A habitat condition resurvey of the Upper Plym Estate in South Dartmoor SSSI:

1. Current condition in 2023

[redacted]

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Summary

Survey approach and methods

A habitat condition resurvey of Site Unit 61 of South Dartmoor Site of Special Scientific Interest (SSSI) was carried out between 10 and 22 January 2023. The survey involved resampling quadrats surveyed for Natural England ten years earlier in February/March and followed Common Standards Monitoring (CSM) guidance for upland habitats with the collection of some additional, more comprehensive data.

Overall condition and the number and percentage of samples passing all and individual attribute targets

No samples from any of the four habitats surveyed passed all the attribute targets assessed. Thus, given that the upland CSM threshold for favourable condition is that 90% of all samples pass all attribute targets, all four habitats are clearly in unfavourable condition.

There was a tendency for more wet heath samples to pass a higher number of attribute targets, followed by blanket bog and dry heath, with acid grassland tending to have fewest passing. The mean proportion of attribute targets passed per sample was nevertheless relatively similar across the four habitats with a range of 7–11 targets passed representing a mean of 71–80% of targets assessed. This was highest for blanket bog and lowest for acid grassland.

The number of samples meeting individual attribute targets indicate the reasons for unfavourable condition in terms of particular attributes and targets failing, and in some cases likely causes/drivers. The proportion of attribute targets passed across samples (met in at least 90% of samples) was relatively similar across the four habitats with a range of 7–9 targets representing 50–69% of targets assessed. The pass rate was again highest for blanket bog and, in this case, lowest for dry heath.

Similar types of attributes tended to be failed across habitats, particularly for blanket bog (BB), and wet and dry heath (WH, DH): too low positive indicator species cover (BB, WH and DH); too high percentage of heather shoots browsed (BB, WH and DH); too low positive indicator frequency (BB, WH, DH and acid grassland, AG in FCT, last marginal); and too high cover of negative indicators/bracken (BB, WH, DH and AG). Some other individual attribute targets were failed in single habitats: too high cover of graminoids[1] (WH); not all heather growth stages present and western gorse too high a percentage of dwarf shrub cover (DH, marginal); and too low percentage forb[2] cover, low structural diversity (too-little, tall c.f. short vegetation) and too high litter cover (AG). Where specific values were quantified for targets, these provide additional information on how close the sampled vegetation is to passing attribute targets. Targets for dwarf shrub (all heather) shoots grazed (BB, WH, DH), positive indicator cover (BB, WH, DH), cover of negative indicators (WH), forb cover (AG), bracken (as part of scrub/bracken) cover (AG) and litter cover (AG) were failed by a considerable margin.

Additional grazing-related variables

Data were also collected on a range of 'overgrazing'[3] and other directly grazing-related variables in 2023. These included graminoid sward height and percentage of heavily grazed (stunted and

[1] A grass, sedge or rush.
[2] An herbaceous flowering plant that is not woody or a 'graminoid' (grass, sedge or rush species).
[3] Overgrazing Environmental Cross-compliance controls attached to livestock support schemes from 1992 (Condliffe 2009) in response to concerns about loss of heather on moorland (e.g., Felton & Marsden 1990).

suppressed) heather growth forms, the two criteria formerly used in overgrazing investigation surveys. A site is considered overgrazed if 25% or more of samples are classed as being 'heavily grazed' based on set thresholds for these criteria. On this basis, the site unit would be considered overgrazed, with 30% of all samples classed as heavily grazed, as would the wet and dry heath habitats with 44% and 69% of samples heavily grazed, respectively. Whilst blanket bog and acid grassland had lower percentages of heavily grazed samples, this partly reflected the low frequency of heather (only recorded in 20% of blanket bog samples with none recorded in acid grassland).

Other grazing-related variables recorded included pulled heather stems (likely reflecting cattle or pony browsing) in 12% of all samples and much higher in samples with heather present (50%), almost entirely in dry heath. Recent livestock dung was recorded in 15% of all samples and was highest in dry heath (31%) and acid grassland (20%). Overall, cattle/pony dung occurred in a higher percentage of samples (12%) than sheep droppings (4%).

These grazing impacts are supported by some upland CSM attribute targets. In particular, across the three habitats where heather was recorded in quadrats, the mean percentage of heather shoots grazed in samples where heather was present was 66%. It was higher in dry (80%) and wet (79%) heath than in blanket bog (60%) samples. This resulted in the upland CSM attribute target (<33% shoots browsed in non-pioneer heather) and the tailored higher South Dartmoor FCT target (<50%) being failed in 74% and 71% of samples, respectively. The failure rate was highest in wet heath (92% for both targets) followed by dry heath (83% for both) and lowest in blanket bog (58% for CSM target and 50% for FCT target).

Taken together, evidence from CSM and other direct grazing-related variables indicates a significant grazing/browsing effect across habitats in the unit. Over time, this is likely to be having, and have had, significant effects on species composition as well as on vegetation structure. Evidence from the comparison between the 2013 and 2023 upland CSM surveys of the same sample points shows that dwarf shrub cover across the three bog/heath habitats declined from 21% to 1.4%. Continued heavy grazing on dwarf shrubs, particularly heather, when now at very low cover (heather mean 0.9%) risks further reduction and potentially loss from at least parts of the unit as has happened in the acid grassland sample points.

The unfavourable declining condition of the habitats on the site may also reflect a range of other co-factors or impacts, e.g., atmospheric deposition, heather beetle and modified hydrology. At least some of these cannot easily be addressed by local land management actions and may require more intensive restoration interventions or in some cases national or even international action, potentially including regulation. Nevertheless, sustainable land management is likely to provide the best, most cost-effective mechanisms to address the current unfavourable declining condition of habitats and to meet national and international objectives and commitments to restore habitat structure and function, and associated species and ecosystem services, and to improve their resilience to other impacts.

Contents

Introduction

This report presents summary statistics from an upland Common Standards Monitoring (CSM) habitat condition resurvey of Site Unit 61 of South Dartmoor Site of Special Scientific Interest (SSSI)[4] carried out between 10 and 22 January 2023. It also presents summary data for a range of additional, mostly grazing-related, variables collected during the same survey.

The SSSI unit comprises most of the National Trust's Upper Plym Estate on the eastern slopes of the Upper Plym Valley north-east of Cadover Bridge. Most of the unit (1,253 ha) lies within Willings Walls and Hentor Warrens Common (WWHW, 'Part D'), along with the smaller Trowlesworthy Warren Common ('Part C') (80 ha in the SSSI unit) which also extends outside the SSSI boundary to the south (with the non-SSSI part not included in the survey). The SSSI area also forms part of the wider Dartmoor Special Area of Conservation (SAC)[5]. These commons form part of a wider area of contiguous common land sometimes referred to as the Shaugh Prior Commons, which are also contiguous with the southern part of the Forest of Dartmoor. Thus, livestock are potentially able to wander over a wider area between these commons.

The main WWHW part of the site was entered into a ten-year Dartmoor Environmentally Sensitive Area (ESA)[6] agri-environment scheme (AES) agreement in 2001 under Tier 1E (Moorland) and subsequently a Higher Level Stewardship (HLS) agreement in 2011 under HL10 (Moorland Restoration) which ended in 2021, since when the site has no longer been under agreement. The smaller Trowlesworthy part was also initially under an ESA agreement, but not subsequently.

The survey was carried out [redacted] (of Leppitt Associates[7]), an experienced field ecologist contracted by Natural England to carry out the fieldwork, with guidance and assistance from [redacted] Natural England. The survey involved resampling the same quadrats originally surveyed for Natural England by Thomson Ecology (2013) ten years earlier between 26 February and 5 March 2013 as part of a wider habitat mapping and condition survey of South and North Dartmoor SSSIs. Both surveys were carried out in mid/late winter. This is the best time to assess the impacts of autumn/winter grazing, which is a key issue on the site, though it may be less optimal for recording the full range of heath and especially mire indicator species.

A separate report has also been produced comparing the results from the previous upland CSM survey of the unit in 2013 and the 2023 resurvey to evaluate the extent and nature of any change in condition (Glaves 2023). This involved a separate analysis based on the habitat classification assigned to the quadrats in 2013. For the current report, some quadrats were reclassified as different habitats based on 2023 data (see Field survey approach and methods below). The intention is to combine this current report and that comparing results between 2013 and 2023, to provide consolidated report that will also review and summarise other available evidence on change in habitat extent and condition on the site.

[4] https://designatedsites.naturalengland.org.uk/SiteDetail.aspx?SiteCode=S1002951&SiteName=South+Dartmoor&countyCode=11&responsiblePerson=&SeaArea=&IFCAArea=.
[5] https://sac.jncc.gov.uk/site/UK0012929.
[6] Archived details about Dartmoor ESA are available at: https://webarchive.nationalarchives.gov.uk/ukgwa/20070402213531/http:/www.defra.gov.uk/erdp/docs/national/annexes/annexx/dmrex2.htm.
[7] https://leppitt-associates.co.uk/.

Field survey approach and methods

The approach involved revisiting all, but one[8], of the 74 sample (2 m × 2 m) quadrats surveyed in 2013 (Figure 1). Only a small number of the sample points were in Part C (four: two acid grassland (Q515 and 516), one blanket bog (Q304) and one wet heath (Q549) sample on or near the boundary, Figure 1). The quadrats were not permanently marked in 2013, so could not be precisely relocated in 2023. Quadrats were placed in as near the same position as possible using a hand-held Global Position System (GPS) unit (Garmin76CS) to relocate the ten-figure Ordnance Survey Grid Reference recorded at the time of the 2013 survey (a general approach recommended in the upland CSM guidance, JNCC 2009b, Section 4, p 19). Although approximately the same areas were resurveyed, this will have resulted in some, likely random, noise in the data in relation to change between the surveys. In part to take this into account, current condition, and change in it between surveys, (in Glaves 2023), is reported across quadrats within a habitat (rather than between individual quadrats in terms of change). More information on the fieldwork is given by Leppitt Associates (2023a) as are photographs of each of the quadrats (Leppitt Associates 2023b).

Two specifically tailored forms developed by Natural England were used in the survey to collect data on upland CSM attributes and additional variables. One covered bogs and heaths, and the other acid grassland and heaths (particularly dry heath). This allowed the collection of more comprehensive data from each quadrat than in 2013, including for a wider range of attributes, species, and other variables. It enabled assessment of whether the habitat and National Vegetation Classification (NVC) community type were the same as in 2013 to be done post-survey. All samples were classed as either blanket bog (24), wet heath (18), dry heath (16) or acid grassland (15) in 2023.

Two parts of (composite) attribute targets were inadvertently missed off the tailored forms: signs of active drainage (<10%, blanket bog and wet heath); and all growth phases of heather *Calluna vulgaris*[9] (hereafter heather) should occur throughout the area outside of sensitive areas (dry heath). However, no evidence of active drainage was seen (as in 2013) and no pioneer heather was recorded in quadrats, so these attribute targets were still able to be assessed. Paper forms were used in the field and the data then digitised in an Excel spreadsheet.

The assessment of current habitat type was informed by new peat depth measurements, with deep peat (>40 cm[10]) typically used to differentiate between blanket bog and wet heath, the latter on shallow peat (typically defined as 20–39 cm). Locations with <20 cm peat generally coincided with dry/humid heath and acid grassland vegetation types on the site[11]. This resulted in a proportion of samples classed as wet heath, and even dry heath and 'upland mire' (valley mire and fen habitats classed as M25 *Molinia caerulea-Potentilla erecta* mire in 2013), being reclassified as blanket bog in 2023. Dry heath and acid grassland habitats on very shallow peat (<20 cm) or mineral soils were identified based on vegetation composition in relation to NVC vegetation types, though most dry heath stands were severely modified and degraded, with heather cover and frequency very low or absent. Thus, all but two quadrats no longer met the 25% dwarf shrub cover criterion normally used

[8] One quadrat (Q173 classed as 'upland mire' (valley mire and flushes, fens and swamps), NVC community type M25, in 2013) was inadvertently missed in the resurvey.

[9] English names of plants mentioned by scientific names in the text and tables are given in Appendix 1.

[10] As used in soil mapping, and in the Blanket bog restoration strategy (Natural England 2015a), Position Statement on burning on blanket bog (Natural England 2020) and The Heather and Grass etc. Burning (England) Regulations 2021, although blanket bog vegetation types can occur on shallower peat with 30 cm sometimes used to identify blanket bog and other related peatlands (e.g., Lindsay 2010, Crowle *et al*. in press).

[11] Although >10 cm is used to define shallow peat in soil mapping and one quadrat (Q549) on 15 cm peat was classed as wet heath based on habitat and vegetation types identified in 2013 and 2023.

to define heaths (e.g., for the UK BAP Upland heathland Priority Habitat, Maddock 2008), though most could be described as potentially restorable 'fragmented heath' (e.g., as in the Higher Level Stewardship [HLS] Farm Environment Plan [FEP] Manual, Natural England 2010b[12]). Two quadrat (Q347 and 348) positions classed as acid grassland in 2013 were relocated on moderately deep peat in 2023. This seemed most likely to reflect a relocation error, especially given that acid grassland on the site tends to occur in localised, often small patches. As such, it was decided in the field to resurvey them using the bogs and heaths, rather than acid grassland, form.

In most cases, actual values, or estimates thereof, were made for each attribute or variable rather than just noting whether a target had been met or not. In the 2013 survey, habitats were sampled in using evenly spaced quadrats on a structured walk across mapped areas of each habitat type within a unit, with a target of 20 quadrats per habitat. In practice, this resulted in a wide, albeit uneven distribution of samples across the unit, with some concentration particularly of dry heath and acid grassland samples towards central slopes of the Plym Valley and samples on the plateau and the central area of blanket bog and wet heath more widely distributed (Figure 1). Given the sampling approach used in 2013 (neither random or using a regular grid), it cannot necessarily be assumed that the samples are representative of the individual habitats or especially of the site unit as a whole. Nevertheless, the 73 samples provide reasonable sample sizes for each of the four habitat types assessed, ranging from 15 to 24 samples per habitat.

Some individual upland CSM attributes set several different, related targets (e.g., that outside of sensitive areas "… all growth phases of heather should occur throughout the area [and] at least 10% of the heather should be in the late-mature[/degenerate] growth phase" for dry heath). For such compound attributes, in most cases each target was assessed and recorded separately in 2023 (but often not in the 2013 baseline). In all cases, whether an attribute target was met or not was assessed from the raw data in spreadsheets post hoc, rather than in the field. Assessments were sometimes based on data from different variables in combination, e.g., by summing cover for individual indicator species to give total cover.

The upland CSM guidance recommends that the assessment of some attribute targets is done at two scales: in quadrats (quadrat scale) and for the area of the habitat feature visible from the sample point (visible feature scale). The latter can be difficult to assess accurately, especially percentage cover, being affected by topography and the ability to differentiate between bog, heath and grassland features sometimes over considerable distances. This can also result in some of the same areas being visible from more than one sample point and hence potential repeat counting of impacts. It should be noted that the upland CSM guidance was designed to be used at the site-feature scale, often covering much larger areas with less chance of overlap in areas visible from different sample points. The assessments at the wider, visible feature scale are likely to be more subjective, susceptible to observer error and less accurate and hence less reliable than data collected at quadrat scale. On the other hand, visible feature scale data may be more representative of the wider feature/site. Some attributes are assessed at both scales and in the 2023 resurvey some attributes previously only assessed at the visible feature were also assessed at the quadrat scale (to provide additional supporting data to aid interpretation). A range of additional, non-CSM variables (not included in 2013) were recorded, particularly to provide information on grazing pressure and impacts. As recommended in the upland CSM guidance for some attribute targets, in the 2023

[12] "Grassland with dwarf shrubs, including western gorse *Ulex gallii*, at least frequent but less than 25% cover (restorable to heath through reduced grazing [pressure])" (Natural England 2010b).

resurvey all assessments at the visible feature scale were also made whilst walking between sample points, which may have improved accuracy through enabling assessments at closer distances.

The survey dates (January in 2023 and February/March in 2013) are appropriate for assessing the impact of the current autumn and winter season's grazing pressure, though its effect is cumulative and continues into March/April (Glaves 2003, Nisbet 2004a,b). However, it may not be ideal for assessing some indicator species which may show little growth or have become senescent and difficult to identify or even see. The CSM guidance recommends survey periods by habitats: blanket bog between May and September (but still possible the rest of the year); wet heath between April and June (but still possible the rest of the year); dry heath March to May (but still possible in June and in January and February); and acid grassland May to September (JNCC 2009b). Thus, the timing of the survey could have resulted in some under-recording of some indicator species, especially in acid grassland, though this will not have affected overall condition or likely the pass rate for most, if any, individual attribute targets.

Determination of habitat condition

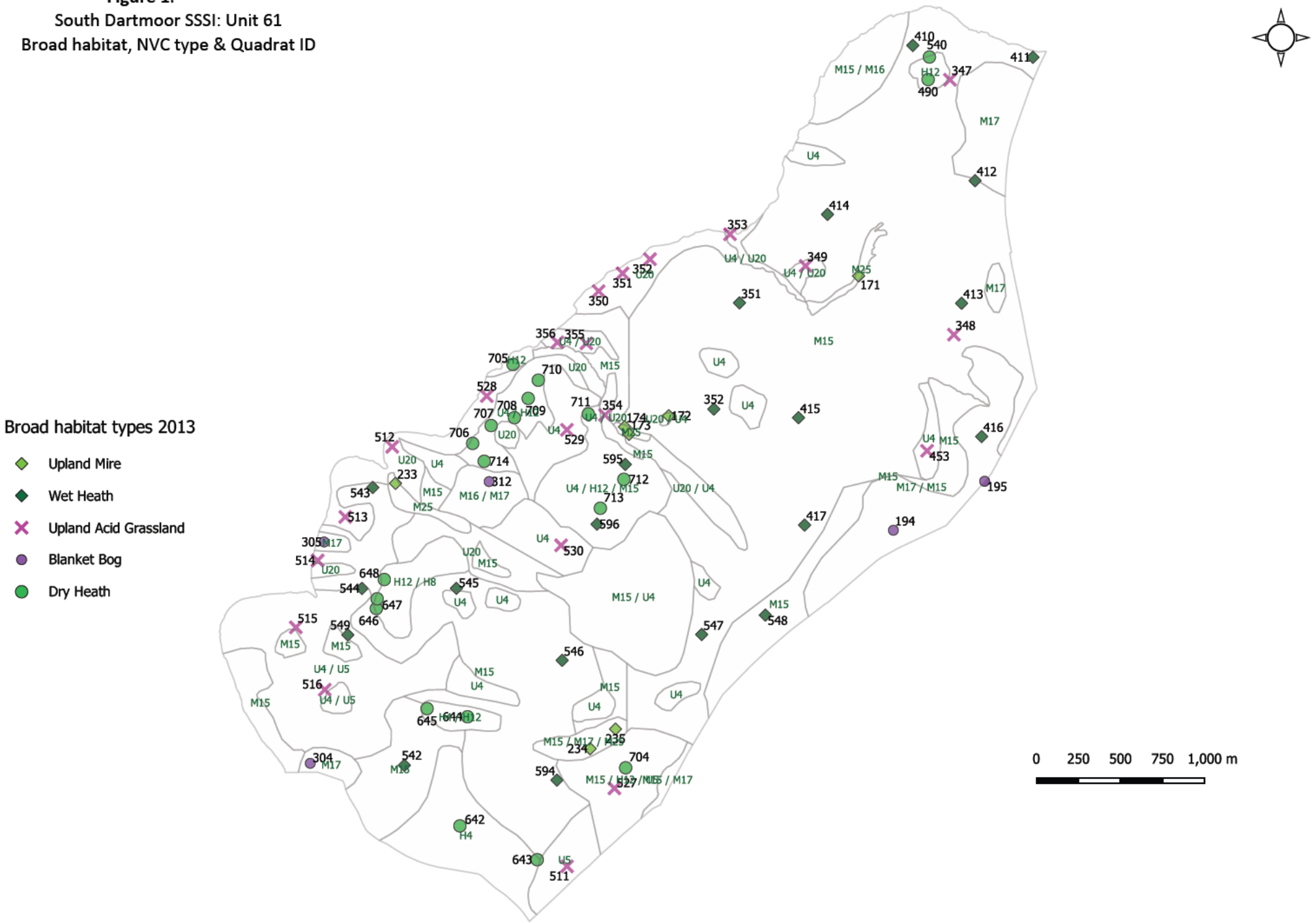
Current condition was assessed based on the habitat feature that samples were classed as in the 2023 resurvey (rather than what they were classed as in 2013). In most cases they were the same, though a much greater number of quadrats were classed as blanket bog in 2023 (24 all on peat >40 cm) than in 2013 (only 5). The difference may reflect changes in vegetation composition and/or in habitat definitions, and how they are interpreted over time (with greater emphasis placed on peat depth in 2023). The focus of this report on current condition based on the current habitat classification. To enable a valid comparison, in a separate assessment of change between the two surveys, the 2023 samples were assessed as the habitat types they were classed as in 2013 (Glaves 2023).

In upland CSM assessments, attribute targets are applied to individual samples and the determination of the condition category for a habitat feature is based on the percentage of samples passing all attribute targets. This follows the JNCC CSM model (Brown 2000) but differs from the approach adopted for some other terrestrial habitats where the assessment is based on whether attribute targets are met on average (e.g., lowland heathland, Alonso *et al*. 2003, JNCC 2009a). The threshold for favourable condition is 90% of samples (and hence of the feature) passing (JNCC 2009b, Section 4, p 20). Data are also presented in this report on the percentage pass rate for individual attribute targets for each habitat relative to the 90% threshold for favourable condition. For attribute targets assessed at both scales, the targets need to be passed at both quadrat and visible feature scales for the sample point/area to pass. In addition, for most attribute targets where values were measured or estimated, mean, median and other summary statistics are given in tables and figures to provide information on the spread of values and indicate how close samples are to meeting targets. They also facilitate comparisons between habitats, and over time since the 2013 survey which is reported separately (Glaves 2023).

In a few cases, the Favourable Condition Table (FCT) [13] for South Dartmoor SSSI (Natural England 2015c) includes tailored or new attribute targets, which differ from the generic upland CSM guidance. In these cases, data are presented based on both the CSM and FCT attribute targets.

[13] Now referred to as the Monitoring Specification, which tailors generic CSM attributes and targets to a site.

Figure 1.
South Dartmoor SSSI: Unit 61
Broad habitat, NVC type & Quadrat ID



Results

Overall condition and the number and percentage of samples passing all and individual attribute targets by habitat

No samples from any of the four habitats surveyed within the unit passed all the attribute targets assessed (Figure 2 and Table 1). Thus, given that the upland CSM threshold for favourable condition is that 90% of all samples (and hence of the feature) should pass all attribute targets, all four habitats assessed in the unit are clearly in unfavourable condition.

This concurs with the 'unfavourable declining' condition currently reported by Natural England. This assessment in part reflects the fact that the HLS agreement ended in June 2021, supported by evidence of declines in relation to some condition attribute targets from a 'rapid site check' of the unit carried out by Natural England in October 2020 (Gillett 2020) and a slightly earlier, similar assessment for the Commoners Association by FWAG in December 2019, and February and May 2020 (Johnson 2020). Condition was previously classed as unfavourable recovering based on past ESA and HLS agri-environment agreements being in place as mechanisms to restore habitat condition rather than on evidence of recovery. Prior to entering ESA agreement in 2001, the site was classed as being in unfavourable declining condition. There are indications from the present survey of an ongoing deterioration in habitat condition (e.g., from current/recent direct grazing impacts summarised in Table 10) which has been further investigated and confirmed in a separate, concurrent analysis comparing the results with those from the 2013 baseline survey (Glaves 2023).

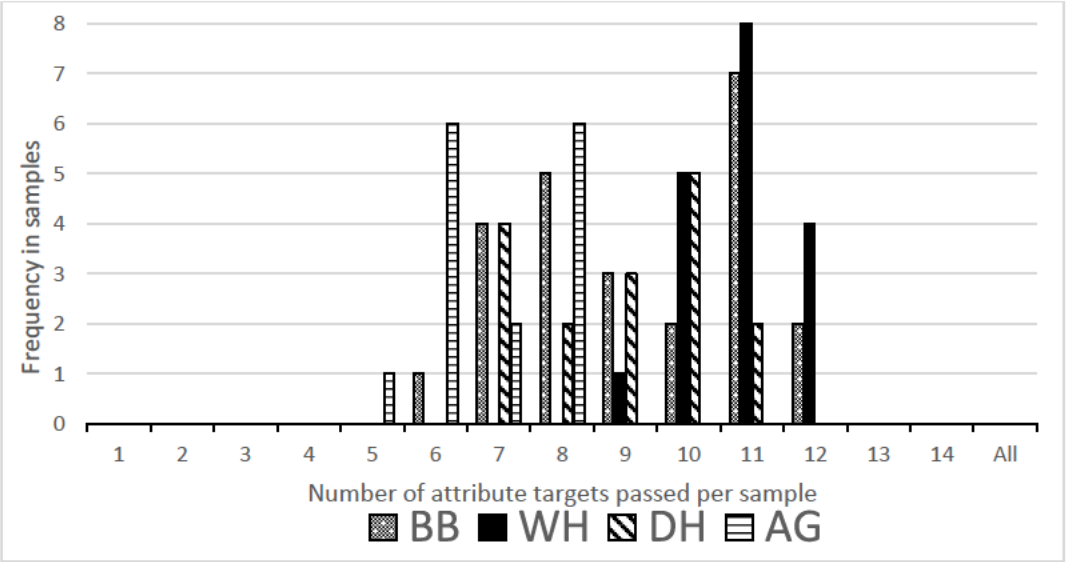


Figure 2. The number of upland CSM attribute targets passed per sample for each habitat in Unit 61 of South Dartmoor SSSI. BB = blanket bog (24 samples and 13 attribute targets assessed), WH = wet heath (18 samples and 15 attribute targets assessed), DH = dry heath (16 samples and 14 attribute targets assessed) and AG = acid grassland (15 samples and 10 attribute targets assessed). A colour version of the figure is given in Appendix 2

At least five attribute targets were met in all samples across the four habitats but no more than 12 in any samples and hence, as noted above, no samples passed all targets in any habitats (Figure 2). There was a tendency for more wet heath samples to pass a higher number of attribute targets, followed by blanket bog and dry heath, with acid grassland tending to have fewest attribute targets passed (Figure 2), though it should be noted that the number of targets assessed and, samples

taken, varied between the four habitats with, for example, fewer attribute targets and samples for acid grassland, and most samples for blanket bog (Table 1 and caption for Figure 2).

In a few cases, some individual CSM attribute targets could not be assessed at all or in some samples. The former involved the percentage of pioneer growth stage heather shoots browsed due to an absence of pioneer heather recorded in quadrats (in part reflecting the moderate frequency [41%] and very low cover [mean 0.9%] of heather in large, 2 m × 2 m, quadrats, i.e., the target was not applicable). A further three attribute targets were not recorded in some sample quadrats due to an absence of the species/groups they related to: percentage of non-pioneer heather shoots browsed (in 28 bog/heath and all acid grassland samples), percentage of *Sphagnum* spp. crushed, broken or pulled-up (in 24 bog/wet heath samples) and percentage of dwarf shrub cover of group (i) and group (ii) species[14] (in four dry heath samples). In addition, some visible feature-scale attribute targets could not easily be assessed for the area of the feature visible from the sample point and/or walking to the next point, or off-site, when the habitat(s) were localised and/or not easily visible, and were not recorded for two samples.

Bearing in mind the above mentioned provisos regarding differences in the number of attribute targets recorded per sample, the mean number and percentage of attribute targets passed per sample was nevertheless relatively similar across the four habitats with a range of 7–11 targets representing a mean 71–80% of targets assessed per habitat (Table 1). The mean percentage pass rate per sample was highest for blanket bog followed by wet heath. As mentioned previously, this compares with the threshold requiring 90% of samples to pass all attribute targets for a feature to be classed as in favourable condition which was not met in any of the 73 samples across the four habitats (Table 1).

Table 1. The mean number of upland CSM attribute targets assessed per sample and the mean number and percentage of attribute targets passed per sample by habitat.

Summary statistic	Blanket bog	Wet heath	Dry heath	Acid grassland
Number of samples	24	18	16	15
Mean no. of attribute targets assessed per sample	12	15	13	10
Mean no. of targets passed per sample	9	11	9	7
Mean % of targets passed per sample	80%	75%	71%	72%
Number of samples passing all attribute targets	0	0	0	0

In addition to considering whether all attribute targets are met in each sample (which is the basis of the assessment of condition of habitat features), the proportion of samples meeting individual attribute targets across each habitat (summarised in Table 2) provides additional information on the reasons for unfavourable condition in terms of particular attributes and targets failing, and in some cases likely causes/drivers, e.g., from those that indicate direct impacts such as grazing/browsing or burning. The number and percentage of individual attribute targets passed across samples (based on the target being met in at least 90% of samples) was relatively similar across the four habitats with a range of 7–9 targets met representing 50–69% of those assessed (Table 2). The pass rate across samples was again highest for blanket bog (69%) and in this case lowest for dry heath (50%).

[14] Group (i) comprises ericaceous spp. including bilberry *Vaccinium* spp.; western gorse *Ulex gallii* was the only group (ii) species recorded in the survey.

Table 2. The number of upland CSM attribute targets assessed across each habitat (not all necessarily in all samples) and number and percentage of attribute targets passed across samples within each of the four habitats. Targets being passed is based on whether the attribute target is met in at least 90% of samples.

Summary statistic	Blanket bog	Wet heath	Dry heath	Acid grassland
No. of attribute targets assessed across samples	13	15	14	10
No. of attribute targets passed across samples	9	9	7	6
% of attribute targets passed across samples	69%	60%	50%	60%

The following results sections present summary data on percentage pass rates across samples for individual attribute targets separately for each habitat, with boxplots summarising the spread of values for attribute targets or part targets (for compound attributes) where values were measured or estimated and were greater than one percent. Summary statistics are also presented on mean and median values and range for measured/estimated attribute targets (Table 3–Table 6) and other summary statistics are given as boxplots which together provide information on the spread of values and indicate how close samples are to meeting targets. They also facilitate comparisons between habitats. In addition, data are presented on frequency and cover of indicator and other species within, and across habitats (Table 7), and on additional, mostly grazing-related, variables across habitats (Table 10).

Similar types of attributes tended to be failed across habitats, particularly for blanket bog, and wet and dry heath: too low positive indicator species cover (BB, WH and DH); too high percentage of heather shoots browsed (BB, WH and DH); too low positive indicator frequency (BB, WH, DH and AG[15], last marginal); and too high cover of some negative indicators or bracken *Pteridium aquilinum* (hereafter bracken) (BB, WH, DH and AG). Some other individual attribute targets were failed in single habitats: too high cover of graminoids[16] (WH); not all heather growth stages present and too high percentage of dwarf shrub cover *Ulex gallii* (DH, marginal); and too low percentage forb[17] cover, low structural diversity (too-little, tall c.f. short vegetation) and too high litter cover (AG).

In addition to the percentage of samples passing or failing attribute targets, for those targets measured or estimated the actual values recorded provide additional information on how close the sampled vegetation is to passing attribute targets and enable comparison between habitats. Those for dwarf shrub shoots grazed (BB, WH, DH, also see Figure 16 b), positive indicator cover (BB, WH, DH), cover of negative indicators (*Agrostis capillaris*, *Holcus lanatus*, *Ranunculus repens*, probably most the first) (WH), forb cover (AG), bracken (as part of scrub/bracken) cover (AG) and litter cover (AG) were failed by a considerable margin.

Blanket bog

Data were collected from 24 blanket bog samples in 2023 on peat >40 cm deep, most (20) >50 cm and nearly half (11) over 1 m. All were classed as NVC communities M15 *Trichophorum germanicum* [*Scirpus cespitosus*]-*Erica tetralix* wet heath[18] (7), M17 *Trichophorum germanicum-Eriophorum vaginatum* blanket mire (14) (Rodwell 1991) or intermediate between them (3) in 2023. Though

[15] Not an upland CSM attribute target for acid grassland but included in the South Dartmoor FCT (Natural England 2015b).
[16] A grass, sedge or rush.
[17] An herbaceous flowering plant that is not woody or a 'graminoid' (grass, sedge or rush).
[18] NVC community names are given at first mention in the text.

referred to as wet heath, M15 straddles the boundary between shallow and deep peat on the site and more generally, and when on deep peat was treated as modified blanket bog as recommended in the CSM guidance (JNCC 2009, p 44) and as described by Averis *et al*. (2004). The M17 samples tended to occur on deeper peat on or towards the plateau to the north and north-east and to be less modified with greater frequency and cover of typical blanket mire species including *Eriophorum vaginatum* (and *angustifolium*), *Narthecium ossifragum* and *Sphagnum* spp. (8 species) than in M15 samples on the upper slopes (e.g., Figure 14 c, d, comparing blanket bog [mostly M17] with wet heath [mostly M15], though M15 occurs in both the blanket bog and wet heath quadrats).

The number and percentage of blanket bog samples passing each of the 13 blanket bog attribute targets[19] recorded are summarised in Figure 3 and Table 3 and for those where actual values were measured or estimated, mean, median and range in the latter table, and as a boxplot in Figure 4. Percentage frequency and mean percentage cover of CSM blanket bog positive indicators are given in Figure 5. Comparison of cover of selected species occurring across several or all habitats is also given as boxplots in Figure 13 and Figure 15, and for all species/groups recorded by habitat in Table 7.

Nine of the blanket bog attribute targets were met in ≥90% of samples with the remaining four not passing this threshold (Figure 3). Cover of negative indicators (only *Agrostis capillaris*, *Holcus lanatus, Ranunculus repens* and bracken were present, target <1%) was met at the quadrat scale (92% passing) but not at the visible feature scale (67%, mean 3.5% cover Table 3), hence, not at both scales combined[20] (58%). Cover of bracken and the other (grass/forb) species (which were assessed separately) both contributed to exceeding the target at the visible feature scale.

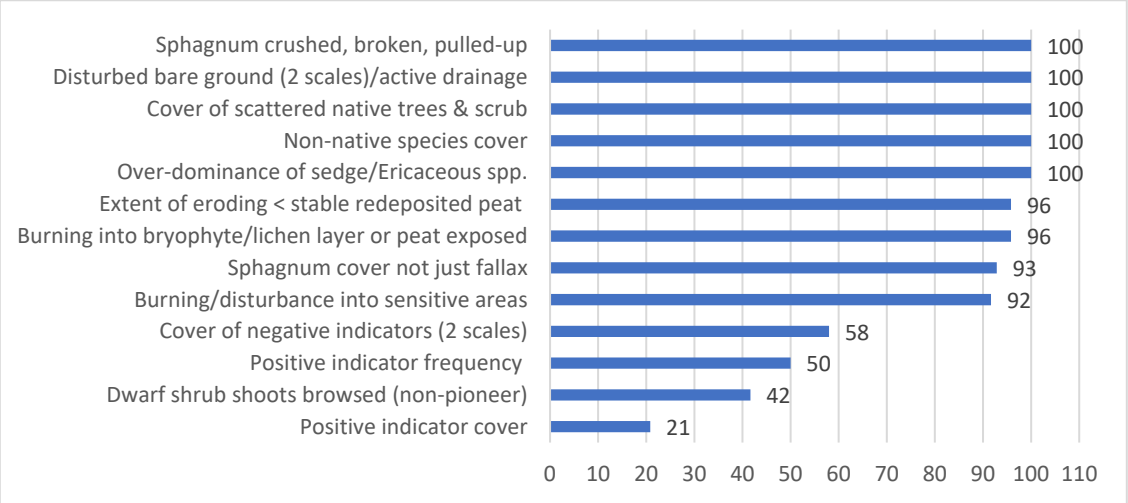


Figure 3. Percentage pass rates for individual CSM attribute targets for blanket bog samples (n = 24) ranked by pass rate. (The upland CSM threshold for favourable condition is 90% of samples passing targets.)

Three other attribute targets were not met at the quadrat scale: positive indicator frequency (the number of positive indicators/sample, ≥6 spp.) was passed in 50% of samples (though the mean was

[19] One, the percentage of heather shoots browsed on pioneer phase plants, could not be assessed as no pioneer heather was recorded in quadrats across all habitats.

[20] The upland CSM requirement for attribute targets assessed at two scales is that the target is met at both scales associated with a sample/area to pass, i.e., at the quadrat and the area of the habitat visible from it and, in this survey (and for some attribute targets in CSM), whilst walking to the next sample.

close to target at 5.8, Table 3) and this increased to 79% for the lower target in the South Dartmoor FCT (≥4 spp.); non-pioneer dwarf shrub (all heather) shoots browsed (<33%) was passed in 42% of samples, though this increased slightly for the higher FCT target (<50%); and positive indicator species cover (≥50% of at least 3 spp.) was only passed in 21% of samples, mainly reflecting a failure to meet 50% cover (only met in 4 samples, mean 28%, Table 3) rather than the number of species contributing to cover. Of the attribute targets failed where values were measured or estimated, those for positive indicator cover and dwarf shrub shoots grazed were failed by a considerable margin (Table 3 and Figure 4).

Table 3. Summary of the number and percentage of blanket bog samples passing individual CSM attribute targets and whether the overall 90% CSM pass threshold is passed (P) (indicated by grey shading) or failed (F), ranked in order of percentage passing at one or both scales (n = 24). (Where assessed at two scales, quadrat scale is the upper figure, and each part of compound attributes are also given separately. Q= quadrat scale, F = visible feature scale.)

Attribute (scale)	Target	n	No. passing	% passing	Pass/ fail	Mean %	Median %	% Range
Positive indicator spp. cover (Q)	>50% 3+ spp.	24	5	21	F	28 5.8	21% 5.5	1–88 1–10
Dwarf shrub shoots browsed (non-pioneer)[1] (Q)	<33%	12[1]	5	42	F	60	48	0–90
Positive indicator spp. frequency (Q)	6 spp.[2]	24	12	50	F	5.8	5.5	1–10
Cover of negative indicators (Q, F)	<1%	24	14	58	F	2.0 3.5	0 3.5	0–45 0–20
Burning/disturbance into sensitive areas (F)	No	24	22	92	P			
Sphagnum cover not just *fallax* (Q)	No	14[3]	13	93	P			
Burning into bryophyte/lichen layer or peat exposed (F)	No	24	23	96	P			
Extent of eroding < stable redeposited peat	Yes	24	23	96	P			
'Over-dominance' of *Eriophorum vaginatum*, ericaceous spp. or *Trichophorum* (Q)	≤75%	24	24	100	P	10 2.1 1.9	2.0 1.0 0	0–50 0–16 0–30
Non-native species cover (F)	<1%	24	24	100	P	0	0	
Cover of scattered native trees & scrub (F)	<10%	24	24	100	P	0	0	
Disturbed bare ground (Q, F)/active drainage (F)	<10%	24	24	100	P	0.02 0.3	0 0	0–0.5 0–2.0
Sphagnum crushed, broken, pulled-up (Q)	<10%	14[3]	14	100	P	0	0	

[1] Only assessed for heather *Calluna vulgaris* where present (12 samples). Higher attribute target (<50% shoots browsed) in S Dartmoor SSSI FCT made little difference with 6 samples passing (50%). Corresponding attribute for pioneer heather not assessed as no pioneer heather was recorded in samples.

[2] Lower target (4 spp.) in South Dartmoor SSSI FCT still resulted in failure of attribute target with 19 samples passing (79%) c.f. 50% CSM target (6 spp.).

[3] Based only on samples where *Sphagnum* was present (14).

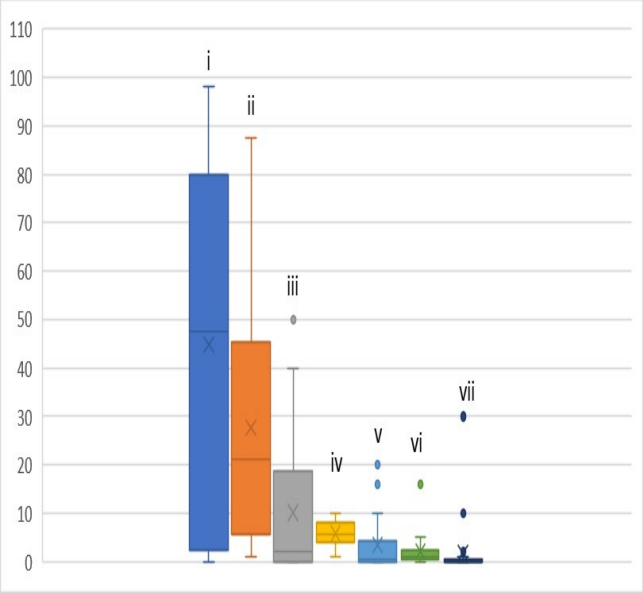


Figure 4. Boxplot summarising the spread of values (% unless indicated otherwise) for blanket bog attribute targets or part (pt.) targets (for compound attributes) where values were measured or estimated and were ≥1%, ranked by mean (n = 24 samples): non-pioneer heather shoots grazed (i, blue, CSM target <33%, FCT <50%); indicator cover (ii, orange, ≥50%, pt.); *Eriophorum vaginatum* cover (iii, grey, ≤75%, pt.); no. of indicators (iv, gold, 6 spp. per sample, FCT 4 spp.); negative indicator cover (F) (v, pale blue, <1%); ericaceous spp. cover (vi, green, ≤75%, pt.); and *Trichophorum germanicum* cover (vii, dark blue, ≤75%, pt.). Plots show upper and lower quartiles (boxes), maximum and minimum values (whiskers), median (line), mean (×), and any outliers (circles). F = visible feature scale.

Of the 14 blanket bog CSM positive indicator species/groups that occur in South Dartmoor SSSI, 11 were recorded within at least one 2 m × 2 m quadrat (Figure 5), with those absent *Drosera* spp., *Empetrum nigrum* and *Rhynchospora alba*. Pleurocarpous mosses were the most frequent (79%), followed by *Eriophorum vaginatum* (67%), and *Sphagnum* spp. and *Erica* spp. (all *tetralix*) (both 58%). Only *Eriophorum vaginatum* (10%) and pleurocarpous mosses (6%) occurred at over 5% mean cover. Although *Sphagnum* spp. frequency was relatively high, cover was low (mean 1%), though eight species were recorded with *S. capillifolium* most frequent (38%) followed by *tenellum*, (33%), and *fallax* and *papillosum* (≥25%) (Table 7).

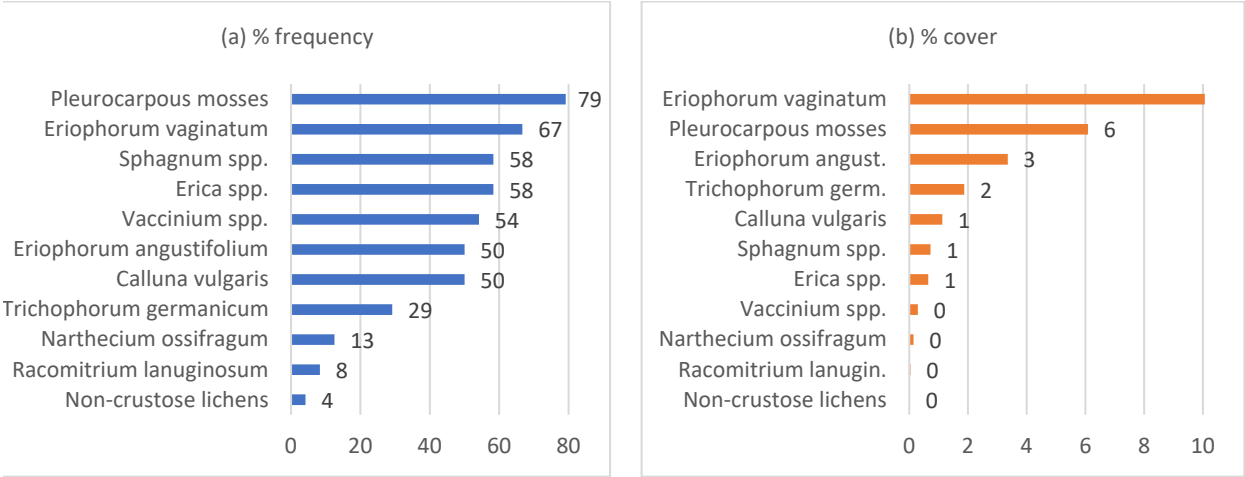


Figure 5. (a) Percentage frequency and (b) mean percentage cover of CSM blanket bog positive indicators in blanket bog samples (n = 24).

Of the other (not positive indicator) species/groups recorded in blanket bog quadrats, purple moor-grass *Molinia caerulea* (hereafter *Molinia*) was the most frequent along with graminoids as a group (both 100%) followed by ericoids as a group (88%) and *Carex* spp. (46%). *Molinia* also had the second highest mean cover (67%) after graminoids as a group (85%, including *Molinia*), with no other species/group >10% (Table 7).

Dominance or 'over-dominance' of *Molinia* is generally considered an issue that can contribute to unfavourable condition of blanket bog, wet heath and some other habitats (e.g., Anderson *et al*. 2006, Glaves 2016). The upland CSM guidance for wet heath has a broader part attribute target of ≤75% cover of graminoids (and dwarf shrubs as a second part) which does, therefore, include *Molinia* through its contribution to graminoid cover (c.f. ≤75% for the similar attribute target for blanket bog for *Eriophorum* spp., *Trichophorum* and ericaceous spp.). Glaves *et al*. (2005) suggested that consideration should be given to adding *Molinia* to the corresponding attribute target for blanket bog. This might be particularly appropriate in areas where over-dominance of *Molina* is considered an issue, which include Dartmoor, Exmoor and the South Pennines (Glaves 2016), and Bodmin Moor (Stewart 2002, Leppitt 2013). If *Molinia* was added to the similar blanket bog target (≤75%), this would result in a revised attribute target being failed for blanket bog at this site with only 63% of samples passing (reflecting the high mean cover of 67%, Table 7 and Figure 15 b) relative to *Eriophorum* spp., *Trichophorum* and ericaceous spp. all with ≤75% cover in all samples. This compares with only one sample (6%) with >75% cover of *Molinia* in wet heath which is also reflected in lower mean cover (27%, Table 7 and Figure 14 b). However, despite the high cover of *Molinia*, a variety of positive indicators still occur in blanket bog samples including heather, *Erica tetralix* and *Vaccinium* spp. (Figure 5).

Wet heath

Data were collected from 18 upland wet heath samples in 2023 on peat 20–39 cm deep. Most (10) were classed as NVC community type M15, or single quadrats transitional between M15 and either M16 *Erica tetralix-Sphagnum compactum* wet heath or H12 *Calluna vulgaris-Vaccinium myrtillus* heath. Three were classed as U20 *Pteridium aquilinum-Gallium saxatile* community (all on 20–23 cm peat), and single quadrats as H12 and H4 *Ulex gallii-Agrostis curtisii* heath (which grades into intermediate 'humid heath') in 2023. In addition, one quadrat on 16 cm deep peat classed as M15/17 in 2013 (and M15/H12 in 2023) was also included as wet heath based on vegetation composition. It should be noted that vegetation on shallower peat down to 10 cm is often treated as wet heath, though with the one exception above, all other quadrats on 10–19 cm peat were classed as dry heath or acid grassland based on vegetation composition. The wet heath samples tended to occur on shallower peat on the slopes below the blanket bog on the plateau and upper slopes.

The number and percentage of samples passing the 15 wet heath attribute targets recorded[21] are summarised in Figure 6 and Table 4 and for those where actual values were measured or estimated, mean, median and range in the latter table, and as a boxplot (Figure 7). Percentage frequency and mean percentage cover of CSM wet heath positive indicators are given in Figure 8. Comparison of cover of selected species/groups occurring across several or all habitats is also given as boxplots (Figure 13 and Figure 15), and for all species/groups recorded by habitat (Table 7).

Nine of the wet heath attribute targets were met in ≥90% of samples with the remaining six not passing this threshold (Figure 6). Cover of negative indicators (only *Agrostis capillaris*, *Holcus lanatus*

[21] One attribute target, that for the percentage of pioneer *Calluna* shoots browsed, could not be assessed as no pioneer stage plants were found in wet heath quadrats or those in other habitats.

and *Ranunculus repens* were present, target <1%) was not met at either the quadrat (61% passing, mean cover 16%) or visible feature scales (39%, 14%) (Table 4 and Figure 7) nor at both scales combined (33%). Four attribute targets were not met at the quadrat scale: cover of positive indicators/dwarf shrubs two part-target (≥50%/≥20%) were not both met in any samples (and means were well below target, 21%/0.9%); non-pioneer dwarf shrub (all heather) shoots browsed (<33%) was met in only 8% of samples with heather present, with the higher FCT target (<50%) making no difference; *Erica tetralix* within a 20 m radius was met in 33% of samples and was only slightly less frequent at the quadrat scale (28%) which could indicate some, perhaps inevitable, under-recording at the larger scale (as frequency is a scale-dependant variable); and the upper cover of dwarf shrubs or graminoids (≤75%) was met in 78% of samples (Table 4 and Figure 7). The cover of bracken attribute target (<10%) was passed in 61% of samples. Of the attribute targets failed where values were measured or estimated, those for positive indicator cover, dwarf shrub shoots grazed and cover of negative indicators were failed by a considerable margin (Table 4 and Figure 7).

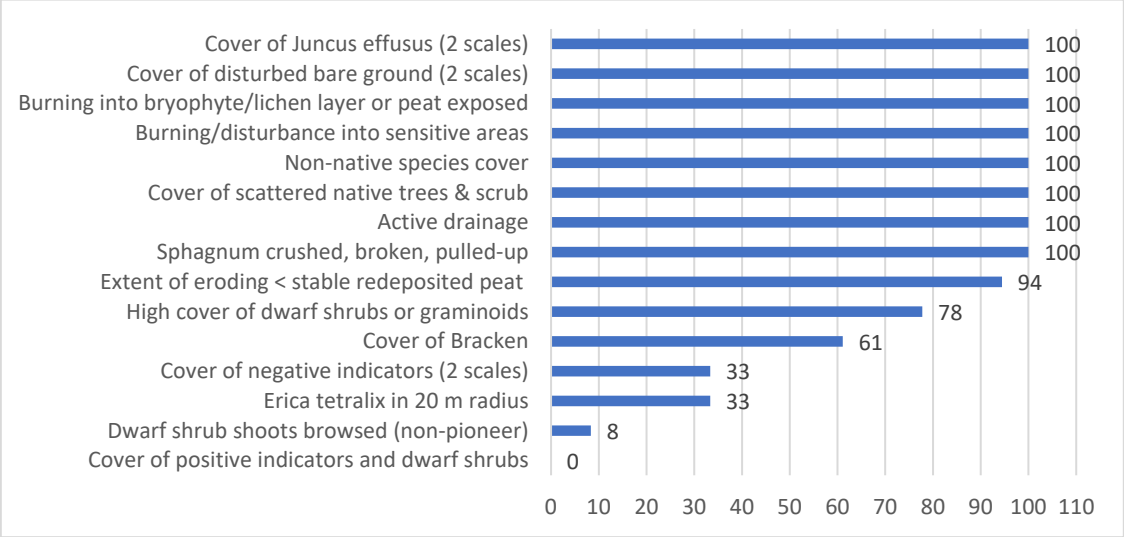


Figure 6. Percentage pass rates for individual CSM attribute targets for upland wet heath samples (n = 18). (The upland CSM threshold for favourable condition is 90% of samples passing targets.)

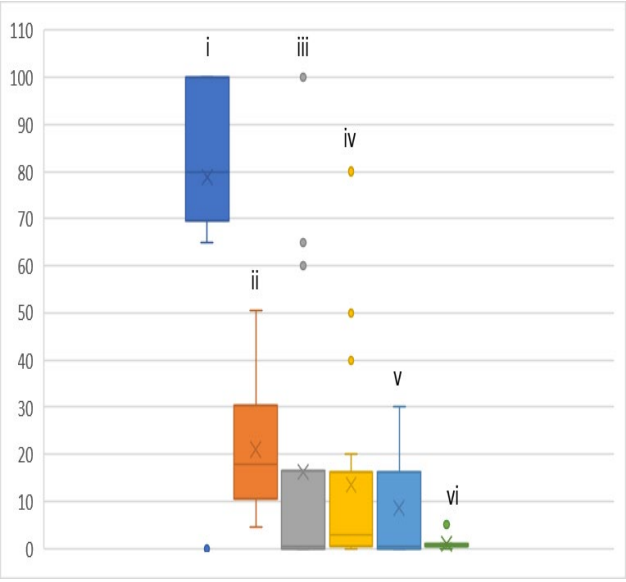


Figure 7. Boxplot summarising the spread of values (% unless indicated otherwise) for wet heath attribute targets or part (pt.) targets (for compound attributes) where values were measured or estimated and were ≥1%, ranked by mean (n = 18 samples): non-pioneer heather shoots grazed (Q) (i, blue, CSM target <33%, FCT <50%); positive indicator cover (Q) (ii, orange, >50%, pt.); negative indicator cover (Q) (iii, grey, <1%, pt.); negative indicator cover (F) (iv, gold, <1%, pt.); bracken cover (F) (v, pale blue, <10%, pt.); and *Juncus effusus* cover (F) (vi, green, <10%, pt.). See Figure 4 caption for explanation of box and whisker plot layout and symbols. Q = quadrat-scale; F = visible feature-scale.

Table 4. Summary of the number and percentage of samples passing individual CSM attribute targets for upland wet heath and whether the overall 90% CSM pass threshold is passed (P) (indicated by grey shading) or failed (F), ranked in order of percentage passing at one or both scales (n = 18). (Where assessed at two scales, quadrat scale is upper figure and multiple part-targets are also given separately. Q= quadrat scale, F = visible feature scale.)

Attribute (scale)	Target	n samples	No. samples passing	% samples passing	Pass/ fail	Mean %	Median %	% Range
Cover of positive indicators/dwarf shrubs (Q)	≥50%/ ≥20%[1]	18	0	0	F	21 0.9	18 1	5–51 0–2.5
Dwarf shrub shoots browsed (non-pioneer)[2] (Q)	<33%	12	1	8	F	79	80	0–100
Erica tetralix in 20 m radius (Q)	Yes	18	6	33	F			
Cover of negative indicators (Q, F)[3]	<1%	18	6	33	F	16 14	0.5 3	0–100 0–80
Cover of Bracken (F)	<10%	18	11	61	F	9	1	0–30
High cover of dwarf shrubs or graminoids (Q)	≤75%	18	14	78	F	1 47	1 55	0–2.5 0–100
Extent of eroding < stable redeposited peat (F)	Yes	18	17	94	P			
Sphagnum crushed, broken, pulled-up (Q)	<10%	18	18	100	P	0	0	
Active drainage (F)	<10%, No	18	18	100	P			
Cover of scattered native trees & scrub[4] (F)	<20%	18	18	100	P	0	0	
Non-native species cover (F)	<1%	18	18	100	P	0	0	
Burning/disturbance into sensitive areas (F)	No	18	18	100	P			
Burning into bryophyte/lichen layer or peat exposed (F)	No	18	18	100	P			
Cover of disturbed bare ground (Q, F)	<10%	18	18	100	P	0.06 0.1	0 0	0–1 0–1
Cover of *Juncus effusus* (Q, F)	<10%	18	18	100	P	0.06 1.1	0 0.5	0–1.0 0–5

[1] ≥50% of vegetation cover consisting of positive indicators from CSM Table 1 (JNCC 2009b) and /≥20% ericoid spp. [2] Only assessed for heather *Calluna vulgaris* where present (12 samples). Higher attribute target (<50% shoots browsed) in S Dartmoor SSSI FCT made no difference with still only 1 sample passing (8%). Corresponding attribute for pioneer heather not assessed as no pioneer heather was recorded in samples. [3] Excluded from S Dartmoor SSSI FCT. [4] Lower target in S Dartmoor SSSI FCT (<10%) made no difference with 100% still passing. [5] Assessed at visible feature scale in CSM and in results given but also recorded at quadrat scale in survey.

Of the 14 upland CSM wet heath positive indicator species/groups that occur in South Dartmoor SSSI, nine were recorded within at least one 2 m × 2 m quadrat (Figure 8), with those absent being *Drosera* spp., *Empetrum nigrum*, *Narthecium ossifragum*, *Racomitrium lanuginosum* and *Rhynchospora alba*. Pleurocarpous mosses were the most frequent (100%), followed by *Carex* spp. and *Vaccinium* spp. (both 72%), and *Calluna* (61%). No other species exceeded 30% frequency, although *Erica* spp. (all *tetralix*) occurred at 28%. Only pleurocarpous mosses (13%) and *Carex* spp. (4.03%) occurred at over 4% mean cover. *Sphagnum* spp. frequency (22%) was lower than in blanket bog (58%) and cover was also lower (mean only 0.1% c.f. 0.7% in blanket bog) (Figure 14 c).

Nevertheless, five *Sphagnum* species were recorded (though less than the 8 in blanket bog) with *S. tenellum* most frequent (33%), followed by *fallax* and *palustre* (both 22%) (Table 7 and Table 8).

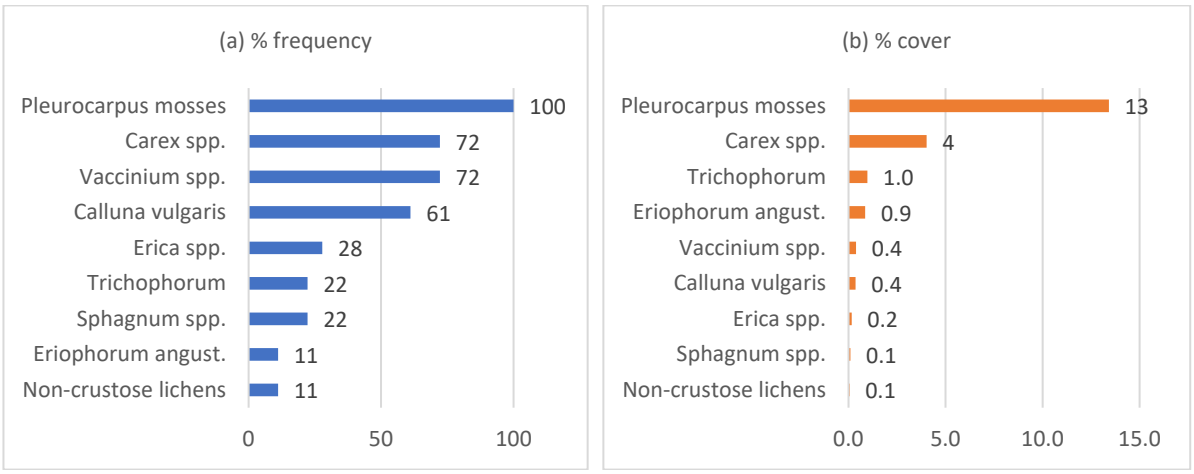


Figure 8. (a) Percentage frequency and (b) mean percentage cover of CSM upland wet heath positive indicators in wet heath samples (n = 18).

Of the other (not positive indicator) species/groups recorded in wet heath samples, graminoids and forbs as groups were the most frequent within the 2 m × 2 m quadrats (both 100%) followed by *Molinia* and *Rhytidiadelphus squarrosus* (both 78%), and *Juncus squarrosus* (33%) (Table 7). *Eriophorum vaginatum* was only recorded in 11% of quadrats, much lower than in blanket bog (67%) as might be expected in view of wet heath's generally greater degree of modification. In terms of cover, graminoids as a group had the highest mean cover (78%) with, perhaps surprisingly, *Molinia* only accounting for 27% of this (much lower cover than in blanket bog where the mean was 67%, Figure 12 b, and only one sample exceeded 75% cover c.f. 9 in blanket bog) with other mire/wetland species (*Carex* spp., *Eriophorum* spp., *Juncus* spp. and *Trichophorum*) only a further 8% cover. This might reflect an artefact of the influence of peat depth on the habitat classification, with a proportion of blanket bog samples on deep peat modified M15 with abundant *Molinia*, and a proportion of wet heath samples on shallow peat severely modified, grass-dominated vegetation resembling fragmented dry heath and acid grassland/bracken with low cover of mire/wetland species. None of the other species recorded occurred at greater than 2% cover.

Dry heath

Data were collected from 16 upland dry heath samples on shallow peat <20 cm deep or mineral soil, all but one classed as dry heath in 2013 and all in 2023. All but one was classed as NVC community types H4 or H12 in both years (and all, 6 and 10, respectively, in 2023), albeit in modified form with low cover and even frequency of dwarf shrubs in 2023. As such, they are probably best regarded as restorable 'fragmented heath'. The dry heath quadrats tended to occur in relatively small patches in the side valleys running west or in the Plym Valley which they run into (Figure 1).

The results in terms of the number and percentage of samples passing the 14 dry heath attribute targets recorded[22] is summarised in Figure 9 and Table 5 and for those where actual values were measured or estimated, mean, median and range in the latter table, and as a boxplot in Figure 10. Percentage frequency and mean percentage cover of CSM dry heath positive indicators are given in

[22] Two dry heath attribute targets were not assessed: the percentage of pioneer *Calluna* shoots browsed, could not be assessed as no pioneer stage plants were found in wet heath quadrats or those in other habitats; and indicator spp. cover for H7, H10d and H16a which do not occur on Dartmoor.

Figure 11. Comparison of cover of selected species/groups occurring across several or all habitats is also given as boxplots in Figure 13 and Figure 14, and for all species/groups recorded by habitat in Table 7.

Seven of the attribute targets were met in ≥90% of dry heath samples with the remaining seven not passing this threshold (Figure 9). Five attribute targets were not met at the quadrat scale: all heather growth stages present (0%); indicator species cover ≥50% (13%); non-pioneer heather shoots browsed <33% (17%); frequency of ('group i'. mostly ericaceous spp.) indicator species (25%); percentage of dwarf shrub cover from 'group ii' species (only *Ulex gallii* in this case) (83%); and percentage of dwarf shrub cover of dwarf shrubs from group I (83%). Two attribute targets were not met at the visible feature scale: all heather growth stages present (0%); and cover of bracken (60%). Of the attribute targets failed where values were measured or estimated, those for positive indicator cover and dwarf shrub shoots grazed were failed by a considerable margin (Table 5 and Figure 10).

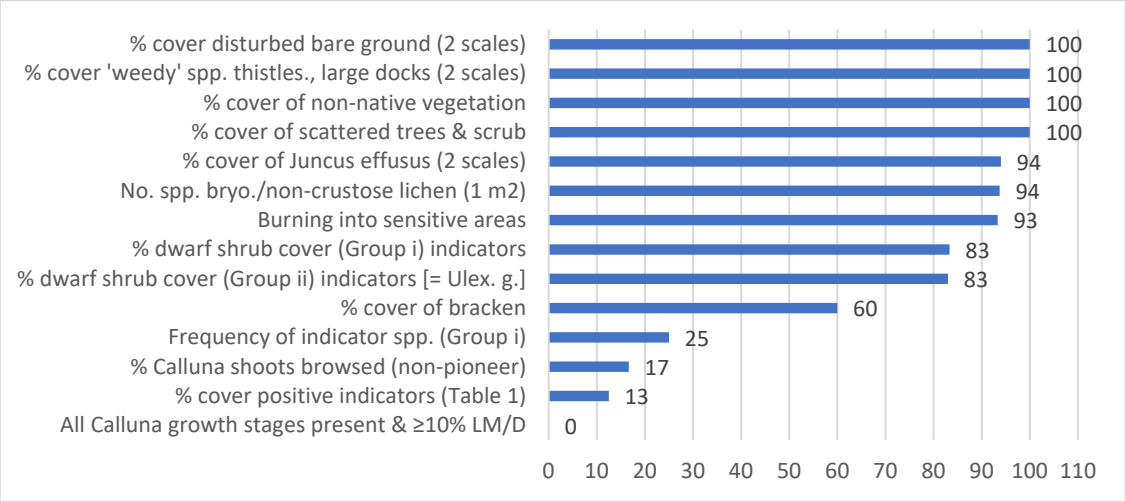


Figure 9. Percentage pass rates for individual CSM attribute targets for upland dry heath samples (n = 16). (The upland CSM threshold for favourable condition is 90% of samples passing targets.)

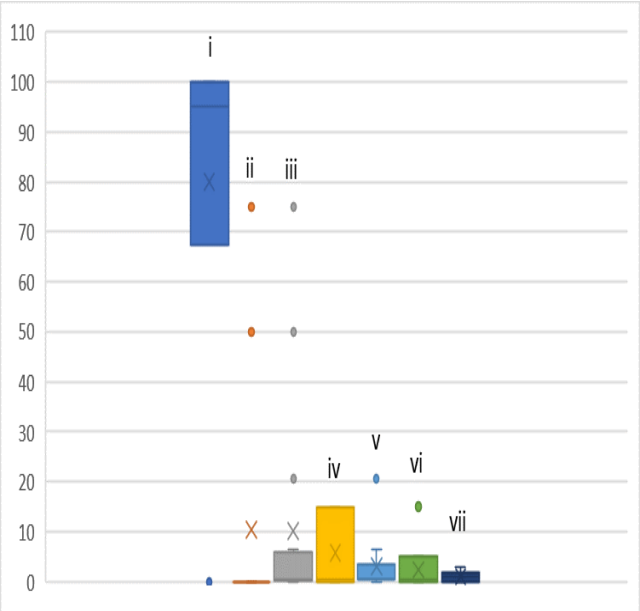


Figure 10. Boxplot summarising the spread of values (% unless indicated otherwise) for dry heath attribute targets or part (pt.) targets (for compound attributes) where values were measured or estimated and were ≥1% (n = 16 samples) ranked by mean: non-pioneer heather shoots grazed (i, blue, CSM target <33%, FCT <50%); *Ulex gallii* as proportion of dwarf shrub cover (Q) (ii, orange, <50%); indicator cover (Q) (iii, grey, ≥50%); bracken cover (F) (iv, gold, <10%); % dwarf shrub cover ericaceous (Q) (v, pale blue, ≥25%); *Juncus effusus* cover (F) (vi, green, <10%); and no, Group (i) indicators (Q) (vii, dark blue, ≥2). See Figure 4 caption for explanation of box and whisker plot layout and symbols. Q = quadrat-scale; F = feature-scale.

Table 5. Summary of the number and percentage of samples passing individual CSM attribute targets for upland dry heath and whether the overall 90% CSM pass threshold is passed (P) (indicated by grey shading) or failed (F), ranked in order of percentage passing at one or both scales (n = 16). (Where assessed at two scales, quadrat scale is the upper figure and multiple part-targets are also given separately. Q= quadrat scale, F = visible feature scale.)

Attribute (scale)	Target	n samples	n samples passing	% samples passing	Pass/ fail	Mean %	Median %	% Range
All heather growth stages present & ≥10% late mature/degenerate (F)	Yes	15[1]	0	0	F			
Cover of positive indicators (CSM Table 1) (Q)	≥50%	16	2	13	F	10	0.5	0–50
% heather shoots browsed (non-pioneer)[2] (Q)	<33%[2]	6[2]	1	17	F	80	95	0–100
Frequency of indicator spp. (CSM Group i)[3] (Q)	≥2	16	4	25	F	0.9	1	0–3
Cover of bracken (F)	<10%	15[1]	9	60	F	5.7	0.5	0–15
Dwarf shrub cover comprising (CSM Group ii) indicators [only *Ulex gallii*] (Q)	<50%	12	10	83	F	17	0	0–100
Dwarf shrub cover comprising (CSM Group i) indicators (Q)	≥25%	12	10	83	F	83	100	0–100
Burning into sensitive areas (F)	No	15[1]	14	93	P			
No. spp. bryophyte/non-crustose lichen (1 m²) (Q)	≥1, Yes	16	15	94	P			
% cover of scattered trees & scrub (F)	<20%	15[1]	15	100	P	0	0	
% cover of non-native vegetation (F)	<1%	15[1]	15	100	P	0	0	
% cover 'weedy' spp. (*Cirsium. arvensis/ vulgaris*, large docks) (2 scales)	<1%	16	16	100	P	0 0	0 0	
% cover of *Juncus effusus* (2 scales)	<10%	16	16	100	P	0.03 2.3	0 0.5	0–0.5 0–15
% cover disturbed bare ground (2 scales)	<10%	16	16	100	P	0.03 0.4	0 0	0–0.5 0–3

[1] One feature-scale assessment was missed (hence 15 samples for some attribute targets).
[2] Only assessed for heather *Calluna vulgaris* where present (6 samples). Higher attribute target (<50% shoots browsed) in S Dartmoor SSSI FCT made no difference with still only 1 sample passing (17%). Corresponding attribute for pioneer heather not assessed as no pioneer heather was recorded in samples.
[3] The addition of *Agrostis curtisii* to CSM Group ii indicators in South Dartmoor SSSI FCT (Natural England 2015c) made no difference with still only four samples passing.

Of the six upland CSM dry heath positive indicator species/groups that occur in South Dartmoor SSSI, four were recorded in 2 m × 2 m quadrats (Figure 11), with those absent *Empetrum nigrum* and *Racomitrium lanuginosum*. heather was the most frequent (44%), followed by *Vaccinium* spp. (38%), and *Ulex gallii* and *Erica* spp. (both 13%). *Agrostis curtisii*, which is an additional (group i) positive indicator in the South Dartmoor SSSI FCT, occurred in 19% of quadrats (though its cover was not recorded. *Ulex gallii* had the highest mean cover (8%), though this reflected very high cover in just two quadrats (50% and 75%), followed by *heather* (1.8%), *Vaccinium* spp. (0.3%) and *Erica* spp. (0.1%).

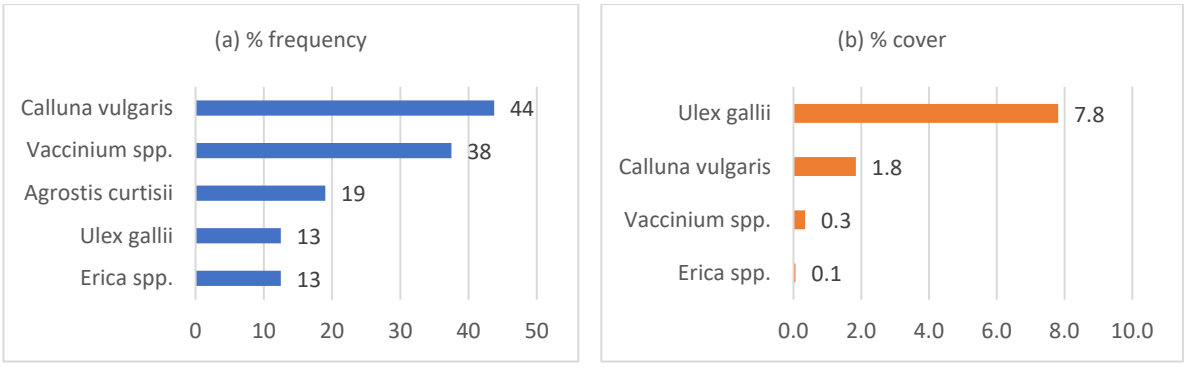


Figure 11. (a) Percentage frequency and (b) mean percentage cover of upland CSM dry heath positive indicators in dry heath samples (n = 16). (*Agrostis curtisii* is an additional positive indicator included in the South Devon SSSI FCT.)

Of the other (not positive indicator) species/groups recorded in dry heath samples, graminoids and forbs as groups were the most frequent in 2 m × 2 m quadrats (both 100%) followed by a range of typical acid grassland species often found in dry, and especially fragmented, heaths: *Festuca ovina* and Pleurocarpus mosses (both 94%), *Carex* spp. (88%), *Agrostis capillaris* (81%), *Galium saxatile* (75%) and a further five species at >20% cover (Table 7). *Molinia* occurred at moderate frequency (38%) but low cover (9%) perhaps reflecting the fact that samples fell on shallow peat (<20 cm), though few if any other mire species were recorded and as would be expected, cover was much lower than in wet heath and blanket bog (Figure 14 b). Both bracken and *Juncus effusus* (negative indicators) only occurred at low frequency (both 6%). Cover was recorded for few other species with, as might be expected, graminoids highest (50%), followed by Pleurocarpus mosses (31%), with no other species ≥5%.

Acid grassland

Data were collected from 15 samples on shallow peat (<20 cm deep) or mineral soils, all classed as generally small pockets of upland acid grassland in both surveys, mostly as NVC community U4 *Festuca ovina-Agrostis capillaris-Galium saxatile* grassland (or U4 transitions to U20 [2] and single samples to U5 *Nardus stricta-Galium saxatile* grassland, and H4 and H12 heaths]) and U20 (5) (Rodwell 1992). All the acid grassland samples were all species-poor and at least some might have been derived from heavy grazing of heath and fragmented heath stands since the SSSI was designated. The acid grassland quadrats tended to occur in relatively small patches in the side valleys running west or in the Plym Valley which they run into, with a few scattered in the south (Figure 1).

The results in terms of the number and percentage of acid grassland samples passing the 14 acid grassland attribute targets recorded is summarised in Figure 12 and Table 6, and for those where actual values were measured or estimated, mean, median and range in the latter table, and as a boxplot in Figure 13. Percentage frequency and mean percentage cover of South Dartmoor SSSI FCT acid grassland positive indicators are given in Figure 14 (there are no individual positive indicators for acid grassland in the upland CSM guidance). Comparison of cover of selected species occurring across several or all habitats is also given as boxplots in Figure 14 (a, ericoids) and Figure 15 (d, pleurocarpous mosses), and for all species/groups recorded by habitat in Table 7.

Six of the attribute targets were met in ≥90% of acid grassland samples with the remaining five not passing this threshold (though one, frequency of positive indicators is not a CSM attribute but is included in the South Dartmoor SSSI FCT) (Figure 12, Table 6). Three attribute targets were not met

at the quadrat scale (pass rates in brackets): cover of forbs (0%); percentage of live leaves and/or flowering shoots > and <5 cm (27%, also see Table 10); and cover of litter (60%). Two attribute targets were not met at the feature scale: cover of bracken and scrub (38%, due to bracken) and frequency of positive indicators (87%, FCT attribute target), though the failure of the latter was marginal and as one species, *Pleurozium schreberi*, was inadvertently omitted from the recording form in 2023, the target might otherwise have just been passed. Of the attribute targets failed where values were measured or estimated, those for forb cover, bracken (as part of scrub/bracken) cover and litter cover were failed by a considerable margin (Table 6 and Figure 13).

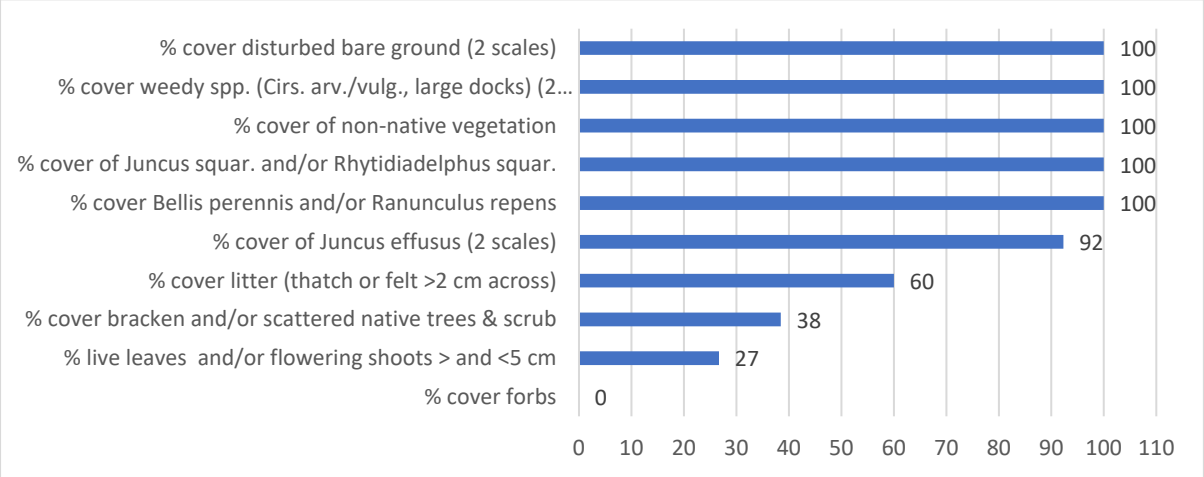


Figure 12. Percentage pass rates for individual CSM attribute targets for upland acid grassland samples (n = 15). (The upland CSM threshold for favourable condition is 90% of samples passing targets.)

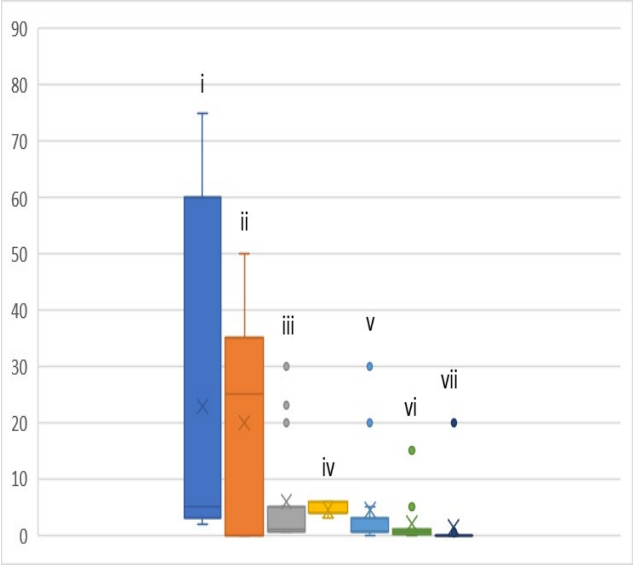


Figure 13. Boxplot summarising the spread of values (% unless indicated otherwise) for acid grassland attribute targets or part (pt.) targets (for compound attributes) where values were measured or estimated and were ≥1% (n = 15) ranked by mean: litter cover (i, blue, target <10%); bracken cover (F) (ii, orange, <10%, pt.); *Juncus*/ *Rhytidiadelphus squarrosus* cover (Q) (iii, grey, <33%, pt.); no. indicators (Q) (iv, gold, <1%, pt.); *Rhytidiadelphus squarrosus* cover (Q) (v, pale blue, <33%, pt.); *Juncus effusus* cover (vi, green, <10%, pt.); and *Juncus squarrosus* cover (Q) (vii, dark blue, <33%, pt.). See Figure 4 caption for explanation of box and whisker plot layout and symbols. Q = quadrat-scale; F = feature-scale.

Table 6. Summary of the number and percentage of samples passing individual CSM attribute targets for upland acid grassland and whether the overall 90% CSM pass threshold is passed (P) (indicated by grey shading) or failed (F), ranked in order of percentage passing at one or both scales (n = 15). (Where assessed at two scales, quadrat scale is the upper figure and multiple part-targets are also given separately. Q= quadrat scale, F = visible feature scale.)

Attribute (scale)	Target	n samples	n samples passing	% samples passing	Pass/ fail	Mean %	Median %	% range
% cover forbs (Q)	>10%	15	0	0	F	0.6	0.5	0.5–1
% live leaves and/or flowering shoots > and <5 cm (Q)	≥25%, Yes	15	4	27	F			
% cover scattered native trees & scrub and/or bracken (F)	<10%	13[1]	5	38	F	0 20	0 25	0–50
% cover litter (thatch or felt >2 cm across) (Q)	<10%	15	9	60	F	23	5	2–75
Frequency of positive indicators (no. spp.)[2] (F)	FCT ≥4 spp.[2]	15	13	87	F	4.5	4	3–6
% cover of *Juncus effusus* (2 scales)	<10%	13[1]	12	92	P	0 0.2	0 5	0–15
% cover *Bellis perennis* and/or *Ranunculus repens* (F)	<25%	15	15	100	P	0 0	0 0	
% cover of *Juncus squarrosus* and/or *Rhytidiadelphus squarrosus* (Q)	<33%	15	15	100	P	1.4 4.5	0 0.5	0–20 0–30
% cover of non-native vegetation (F)	<1%	13[1]	13	100	P	0	0	
% cover weedy spp. (*Cirsium. arv. /vulg.*, large docks) (2 scales)	<1%	15	15	100	P	0	0	
% cover disturbed bare ground (2 scales)	<10%	15	15	100	P	0.3 0.7	0 0	0–3 0–5

[1]Two feature-scale assessments missed, hence 13 samples for some attribute targets.

[2] Attribute target from S Dartmoor SSSI FCT not included in CSM upland guidance.

The upland CSM guidance for acid grassland does not specify attribute targets for frequency or cover of positive indicator species/groups other than that more than 10% of vegetation cover should consist of forbs (which was failed in all samples, all <1%, Figure 12). Nevertheless, the FCT for South Dartmoor SSSI does specify an attribute target for frequency of positive indicators: at least four species should be present from a list of nine grass (5), forb (3) and moss (1) species (Figure 14). However, of the seven species recorded, all but one occurred at moderate to high cover and are common in the nationally widespread U4, U5 and U20 acid grasslands. Only *Agrostis curtisii* is more localised in distribution nationally (in the South West and south Wales) and is a constant in U3 *Agrostis curtisii* grassland (Rodwell 1992) which occurs locally on the site, though it was only recorded in 7% of acid grassland samples (less than the 19% in dry heath, Figure 11).

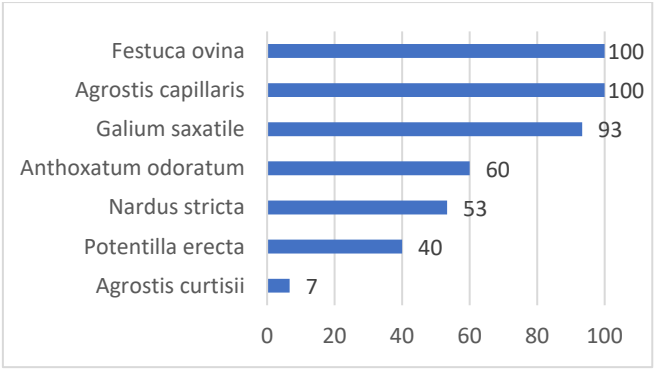


Figure 14. Percentage frequency of South Dartmoor SSSI FCT positive indicators in acid grassland samples (n = 15). (In addition, *Rumex acetosella* was absent in all samples[23].)

Of all other (not positive indicator) species/groups recorded in acid grassland samples, two groups, pleurocarpous mosses and forbs occurred in all samples, followed by *Rhytidiadelphus squarrosus* (in 93% of samples), *Carex* spp. and bracken (60%), *Vaccinium* spp. (53%) with the only others, non-crustose lichens (27%), *Juncus squarrosus* (20%) and *Racomitrium lanuginosum* (7%) (Table 7). Mean cover was recorded for few other species/groups: pleurocarpous mosses (42%), *Rhytidiadelphus squarrosus* (4.5%), *Carex* spp. (3.6%) and *Juncus squarrosus* (1.3%), with non-crustose lichens, forbs, *Vaccinium* spp. and *Racomitrium lanuginosum* all less than 1%. This indicates that the acid grassland sampled is species-poor, at least some of may be derived from heath (with *Vaccinium* at high frequency but very low cover).

Species and species group frequency and cover across habitats

Data on the frequency and percentage cover of individual species and species groups are summarised across habitats in Table 7 and the range of percentage cover values for selected abundant or important species and species groups are presented as boxplots in Figure 14-Figure 15. Complete species lists were not recorded, so it is not possible to comment on full species composition. Instead, frequency and in most cases, cover were recorded for species/groups included in the upland CSM guidance, mostly as positive or negative indicators. In most cases this was to species level even when the attribute target related to a wider species group. In addition, positive indicators included in the FCT for South Dartmoor SSSI (Natural England 2015c) for acid grassland (frequency only) and some other important species were recorded, e.g., *Molinia*.

Inevitably, of the species and species groups assessed across all habitats, broad species groups tended to have the highest percentage frequency in quadrats: pleurocarpous mosses (92%), ericoid dwarf shrubs (74%) and *Carex* spp. (64%), followed by *Molinia* (60%), the dwarf shrubs *Vaccinium myrtillus*[24] (55%), heather (41%) and *Erica* spp.[25] (29%), and *Sphagnum* spp. (25%) with no other species/groups occurring in 15% or more of samples (Table 7). Two other groups occurred at 100% frequency in habitats that they were assessed in: forbs (three habitats, WH, DH, AG) and graminoids (two habitats, BB, WH[26]).

[23] *Pleurozium schreberi* was inadvertently omitted from the recording form and hence not recorded.
[24] Though recorded as *Vaccinium* spp. (as in the CSM attribute targets) only *myrtillus* was recorded.
[25] Though given as *Erica* spp. (as in most of the CSM attribute targets) only *tetralix* was recorded.
[26] And one quadrat in dry heath.

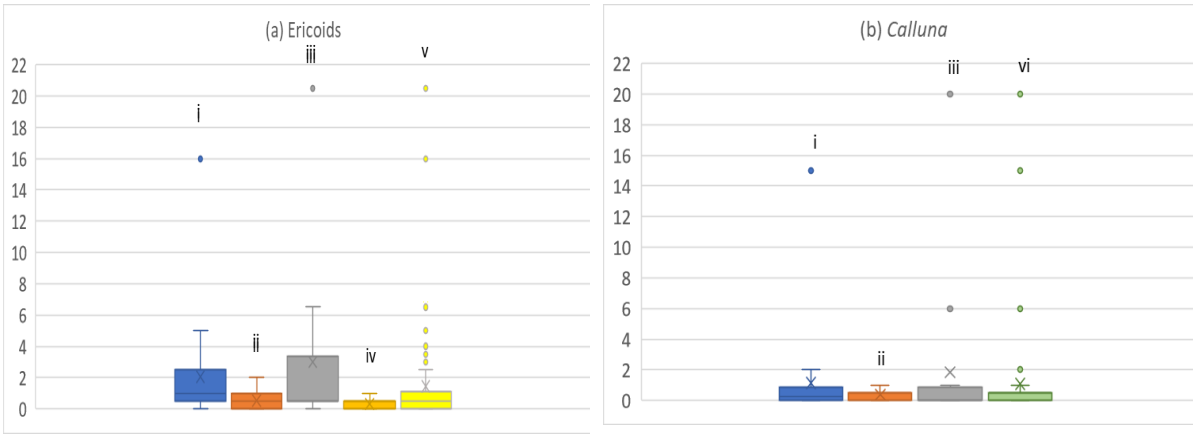


Figure 15. Boxplots showing percentage cover of (a) ericoid dwarf shrubs[27] and (b) heather *Calluna vulgaris* by habitats: blanket bog (i, blue, n = 24), wet heath (ii, orange, 18), dry heath (iii, grey, 16), acid grassland (iv, gold, 15), all habitats (v, yellow, 73, only a) and all bog and heath (vi, green, 58, only b). heather did not occur in acid grassland quadrats. See Figure 4 caption for explanation of box and whisker plot layout and symbols.

There was a similar pattern with mean percentage cover, with only graminoids (82%, Figure 15 a), *Molinia* (31%, Figure 15 b, highest in blanket bog) and pleurocarpous mosses (21%, Figure 15 d, highest in acid grassland) exceeding 10% cover (Table 7). Though occurring at high frequency across habitats (78%), ericoid dwarf shrubs occurred at much lower cover (1.5%, across habitats, highest in dry heath at 2.3%, Figure 14 a, Table 7), representing a major decline over the preceding ten years, for example, from 29% in 2013 to 1.4% in 2023 in the same quadrats assessed as dry heath (Glaves 2023). Similarly, mean cover of individual dwarf shrub genera is now low across habitats: heather (0.9%, absent in acid grassland quadrats, Figure 7 b), *Erica* and *Vaccinium* (both 0.3%, former absent in acid grassland quadrats) (Table 7).

Other typical mire species restricted to blanket bog and/or wet heath quadrats were: *Erica tetralix* (58% frequency and 0.6% mean cover in blanket bog, and 56% and 0.3% in wet heath), *Eriophorum angustifolium* (50% and 3.4% in BB, and 11% and 0.9% in WH), *Trichophorum germanicum* (29% and 1.9% in BB, and 22% and 1.0% in WH) and *Narthecium ossifragum* (13% frequency and 0.1% cover just in BB) (Table 7). As would be expected, *Ulex gallii* (13% frequency, 7.8% mean cover) was restricted to dry heath and *Agrostis curtisii* to dry heath (19% frequency, cover not recorded) and acid grassland (6.7%) (Table 7).

[27] Heather-like plants characterised by sclerophyllous leaves and short internodes.

Table 7. Frequency and percentage cover of individual species and species groups in 2 m x 2 m quadrats in total and across habitats ranked by overall frequency across habitats (n = 73, though some species or groups were not assessed in all habitats/quadrats).

Species/group	Total				Blanket bog				Wet heath				Dry heath				Acid grassland			
	Freq. n[1]	n[2]	% freq.[3]	% cover[4]	Freq. n	n	% freq.	% cover	Freq. n	n	% freq.	% cover	Freq. n	n	% freq.	% cover	Freq. n	n	% freq.	% cover
Pleurocarpous mosses*	67	73	92	21	19*	24	79	6.1	18*	18	100	13	15	16	94	31	15	15	100	41
Ericoids*	54	73	74	1.5	21	24	88	2.1	9*	10	90	1.2	10*	16	63	2.3	8	15	53	0.3
Carex spp.*	47	73	64	2.5	11	24	46	0.3	13*	18	72	4.0	14	16	88	3.1	9	15	60	4
Molinia caerulea	44	73	60	31	24	24	100	67	14	18	78	27	6	16	38	9.1	0	15	0	0
Vaccinium spp.*	40	73	55	0.3	13*	24	54	0.3	13*	18	72	0.4	6*	16	38	0.3	8	15	53	0.3
Forbs°	39	39	100	0.6					9	9	100	0.5	15	15	100	0.7	15°	15	100	0.6
Graminoids	34	34	100	82	24	24	100	85	9	9	100	78	1	1	100	50				
Rhytidiadelphus squarrosus	31	39	79	2.3					7	9	78	2.1	10	15	67	0.4	14	15	93	4.5
Festuca ovina °	30	31	97										15	16	94		15°	15	100	
Calluna vulgaris *	30	73	41	0.9	12*	24	50	1.1	11*	18	61	0.4	7*	16	44	1.8	0	15	0	0
Agrostis capillaris °	28	31	90										13	16	81		15°	15	100	
Galium saxatile °	26	31	84										12	16	75		14°	15	93	
Erica spp.*	21	73	29	0.3	14*	24	58	0.6	5*	18	28	0.2	2*	16	13	0.1	0	15	0	0
Erica tetralix *	19	34	56	0.5	14	24	58	0.6	5*	9	56	0.3	0	1	0	0	0	0		
Eriophorum vaginatum *	19	73	26	7.3	16*	24	67	10	2	18	11	0.6	0	16	0	0	0	15	0	
Sphagnum spp.*	18	73	25	0.3	14*	24	58	0.7	4*	18	22	0.1	0	16	0	0	0	15	0	0
Nardus stricta °	16	31	52										8	16	50		8°	15	53	
Potentilla erecta °	15	31	48										9	16	56		6°	15	40	
Pteridium aquilinum	15	73	21		1	24	4.2		0	18	0		1	16	6		9	15	60	
Eriophorum angustifolium *	14	73	19	1.3	12*	24	50	3.4	2*	18	11	0.9	0	16	0	0	0	15	0	0
Anthoxanthum odoratum °	11	31	35										2	16	13		9°	15	60	
Sphagnum tenellum	11	34	32	0.2	8	24	33	0.2	3	9	33	0.3	0	1	0	0				
Juncus squarrosus	11	39	28	2.6					3	9	33	1.4	5	15	33	4.4	3	15	20	1.4
Non-crustose lichens*	11	73	15	0.3	1*	24	4.2	0.0	2*	18	11	0.1	4	16	25	0.4	4	15	27	0.7
Trichophorum germanicum *	11	73	15	0.9	7*	24	29	1.9	4*	18	22	1.0	0	16	0	0	0	15	0	0
Sphagnum capillifolium	9	34	26	0.7	9	24	38	1.0	0	9	0	0	0	1	0	0				
Sphagnum fallax	9	34	26	0.8	7	24	29	0.8	2	9	22	0.8	0	1	0	0				
Juncus effusus	8	73	11	1.5	6	24	25	4.5	1	18	5.6	0.1	1	16	6	0	0	15	0	0
Sphagnum papillosum	7	34	21	1.6	6	24	25	2.3	1	9	11	0.1	0	1	0	0				
Sphagnum palustre	6	34	18	0.7	4	24	17	0.9	2	9	22	0.2	0	1	0	0				
Agrostis curtisii °	4	31	13										3	16	19		1°	15	6.7	
Sphagnum denticulatum	4	34	12	0.2	4	24	17	0.3	0	9	0	0	0	1	0	0				
Narthecium ossifragum *	3	73	4.1	0.0	3*	24	13	0.1	0*	18	0	0	0	16	0	0	0	15	0	0
Racomitrium lanuginosum *	3	73	4.1	0.0	2*	24	8.3	0.0	0*	18	0	0	0*	16	0	0	1	15	6.7	0.03
Sphagnum cuspidatum	2	34	5.9	0.1	1	24	4.2	0.1	1	9	11	0.2	0	1	0	0				
Ulex gallii *	2	73	2.7	1.7	0	24	0	0	0	18	0	0	2*	16	13	7.8	0	15	0	0
Sphagnum subnitens	1	34	2.9	0.1	1	24	4.2	0.2	0	9	0	0	0	1	0	0				
Drosera spp.*	0	73	0	0	0*	24	0	0	0*	18	0	0	0	16	0	0	0	15	0	0
Erica cinerea	0	34	0	0	0	24	0	0	0	9	0	0	0	1	0	0	0	0		
Empetrum nigrum *	0	34	0	0	0*	24	0	0	0*	9	0	0	0*	1	0	0	0	0		
Rhynchospora alba *	0	73	0	0	0*	24	0	0	0*	18	0	0	0	16	0	0	0	15	0	0
Ulex europeaus	0	73	0	0	0	24	0	0	0	18	0	0	0	16	0	0	0	15	0	
Bellis perennis	0	39	0	0					0	9	0	0	0	15	0	0	0	15	0	0
Ranunculus repens	0	39	0	0					0	9	0	0	0	15	0	0	0	15	0	0
Rumex acetosella °	0	31	0										0	16	0		0°	15	0	

[1] Number of quadrats a species or group was recorded in.

[2] Number of quadrats a species or group was assessed in (different species or groups were recorded in some habitats).

[3] As a percentage of the quadrats that the species was assessed in.

[4] Mean percentage cover overall and by habitats in quadrats that the species or group was assessed in (not recorded for some species or groups where only frequency recorded, e.g., acid grassland FCT indicator species).

* CSM positive indicator for the habitat(s); ° positive indicator in S Dartmoor SSSI FCT for acid grassland.

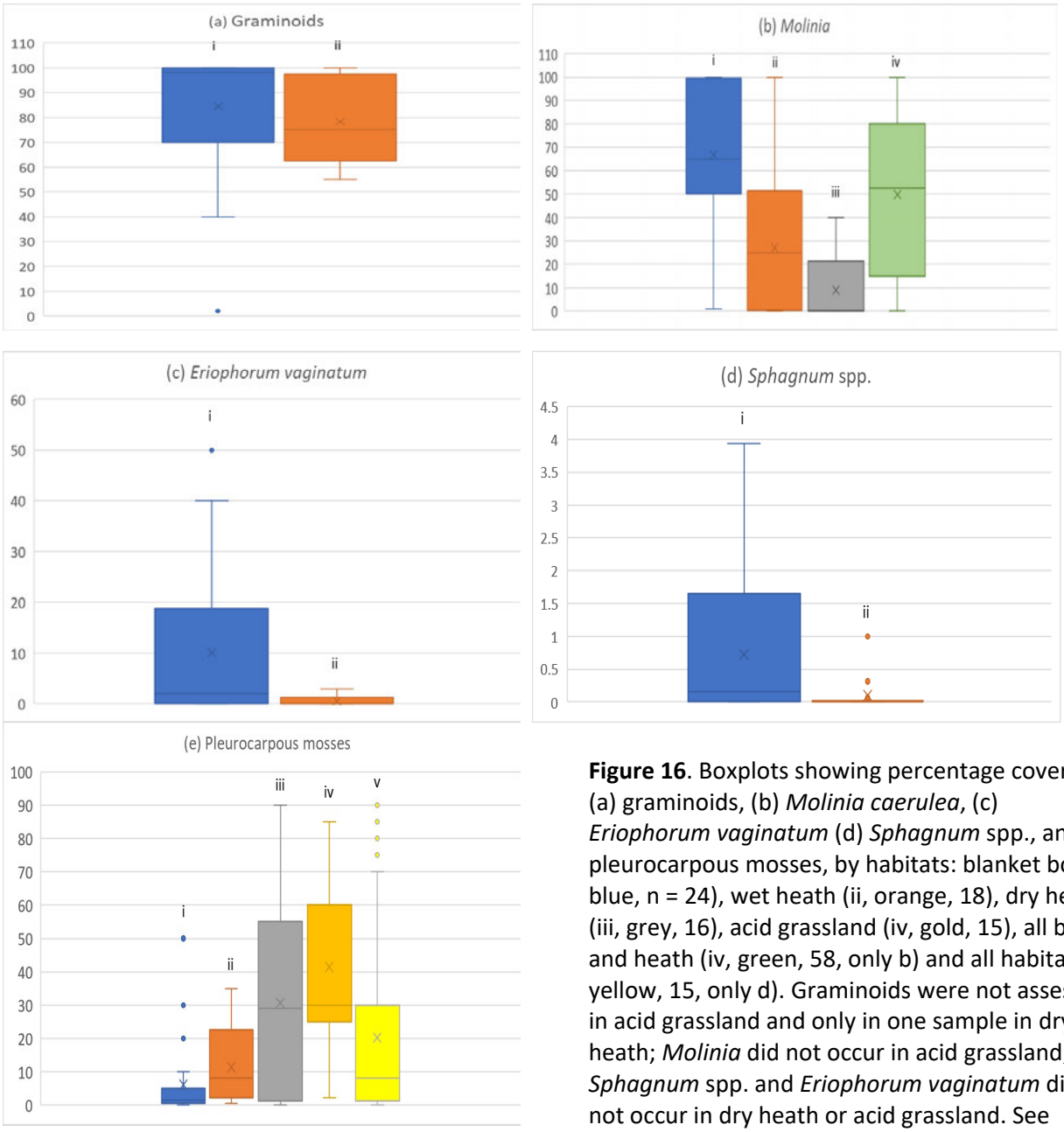


Figure 16. Boxplots showing percentage cover of (a) graminoids, (b) *Molinia caerulea*, (c) *Eriophorum vaginatum* (d) *Sphagnum* spp., and (e) pleurocarpous mosses, by habitats: blanket bog (i, blue, n = 24), wet heath (ii, orange, 18), dry heath (iii, grey, 16), acid grassland (iv, gold, 15), all bog and heath (iv, green, 58, only b) and all habitats (v, yellow, 15, only d). Graminoids were not assessed in acid grassland and only in one sample in dry heath; *Molinia* did not occur in acid grassland; and *Sphagnum* spp. and *Eriophorum vaginatum* did not occur in dry heath or acid grassland. See Figure 4 caption for explanation of box and whisker plot layout and symbols.

Table 8. Percentage frequency and mean cover of *Sphagnum* species in blanket bog and wet heath 2°m × 2 m quadrats ranked by mean percentage cover in blanket bog.

Sphagnum species	**Blanket bog (n = 24)**		**Wet heath (n = 18)**	
	% frequency	**Mean % cover**	**% frequency**	**Mean % cover**
S. papillosum	25	2.3	11	0.1
S. capillifolium	38	1.0	0	0
S. palustre	17	0.9	22	0.2
S. fallax	29	0.8	9	0.8
S. denticulatum	17	0.3	0	0
S subnitens	4	0.2	0	0
S tenellum	33	0.2	33	0.3
S. cuspidatum	4	0.1	0	0

Additional disease, dieback and burning variables

Evidence of presence of disease or 'dieback' were recorded in just six samples, all on heather (8% of all samples and 19% of those with heather present). All was classed as 'other' with none as specifically due to heather beetle *Lochmaea suturalis*. Recent burning was recorded in just one sample quadrat (1%), although the effects of a recent uncontrolled 'wildfire' were evident on the south-east fringe of the unit, crossing the boundary on to the contiguous Penn Moor around Shell Top. This may have influenced livestock distribution as a result of regrowth attracting grazing animals.

Additional grazing-related variables

Data were also collected on a range of 'overgrazing'[28] and other directly grazing-related variables in samples across the four habitats (Table 10 which also includes some CSM direct grazing-related variables), most at 1 m^2 scale to maintain comparability with overgrazing assessment methodologies (Nisbet 2003, 2004b).

These included graminoid sward height[29] and the percentage of heather cover showing heavily grazed (stunted and suppressed) growth forms (often described as 'carpet', 'topiary' and 'drumstick' forms, also referred to as heavily grazed features, HGF) which were the two criteria formerly used in overgrazing surveys (Glaves 2003, Nisbet 2003, Nisbet *et al*. 2003) to sift sites in to overgrazing investigations and measures under livestock, area payment and agri-environment schemes, and cross compliance. Graminoid sward height in winter is a direct measure of autumn and winter grazing impact on the previous season's growth, i.e., current or recent grazing. As would be expected, sward height was lowest in acid grassland and highest in blanket bog (Figure 16 a). Stunted, suppressed heather growth forms represent the cumulative effect of browsing of heather, particularly by sheep, over several years (McDonald 1993). A site is considered overgrazed if 25% or more of samples are classed as being 'heavily grazed' based on the thresholds given in Table 9.

Table 9. Thresholds for identifying 'heavily grazed' samples from overgrazing Rapid Appraisal Surveys (based on Nisbet 2003).

Vegetation type	**Overgrazing threshold for heavily grazed samples**
Palatable grassland[1]	Graminoid sward height of ≤3 cm
Rough grassland[2]	Graminoid sward height of ≤5 cm
Heaths and mires[3]	Graminoid sward height of ≤5 cm and/or ≥50% of heather showing HGF[4]

[1]Bent-fescue grassland and calcareous grassland.

[2]Rough acid grassland, rush pasture or rank grassland and bracken.

[3]heather (dry) heath, western heath, wet heath, blanket bog and valley mire.

[4] Heavily grazed features (HGF), i.e., 'carpet', 'topiary' and 'drumstick' growth forms.

Based on these thresholds, the site unit would be considered overgrazed, with 30% of all samples classed as heavily grazed[30], as would the wet and dry heath habitats individually, with 44% and 69% of samples heavily grazed, respectively (Table 10), compared to the 25% overgrazing threshold. Whilst blanket bog and acid grassland had lower percentages of heavily grazed samples, this partly reflected the low cover and especially frequency of heather, with it only recorded in 20% of blanket

[28] Overgrazing Environmental Cross-compliance controls attached to livestock support schemes from 1992 (Condliffe 2009) in response to concerns about loss of heather on moorland (e.g., Felton & Marsden 1990).
[29] Measured using a sward stick from the centre of the four quarters of the 2 m × 2 m quadrat and averaged.
[30] Though this would normally be assessed in an overgrazing Rapid Appraisal Survey using a 'triangular' grid with sample positions spaced to achieve a minimum of 40 samples per grazing unit (Nisbet 2003).

bog samples (at 1 m^2 scale used in overgrazing and in 50% of samples at 2 m x 2 m scale) and none recorded at either scale in the acid grassland samples. When assessed based on samples with heather present in wet and dry heath 1 m^2 samples, the percentage failing the HGF threshold was higher still, at 57% and 83%, respectively (Table 10).

Other additional grazing-related variables indicated that, whilst pulled heather stems (likely reflecting cattle or pony grazing) occurred in 12% of all samples, as would be expected the frequency was much higher in samples with heather present (50%), almost entirely in dry heath (Table 10). Recent livestock dung was recorded in 15% of all 1 m^2 samples. As might be expected, this was highest in dry heath (31%) and acid grassland (20%). Overall, cattle or pony dung occurred in a higher percentage of samples (12%) than sheep dung (4%).

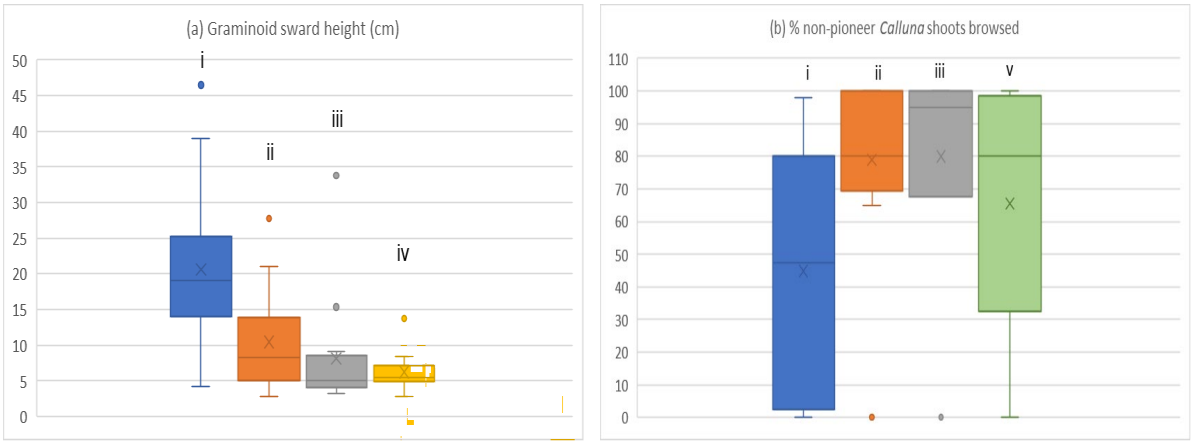


Figure 17. Boxplots showing (a) graminoid sward height (cm) and (b) percentage of non-pioneer heather *Calluna vulgaris* shoots browsed, by habitats: blanket bog (i, blue, n = 24), wet heath (ii, orange, 18), dry heath (iii, grey, 16), acid grassland (iv, gold, 15) and all bog and heath (v, green, 58). No heather was present in acid grassland quadrats. See Figure 4 caption for explanation of box and whisker plot layout and symbols.

CSM grazing-related variables

Some upland CSM attribute targets also provide data on direct grazing-related impacts. In particular, the percentage of heather shoots browsed is a direct measure of the cumulative effect of sheep grazing on the previous season's growth over the autumn/winter especially when assessed in late-winter (in this case early/mid-January so underestimating the full autumn/winter season's grazing effect). Across the three habitats where heather was recorded in quadrats (none was recorded in acid grassland samples), the mean percentage of shoots grazed in samples where heather was present was 66% (Table 10). It was higher in dry (80%) and wet (79%) heath than in blanket bog (60%) samples. This resulted in the upland CSM attribute target (<33% shoots browsed in non-pioneer heather) and the tailored higher South Dartmoor FCT target (<50%) being failed in 74% and 71% of samples, respectively. The failure rate was highest in wet heath (92% for both targets) followed by dry heath (83% for both) and lowest in blanket bog (58% for CSM target and 50% for FCT target) (Table 10 and Figure 16 b).

The CSM vegetation structure attribute target for upland acid grassland of the percentage of leaves and shoots above and below 5 cm (≥25% above and below 5 cm) which is described as an "indicator of current grazing" (JNCC 2009b, p 34) was also assessed in dry heath samples (for which it is not a CSM attribute target). The sub-target of ≥25% of leaves/shoots below 5 cm was passed in a much higher percentage of samples (93% for acid grassland and 73% for dry heath) than for leaves/shoots

Table 10. Additional direct overgrazing and other grazing-related variables by habitats and for the whole unit (those failing overgrazing and CSM thresholds are indicated by grey shading).

Variables	Blanket bog				Wet heath				Dry heath				Acid grassland				Total			
Overgrazing criteria thresholds	Mean	n	% all	% sp. pr.	Mean	n	% all	% sp. pr.	Mean	n	%	% sp. pr.	Mean	n	% all	% sp. pr.	Mean	n	% all	% sp. pr.
Mean graminoid ht (cm)	20.6	24			10.5	18			8.2	16			6.3	15			12.4	73		
Graminoid ht ≤5 cm		1	4%			4	22%			8	50%			3	20%			16	22%	
Graminoid ht ≤3 cm		0	0			1	6%			0				1	7%			2	3%	
Heavily grazed heather growth forms (HGF) ≥50%		1	4%	20%		4	22%	57%		5	31%	83%		NA				10	14%	56%
Fail OG ht/HGF		2	8%			8	44%			11	69%			1	7%			22	30%	
Other non-CSM grazing-related variables																				
Pulled heather		1	4%	20%		0	0	0		8	50%	100%		0	0	0		9	12%	50%
Sheep droppings present		0	0			1	6%			2	13%			0	0			3	4%	
Cattle/pony droppings present		1	4%			1	6%			4	25%			3	20%			9	12%	
Any livestock droppings present		1	4%			2	11%			5	31%			3	20%			11	15%	
CSM grazing-related variables																				
% heather shoots browsed (non-pioneer)	60%	12			79%	12			80%	6				NA			66%	30		
% heather shoots browsed (non-pioneer) ≥33% CSM		7	29%	58%		11	61%	92%		5	31%	83%		NA				23	32%	74%
% heather shoots browsed (non-pioneer) ≥50% FCT		6	25%	50%		11	61%	92%		5	31%	83%		NA				22	30%	71%
% cover disturbed diffuse/scattered bare ground (quad.)	0.02%	24			0.1%	18			0.0%	16			0.3%	15			0.01%	72		
% cover disturbed diffuse/scattered bare ground (quad.) ≥10%		0	0	0		0	0	0		0	0	0		0	0	0		0	0	0
% cover disturbed linear bare ground (feature vis.)	0.3%	24			0.1%	18			0.4%	16			0.7%	13			0.3%	70		
% cover disturbed linear bare ground (feature vis.) ≥10%		0	0	0		0	0	0		0	0	0		0	0	0		0	0	0
% cover disturbed bare ground/active drainage (2 scales) ≥10%		0	0	0		0	0	0		0	0	0		0	0	0		0	0	0
% Sphagnum crushed, broken, pulled-up	0	14			0	18				NA				NA						
% Sphagnum crushed, broken, pulled-up >9%		14	0	0		18	0	0		NA				NA				0	0	0
% live leaves and/or flowering shoots >5 cm tall (≥25%)		NA				NA				7	47%			5	33%			12	40%	
% live leaves and/or flowering shoots <5 cm tall (≥25%)		NA				NA				11	73%			14	93%			25	83%	
% live leaves and/or flowering shoots > and <5 cm (≥25%)		NA				NA				5	33%			4	27%			9	30%	

% sp. pr. = percentage when the species a variable relates to, e.g., heather, is present.

above 5 cm tall (33% and 47%) indicating heavy grazing pressure especially on acid grassland (Table 10). This resulted in low pass rates for the combined attribute target (≥25% both > and <5 cm): 27% for acid grassland and 33% for dry heath.

Bare ground was recorded at two scales: diffuse/scattered bare ground at the quadrat scale and linear (paths, tracks etc.) at the feature scale (visible from the point and walking between points) but was infrequent at both scales with mean percentage cover less than 1% across all four habitats and highest in acid grassland (Table 10). Thus, the combined CSM attribute target (<10%) was met for all habitats. Nevertheless, some localised patches of bare ground were observed whilst walking across the site particularly in the southern end of the unit. No evidence of crushed, broken or pulled-up *Sphagnum* was recorded in blanket bog and wet heath samples in which it was assessed (Table 10).

Taken together, evidence from CSM and other direct grazing-related variables indicates a significant grazing/browsing effect across habitats in the unit. Over time, this is likely to be having, and have had, significant effects on species composition as well as on vegetation structure. Evidence from a comparison between the 2013 and 2023 upland CSM surveys of the same sample points based on the habitat classification of samples in 2013 (Glaves 2023) showed that dwarf shrub cover across the three bog/heath habitats declined from 21% to 1.4%. The decline was greatest in dry heath samples in which cover was highest in 2013 at 29%, falling to 1.7% in 2023, with a similar decline in wet heath from 16% to 1.4%. Blanket bog, which had just the lowest mean cover in 2013 at 15%, showed the smallest decline down to 5.2%, presumably reflecting the less accessible, wetter, less modified areas of bog, especially on the northern plateau. Continued heavy grazing on dwarf shrubs, particularly heather, when now at very low cover (heather mean 0.9%, Table 7), risks further reduction and potentially loss from at least parts of the unit as has happened in the acid grassland sample points.

There is evidence that the reduction in dwarf shrub, especially heather, cover has occurred over a much longer period going back at least to before 1990. Boyce (2004) reported declines in heather condition and extent on the site since vegetation and heather condition were mapped across the Dartmoor commons by Wolton *et al*. (1994) in 1989/90 who also refer to a livestock grazing having "… caused considerable decline in cover of heather" on the site prior to their survey. This decline continued over subsequent resurveys in 2007 and 2015, particularly in dry heath and acid grassland (Boyce 2015).

It is likely that the unfavourable declining condition of the habitats on the site may also reflect a range of other co-factors or impacts, with atmospheric deposition (especially nitrogen), heather beetle, inappropriate burning and uncontrolled 'wildfires', climate change, and past drainage, peat cutting, tin mining, soil compaction (from livestock) and other factors affecting hydrological function, as has been suggested more widely on Dartmoor and nationally (e.g., Natural England 2008, 2009a,b, 2010a, 2014, 2015b, Glaves *et al*. 2013, 2020, Brazier 2020, Natural England & RSPB 2020). At least some of these factors cannot easily be addressed by local land management actions alone and may require more intensive restoration interventions or in some cases national or even international action. There is a risk that more intensive restoration interventions may also become necessary if heather and other dwarf shrubs, and/or other key species, decline further and are lost. Nevertheless, sustainable land management interventions that can be supported through agri-environment agreements are likely to provide the best, most cost-effective mechanisms to address the current unfavourable declining condition of habitats and to meet national and international objectives and commitments to restore habitat structure and function, associated species and ecosystem services, and to improve their resilience to other impacts.

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Appendix 1. English names of plants mentioned by scientific name in the text, tables and figures.

Scientific name	**English name**
Agrostis capillaris	Common Bent
Agrostis curtisii	Bristle Bent
Anthoxanthum odoratum	Sweet Vernal-grass
Bellis perennis	Daisy
Calluna vulgaris	Heather
Carex spp.	Sedge species
Drosera spp.	Sundew species
Empetrum nigrum	Crowberry
Erica cinerea	Bell Heather
Erica spp.	Erica species
Erica tetralix	Cross-leaved Heath
Eriophorum angustifolium	Common Cottongrass
Eriophorum vaginatum	Hare's-tail Cottongrass
Festuca ovina	Sheep's-fescue
Galium saxatile	Heath Bedstraw
Juncus effusus	Soft-rush
Juncus squarrosus	Heath Rush
Molinia caerulea	Purple Moor-grass
Nardus stricta	Mat-grass
Narthecium ossifragum	Bog Asphodel
Potentilla erecta	Tormentil
Pteridium aquilinum	Bracken
Racomitrium lanuginosum	Woolly Fringe-moss
Ranunculus repens	Creeping Buttercup
Rhynchospora alba	White Beak-sedge
Rhytidiadelphus squarrosus	Springy Turf-moss
Rumex acetosella	Sheep's Sorrel
Sphagnum compactum	Compact Bog-moss
Sphagnum capillifolium	Acute-leaved/Red Bog-moss
Sphagnum cuspidatum	Feathery Bog-moss
Sphagnum denticulatum	Cow-horn Bog-moss
Sphagnum fallax	Flat-topped Bog-moss
Sphagnum palustre	Blunt-leaved Bog-moss
Sphagnum papillosum	Papillose Bog-moss
Sphagnum spp.	Bog-moss species
Sphagnum subnitens	Lustrous Bog-moss
Sphagnum tenellum	Soft Bog-moss
Trichophorum germanicum	Deergrass
Ulex europaeus	(Common) Gorse
Ulex gallii	Western Gorse
Vaccinium myrtillus	Bilberry
Vaccinium spp.	Bilberry species

Appendix 2. Colour version of Figure 2.

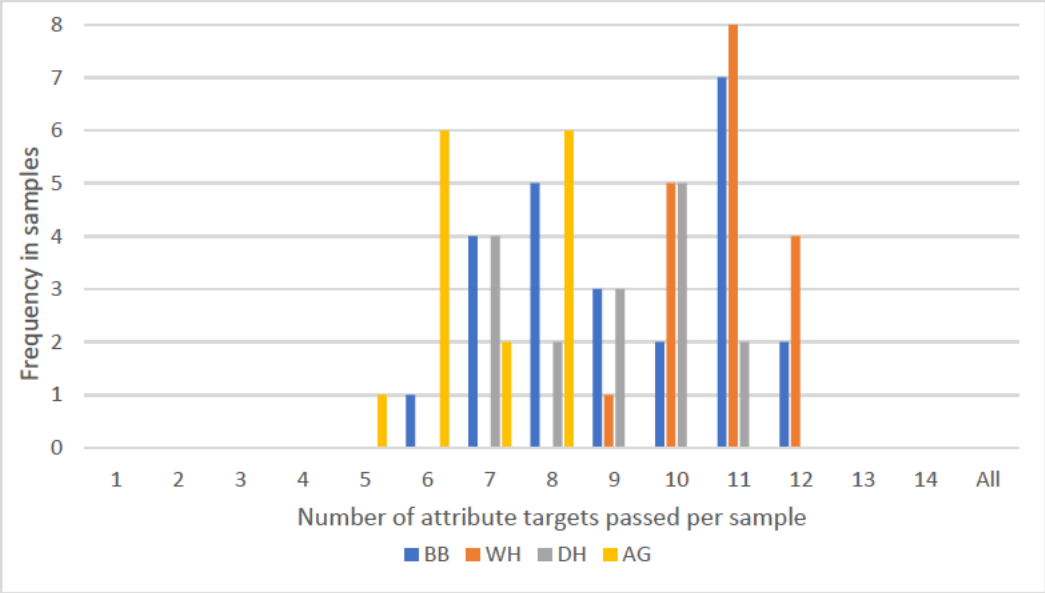

Figure A2. The number of upland CSM attribute targets passed per sample for each habitat in Unit 61 of South Dartmoor SSSI. BB = blanket bog (24 samples and 13 attribute targets assessed), WH = wet heath (18 samples and 15 attribute targets assessed), DH = dry heath (16 samples and 14 attribute targets assessed) and AG = acid grassland (15 samples and 10 attribute targets assessed). A black and white shaded version of the figure is given in **Figure 2**.