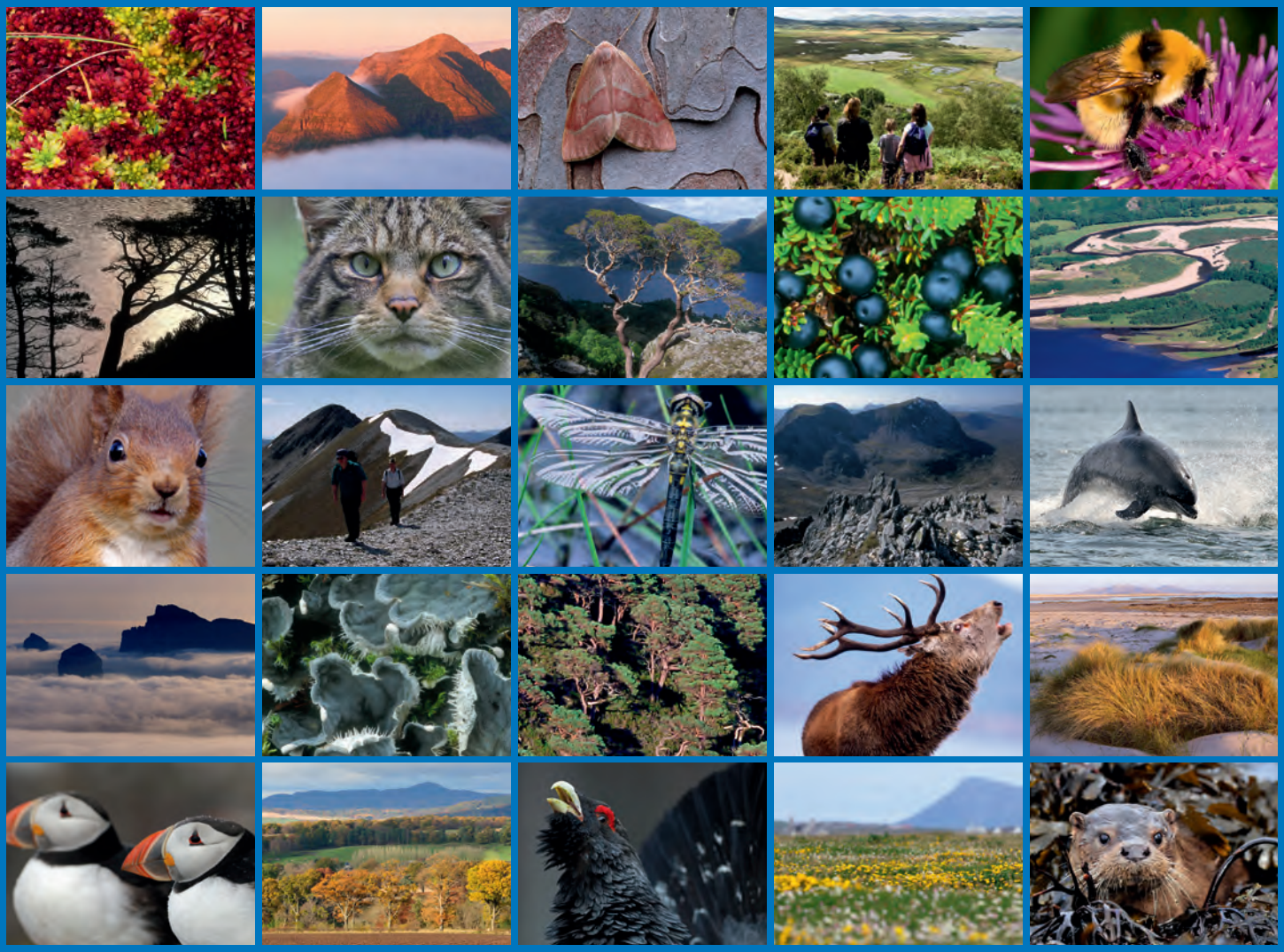
Scottish Natural Heritage
Commissioned Report No. 575

Herbivore Impact Assessment of the Torridon Forest SSSI



Scottish Natural Heritage
Dualchas Nàdair na h-Alba
All of nature for all of Scotland
Nàdar air fad airson Alba air fad

COMMISSIONED REPORT

Commissioned Report No. 575

Herbivore impact assessment of the Torridon Forest SSSI

For further information on this report please contact:

Tamara Lawton
Scottish Natural Heritage
17 Pulteney Street
ULLAPOOL
IV26 2UP
Telephone: 01854 613418
E-mail: tamara.lawton@snh.gov.uk

This report should be quoted as:

Campbell, D. and Marchbank, M. 2013. Herbivore impact assessment of the Torridon Forest SSSI. *Scottish Natural Heritage Commissioned Report No. 575.*

COMMISSIONED REPORT

Summary

Herbivore impact assessment of the Torridon Forest SSSI

Commissioned Report No.: 575
Project no: 12605
Contractor: Strath Caulaidh Ltd
Year of publication: 2013

Background

An Herbivore Impact Assessment (HIA) of Torridon Forest SSSI was undertaken in July and August 2012. SNH commissioned Strath Caulaidh Ltd (SCL) to undertake the work as part of a wider study of the site, which complimented a study of Beinn Eighe the previous summer.

The Torridon Forest study involved visiting 124 points across the SSSI on an evenly-spaced sampling grid. At each point the habitat type was ascertained and the appropriate suite of small-scale and trend indicators (MacDonald *et al.* 1998) was assessed - these methods were developed to provide a rapid means of characterising land management impacts across large tracts of the Scottish uplands. The aim of this study was to classify Grazing/Browsing impacts and Trampling impacts as Low, Moderate or High according to the system described by MacDonald *et al*.

Main findings

- The nature of the site meant that only 97 of the 124 plots were assessed; 8 of the planned points had been affected by the wildfire in the summer of 2011 and were not in a suitable condition for survey whilst, 19 of the planned points were deemed too dangerous to survey due to being located on or near cliffs.

- The main range of habitat types assessed included blanket bog, sub-alpine dry heath, northern atlantic wet heath and alpine heaths / montane acid grasslands. The most common habitat was northern atlantic wet heath which, along with sub-alpine dry heath, made up over 60% of the study area as sampled.

- The use of a systematic sampling framework meant that the majority of plots fell on wet heath, with a much smaller number on each of the other habitat types. Across all habitats assessed, the Grazing/Browsing impacts were classed as Low or Low-Moderate on 92% of plots, Moderate on 8% and Moderate-High or High on 0%. Across all habitats, the Trampling impacts were classed as Low or Low-Moderate on 71% of plots, Moderate on 19% and Moderate-High or High on 10%.

- Trend indicators were generally considered to be of limited applicability but, where recorded and deemed reliable, suggested that impact levels have probably been Constant in many areas over the past decade or so.

- Additional quantitative data were gathered, the most notable finding being that average levels of *Calluna vulgaris* off-take were low in all the broad habitat types (the highest average value was < 10%).

- The pattern of occupancy, assessed using dung counts, showed that deer occupancy levels varied markedly across the site. There were higher levels of occupancy to the north of Liathach, the north of Beinn Eighe and around Beinn Alligin, with lower levels recorded in most areas to the south of the Liathach ridge.

- The data from deer occupancy assessments undertaken by SCL at the same time for the NTS showed impact levels to be generally correlated with deer occupancy levels across the various sub-areas of the SSSI. At the more local scale, there were often higher levels of impacts present in corries and in other sheltered areas (e.g. gullies) obviously used by deer in winter and spring for sheltering. In terms of habitat preferences, grazing impacts tended to be focused on the less extensive areas of dry heaths and grasslands rather than the more extensive wet heaths and blanket bogs.

For further information on this project contact:
Tamara Lawton, Scottish Natural Heritage, 17 Pulteney Street, Ullapool, IV26 2UP.
Tel: 01854 613418 or tamara.lawton@snh.gov.uk
For further information on the SNH Research & Technical Support Programme contact:
Knowledge & Information Unit, Scottish Natural Heritage, Great Glen House, Inverness, IV3 8NW.
Tel: 01463 725000 or research@snh.gov.uk

Table of Contents **Page**

Acknowledgements

We would like to thank the landowners and keepers for giving permission to access the study site. We also want to thank Jenny Bryce and Nicola Tallach of SNH for helping with the management of the contract.

1 INTRODUCTION

1.1 Study Background

Torridon Forest SSSI is notified for a long list of geological features, species and habitats. SNH reports that the upland habitats and vascular plants are most directly influenced by herbivore impacts. In the second cycle (2006) of Site Condition Monitoring (SCM) two habitats (dry heath and calcareous grassland) were assessed as being in unfavourable condition (no change) with the remainder of features being considered to be in favourable condition (Table 1). Although the number of sample points that did not meet SCM targets was small, the indicators that were not met related to the current level of herbivore impacts.

Table 1. Status of habitats according to previous site monitoring.

Date of survey	Designation	Reporting category	Feature name	Condition assessment
29-Jun-06	SSSI	Montane habitats	Alpine heath	Favourable Maintained
26-Jun-06	SSSI	Montane habitats	Alpine moss heath and associated vegetation	Favourable Maintained
26-Jun-06	SSSI	Inland rock	Siliceous scree (includes boulder fields)	Favourable Maintained
28-Jun-06	SSSI	Calcareous grassland (Upland)	Subalpine calcareous grassland	Unfavourable No change
29-Jun-06	SSSI	Dwarf shrub heath (Upland)	Subalpine dry heath	Unfavourable No change
07-Sep-03	SSSI	Vascular plants	Vascular plant assemblage	Favourable Maintained
22-Nov-06	SAC	Dwarf shrub heath (Upland)	Dry heath	Unfavourable No change
22-Nov-06	SAC	Dwarf shrub heath (Upland)	Wet heathland with cross-leaved heath	Unfavourable No change

Torridon Forest is also part of the Loch Maree Complex SAC. The wet and dry heath features for Loch Maree Complex were also found in the most recent assessment (2006) to be in unfavourable condition, in part due to areas within the Torridon Forest SSSI failing to meet the SCM targets.

In summer 2012 SNH commissioned SCL to undertake a study of the Torridon Forest SSSI using the MacDonald *et al* 1998 method. The methods of MacDonald *et al* (1998) were developed to provide a rapid means of characterising land management impacts across large tracts of the Scottish uplands.

The aim of this study was to provide more information on herbivore impacts on the SSSI including the habitats classed as being in unfavourable condition. The objectives of the study were to:

- Assess the current levels of grazing and trampling impacts from herbivores on a systematic sample of locations within the SSSI, involving a range of habitats.
- Assess the direction of any apparent trends in impact levels and make a prognosis for the future condition of the upland habitats, based on the current impacts and trends.

In summer 2011 a wide ranging ecological study was carried out for SNH on the neighbouring Beinn Eighe National Nature Reserve by Strath Caulaidh Ltd (SCL). One part of the survey used a systematic grid of transects on which deer faecal pellet group densities

were measured and mapped in summer 2011. SNH requested that SCL gathered some deer occupancy data from Torridon Forest in tandem with the proposed HIA in summer 2012, the aim being to create a unified map of deer occupancy levels across Torridon Forest and Beinn Eighe landholdings.

The SCL study of Beinn Eighe study in 2011 also involved a much wider range of habitat data being gathered. This included undertaking an HIA for SNH using the methods of MacDonald *et al.* (1998) as well as a more detailed, quantitative assessment of herbivore impacts using SCL's in-house methodology.

National Trust for Scotland (NTS), who are the major landowner in the SSSI, requested that SCL carry out a range of other assessments on Torridon Forest at the same time as the HIA. The additional work included the following:

- A detailed analysis of the dung count data gathered on Torridon Forest (SNH asked only for the raw pellet density data and a map). This analysis is reported separately in a joint report to SNH and National Trust for Scotland (NTS), as the work was funded by NTS.

- A detailed habitat-impact assessment at the same locations as the pellet group count transects, using the SCL methods as were used at Beinn Eighe. This work was funded by NTS and is reported separately in the joint report.

- A review of previous HIA work undertaken by contractors on NTS land at Torridon. This work was funded by NTS and is reported separately in the joint report.

- A detailed assessment of the impacts of the wildfire which occurred in Torridon in summer 2011. This work was funded by NTS and is reported separately in the joint report.

Site Condition Monitoring (SCM) of the Sub-Alpine Calcareous Grassland feature of the SSSI, which previously failed the 2nd cycle of SCM, was also undertaken as part of SNH's Scope of Work. This work is reported upon separately in a dedicated short report to SNH.

1.2 Key Habitats Present

Torridon Forest Site of Special Scientific Interest (SSSI) encompasses the mountains Beinn Alligin, Liathach and Ruadh-stac Mòr to the north of the village of Torridon and Sgurr Dubh and Coire a'Cheud-Chnoic 8 km to the east.[1]

This range of mountains exhibit typical western upland communities with evidence of low burning pressure. The range of important upland habitats includes subalpine calcareous grassland, alpine and subalpine dry heath, alpine moss heath and siliceous screes. Several of the plant communities are restricted to the NW Highlands and associated with oceanic conditions. The communities on the north-facing slopes of Sgurr Dhubh, Liathach and Beinn Alligin are rich in Atlantic liverworts and the upper slopes of these mountains also have extensive rock and ablation surfaces where Rhacomitrium moss heath occurs widely with dwarf willow abundant. There are patches of herb-rich grassland on the south side of Liathach and Coire Toll a'Mhadaidh Mór contains an outstanding example of boulder field scree, created by the rock avalanche, where moss-heath has been colonised by birch and rowan, and is interspersed with herb-rich grassland. Numerous mounds and hummocks on the lower ground support a characteristic patchwork of heath and bog communities.

[1] The text for Section 1.2 is taken directly from the SSSI Citation for Torridon Forest.

The varied mountain flora includes a number of rare vascular plant species including tufted saxifrage *Saxifraga cespitosa*, curved woodrush *Luzula arcuata*, arctic mouse ear *Cerastium arcticum*, northern rock-cress *Arabis petraea* and rock whitlow grass *Draba norvegica*.

2 METHODS

2.1 Sampling Strategy

A grid of evenly spaced points was employed for the assessment. It was created by extending out the sampling grid used for the Beinn Eighe assessment in summer 2011 (Appendix 1 – Map 1). The assessment area for summer 2012 covered a number of estates who all own land within the Torridon Forest SSSI (Appendix 1 – Map 1).

2.2 Field Survey

The field survey was carried out over a period of several weeks from late July to mid-August 2012.

The sample points were located using a hand-held geographical position system (GPS) and their location was marked with a short wooden post. At each point, a 2x2m temporary quadrat was marked out at using two bamboo canes to temporarily mark the sides.

SNH proposed a systematic sampling strategy which involved sampling the habitats present at sample locations as opposed to having pre-selected particular habitats to be assessed. The habitat type present was recorded by reference to the range of NVC codes recorded for the polygon in which the point fell.

The small-scale field indicators of current impacts from herbivores, and trend field indicators, for the particular habitat present were assessed within the quadrat using the appropriate indicators from MacDonald *et al*. (1998; see Appendix 2 for an overview of the methods) but taking into account suggested changes as listed in MacDonald (2007).

One related problem arose when assessing U7 and U13 features, whereby surveyors followed the old guidance (1998), and used Tussock Grassland data forms, whereas the updated guidance (MacDonald 2007) recommended a mixture of indicators from several habitats be used. Almost all of the indicators required for the recommended 2007 approach could be extracted either from the TG form or otherwise from the detailed quantitative assessment which SCL undertook in the same areas in parallel for the NTS. The indicators used in the analysis for U7/U13 plots involved us constructing a data set using a mixture of the data from the TG forms and from SCL's own assessment forms in preference to the suite of data recorded on the TG field survey forms. The communities assessed using this approach were typically summit grassland communities (i.e. montane acid grassland). We chose to term these indicators wind-clipped summit heath (WCSH - Grassland) to distinguish them from WCSH (Heath) which was the other set of summit communities assessed.

Most of the indicators used in the HIA require an examination of the vegetation and substrate within the 2m x 2m quadrat, but for the abundance of hoof-prints in bare peat these were assessed over a larger area ('patch scale'; 25x25m or 625m^2) centred on the smaller 2x2m (4 m^2) sample plot. The density of deer faecal pellet groups was recorded on 80m transects as part of the detailed study carried out for NTS,[2] in preference to being assessed categorically as recommended by MacDonald.

Additional quantitative data was gathered including: percentage off-take of *Calluna* & *Vaccinium*, mean *Calluna* height, percentage quadrats covered in hoof prints etc. The cover of the quantitative variables was estimated by eye other than for plant height which was measured using a tape with millimetre gradations.

[2] The original specification asked for a 10x10m area centred on the 2x2m quadrat but SCL advised that an 80m line ransect is more efficient and produces more accurate counts.

A photograph was taken of the sample plot in relation to features and markers that would aid its re-location in any future surveys. Another was taken of the quadrat. A problem was experienced with one camera during the second week of fieldwork (memory card corrupted) which resulted in the complete loss of photos from one surveyor. Several other images of quadrats had to be discarded more generally because they were out of focus or the camera lens was wet.

As anticipated, a considerable number of transects were judged to be unsafe or impossible to access and hence were left un-surveyed (Appendix 1 – Map 1) due to the rocky and inaccessible nature of much of the terrain on the site. Several plots were located on the area recently burnt by the fire (summer 2011) and hence few of the indicators were able to be assessed because many for wet heaths and dry heaths (the assumed dominant habitats in the burnt area) rely on presence of well developed *Calluna* bushes.

2.3 Data Analysis

The assessment of herbivore impacts was scored on a 3 point scale in the field (Low, Moderate or High) for each recommended indicator, if applicable, on each plot; not all indicators were applicable at every individual sample location and were thus recorded NA. Some indicators were present but uninformative (UI). The number of indicators used varied partly because of the reasons above, but also because the method actually uses different numbers of indicators for each impact-habitat combination on site. The actual number of indicators used in each situation is confirmed in the results.

The suite of recorded indicators for each plot was aggregated by the type of impact they related to: 'Grazing/Browsing' or 'Trampling'. The median impact score was calculated for each impact type (Grazing or Trampling) on each plot within each habitat type. The approach was to assign each indicator in each habitat a score of 1, 2 or 3 for L, M or H. Frequency distributions were then created for each habitat type and impact type, showing the percentage of sampled plots which fell into each median impact class. When calculated, the median score for a plot sometimes lay in between two classes (i.e. the median score was sometimes 1.5 or 2.5 for a plot, even though the individual scores used in the field could only be 1, 2 or 3; an example would be when a plot had 4 indicators recorded as L, L, M and M which would correspond with scores of 1, 1, 2, and 2 hence the median would be 1.5). The frequency distributions presented therefore used 5 impact classes (Low, Low-Moderate, Moderate, Moderate-High and High).

The appropriate trend indicators were assessed and recorded where applicable. For each sample point, where possible, there was an evaluation of impact trends based on an amalgamation of the trend indicators and based on the terminology recommended by MacDonald (2007): 'Constant', 'Decreasing' or 'Increasing'. Note was also taken of other relevant factors and other potential causes of impacts (humans, vehicles, fire).

The additional quantitative data were analysed and descriptive statistics presented.

3 RESULTS

3.1 Plot Status & Habitats Present

A total of 97 of the planned plots (78%) had a formal assessment undertaken using the methods of MacDonald *et al* (1998) (Figure 1). Of the plots that were not surveyed, 8 fell on recently burned land, 19 plots were deemed either completely inaccessible (crags) or were otherwise deemed unsafe to visit (plots lay on terraces between crags; unsafe due to the consequences of a slip).

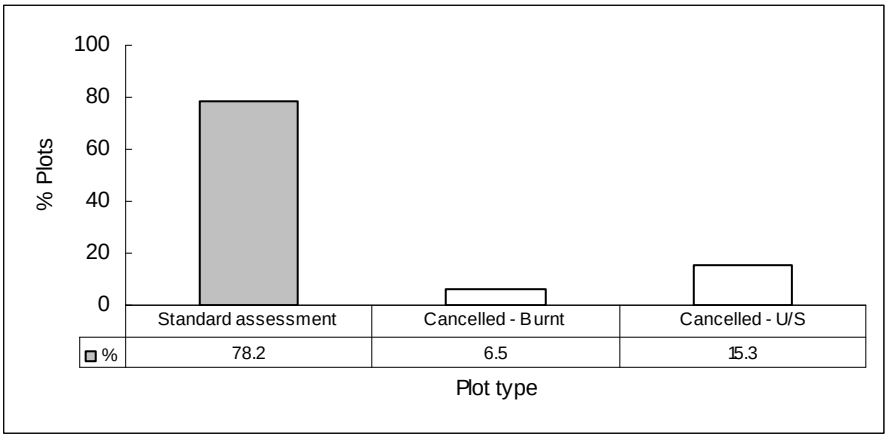


Figure 1. Status of plots in the study area, according to whether they were surveyed (Standard Assessment), visited but not surveyed because of the effects of fire (Cancelled-Burnt) or left un-surveyed due to dangerous access / position (Cancelled – U/S).

The majority of the plots (58%) were assessed using the dwarf shrub heath (DSH) indicators (Figure 2). Blanket bog (BB) indicators were used on 8% of plots. The various summit community indicators, as described in the methods, were used on 12% of plots. Twenty two percent of plots had no assessment undertaken for the reasons stated previously.

The majority of the land assessed was dominated by wet heath (M15; with occasional patches of M3) (Figure 3 upper and lower). Dry heath (H10, H14, H20 & H21[3]) was the next most common habitat type recorded. The remaining land fell either into the blanket bog category (M17 or M19), summit heaths (H14, H20 and U10) or summit grasslands (U7 and U13).

[3] Several mid-altitude plots were assessed with DSH indicator although the NVC communities mapped were alpine heaths. These plots (n=4) were all located at mid-altitude (500-650m) where transitions from sub-alpine to alpine heath are apparent.

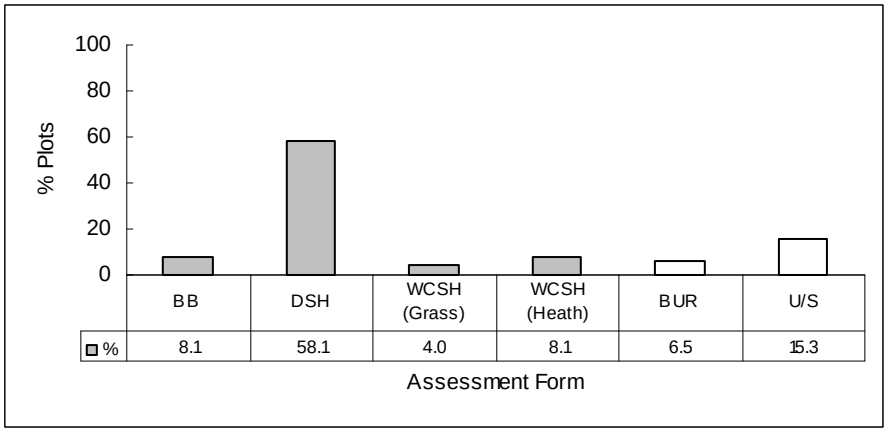


Figure 2. Percentage plots by small-scale indicators used. Blanket bog (BB), dwarf shrub heath (DSH), wind-clipped summit heath (Heath dominated) (WCSH Heath), wind-clipped summit heath (Grassland) (WCSH Grass), BUR = burnt and U/S = un-surveyed.

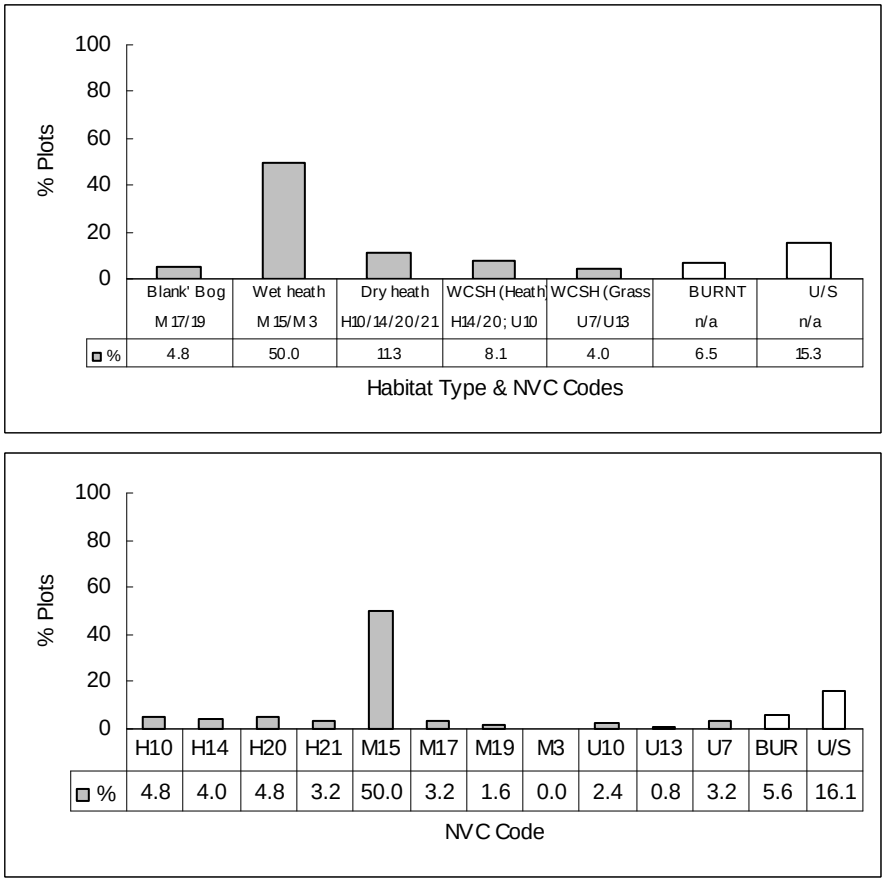


Figure 3. Percentage plots by habitat type (with associated NVC codes) (upper) and percentage plots by NVC code (lower).

3.2 Grazing/Browsing Impacts & Trampling Impacts

The results of the small-scale indicators assessment are presented in Figure 4, which illustrates the degree of variation in results for the median analysis of each impact type used (Grazing/Browsing or Trampling) and set of indicators applied.

Sample sizes varied markedly for each assessment type, with small sample sizes apparent for the BB assessment (n=10), WCSH Heath (n=10) and WCSH Grass (n=5); the sample size was much larger for the assessment using the DSH indicators (n=72). The DSH

category was used on both the dry heath and most of the wet heath communities, with wet heath being encountered approximately 80% of the time and dry heath 20% of the time during the assessments.

The vast majority of plots across all habitats, when assessed for Grazing, were classed overall as having Low impacts (Figure 4). Across all habitats assessed, the Grazing/Browsing impacts were classed as Low or Low-Moderate on 92% of plots, Moderate on 8% and Moderate-High or High on 0%.

The results for the Trampling indicators were on average slightly higher than for Grazing (Figure 4). Across all habitats, the Trampling impacts were classed as Low or Low-Moderate on 71% of plots, Moderate on 19% and Moderate-High or High on 10%.

Map 2 (Appendix 1) shows the distribution of habitat types and Map 3 shows the level of impacts (Grazing/Browsing and Trampling) recorded at each point.

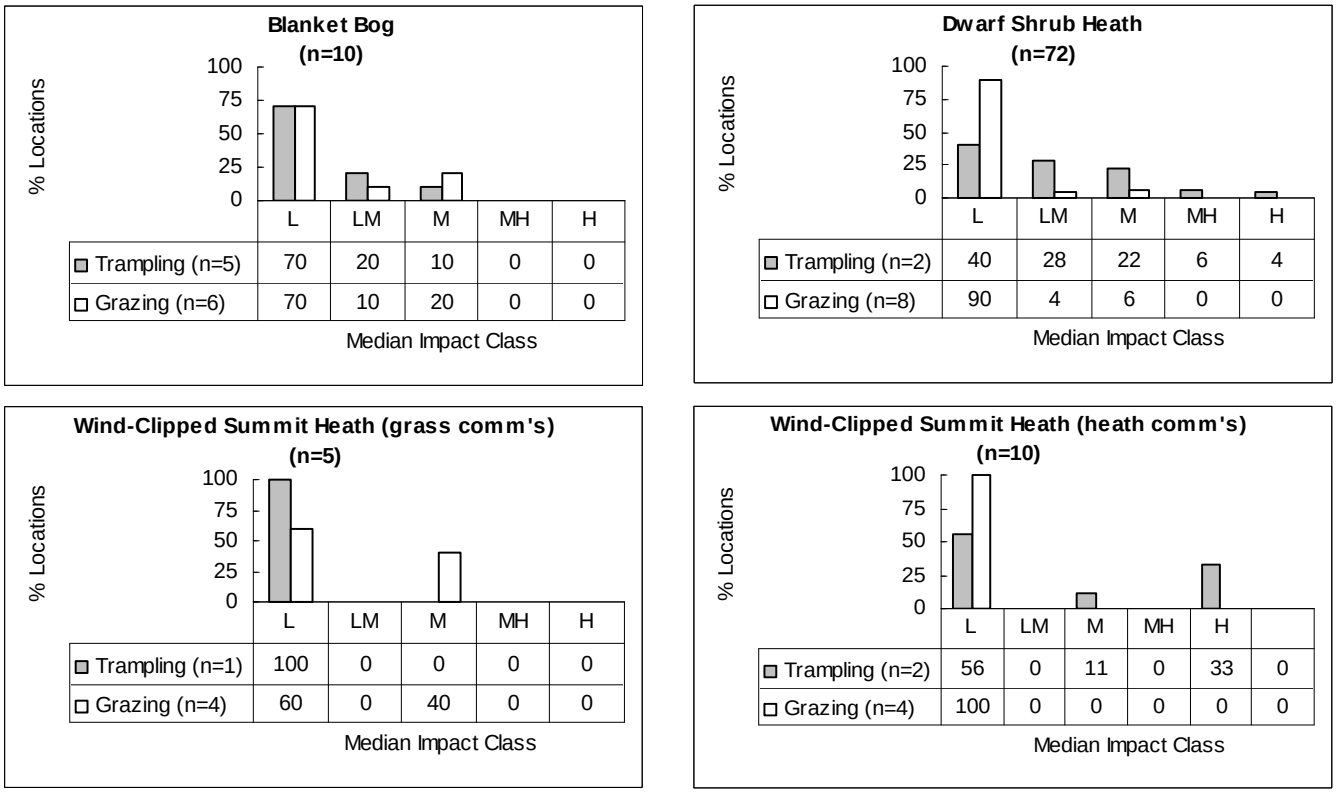


Figure 4. Frequency distributions of Grazing/Browsing impact class and Trampling impact class for each of the 4 assessment types undertaken, based on the median impact class recorded on plots[4]. The graphs show the percentage of locations sampled at which a particular impact class was recorded (e.g. 90% of DSH plots had a 'Low' level of grazing impacts). Sample sizes of plots are shown in the graph titles and the number of indicators used is shown in the legends for each impact type. N.B. All habitats other than DSH had small sample sizes (10 plots or less) and were restricted in geographic extent hence the frequency distributions are unlikely to be a reliable reflection of the features as a whole.

[4] The approach of using medians can sometimes produce intermediate scores between L and M or M and H, hence LM and MH are classes in these Figures.

3.3 Trend Indicators

Trend indicators for WCSH suggested, where applicable, that impact levels were likely to have been Constant based on evidence available. Where trend indicators were applicable on blanket bog they were also indicative of a generally Constant level of impacts. Where the DSH indicators were used, the trend recorded varied depending on the plot (mix of Constant, Increasing and Decreasing). The view of surveyors on site, given all available evidence, was that impacts on most habitats and in most areas appeared to have been fairly constant and low over the previous period. That said, impacts on dry heath could locally be fairly heavy. The most obvious examples were in corries and sheltered gullies where some *Calluna* patches might be very slowly shrinking from their edges although this process may allow other habitats to be maintained or otherwise develop e.g. calcareous grasslands (see separate SCM report).

3.4 Additional Quantitative Measures

The additional quantitative data are summarised in Figure 5. Noteworthy statistics include the following:

- The highest mean off-take of *Calluna* was on plots assessed using DSH indicators (c. 9%) whilst other habitats showed lower rates (c. 5%); these rates are all relatively low for an upland site.

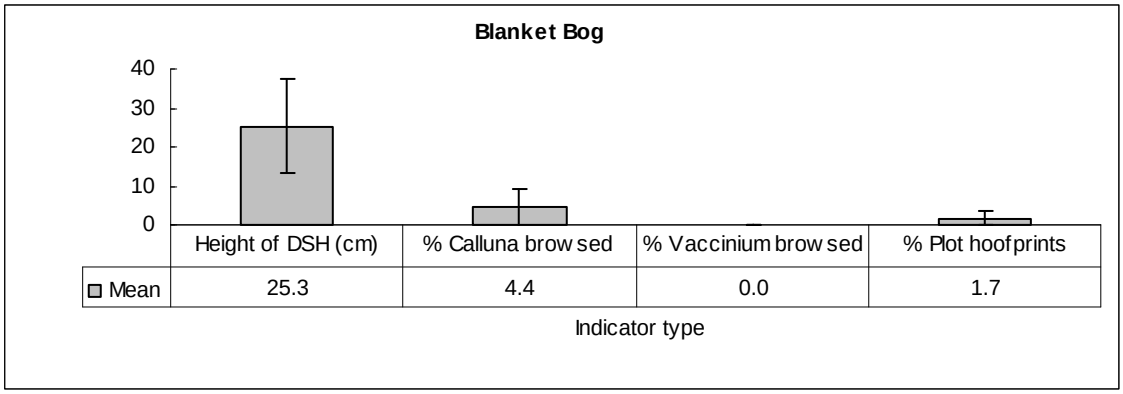
- *Vaccinium* was utilised markedly more than *Calluna* on plots assessed using DSH indicators – this is commonly observed on many upland sites.

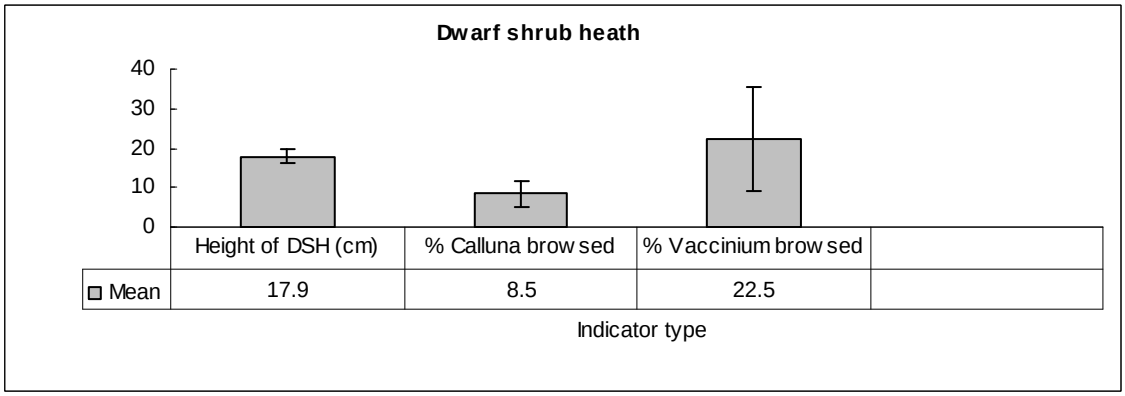
- The mean height of dwarf shrubs was highest in BB, lowest in WCSH (because the shrubs are, by definition, stunted in this habitat) and intermediate in DSH; this is because the DSH habitat covers a much wider altitudinal range than the others, which have distributions restricted to the lower and higher slopes respectively.

- Recorded levels of trampling, as measured by the percantage of plots with visible hoof marks, were extremely low. However, the reliability and hence utility of this measure is in part affected by variations in substrate, the vegetation composition and water table depth which, in turn, affect the visibility and longevity of hoof marks.

- The recorded percentage cover of bare peat/disturbed ground on BB was relatively high, but the sample size was small and hence sampling errors were large. It is unclear whether this is a reliable reflection of the extent of bare peat across the bog feature as a whole.

Map 4 (Appendix 1) shows the off-take level of *Calluna* on a quadrat-by-quadrat basis.





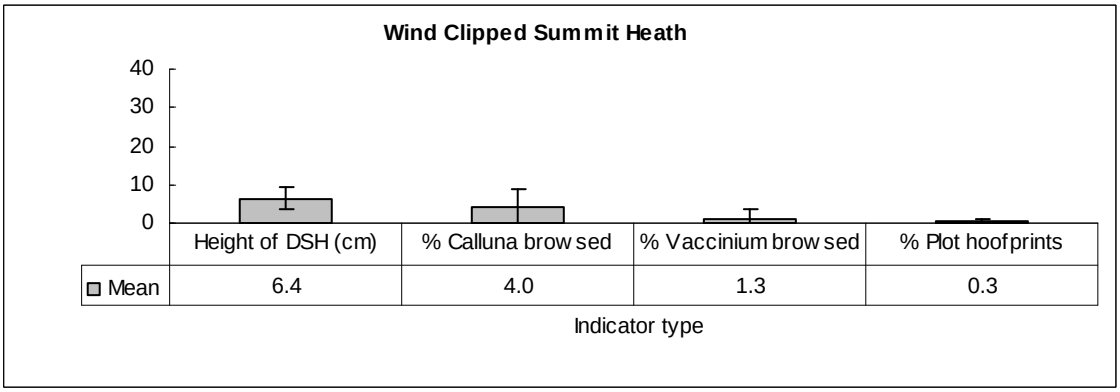


Figure 5. Summary statistics for the additional quantitative measures gathered on key habitats (blanket bog, dwarf shrub heath and wind-clipped summit heath – heath type), showing variables common to all habitats.

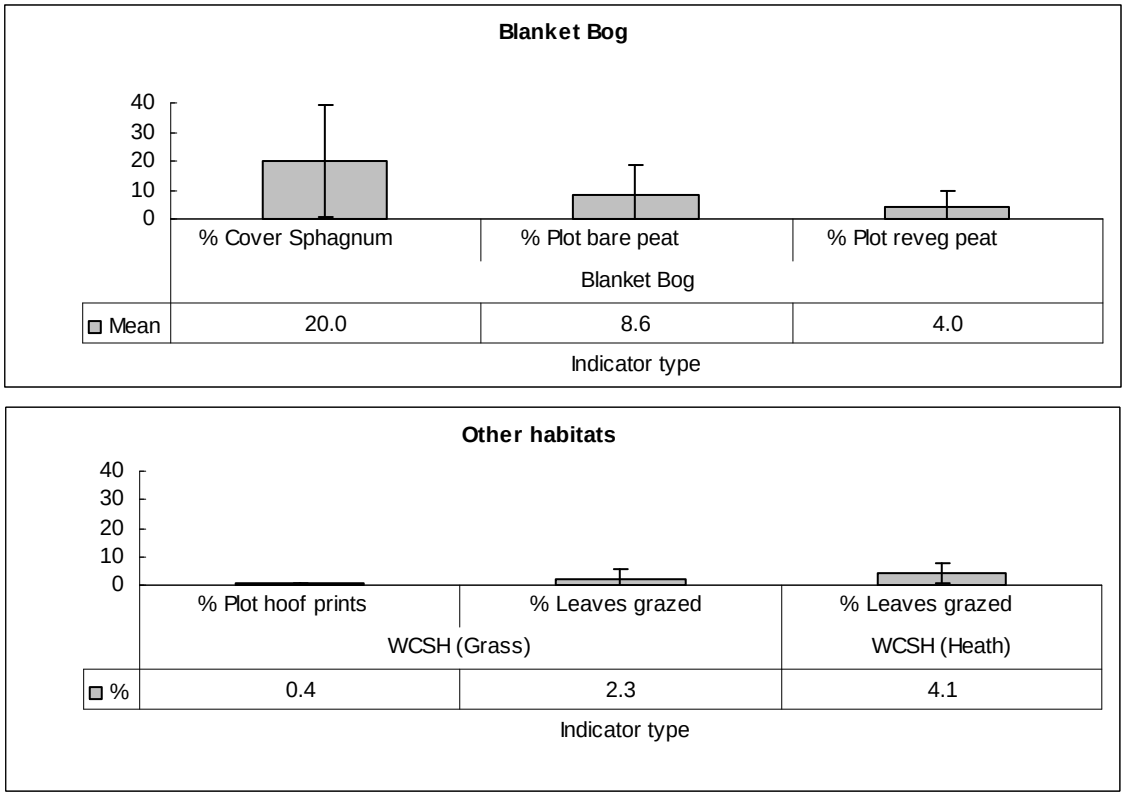


Figure 6. Summary statistics for the additional quantitative measures for variables recorded in some habitats only: blanket bog (upper) and summit communities (lower).

3.5 Herbivores

Red deer were the most commonly observed large herbivore present within the study area. Sheep were not encountered during the assessment. Grouse were occasionally seen or heard. Mountain hare dung was occasionally seen. Heather beetle damage was noted in some areas although not at high levels. It is assumed that Red deer are responsible for the majority of the impacts detected.

Map 4 (Appendix 1) shows the density of deer faecal pellet groups recorded on the 80m transect laid out at each HIA sampling point. The pattern of deer occupancy across the site was very variable, with some areas showing relatively high levels and some areas showing very low levels. In general, occupancy levels were markedly higher in the northern half of the SSSI than in the southern half, as defined by the Liathach ridge running east-west. Occupancy at the local scale was generally highest in corries and sheltered areas (e.g. gullies).

3.6 Land Ownership

A variety of owners manage the SSSI. Map 4 (Appendix 1) shows the boundaries of each estate and illustrates the level of variation in impact levels recorded between properties. That said, it should be noted that due to the even spaced sampling, NTS is the only property which was sampled intensively; all other properties had very small sample sizes (e.g. Grudie had n=17 plot locations) hence less weight should be attached to any apparent variations in level between them individually.

4 DISCUSSION

The results of the HIA undertaken on Torridon Forest in summer 2012 suggest that, in general, the level of Grazing/Browsing impacts was Low according to the methods of MacDonald *et al* (1998). There were a few locations where Grazing impacts levels were Moderate but these were relatively rare.

The assessment of Grazing impacts relied on the use of 4-8 indicators per habitat type, many of which involve direct observation of plant leaf or shoot utilisation. The use of direct observations of herbivore activity means that these indicators are fairly reliable measures of recent activity. That said, the sample size of plots assessed was small for all habitats other than DSH which means that it is difficult to summarise impact levels by habitat type – it is therefore difficult to know if the results provide a reliable picture of these 'rarer' features. It is noteworthy that their 'rarity' in the analysis is mainly related to the sampling framework used, whereby only one habitat feature was assessed at each point even if others were present nearby. The corollary is that the less abundant features, even though often widely distributed on the SSSI (e.g. blanket bog which often occurs in smaller patches on this site) have been under-sampled geographically and this will undoubtedly have introduced a degree of geographic bias into the statistics presented for these rarer features. Of course, the purpose of the study was mainly to quantify the condition of the dry and wet heaths which were sampled more intensively.

A related point is that the size and number of quadrats used, a single 2x2m for this assessment, produces some potential difficulty in interpreting the quantitative assessment data. The reason is that impact levels can be very variable locally, such that a 2x2m quadrat moved from one position in a stand of *Calluna* to another can produce a different outcome (e.g. one on patch edge and one on stand 'interior'). The result is that the measure of off-take at that location (2x2m scale) is not necessarily reflective of the wider area around it (e.g. 100-500m^2 + scale) and hence mapping of these rates (see Map 4) is potentially somewhat misleading. However, the quantitative assessment indicators still provide the most reliable basis for monitoring change going forward.

On a related point, the MacDonald indicators are grouped into very 'coarse' classes hence a fairly major shift in grazing pressure would be needed on a site to detect an ecologically significant change. The use of these coarse classes manifests itself as a lack of sensitivity when mapping variation in impact level geographically, in that the deer occupancy map displays far more variation than the HIA grazing map even though we would expect the two variables to be closely correlated (see joint report to SNH and NTS for Torridon Forest). That said, the system was not designed in the first instance for monitoring; it was designed to act as a high-level check at the landscape scale to distinguish areas of generally higher from generally lower land management impacts.

The issues outlined for Grazing previously, notably in terms of the use of single quadrats, apply for Trampling impact assessment equally. Moreover, the Trampling indicators produced a markedly different picture of the site when compared with the pattern in the Grazing indicators; in general, the Trampling indicators showed higher impacts than the grazing indicators. There are several factors which might explain this difference, with one of the more notable being that some of the Trampling indicators used on habitats showing high impacts relate to the extent of bare soil. However these indicators are used in locations such as summit ridges, where deflation scars and other weather-related phenomena more commonly occur, and on bogs and wet heath where bare peat can occur as a result of natural processes (e.g. fluvial erosion after fire). The key issue is that it is difficult for a surveyor on a single visit to ascertain whether the bare ground is caused by physical processes, or by physical processes 'catalysed by herbivore disturbance'. Most habitats

have very few Trampling indicators applicable in the assessment (1-3; 5 in bog of which only some relate to bare soil) and not all are always relevant at each plot – the result is that plots with only 1 or 2 'bare soil' type indicators can be classed as having High trampling impacts and yet the bare ground might be naturally-occurring; it is simply the case that herbivores are walking on the ground and footprints hence show up. It is probably the case that the Grazing and Trampling indicators for the Torridon survey would be better merged together for these reasons than presented separately, to provide an appropriate reflection of general impact levels present. The decision was made to leave then separate in the report for interested readers, but caution should be exercised in interpreting the significance of the Trampling results.

Trend indicators, when used on many areas and habitats, suggested impact levels had most likely been Constant in recent times, and in some places might be declining. The growth form of *Calluna* on wet heath can resemble that of *Calluna* deformed by browsing and it can be hard to distinguish the difference between old dead and old browsed shoots. On balance, we felt that the results for the trends indicators were difficult to determine on many of the plots assessed.

Having spent a great deal of time working on the Torridon Forest SSSI whilst undertaking the wider suite of work for NTS and SNH, it was felt appropriate to include some of our own thoughts and observations on the site in this section of the report. Our view was that impact levels on the wet heath were generally fairly low, although there was undoubtedly variation in impact level across the site notably in relation to *Calluna* off-take and trampling levels. For example, the level of impact was generally higher on the north side of Liathach than on the south. The very marked local variations in deer occupancy across the site, as detected during our occupancy survey, seemed closely correlated with the impact levels we measured as is evidenced using the SCL habitat impact methods as reported separately.

It was also apparent that there were marked differences in impact levels, for example on *Calluna*, between habitat types. A good example was the impacts on dry heath in Coire Toll a' Mhadhaidh on Beinn Alligin which appeared fairly high, whereas impacts on the much more extensive wet heath in the same areas appeared generally much lower. Of course, variation in impact levels between habitats situated adjacent to each other would be expected in a landscape where preferred habitats are in limited supply and especially where the preferred habitats are situated in areas where deer tend to shelter.

More general points on data analysis are also worthy of consideration. The approach to analysis employed herein involved use of medians, whereas there are several approaches available including mean score, mode and weighted mean. The weighted approach is interesting as it gives some indicators more prominence than others based on their reliability and the degree to which their importance is understood in scientific literature (e.g. *Calluna* off-take is more heavily weighted than moss uprooting). The various approaches all produce different results. The use of medians also produced some problems at analysis stage when the number of indicators used on a plot was even (n=2, 4, 6 etc) . That is because in some of these cases the median value fell between 2 classes (e.g. true median of the string of example values L, L, M, M (or 1, 1, 2 and 2 in our analysis) lies half-way between L and M (i.e. is LM or equates with 1.5 in our analysis). That said, the same problem is apparent when using mode because equal numbers of classes (e.g. plot had 2 indicators and values were L and M; neither is more common and hence one has to be chosen) still present a 'tied situation'.

One final point to be borne in mind is that a suite of points was not sampled at all. Many locations were judged too dangerous to assess, even by the experienced mountaineers we employ, so omission of these points was unavoidable. Another sub-set of points was affected by the wildfire of 2011 and these points, judged often to have comprised wet heath

and some dry heath previous to the fire, could not be assessed because most of the indicators used rely on properly developed *Calluna* bushes being present; at the time of survey the seedlings, albeit very numerous, were typically only 1-2cm tall. Future studies of this site will need to take this into account.

5 CONCLUSIONS

This HIA has helped us to confirm that impacts are generally Low across the site according to the classification of MacDonald *et al* (1998). Evidence from site, where available and reliable, suggests that impact levels are likely to be fairly Constant in most areas. Due to the small sample sizes obtained for some habitats, caution should be applied in interpreting the results for each habitat separately, and in some cases where the number of indicators for trampling was few. However we believe that results obtained, particularly for less abundant habitat types and relating to Trampling, should be treated with a degree of caution by managers given the potential weaknesses of the sampling framework and methods employed for the assessment.

6 RECOMMENDATIONS

A list of our recommendations is included below:

- Additional analysis

    - The results of the Beinn Eighe HIA could be incorporated into the maps presented herein, to provide an overview for the entire Loch Maree Complex SAC based on the methods of McDonald *et al*. 1998. The results could then be compared for different geographic areas within the SAC linked to deer occupancy levels. That said, the sampling frameworks were different for the HIA assessments as a fixed sample size of random plots was used in each feature at Beinn Eighe and this would need to be considered.

    - The analysis methods proposed by SNH for this assessment, based on using medians, will produce different results to the weighted approach recommended by MacDonald (2007) or to the approach of using straightforward means or modes. Whilst all have their merits, and all have their disadvantages also, it might be useful to include all forms of analysis in any future report for comparison.

- Methodology & Future Assessments

    - Overall, we felt that the division of Grazing and Trampling indicators in the analysis was problematic because of small number of Trampling indicators used. The data for Torridon might therefore best be analysed by combining all indicators, or otherwise at least giving most weight to the Grazing indicators.

    - The wet heath habitat at Torridon would perhaps be better assessed using a combination of BB and DSH indicators at all plots, rather than using the DSH form as is recommended for most of the M15 sub communities. That is because many of the observed impacts on wet heath are more akin to bog (*Sphagnum* trampling, poaching of shallow pool edges etc) than to dry heath.

    - Multiple quadrats should ideally be assessed in the vicinity of each point (3-5 smaller quadrats rather than one larger; spread over a larger area e.g. 100m line) to provide a better local average for the area sampled, and ideally for each feature type present (i.e. separate assessments for dry heath, wet heath etc); dry heath would be particularly important to assess separately on the Torridon site at as many locations as possible given it is a preferred habitat and it will therefore act as a sensitive barometer of population pressures.

    - Any repeat HIA of this area should place most weight on changes detected using the additional quantitative measures rather than the 'categoric' MacDonald indicators, given their inherently low precision. The parallel SCL impacts data set gathered in summer 2012 provides, additional quantitative assessments.

    - The longer-term effects of the wildlife might be significant and could be worthy of monitoring in near future for elevated levels of impact caused by deer drawn onto the burnt land.

7 REFERENCES

MacDonald, A., Stevens, P., Armstrong, H., Immirzi, P. & Reynolds, P. 1998. *A Guide to Upland Habitats Surveying Land Management Impacts*. 2 Volumes. Battleby, SNH Publications.

MacDonald, A. 2007. Addendum to The Guide to Upland Habitats: Surveying Land Management Impacts. Unpublished report to SNH.

Rodwell, J.S. 1991. *British plant communities. Volume 2. Mires and heaths.* Cambridge, Cambridge University Press.

Stace, C. 1997. *New Flora of the British Isles,* 2nd edition. Cambridge, Cambridge University Press.

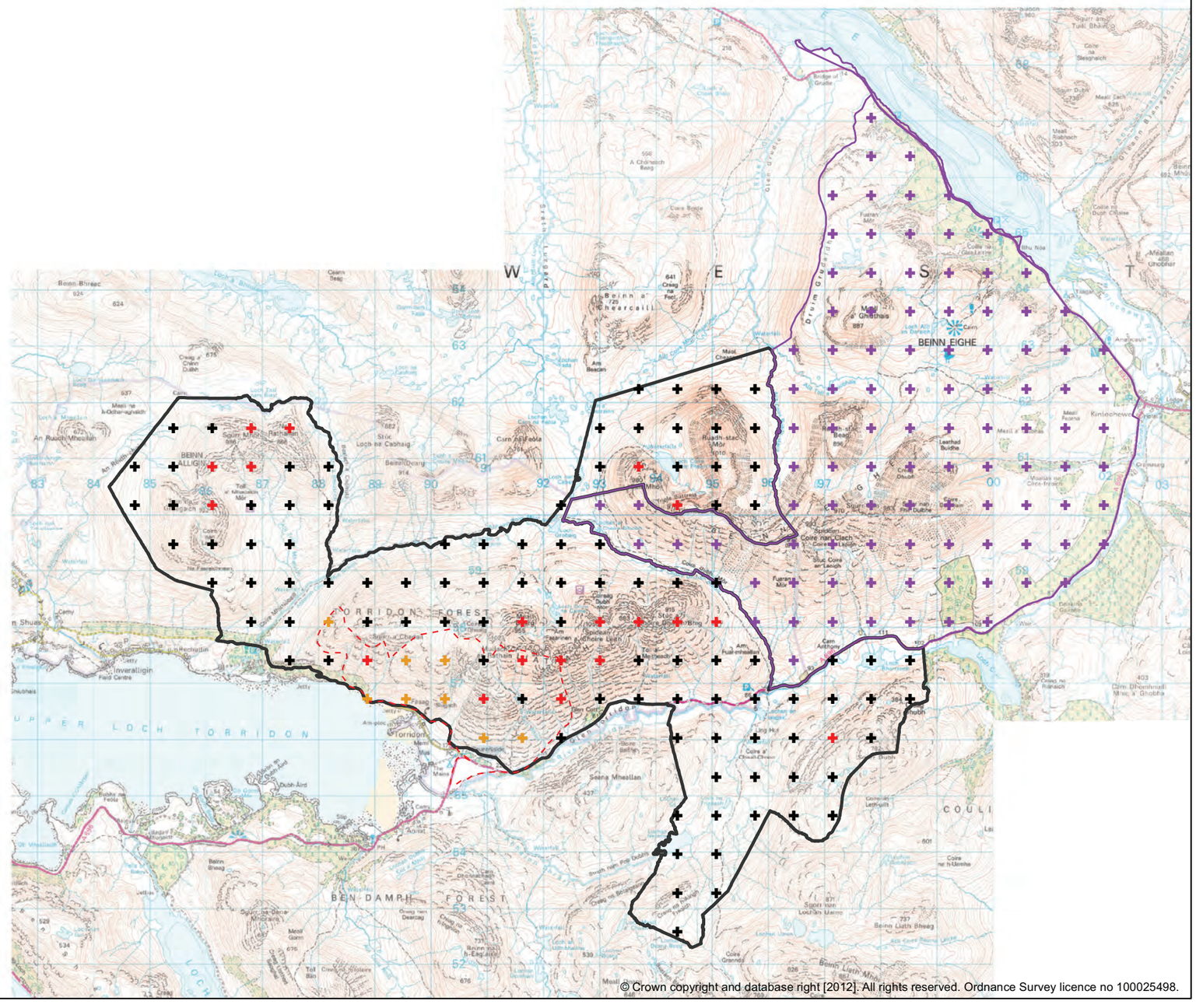
ANNEX 1: MAPS

Legend

- Beinn Eighe survey area 2011
- Beinn Eighe deer density plots
- Torridon survey area 2012
- Burnt area - approximate extent

Torridon HIA and deer density plots

- Surveyed
- Unsurveyed - burnt
- Unsurveyed - dangerous



	Initials	Date	Status:	Title:		
Drawn:	CH	23/01/13	FINAL	Map 1 - Site location and sampling overview		
Checked:	DC	23/01/13				
Approved:				**Version:** 1	**Location:** Torridon	**Scale:** 1:75,000

Legend

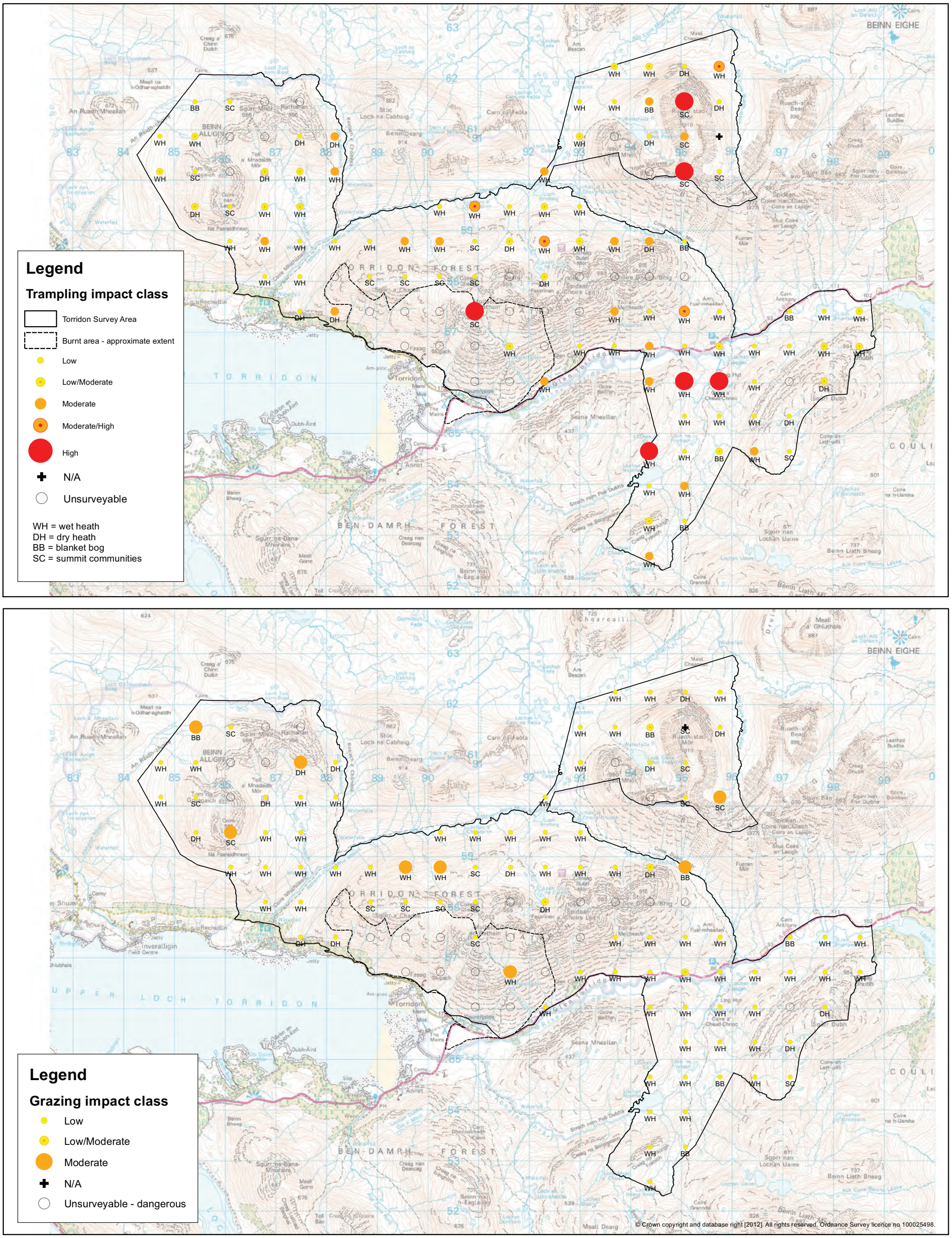
- Torridon survey area
- Burnt area - approximate extent

Habitat type

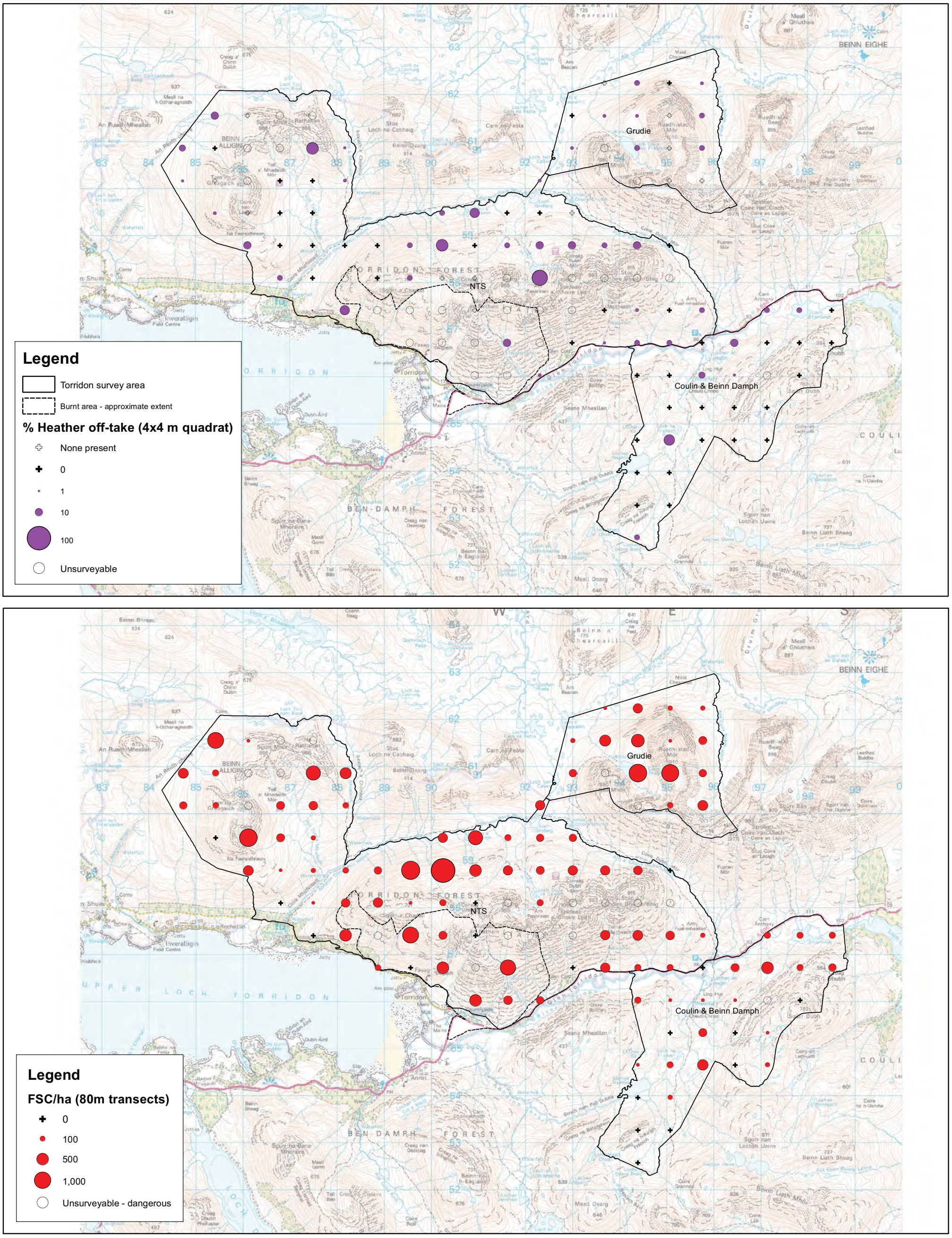
- Blanket Bog
- Dry heath
- Summit communities (grassland)
- Summit communities (heath)
- Wet heath
- Unsurveyable

In the burnt area wet heath appeared to have been the most common habitat before the fire; dry heath also appears to have been locallly common

	Initials	Date	Status:	Title:		
Drawn:	CH	23/01/13	FINAL	Map 2 - Habitats Present		
Checked:	DC	23/01/13				
Approved:				**Version:** 1	**Location:** Torridon	**Scale:** 1:50,000



	Initials	Date	Status:	Title:		
Drawn:	CH	23/01/13	FINAL	Map 3 - Trampling and grazing impact classes		
Checked:	DC	23/01/13				
Approved:				**Version:** 1	**Location:** Torridon	**Scale:** 1:65,000



	Initials	Date	Status:	Title:		
Drawn:	CH	23/01/13	FINAL	Map 4 - Heather off-take and deer occupancy		
Checked:	DC	23/01/13				
Approved:				Version: 1	Location: Torridon	Scale: 1:70,000

ANNEX 2: OVERVIEW OF THE HIA METHODS

The methods of MacDonald *et al* (1998) were developed to provide a rapid means of characterising land management impacts across large tracts of the Scottish uplands. The original method involved assessment of a variety of impacts including: herbivore grazing, herbivore browsing, herbivore trampling, land drainage/drying, muirburn and peat cutting. The assessment was undertaken for a range of habitats – dwarf shrub heath, blanket bog, bracken etc – in recognition of the fact that some impacts only occurred in some areas, and also that impacts had different effects on each habitat.

The assessments were undertaken at two scales: landscape scale (Phase 1; using 'large scale' indicators) and plot scale (Phase 2; using 'small-scale' indicators and 'trend indicators'). Phase 1 work was done by eye, or using binoculars, and helped the surveyor gain a general appreciation of whether land management impacts were noticeably high from a distance or not. They then proceeded, if required, to undertake a Phase 2 assessment.

The original method for Phase 2 was designed to be applied to 1km squares, and the surveyor would assess 10 points (of c. $1m^2$) in each habitat type in each 1km square. The result of the assessment would be a map, showing each square coloured according to the impact level assigned (e.g. High = red; Moderate= orange; Low = yellow). A map would either be produced for each habitat, or results integrated for all habitats. The idea was to produce an 'at a glance' picture of where impacts were highest on large sites.

The Phase 2 methods were adopted by Scottish Natural Heritage and the then Deer Commission for Scotland, in the early 2000's to be used as a tool for monitoring herbivore impacts on Designated Sites. The approach adopted was to use the Phase 2 assessment technique on a set of fixed plots of 2x2m in each feature of interest (e.g. a set of plots in Wet Heath, a set in Flushes etc). The plots were marked and photographed, so they could be followed up in future years to try and establish whether impact levels were changing over time.

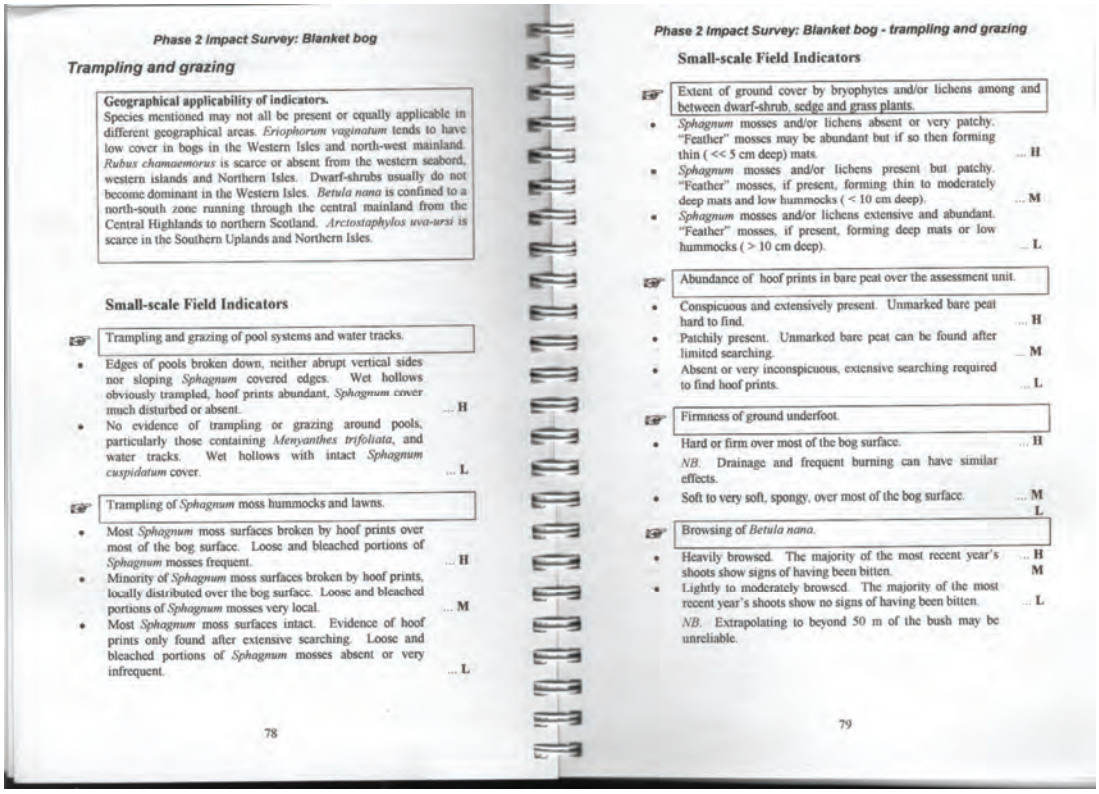
The Phase 2 method at the plot scale involves an examination of a wide suite of indicators of Grazing or Trampling on each plot, assuming indicators are applicable. Each habitat type has its own set of 'small-scale indicators' and its own set of 'trend indicators'. Each indicator is assessed as being in one of three classes (Low, Moderate or High). An example set for some of the Blanket Bog assessment has been copied below, for interested readers to see.

Trampling and grazing

Phase 2 - Small-scale Indicators	**H**	**M**	**L**
Pool systems and water tracks			
Sphagnum hummocks and lawns			
Cover of *Sphagnum* and/or lichens vs "feather" mosses			
Hoof prints in bare peat			
Firmness of ground underfoot			
Browsing of *Betula nana*			
Signs of browsing of less palatable dwarf-shrubs (*Auu, En, Et, Vvi*)			
Amount of flower and fruit on *Rubus chamaemorus*			
Amount of flower and fruit on *Eriophorum*			
Growth form and signs of browsing of *Myrica*			
Browsing of *Calluna* and/or *Vaccinium myrtillus*			
Dung			

Trend	**I**	**CH**	**CM**	**D**	**CL**
Changes in growth-form of dwarf-shrubs					
Height of *Myrica*					
Height and cover of dwarf-shrubs vs graminoids					
Abundance and vigour of *Juncus squarrosus*					
Presence of "grassland" species (*Ac, Ac, Ao, Df, Fo, Ns*)					
Abundance of *Carex panicea* on drier "ridge" areas					

Image 1. Blanket bog small-scale and trend indicators (Copyright of SNH).



Phase 2 Impact Survey: Blanket bog

Trampling and grazing

Geographical applicability of indicators.
Species mentioned may not all be present or equally applicable in different geographical areas. *Eriophorum vaginatum* tends to have low cover in bogs in the Western Isles and north-west mainland. *Rubus chamaemorus* is scarce or absent from the western seabord, western islands and Northern Isles. Dwarf-shrubs usually do not become dominant in the Western Isles. *Betula nana* is confined to a north-south zone running through the central mainland from the Central Highlands to northern Scotland. *Arctostaphylos uva-ursi* is scarce in the Southern Uplands and Northern Isles.

Small-scale Field Indicators

☞ Trampling and grazing of pool systems and water tracks.

- Edges of pools broken down, neither abrupt vertical sides nor sloping *Sphagnum* covered edges. Wet hollows obviously trampled, hoof prints abundant, *Sphagnum* cover much disturbed or absent. ... H
- No evidence of trampling or grazing around pools, particularly those containing *Menyanthes trifoliata*, and water tracks. Wet hollows with intact *Sphagnum cuspidatum* cover. ... L

☞ Trampling of *Sphagnum* moss hummocks and lawns.

- Most *Sphagnum* moss surfaces broken by hoof prints over most of the bog surface. Loose and bleached portions of *Sphagnum* mosses frequent. ... H
- Minority of *Sphagnum* moss surfaces broken by hoof prints, locally distributed over the bog surface. Loose and bleached portions of *Sphagnum* mosses very local. ... M
- Most *Sphagnum* moss surfaces intact. Evidence of hoof prints only found after extensive searching. Loose and bleached portions of *Sphagnum* mosses absent or very infrequent. ... L

78

Phase 2 Impact Survey: Blanket bog - trampling and grazing

Small-scale Field Indicators

☞ Extent of ground cover by bryophytes and/or lichens among and between dwarf-shrub, sedge and grass plants.

- *Sphagnum* mosses and/or lichens absent or very patchy. "Feather" mosses may be abundant but if so then forming thin (<< 5 cm deep) mats. ... H
- *Sphagnum* mosses and/or lichens present but patchy. "Feather" mosses, if present, forming thin to moderately deep mats and low hummocks (< 10 cm deep). ... M
- *Sphagnum* mosses and/or lichens extensive and abundant. "Feather" mosses, if present, forming deep mats or low hummocks (> 10 cm deep). ... L

☞ Abundance of hoof prints in bare peat over the assessment unit.

- Conspicuous and extensively present. Unmarked bare peat hard to find. ... H
- Patchily present. Unmarked bare peat can be found after limited searching. ... M
- Absent or very inconspicuous, extensive searching required to find hoof prints. ... L

☞ Firmness of ground underfoot.

- Hard or firm over most of the bog surface. ... H

  NB. Drainage and frequent burning can have similar effects.
- Soft to very soft, spongy, over most of the bog surface. ... M L

☞ Browsing of *Betula nana*.

- Heavily browsed. The majority of the most recent year's shoots show signs of having been bitten. ... H M
- Lightly to moderately browsed. The majority of the most recent year's shoots show no signs of having been bitten. ... L

  NB. Extrapolating to beyond 50 m of the bush may be unreliable.

79

Image 2. An excerpt of the blanket bog small-scale indicators, as explained in the SNH handbook (Copyright of SNH).

There are different ways of analysing the data, but common ways include using the most common or the middle class as a value for the plot (e.g. 15 Low values and 3 Moderate values from a plot would be classed as a Low score overall) for that plot. The data from each plot are often mapped, to assess spatial variations in impact, and are also often presented in tables or graphs which show the percentage of plots in a feature which were recorded as Low, Moderate or High overall.

www.snh.gov.uk

ISBN: 978-1-85397-961-3

Policy and Advice Directorate, Great Glen House,
Leachkin Road, Inverness IV3 8NW
T: 01463 725000

You can download a copy of this publication from the SNH website.

recycle

Scottish Natural Heritage
Dualchas Nàdair na h-Alba
All of nature for all of Scotland
Nàdar air fad airson Alba air fad