full (%)	Half (%)	Full (%)
Basal shoots	87	100	93	100	93	100	73	87
Epicormic and lower shoots	73	100	93	100	80	100	73	100
Seedlings and saplings	73	100	100	100	93	100	80	100
Preferentially browsed or grazed plants	87	100	100	100	80	100	80	100
Bark stripping, fraying and stem breakage	93	100	93	100	100	100	100	100
Sward	67	93	87	100	80	93	67	93
Ground disturbance	80	93	93	100	93	100	80	100

Table 12. The difference between the values in Table 11 and those in the equivalent cells in Table 7. "Half" and "Full" as per Table 11.

Indicator	Pass of Leny		Fairy Knowe		Beinglas		Glen Loin	
	Half (%)	Full (%)	Half (%)	Full (%)	Half (%)	Full (%)	Half (%)	Full (%)
Basal shoots	-6	0	26	0	-7	0	-7	-6
Epicormic and lower shoots	0	0	0	0	13	7	13	13
Seedlings and saplings	6	0	0	0	13	0	0	0
Preferentially browsed or grazed plants	14	0	0	0	27	0	20	0
Bark stripping, fraying and stem breakage	6	13	20	0	7	7	0	0
Sward	0	0	14	0	7	0	-6	6
Ground disturbance	0	-7	20	0	6	0	20	0

3.4 Variation between surveyors in the conversion of seedling /sapling browsing /grazing rates into stop- and site-level results

In converting results for the browsing rates observed on seedlings and saplings at a stop into an overall impact for the stop, surveyors had to first convert browsing rates on individual seedlings or saplings (unbrowsed or lightly, moderately, heavily or very heavily browsed) into an overall browsing rate for all palatable and all unpalatable species. They then had to convert this information into an overall impact level, using the guidance provided in the methodology (Annex 1, Table A1.1). Both of these processes can involve an element of subjectivity, the latter because the results for stops do not always fit exactly into one of the descriptions of the impact levels that are provided in the guidance (Annex 1, Table A1.1). Both of these factors could, therefore, lead to variation between surveyors in the overall impact assessment for each stop. To determine the level of this variation that might be attributable to these factors, the total number of seedlings and saplings in each browsing category was calculated for both palatable and unpalatable tree /shrub species (Annex 1, Table A1.3). The median browsing rate was then calculated separately for the palatable species and for the unpalatable species in classes 4 and 5 and in class 6 (Annex 1, Table A1.3). This was then used, with the guidance in the methodology (Annex 1, Table A1.1 and summarised in Table 13), to make a new assessment of impact level for each stop at all sites. The impact assessments made using these strict rules, applied to each surveyor's browsing results for each stop, were then compared with the surveyor's own impact assessments.

Table 13. The look-up table used to convert browsing on seedlings and saplings into an impact level for palatable species, unpalatable species in classes 4 and 5 and unpalatable specie in class 6 (Annex 1, Table A1.3). If results for different palatability groups do not agree with each other, preference is given to whichever of the palatable or unpalatable species groups leads to the highest impact level (see also footnotes).

	Browsing rate		
	Palatable species	Unpalatable species	
Impact level		Class 4,5	Class 6
No Impact	Unbrowsed	Unbrowsed[1]	Unbrowsed[1]
Low	Light (a few may be Unbrowsed)	Unbrowsed[1]	Unbrowsed[1]
Medium	Moderate (a few may be Heavy)	Light	Unbrowsed[1]
High	Heavy	Moderate[2]	Light
Very High	Very Heavy	Moderate - Very Heavy[3]	Moderate - Very Heavy

[1] Impact level = No impact. In practice, the impact may be higher since unpalatable species can be unbrowsed at Low, or in the case of class 6 species, Low or Medium impact levels but this uncertainty cannot be included in this analysis method.

[2] Where palatable species are not present, impact level = High – Very High. Where palatable species are present, impact level = High. The basis of this rule is that if the impact on palatable species is High or Very High then this will be the overall impact but if the impact on palatable species is between No Impact and Medium then the impact on unpalatable species in class 4,5 should be set at its lowest i.e. High.

[3] A median browsing level of Moderate – Heavy or Moderate – Very Heavy translates to an impact level of High – Very High.

Calculating the overall impact using strict rules did not make the results any more consistent between surveyors and, in most cases, the surveyors' results were more consistent than the calculated results (Table 14a c.f. Table 14b).

Table 14. The percentage of surveyors whose impact assessment for the seedlings and saplings indicator was within half (Half) or a full (Full) impact category of the median result for all surveyors. Results are shown for: each stop and for the average of the results for each stop (Average).

a) Calculated results.

Stop	Pass of Leny		Fairy Knowe		Beinglas		Glen Loin	
	Half (%)	Full (%)	Half (%)	Full (%)	Half (%)	Full (%)	Half (%)	Full (%)
1	80	80	47	87	92	100	50	92
2	93	93	40	93	77	77	50	90
3	45	82	50	93	60	100	36	93
4	60	100	50	100	47	93	80	87
5	67	100	60	100	67	100	47	100
6	47	100	67	100	71	100	57	100
7	60	93	60	100	79	79	31	100
8	33	100	47	87	75	75	46	100
9	62	100	87	93	33	100	64	91
10	62	100	40	100	86	86	29	100
Average	61	95	55	95	69	91	49	95

b) Surveyors' results

Stop	Pass of Leny		Fairy Knowe		Beinglas		Glen Loin	
	Half (%)	Full (%)	Half (%)	Full (%)	Half (%)	Full (%)	Half (%)	Full (%)
1	67	87	47	87	69	100	67	92
2	53	100	64	86	92	100	70	100
3	45	91	50	100	100	100	43	100
4	67	100	57	100	80	100	53	80
5	73	100	80	100	80	100	87	100
6	67	93	87	100	71	93	71	100
7	60	93	80	100	64	93	77	77
8	60	93	64	86	67	92	85	100
9	69	100	87	100	75	92	55	100
10	62	100	67	100	67	100	57	100
Average	62	96	68	96	77	97	66	95

The calculated and surveyors' impact assessments differed for a large number of stops x surveyors at all sites (Table 15) showing that the surveyors were often not adhering to the rules for converting browsing rates into impacts levels. The fact that the surveyors' assessments were less variable than the calculated ones suggests that the surveyors often used similar methods of making 'adjustments' so that the overall result better reflected their browsing rate assessments. The variation between surveyors was therefore reduced.

Table 15. Numbers of stops x surveyors where seedlings and /or saplings were recorded, where the calculated and the surveyor's impact assessment differed and where there were two potential reasons for the difference.

No. of stops x surveyors where:	Pass of Leny	Fairy Knowe	Beinglas	Glen Loin
Seedlings /saplings were recorded	142	148	137	131
Calculated and surveyors' impact assessments differed.	61	58	80	52
There were two potential reasons for the difference	7	8	19	5

Where a surveyor's impact assessment for a stop differed from the calculated impact assessment, it was usually possible to determine the likely reason(s) for the difference. Ten possible reasons were identified:

1. The surveyor did not adhere to the rules (Table 13) and there was no obvious rationale. One surveyor noted that, where there were very few seedlings or saplings, they erred towards higher impact levels than they might have otherwise. This is not in accordance with the guidance which clearly states that it is only the current impact that is being recorded, not any longer-term effects such as on seedling and sapling density. This may have explained some of the apparent 'errors'.
2. The surveyor did not take account of the impact on unpalatable species and determined the impact level by reference to the palatable species only. Since the guidance states that the overall impact should be whichever is highest of the impacts on the palatable or unpalatable species, this is an error. This sometimes occurred, however, because there were very few unpalatable seedlings or saplings present in either classes 4 and 5 (UP(4,5)) or in class 6 (UP(6); see reason no. 4 below and Table 16) in comparison to the number of palatable (P) species. Since the effect of using UP(6) rather than P to make the final assessment could, on occasion, make the difference between the result being Very High rather than Low, this was sometimes a logical 'error' to make .
3. The surveyor summarised the browsing rate on the most heavily impacted palatability class of seedlings /saplings in a way other than the median or mode. For example, if there were 3 heavily, and 7 very heavily, browsed seedlings /saplings, they took the overall browsing rate to be 'heavy – very heavy' rather than 'very heavy' as it would have been had they used either the median or the mode. Alternatively, where the results were split between very different browsing levels, for example, with six lightly browsed and four heavily browsed seedlings, they did not assess the overall result as the median or the mode (light in this example) but recorded moderate browsing which translates to Medium impact rather than Low (which would be the impact if the median had been used). This is often a logical 'error' and would give a result that would be closer to a weighted numeric mean, which may give the most representative results were it to be used (see below).
4. The surveyor gave more weight to the more numerous category e.g. if there were many P seedlings browsed heavily and a few UP(4,5) seedlings, all also heavily browsed, the former gives rise to a High impact and the latter to a Very High impact. The guidance is that the final impact is the highest recorded

for any palatability category i.e. Very High, but some surveyors may have given more weight to the palatable seedlings because they were more numerous. This is a logical 'error' since, if there are far more palatable species than unpalatable species, a more representative result would be based on the palatable species. Unpalatable species did often have a higher browsing rate than might be expected from the impact on the palatable species. This may be because there were fewer of them so inevitably the results for some of them were higher than they 'should' be since there was high variation between browsing levels on different individuals of any one species. The chances are quite high therefore that, if there are only a few individuals present, the impact will appear to be high. This applies especially if UP (4,5) species are treated separately to UP(6) species (as they should be according to the guidance) since, in this study, there were often very few UP(6) seedlings but the browsing rate on the UP(6) species was often sufficiently high to translate into a higher impact than that on the P species.

5. The surveyor ignored unbrowsed seedlings because they were very small or appeared to be unavailable for another reason e.g. they were located on a steep bank or were thought to be protected by bracken or alder basal growth. This can be a reasonable 'error'.
6. The surveyor used the mode rather than the median to decide on the overall browsing rate for P, UP(4,5) or for UP(6) seedlings. This is in accordance with the guidance, though not with the calculated method used here, and is not the method used by most surveyors. Its use does, in fact, often lead to an unrepresentative result.
7. The surveyor made the assumption that there is no such category as No Impact – Low since even a very low impact can be construed as low. This is a logical 'error'.
8. The surveyor recorded only >10 or >20 seedlings /saplings under more than one browsing category but, in practice, there were many more seedlings /saplings under one category than under another. When summarizing for the stop they may have taken this into account and given more weight to the more numerous category. This information was not recorded on the field sheet but this would be correct procedure.
9. The surveyor gave less weight to species that appeared to be showing lower browsing rates than would be expected from the browsing rates on other species of the same palatability. At the sites used in this study, this often applied to willow and hazel which, although listed as very palatable, often showed lower browsing rates that the other very palatable species. Since there is variation between sites and years in the relative palatability of different tree species, this 'error' could potentially occur at other sites. At the sites used in this study, this 'error' occurred rarely (Table 16) so most surveyors followed the guidance and did not make this adjustment.
10. The surveyor modified the result from the palatable species according to the unpalatable species results i.e. instead of recording whichever is higher, they recorded an amalgamated result. This occurred where there were similar numbers of palatable and unpalatable species, For example, if there were six P seedlings (five lightly browsed and one moderately browsed) and two UP(6) seedlings that were lightly browsed, the impact on the former would be Low and on the latter would be High. Following the guidance would give an impact

for the stop of High but the surveyor recorded Medium to take account of the Low impact on the palatable seedlings. This is a logical 'error'.

Reasons 1, 2 and 3 were the most common 'errors' with reason 4 also occurring relatively often but at Pass of Leny only (Table 16).

Table 16. The percentage of the total number of stops x surveyors where the calculated and surveyor's impact assessment differed and where the difference was likely to have been caused by each of ten possible reasons (see text for a description of each reason). Where there were two possible reasons for a difference, each was counted separately. The most common reasons are highlighted in yellow.

Reason	Pass of Leny	Fairy Knowe	Beinglas	Glen Loin
1	22	27	19	42
2	28	17	33	16
3	27	52	36	32
4	15	3	0	0
5	0	0	1	2
6	3	0	2	0
7	1	0	1	0
8	1	0	0	0
9	3	2	1	4
10	0	0	6	5

Improving the clarity of the guidance on summarizing impact at a stop should help to improve errors due to reason 1. The inclusion of Table 13 in the guidance might also help with this. Similarly, improving the guidance on what constitutes an 'available' seedling or sapling might help to address reason 5. The guidance would need to state whether very small seedlings should be categorized as available or not. When only very small seedlings are present in a wood, and very few of them have been browsed, presumably because they have not been found by deer, a result that suggests a low impact can be very mis-leading. The inclusion of a rule that any seedlings below 5 cm tall should be ignored could be considered. To address reason 7, the guidance could be strengthened to make it clear that an impact of No Impact – Low is acceptable. Reason 8 is likely to occur very rarely (Table 16) and is a reasonable 'error' when it does. The guidance could be changed, however, so that where the numbers of a species in more than one browsing category have been recorded as '>10' or '>20', a note is made of whether the number in one browsing category were significantly greater than the number in the other. Although reason 9 appears logical, it would not be possible to provide guidance that would lead to it being consistently applied. Making this adjustment for an unexpected result is therefore not possible and the guidance should, therefore, be improved to make it clear that all species in a palatability group need to be given equal weighting.

Reasons 2,3,4, 6 and 10 are all 'errors' that result from surveyors attempting to find the best means of representing diverse results that often conflict with the relative browsing levels that would be expected on seedlings and saplings of different palatabilities. In many cases, the browsing rates observed on seedlings /saplings in the three palatability groups (P, UP(4,5) and UP(6)) did not fit with the expected relative browsing rates as described in Table 13 (Table 17). In these cases, the

overall impact assessment should have been based on the palatability group that showed the highest impact but, in many cases, surveyors did not apply this rule, especially where the group that showed the highest impact was an unpalatable group (Table 17). This may often have been because there were far fewer seedlings /saplings in this group than in the palatable group.

Table 17. The percentage of stops x surveyors where the seedling and sapling browsing results did not match the descriptions in Table 13, in total (Total) and where palatable species, unpalatable species in classes 4 and 5 or unpalatable species in class 6 showed the highest impact (P, UP(4,5) and UP(6) respectively). Also shown is the percentage of P, UP(4,5) and UP(6) stops x surveyors where the surveyor's impact assessment differed from the calculated impact assessment (P diff, UP(4,5) diff, UP(6) diff respectively).

	Pass of Leny	Fairy Knowe	Beinglas	Glen Loin
Total	42	38	56	15
P	16	26	22	5
UP(4,5).	22	7	12	5
UP(6).	4	5	22	5
P diff	22	33	57	29
UP(4,5) diff	84	70	81	83
UP(6) diff	80	71	87	83

In reality, the approach of basing the impact assessment on the palatability group with the highest impact, together with the guidance that the 'most common' browsing rate, i.e. the mode, should be used to summarise the browsing rate on each palatability group, does not always provide a good representation of the impact level. Using the median to summarise browsing rates within a palatability group also does not always provide a good representation of browsing rates (see reason 3 above) though it is usually better than the mode. The different methods employed by the surveyors to address these issues may have contributed to the variance between surveyors in their results for individual stops. One means of addressing this would be to convert the browsing rates on each palatability group into numerical values representing the impact level (the value would increase with browsing rate). This approach is similar to the one described in section 3.3 for reducing the variation in the methods used to summarise stop-level results to produce a site-level result. The numerical value for a given browsing level for unpalatable species would be higher than for a palatable species since a given browsing level on an unpalatable species translates to a higher impact level than the same browsing level on a palatable species (Table 18). All the calculated values would then be summed and the mean value per seedling /sapling calculated. This would then be back-transformed to provide an impact level for the stop. This method would give more weight to palatability groups that contained larger numbers of seedlings /saplings and would also take account of the spread of browsing rates within each group. As such, it would address reasons 2, 3, 4, 6, 9 and 10 above and may make assessments carried out by different surveyors more consistent.

Table 18 a) The rules used to convert browsing rates observed on palatable and unpalatable seedlings and saplings into an overall impact level (Table 13) and a numerical impact score. P = palatable seedlings /saplings, UP(4,5) = unpalatable seedlings /saplings in palatability classes 4 and 5, UP(6) = unpalatable seedlings /saplings in palatability class 6 (Annex 1, Table A1.4). NI = No Impact, L = Low, M = Medium, H = High, VH = Very High.

	P		UP(4,5)		UP(6)	
Browsing category	Impact level	Impact score	Impact level	Impact score	Impact level	Impact score
Unbrowsed	NI	0	NI	0[1]	NI	0[1]
Light	L	1	M	2	H	3
Moderate	M	2	H-VH	3.5[2]	VH	4
Heavy	H	3	VH	4	VH	4
Very Heavy	VH	4	VH	4	VH	4

[1] Note that an absence of browsing on UP(4,5) or UP(6) seedlings /saplings can occur under impact levels from NI – L for UP(4,5) and NI-M for UP(6) (Table 13)). Since it is not possible to represent this in numerical form, a lack of browsing in these cases is given a score of 0. Where there are large numbers of unbrowsed, unpalatable species and few palatable specie this may result in the final impact score being unduly low.

[2] Note that moderate browsing on UP(4,5) seedlings /saplings translates into an impact of somewhere in the range from H to VH. Since there is no simple way to represent a range numerically, this has been summarised here as H-VH and the score given is half way between H and VH. This may therefore over-represent or under-represent the impact level in some cases.

Table 18 b) The look-up table used to back-transform the overall impact score for a stop to an impact level.

Impact score	Impact level
0-0.24	NI
0.25-0.74	NI-L
0.75-1.24	L
1.25-1.74	L-M
1.75-2.24	M
2.25-2.74	M-H
2.75-3.24	H
3.25-3.74	H-VH
3.75-4.00	VH

This method of deriving impact scores for each stop x surveyor gave a slightly lower variance between surveyors compared to the surveyors' own results (Table 19 c.f. Table 14b). The reduction in the variance is small, however, and there is, in fact, an increase in variance for Glen Loin. This suggests that, although it would be advantageous to have clearer rules on summarizing browsing rates for a stop and translating the result into an impact level, calculating a result using a numerical, weighted mean may not be worth the extra effort. Additionally, where there are relatively more unbrowsed seedlings /saplings of unpalatable species present compared to those of palatable species, the weighted mean approach described here can lead to an impact result that is lower than the impact on the ground

because unbrowsed, unpalatable species always score 0 when, in fact, the impact can be higher (see footnote 1 to Table 17). This would have been particularly relevant at Beinglas where there was a relatively large number of unbrowsed, unpalatable seedlings and saplings in class 6 (Annex 6, Table A6.1c). For this reason, as well as the fact that, with the weighted mean approach, priority is not given to the palatability group showing the highest impact regardless of the number of seedlings /saplings in that group, the impact scores resulting from this analysis method are lower than both those calculated using medians and those recorded by the surveyors (Table 20 c.f. Table 21).

Table 19. The percentage of surveyors whose impact assessment for the seedlings and saplings indicator was within half (Half) or a full (Full) impact category of the weighted mean result for all surveyors. Results are shown for each stop and for the average over all stops (Average).

	Pass of Leny		Fairy Knowe		Beinglas		Glen Loin	
Stop no.	Half (%)	Full (%)	Half (%)	Full (%)	Half (%)	Full (%)	Half (%)	Full (%)
1	80	93	60	93	92	92	67	83
2	87	93	53	80	92	100	50	90
3	45	73	71	100	60	100	57	86
4	73	100	64	100	93	100	80	87
5	87	100	80	100	40	93	67	100
6	67	87	93	100	73	87	71	93
7	67	93	73	100	67	93	46	85
8	73	100	80	93	54	77	69	100
9	85	100	80	100	69	92	36	73
10	85	100	73	93	80	87	64	93
Average	75	94	73	96	72	92	61	89

Table 20. Weighted mean impact scores for seedlings and saplings for each stop at each site and the mean of these across all stops (Mean). Also shown are the equivalent impact levels.

	Weighted means							
	Scores				Impact levels			
Stop no.	Pass of Leny	Fairy Knowe	Beinglas	Glen Loin	Pass of Leny	Fairy Knowe	Beinglas	Glen Loin
1	2.27	2.39	1.93	2.55	M-H	M-H	M	M-H
2	2.98	2.51	1.33	2.94	H	M-H	L-M	H
3	2.62	2.17	2.04	2.83	M-H	M	M	H
4	2.77	3.22	2.01	3.28	H	H	M	H-VH
5	3.13	2.60	2.12	3.20	H	M-H	M	H
6	2.52	2.64	2.19	2.78	M-H	M-H	M	H
7	2.19	3.13	1.99	2.84	M	H	M	H
8	2.58	2.28	2.36	3.14	M-H	M-H	M-H	H
9	2.99	2.53	2.08	2.61	H	M-H	M	M-H
10	2.71	2.70	2.24	2.78	M-H	M-H	M	H
Mean	2.68	2.61	2.03	2.89	M-H	M-H	M	H

Table 21. Median impact levels calculated for seedlings and saplings for each stop, the median of the medians across all stops and the equivalent median impact levels recorded by the surveyors at each site.

	Calculated medians				Surveyors' results			
Stop	Pass of Leny	Fairy Knowe	Beinglas	Glen Loin	Pass of Leny	Fairy Knowe	Beinglas	Glen Loin
1	M-H	H	M-H	H	M	H	M	H
2	H-VH	H	M-H	H	H	M-H-H	L-M	H
3	H	M	M	H	H	M-H-H	M-H	H
4	H	H	H	VH	H	H-H-VH	M	VH
5	H	H	M	H	H	H	M	H-VH
6	H	H	H	H	H	H	M-H-H	H
7	H	H	M-H-H	H	H	H	M-M-H	H-VH
8	H	H	M-H-H	H	H	H	M-H	H-VH
9	H	M-H	H	H	H	M-H	M-H	H
10	H	H	M-M-H	H	H	H	M-H-H	H
Median	H	H	M-H	H	H	H	M-H	H

Some of the drawbacks of using the weighted mean approach as described here might be overcome by calculating the weighted mean impact for each of the three palatability groups (P, UP(4,5) and UP(6)) separately. The impact level that is taken as the overall impact level for the stop would then be the highest impact level of the three groups unless the group showing the highest impact level contained very few seedlings and saplings relative to the number recorded for the other groups. ‘Relatively few’ would need to be strictly defined. The definition could be, for example, ‘fewer than ten seedlings /saplings recorded and less than half the number recorded in any other palatability group’. Using this definition, palatability groups showing the highest impact level, but where few seedlings /saplings had been recorded, would be used to determine the overall impact level if there were also few seedlings /saplings in the other groups but would not be used if there were at least twice as many seedlings /saplings in any of the other groups. This may be the approach that many surveyors used in practice, albeit in an approximate way. Providing a well-defined means of carrying out this analysis may reduce the variance between surveyors in the stop-level results. This may be worth further investigation.

The four methods of summarizing results described in this, and the preceding, section (methods 2-5 listed in Table 22) had the potential to reduce the variance between surveyors in seedling and sapling results at not only the stop level but also at the site level.

Table 22. Summary descriptions of the five methods used in this study to determine variation between surveyors in their assessment of site level impacts on seedlings and saplings.

Method	Description
1.Surveyors' site-level results	Surveyors' actual results for each site compared to the median for all surveyors for each site.
2.Site-level medians	Median impact across all stops for each surveyor compared with the median of these for all surveyors for each site.
3.Calculated site-level means	For each surveyor, each recorded impact at each stop is given a numerical value that increases with impact level. The mean is then calculated across all stops for each surveyor and compared to the mean for all surveyors for each site.
4.Calculated stop-level medians	For each surveyor, median browsing levels for each browsing category are determined then rules are used to decide on the overall stop impact. The median of all stop impacts then gives the site impact for each surveyor. These are then compared with the median of all surveyors' impacts for each site.
5.Weighted stop-level means	For each surveyor, an impact for each stop is calculated by giving numerical values to browsing rates for each palatabilty group (the value relates to the impact level of each browsing rate). A weighted mean of these values is then calculated to give an impact score for each stop. The mean of these is then calculated and back transformed to give an impact level for each site. The impact level for each surveyor is compared to the mean impact for all surveyors (the numerical mean is calculated then back-transformed to an impact level to give the overall mean).

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Overall, however, the method used to summarise the seedling and sapling results at the site level appears to make only a small difference to the consistency between surveyors (Table 23). Method 5 provided the highest consistency between surveyors on average but not at every site (Table 23) and was little different to method 3. Since the latter requires fewer computations than does method 5, it would appear that, for seedlings and saplings, the extra effort involved in calculating weighted mean impacts at the stop level based on browsing results, provides little, if any, benefit in terms of observer consistency over determining the site-level impact using method 3.

Table 23. The percentage of surveyors whose assessment of impact on seedlings and saplings at each site was within half an impact category of the median or mean (see Table 22 for a description of each method).

Method	Pass of Leny	Fairy Knowe	Beinglas	Glen Loin	Average
1	67	100	80	80	81.8
2	60	100	80	73	78.3
3	73	100	93	80	86.5
4	60	80	93	60	73.3
5	93	93	94	73	88.3

The final approach that might be used to reduce between-surveyor variation in the assessment of site-level impacts is to sum all browsing impacts on seedlings and saplings across all stops and then treat the results as if they had come from one, large stop. By combining all data across all stops, this might reduce any variation caused by differences between surveyors in the species of seedling /sapling found at a stop, or in the individual seedlings and saplings that were found.

Neither methods 4 nor 5 (Table 22),when applied to the data from all stops combined, resulted in an improvement to the between-surveyor variance and, in fact, consistency was lower for both methods than when they were applied to the stops individually (Results for methods 4 and 5 in Table 24 c.f. Table 23). This suggests that more of the inter-surveyor variation is due to differences in assessing browsing rates than on which, or how many, seedlings and saplings of different species are found.

Table 24. The percentage of surveyors whose assessment of impact on seedlings and saplings at each site was within half an impact category of the median or mean when all seedling and sapling browsing results are summed over all stops before the site impact was calculated (see Table 22 for a description of each method). For comparison, the equivalent percentages for the surveyor's recorded results are also shown (method 1).

Method	Pass of Leny	Fairy Knowe	Beinglas	Glen Loin	Average
1	67	100	80	80	81.8
4	80	40	53	73	61.5
5	93	93	81	80	86.8

The conclusion from the above analyses is that, although small increases in between-surveyor variance can be achieved by using an arithmetic mean approach of summarizing stop data at the site level or browsing data at the stop level (methods 3 and 5 respectively), neither increases surveyor consistency to a large extent. Summing all browsing data over all stops before performing these analyses similarly does not improve the consistency of the impact results for seedlings and saplings at the site level. Taken together, these results suggest that most of the between-surveyor variation is due to differences between surveyors in the assessment of browsing rates on seedlings and saplings rather than in summarizing browsing impacts at stops, summarizing across stops or in finding seedlings and saplings.

3.5 Variation between surveyors in the number and species of seedlings /saplings recorded

3.5.1 Number of seedlings and saplings recorded

On average, the highest number of seedlings and saplings per stop was recorded at Beinglas and the lowest at Glen Loin with similar numbers being recorded at Pass of Leny and Fairy Knowe (Figure 3; Annex 7, Table A7.1 a-d). This pattern was evident in the results from all individual surveyors (Figure 3).

There was considerable variation in the numbers of seedlings and saplings recorded at each site and stop (Figure 3; Annex 7, Table A7.1 a-d). Only four surveyors recorded numbers of seedlings and saplings that were consistently i.e. at all sites, below (surveyors 2, 11 and 14) or above (surveyor 7) the average recorded by all surveyors (Figure 3).

These results suggest that, although there were sometimes large differences in the numbers of seedlings and saplings found by different surveyors at individual stops, and overall across a site, few surveyors (three out of fifteen) consistently found fewer seedlings and saplings than did the others.

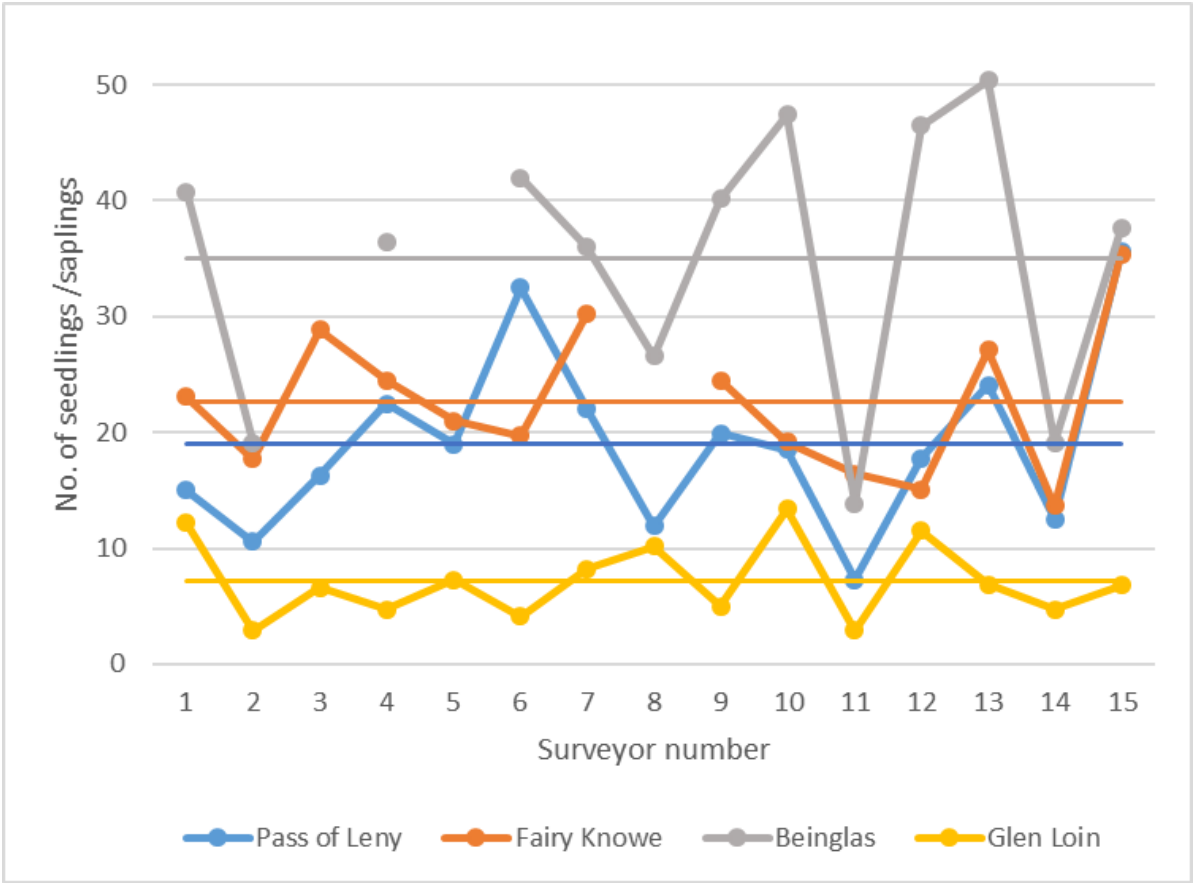

Figure 3. Average number of seedlings /saplings recorded per stop by each surveyor (numbered on horizontal axis) at each site. Horizontal lines represent the average of all surveyors. Missing values are where numbers were not recorded.

3.5.2 Number of species recorded

On average, most species of seedling and sapling were recorded at Beinglas with similar numbers being found at the other three sites (Figure 4). The results for most surveyors showed this pattern (Figure 4).

There was considerable variation in the number of species found by different surveyors at individual stops and sites (Figure 4; Annex 7, Table A7.2 a-d) but no surveyor recorded total numbers of species at all four sites that were consistently above, or below, the average. (Figure 4).

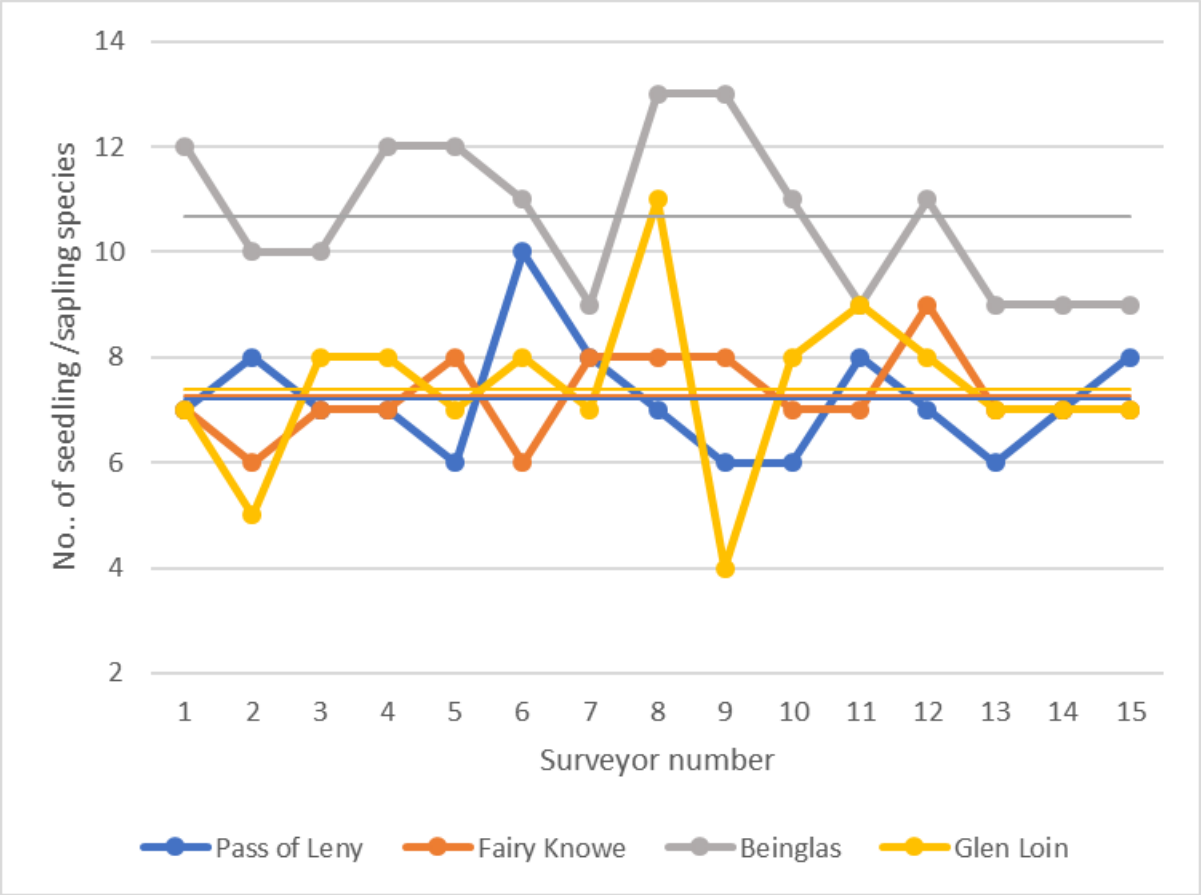

Figure 4. Total number of tree seedling and sapling species recorded by each surveyor at each site. Horizontal lines represent the average of all surveyors.

3.6 Variation between surveyors in the assessment of browsing /grazing rates on seedlings and saplings

All surveyors recorded a wide range of browsing rates on seedlings /saplings falling into each palatability group at each site (Annex 6). The median browsing rates on the three palatability groups for each surveyor span three or four browsing classes for all groups at all sites except for UP(4,5) at Beinglas which spans only two classes (Annex 6). There is, thus, a large amount of variation between surveyors in the browsing rates recorded on each palatability class of seedlings and saplings. Some of this variation may be caused by differences in the way that surveyors have assessed browsing on different species of seedling /sapling.

Comparisons of browsing rate assessments on different seedlings /sapling species could only be carried out on species that were abundant or frequent. Surveyors were generally consistent in their recording of the relative abundance of the most common species of seedling and sapling at each site (Table 25; Annex 7, Table A7.3 a-d). Six species fell into these categories at Pass of Leny, seven at Fairy Knowe, eleven at Beinglas and nine at Glen Loin (Table 25).

Table 25. Frequency of each species of seedling and sapling at each site (based on results shown in Table A7.3 a-d). A = Abundant (green background), F = Frequent (yellow background), O = Occasional (blue background).

	Pass of Leny	Fairy Knowe	Beinglas	Glen Loin
Alder	O	O	A	F
Ash	O	F	A	A
Beech	O	A	A	
Birch	A	O	A	F
Blackthorn			F	O
Bog Myrtle	O			
Broom		O	O	
Cotoneaster	O			
Dog rose			F	O
Elm			O	
Gorse	O			O
Hazel	O	A	A	A
Hawthorn	O	O	A	A
Holly	A	A	A	A
Juniper	O	O	O	
Lime			O	
Norway spruce		O		O
Oak	F	A	F	F
Rowan	A	A	A	A
Sitka spruce	F	F	O	F
Willow	F	O	O	O

A wide range of browsing categories was recorded by the surveyors on all species of tree seedling /sapling (Annex 8, Table 8.1). The median browsing categories recorded for each species of seedling /sapling also showed wide variation between surveyors for all tree species at all sites (ranging between 2.5 and 5 browsing

categories; Table 26). There were no obvious patterns in the range of variation in median browsing categories with either species or site (Table 27).

The median of all the surveyors' median browsing categories for each site (the 'Median' rows in Table 26 a-d) generally reflected the relative palatabilities of the different tree species documented in the guidance (Annex 1, Table 1.3). Only those of willow at Pass of Leny and hazel at Fairy Knowe did not. These appeared to be less heavily browsed than the other palatable species at the site. Willow only occurred in any numbers at Pass of Leny but hazel at Beinglas and Glen Loin was browsed to the same degree as the other palatable species. This highlights the site-specific, and perhaps year-specific, nature of relative palatability.

There was, however, a large amount of variation between individual surveyors in their assessment of browsing rates on most seedling and sapling species at all sites. This was a major contributor to the high variation in the impact levels recorded by surveyors at individual stops and overall at a site.

Table 26. The median browsing category of all abundant and frequently occurring seedling and sapling species recorded at all stops by each surveyor. UB = unbrowsed, L = lightly, M = moderately, H = heavily and VH = very heavily browsed. Two categories separated by a hyphen indicate a browsing rate intermediate between the two. Also shown is the median of the surveyors' medians and the range of median browsing categories recorded by surveyors (number of browsing categories). Columns with a green, yellow or red background represent, respectively, palatable species, unpalatable species in palatability classes 4 or 5 and unpalatable species in palatability class 6 (Annex 1. Table 1.3).

a) Pass of Leny

	Tree /shrub species					
Surveyor	Birch	Holly	Oak	Rowan	Sitka spruce	Willow
1	M	VH	VH	VH	UB	M
2	M	M	H	H	UB	M
3	H	H	VH	VH	L-M	L
4	L	M-H	VH	VH	UB	L
5	M	H	H-VH	H		L
6	M	M	M	M	UB	M
7	L	H	H	H	UB	L
8	M	H		H	UB	M
9	M	H	H	H	UB	M
10	L-M	M	L	M		L
11	M	H	M	M-H	UB	
12	M	H	VH	VH		L
13	M	H	L	H	UB	M-H
14	M	M		H	L	M
15	M	H	VH	H		L
Median	M	H	VH	H	UB	L-M
Range	3	3	4	3	2.5	2.5

b) Fairy Knowe

	Tree /shrub species						
Surveyor	Ash	Beech	Hazel	Holly	Oak	Rowan	Sitka spruce
1	H-VH	UB	M	H	VH	VH	UB
2		L	M	M	H	M	UB
3	VH	M	L	H	H	VH	
4	VH	UB	L	M	M	H	L
5	L	UB	L	M	M	H	
6		L	M	H	H	M	UB
7	H	L	M	H	H	H	M
8	H	L	M	H	H	H	M
9	H	UB	M-H	H	H	H	UB
10	M	L	M	H	M	M	
11	M	L	M	M	H	H	M
12	L	M-H	H	H	VH	VH	
13	M	M	M	H	H	H	
14		M	H	H	VH	H	L
15		L	H	H	VH	H	L
Median	H	L	M	H	H	H	L
Range	3.5	3.5	3	2	3	3	3

c) Beinglas

	Tree /shrub species										
Surveyor	Alder	Ash	Beech	Birch	Black-thorn	Dog rose	Hazel	Haw-thorn	Holly	Oak	Rowan
1	UB	H	UB-L	M	L	H	M	M	VH	VH	M
2	UB	M	L	L		L	M	M	L-M	H	M
3	UB	M	UB	L	H		H	L	VH		L
4	UB	VH	L-M	L	H	M	M	M	M	M	M
5	UB	M	L	L	L		M	L	M	L-M	M
6	UB	M	L	L	L	L	M	L	L-M	M	M-H
7	UB	M	UB-L	UB			M	L		M	M
8	UB	M	UB-L	UB	M-H	L-M	M	L	M	UB	L
9	L	M	L	L	L	M	L	L	H	L	H
10	UB	M	L	L	L		L	L	M	H	M
11	UB	M	L	L-M			M	M	UB	L	H
12	L	M	L	L		H	M	M	L	M	H
13	L	VH	L	L		H	M	M	M		M
14	M	M	L	L	M		M	UB	H		H
15	L	H	M	L	M		M	L	M		M
Median	UB	M	L	L	M	M	M	L	M	M	M
Range	3	3	3	3	3	3	3	3	5	5	3

d) Glen Loin

Surveyor	Tree /shrub species								
	Alder	Ash	Birch	Hazel	Hawthorn	Holly	Oak	Rowan	Sitka spruce
1		VH	VH	VH		VH		VH	L
2		M		L		H		L	
3	H	VH	M	VH		VH	VH	VH	H
4	H-VH	M-H		H-VH	H	H	H	H	L-M
5		H	M	L	M	H		H	
6	M	M-H	L-M	M-H	M	VH	H	M	
7	M-H	H		H	H	H	H	H	
8	M	M-H	L	M-H	H	H	M	H	M
9		VH		VH		H		VH	
10		L	M	L	L	M	M	M	UB
11	H	H	L	H		VH	M	H	M
12	H			H	H	H	H	H-VH	
13		H	L	M	M	H	M	M	
14	M	VH		VH	VH	VH		VH	L-M
15	H	VH	H	H		VH	VH	H	
Median	H	H	M	H	H	H	H	H	M
Range	2.5	4	4	4	4	3	3	4	4

Table 27. The range in median browsing categories (number of categories) recorded by surveyors on each tree species at each site.

Tree species	Site			
	Pass of Leny	Fairy Knowe	Beinglas	Glen Loin
Alder			3	2.5
Ash		3.5	3	4
Beech		3.5	3	
Birch	3		3	4
Blackthorn			3	
Dog rose			3	
Hazel		3	3	4
Hawthorn			3	4
Holly	3	2	5	3
Oak	4	3	5	3
Rowan	4	3	3	
Sitka spruce	2.5	3		4
Willow	2.5			

One possible reason for some of the variation between surveyors in the assessment of browsing on ash, oak and rowan may be that, if a seedling is browsed in summer, it may have time to put on a small amount of new growth before the end of the growing season. This can then result in a very short shoot. Some surveyors noted on field sheets that they had assumed this to be the case and had ignored these shoots. Other surveyors may have assumed that the short shoots were all that had grown in the previous summer and that these had not been browsed. In the absence of research on this issue, the results might be more consistent if surveyors were told to ignore very short shoots e.g. those of 1 cm or less in length.

Another surveyor noted that, due to holly's dense, evergreen foliage, it was difficult to tell whether the shoots had been browsed back past the start of the previous summer's growth or not. Holly seedlings are often present in woodlands since, although the new growth is palatable, older leaves are tough and spiny and this helps to reduce browsing on older foliage. Due to their evergreen nature they are also relatively easy to see in winter. At three of the sites visited in this study, median browsing rates on holly were fairly uniform between surveyors whereas at Glen Loin there was wide variation (Table 26). This may have been linked to the high browsing pressures at Glen Loin leading to dense, 'topiaried' hollies that were more difficult to assess. Improved guidance on assessing holly may help with this issue.

The small numbers of some tree species at some sites (Annex 7, Table A7.3d), coupled with the wide range in browsing rates observed on most species by all surveyors, is also likely to contribute to the variation between surveyors. When numbers are low, and different surveyors find different individual trees, this may result in different median browsing rates being recorded. Even for those tree species that occurred in high numbers, however, surveyors usually recorded a wide range of different median browsing rates. It seems likely, therefore, that the most important reason for the wide range in median browsing rates recorded by surveyors was differences in the assessment of the percentage of shoot biomass removed by browsing. Since this assessment involves the estimation of a quantity that does not exist (the biomass of shoots had the seedling/sapling not been browsed) this is not an easy quantity to accurately estimate and, even though each browsing category covers a wide range in browsing rates, it appears likely that individual surveyors assess browsing rates quite differently.

4 DISCUSSION

Due to the expense of making large numbers of precise field measurements, many ecological methods, and especially those that are survey-based, involve observers estimating, rather than measuring, the quantities of interest. The inter-observer consistency of the results of such methods is rarely investigated. This study represents a rare example of such an investigation.

Although the impact results produced by the fifteen surveyors in this study clustered around the median for all indicators, the range of results was wide with, for example, surveyors recording anything between Low and Very High on epicormic and lower shoots at Glen Loin. The range in results for other indicators and/or sites was not as large, however results were not completely consistent for any of the indicators. This means that it is impossible to know for certain for any site and indicator how close to the 'actual' impact level (assumed here to be the median result obtained by fifteen independent surveyors) any surveyor's result will be. The results reported here do, however, give a 72-88% probability, and a 93-100% probability, respectively, that the impact level determined by one surveyor for any indicator will be within half, or one, impact level, of the 'actual' result (Table 28). Where this level of probability is acceptable for a particular survey then the results from one surveyor will be adequate. It would not, however, be possible to use the result from one surveyor using this method, in its current form, to 'prove' that a given impact target had, or had not, been met. In cases where the same surveyor assesses the same site on numerous occasions to look for changes in impact, the method may be sufficiently robust for any detected direction of change to be reliable. This was not tested, however, in this study. Similarly, where two surveyors work together, the assessment of impact levels may be more consistent between survey pairs. Alternatively, a second surveyor could be asked to check on the detailed results for a key indicator or indicators at a sample of survey stops. However neither of these approaches to increasing reliability was tested in this study. Use of the updated version of the methodology (Armstrong *et al*. 2020) may also provide more consistent results but this has also not been tested. The median result from a number of independent assessments will provide a more reliable assessment than that from one assessment alone. This is an approach that could be taken where a more robust assessment is required.

Table 28. The range of possible 'actual' impact levels, at two probability levels, NI = No Impact, L = Low, M = Medium, H = High, VH = Very High. The probability range reflects the fact that the variation between surveyors differed between indicators.

	Range of possible 'actual'[1] impacts at two probability levels	
Recorded impact level	72-88 %	93-100 %
NI	NI to (NI - L)	NI to L
L	(NI – L) to (L - M)	NI to M
M	(L - M) to (M - H)	L to H
H	(M – H) to (H – VH)	M to VH
VH	(H – VH) to VH	H to VH

[1] Here taken to be the median impact level obtained by fifteen independent surveyors.

For seedlings and saplings, impacts on palatable species and on unpalatable species in palatability classes 4, 5 and 6 often did not fit with the descriptions in the guidance (Annex 1, Table A1.1). This can lead to the overall impact at a stop being determined by a small number of individuals of unpalatable species. Since there is a lot of variation in browsing rates on seedlings and saplings of any one species, small numbers of seedlings and saplings in any palatability group can lead to large variation between surveyors depending on which individual seedlings/saplings a surveyor does, or does not, find. However, the fact that, in this study, surveyor variation was not improved by combining all seedling and sapling data at a site, suggests that it is not the numbers, nor the individual seedlings and saplings that are found, that is contributing most to the variation between surveyors but it is, instead, the underlying browsing rates that are recorded on the seedlings and saplings that has most effect.

Results for the indicators other than seedlings and saplings have not been reported here but it is likely that similar conclusions will apply to the other indicators where browsing rates need to be estimated (basal shoots, epicormic and lower shoots). They may also apply, possibly to a lesser extent, to preferentially browsed species. For this indicator, only the percentage of shoots browsed or grazed needs to be estimated, rather than the more complex percentage of shoot biomass removed.

Although improving the guidance on summarizing browsing impacts to give an impact level for each stop, and on summarizing stop impacts to give a site impact, may lead to a small improvement in the consistency of results between surveyors, and is worth doing, the benefit in terms of surveyor consistency, is likely to be small. The same applies to the use of a numerical method of summarizing these values. The latter would, however, move the method away from being non-quantitative and would increase the time needed for data analysis. Using a clearly-defined plot, rather than a roughly-defined ‘stop’ might increase the consistency of the indicators that are found by different surveyors, but it would also increase the time needed in the field and, based on the analysis described here on seedlings and saplings, it may not lead to much, if any, improvement in observer consistency.

The conclusion from this study is, therefore, that it is the variation in estimates of browsing/grazing/other impacts in the field that leads to most inter-surveyor variation in the assessment of impact. This conclusion is, however, based largely on an analysis of the seedling /sapling data. A similar analysis of the data on the other indicators would allow the generality of this conclusion to be tested.

The consistency of impact assessment at a stop might be increased if the guidance on assessing each indicator, were improved. For seedlings and saplings, for example, guidance on whether or not to take account of browsing small shoots could be provided. Such shoots often grow at the end of summer after browsing. This can lead to an appearance of no browsing whereas the seedlings may have been heavily browsed in the summer. Guidance that very short shoots e.g. those less than 1 cm long, should be ignored might improve the consistency of browsing rate assessments to some degree. Similarly, very small seedlings are often unbrowsed, presumably because deer do not notice them, whereas larger seedlings at the same site can be heavily browsed. Seedlings that are protected by e.g. bracken or alder basal shoot growth are also, to some extent, unavailable. Improved guidance on

what constitutes an ‘available’ seedling or sapling might help to improve consistency. For preferentially browsed plants, providing clearer guidance on which species come into this category and whether species not listed can be included or not, might improve inter-surveyor consistency. All of these issues, along with several others, have been addressed in an updated version of the guidance (Armstrong *et al*. 2020).

For the indicators based on tree shoots (basal shoots, epicormic and lower shoots and seedlings and saplings), the best means of improving assessment consistency may be to improve the method of assessing browsing rates. The method, as it stands, uses broad ranges of percentage of biomass removed to categorise browsing rate. Despite these broad ranges, there were large differences between surveyors at the same stop in the browsing rates recorded on seedlings and saplings. This suggests that the ‘percentage of shoot biomass removed’ is a difficult quantity for surveyors to estimate. This is perhaps not surprising given that it involves estimating something that is not there. Use of the simpler measure of ‘percentage of shoots browsed’ might give more consistent results between surveyors. This approach might enable the distinction to be made between ‘unbrowsed’, ‘lightly browsed’ and possibly also ‘moderately browsed’ trees but is unlikely to distinguish between trees that are ‘moderately’, ‘heavily’ or ‘very heavily’ browsed. This is because the percentage of shoots browsed cannot distinguish between trees with many shoots lightly browsed i.e. with little of each shoot removed, and those with many shoots heavily or very heavily browsed i.e. with most of each shoot removed. The tree might suffer little impact from the former but might be severely affected by the latter. Where the method is to be used to determine merely whether a site has a Low impact or not, using the ‘percentage of shoots browsed’ instead of the ‘percentage of shoot biomass removed’ may be adequate and may give better inter-surveyor consistency. This change would be less useful, however, where a clear distinction needs to be made between Medium, High or Very High impact levels.

Having two surveyors working together on an impact assessment, at least for the initial stop or stops, may help produce results that are closer to a hypothetical median.

The production of a field handbook, or phone-based app, with illustrations and photographs that can be compared with observations, might improve inter-observer consistency since observation methods based on comparisons are generally more accurate than are those that are based on absolute estimates. This would, however, be costly to produce and would mean surveyors having to regularly refer to the handbook, or app, in the field. This would increase the complexity, and time requirement of the method. This may be acceptable, however, for professional surveyors carrying out high quality assessments where it is essential to know that the same, or very similar, results would be obtained by a different surveyor. Similar studies to this one, would be needed to test the efficacy of improved field guidance and /or of the use of a field handbook /app. The scale of such studies would not need to be as large as this one, however, as they would only need to compare surveyor consistency at the individual tree /plant level and at stop-level since this is the level at which most variation occurs.

This study compared sites that had between Medium and High impacts on browsing /grazing based indicators. Since it may be easier to identify the difference between sites with Low browsing /grazing impacts and those with Medium impacts, the results reported here may have been different if sites with Medium and Low impacts had been compared. Finding woodlands in Scotland that are browsed at a Low, or even a Medium, level would, however, be challenging since very few woodlands have browsing impacts as low as this. In this study, the site at Beinglas was within a deer fence but, despite this, median browsing impacts were Medium presumably because roe deer, and possibly also goats, were able to enter the ‘exclosure’. This is likely to be the case at other, apparently securely deer-fenced, sites.

5 CONCLUSIONS

This study has shown that the variation between different surveyors in the results obtained using the WHIA method, in the form and with the guidance used in this study, is such that it may not be suitable for use where it is essential to know that the same result would be obtained by any trained surveyor. The results of this study suggest however, that there is a 70-80% chance that the result obtained for any indicator by one surveyor will be within half an impact level of the median result that would be obtained by fifteen independent surveyors. This may be sufficiently reliable for many uses. Taking the median of several independent assessments at one site will yield a more reliable result than any one assessment. This is an approach that could be taken where a more reliable assessment is required.

The results of this study have indicated that making the method more 'precise' by requiring surveyors to find, and record, every example of each indicator in a plot, of an exact size, is likely to have little effect on reducing inter-surveyor variation. The factor that contributed most to the variation in the surveyors' impact assessments was their estimate of impacts on indicators at stops. The assessment of the 'percentage of shoot biomass removed' may be a particularly difficult quantity to estimate consistently. Its replacement with the 'percentage of shoots browsed' may improve inter-surveyor consistency but the use of this approach is unlikely to allow sites with Medium, High and Very High browsing impacts to be distinguished from each other. Testing of updated versions of the methodology should, therefore, be focussed on testing the consistency with which surveyors assess browsing /grazing rates.

Requiring surveyors to work in pairs, and improving the guidance on the use of the WHIA (see the updated version of the guidance; (Armstrong *et al.* 2020)) may result in surveyors being more consistent in their assessment of impacts, as might the production of a field handbook, or phone-based app that would provide tree species-specific diagrams and descriptions of different impact levels. The method is likely to be more reliable when assessing the direction of change over time at a site, when repeat surveys are carried out by the same person since this would likely reduce the effect of any observer bias. The impact of these suggested approaches on the reliability of the resulting assessment has not, as yet, been tested.

As part of this study, detailed data were collected on all seven indicators but only those on the seedlings and saplings indicator were analysed. Analysing the remaining data may indicate further improvements to the guidance. Comparing assessments at sites with Low browsing impacts to those at sites with Medium impacts, if such sites could be found, may also be worthwhile since this may be an easier distinction for surveyors to determine than is the difference between Medium, High and Very high impacts.

6 REFERENCES

Armstrong, H., Black, B., Holl, K & Thompson, R. 2019. *Assessing herbivore impacts in woodlands: an observation-based method*. Report to Scottish Natural Heritage and Forestry Commission Scotland, 25 February 2019.

ANNEX 1: DESCRIPTION OF THE WHIA METHOD USED IN THIS STUDY

Version 29 December 2017

Introduction

The Woodland Herbivore Impact Assessment Method is a method of assessing and monitoring the impact of large herbivores (cattle, sheep, deer, goats, pigs, horses) on habitats that are already wooded or may develop woodland. The method is based on observations, not detailed measurements. It requires the observer to pay close attention to particular indicators within the habitat. All the information needed to carry out an assessment is contained in this guide however, within the guide, there are links to online documents, web pages and photo galleries that provide additional information.

Overview of the method

The method described here involves looking at **current herbivore impacts.** Current herbivore impacts play a major role in determining how the woodland will change in the future. Table A1.1 (pp. 48-52) describes the impact of current browsing and /or grazing, at a number of levels, from absent to very high, on seven indicators:

1. Basal shoots
2. Epicormic /lower shoots
3. Seedlings /saplings
4. Preferentially browsed or grazed plants
5. Bark stripping and stem breakage
6. Sward
7. Ground disturbance

These indicators relate to grazing /browsing by large herbivores.

Time of year to carry out an assessment

Current impact is normally, and most easily, assessed on the most recent season's plant growth. Assessing impact at the end of winter, before new growth starts in spring, provides an assessment of the impact over the previous twelve months. Assessing impact on the current season's growth at the end of summer provides an assessment of summer impact only. The best time of year to carry out an assessment therefore depends on the objectives. For example:

1. If grazing (by domestic stock and /or deer) is occurring all year round, and the objective is to assess the impact of all large herbivores over the whole year, then the assessment should be carried out at the end of winter before new spring growth has started. It can be very instructive, however, to also look informally at the woodland towards the end of the summer to see how much spring /summer browsing has already taken place, as well as to get an idea of the length of unbrowsed shoots. This is particularly useful where winter browsing is heavy and there are few unbrowsed shoots left by the end of winter to help assess the amount that has been removed by browsing (see Table A1.1 below).
2. If domestic stock are grazed seasonally and there are no wild deer present, and the objective is to assess the impact of the stock, then an assessment should be carried out at both the start and end of the grazing period.
3. If domestic stock are grazed seasonally in the presence of wild deer and the objective is to assess the impact of the stock and deer over the grazing period and of the deer at other times of the year, then the assessment should be carried out at the start and end of the stock grazing period as well as at the end of winter.

Although it is possible to record the impact of large herbivores on the previous season's growth of some of the indicators (rather than on the current season's growth) this is not straightforward since new growth often obscures the previous season's growth. This is therefore only recommended for experienced surveyors who are confident that they can distinguish the current season's growth and impacts from the previous season's.

Frequency of assessment

Since current herbivore impact is defined as the impact of herbivores in the previous twelve months or less, monitoring every year can provide useful information on how impacts are changing over time. This can be especially useful for tracking the effect of management on herbivore impacts. Management can then be tailored to achieve the desired level of herbivore impact.

Level 1 or level 2?

In this guide we describe two levels at which this method can be used. Level 1 is suitable for land managers e.g. woodland managers, deer managers or graziers wishing to monitor herbivore impacts on a regular basis with the aim of adjusting herbivore pressure, either by deer culling, or by adjusting the stock grazing regime, to achieve a particular woodland condition target. Level 2 is for use by surveyors who need to be able to explain their results.

A level 1 assessment involves less detailed recording of observations and is quicker to carry out than a level 2 assessment. At level 2, you will be asked to record more information. As a result, the assessment will take longer than a level 1 assessment but will enable you to better explain your results to other people. We also describe a number of 'optional extras'. These are observations on additional elements of the woodland that will help you to understand the impact of herbivores on the woodland, both currently and in the past, as well as to predict the long-term impact of different herbivore impact levels on the woodland.

Level 1 assessment

To carry out a level 1 assessment follow the steps below.

Before going into the field:

1. Mark on a map the boundary of each woodland and /or open ground area for which you want a separate habitat impact assessment.

Assessment areas. Assessment areas may be defined by, for example, land use type and /or land management type and /or habitat type depending on the nature of the site and the objectives of management. See the Woodland Grazing Toolbox for more guidance on defining habitat types. Individual areas may be one discrete patch or may be composed of separate patches e.g. patches of oak woodland within an open pasture. The most important consideration when deciding on assessment areas is that there should be no prior reason to suspect that different parts of the area will be subject to different levels of herbivore impact. If, after the assessment has been carried out, there appear to be discrete areas within the assessment area that have significantly different herbivore impact levels then sub-division of the area, and possibly further assessment, may be needed.

2. Print out the Herbivore Impact Field Guide to take into the field with you.

Field guide and field sheets. It may be helpful to laminate the Field Guide (pp.14-17) or to print it on waterproof paper. You will need a separate copy of the Herbivore Impact Assessment field sheet (p.13) for each of the assessment areas identified on your map.

Within each assessment area:

1. Walk through the areas stopping at 10 points.

Stops. Stops do not need to be a set distance apart however they should be fairly evenly spread out so that they provide a good representation of the area concerned. The stops do not have to be at the same locations as those of any previous assessment.

At each stop:

1. Visualise a circular plot with a radius of about 25 m with yourself at the centre.

2. Record the grid, or GPS waypoint, reference.

3. Use Table A1.1 to help you decide on one current herbivore impact level (on a scale from 'no impact' to 'very high) for each of the seven indicators.

Current impact. Record the impact of large herbivores on the most recent growing season's plant growth. Definitions of different levels of grazing /browsing intensity, in terms of percentage of leaves /shoots grazed or browsed, are provided within Table A1.1. These need to be referred to when assessing impacts on five of the seven indicators. More information on the relative palatability of different plant species is given in Tables A1.2 and A1.3. Note that, for some indicators, definitions of some impact levels overlap. Where this is the case, both possible impact levels should be noted. It may be helpful to look at the online photos of current impact levels (Table A1.4).

4. Write the number of the stop in the appropriate cell in **Box 1** of the **Herbivore Impact Assessment Field Sheet**. If the indicator could fall into either of two impact levels, write the number of the stop in both relevant cells.

Palatable and unpalatable species. If the level of browsing on palatable species of seedlings /saplings, or of basal shoots, provides a different result to that on unpalatable species, record the result for the indicator as the higher of the two impacts, whether on the palatable or unpalatable species. If there are no palatable species present within the notional plot, search a wider area and /or take account of palatable species found between stops. If still no palatable species are found, record the impact level, or levels, on the unpalatable species but make a note that no palatable species were found.

Use the “Not applicable” column in **Box 1** where the feature is not present at the stop.

‘Not applicable’. Impact should be recorded as ‘Not applicable’ where, for example:

- there are no **basal shoots** because the stand is composed only of tree species that do not produce basal shoots, e.g. Scots pine
- there cannot be any **bark stripping** because all the trees are mature and rough barked and so are not susceptible to bark stripping or
- there cannot be any **ground disturbance** because the site is composed of boulders, where ground disturbance would be unlikely to occur.
- The stop is on open ground so there are no basal shoots, epicormic /lower shoots or mature trees that could be bark stripped.

Use the “No impact” column in **Box 1** where the feature is present and could be impacted but where there is no sign of an impact

‘No impact’. ‘No impact’ should be recorded where, for example:

- seedlings /saplings are present but show no sign of browsing
- rowan or ash are present but have not been bark stripped or frayed or
- soil and vegetation could be disturbed by trampling but there is no obvious ground disturbance.

5. Make notes on anything you see that might help you to interpret your results.

Notes. You may want to record, for example:

- which species of tree /plant are present in different size /age groups
- the abundance of a particular species on which an assessment rests
- obvious signs of browsing on previous seasons’ growth
- signs of the presence of a particular species of large herbivore

Once you know how to complete the field sheet you may want to remove the guidance notes on the sheet to leave more room for notes.

Between stops:

1. Note the level of impact on indicators while walking between stops.

Between stops. If an indicator is absent, or rare, at a stop then include in the assessment for the stop any examples of the indicator encountered up to half way between the stop and the preceding and /or following one.

After completing all 10 stops within an assessment area:

1. Enter the most common impact level for each indicator, on the scale of 'No impact' to 'Very High', in the right hand column of **Box 1**.

Summarising impact on each indicator. If no impact level is the most common e.g. you have five 'Highs' and five 'Lows', you will need to judge which impact level best represents the overall impact. In this case you may decide to summarise the result as 'Medium'. Alternatively, if the 'Highs' and 'Lows' are divided spatially, you may want to divide up the area and re-assess each part separately. If the result for an indicator gives equal numbers of stops with different impact levels but the levels are next to each other on the impact scale, e.g. there are five 'Mediums' and five 'Lows' you may decide to record the overall impact as intermediate between the two i.e. 'Low /Medium'. Lastly, you may simply decide that it is not useful to attempt to summarise the result for an indicator.

2. Compare the current impact level recorded for each indicator. It is not essential to record an overall current impact but, if you want to, do so in the bottom row of **Box 1**.

Summarising overall impact. Summarising the current impact level in an assessment area as one overall result giving equal weight to all indicators can mask important information and occasionally give a misleading result. You may find that not all the indicators give the same result. There are a number of factors that may account for this. For example:

- Roe deer are browsers rather than grazers. They also do not create much ground disturbance, nor do they bark strip (though they will fray young trees). If roe deer are the main herbivore species present then you may find that the indicators relating to preferentially grazed species, seedlings, saplings, epicormic and basal shoots indicate heavy impact whereas those relating to ground disturbance, sward and bark stripping indicate a low impact**.**
- Cattle and pigs are more likely than other large herbivores to create ground disturbance, especially around feeding areas or pig shelters. If cattle and /or pigs are the main herbivores, then the ground disturbance indicator may be relatively high whilst the other indicators are relatively low.

When summarising the overall current impact level, it may be appropriate to take these differences into account as well as to consider the objectives for the area. If, for example, the site is grazed by roe deer and the objective is to increase the number of palatable seedlings and /or saplings and these are being heavily browsed, then the overall current impact should be recorded as 'high' even if the ground layer and bark stripping impacts are 'low'. Alternatively, do not attempt to summarise current impact but retain the information for each indicator separately and compare these with subsequent

3. Mark the location of each stop on your map and look at how the current impact level on each indicator differs between the 10 stops.

Spatial patterns. A stop may have a particularly high impact because, for example, it is near a feeding site, the ground flora at the stop is particularly palatable and/or it contains, or it is close to, routes habitually used by herbivores. Impact may be particularly low if there are obstructions to animal movement around the stop or the ground flora is particularly unpalatable.

4. Make a note of any obvious reason for differences between stops.

Distribution of impact. Some assessment areas will be very uniform, others more varied and, in some cases, one or two stops may differ from the rest. If there is a spatial pattern to the variation e.g. stops in one part of the assessment area differ from those in another, you may want to go back and assess each part separately.

Once you have completed all assessment areas:

1. Compare the results for each area with any existing targets for current herbivore impact. If none exist, consider setting targets.
2. If this is not the first assessment to be carried out at the site, compare the results with previous impact assessments and note the direction of change in impacts if there is one.

Herbivore Impact Assessment Field Sheet – Level 1

Date:	**Surveyor:**	**Woodland name:**
		Area name:

Stop	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Grid /waypoint ref.										

Box 1: Current herbivore Impact

Impact Indicator	**Not applicable**	**Very high**	**High**	**Medium**	**Low**	**No Impact**	**Overall impact**
Basal shoots							
Epicormic and lower shoots							
Seedlings and saplings							
Preferentially browsed or grazed plants							
Bark stripping and stem breakage							
Sward							
Ground disturbance							
Overall impact level							

Notes
(Continue overleaf if necessary)

Complete this field sheet for each assessment area in your wood. For each of 10 stops within the assessment area*:*

1. Enter the grid reference, or GPS waypoint reference, of the stop.
2. For each of the seven browsing indicators listed in the left-hand column of **Box 1,** rate the current herbivore impact on a scale between 'No impact' and 'Very high'. Enter the number of the stop in the appropriate cell of the box. Make notes on other features of interest at the stop e.g. which species of tree /plant are present or signs of large herbivores present.

When all stops have been completed:

1. In **Box 1**, ignoring the 'Not applicable' column, enter the most representative impact for each indicator in the right-hand column and the most representative overall impact level in the bottom box. Where impacts differ between indicators, include the rationale for determining the overall impact level.

Table A1.1. Current Herbivore Impact **(current =** within all, or part, of the preceding twelve months, depending on the time period of interest[1])

Note: if palatable and unpalatable species are present and the impacts on both do not match the descriptions below, use the higher impact, whether on the palatable or unpalatable species. This situation should rarely occur.

Indicator	Very High	High	Medium	Low	No impact
Bark stripping & stem breakage dbh = diameter at breast height (1.3 m above ground). Score as "Not applicable" if there are no trees susceptible to bark stripping or stem damage or if all damage occurred prior to the time period of interest.	>50% of live stems, and recently fallen branches, showing recent bark stripping that may be severe. One tree species, e.g. rowan, can have all accessible live stems stripped by deer. And /or >20% of live stems of saplings <5 cm dbh snapped by cattle and /or red deer.	20-50% of live stems, and recently fallen branches, showing recent bark stripping. One tree species, e.g. rowan, can have all accessible live stems stripped by deer. And /or 10-20% of live stems of saplings <5cm dbh snapped by cattle and /or red deer.	<20% of live stems, and recently fallen branches, showing signs of recent bark stripping. Sometimes one individual tree is badly bark stripped. And /or <10% (but more than occasional) live stems of saplings <5 cm dbh snapped by cattle and /or red deer. One tree species (e.g. rowan) may be heavily targeted.	Recent bark stripping generally hard to find. There may be one stripped or frayed tree. And /or Occasional stem snapping by cattle and /or red deer.	No recent bark stripping or stems snapped by large herbivores.
Ground disturbance **Animal disturbance** = trampling, pathways or wallows created within the assessment period. Score as "Not applicable" if the ground is composed of boulders or scree. N.B. plant litter is very quickly mineralised in moist, very rich woodlands and soil may be bare in spring. The lack of vegetation in these cases is not due to animal disturbance.	>30% of ground disturbed by large herbivores. Deer and /or livestock: frequent wide, heavily used, and wholly unvegetated, pathways and /or, on wet, open ground, there may be kicked out clods of turf and *Sphagnum* as well as well-defined deer wallows. Livestock: there may also be substantial areas of bare ground caused by poaching especially if the ground is wet. There may be heavier disturbance around feeding areas and pig shelters.	15-30% of ground disturbed by large herbivores. Deer and /or livestock: pathways frequent and partially, or mostly, unvegetated. Livestock: disturbance may be more widely distributed with some poached and /or unvegetated ground especially if the ground is wet. There may be heavier disturbance around feeding areas and pig shelters	5-15% of ground disturbed by large herbivores. Deer and /or livestock: pathways not hard to find but largely vegetated or pathways rare but unvegetated. Livestock: There may be heavier disturbance around feeding areas and pig shelters.	<5% of ground disturbed by large herbivores Deer and /or livestock: pathways rare and almost completely vegetated.	No areas of ground devoid of vegetation due to disturbance by large herbivores. No recognisable pathways.
Basal shoots Includes all accessible shoots sprouting from tree bases. Score as 'Not applicable' if there are no trees with basal shoots or if it is unclear whether shoots have been browsed or have died, and broken off, for other reasons e.g. frost, drought or lack of light. This may be an issue especially for Birch.	***Palatable*** species very heavily browsed, ***Unpalatable*** species heavily to very heavily browsed NB. Where large herbivores have been rare or absent in previous years there may be basal shoots that are now of too large a diameter to be browsed.	***Palatable*** species generally heavily browsed; a few may be very heavily browsed. ***Unpalatable*** species moderately browsed; a few may be heavily browsed.	***Palatable*** species generally moderately browsed; a few may be heavily browsed. ***Unpalatable*** species generally lightly browsed; a few may be moderately browsed.	***Palatable*** species generally lightly browsed; a few may be moderately browsed. ***Unpalatable*** species generally unbrowsed; a few may be lightly browsed.	***Palatable*** species unbrowsed ***Unpalatable*** species unbrowsed.
	Browsing rates	**Estimate % of current year's shoot growth removed based on the ratio of shoot diameter to length.**			
	Very heavy	> 90% of the current year's growth removed. Short stubby stems, difficult to see on some species. Most older, woody shoots browsed.			
	Heavy:	50%-90% of the current year's growth removed. Some older, woody shoots browsed.			
	Moderate:	10% -50% of the current year's growth removed. No older, woody shoots browsed.			
	Light:	<10% of the current year's growth (only shoot tips) removed.			

Table A1.1. Current Herbivore Impacts continued (current = within all, or part, of the preceding twelve months depending on the time period of interest[1])

Note: if palatable and unpalatable species are present and the impacts on both do not match the descriptions below, use the higher impact, whether on the palatable or unpalatable species. This situation should rarely occur.

Indicator	Very High	High	Medium	Low	No impact
Epicormic & lower shoots Includes all shoots on tree trunks (epicormic), lower branches or fallen trees that are within reach of herbivores. Score as 'Not applicable' if there are no trees with epicormic or lower shoots	A very obvious and well maintained browse-line on all trees, with plenty of evidence of recent browsing to shoot tips. ***Palatable*** species: shoots difficult to find because they are browsed close to the trunk or well into old woody growth. Any remaining shoots very heavily browsed. ***Unpalatable*** species moderately to very heavily browsed, even if shoots are woody.	An obvious browse-line on all trees that have live lower branches with most, or all, shoot tips browsed. ***Palatable*** species heavily browsed ***Unpalatable*** species**:** all but the most unpalatable shoots e.g. old woody birch shoots, moderately or heavily browsed.	An established browse-line is being maintained or a new browse-line is starting to develop i.e. there is evidence of some recent browsing to shoot tips, on most, or all, tree species. The presence of some unbrowsed lower branches may interrupt the horizontal browse-line. ***Palatable*** species moderately browsed. ***Unpalatable*** species unbrowsed or lightly browsed.	***Palatable*** species lightly browsed ***Unpalatable*** species unbrowsed.	No sign of *recent* browsing on any live shoots within reach of large herbivores.
Seedlings & saplings **Seedlings** = <50 cm tall (includes 'old seedlings'). **Saplings** = 50-200 cm tall. **'Old seedlings'** = trees < 50 cm tall that may be many years, or even decades, old but adverse conditions, usually browsing pressure, prevent them from growing upwards They often have a woody stem but rarely exceed 30 cm in height. Annual shoot extension is often negligible Score as 'Not applicable' if seedlings and saplings are absent since a lack of seedlings and saplings may be due to a cause other than browsing pressure.	**Seedlings** ***Palatable*** species, if present, will be very heavily browsed. If the survey is taking place during the growing season, unbrowsed seedlings in their first year may be present. ***Unpalatable*** species moderately to very heavily browsed. **Saplings** ***Palatable*** species battered by very heavy browsing, with many woody side shoots browsed back or snapped. Leading shoots unbrowsed only if they cannot be reached by herbivores. ***Unpalatable*** species heavily or very heavily browsed.	**Seedlings** ***Palatable*** species, if present, will be heavily browsed. If the survey is taking place during the growing season, unbrowsed seedlings in their first year may be present. ***Unpalatable*** species lightly browsed if in palatability class 6 or moderately browsed if in palatability class 4 or 5 (see Table 3). **Saplings** ***Palatable*** species heavily browsed. Leading shoots undamaged only if they cannot be reached by herbivores. ***Unpalatable*** species lightly browsed if in palatability class 6 or moderately browsed if in palatability classes 4 or 5 (see table 3).	**Seedlings** ***Palatable*** species generally moderately browsed; a few may be heavily browsed. ***Unpalatable*** species unbrowsed if in palatability class 6 or lightly browsed if in palatability class 4 or 5 (see Table 3). **Saplings** ***Palatable*** species generally moderately browsed; a few may be heavily browsed. Leaders undamaged only if they cannot be reached by herbivores. U***npalatable*** species unbrowsed if in palatability class 6 or lightly browsed if in palatability class 4 or 5 (see Table 3).5	**Seedlings** P***alatable*** species generally lightly browsed; a few may be moderately browsed. ***Unpalatable*** species unbrowsed. **Saplings** ***Palatable*** species lightly browsed. ***Unpalatable*** species unbrowsed.	**Seedlings** If present, all species unbrowsed. **Saplings** If present, all species unbrowsed.

	Browsing rates	**Estimate % of current year's shoot growth removed based on the ratio of shoot diameter to length.**
	Very heavy	All outer shoots removed (including many old, woody shoots) and remaining growth old and woody.
	Heavy:	>80% of the current year's growth removed. Older, woody growth removed from some shoots.
	Moderate:	30-80% of the current year's growth removed. Older, woody growth removed from some shoots.
	Light::	<30% of the current year's growth removed.

Table A1.1. Current Herbivore Impacts continued **(current** = within all, or part, of the preceding twelve months, depending on the time period of interest[1])
Note: if palatable and unpalatable species are present and the impacts on both do not match the descriptions, use the higher impact, whether on the palatable or unpalatable species. This situation should rarely occur.

Indicator	Very High	High	Medium	Low	No impact
Preferentially browsed or grazed plants Vegetation other than trees; primarily species listed as "very palatable" in Table 2. Score as "Not applicable" if there no accessible preferentially browsed or grazed plants can be found.	All accessible shoots very heavily browsed /grazed. No unbrowsed accessible runners of palatable species e.g. honeysuckle, bramble. There may be some growth of the current year's shoots in the growing season.	Accessible shoots generally heavily browsed /grazed but some of the most preferred species may be very heavily browsed /grazed. No unbrowsed accessible runners of palatable species e.g. honeysuckle, bramble.	Accessible shoots generally moderately browsed /grazed. Some, more preferred, species may be heavily browsed while others are unbrowsed e.g. bramble browsed but blaeberry unbrowsed. No unbrowsed accessible runners of palatable species e.g. honeysuckle, bramble.	Accessible shoots generally lightly browsed /grazed but there may be some shoots or individual species moderately browsed /grazed or unbrowsed /ungrazed. There may be some unbrowsed runners of palatable species e.g. honeysuckle, bramble.	No browsing /grazing on accessible shoots. Depending on the time since large herbivores have been present, there may be long unbrowsed runners /climbers or a dense tangled field layer obscuring views through the wood.
Sward Ground cover vegetation. This may include preferentially grazed species Rank = tall, dense vegetation, sometimes with a well-developed understorey of mosses or herbs. Score as 'Not applicable' if the ground cover is < 5%.	***Palatable*** species very heavily grazed. Flowering herbs of palatable species hug the ground, flower stalks difficult to find. In the growing season, spring flowering herbs may be ungrazed even where winter impacts were very high. ***Unpalatable*** species, such as rushes and tussock-forming grasses (e.g. tufted hair-grass, purple moor-grass,) heavily grazed. If grazing limited to autumn /winter, unpalatable species may be only lightly grazed.	***Palatable*** species heavily grazed. Flowering herbs of palatable species hug the ground, flower stalks difficult to find. In the growing season, spring flowering herbs may be ungrazed even where winter impacts were high. ***Unpalatable*** species moderately grazed. If grazing limited to autumn /winter, unpalatable species may be only lightly grazed.	***Palatable*** species moderately grazed. If palatable species are abundant, ***unpalatable*** species will be ungrazed. If palatable species are rare or absent, unpalatable species will be lightly grazed, except where livestock have been put into the wood at the start of the spring, At this time many unpalatable species are relatively palatable and they may be heavily grazed.	***Palatable*** species lightly grazed. ***Unpalatable*** species ungrazed. They may form a rank field layer more than 10 cm tall that shades the ground layer vegetation beneath.	**All sward species** ungrazed. There may be a rank and tussocky sward with abundant leaf litter, and /or a high proportion of woody herbs (e.g. bramble) or heathy species in the sward, depending on site characteristics such as soil, exposure and light availability.
	Browsing //grazing rates				
	Very heavy	All of leading shoots browsed or leaves grazed.			
	Heavy:	>75% of leading shoots browsed or leaves grazed.			
	Moderate:	25-75% of leading shoots browsed or leaves grazed.			
	Light:	<25% of leading shoots browsed or leaves grazed.			

[1] The time period of interest depends on the objective of the assessment as well as on the time of year that the assessment is carried out. For example, if the assessment is to determine impacts solely over the summer e.g. from summer cattle grazing, and it is carried out at the end of the summer, only the impacts occurring during the previous summer months would be considered. If the assessment is to determine impacts over a whole year, then impacts occurring during the whole of the previous year would be considered. For end-of-summer assessments, this will mean looking at over-winter browsing on the previous summer growth (recommended only for experienced surveyors) as well as browsing on the current year's summer growth. If the assessment is being carried out at the end of winter, it would only be necessary, and possible, to look at browsing on the previous summer's growth.

*Table A1.2. Relative palatability of non-tree plant species**			
Season	**Very palatable**	**Moderately palatable**	**Unpalatable**
All year	Bramble, Honeysuckle, dog rose, Ivy, Blaeberry, **Great woodrush,** Common Bent, Red Fescue, Yorkshire fog, Broom	*Hard fern,* Bog myrtle, Heather (Ling), Bell heather, Sheep's fescue	Hard fern, Great woodrush, Purple moor-grass, Mat grass, Tufted hair-grass, Soft and Sharp-flowered rush, Cross-leaved heath
Spring - Summer	As above. In addition: Valerian, Meadowsweet, Angelica, Raspberry, *Buckler ferns*	Devil's-bit scabious, **Purple moor-grass, Soft and Sharp-flowered rush,** *Lemon-scented fern, Lady fern, Great woodrush (especially flower shoots)*	Buckler ferns, Lemon-scented fern, Lady fern, Primrose

***** Normal font = all large herbivore species, except where also listed in bold or italics. **Bold = cattle only**, *italics = deer only*. More detailed information can be found here.

Table A1.3. Relative palatability and resilience of different tree species[1]			
Palatability[2] **(**Innate attraction of the species to being browsed)		**Resilience** (ability to survive being browsed & continue to grow)	
1 – Most palatable	Aspen, Willow, Ash, Elder[3]	1 – Most resilient	Eared Willow, Birch, Alder, Bird cherry, Hawthorn
2	Holly, Rowan, Hazel, Oak, Elm	2	Holly, Juniper, Blackthorn
3	Douglas Fir, Larches, Sycamore, Hawthorn, Gean, Blackthorn	3	Hazel, Oak, Rowan, Ash, Elm, Sycamore
4	Birch, Scots Pine, Lodgepole Pine, Beech	4 – Least	Scots pine and non-native conifers
5	Juniper, Bird cherry, Norway Spruce, Western Hemlock	More detailed information can be found here.	
6 – Least	Alder, Rhododendron, Sitka Spruce		

[1] Based largely on observation by the authors supported by limited published information.
[2] Assume that palatability classes 1-3 are 'palatable' and classes 4-6 are 'unpalatable'.
[3] Elder is unpalatable to rabbits.

Table A1.4. Links to current herbivore impact photos

Impact Type	Impact Level	Link
Bark stripping	Low	https://photos.app.goo.gl/K7uKmrRtRRYZiQqH3
	Medium	No photos yet.
	High	https://photos.app.goo.gl/Ktco3QAtHqM5HaYf2
	Very High	https://photos.app.goo.gl/4uuJHwPT7R6SLFUO2
	Not Applicable	https://photos.app.goo.gl/ynkorMpXKjtBEZH92
Basal shoots	No Impact	https://goo.gl/photos/8PyrcPqpB7s4UgVu7
	Low	https://goo.gl/photos/4VFGvHqPNgrZGe68A
	Medium	https://goo.gl/photos/dvTxuHnKqScan85G6
	High	https://goo.gl/photos/rFDZ1w9GvpNaqTwQ8
	Very High	https://goo.gl/photos/w2KJ5i6TfcHienev6
	Not Applicable	https://goo.gl/photos/X5Hj6sAvMZ7F35m5A
Epicormic and Lower shoots	No Impact	https://goo.gl/photos/MEfujp1HebExJgsZ7
	Low	https://goo.gl/photos/RfMvELTrwM4JPYS18
	Medium	https://goo.gl/photos/atSAHqaUVygkZoEE7
	High	https://goo.gl/photos/e49WqKTHBB4a19zr9
	Very High	https://goo.gl/photos/SujPofNUnHevvbQ49
Ground Disturbance	Low	https://goo.gl/photos/BTRDEJVjptPDwcGu5
	Medium	No photos yet.
	High	https://goo.gl/photos/xv931wuyzy5yyU787
	Very High	https://goo.gl/photos/Tq3PWfns96Xhcimf9
Preferentially browsed plants	No Impact	https://goo.gl/photos/37HCp8ic8zWvfMnG6
	Low	https://goo.gl/photos/GbZWQpMSCnBromhv8
	Medium	https://goo.gl/photos/pGAQ8n3BVEja3HNaA
	High	https://goo.gl/photos/GATqfGeuwi4YBK5M9
	Very High	https://goo.gl/photos/WBRp4E3PohqVSxSa9
	Not Applicable	https://goo.gl/photos/pqrnwL75pkL44kNh8
Seedlings and saplings	No Impact	https://goo.gl/photos/8oYC3JxDKwzjr9hM8
	Low	https://goo.gl/photos/PDV5tVJQDJhp1y4e7
	Medium	https://goo.gl/photos/g2f3K3soyVfagNTs8
	High	https://goo.gl/photos/gfrLbHfw4wXd6L8y7
	Very High	https://goo.gl/photos/9vdAxpUYSfqzXZ5CA
Sward	No Impact	https://goo.gl/photos/Akd5dkrM3CXc4smE6
	Low	https://goo.gl/photos/DJ2ZKsHzYPMEfBYz7
	Medium	No photos yet.
	High	https://goo.gl/photos/YcVXKmYqriDkjL7z7
	Very High	https://goo.gl/photos/GNdqtCC8KAnFTRWe8
	Not Applicable	https://goo.gl/photos/epr8yAAVpocP3bdU6

Level 2 assessment

A level 2 assessment is intended for experienced surveyors who need to carry out a herbivore impact assessment that not only provides a result but also provides additional information to explain the result. At this level, surveyors are expected to make detailed notes and take photos at each stop, as well as, where useful, between stops. Additionally, where there is a need to assess the likely longer-term impacts that herbivores have had on the wood and /or the implications of the result for the future of the wood, there is a range of additional observations that can be added to the basic method.

To carry out a level 2 assessment for current impact only, follow the instructions for level 1, above, but with the following changes:

1. Use at least one field sheet per stop. An example field sheet is given below. More than one field sheet may be needed if 'optional extras' are being recorded.
2. As you walk around the stop, record the observations you make relevant to each indicator. For example, you might find many very heavily browsed ash seedlings and a few heavily browsed ones, together with a heavily browsed hazel sapling and a lightly browsed beech seedling. Record all of this in your notes box under 'Seedlings and saplings'.
3. Record sighting, or signs, of large herbivores. See Indicators of the presence of different grazing species and Distinguishing between browsing by different mammal species for more help.
4. Take photos looking in all four cardinal directions from the centre of the stop, as well as of examples of what you are seeing.
5. When you have covered the whole area, use your notes on each indicator to determine an overall impact level for each. If your observations, for a particular indicator, do not point clearly to one overall impact, make further notes to justify your assessment for that indicator.
6. If you see relevant indicators between stops, include them with either the previous stop, or the next stop, whichever is nearest and take photos.

Experienced surveyors may decide to carry out their assessment in summer or autumn, rather than at the end of winter. This is more difficult since new growth can often obscure the impact of browsing /grazing on the previous season's growth. With practice, it is possible to carry out an assessment at these times of year.

When recommending appropriate herbivore management for a site, it can be useful to have additional information on past herbivore impacts and /or current condition of the woodland area. When regular monitoring is being carried out, it may not be necessary to include all, or any, of the optional extras in every assessment. Woodland structure class, for example, will not change as rapidly as current herbivore impact so need not be assessed at every visit.

Herbivore Impact Assessment Field Sheet – Level 2	Woodland name:	Area name:

Date:	Surveyor:	Stop number:	Grid ref.:

	Impact	Species of tree /plant seen plus browsing /grazing rate. Other notes e.g. signs of older impacts.
Basal shoots		
Epicormic and lower shoots		
Seedlings and saplings		
Preferentially browsed or grazed plants		
Bark stripping, fraying & stem breakage		
Sward		
Ground disturbance		
Signs of herbivores		
Notes		

ANNEX 2: SUMMARY OF RESULTS FOR EACH SITE, SURVEYOR AND STOP

See separate spreadsheet Annex 2 – Summary of results for each site surveyor and stop.

ANNEX 3: SUMMARY GRAPHS AND TABLES

See separate spreadsheet Annex 3 – Summary graphs and tables

ANNEX 4: CONSISTENCY OF SURVEYORS' ASSESSMENTS RELATIVE TO THE MEDIAN

Table A4.1a-g. Number of impact categories above or below the median recorded by each surveyor for each indicator. PL = Pass of Leny, FK = Fairy Knowe, BG = Beinglas, GL = Glen Loin, T = Total. Background colours highlight where the impact has been assessed as equal to (green), above (orange) or below (blue) the median impact; darker shades represent greater deviation from the median.

a) Basal shoots

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
PL	0.5	-0.5	0.5	0.5	0	0	0.5	-0.5	0.5	-0.5	0	-0.5	-1	-0.5	0
FK	0	-0.5	0	-1	-1	0	0	-1	0	-0.5	-1	0	-1	0	0
BG	0.5	0	0.5	0.5	0	0	0.5	0.5	-0.5	-0.5	0.5	0	0	1	-0.5
GL	1	-0.5	0.5	0.5	-0.5	-0.5	0	0	0.5	-0.5	0	0	-1.5	0.5	0
T	2	-1.5	1.5	0.5	-1.5	-0.5	1	-1	0.5	-2	-0.5	-0.5	-3.5	1	-0.5

b) Epicormic and lower shoots

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
PL	1	0	1	1	0	0.5	-0.5	0	0	-1	0	-0.5	-0.5	0	0
FK	0.5	-0.5	0.5	0	-1	0	-0.5	0.5	-0.5	-0.5	-0.5	0	-0.5	-0.5	-0.5
BG	1	0	1.5	1	0	-0.5	0	0	0	0	1	1	0	0	0
GL	1	-1	0.5	0	-1	0	0	0	-0.5	-1	-0.5	-1	-1.5	0	0
T	3.5	-1.5	3.5	2	-2	0	-1	0.5	-1	-2.5	0	-0.5	-2.5	-0.5	-0.5

c) Seedlings and saplings

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
PL	1	-0.5	1	1	0	-1	0	0	0	-0.5	-0.5	0	0	-1	0
FK	0	0	0	0	-0.5	-0.5	0	0	0	-0.5	0	0.5	0.5	0	0
BG	1	-0.5	0.5	0.5	-0.5	-1	-1	-0.5	-0.5	0	0	0	0	0.5	0.5
GL	1	-0.5	1	0.5	-0.5	0	0	0	0.5	-0.5	0.5	0.5	0	1	0
T	3	-1.5	2.5	2	-1.5	-2.5	-1	-0.5	0	-1.5	0	1	0.5	0.5	0.5

d) Preferentially browsed /grazed plant species

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
PL	1	-0.5	0	0	0.5	0.5	0	0	0.5	-0.5	-1	1	1	0	0
FK	0.5	0	-0.5	0	0.5	0	0	0	0	0.5	-0.5	0	0	0	0
BG	1	-0.5	0	1	1	-0.5	-1	0	0	0	0.5	-1	1	0	-1
GL	1	-1	0	0	0.5	-0.5	0	0	1	0.5	-0.5	1	-0.5	-1	0
T	3.5	-2	-0.5	1	2.5	-0.5	-1	0	1.5	0.5	-1.5	1	1.5	-1	-1

e) Bark stripping, fraying and stem breakage

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
PL	0.5	-0.5	0	0.5	1	0.5	1	0.5	0	0	-0.5	-0.5	-0.5	-0.5	0.5
FK	-1	0	-0.5	0	0	-0.5	-1	-0.5	0	-0.5	0	-0.5	-0.5	-1	1
BG	-0.5	0	0	0.5	1.5	0.5	-0.5	0.5	-0.5	0.5	0.5	-0.5	0	-0.5	0.5
GL	-0.5	-0.5	0	0.5	-0.5	0	-0.5	0.5	-0.5	-0.5	0	-0.5	0	-0.5	0.5
T	-1.5	-1	-0.5	1.5	2	0.5	-1	1	-1	-0.5	0	-2	-1	-2.5	2.5

f) Sward

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
PL	-0.5	0.5	-1	1.5	1	1	0	0.5	-0.5	0.5	-0.5	-0.5	1	-0.5	-0.5
FK	0	0.5	0	1	0	1	0	1	0.5	0	0	0.5	0.5	0	0
BG	0	0	-0.5	1.5	1	0	0	1	0	0	0	-1	0	0	0
GL	-0.5	0	-1	1	1.5	0.5	0	1.5	0	0	-0.5	-0.5	-0.5	-0.5	0.5
T	-1	1	-2.5	5	3.5	2.5	0	4	0	0.5	-1	-1.5	1	-1	0

g) Ground disturbance

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
PL	0	0	1	0	1	0	0	1	0	0	0	0.5	0.5	0	0
FK	0	0.5	1	0	0.5	0	0	1	0.5	0	0	0.5	0.5	-1	0
BG	-0.5	0	0	0	0.5	0	-1	0	-0.5	0	0	0	-0.5	0	0
GL	0	-0.5	1	0	0.5	-1	0	1	0	0.5	-0.5	-1	-0.5	-1	0
T	-0.5	0	3	0	2.5	-1	-1	3	0	0.5	-0.5	0	0	-2	0

ANNEX 5. COMPARISON OF SURVEYOR RESULTS WITH THE MEAN, MODE AND MEDIAN

Table A5.1. Comparison of impacts recorded by surveyors (Overall) with the median, mode and mean result for each surveyor (identified by number in the left-hand column). Background colours represent differences from the overall results of: a quarter of an impact category (pale yellow), half an impact category (pale pink), one impact category (dark pink), 1.5 impact categories (bright yellow), more than 1.5 impact categories (red).

		Pass of Leny				Fairy Knowe				Beinglas				Glen Loin			
	Indicator	Overall	Median	Mode	Mean	Overall	Median	Mode	Mean	Overall	Median	Mode	Mean	Overall	Median	Mode	Mean
1	1	H	H	H	H	H	H	H	H	M	M-M-H	VH	M-H	VH	VH	VH	VH
	2	H	H	H	H	H	H	H	M-H	M	M	M	M-H	VH	VH	VH	H-VH
	3	VH	VH	VH	VH	H	H	H	H	H-VH	H-H-VH	VH	H	VH	VH	VH	VH
	4	VH	VH	VH	H-VH	H-VH	H-VH	H	H-VH	H	H	M	H	VH	VH	VH	VH
	5	L	NI	NI	NI-L	NI	NI	NI	NI-L	NI	NI	NI	NI-L	NI	NI	NI	NI
	6	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	7	L	L	L	NI-L	L	L	L	L	NI-L	NI-NI-L	NI-NI-L	NI-L	M	M-M-H	M-H	M-H
2	1	M	M	M	M	M-H	M	M	M	L-M	L-L-M	L	L-M	M-H	M-M-H	M	M-H
	2	M	L-M-M	M	L-M	M	M	M	M	L	L	L	L	M	M	M	M
	3	M-H	M-H	M	M-H	H	M-H	M-H	M-H	M	M	M	M	M-H	M-H	M-H	M-H
	4	M-H	M-M-H	M	M-H	H	M-H	M	M-H	L-M	L	L	L-M	M	M	M-H	M
	5	NI	NI	NI	NI	L	NI	NI	NI-L	NI-L	NI	NI	NI-L	NI	NI	NI	NI
	6	M	M	M	M	L-M	L	L	L	L	NI-L-L	L	NI-L	L-M	L-M	L	L-M
	7	L	L	L	L	L-M	L	L	L	L	L	L	L	L-M	L	L	L-M
3	1	H	H	H	H	H	H	H	H	M	M	M	M	H-VH	H	H	H-VH
	2	H	H	H	H	H	H	H	H	M-H	M	M-H	M	H-VH	H	H	H-VH
	3	VH	VH	VH	H-VH	H	H	H	H	H	H	H	M-H	VH	VH	VH	H-VH
	4	H	H	H	H	M-H	H	H	H	M	M	L	M	H	H	H	H
	5	NI-L	NI	NI	NI	NI-L	NI	NI	NI-L	NI-L	NI-L-L	NI-L	NI-L	NI-L	NI	NI	NI-L
	6	NI-L	NI	NI	NI-L	L	L	M	L	NI-L	NI	NI	NI	NI-L	NI	NI	NI-L
	7	M	M	M	M	M	M	M	L-M	L			L	H	H	H	M-H

4	1	H	H	H	M-H	M	M	M	M	M	L-M-M	L-M	L-M	H-VH	H-H-VH	VH	H-VH
	2	H	H	H	H	M-H	M	M-H	M-H	M	M	M	L-M	H	H	H	H
	3	VH	VH	VH	H-VH	H	H	H	M-H	H	H-VH	H-VH	H	H-VH	H-H-VH	VH	H
	4	H	H	H	H	H	H	M	M-H	H	M	L	M	H	H	M-H	H
	5	L	NI	NI	NI-L	L	NI	NI	NI-L	L	NI	NI	NI-L	L	NI	NI	NI-L
	6	H	H	H	M-H	M	M	M	M	M-H	M-H	M-H	M-H	M-H	M	M	M-H
	7	L	L	L	NI-L	L	L	L	L	L	L	L	L	M	L	L	L-M
5	1	M-H	M-M-H	M	M-H	M	M	M	L-M	L-M	L-M	L-M	L-M	M-H	M-H	M-H	M-H
	2	M	M	M	L-M	L-M	L-M	H	L-M	L	L	L	L-M	M	M	M	M
	3	H	H	H	H	M-H	M-M-H	M-H	M-H	M	M	M	M	M-H	M-H	M-H	M-H
	4	H-VH	H-VH	H-VH	H-VH	H-VH	VH	VH	H-VH	H	H	H	H	H-VH	H	H-VH	H-VH
	5	N/A	L	L	L	L	L	L	L	M	L	L	L	NI	NI	NI	NI-L
	6	M-H	M	M	M-H	L	L	L	L	M	M	M	M	H	H	H	H
	7	M	M	M	M	L-M	L	L	L-M	L-M	L	L	L-M	M-H	H	H	M-H
6	1	M-H	M-M-H	M-H	M	H	H	H	H	L-M	L-M-M	L-M	M	M-H	M-H	M-H	M-H
	2	M-H	M-M-H	M-M-H	M-H	M-H	M-H	M-H	M-H	L-M	L-M	L-M	M	H	H	H	H
	3	M	M	M	M	M-H	M-H	M-H	M-H	L-M	L-M	L-M	M	H	H	H	H
	4	H-VH	H-VH	H-VH	H-VH	H	M-H-H	M-H-H	M-H	L-M	L-M	L-M	L-M	M-H	M-H-H	H	M-H
	5	L	L	L	L-M	NI-L	NI	NI	NI-L	L	L	L	L	NI-L	NI	NI	NI-L
	6	M-H	M-H-H	M-H-H	H	M	M	M	M	L	L	L	L-M	M	M	M-H	M
	7	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
7	1	H	H	H	H	H	H	H	H	L	L	L	L	H	H	H	H
	2	L-M	M	M	L-M	M	M	M	M	L	L	L	L	H	H	H	M-H
	3	H	H	H	H	H	H	H	H	L-M	M	M	L-M	H	H	H	H
	4	H	H	H	H	H	H	H	H	L	L	L	L-M	H	H	H	H
	5	N/A	L	L	L	NI	NI	NI	NI-L	NI	NI	NI	NI	NI	NI	NI	NI
	6	L-M	L-M	L-M	L-M	L	L	L	L-M	L	L	L	L	L-M	M	M	M
	7	L	L	L	NI-L	L	L	L	L-M	NI	NI	NI	NI	L	I	L	L

8	1	M	M-H	M	M-H	M	M	M	M	M	L-M-M	M	L-M	H	M-H-H	H	M-H
	2	M	M	M	L-M	H	M-H-H	H	M-H	L	L-L-M	L	L-M	H	M-H	H	M-H
	3	H	H	H	H	H	H	H	H	M	M	M-M-H	M	H	M-H-H	H	M-H
	4	H	H	H	H	H	H	H	M-H	M	M	M	M	H	H	H	H
	5	L	L	NI	NI-L	L-M	L-L-M	L-M	L-M	L	L	L	NI-L	L	L	NI	L
	6	M	M	M	M	M	M-M-H	M-H	M-H	M	L-M	M	L-M	H	M-H	H	M-H
	7	M	M	M	M-H	M	M	M	M	L	L	L	L	H	H	H	M-H
9	1	H	H	H	H	H	H	H	H	L	L	L	L	H-VH	H	H	H-VH
	2	M	M	M	M	M	M	M	M	L	L	L	L	M-H	M-H	M-H	M-H
	3	H	H	H	H	H	H	H	H	M	M	M	M	H-VH	H-VH	H-VH-VH	H-VH
	4	H-VH	H-H-VH	H	H-VH	H	H	H	H	M	M	M	L-M	VH	VH	VH	VH
	5	NI-L	NI	NI	NI-L	L	NI	NI	NI-L	NI	NI	NI	NI	NI	NI	NI	NI
	6	L	L	L	L	L-M	L-L-M	L	L-M	L	L	L	L	L-M	L-M-M	L-M	L-M
	7	L	L	L	L	L-M	L	L	L-M	NI-L	NI-L	NI-L	NI-L	M	L-M-M	L-M	M
10	1	M	M	M	L-M	M-H	M-M-H	M-H	M	L	L	L	L	M-H	M	M	M
	2	L	L	L	L	M	M	M	M	L	L	NI-L	NI-L	M	M	M	M
	3	M-H	M	M-H	M	M-H	M-H	M-H	M-H	M-H	M	M	M	M-H	M	M	M
	4	M-H	M-M-H	M	M-H	H-VH	H-H-VH	M-H	H-VH	M	M	M	M	H-VH	H-H-VH	VH	H
	5	NI-L	NI	NI	NI	NI-L	NI	NI	NI-L	L	L	L	NI-L	NI-L	NI	NI	NI
	6	M	M	M	M	L	L	L	L	L	L	L	L	L-M	L	L	L-M
	7	L	L	L	L	L	L	L	L	L	L	L	L	M-H	M	L	M
11	1	M-H	H	H	M-H	M	M	M	M-H	M	M	M	M	H	H	H	H
	2	M	M-H	M-H	M-H	M	M	M	M	M	M	M	M	M-H	M-H	M-H	M-H
	3	M-H	H	H	H	H	M-H-H	H	H	M-H	M-H	M-M-H	M-H	H-VH	H	H	H-VH
	4	M	M	M	M	M-H	M	M	M-H	L-M	M	M	L-M	M	L-M	L	M-H
	5	NI	NI	NI	NI	L	Ni	Ni	L	L	L	L	L	NI-L	NI	NI	NI-L
	6	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	7	L	L	L	L	L	L	L	L	L	L	L	L	L-M	L	L	L-M

12	1	M	M	M	M	H	M-H-H	H	H	L-M	L-M	L-M	L-M	M	M	M	L-M
	2	M	M	M	M	M-H	M-H	M-H	M-H	M	M-M-H	M	M-H	L	L	L	L-M
	3	H	H	H	H	H-VH	H-H-VH	VH	H-VH	M-H	M-H	M-H	M-H	H-VH	H-VH	H-VH	H-VH
	4	VH	VH	VH	H-VH	H	H	H	H	L	M	L	M	VH	H-VH-VH	VH	H-VH
	5	NI	NI	NI	NI	NI-L	Ni-L	NI	NI-L	NI	NI	NI	NI-L	NI	NI	NI	NI
	6	L	L	L	L-M	L-M	L-M	L	M	NI or N/A	NI	NI	NI-L	L	L	L	NI-L
	7	L	L-L-M	L	L-M	L-M			L-M	L	L	L	L	L	I	L	L
13	1	L-M	L-M	L-M	L-M	M	M	M	M	L-M	L-M	L-L-M	L-M	L-M	L-M	L-L-M	L-M
	2	L-M	L-L-M	L-M	L-M	M	M	M	M	L	L	L	L	L-M	L	L	L-M
	3	H	H	H	H	H-VH	H	H	H	M-H	M-H	M-N-H	M-H	H	H	H	H
	4	VH	VH	VH	VH	H-VH	H-VH	H-VH	H-VH	H	H	H	M	M-H	H	H-H-VH	H
	5	NI	NI	NI	NI	L-M	L	L	L	NI-L	NI	NI	NI-L	NI-L	NI	NI	NI
	6	M-H	M-H-H	M-H-H	M-H	M	M	M	M-H	L	L	L	NI-L	L	L	L	L
	7	L-M	L-M	L	L-M	M	L-L-M	L-M	L-M	NI-L	NI	NI	NI-L	L-M	M	M	L-M
14	1	M	M	M	M	H	H	H	H	M	M	M	M	H-VH	H-VH	H-VH	H-VH
	2	M	M	M	L-M	M-H	M-H	M	M-H	L	L	L	L	H	M-H	M	H
	3	M	M	M	M	H	H	H	H	H	H	H	M-H	VH	VH	VH	VH
	4	H	H	H	M-H	H	H	H	M-H	M	M	M	L-M	M	M	M	M-H
	5	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
	6	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	7	L	L	L	L	NI	NI	NI	NI-L	L?	L	L	L	L	L	L	L-M
15	1	H-M	M-H	M-H	M-H	H	H	H	H	L	L	L	L-M	H	H	H	H
	2	M	M	M	M	H	H	H	H	L	L	L	L-M	H	H	H	H
	3	H	H	H	H	H	H	H	H	H	M-H	H	M-H	H	H	H	H-VH
	4	H	H	H	H	H	H	H	H	L	L	L	L	H	H	H	H
	5	L	NI	NI	NI	M	L-M	NI	L	L	L	L	NI-L	L	NI	NI	NI-L
	6	L	L	L	L	L	L	L	L	L	L	L	L	M	M	M	L-M
	7	L	L	L	L	L	L	L	L-M	L	L	L	L	M	M-H	H	M

To calculate the mean impact value for each indicator, surveyor and site, the impact recorded at each stop was converted into a numeric value. (Table A5.2). The mean value was then calculated for each indicator, surveyor and site and converted back to an impact category (Table A5.2).

Table A5.2 The value given to each recorded impact and the range of numeric values of mean impacts corresponding to each impact category.

Impact category	Numeric value given to impact category	Range of numeric values of mean impacts corresponding to each impact category
No Impact	0	0-0.49
No Impact - Low	1	0.5-1.49
Low	2	1.5-2.49
Low-Medium	3	2.5-3.49
Medium	4	3.5-4.49
Medium-High	5	4.5-5.49
High	6	5.5-6.49
High-Very High	7	6.5-7.49
Very High	8	7.5-8.0

ANNEX 6: NUMBER OF SEEDLINGS AND SAMPLINGS IN EACH PALATABILITY CATEGORY

Table A6.1 Number of seedlings and saplings in each palatability group recorded by each surveyor at all stops in each browsing category. UB = unbrowsed, L = lightly, M = moderately, H = heavily, VH = very heavily browsed. Median values are highlighted in green.

a) Pass of Leny

	Palatable					Unpalatable Class 4 & 5					Unpalatable Class 6				
Surveyor	UB	L	M	H	VH	UB	L	M	H	VH	UB	L	M	H	VH
1	1	2.5	5.5	6	90	0	6	12	16	0	7	3	0	0	0
2	0	15	22	36	0	1	8	9	10	0	3	2	0	0	0
3	7	25	2	20	61	1	5	3	23	13	0	1	1	0	0
4	2	27	31	38	51	10	24	27	4	1	7	3	0	0	0
5	22	2	24	51	38	1	3	26	26	0	0	0	0	0	0
6	0	34	63	27	0	0	25	164	0	0	13	0	0	0	0
7	3	12	5	71	8	10	44	47	1	0	18	1	0	0	0
8	4	4	20	36	1	4	14	18	10	0	4	1.5	1.5	0	0
9	0	1.5	4.5	79	25	0	19	43	13	0	9	5	1	0	0
10	21	36	31	18	3	6	29	36	6	0	0	0	0	0	0
11	1	0	14	29	2	2	1	13	1	0	5	0	2	0	0
12	0	12	9	19	26	0	16	6	10	0	0	0	0	0	0
13	1	7	39	40	36	0	12	34	25	0	0	0	0	0	0
14	1	9	43	11	0	0	30	22	3	0	5	0	0	0	0
15	0	19	27	71	50	0	84	54	36	1	0	12	1	0	0

b) Fairy Knowe

	Palatable					Unpalatable Class 4 & 5					Unpalatable Class 6				
Surveyor	UB	L	M	H	VH	UB	L	M	H	VH	UB	L	M	H	VH
1	3	19	20	44	128	8	4	1	0	0	4	0	0	0	0
2	1	39	58	49	15	1	9	1	0	0	3	0	1	0	0
3	7	41	67	38	131	0	0	2	0	3	0	0	0	0	0
4	16	52	49	40	19	16	3	0	0	0	0	1	0	0	0
5	31	49	53	54	12	5	2	0	0	0	0	0	3	0	0
6	0	12	88	70	4	8	13	2	0	0	2	0	0	0	0
7	4	9	70	196	0	3	16	4	0	0	0	0	1	0	0
8	1	2	12	34	2	1	4	1	0	0	0	0	1	0	0
9	1	4	25	173	3	19	7	2	1	0	7	3	0	0	0
10	25	22	86	27	16	3	8	4	1	0	0	0	0	0	0
11	3	10	55	68	20	1	5	1	0	0	0	0	1	0	0
12	0	11	12	55	71	0	1	1	1	0	0	0	0	0	0
13	1	11	48	109	68	0	16	8	10	0	0	0	0	0	0
14	3	0	31	64	22	1	2	12	0	1	0	1	0	0	0
15	0	20	55	131	122	0	13	4	3	1	0	3	2	0	0

c) Beinglas

	Palatable					Unpalatable Class 4 & 5					Unpalatable Class 6				
Surveyor	UB	L	M	H	VH	UB	L	M	H	VH	UB	L	M	H	VH
1	37	44	32	97	96	13	31	8	18	4	17	6	1	0	4
2	12	34	54	50	0	1	21	2	0	0	10	6	1	0	0
3	9	6	9	5	17	7	3	2	1	0	3	1	0	1	0
4	1	33	45	33	187	2	31	11	0	0	14	7	1	0	0
5	6	8	28	7	6	3	8	5	0	0	3	2	0	0	0
6	9	24	272	66	0	1	25	10	0	0	12	3	0	0	0
7	28	24	51	39	0	21	10	0	0	0	5	1	1	0	0
8	54	40	74	50	0	20	9	2	0	0	13	4	0	0	0
9	45	69	79	90	0	15	32	4	2	0	26	22	10	8	0
10	46	108	117	50	12	22	56	10	0	0	31	8	7	6	1
11	7	11	58	42	2	2	6	7	0	0	3	1	0	0	0
12	5	24	61	77	121	0	14	9	2	0	21	40	0	0	0
13	0	50	169	97	41	1	20	6	0	0	2	18	0	0	0
14	4	5	29	89	1	5	27	11	0	0	0	10	0	9	1
15	0	98	95	94	0	0	37	12	3	0	0	37	0	0	0

d) Glen Loin

	Palatable					Unpalatable Class 4 & 5					Unpalatable Class 6				
Surveyor	UB	L	M	H	VH	UB	L	M	H	VH	UB	L	M	H	VH
1	2	0	0	12	105	0	0	0	0	1	1	1	0	0	1
2	1	6	10	11	0	0	0	1	0	0	0	0	0	0	0
3	2	1	2	6	47	1	1	1	0	2	0	0	0	3	0
4	1	6	7	12	18	0	0	0	0	0	1	0	0	2	1
5	7	0.5	9.5	18	14	0	0	2	0	0	0	0	0	0	0
6	0	1	11	13	8	0	1	1	0	0	0	0	2	0	0
7	1	2	9.5	51	2	0	0	0	0	0	0	0	0.5	0.5	0
8	14	8	18	47	6	0	1	0	0	0	0	1	4.5	2.5	0
9	1	0	0	21	28	0	0	0	0	0	0	0	0	0	0
10	23	31	60	12	4	0	0	2	1	0	1	0	0	0	0
11	1	2	2	11	10	0	1	0	0	0	0	0	1	1	0
12	0	2.5	6	20	85	0	0	0	0	0	0	0	0.5	1.5	0
13	1	5	24	28	9	0.5	1.5	0.5	0.5	0	0	0	0	0	0
14	2	0	1	10	30	0	0	0	0	0	1	0	2	1	0
15	0	0	5	22	38	0	0	0	1	0	0	0	0	2	0

ANNEX 7: TOTAL NUMBER, AND NUMBER OF SPECIES, OF SEEDLING AND SAPLING RECORDED BY EACH SURVEYOR AT EACH STOP

Table A7.1 a-d. Number of tree seedlings and saplings recorded at each site by each surveyor. Where it has been recorded as '>x' this has been entered as 'x'. Where no number was recorded, this was scored as '1'. Where abundance was erroneously recorded as 'lots' or 'abundant' this has been scored as '10'. Surveyor 14 recorded abundance categories (rare, occasional, frequent, abundant) rather than numbers of seedlings /saplings. These have been entered as 1, 5, 10 and 20 respectively. Where only the presence or absence, rather than the total number, of seedlings or saplings of each species in each browsing category was assessed, this has been entered as one seedling /sapling. NA = Stop not assessed.

a) Pass of Leny

	Stop										
Surveyor	1	2	3	4	5	6	7	8	9	10	Total
1	13	20	4	14	10	17	20	16	17	19	150
2	3	10	0	11	10	9	26	12	17	8	106
3	10	19	2	10	13	37	8	18	33	13	163
4	32	29	6	15	18	24	33	24	30	14	225
5	4	41	3	13	5	25	13	21	42	23	190
6	38	14	12	14	58	66	68	19	19	17	325
7	21	32	5	4	40	11	45	6	31	25	220
8	5	14	1	13	22	13	13	12	12	14	119
9	22	33	12	9	25	11	34	21	24	8	199
10	18	22	2	11	23	14	30	13	38	14	185
11	7	5	0	5	5	14	9	7	14	7	73
12	2	18	0	6	17	60	29	10	NA	NA	142
13	5	18	0	14	48	42	52	14	NA	NA	193
14	12	7	2	5	14	14	33	6	23	9	125
15	18	31	18	21	54	42	77	23	47	25	356

b) Fairy Knowe.

	Stop										
Surveyor	1	2	3	4	5	6	7	8	9	10	Total
1	30	1	19	18	25	13	12	31	39	43	231
2	11	6	17	13	21	15	16	35	10	33	177
3	10	12	37	24	24	22	7	70	29	54	289
4	33	27	NA	NA	31	17	4	30	34	23	196
5	18	11	25	24	27	13	4	39	24	25	210
6	11	21	39	11	29.5	11	4	14	25	32	197
7	28	27	39	27	41	21	3	36	36	45	303
8[1]	7	5	5	5	5	4	2	12	8	6	59
9	30	18	23	25	39	15	3	18	35	39	245
10	20	21	23	14	20	22	4	29	25	14	192
11	15	14	13	20	14	2	1	28	33	24	164
12	18	1	17	31	13	6	3	12	26	24	151
13	8	11	16	7	45	36	12	23	50	63	271
14	18	3	16	21	8	12	1	26	8	24	137
15	16	13	31	38	39	30	7	39	44	97	354

[1] Only presence /absence of each species in each browsing category was assessed by this surveyor (see Table caption) so results are likely to be low.

c) Beinglas

	Stop										
Surveyor	1	2	3	4	5	6	7	8	9	10	Total
1	63	19	67	37	40	64	48	12	24	30	408
2	26	5	26	19	11	24	33	12	11	16	191
3[1]	4	6	8	8	3	9	3	4	9	11	65
4	NA	NA	25	48	6	53	44	117	16	86	365
5[1]	NA	NA	18	10	6	6	8	5	8	15	76
6	35	7	119	28	39	40	54	57	27	14	420
7	44	32	37	32	35	NA	NA	NA	NA	NA	180
8	28	15	26	31	24	21	35	38	21	25	266
9	54	29	42	42	35	40	40	26	18	40	402
10	44	53	62	57	27	54	66	26	32	53	474
11	26	7	15	10	10	19	20	6	12	13	139
12	44	6	32	12	30	167	66	NA	NA	16	372
13	61	8	12	39	51	121	101	NA	NA	10	403
14	25	10	14	21	26	13	20	25	7	20	191
15	53	17	33	35	36	52	60	30	31	29	376

[1] Only presence /absence of each species in each browsing category was assessed by this surveyor (see Table caption) so results are likely to be low.

d) Glen Loin

	Stop										
Surveyor	1	2	3	4	5	6	7	8	9	10	Total
1	6	0	9	58	21	9	3	11	5	0	122
2	3	0	0	12	5	2	1	4	0	2	29
3	4	3	14	9	12	3	7	3	4	7	66
4	3	1	4	4	9	11	13	7	1	3	47
5	3	3	4	27	3	NA	NA	NA	7	4	51
6	1	4	5	8	5	4	6	3	NA	1	37
7	5	5	13	8	14	11	NA	NA	4	6	66
8	5	5	6	28	14	6	10	11	2	8	102
9	0	0	2	4	12	2	9	11	0	10	50
10	11	6	17	30	16	6	14	11	14	9	134
11	1	1	4	2	5	3	2	5	3	3	29
12	0	0	3	73.5	8	5	8	11	5	2	115.5
13	0	0	4	8	9	5	8	12	9	14	69
14	10	1	6	12	6	7	2	2	0	1	47
15	5	1	13	4	22	6	5	4	6	2	68

Table A7.2 a-d. Number of tree /shrub seedling /sapling species recorded at each stop by each surveyor. NA = Stop not assessed.

a) Pass of Leny

	Stop										
Surveyor	1	2	3	4	5	6	7	8	9	10	Total
1	4	4	3	5	4	3	4	5	2	4	7
2	1	2	0	4	2	3	6	5	4	3	8
3	3	6	2	2	2	1	4	4	2	1	7
4	6	5	3	3	3	3	5	5	4	3	7
5	4	3	3	3	4	2	4	6	4	4	6
6	6	3	3	5	4	4	6	4	5	5	10
7	6	7	2	1	4	2	3	4	4	4	8
8	4	5	1	4	4	2	5	4	3	2	7
9	5	4	4	5	4	2	4	4	3	3	6
10	4	3	2	2	2	1	4	4	3	3	6
11	3	4	0	4	2	1	3	3	2	2	8
12	2	3	0	1	1	2	3	2	NA	NA	7
13	3	3	0	4	3	1	3	3	NA	NA	6
14	3	2	2	1	2	2	4	4	4	3	7
15	5	4	4	6	5	3	5	4	3	4	8

b) Fairy Knowe

	Stop										
Surveyor	1	2	3	4	5	6	7	8	9	10	Total
1	3	1	5	2	5	4	5	5	6	6	7
2	2	2	4	2	5	4	5	4	4	6	6
3	3	5	3	3	2	3	2	4	3	5	7
4	3	5	NA	NA	5	4	2	5	6	5	7
5	3	5	5	3	4	2	2	4	4	5	8
6	3	4	5	2	5	4	3	5	5	6	6
7	4	4	5	5	3	3	2	5	5	5	8
8	4	5	3	3	3	3	2	2	4	5	8
9	4	5	4	6	6	4	2	6	5	6	8
10	4	5	5	4	5	3	2	4	5	3	7
11	2	5	4	1	3	1	1	3	5	3	7
12	3	1	4	5	3	3	1	3	5	4	9
13	3	2	4	5	3	3	3	4	4	5	7
14	3	2	3	4	4	5	1	5	2	5	7
15	4	5	6	4	4	5	3	4	5	6	7

c) Beinglas

	Stop										
Surveyor	1	2	3	4	5	6	7	8	9	10	Total
1	7	3	7	7	8	4	5	4	6	4	12
2	2	3	6	6	3	2	6	1	3	5	10
3	4	5	5	5	3	5	1	3	6	4	10
4	NA	NA	6	7	3	6	6	6	4	7	12
5	NA	NA	7	7	4	5	5	5	5	5	12
6	4	4	6	8	4	4	5	4	3	4	11
7	3	6	7	7	4	NA	NA	NA	NA	NA	9
8	5	5	3	6	3	4	7	5	3	6	13
9	5	8	6	7	7	6	6	5	6	6	13
10	5	8	7	8	7	6	8	4	4	7	11
11	4	3	4	4	2	4	1	4	4	2	9
12	4	3	5	4	4	5	6	NA	NA	3	11
13	2	4	2	4	4	6	5	NA	NA	5	9
14	2	5	3	4	4	3	3	2	2	2	9
15	5	4	4	6	5	6	3	4	5	5	9

d) Glen Loin

	Stop										
Surveyor	1	2	3	4	5	6	7	8	9	10	Total
1	3	0	3	3	3	1	2	4	4	0	7
2	1	0	0	2	1	2	1	2	0	1	5
3	3	2	4	3	2	2	3	3	2	3	8
4	2	1	3	3	2	2	2	3	1	1	8
5	2	2	4	4	3	NA	NA	NA	2	3	7
6	1	2	3	3	2	2	2	2	NA	1	8
7	3	2	3	3	3	3	NA	NA	1	1	7
8	2	3	3	6	2	2	2	2	2	2	11
9	0	0	1	2	1	1	2	3	0	1	4
10	2	2	3	3	2	2	3	3	4	3	8
11	1	1	3	2	1	1	2	2	2	3	9
12	0	0	2	3	2	1	3	3	1	2	8
13	0	0	3	2	4	1	1	3	3	4	7
14	1	1	2	3	2	2	2	2	0	1	7
15	3	1	4	2	3	1	2	1	3	2	7

See also separate spreadsheet ‘Annex 7 – Seedling and sapling results (final)’

Table A7.3 a-d. Number of tree /shrub seedlings and saplings of each species found by each surveyor at each site. An empty cell denotes where no seedlings or saplings were found. Where abundance was recorded as 'lots' or 'abundant' this has been scored as '10'. Where it has been recorded as '>x' this has been entered as 'x'. Where the browsing rate was recorded as between two categories, half the total number has been entered under each category. Surveyor 14 recorded abundance categories (rare, occasional, frequent, abundant) rather than numbers of seedlings /saplings. These have been entered as 1, 5, 10 and 20 respectively. Where only presence /absence was assessed, a record of a species at a stop has been entered as one seedling /sapling.

a) Pass of Leny,

Surveyor	Species														
	Alder	Ash	Beech	Birch	Bog myrtle	Coton-easter	Gorse	Hazel	Haw-thorn	Holly	Juni-per	Oak	Rowan	Sitka	Willow (eared)
1				34			1			53		4	37	10	11
2				27				2		25	1	3	28	5	15
3				45			1			91		1	15	2	8
4			1	65						69		5	55	10	20
5				55				2		39		4	64		26
6		1		188				1	6	33	1	16	41	13	25
7			3	99					1	41		2	42	19	13
8			1	45			1			24			27	7	14
9				74						48		2	52	15	8
10				73						41	4	3	53		11
11	3	1		16						35	1	4	6	7	0
12				32	45				1	32		1	27		4
13		1		71						68		1	50		2
14				55		1		1		23			22	5	18
15		2		175		1				73		2	59	13	31

b) Fairy Knowe

Surveyor	Species													
	Alder	Ash	Beech	Birch	Broom	Hazel	Haw-thorn	Holly	Juniper	Norway spruce	Oak	Rowan	Sitka	Willow (eared)
1		4	13			50		51			64	45	4	
2			11			43		50			38	31	4	
3		21	2	3		34		98			88	43		
4		6	19			45		52			48	25	1	
5	3	3	7		1	39		59			41	57		
6			23			35		60			41	37	2	
7		1	20	3		47		139			58	34	1	
8[1]		4	6		1	9		22			7	9	1	
9		1	28			38		78		1	51	38	10	
10		1	16			55		52			34	32		2
11		6	7			3		53			81	13	1	
12		1	2			29	3	37	1		47	27		4
13		4	34			18	1	112			86	16		
14			15	1		17		45			31	27	1	
15			20	1		73		78			92	85	5	

[1] Only presence /absence assessed by this surveyor (see caption to Table) so results are likely to be low.

c) Beinglas

Surveyor	Species																
	Alder	Ash	Beech	Birch	Black-thorn	Broom	Dog rose	Elm	Hazel	Haw-thorn	Holly	Juni-per	Lime	Oak	Rowan	Sitka	Willow (eared)
1	28	199	22	52	12		3		29	11	20			1	30		1
2	17	86	7	17			2		21	12	12			1	16		
3[1]	5	22	4	9	1	1			7	1	11				4		
4	22	209	12	32	13		4		24	15	13			2	13		6
5[1]	5	20	6	10	1		3		8	4	5			2	11		1
6	15	227	7	28	1		1		21	8	6			4	102		
7	7	89	12	18					28	1		1		6	18		
8	17	121	6	25	2		2	1	50	7	9		1	3	22		
9	65	142	18	35	23		1		53	12	17			5	29	1	1
10	53	170	8	80	11				65	19	25			9	31		3
11	4	95	5	10					14	2	7			1	1		
12	61	227	3	21			2		18	13	9			1	16		1
13	20	277	8	19			1		10	8	10				50		
14	20	82	15	28	10				21	2	6				7		
15	37	186	12	40	7				56	11	8				19		

[1] Only presence /absence assessed by this surveyor (see caption to Table) so results are likely to be low.

d) Glen Loin

Surveyor	Species													
	Alder	Ash	Birch	Black-thorn	Dog rose	Gorse	Hazel	Haw-thorn	Holly	Norway spruce	Oak	Rowan	Sitka	Willow (eared)
1		36	1									10		
2		11							3		1	5		
3	2	18	5				1		1				1	
4	2	2									1	1		
5		22	2				6				2	2		
6	2	4	2				1					0		
7	1	7					0				1	1		
8	1	8	1				10	6	28			38	3	
9		5					1		12	1		4		
10		37	3				13		16		3	8	1	
11	1	2	1	1			2	2	23		1	13	2	
12	2				1		10	1	4			11		1
13		8	3				8	3	14		1	3		
14	2	6					16	1	14		2	25		
15	2	6	1			1	4	4	11		1	63	7	1

ANNEX 8. BROWSING RATES ON EACH SEEDLINGS AND SAPLING SPECIES

Table A8.1 Numbers of seedlings /saplings of abundant and frequently occurring tree species recorded by each surveyor in each browsing category at all stops. UB= unbrowsed, L = lightly, M = moderately, H = heavily, VH = very heavily browsed. Also shown is the number of surveyors for whom the median browsing rate fell into each browsing category (Median; where the median fell between two categories, 0.5 has been allocated to each category). The median browsing categories for each surveyor, and overall, are coloured green. For clarity, other positive values are coloured yellow. a) Pass of Leny, b) Fairy Knowe, c) Beinglas, d) Glen Loin.

a) Pass of Leny

	Tree /shrub species														
	Birch					Holly					Oak				
Surveyor	UB	L	M	H	VH	UB	L	M	H	VH	UB	L	M	H	VH
1	0	6	12	16	0	1	0	1	2	49	0	0	0	0	4
2	1	8	8	10	0	0	5	10	10	0	0	0	0	3	0
3	1	5	3	23	13	6	17	1	20	47	0	0	0	0	1
4	10	24	27	4	0	1	10	24	19	15	0	0	0	0	5
5	0.5	2.5	26	26	0	7	0	0	20	12	0	0	0	2	2
6	0	25	163	0	0	0	6	11	16	0	0	5	7	4	0
7	10	41	47	1	0	2	0	3	32	4	0	0	0	2	0
8	4	13	18	10	0	2	2	5	14	1	0	0	0	0	0
9	0	18	42	13	0	0	0.5	0.5	42	5	0	0	0	2	0
10	7	32	34	5	0	6	8	5	6	2	2	2	2	0	0
11	1	1	13	1	0	1	0	7	25	2	0	0	4	0	0
12	0	16	6	10	0	0	7.5	7.5	6.5	11	0	0	0	0	1
13	0	13	35	25	0	0	4	25	15	15	0	2	0	0	0
14	0	16	17	3	0	0	3	16	0.1	0	0	0	0	0	0
15	0	84	54	36	1	0	1	6	48	18	0	0	0	0	2
Median		2.5	11.5	1				4.5	9.5	1		2	2	3.5	5.5

	Tree /shrub species														
	Rowan					Sitka spruce					Willow (eared)				
Surveyor	UB	L	M	H	VH	UB	L	M	H	VH	UB	L	M	H	VH
1	0	0	0	1	36	7	3	0	0	0	0	2.5	4.5	3	1
2	0	3	6	19	0	3	2	0	0	0	0	5	6	4	0
3	0	4	0	0	11	0	1	1	0	0	1	4	1	0	2
4	1	6	3	14	31	7	3	0	0	0	0	11	4	5	0
5	1	0	11	29	24	0	0	0	0	0	12	2	12	0	0
6	0	5	31	5	0	13	0	0	0	0	0	12	12.5	1	0
7	0	1	0	37	4	18	1	0	0	0	1	10	2	0	0
8	1	0	4	22	0	4	2	1.5	0	0	1	2	11	0	0
9	0	0	1	31	20	9	5	1	0	0	0	1	3	4	0
10	8	15	17	12	1	0	0	0	0	0	1	8.5	3.5	0	0
11	0	0	3	3	0	5	0	2	0	0	0	0	0	0	0
12	0	1	0	12	14	0	0	0	0	0	0	3	0.5	0.5	0
13	0	3	13	18	13	0	0	0	0	0	0	0	0.5	0.5	1
14	0	5	3	11	0	5	0	0	0	0	1	1	16	0	0
15	0	1	11	19	28	0	12	1	0	0	0	17	10	4	0
Median			2.5	8.5	4	9	2	1				7	6.5	0.5	

I

b) Fairy Knowe

	Tree /shrub species																			
	Ash					Beech					Hazel					Holly				
Surveyor	UB	L	M	H	VH	UB	L	M	H	VH	UB	L	M	H	VH	UB	L	M	H	VH
1	0	0	0	2	2	8	4	1	0	0	1	19	16	13	1	1	0	2	24	24
2	0	0	0	0	0	1	9	1	0	0	0	18	19	6	0	0	10	17	21	2
3	0	0	0	1	20	0	0	2	0	0	3	22	3	5	1	3	18	27	9	41
4	0	0	1	0	5	16	3	0	0	0	6	28	10	1	0	0	6	21	14	11
5	0	2	0	1	0	5	2	0	0	0	8	28	3	0	0	0	9	32	17	1
6	0	0	0	0	0	8	13	2	0	0	0	7	28	0	0	0	0	24	32	4
7	0	0	0	1	0	3	16	1	0	0	1	9	20	17	0	1	0	26	112	0
8[1]	0	0	1	3	0	1	4	1	0	0	0	2	4	3	0	0	0	4	17	1
9	0	0	0	1	0	18	7	2	1	0	1	4	14	19	0	0	0	4	74	0
10	0	0	1	0	0	3	8	4	1	0	4	10	39	2	0	4	6	15	16	11
11	0	0	5	1	0	1	5	1	0	0	0	0	2	1	0	1	3	28	21	0
12	0	1	0	0	0	0	0	1	1	0	0	0	8	11	10	0	10	2	16	9
13	0	0	3	1	0	0	16	8	10	0	0	4	11	1	3	1	5	30	32	44
14	0	0	0	0	0	1	2	12	0	0	0	0	7	10	0	2	0	9	34	0
15	0	0	0	0	0	0	13	4	3	0	0	8	21	35	9	0	6	13	41	18
Median		2	3	4	3	4	7	4	1			3	9	4				4	11	

	Tree /shrub species														
	Oak					Rowan					Sitka Spruce				
Surveyor	UB	L	M	H	VH	UB	L	M	H	VH	UB	L	M	H	VH
1	1	0	0	2	61	0	0	2	3	40	4	0	0	0	0
2	1	2	6	16	13	0	9	16	6	0	3	0	1	0	0
3	1	0	22	23	42	0	1	15	0	27	0	0	0	0	0
4	10	12	15	9	2	0	6	2	16	1	0	1	0	0	0
5	13	5	8	5	10	10	5	10	31	1	0	0	0	0	0
6	0	5	11	26	0	0	0	25	12	0	2	0	0	0	0
7	2	0	18	38	0	0	0	6	28	0	0	0	1	0	0
8[1]	1	0	2	3	1	0	0	1	8	0	0	0	1	0	0
9	0	0	6	44	1	0	0	1	35	2	7	3	0	0	0
10	11	1	16	5	1	6	5	13	4	4	0	0	0	0	0
11	2	7	17	35	20	0	0	3	10	0	0	0	1	0	0
12	0	0	1	16	30	0	0	1	5.5	21	0	0	0	0	0
13	0	0	5	66	16	0	2	0	9	5	0	0	0	0	0
14	1	0	5	6	19	0	0	10	14	3	0	1	0	0	0
15	0	0	7	7	78	0	6	14	48	17	0	3	2	0	0
Median			3	8	4			3	9	3	4	3	3		

[1] *Only presence /absence, not numbers, of seedlings /saplings recorded at each stop. Numbers represent the number of stops where each species was recorded.*

c) Beinglas

	Tree /shrub species																			
	Alder					Ash					Beech					Birch				
Surveyor	UB	L	M	H	VH	UB	L	M	H	VH	UB	L	M	H	VH	UB	L	M	H	VH
1	17	6	1	0	4	20	18	13	67	81	11	10	1	0	0	2	21	7	18	4
2	10	6	1	0	0	8	16	32	30	0	1	6	0	0	0	0	15	2	0	0
3[1]	3	1	0	1	0	3	3	7	3	6	3	0	1	0	0	4	3	1	1	0
4	14	7	1	0	0	1	8	10	16	174	0	6	6	0	0	2	25	5	0	0
5[1]	3	2	0	0	0	0	0	15	4	1	1	3	2	0	0	2	5	3	0	0
6	12	3	0	0	0	8	2	203	14	0	0	5	2	0	0	1	20	7.5	0	0
7	5	1	1	0	0	23	11	24	31	0	6	6	0	0	0	14	4	0	0	0
8	13	4	0	0	0	28	18	36	39	0	3	3	0	0	0	17	6	2	0	0
9	26	21	10	8	0	20	10	58	54	0	7	8	2	1	0	8	24	2	1	0
10	31	8	7	6	1	28	38	63	35	6	3	3	2	0	0	19	53	8	0	0
11	3	1	0	0	0	3	9	46	35	2	2	1	2	0	0	0	5	5	0	0
12	21	40	0	0	0	2	7	40	63	115	0	3	0	0	0	0	11	8.5	2	0
13	2	18	0	0	0	0	37	126	80	34	1	5	2	0	0	0	15	4	0	0
14	0	10	0	9	1	0	2	5	74	1	5	10	0	0	0	0	17	11	0	0
15	0	37	0	0	0	0	54	58	74	0	0	5	7	0	0	0	32	5	3	0
Median	10	4	1					11	2	2	4	11	1			2	11	2		

	Tree /shrub species																			
	Blackthorn					Dog rose					Hazel					Hawthorn				
Surveyor	UB	L	M	H	VH	UB	L	M	H	VH	UB	L	M	H	VH	UB	L	M	H	VH
1	0	10	0	2	0	0	0	1	2	0	3	10	7	7	2	0	3	5	3	0
2	0	0	0	0	0	0	2	0	0	0	1	5	8	7	0	0	4	6	2	0
3[1]	0	0	0	1	0	0	0	0	0	0	1	1	1	1	3	0	1	0	0	0
4	0	3	0	7	3	0	0	3	0	1	0	11	10	2	1	0	5	5	2	3
5[1]	0	1	0	0	0	0	0	0	0	3	1	1	5	1	0	0	3	0	0	1
6	0	1	0	0	0	0	1	0	0	0	0	10	12	0	0	0	7	1	0	0
7	0	0	0	0	0	0	0	0	0	0	4	8	16	0	0	0	1	0	0	0
8	0	0	1	1	0	0	1	1	0	0	11	9	24	6	0	3	4	0	0	0
9	3	20	0	0	0	0	0	1	0	0	12	28	10	3	0	4	6	2	0	0
10	0	11	0	0	0	0	0	0	0	0	11	23	29	2	0	1	15	3	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	9	5	0	0	1	0	1	0
12	0	0	0	0	0	0	0	0	2	0	0	6	5	8	0	0	5	7	1	0
13	0	0	0	0	0	0	0	0	1	0	0	2	7	0	1	0	2	5	1	1
14	0	0	10	0	0	0	0	0	0	0	0	2	14	5	0	2	0	0	0	0
15	0	2	2	3	0	0	0	0	0	0	0	26	22	8	0	0	9	2	0	0
Median		5	3	3			3	3	3			2	12	1		1	8	6		

	Tree /shrub species														
	Holly					Oak					Rowan				
Surveyor	UB	L	M	H	VH	UB	L	M	H	VH	UB	L	M	H	VH
1	3	0	2	4	11	0	0	0	0	1	10	3	4	12	1
2	1	5	3	3	0	0	0	0	1	0	2	2	5	7	0
3[1]	3	0	1	0	7	0	0	0	0	0	2	1	0	0	1
4	0	2	5	4	2	0	0	2	0	0	0	2	6	2	3
5[1]	1	1	2	1	0	0	1	1	0	0	4	0	5	1	1
6	0	3	3	0	0	1	0	1.5	2	0	0	0	51	51	0
7	0	0	0	0	0	1	0	4	1	0	0	4	7	7	0
8	1	1	5	2	0	2	0	1	0	0	8	6	6	2	0
9	1	0	0	16	0	2	2	0	1	0	3	2	8	16	0
10	2	10	10	3	0	0	1	3	4	1	3	9	8	6	5
11	4	0	3	0	0	0	1	0	0	0	0	0	0	1	0
12	2	4	3	0	0	0	0	1	0	0	1	1.5	5	2.5	6
13	0	3	4	3	0	0	0	0	0	0	0	6	27	12	5
14	1	0	0	5	0	0	0	0	0	0	1	1	0	5	0
15	0	3	4	1	0	0	0	0	0	0	0	4	7	8	0
Median	1	3	8	2	2	1	3	5	2	1		2	9	5	

[1] Only presence /absence, not numbers, of seedlings /saplings recorded at each stop. Numbers represent the number of stops where each species was recorded.

d) Glen Loin

	Tree /shrub species																			
	Alder					Ash					Birch					Hazel				
Surveyor	UB	L	M	H	VH	UB	L	M	H	VH	UB	L	M	H	VH	UB	L	M	H	VH
1	0	0	0	0	0	0	0	0	0	36	0	0	0	0	1	0	0	0	4	6
2	0	0	0	0	0	0	2	6	3	0	0	0	0	0	0	0	1	0	0	0
3	0	0	0	2	0	0	0	1	2	15	1	1	1	0	2	0	1	0	2	10
4	0	0	0	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	1	1
5	0	0	0	0	0	0	0	1	11	10	0	0	2	0	0	5	0	4	1	0
6	0	0	2	0	0	0	0	2	2	0	0	1	1	0	0	0	0	4	4	0
7	0	0	1	1	0	0	0	0	7	0	0	0	0	0	0	1	2	3	10	0
8	0	0	1	0	0	0	1	3	4	0	0	1	0	0	0	0	0	2	2	0
9	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	2
10	0	0	0	0	0	9	15	11	2	0	0	0	2	1	0	2	3	4	0	0
11	0	0	0	1	0	0	0	0	2	0	0	1	0	0	0	0	1	0	4	0
12	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	2
13	0	0	0	0	0	1	0	2	5	0	0.5	1.5	0.5	1	0	0	2	7	7	0
14	0	0	2	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	1
15	0	0	0	2	0	0	0	1	1	4	0	0	0	1	0	0	0	0	6	0
Median			4	6	1		1	4	7	5		4	4	1	1		3	3	7	5

	Tree /shrub species																			
	Hawthorn					Holly					Oak					Rowan				
Surveyor	UB	L	M	H	VH	UB	L	M	H	VH	UB	L	M	H	VH	UB	L	M	H	VH
1	0	0	0	0	6	1	0	0	1.5	25.5	0	0	0	0	0	1	0	0	6	31
2	0	0	0	0	0	0	1	4	7	0	0	0	0	0	0	1	2	0	1	0
3	0	0	0	0	0	0	0	1	1	14	0	0	0	0	3	2	0	0	1	5
4	0	0	1	0	1	1	3	2	7	10	0	0	0	1	0	0	3	3	1.5	5.5
5	0	0	1	0	0	0	0	1.5	2.5	0	0	0	0	0	0	2	0	1.5	3.5	4
6	0	1	2	0	0	0	0	0	6	8	0	0	0	1	0	0	0	3	0	0
7	0	0	0.5	1	0	0	0	1	11	2	0	0	0	2	0	0	0	5	20	0
8	0	0	0	4	0	1	0	3	5	2	0	0	1	0	0	13	7	8.5	30.5	4
9	0	0	0	0	0	0	0	0	21	8	0	0	0	0	0	1	0	0	0	13
10	0	1	0	0	0	2	2	24	2	4	1	0	3	3	0	9	10	18	5	0
11	0	0	0	0	0	1	0	0	5	9	0	0	1	0	0	0	0	1	0	1
12	0	1	0.5	2	0	0	1	5.5	5	5.5	0	0	0	1	0	0	1	0	6	7
13	0	1	1.5	1	1	0	1.5	4.5	9	8	0	1	0	1	0	0	0	9	5	0
14	0	0	0	0	1	2	0	1	0	5	0	0	0	0	0	0	0	0	10	17
15	0	0	0	0	0	0	0	1	3	18	0	0	0	0	5	0	0	3	12	11
Median		1	3	4	2			1	8	6			4	4	2		1	3	7	5

	Tree/shrub species Sitka spruce				
Surveyor	UB	L	M	H	VH
1	1	1	0	0	1
2	0	0	0	0	0
3	0	0	0	1	0
4	1	0	0	1	0
5	0	0	0	0	0
6	0	0	0	0	0
7	0	0	0	0	0
8	0	1	3.5	3	0
9	0	0	0	0	0
10	1	0	0	0	0
11	0	0	1	0	0
12	0	0	0	0	0
13	0	0	0	0	0
14	1	0	0	1	0
15	0	0	0	0	0
Median	1	3	4	1	

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