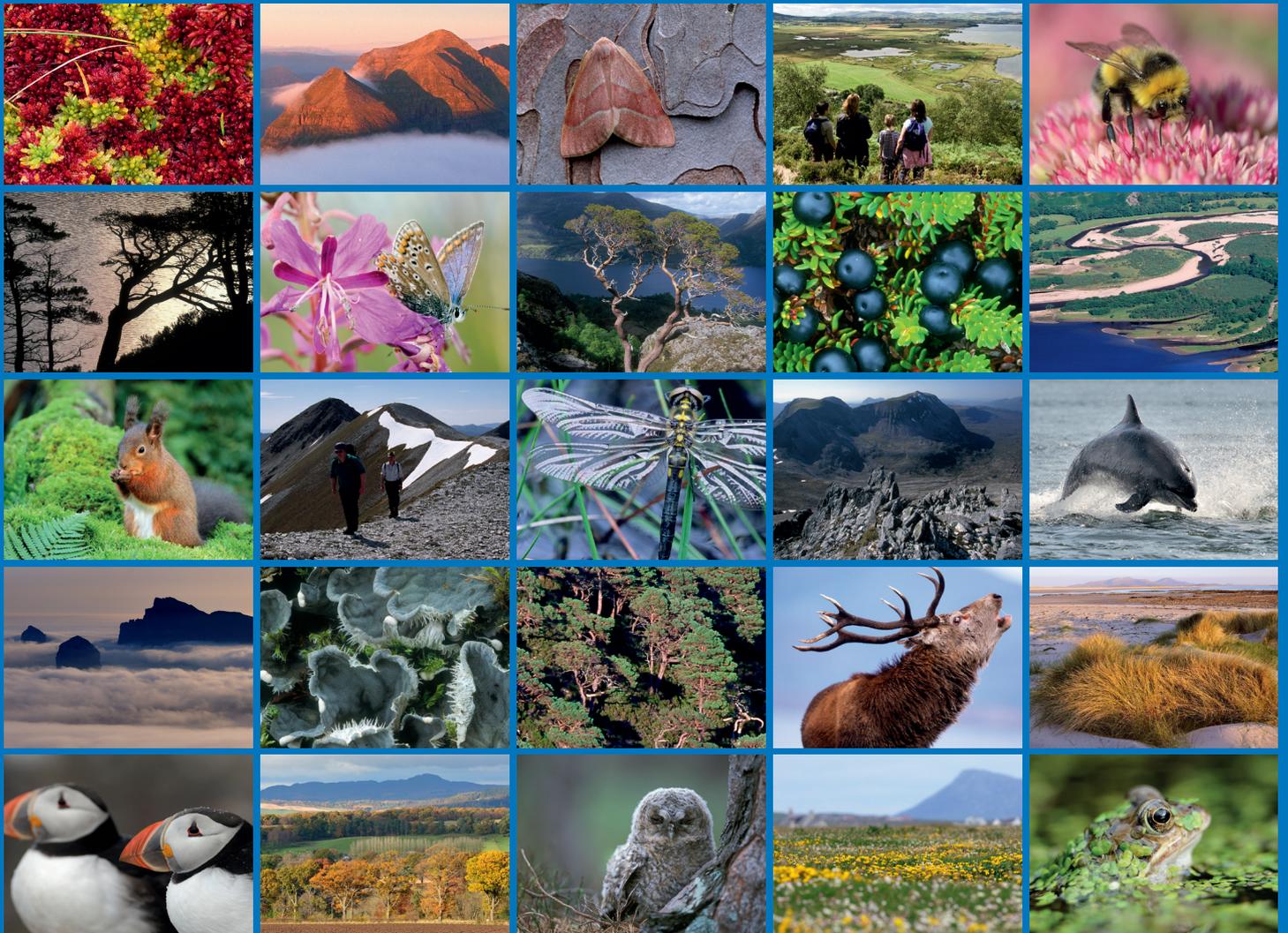


Ardvar Woodlands SSSI/SAC Herbivore Impact Assessment 2018





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RESEARCH REPORT

Research Report No. 1068

Ardvar Woodlands SSSI/SAC Herbivore Impact Assessment 2018

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RESEARCH REPORT

Summary

Ardvar Woodlands SSSI/SAC Herbivore Impact Assessment 2018

Research Report No. 1068

Project No: 016686

Contractor: Haycock and Jay Associates Ltd.

Year of publication: 2019

Keywords

Ardvar; woodland; deer browsing; regeneration; plots; survey; assessment; herbivore; impacts.

Background

Haycock and Jay Associates Ltd was commissioned by Scottish Natural Heritage (SNH) to undertake an Assessment of Herbivore Impacts at Ardvar Woodlands SSSI/SAC in April 2018.

This assessment aims to set a baseline to determine the trends and current herbivore impacts in each of the estates across Ardvar SSSI/SAC, and to discuss these results in relation to the previous herbivore impact assessment in 2016 in order to determine a prognosis of the Ardvar Woodland.

Main findings

- Over the whole of Ardvar woodland the most frequent current herbivore impact level is Medium (57% of plots), although High impacts (29% of plots) are still widespread.
- For 96% of plots the mean height of the ten nearest seedlings to the centre of each survey plot is less than 100cm in height with 56% of the plots having a mean seedling height of 10cm or less. Considering all seedlings that were measured, 67% are \leq 10cm and 95% are $<$ 1m.
- Except for sheep wool recorded at Reintraid Estate, all other recorded signs of herbivore activity indicate that red deer are the main herbivore within Ardvar woodland.
- Deer fenced exclosures recorded low to no herbivore impacts.
- Results are not directly comparable with the 2016 survey, as 2018 plots were four times larger than those surveyed in the previous survey, and because of differences in the time of year when survey was carried out. The 2016 survey took place in October, whereas the 2018 work was carried out in May. It is thus not possible to comment on changes over this period.

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1. INTRODUCTION

1.1 Background

Haycock and Jay Associates Ltd was commissioned by Scottish Natural Heritage (SNH) to undertake an Assessment of Herbivore Impact at Ardvar Woodlands Site of Special Scientific Interest (SSSI)/ Special Area of Conservation (SAC) in May 2018.

The woodland Herbivore Impact Assessment (HIA) is required to provide an assessment of the current herbivore browsing levels and provide a baseline for future assessments. This will allow SNH and land managers to monitor progress towards achieving favourable condition.

This report details the methodology, results, analysis and conclusions of an HIA carried out in May 2018. Comparison with the previous 2016 assessment is not possible because of differences in the assessments, such as increased plot size and time of year; this survey should be used as a baseline going forward rather than to compare with previous assessments. The general prognosis for the woodland is also discussed.

1.2 Ardvar woodlands

Ardvar woodlands are located on the northwest coast of Scotland between Drumbeg and Unapool in Sutherland. The woodland mainly falls within the Ardvar woodland SSSI, part of Ardvar and Loch a' Mhuilinn Woodlands SAC, along with smaller areas of woodland contiguous with the SSSI to the south and west of Loch Ardbhair.

Ardvar woodland is birch dominated and is split into three main areas: 1 Nedd/Gleann Learaig; 2 Loch Ardbhair, Gleann Ardbhair and Clais Ardbhair; and 3 Kerrachar to Unapool. There is also a small area of woodland on a steep gorge at Creag an Spardain. These woodlands are a relic of what would have once been more extensive forests of northwest Scotland and are of high conservation value. The woodland falls within four different management units; the North Assynt Estate, the Ardvar Estate, the Reintraid Estate and the Quinag Estate (JMT). It should be noted that the deer management carried out on the Reintraid estate is managed by Ardvar Estate and so for this assessment the Reintraid data is included with the Ardvar data.

Despite its high conservation value and relatively unique nature and species richness, the woodland was recorded as being in 'Unfavourable Declining' condition during the last condition assessment in 2004 as part of SNH's monitoring of SSSIs (Scottish Natural Heritage, 2004). This was due to the canopy of mature woodland being fragmented in many areas and being below 50% cover; the low numbers of saplings of all species throughout the woodland; and the suppression of woodland understorey and field layer, due to the impacts of browsing and grazing.

There has been a long history of farm animals grazing within the woodlands, however, sheep were removed from the Ardvar estate in the 1970s and the main herbivore of the woodlands is now red deer.

Deer fenced enclosures have been established in areas of the Ardvar Estate and efforts have been made to reduce deer occupancy within the woodland to a level that would allow recovery of the woodland habitat.



Photo 1. A typical view of Ardvar woodlands, featuring birch woodland with a suppressed understory and grassy field layer.

2. OBJECTIVES

The main objective of the survey was to give an assessment of the current herbivore impacts within Ardvar woodland. It will build on the information gathered in the previous Herbivore Impact Assessment (HIA) which was carried out in autumn 2016 (Clifford and Mackenzie, 2017). More importantly it will provide a new pre-growing season baseline for future comparison. The data gathered in this survey and future ones will be critical in informing site management.

The specific objectives:

- To provide baseline information on the current browsing impacts on woodland structure and field layer vegetation within the woodland and separate Estates.
- To provide a baseline of the progression of seedling and sapling regeneration and woodland expansion within the survey areas.

3. METHODOLOGY

3.1 The survey area

The total survey area was 620ha which includes all of the existing woodland within the SSSI, a 50m buffer zone around the existing woodland stands and woodland outside of the designated area but within a wider woodland network.

3.2 Timing of survey

The survey was carried out in the second half of May allowing the survey to take place at the optimal time of year for woodland herbivore impact assessment (Armstrong *et. al.*, 2014).

This enables the survey to assess the browsing impacts that occurred during the winter months on the previous year's growth. Impacts on the current season's spring growth were also recorded.

3.3 Number of plots, distribution and plot size

The plots surveyed were the same as those surveyed in 2016 and follow the arrangement of plots used in Woodland Profile Surveys which is based on Forestry Commission Information Note 45 (Kerr *et al.*, 2002).

The number of plots surveyed was 122. In a change from the previous survey the plots were of 25m in radius (0.2ha) meaning that the area surveyed will be 3.9% of the total woodland area. This was an increase from the original plot size of a 12.6m radius.

Since the 2016 monitoring a number of new exclosures have been put in place and at least one plot was surveyed within each of these areas. Any signs of herbivore presence were also recorded whilst navigating between plots.

3.4 Plot measurements

During previous monitoring in 2016 each plot centre was marked with a wooden peg. For the 2018 HIA each of these plots was relocated. The following attributes were measured and recorded within the plot:

- The 10 figure grid reference of the wooden peg at the centre of the plot, if the grid reference was different to that supplied.
- The current herbivore impacts were assessed using the indicators; Seedlings and Saplings; and Preferentially Browsed Species taken from the FCS Woodland Grazing Toolbox (WGT) for herbivore impacts.
- The height of the ten nearest seedlings and saplings to the centre of the plot. The measurement was based on the regeneration visible above the surrounding vegetation, also recording the distance from the centre of the plot and direction as a compass bearing.
- The plot vegetation height based on an average of 5 measurements taken in a 'W' formation across the plot.
- The predominant habitat type or habitat mosaic.
- The presence of factors other than browsing that may be limiting natural regeneration (e.g. shade, water-logging, drought, areas of dense bracken cover, exposed rock, altitude or exposure, deep and/or continuous bryophyte layer, dense field layer, distance from seed source).
- Other obvious signs of herbivore presence.
- Plot photos taken from the southern edge facing north as a standard, with any variations from this recorded.

The field survey took place over 14 days between the 15th and 31st of May 2018. To ensure consistency of the collection of data across the survey, all plots were visited by the same surveyor, Steven Heaton MCIEEM.

The definition of a seedling and saplings was taken as any tree species < 5 m tall and with a DBH (Diameter at breast height 1.3m) of <7cm.

Table 1. Current herbivore browsing impacts

Current Browsing	Very High	High	Medium	Low	Absent
Seedlings and saplings	Either no seedlings or only newly germinated. Undamaged saplings only in inaccessible places	No seedlings of palatable spp, only recently germinated or in inaccessible places. >90% shoots removed of mod - palatable spp. e.g. birch.	Unpalatable unbrowsed. 50-90% growth of moderately palatable removed.	Palatable lightly browsed (<50% current years growth removed). Some palatable saplings with leaders unbrowsed.	No browsing.
Preferentially browsed species	Restricted to inaccessible locations.	Heavily browsed (>75% shoots browsed).	Moderately browsed (25-75% shoots browsed).	Lightly browsed (<25% shoots browsed).	Vegetation may be thickets of palatable species e.g. bramble, woodrush.

Preferentially browsed species recorded in the previous 2016 survey comprised blaeberry, bramble, dog rose, greater woodrush, ivy, honeysuckle, bog myrtle and ferns (other than bracken). Table 2, taken from Armstrong *et al.* (2014), is a table of relative palatability of non-tree species.

Table 2. Table of relative palatability

Season	Very palatable	Moderately palatable	Unpalatable
All year	Bramble, Honeysuckle, Ivy, Blaeberry, Greater woodrush , Common Bent, Red Fescue, Yorkshire fog	<i>Hard fern</i> , Bog myrtle, Heather (Ling), Bell heather, Sheep's fescue	Hard fern, Greater 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, Dog's mercury, Raspberry, <i>Buckler ferns</i>	Devil's-bit scabious, Purple moor-grass , Soft and Sharp-flowered rush , <i>Lemon-scented fern</i> , <i>Lady fern</i>	Buckler ferns, Lemon-scented fern, Lady fern, Primrose

Bold = cattle only, *Italic = deer only*

3.5 Summary of differences from 2016 survey

There are a number of differences between the method used for this Woodland HIA carried out in 2018 and the assessment from 2016 and there are therefore substantial limitations in making comparison between the two assessments.

- The 2016 survey was a full HIA whereas the 2018 survey just assessed the browsing impacts on seedlings and saplings and preferentially browsed species, making the survey quicker and easier to repeat in the future though possibly less robust. A wider suite of indicators are assessed in the standard methodology and so care is need when selecting a reduced number of indicators as different indicators have different weightings and reducing the number of indicators increases the chance of them not being present. Both seedlings and saplings and preferentially browsed species are indicators that are critical for assessing the herbivore impacts within native and ancient woodlands.
- The 2016 survey was carried out in September and October, whilst this survey took place in the second half of May to allow an assessment of the winter browsing levels to take place.
- The plot size was increased for the 2018 assessment from 12.6m radius to a 25m radius meaning that the survey area was almost four times larger.
- The 2016 survey took place when bracken was at its full height which would have made looking for seedlings and preferentially browsed species more difficult.
- In the 2016 assessment all the seedlings and saplings in each plot were counted, whereas in 2018 the ten seedlings or saplings nearest to the centre of the plot had their height and distance from the centre of the plot recorded.

4. RESULTS

4.1 Sampling effort

Within Ardvar woodland SSSI 122 sample plots were assessed for herbivore impacts. Numbers of sample plots, including numbers of plots within each of the different management units, and the number of plots within exclosures, are summarised in Table 3 below.

Table 3. Number of sample plots

Property	Unenclosed plots	Enclosed plots	Total number of plots
North Assynt Estate	21	0	21
Ardvar Estate*	73	14	87
Quinag Estate (JMT)	14	0	14
Total	108	14	122

* Includes Reintraid Estate

4.2 Current herbivore impacts on seedlings and saplings and preferentially browsed herbs

The herbivore impact levels were recorded as either VH = Very High, H = High, M = Medium, L = Low or N = Absent. Where an indicator was not present, this was recorded as NA. In total, seedlings and saplings were found in a total of 115 plots, and preferentially browsed species in 116. Plots for which an indicator was absent were not included in calculating impacts for that indicator.

Table 4 shows the overall percentage of plots recorded as each impact class for the two indicators that were assessed during the survey (Seedlings and Saplings and Preferentially Browsed Herbs), in each estate. Overall the majority of plots were recorded as having Medium herbivore impacts, both for Seedlings and Saplings and for Preferentially Browsed Herbs.

Table 4. Current herbivore impacts (excludes plots where indicators were absent)

Estate	Seedlings and Saplings					Preferentially Browsed Herbs				
	VH%	H%	M%	L%	N%	VH%	H%	M%	L%	N%
Overall	0	13.04	65.22	20	1.74	0	22.41	48.28	25.86	3.45
North Assynt	0	30	35	35	0	0	30	45	25	0
Ardvar	0	9.87	69.14	18.52	2.47	0	15.66	49.40	30.12	4.82
Quinag	0	7.14	85.72	7.14	0	0	53.85	46.15	0	0

Tables 5 and 6 show the overall percentages of plots recorded as each impact class both inside and outside exclosures, on Seedlings and Saplings and on Preferentially Browsed Herbs respectively, in each estate. The results show that for plots within deer fenced exclosures the herbivore impacts are notably lower than those plots outside of exclosures.

Table 5. Herbivore impacts on Seedlings and Saplings inside and outside exclosures (excludes plots where indicators were absent)

Estate	Plots in exclosures					Plots not in exclosures				
	VH%	H%	M%	L%	N%	VH%	H%	M%	L%	N%
Overall	0	0	21.43	64.29	14.28	0	14.85	71.29	13.86	0
North Assynt	NA	NA	NA	NA	NA	0	30	35	35	0
Ardvar	0	0	21.43	64.29	14.28	0	11.94	79.1	8.96	0
Quinag	NA	NA	NA	NA	NA	0	7.14	85.72	7.14	0

Table 6. Herbivore Impacts on Preferential Browsed Herbs inside and outside exclosures. (excludes plots where indicators were absent)

Estate	Plots in exclosures					Plots not in exclosures				
	VH%	H%	M%	L%	N%	VH%	H%	M%	L%	N%
Overall	0	0	0	84.62	15.38	0	25.24	54.37	18.45	1.94
North Assynt	NA	NA	NA	NA	NA	0	30	45	25	0
Ardvar	0	0	0	84.62	15.38	0	18.57	58.57	20	2.86
Quinag	NA	NA	NA	NA	NA	0	53.85	46.15	0	0

4.3 Overall current browsing impacts

The overall browsing impact level for each plot was worked out by using the highest of the two impact scores for the two categories recorded at each survey plot. This data was then collated to make Figure 1 (see Annex 2: Maps).

Table 7 shows the percentages of plots with each overall browsing impact level across the whole of the woodland. The majority of plots (56.56%) have medium overall browsing impacts, however over a quarter of the plots (28.69%) had high overall browsing impacts.

Table 7. Percentage overall current browsing impacts across the whole woodland

	No Impact	Low	Medium	High	Very High
Percentage	0.82	13.93	56.56	28.69	0

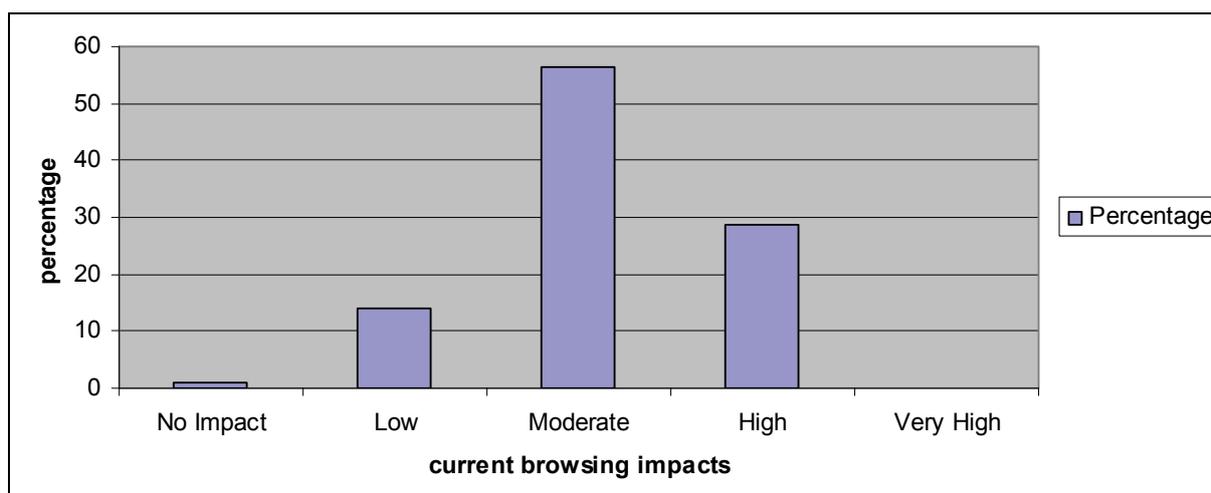




Photo 2. An example of birch saplings in Ardvar Woodland showing signs of historic high browsing impacts, restricting the growth of the young trees.



Photo 3. Birch saplings in an area with lower historic herbivore impacts; the young trees have a more open structure.

4.4 Current browsing impacts for each property

Table 8, shows the current overall browsing impacts broken down for each property. It is notable that North Assynt and Quinag have a higher percentage of plots assessed as having a High herbivore impact level than Ardvar does. Table 9 shows that even when taking enclosure areas into account this is still the case, this may be because the majority of plots are on the Ardvar Estate, or it may be due to higher levels of browsing on the North Assynt and Quinag Estates. Further repeat HIA should clarify the situation.

Table 8. Current browsing impacts for each property (percent of plots)

	No Impact	Low	Medium	High	Very High
North Assynt	0	19.05	38.10	42.86	0
Ardvar	1.15	14.94	62.07	21.84	0
Quinag	0	0	50	50	0

Table 9. Current browsing impacts for Ardvar Estate inside and outside exclosures (percent of plots)

	No Impact	Low	Medium	High	Very High
Plots In Exclosures	7.14	71.43	21.43	0	0
Plots Outside Exclosures	0	4.11	69.86	26.03	0

4.5 Field layer vegetation height for each property

Table 10 shows the average height of the field layer vegetation recorded in the plots for each estate, with exclosure areas shown separately. For the average height of field layers within individual plots see raw data Appendix 1.

On the whole the average field layer vegetation height across the different estates appears to be remarkably consistent, and interestingly appears to vary little between plots inside and outside of exclosures.

Table 10. Average field layer vegetation height recorded in the plots in each estate

	Vegetation Height (Metres)				
	North Assynt	Ardvar	Reintraid	Quinag	Whole Woodland
Whole property	0.26	0.23	0.22	0.25	0.24
Plots in exclosures	NA	0.28	0.20	NA	
Plots not in exclosures	0.26	0.22	0.22	0.25	

4.6 Average height of seedlings within survey plots

The actual heights of the ten nearest seedlings to the centre of the plot recorded for each individual plot are available at Annex 1. Table 11 groups the average height of seedlings into four height categories and displays the percentages of plots which fall within each.

The results show that in the majority of plots (56%) the average heights of the ten nearest seedlings to the centre of the plot were in the smallest height category of 10cm or less. In the vast majority of plots (96%) the average seedling height was less than 100cm.

Table 11. Average height of the ten nearest seedlings to the centre of the plot

Average seedling height category	0-10cm	11-50cm	51-100cm	>100cm
Percentage of plots	56%	30%	10%	4%

In total, 67% of all seedlings measured were 10cm or less, and 95% of seedlings were 1m or less.

4.7 Seedling height and herbivore impact levels

Table 12 shows the average seedling height together with the current overall browsing impact levels giving the percentage of plots in each category. There appears to be very little correlation between seedling height and impact level, however this analysis would be worth repeating for future HIA surveys.

Table 12. Average seedling height and herbivore impact levels

Average seedling height in metres per plot	Percentage of plots at each current overall herbivore impact level				
	No Impact	Low	Medium	High	Very High
≤0.1	1.56	12.5	56.25	29.69	0
>0.1 - ≤0.5	0	11.76	61.76	26.47	0
>0.5 - ≤1	0	25	41.67	33.33	0
>1	0	20	60	20	0

4.8 Preferentially browsed herbs

Table 13 displays the percentages of plots in which each of the different Preferentially Browsed Herb species used in the assessment of herbivore impacts occurred.

The results show that 95% of the plots had at least one Preferably Browsed Herb species present. Of all of the species, blaeberry and ferns occurred in the greatest number of plots (67% and 53% respectively).

Table 13. Percentage of plots with each Preferentially Browsed Herb species present.

Preferentially Browsed Herb Species	Occurrence in % of plots
Blaeberry	67
Bog myrtle	25
Ferns*	53
Buckler fern	6
Meadowsweet	14
Valerian	8
Ivy	2
Honeysuckle	5
Bramble	3
Angelica	6
Greater woodrush	5
Dog rose	8
Devil's bit	2
None present	5

* Excluding bracken. Made up of lemon scented fern and hard fern.

4.9 Obvious signs of herbivore presence

Except for sheep wool recorded in one plot at Reintraid Estate all other signs of herbivore activity were from deer. Some signs were found in 23 of the 122 plots. Tracks/ trampling were recorded at nine plots, and a wallow in another, fresh dung was found in three, and deer were seen in or from ten plots.

5. COMPARISON 2018 DATA AND THE PREVIOUS 2016 SURVEY

There are some major constraints in drawing comparisons between this survey and the one from 2016 which means that this 2018 survey should be considered as the baseline survey for all future surveys.

The previous 2016 survey was carried out during September and October through necessity which is a suboptimal time of year for woodland HIA, whereas the fieldwork for this assessment took place in May, an optimal month for woodland herbivore impact assessment. The May survey enables the surveyor to have a much clearer picture of impacts over the critical winter browsing period particularly on tree regeneration and preferentially browsed species such as blaeberry (*Vaccinium myrtillus*). It is also likely that when surveying later in the year, when bracken is at full height and density, the surveyor is less able to detect small or sparse species or seedlings at many plots.

The previous survey in 2016 used a smaller plot size with a 12.6m radius (0.05ha), whereas this survey used a 25m radius (0.2ha). This may also go some way to explaining the differences in records for preferentially browsed species during the 2018 assessment, such as blaeberry, which was recorded in 67% of the plots during this survey, compared to 11% for the 2016 survey.

The 2018 assessment uses a shortened version of the woodland herbivore impact assessment and so does not assess the whole suite of browsing impact indicators that were assessed in 2016. This will make the assessment more repeatable in the future though potentially less robust.

Lastly, as indicated by Armstrong et al 2014 from which the methods of woodland herbivore assessment are taken, woodland herbivore impact assessment is somewhat subjective. There will therefore be some small differences in the assessment of impacts between surveyors. However, the impact levels for 'seedlings and saplings' and 'preferentially browsed species' have defined percentage levels and definitions which should have minimised this subjective effect.

Some efforts to make comparisons between the data from this assessment and the 2016 survey have been made, which are discussed below.

5.1 Current overall browsing impacts

Using the two impact categories surveyed for the 2018 herbivore impact assessment, (Seedling and Saplings and Preferentially Browsed Herbs) to create overall browsing impacts, a comparison of the overall browsing impacts scores can be made. These are presented in Table 14 below. A much higher percentage of plots were recorded within the High herbivore browsing impact category in 2016. However due to differences between the surveys, particularly the increased plot size and time of year, it is not possible to conclude whether this is down to a reduction in browsing levels or an artefact of the change in survey method.

Table 14. Comparison of overall browsing impacts 2016 and 2018.

Year of survey	No Impact %	Low %	Medium %	High %	Very High %
2018	0.82	13.93	56.56	28.69	0
2016	3.39	8.47	30.51	56.78	0.85

5.2 Changes in ground vegetation

The raw survey data in Annex 1 includes a column showing what ground vegetation was recorded in the previous 2016 survey, as well as the ground vegetation assessed and recorded for the 2018 assessment. Between the surveys in general there has been very little or no change in the vegetation type recorded at each plot. The main differences may be down to surveyor interpretation i.e. it can be difficult to distinguish wet heath and blanket bog on floristic composition alone, and the fact that the plot size for the 2018 survey was nearly four times larger and therefore contained additional different habitats/habitat mosaics.

5.3 Changes in other factors that may affect the performance of tree regeneration

For both the 2018 and 2016 assessments, factors other than herbivore impacts that may be inhibiting tree regeneration were recorded. Considerably more factors were listed in the 2018 assessment. This is due most likely to differences in surveyor interpretation and the larger plot size. It should be noted that in many cases the limiting factors did not make up the entirety of the survey plot. It should also be noted that in many cases the factors recorded were not a complete barrier to tree regeneration, rather they impeded its progress. E.g. different levels of shade would be more or less of a barrier to birch regeneration, and would be less likely to restrict regeneration of other species, such as holly or rowan.

Even if some inhibitory factors are present, these don't necessarily mean that the entire plot is unsuitable. This is illustrated by the fact that only seven of the plots contained no seedlings, compared to 109 (89%) where it was possible to record 10 seedlings.

The factors recorded during the 2018 survey include: water-logging (including areas of peat bog); dense field layer; dense moss layer; bracken; exposure/altitude; rock; and canopy shade (for birch regen).



Photo 4. Example of an area of peat bog in Ardvar Woodland showing little or no tree regeneration. Such habitats are naturally less suitable for tree growth due to the waterlogged ground.

6. DISCUSSION

6.1 Seedling and sapling height

This survey sets down a baseline assessment against which future surveys can be compared to provide an assessment of the woodland and progression of tree regeneration and woodland structure, and whether the woodlands are progressing towards meeting their SCM targets. Recording of the height of the ten nearest seedlings to the centre of each plot should give an indication of the success of tree regeneration across the site. However even with the distance and compass direction from the plot centre recorded for each seedling it is very likely the original seedlings will prove difficult if not impossible to relocate with any confidence. This will be the case particularly for plots under mature woodland canopy where the overwhelming majority of seedlings measured were rowan (*Sorbus aucuparia*). Rowan germinates very readily and is very preferentially browsed, so even at low browsing pressures where seedlings will be getting away it is likely that some smaller seedlings will be browsed off and new seedlings will germinate.

Repeating this section of the assessment in future surveys will still produce valuable results and comparisons as it will still show whether seedling height is increasing, give an indication of seedling density and how woodland understorey is developing. It was not a requirement of this survey but in the future it may prove valuable to record the species of each seedling.

6.2 Success of enclosures

Red deer are themselves a woodland species and a natural and important element of healthy dynamic woodlands, so it is unrealistic and inappropriate to aim for their complete exclusion from large areas of the woodland. However their numbers need to be managed within the woods so that they are at a sufficiently low number per hectare to allow the development of woodland structure and tree regeneration. The Deer Management plan for West Assynt (Clements, 2018) states that of March 2018 the predicted density of deer is around 7 per km square across the Assynt Peninsula, however the actual count for March 2018 was 11 deer per km square and out of season authorizations are being used in Spring and Summer to deter deer from using Ardvar Woodlands.

Exclosures are an excellent method of protecting regenerating trees and other woodland vegetation from the browsing pressures of herbivores such as deer in woodland, and are particularly useful for establishing new areas of woodland. However these are costly and time consuming to erect and require regular monitoring to ensure the integrity of the fencing is maintained throughout the years.

Large enclosed areas are not always beneficial for tree regeneration and the development of woodland structure, and considerable attention needs to be given to their placement. This is particularly demonstrated by the existing deer fenced area near Kerrachar Bay. This enclosure was erected a number of years ago and whilst there has been some limited tree regeneration the majority of the enclosure has become rank vegetation dominated by waist high purple moor-grass (*Molinia caerulea*) and bog myrtle (*Myrica gale*). Few species can compete with this rank vegetation and it can form a substantial barrier to tree regeneration and woodland development.

Perhaps a better option for Ardvar woodlands, in addition to maintaining the deer population at a sufficiently low number per hectare within the woodlands to allow trees and woodland structure to develop, would be the creation of a larger number of smaller enclosed areas. Examples of these smaller exclosures have already been erected in the area of Ardvar woodland around Nedd Bay on the Ardvar Estate (exclosures N1, N2, N3 and N4). This will also promote heterogeneity in the woodland, creating a varied mosaic of different vegetation

heights and structures as well as regenerating trees across areas, and will be of benefit for the biodiversity of the habitat.

It is likely that in the past the north-western forests of Scotland such as Ardvar had a higher percentage of oak, and other species such as rowan, holly, hazel and aspen, within the canopy. At present browsing and shade levels within the woodland appear to be inhibiting the regeneration of young oak trees at Ardvar. In addition, mature oak trees only mast infrequently in the far northwest of Scotland and so only a limited seed source is available.

It may be beneficial to promote the regeneration of new oak trees in the site by collecting acorns during productive mast years and propagating them ex-situ. With a view to plant up the resulting saplings in suitable enclosed areas with open canopy once they are large enough to compete with the surrounding vegetation. Consideration could also be given to planting other species such as hazel and aspen in enclosed areas.

6.3 Preferentially browsed species and their assessment

Assessing the browsing impacts on preferentially browsed species within woodland is essential in understanding the browsing levels within woodland. It is particularly important in understanding whether the woodland is recovering or not. Interpretation of the preferentially browsed species present in the assessment needs some care.

Table 2, taken from Armstrong *et al.* 2014, provides a list of browsed species, their palatability, the seasons in which they tend to be browsed, and which herbivores browse the species. This is not an exhaustive list and it is likely that further research needs to be carried out in this area. During the 2016 assessment ferns (other than bracken) were recorded as the most abundant preferentially browsed species. By far the two most commonly recorded fern species recorded in Ardvar woodlands were hard fern (*Blechnum spicant*), and lemon scented fern (*Oreopteris limbosperma*), both of which are only moderately preferentially browsed by deer and tend to be browsed later in the year than May when the 2018 assessment was carried out. For the 2018 assessment the presence of hard fern or lemon scented fern was recorded using the term 'ferns' however if buckler fern was present this was recorded separately. This is because buckler fern is very preferential to deer species and is far less common within Ardvar woods, and in all cases when its presence was noted it was significantly browsed. For the 2018 assessment, in most cases, lemon scented and hard fern were only used to assess the impact of browsing on preferentially browsed species at a plot if no other preferential species were present.

Blaeberry, a dwarf shrub common in many upland birch woods, was the most commonly recorded preferentially browsed species during this HIA. Blaeberry is a particularly useful species for assessing browsing impact levels as its woody structure allows the surveyor to make an assessment of the current browsing level over the last twelve months (particularly winter browsing levels). The species' structure can also give the surveyor an idea of browsing levels over the last few seasons. Within Ardvar woodlands the blaeberry structure indicates that historic browsing levels were high and that near to 100% of the shoots were browsed each year, meaning that the species was unable to grow out of the mossy field layer. However, during this survey, in 78% of the plots containing blaeberry the browsing impacts were assessed as medium or low, meaning that more than 25% of the shoots had been left un-browsed during the previous winter. It is too early to assess whether this indicates a recent reduction in browsing impacts, further repeat HIA will be needed to see if the browsing impacts are allowing blaeberry to grow away from the mossy field layer.

6.4 Prognosis for woodland structure and expansion

The previous 2016 survey concluded that the woodland was at a 'tipping point' with the potential for a significant pulse of tree regeneration and expansion, as well as development of woodland structure, which could be achieved through a relatively minor sustained reduction in browsing pressure. The results from this survey back up this conclusion. However any reduction needs to be sustained over a longer term as any increase in browsing pressure would lead to a rapid and detrimental increase in herbivore impact levels.

There are still areas within the woodland where the herbivore impact categories are High (nearly 29% of the plots). If the browsing pressures are reduced over a sustained period then the number of plots with High impacts should reduce further over time to reflect this.

The key conclusions from the current survey are that it is too early to ascertain whether there has been a reduction in herbivore browsing levels. The woodlands are still at a balancing point where any reduction in browsing levels needs to be sustained over time to see if the reduction is significant enough to allow the desired development of woodland structure and expansion to take place. This HIA will need to be repeated regularly to assess the progress of any tree regeneration and structural development to ensure the SCM targets can be met in the future. In the short term (2 to 4 years) if future HIA surveys show the browsing pressures are not at a level that will allow progression towards this then herbivore numbers within the woodlands will need to be reduced further.

7. CONCLUSIONS

- Over the whole of Ardvar woodland the most frequent current herbivore impact level is Medium.
- For 96% of the plots, the mean height of the ten nearest seedlings to the centre of each survey plot is less than 100cm in height, with 56% of the plots having a mean seedling height of 10cm or less. Considering all seedlings that were measured, 67% are $\leq 10\text{cm}$ and 95% are $< 1\text{m}$. This shows how vulnerable the majority of tree regeneration within Ardvar woodland is to any increase in browsing levels. This may also indicate that browsing levels are still too high within the woodlands to allow seedlings to establish, further repeat HIA surveys will be needed to establish whether this is the case.
- Preferentially browsed species appeared to be more abundant than in the previous 2016 survey and high impact levels were recorded at fewer points. However, this may be an artefact of changes in the survey method, in particular the increased size of the survey plots and the fact that the surveys were carried out at different times of the year. These limitations mean that no definitive conclusion can be made as to whether herbivore impacts have decreased within the woodlands.
- Except for sheep wool recorded at Reintraid Estate all other recorded signs of herbivore activity indicate that red deer are the main herbivore within the Ardvar woodlands.
- It is recommended the HIA surveys of this assessment are repeated every two years to give a clear assessment of the levels of tree regeneration and browsing within Ardvar woodland and establish whether further action is required to achieve favourable condition of the woodland habitat. The frequency of repeat assessments should be agreed through discussion between the stakeholders and SNH as well as input from Forestry Commission Scotland and land managers. Whilst it would be ideal to visit every plot on a biennial basis, resources may dictate that only a certain percentage of plots could be surveyed at random on a biennial basis.

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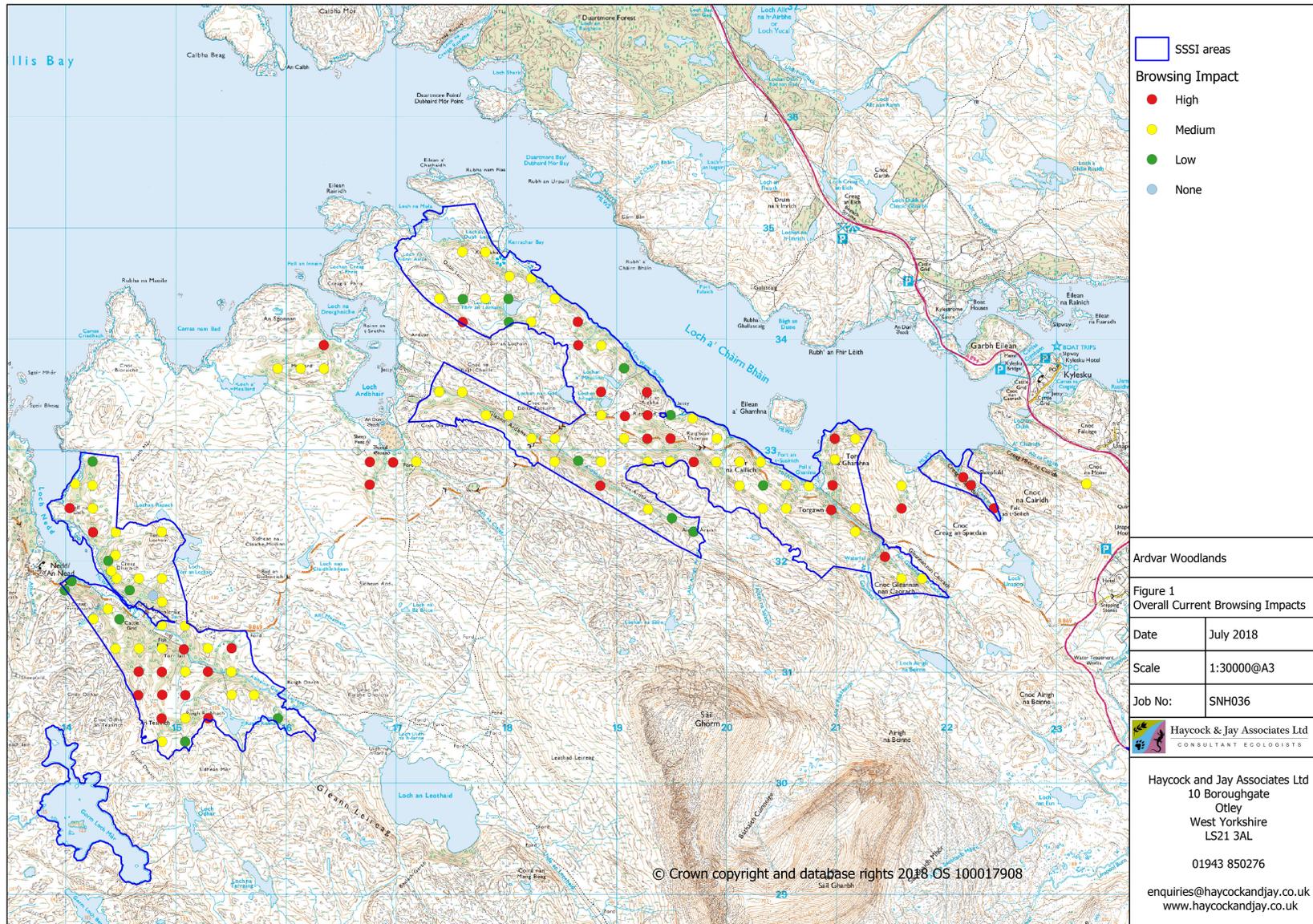
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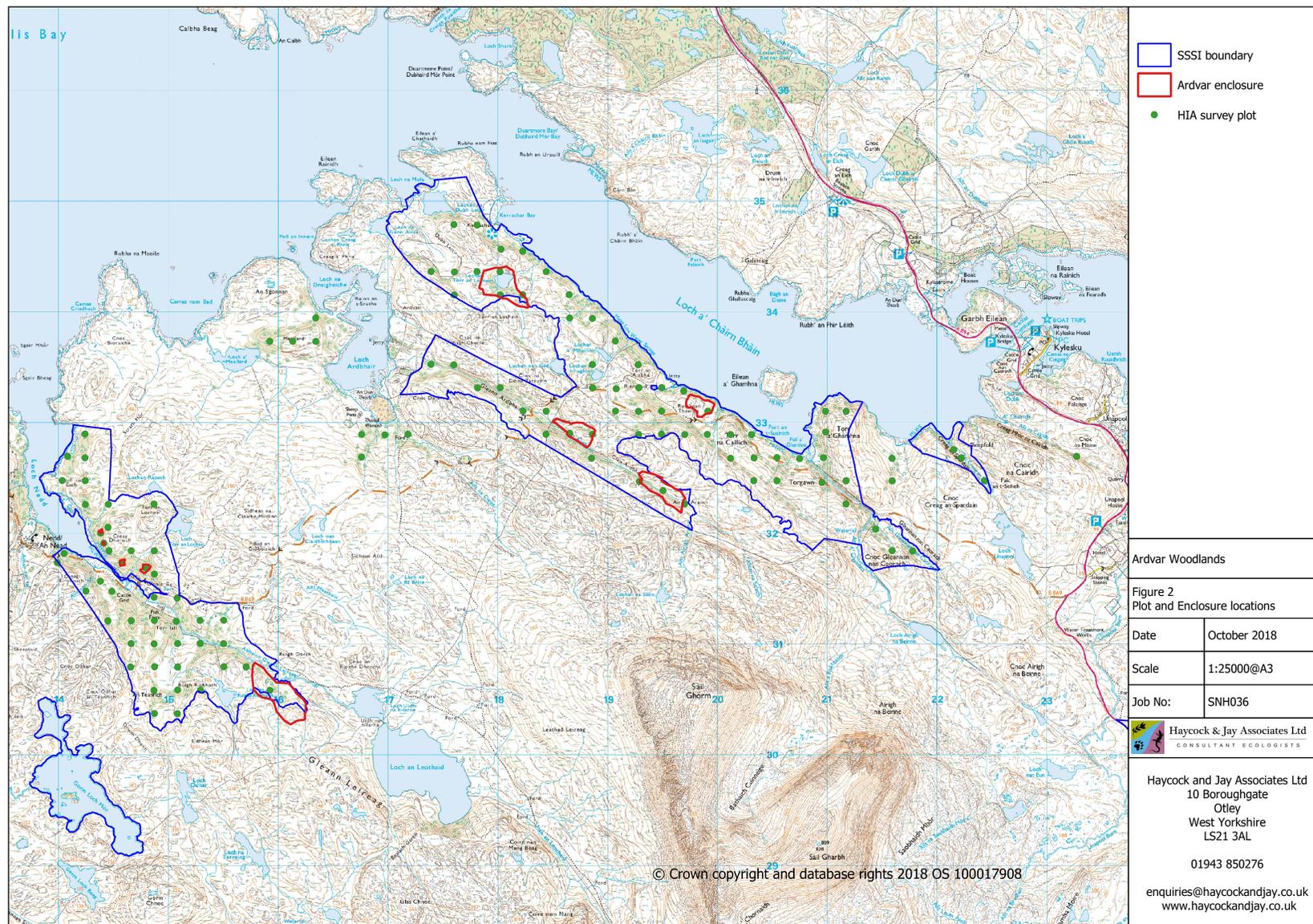
ANNEX 1: THE RAW SURVEY DATA

This data is available as a separate Excel file.

ANNEX 2: MAP OF OVERALL CURRENT BROWSING IMPACTS



ANNEX 3: MAP SHOWING EXCLOSURES AND PLOT LOCATIONS



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