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New Forest Wetland Restoration Vegetation Monitoring: Picket Mire, 2022.

Higher Level Stewardship Agreement.

The Verderers of the New Forest AG00300016

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Summary

Picket Mire, situated at the top of the Linford Bottom catchment near Linford in the New Forest, is currently in "Unfavourable Recovering" condition due to historic modifications to the watercourse that have resulted in a straightened, incised channel which is undergoing significant headward erosion. This is impacting on the wetland habitats surrounding the watercourse in addition to the watercourse itself. Forestry England are therefore considering works involving a small amount of selective felling, infilling of the scour basin and bed-raising to restore natural functioning to the wetland system.

The draft New Forest Freshwater and Wetland Restoration plan has been developed on behalf of the New Forest Freshwater and Wetland Restoration Forum to establish common ground and provide guidance on the overall restoration process, including establishing overall objectives, criteria for the selection of sites for restoration, likely measures of success, pre-restoration surveys, restoration protocols and appropriate monitoring. The proposed Picket Mire restoration provides an opportunity to trial the approach laid out in the plan, including undertaking "meso-habitat" mapping and vegetation surveys to understand the extent, distribution and condition of the key wetland habitats for which the New Forest freshwater and wetlands are so important.

Habitat mapping and vegetation sampling was therefore carried out during August-September 2022 following the monitoring protocol from the plan (which is appended to this report). This includes using "meso-habitats" which are not easily mapped using vegetation survey techniques that are typically employed such as Phase I (or now UKHab) habitat mapping or National Vegetation Classification community mapping.

Picket Mire was found to support a range of wetland types including Floodplain Lawn, Oligotrophic Stream, Poached and Disturbed Habitat, Valley Bog, and Wet Heath which between them supported at least 96 species, almost all of which were typical of the habitats surveyed. The current extent and distribution of these habitats reflect the historic modifications and the quality of some had clearly also been impacted.

The data provided will provide a useful baseline against which to compare the habitats and vegetation communities post restoration. Additional monitoring may be required (e.g. geomorphological surveys). Given the small size of the site and the limited nature of the interventions required, this may not be necessary, although it would be useful to trial the overall monitoring approach, which requires information from the different surveys to be integrated to provide a narrative of change.

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Acknowledgements

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1. Introduction

Overview

1.1 The freshwaters and wetlands of the New Forest are of exceptional importance at an international level for the habitats and species they support. However, the New Forest has a history of freshwater and wetland modifications that have impacted on the interest features of the New Forest protected sites (Site of Special Scientific Interest, Special Area of Conservation, Special Protection Area and Ramsar site).

1.2 In particular, the canalization of watercourses has led to the direct loss of aquatic and marginal habitat (through the loss of meanders) while the erosion caused by faster water flow has resulted in incised channels with lowered beds and the loss of natural geomorphological features. This has again led to the direct loss of habitats and increased drainage of the adjacent wetland habitat. Together with bank-side spoil banks, it has also disrupted the interaction between the water course and the surrounding floodplain, again leading to the loss of habitat (such as ephemeral pools and poached and disturbed habitat) and the drying out of valley mire and wet lawn vegetation. Prevention of natural flooding also concentrates energy within the watercourse, further exacerbating erosion. In some cases, lowered stream beds have led to the headward erosion of watercourses within mires, causing destabilisation and the loss of peat.

1.3 For over 20 years, work has been undertaken in the New Forest to remove modifications and reinstate natural processes as the driving force behind naturally functioning habitat mosaics that support characteristic assemblages of species. In 2016, the New Forest Freshwater and Wetlands Restoration Strategy 2019 (Hill et al., 2019) was developed with a wide range of stakeholders. Among other aspects, this strategy highlighted the need for effective monitoring and in 2022 the New Forest Freshwater and Wetlands Evidence and Monitoring plan was finalised (Lake, 2022) (note that this plan

will form part of the New Forest Freshwater and Wetland Restoration Plan (FWRP), currently in prep.).

Proposed monitoring

1.4 The Evidence and Monitoring Plan sets out recommendations for both pre-restoration surveys and post-restoration monitoring, and includes a number of monitoring principles and a recommended approach. In 2022, Forestry England (FE) identified three sites where two of the suggested monitoring approaches could be trialled - meso-habitat mapping and vegetation surveys. Two of the sites had already undergone restoration and significant survey work had therefore been undertaken to inform the planning process. This survey work was not set up to provide a baseline for future monitoring tailored to identify the outcomes of the restoration. However, the proposed approach will identify the current extent and quality of habitat, although it cannot provide a quantitative comparison with the pre-restoration surveys. The third site is yet to be restored and therefore offers an opportunity for the approach to be fully trialled.

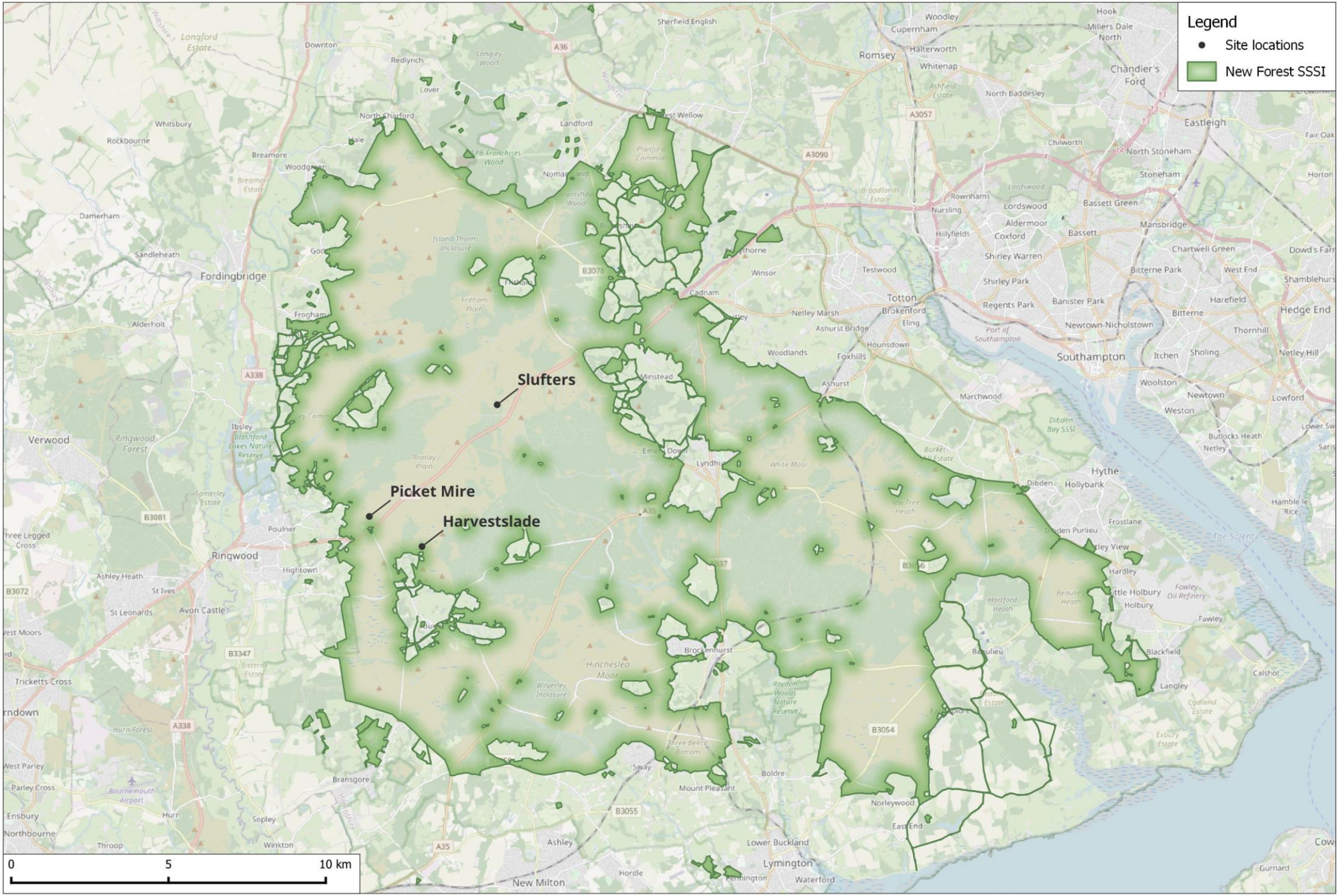
1.5 In the Evidence and Monitoring Plan, meso-habitat mapping is recommended in order to evidence any change in extent of the specific meso-habitats that are an important feature of the New Forest wetland habitats, such as poached and disturbed margins and ephemeral pools (these quintessential New Forest habitat are described fully within the FWRP). Specific targets for increase in area are not appropriate, as changes will be driven by natural processes and the exact outcome cannot be predicted, but an overall increase in the extent and diversity of wetland habitats is likely to be a desired outcome. Meso-habitat mapping is recommended because Phase 1 (JNCC, 2010) and its more recent equivalent, UKHab[1]) do not adequately differentiate the quintessential New Forest habitats. Similarly, NVC maps, although providing more detail about the vegetation communities, do not show the distribution and extent of the habitats without further interpretation and in many cases small-scale features are often mapped as a mosaic rather than individually.

1.6 More detailed vegetation work is also recommended to assess the quality of the restored habitat – for example, is there an increase in the cover and diversity of Bog-mosses *Sphagnum* in the mire, does poached marginal habitat include characteristic species such as Pillwort *Pilularia globulifera.* For

[1] https://ukhab.org/

post restoration sites, direct comparison with previous data is not possible, as suitable data were only collected to inform NVC surveys so were only collected from one or two quadrats per habitat type, which does not allow for the variety found within the habitats.

Map 1: Site locations



The sites

1.7 The sites chosen to trial the monitoring approach in 2022 were Harvestslade, Slufters and Picket Mire (see Map 1).

1.8 Restoration has already been carried out at Harvestslade and Slufters, and these sites are reported on separately. Picket Mire has been identified by Natural England as requiring restoration, and Forestry England progressed work at this site in the summer of 2023. This site offers the first opportunity to follow the approach set out in the New Forest Freshwater and Wetlands Restoration Plan, including setting up habitat and vegetation monitoring that will provide a narrative of change. This involves mapping meso-habitats (to allow an assessment of changes in the extent and distribution of typical New Forest wetland habitats) and sampling the vegetation within different meso-habitats (to provide more detailed information on the characteristics of the vegetation). The meso-habitats are those described in the draft Freshwater and Wetland Restoration Plan and include, at Picket Mire, Valley Bog, Poached and Disturbed Habitat, Wet Lawns and also wet heath (capitalized habitats are those described in the Restoration Plan). These meso-habitats are referred to simply as habitats in the report.

Picket Mire

1.9 Picket Mire is a small area at the southern tip of Picket Bottom within the Linford Brook catchment, located within the open Forest near Picket Post just north of the A31. It drains northwest via a drainage ditch which develops into a stream and runs through Little Linford Inclosure before emerging onto the Open Forest again, just before it joins the Linford Brook. The immediate area around the proposed restoration includes an area of Wet Lawn, Wet Heath and Valley Bog (in the form of seepage step mires) together with an old wooded Inclosure surrounded by a bank and ditch that is now open to grazing animals.

1.10 Work was carried out in 2015 at Picket Bottom to raise the bed level of the watercourse and reinstate the remnant stream meanders in order to allow the stream to reconnect with the surrounding floodplain. The SSSI unit (Picket Bottom 091[2]) was assessed in 2020 as unfavourable-recovering. Although the current management of the area was considered appropriate and the restored stream and mires were recovering well, significant

[2] https://designatedsites.naturalengland.org.uk/UnitDetail.aspx?UnitId=1027404

headward erosion along the ditch that runs parallel with the old inclosure bank meant that it was scored as Unfavourable Recovering. The ongoing erosion has resulted in a 2m high erosion face with an undercut bank and has incised the ditch for around 15m, resulting in drainage of the adjacent mire habitat. Above the erosion face, there are a number of smaller nick points moving up the watercourse where it flows through wet lawn, thought to be due to the increased speed of flow.

1.11 The planned restoration is shown in Map 2. Further detail can be found in the FE document "*SSSI restoration plan 2023: Picket Mire Unit 91*". Work entails selective tree felling to allow access to the watercourse and facilitate the works, bankside reprofiling and channel infilling along approximately 100m of the ditch, plus infilling of nick points and bed-level raising in order to stabilise the erosion and allow the watercourse to interact with its floodplain while preventing further damage to the ditch and bank heritage feature. Additionally, an old fenced off sewage works hole will be infilled with inert material to make it safe for livestock. Specifically:

- The nick points at the top of the mire that continue intermittently for 37m will be infilled using hoggin, and bare surfaces will be revegetated using translocated turf
- The eroding drop off point ("waterfall") and deeply incised channel below it will be infilled using hoggin and rejects with clay plugs as necessary to bring it to the level of the surrounding ground
- The level of the watercourse bed beyond this will be raised for 34m using hoggin/rejects

1.12 This methodology was selected because the mire dries out seasonally (using heather bales to infill nick points is only effective at sites where they will be permanently inundated with water).

Map 2: Restoration works carried out at Picket Mire

2. Methods

Determining the site boundary

2.1 A monitoring site boundary was identified in order to provide a definitive limit to the survey area to enable a quantitative comparison of the number of different habitats present over time.

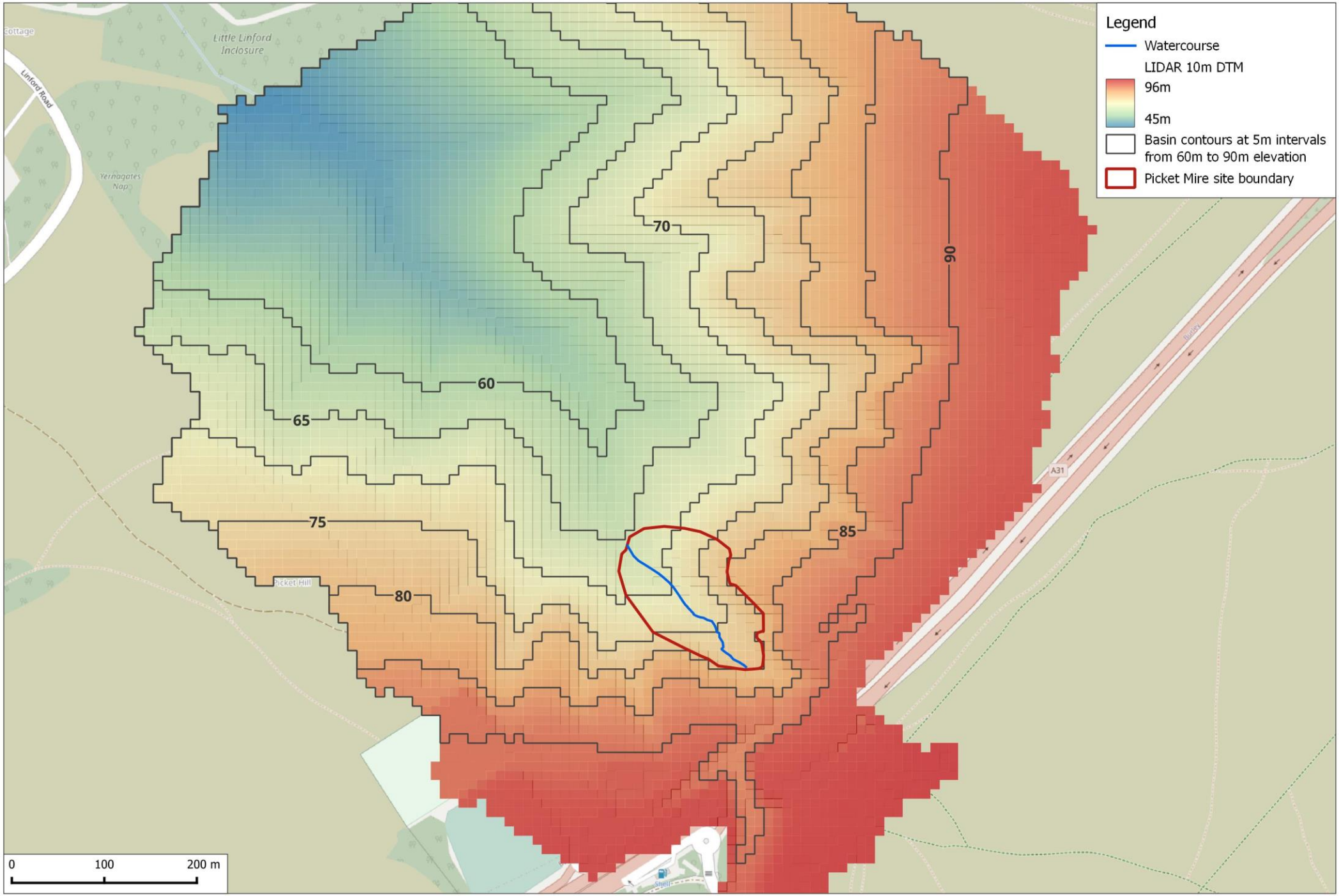
2.2 We used the Environment Agency 2019 Lidar Composite Digital Terrain Model (DTM) which is a raster elevation model with a resolution of 10m. 'Watershed' and 'water outlet' tools were executed in QGIS to define a basin for the site. The elevation was then added to the basin layer so that an appropriate maximum height could be selected, as a basis for the site boundary. This boundary was then further refined as necessary in the field (see Map 3).

2.3 The topography within the restoration ranged from just below 85m to just above 65 metres. However, as the watercourse drops down into Picket Bottom, the small valley that holds Picket Mire fans out widely, meaning that a large area of habitat some distance from the watercourse would have been included if these contours were used to define the site boundary. Therefore the western and eastern boundaries were chosen in the field based on local topography and change in vegetation. The south-western boundary followed the 80m contour then dropped at right angles down to the 60m contour roughly parallel with the drain and a few metres to the north-west, to ensure both banks of the restored channel would be included in future monitoring. The south-eastern boundary again followed the 80m contour then dropped down to the 60m contour following the break in slope.

Fixed point photography

2.4 A number of photographs were taken of key features with the intention that they could be used as a baseline for fixed point photography in the future.

Map 3: Height data used to identify a site boundary for Picket Mire



Landscape context of habitats

2.5 Following the surveys at Harvestlade and Slufters, it was recognised that a "pen portrait" or written description of the monitoring site would be very useful in helping to interpret monitoring data (including different monitoring techniques such as geomorphological surveys). Therefore, a description of each habitat along and around the watercourse and how they interact was made in the field during the survey.

Meso-habitat mapping

2.6 Mapping was undertaken within the monitoring boundary using a combination of desk-based examination of aerial imagery combined with fieldwork, and were digitised using QGIS 3.22. Habitats were characterised by the typology defined by Neil Sanderson who was commissioned to inform the New Forest Freshwater and Wetlands Restoration Plan (in prep) (see Table 1). These include typical New Forest "meso-habitats" such as the poached and disturbed edges of water courses and ephemeral pools. Fieldwork was undertaken between 14th August and 20th September 2022, following a particularly dry summer. Note that "meso-habitats" are referred to simply as habitats in the report from this point forwards.

Detailed vegetation monitoring of wetland habitats

2.7 The percentage cover of vascular plants, bryophytes and lichens were recorded from one 2m x 2m quadrat at up to 10 random points within each wetland habitat (the number of quadrats was constrained by the size of the site and habitat patches). Woodland and Bracken-dominated Dry Heath were not sampled as it was considered that the topography precludes the likelihood of these habitats being influenced by the restoration at this site. However, Wet Heath was included as, although not technically a wetland habitat, it is low-lying and includes areas of Valley Bog and is potentially likely to be influenced by any hydrological changes due to the proposed restoration work. Occasionally, linear quadrats of 1m x 4m or 0.5 x 8m were used (for example, for in-channel vegetation). The percentage of bare ground, open water, litter and dung was also recorded and the bulk of the vegetation (using a drop disc of 15cm diameter, 200g weight). A total of 49 quadrats were recorded (the area of some habitats was too small for 10 quadrats).

2.8 The original method involved creating random points using the same approach as at Harvestslade and Slufters; however, this did not prove to be feasible. The habitat polygons were in many cases too small for the approach to be used as buffering the polygons greatly reduced the area available, while GPS accuracy of around 3m meant that points were often outside of the required habitat. Instead, random quadrat locations were chosen in the field using the old-fashioned method of throwing a peg.

Table 1: Habitats present within the monitoring areas at Picket Mire. Habitats in bold are those described in the New Forest Freshwater and Wetlands Restoration Plan that are the focus of the restoration monitoring. The remaining habitats were mapped to provide context but were not studied in more detail. Wet Heath has been added to the detailed monitoring as it is likely that this could be affected by the restoration.

Habitat	Description	Included in the detailed vegetation monitoring
Dry broadleaved woodland	Generally dominated by oak *Quercus* sp. and/or Silver Birch *Betula pendula* with a Bracken *Pteridium aquilinum* and acid grassland understory, with some Bramble *Rubus fruticosus* and scrub species (Hawthorn *Crataegus monogyna*).	
Lowland dry heathland	Bracken-dominated "humid" heath with Heather *Calluna vulgaris*, Purple Moor-grass *Molinia caerulea* and Gorse *Ulex europeaus*.	
Lowland wet heathland	Dwarf Shrub and grass dominated habitat supporting Cross-leaved heath *Erica tetralix*, Heather, Purple Moor-grass and Bog-mosses *Sphagnum* spp.	✓
Floodplain lawn	Characterised by closely- grazed grasses including Purple Moor-grass and Heath Grass *Danthonia decumbens* with Velvet Bent *Agrostis canina* and Jointed Rush *Juncus articulatus*. Tormentil *Potentialla erecta*, Self-heal *Prunella vulgaris,* Smooth Hawk's-bit *Crepis capillaris* and Lesser Skullcap *Scutellaria minor*, are some of the forbs present	✓
Floodplain lawn (under canopy)	A modified version of Floodplain Lawn with wetter areas with Bog-mosses, also typical woodland bryophytes and a significant cover of leaf litter under an open woodland canopy.	✓
Valley Bog (seepage step mire)	Characterised by Common Cotton-grass *Eriophorum angustifolium,* White Beak-sedge *Rhynchospora alba*, Bog Asphodel *Narthecium ossifragum*, Round-leaved Sundew *Drosera rotundifolia* and a variety of Bog-mosses	✓
Poached and disturbed vegetation	A variable community found in Floodplain Lawn with sparse Purple Moor-grass, Heath Grass, Lesser Spearwort, Sharp-flowered Rush,	✓
Oligotrophic stream	Largely open water. In channel and marginal vegetation typically includes Bog Pondweed *Potamogeton polygonifolius*, Sharp-flowered Rush *Juncus acutiflorus*, Marsh St. John's-wort *Hypericum elodes*, Lesser Spearwort *Ranunculus flammula* and Common Marsh-bedstraw *Galium palustre.*	✓

3. Results

Landscape context of habitats

3.1 Picket Mire forms the southernmost arm of the Y-shaped upper catchment of Linford Brook. A small indistinct watercourse runs through close-grazed Floodplain Lawn (grazed by both New Forest ponies and British White cattle at the time of the survey). The watercourse has a mixed gravel and silt bed with multiple indistinct shallow channels, which were heavily poached in places at the time of the survey. This upper section of the watercourse (Oligotrophic Stream) is eroded in places and unstable. Where it joins the woodland at a willow *Salix* sp. copse there is a significant erosion face with a scoured basin below. From this point, the water flows through a deeply incised and shaded straight channel which flows along the Inclosure bank. This gradually shallows out towards the bottom of the Inclosure where the watercourse joins sources lower down the slope to flow into Picket Bottom.

3.2 Immediately above the watercourse (to the south), the grassland is drier, although there was a distinct poached strip at the time of the survey - a winter visit is needed to clarify whether this holds water in the winter. To the north-east, the Lawn transitions into Wet Heath as the land rises away from the floodplain. To the south-west, the watercourse lies adjacent to an area of dry woodland and Bracken patches on higher ground, which encompasses an Inclosure with older woodland that is now open to grazing animals. The slopes to the north-east supporting Wet Heath contain a complex of seepage step mires with classic Valley Bog vegetation, and some of these descend down the slope to the channel. However, the hydrology has been interrupted by modifications to the channel, and on this side of the watercourse there is a strip of grazed, open woodland with a modified Floodplain Lawn flora. Above the watercourse, at the break of slope, the Wet Heath transitions to Bracken-dominated dry (humid) heath.

Meso-habitat mapping

3.3 Map 3 habitat, boundary and current watercourse show the extent and distribution of habitats at Picket Mire. Areas are presented in Table 2. A strip of grazed woodland with a sparse canopy on the north-east side of the channel was mapped as Floodplain Lawn under canopy due to floristic similarities with the Floodplain Lawn just upstream. Oligotrophic Stream in-

channel vegetation was very limited and too small to map as a polygon. The approximate line of the channel has been included in Map 4 (note that GPS accuracy was reduced under the tree canopy).

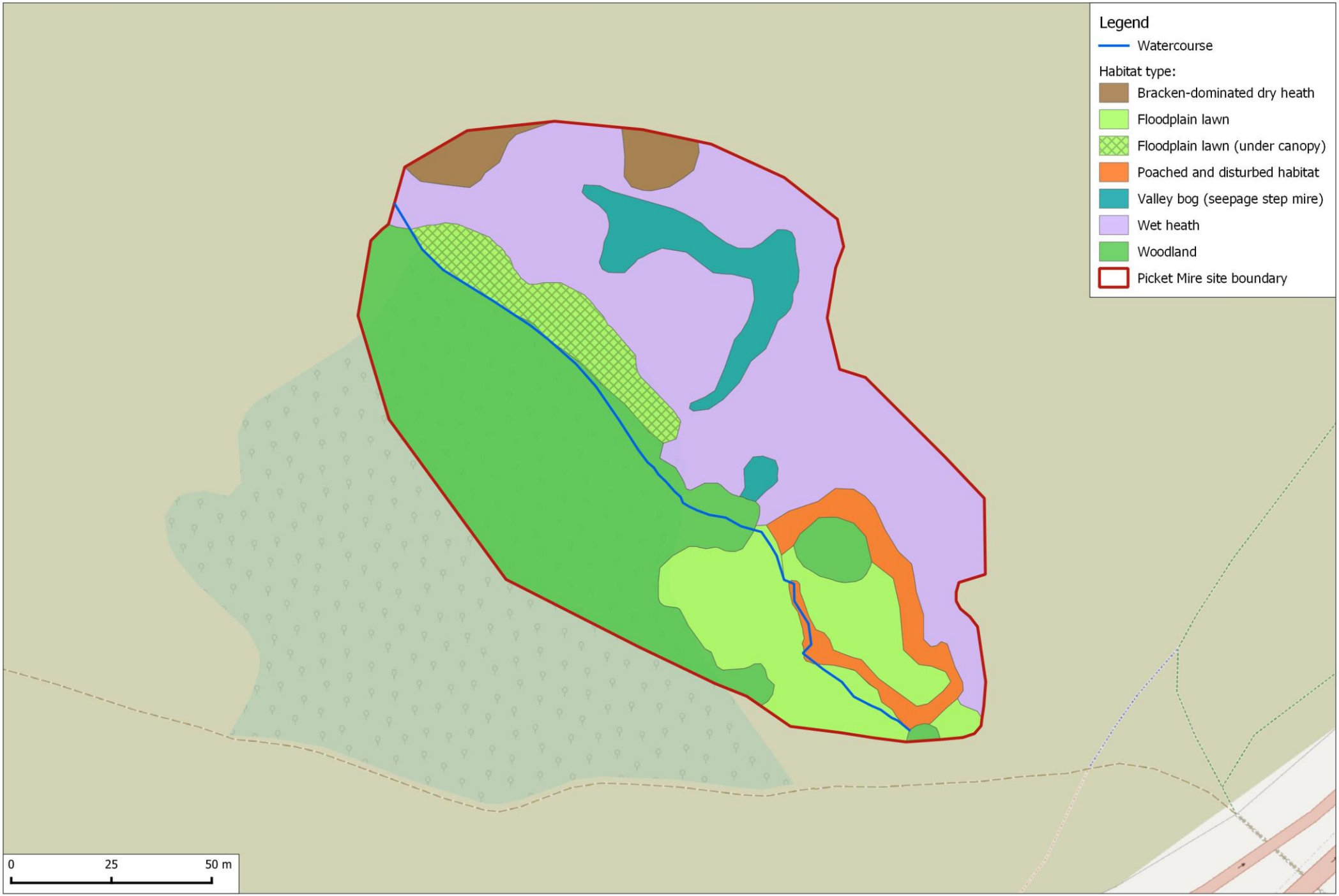
Table 2: Area in square metres of habitats mapped at Picket Mire within the monitoring boundary

Meso-habitats	Area (m^2)
Wet Heath	5980
Woodland	5210
Floodplain Lawn	2040
Valley Bog (seepage step mire)	900
Floodplain Lawn under canopy	860
Poached and Disturbed Habitat	680
Bracken-dominated Dry Heath	480

Vegetation

3.4 Figure 1 and Tables 3 provide summary data for key characteristics (sward bulk, species numbers and percentage cover of bare ground, plant litter, and key plant groups). The raw data, including species cover, are provided in an Excel spreadsheet accompanying this report.

Map 4: Picket Mire habitats



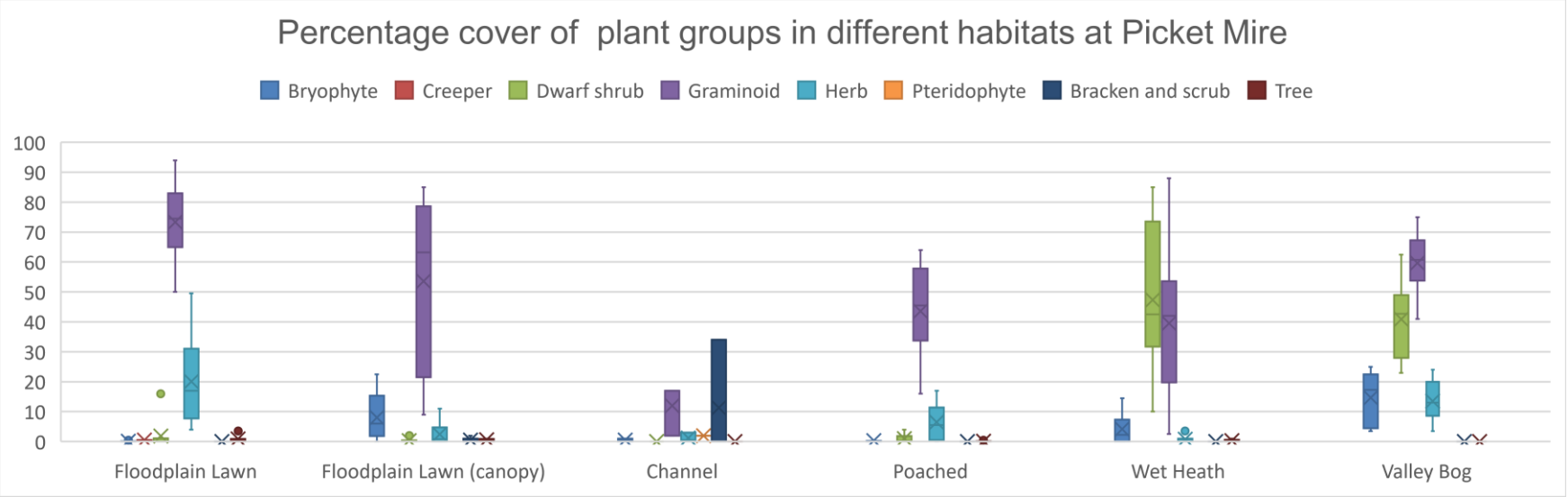


Figure 1: Box plots indicating the cover of different plant groups according to habitat type at Picket Mire (the solid box shows the interquartile range, with the median value represented by X. Whiskers indicate the minimum and maximum values.

Table 3: Species richness and other variables recorded from quadrats within each wetland habitat type surveyed at Picket Mire.

	Floodplain Lawn	Floodplain Lawn (with canopy)	Oligotrophic Stream (in-channel)	Poached and Disturbed Habitat	Wet Heath	Valley Bog
Bare ground (%)	4.9(+/-1.35)	9(+/-1.9)	81.33(+/-10.81)	48.9(+/-4.27)	5.3(+/-1.82)	4.88(+/-1.26)
Leaf litter (%)	0.8(+/-0.41)	30.63(+/-12.71)	0.33(+/-0.33)	0(+/-0)	2.05(+/-0.63)	1.25(+/-0.37)
Dung (%)	0	0	0	0	1(+/-0.47)	0
Sward Height (cm)	2.5(+/-0.27)	4.25(+/-0.65)	12.33(+/-9.06)	3.7(+/-0.68)	20(+/-3.3)	10(+/-0.83)
No. of species	13.7(+/-0.9)	8.63(+/-1.18)	5.67(+/-1.2)	14.6(+/-1.8)	7.6(+/-0.65)	9.25(+/-0.37)

Habitat descriptions

Oligotrophic Stream

3.5 At the top (southern tip) of the site, the channel is poorly defined and heavily poached, with no in-channel or marginal vegetation. The highly incised channel below the erosion face is bare and heavily overhung with Bracken and Bramble growing from the bank top. A few metres further downstream, two large oaks have fallen across the stream and below this, although the channel is still incised where it runs along the Inclosure bank, it is wider and more open, although there is little or no marginal or in-channel vegetation. Towards the end of the woodland, it shallows out and there is sparse marginal vegetation, mainly Creeping Bent *Agrostis stolonifera* with a little Bulbus rush *Juncus bulbosa* and Soft Rush *Juncus effusus*. Herbs are very sparse and represented by Lesser Spearwort *Ranunculus flammula*, Lesser Skullcap *Scutullaria minor*, Marsh Willowherb ***Epilobium palustre,*** Water-pepper *Persicaria hydropiper* and Common Marsh-bedstraw, and the banks support occasional Lady Fern *Athyrium filix-femina* and the liverwort *Pellia epiphyllia*. **In its current form, the watercourse does not represent a good example of Oligotrophic Stream**. An interesting comparison can be made with the channel below the woodland, where it is stable (see Figure 2 below, compared to Photos 1 and 2). Here the watercourse is shallow without banks and supports characteristic Soakway vegetation with abundant Marsh St. John's-wort *Hypericum elodes*, Bog Pondweed *Potamogeton polygonifolius* and Floating Club-rush *Eleogiton fluitans.*

Poached and Disturbed habitat

3.6 This was found in the wetter channels in the main area of Floodplain Lawn, also fanning out horizontally across the lawn. The boundary between Poached and Disturbed Habitat, Wet Heath and Floodplain Lawn was highly complex as these habitats formed a fine-scale mosaic, and transitional habitat was widespread. The boundaries were simplified for the purposes of mapping according to the predominant type, but it is recognised that these boundaries will change according to livestock pressure and season.

3.7 Poached and Disturbed Habitat was characterised by Velvet Bent *Agrostis canina*, Purple Moor-grass *Molinia caerulea* and Creeping Bent *Agrostis stolonifera* with varying amounts of Deergrass *Trichophorum germanicum*. Other species included small sedges such as Carnation Sedge *Carex panicea* and Yellow Sedge *Carex demissa*, Bulbous Rush *Juncus bulbosa* and a variety

of herbs associated with damp and wet grassland including Lesser Skullcap, Lesser Spearwort, Marsh Pennywort *Hydrocotyle vulgaris,* Bog Pimpernel *Lysmachia tenella* and Trailing St. John's-wort *Hypericum humiferum.* There were also species characteristic of neutral New Forest greens, including Chamomile *Chamaemelum nobile*, Daisy *Bellis perennis*, Dandelion *Taraxacum agg.* etc., particularly in the top southern area where the Floodplain Lawn transitions into drier grassland. In contrast, areas transitional to Wet Heath included a little Cross-leaved Heath and occasional bog-mosses. **On the whole, this habitat reflected the composition of the surrounding habitat rather than supporting typical species associated with Poached and Disturbed Habitat across the New Forest such as Pillwort *Pilularia globifera* or Lesser Marshwort *Helosciadium inundatum.***

Floodplain Lawn

3.8 Floodplain Lawn occupies the narrow floodplain at top of the site and extends to some 0.2ha. This was characterised by fine grasses such as Creeping Bent and Velvet Bent with small sedges, and some well-grazed Purple Moor-grass and rushes. Herbs include characteristic species such as Meadow Thistle *Cirsium dissectum*, Marsh Pennywort, Bog Pimpernel, Marsh St. John's-wort *Hypericum elodes* and Common Marsh-bedstraw *Galium palustre,* although there were also patches of Chamomile, indicating slightly drier, more nutrient-enriched conditions. Towards the north-eastern periphery, species such as Cross-leaved Heath *Erica tetralix* indicated a transition towards Wet Heath. **This habitat aligns well with the description of Wet Lawn in the FWRP.**

3.9 Floodplain Lawn is also found between the Wet Heath and Valley Bog (seepage step mires) and the watercourse where it runs alongside the Inclosure bank. Here, the tree canopy shades the vegetation and greatly increases the cover of leaf litter. The lawn here is partly fed by the seepage mires on the slope above and in some places supports a variety of bog-mosses. However, there are also more typical woodland species present such as *Orthotrichum affine, Polytrichum formosa* and *Thuidium tamariscinum.* **This area of Floodplain Lawn is transitional in nature and does not align so well with the FWRP descriptions.**

Wet Heath

3.10 Wet Heath is the most extensive habitat within the Picket Mire monitoring area and occupies the valley side forming the south-eastern boundary to the area. Dominated by Heather *Calluna vulgaris*, Purple Moor-grass and Cross-

leaved Heath with Creeping Bent and Velvet Bent, it also supports bog-mosses (particularly *Sphagnum tenellum, also S. palustre, S. denticulatum, S. compactum, S. subnitens and S. cuspidatum*) and other species indicative of permanently waterlogged conditions such as White Beak-sedge *Rhynchspora alba,* Common Cottongrass *Eriophorum angustifolium* and Bog Asphodel *Narthecium ossifragum.* Other characteristic species such as Round-leaved Sundew *Drosera rotundifolia* are also present. The wet heath is generally in good condition and can be assigned to the National Vegetation Classification wet heath M16 *Erica tetralix – Sphagnum compactum* wet heath (Rodwell, 1991) (a description is not currently available in the draft FWRP). It forms a transition with Floodplain Lawn where it reaches the small floodplain of the watercourse.

Valley Bog

3.11 Valley Bog is found in the form of a complex array of seepage step mires within the Wet Heath-dominated slope above the watercourse to the south-east. The seepage mires are small but interlinked and form an intricate mosaic with the Wet Heath, although an attempt was made to map them separately. The vegetation is characterised by Bog Asphodel and White Beak-sedge with Deergrass and an array of bog-mosses similar to that found in the adjacent Wet Heath, plus Jointed Rush *Juncus articulatus,* Round-leaved Sundew and Purple Moor-grass. **The Valley Bog aligns well with the FWRP description and is generally in good condition although the interaction with the watercourse has been interrupted and some areas of transitional, rather poached vegetation appeared to be affected by the draining action of the incised watercourse.**

Fixed-point photographs

3.12 Several photographs were taken at locations chosen to show the areas where restoration works will be carried out, plus provide contextual information about each habitat type.

Photo and Grid Refence	Description	2022 image
1. SU19189 06295	Looking down the watercourse from the top of the monitoring area. The channel is characterised by Poached and Disturbed Habitat and runs through Floodplain Lawn until it reaches the wooded Inclosure	
2. SU19163 06330	Looking up the channel from the bottom of the Floodplain Lawn. Here the channel has become a little more incised	

Photo and Grid Refence	Description	2022 image
3. SU19119 06378	Looking upstream at the erosion face, which is concealed by overhanging Bramble and Bracken. The channel is deeply incised here	
4. SU19102 06386	The channel remains incised downstream where it runs along the Inclosure bank but gradually becomes shallower.	
5. SU19119 06378	Floodplain Lawn under a light tree canopy on the north-eastern bank of the watercourse	

Photo and Grid Refence	Description	2022 image
6. SU19128 06405	Valley Bog in the form of seepage step mires within Wet Heath on the north-eastern slopes of the monitoring area	
7. SU19171 06374	Wet Heath above the floodplain, looking south towards Picket Hill	

Species of note

3.13 Notable and protected species data were requested from HBIC for the site and surrounding area. Chaffweed *Centunculus minimus* was recorded within the 100m grid square within which most of the site sits in 2013. Chaffweed is considered to be Endangered in England (Stroh et al., 2014) and Near Threatened in the UK (Leach, 2021). This species is one of a suite of small summer annuals typically found in winter-wet rutted paths. It was not observed during the survey and may previously have been recorded from one of the paths, rather than the habitat patches surveyed. In general, this species is likely to benefit from wetter conditions, but its response will depend on the exact location and changes in microhabitat.

3.14 In addition, Chamomile was recorded from the very southern tip of the site in 2013 and also during this survey. This species is Vulnerable in England

(Stroh et al., 2014), and Great Britain (Cheffings et al., 2005), and is a priority species listed under S41 of NERC Act 2006. Chamomile was observed to be a component of the Floodplain Lawn just above the watercourse where the grassland was drier. Chamomile requires seasonally wet conditions (e.g., Stroh et al., 2023). In general terms, it is likely to benefit from damper conditions, but its response to the restoration will depend on the extent of re-wetting - it is not a classic species of Floodplain Lawn, but is often found on drier banks and hummocks within floodplains. Although nationally Vulnerable, it is widespread on roadsides and neutral greens throughout the New Forest.

4. Discussion

4.1 Despite modifications, the New Forest wetlands are generally of very high nature value. The restoration of natural processes as a driving force shaping habitats and species assemblages is not necessarily expected to change the types of habitat present but to change the extent, distribution and quality of such habitats. The monitoring carried out at Picket Mire should provide a baseline against which future monitoring data can be compared. For example, it should show whether the condition of the Oligotrophic Stream has improved with in-channel and marginal vegetation developing, whether the Poached and Disturbed Habitat has diversified. Similarly, the Floodplain Lawn and Valley Bog may become wetter, possibly with corresponding vegetational changes, and change in area.

4.2 Cattle numbers have been notably high here in the recent past, although are thought to have reduced somewhat (S. Oakley, J. Thomas pers. comm). Future monitoring should consider the potential impact of livestock on the restoration – for example, the degree of poaching in the Floodplain Lawn. A site visit should also be carried out earlier or later in the season. Recent weather patterns have been variable[3], with both heat waves and storm events more frequent, the New Forest wetlands are generally significantly drier in the summer, when botanical recording is usually carried out. A winter visit would allow a more comprehensive assessment of habitat re-wetting.

[3] https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/weather/learn-about/uk-past-events/summaries/uk_monthly_climate_summary_annual_2022.pdf

4.3 The site is very small and probably does not warrant a full physical survey (e.g. River Habitat Survey or geomorph survey). However, a written description, including photographs and measurements of key features (such as the depth of the erosion face, the length of the gullied stream etc.) would provide a useful baseline for showing changes in the physical character of the watercourse post-restoration.

4.4 In this case, additional species data (provided through the local environmental records centre) provided additional context in terms of notable species present at the site within the past 10 years but does not provide sufficient baseline data to interpret changes in the population of any specific species. It will be interesting to note the presence or absence of Chamomile in the upper Floodplain Lawn in future monitoring. Similarly, it would be of interest to search for Chaffweed, although this is a dynamic annual species and populations would be expected to fluctuate naturally depending on disturbance and other factors.

Figure 2: Soakway picking out the watercourse where it runs through Wet Lawn downstream of the modified section of the watercourse at Picket Mire (below the proposed restoration area) in 2023 prior to the restoration work.

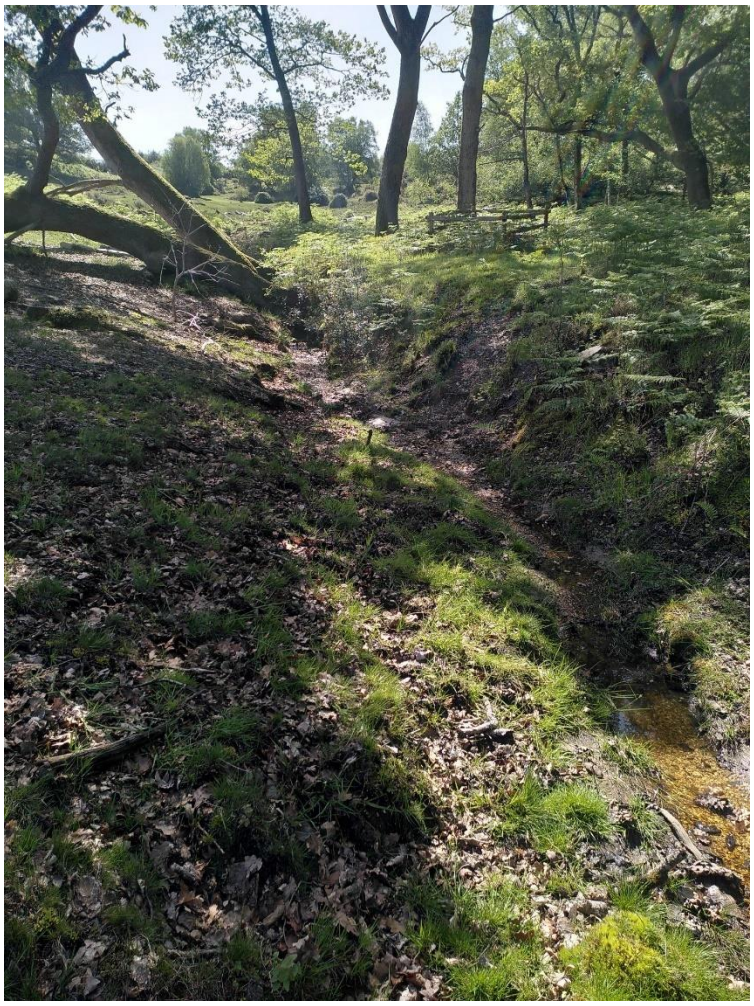


Figure 3: The watercourse below the erosion face where it runs along the ditch below the inclosure bank in 2023 prior to restoration work.

Recommendations

4.5 The process of carrying out the meso-habitat and vegetation baseline monitoring has raised a number of points:

- Familiarity with the site at different times of year would be useful (e.g. to confidently identify features that dry out in the summer months). If this is not possible, a site visit with someone with suitable experience of the site would be informative.
- A preliminary site visit with someone with first hand experience of proposed restoration is very useful to help target the monitoring.
- Pragmatism is needed an applying the protocol which should be flexible, for example at Picket Mire the approach to identifying the boundary and quadrat locations was adapted due to the small size of the site, and differentiation was made between areas of Floodplain Lawn depending on canopy cover.

- The FWRP suggests measures of success for restorations. These should be reviewed in the context of Picket Mire and appropriate measures selected to inform future monitoring and allow an objective assessment of the success of the restoration.
- Post restoration, a narrative of change should be created incorporating the data derived from the habitat and vegetation surveys together with the outputs from geomorphological surveys and any other specific surveys undertaken. This will provide an holistic understanding of the post-restoration changes and allow all change to be viewed in the context of the overall change to the site in terms of the measures of success.

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Appendix 1: Wetland restoration vegetation monitoring protocol

This document provides an outline of a trial protocol for monitoring for New Forest freshwater and wetland restorations (see the New Forest Freshwater and Wetland Restoration Strategy: Evidence and Monitoring Plan). It is likely to be used in combination with other monitoring techniques, such as fixed-point photography and geomorphological surveys, providing a layered approach to monitoring in order to show the progress made in the years following restoration interventions. It will build on geomorphological monitoring to show how changes in the structure and function of freshwaters and wetlands result in desirable change to the habitats in terms of the plant communities they support. At the same time, it will provide more detailed quantitative data to underlie changes seen through fixed-point photography.

The protocol is intended to be straightforward to carry out (although some expert botanical skills are necessary e.g. for lower plants). Basic analysis should also be easily achievable, although some additional geospatial analysis and use of multivariate statistics could be useful in some circumstances, for example where more detailed information about changes or community types is required.

This protocol will be trialled for the Harvestslade Bottom and Slufters restorations (which were completed five years ago) and to provide pre-restoration baseline data for Picket Bottom in 2022. The steps are outlined in Figure 1 and described below.

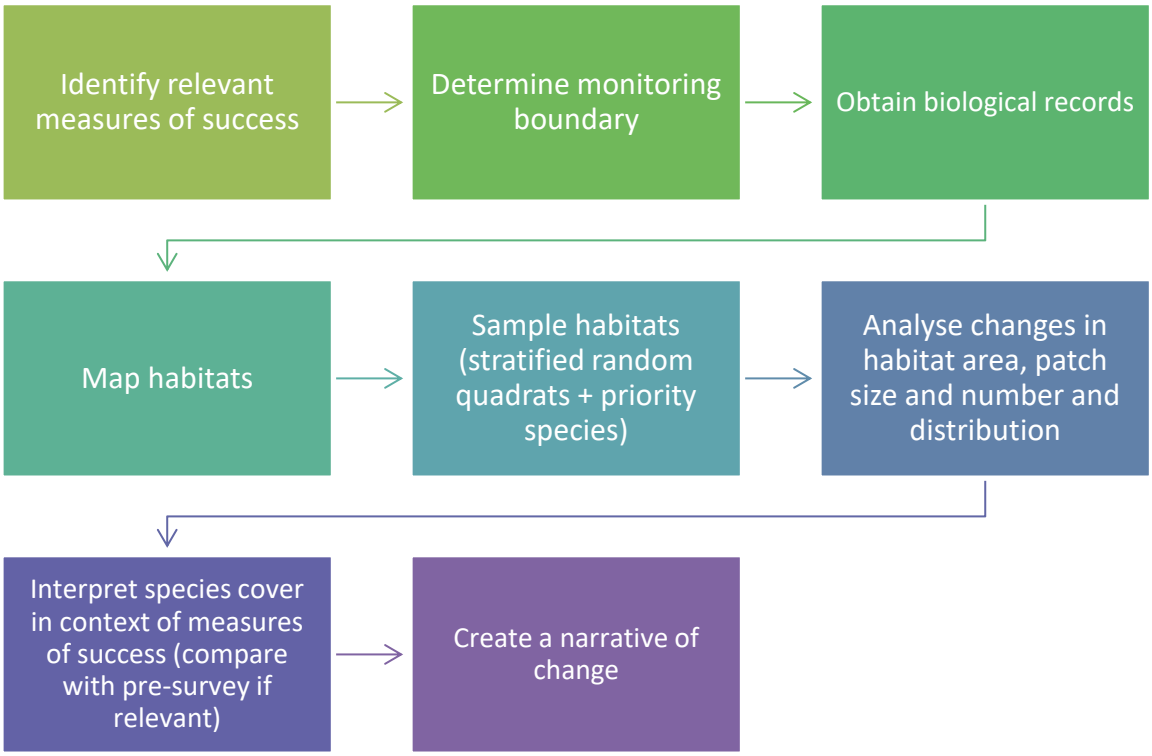

Figure 1: The steps required for vegetation monitoring are outlined below.

Outputs and measures of success

The overall aim of new restorations will be to remove modifications and restore natural processes to allow the characteristic abiotic features and habitats to support the full range of natural species assemblages. The role of vegetation monitoring will be to evaluate restorations by identifying changes in habitat area and quality seen in the vegetation communities representative of characteristic New Forest freshwater and wetland habitats. Specific measures of success will be derived from descriptions of quintessential New Forest habitats, which are currently under development. Measures of success are unlikely to be defined strictly quantitively[4], but may include, for example, an increase in the area of Valley Bog with a concomitant increase in the abundance and variety of Sphagnum mosses, or an increase in the extent of marginal disturbed habitat characterised by species such as Pillwort. Depending on the level of evidence required, it will also be possible to compare post restoration monitoring data with baseline data to provide a more quantitative assessment of change in terms of habitat extent, distribution and quality (again using the measures of success to help define good quality).

For previous restorations, for which measures of success have not necessarily been defined using the new approach[52], it will be necessary to deduce intended outputs from the original project plans. Example outputs relevant to vegetation monitoring could include, among others, increasing the area of valley mire, improving the quality of streamside lawns, increasing the amount of poached and disturbed stream margins, increasing the cover of aquatic vegetation etc.

The success of other outputs, such as restoring meanders or increasing the diversity of in-channel features such as riffles, snags etc. will be addressed separately through geomorphological monitoring, as appropriate.

Monitoring boundary

A site boundary is set for the purposes of the restoration, including planning applications. However, this is not necessarily relevant for the monitoring, as it may include, for example, areas of dry heath that are not part of the restoration but were part of the area used during the restoration for access. A monitoring boundary should be established for pre-restoration surveys that will be relevant after the restoration. This is likely to require a combination of lidar data and aerial imagery plus information from project planning - Lidar data may be used to help inform the boundary by using a maximum contour height and taking into account the planned restoration work.

Biological records

Once the boundary is determined, existing biological records (e.g. from HBIC) should be obtained to provide a baseline. It is not intended that the presence of each species should be reinvestigated after the restoration as part of the monitoring, but such data will provide useful context, particularly for those species that are indicative of particular mesohabitats (see below).

[4] Quantitatively defined targets would difficult to apply where the objective is to restore natural functionality, as the exact outputs may be hard to predict.

[5] See New Forest Freshwater and Wetland Restorations: Evidence and Monitoring Plan.

Data should also be obtained for post-restoration surveys, although it is recognised that surveys and ad hoc records from the intervening period may be limited.

Habitat extent - mapping

Within the monitoring site boundary, the distribution and extent of habitat types should be mapped. Again this may be informed by aerial imagery, but should be ground-truthed, using a GPS where necessary. Mapped habitats will include standard priority habitats (e.g. UK Habitat Classification, level 4) but also the "mesohabitats" typical of the New Forest. The National Vegetation Classification should not be used as it does not adequately describe many of the characteristic habitats of the New Forest, but conversely includes more detail than is required here about other habitats (such as heathland). These "mesohabitats" should be identified with reference to the New Forest quintessential habitat descriptions created by Neil Sanderson that will form part of the overall strategic New Forest Freshwater and Wetlands Plan. However, note that only a subset of these are likely to be present at any one site. The habitat types are likely to include:

- Wet Heath
- Humid Heath
- Valley Bogs (including seepage step mires)
- Bog pools (may be included within Valley Bog)
- Soakways
- Poor Fen
- Moorgrass Mires
- Transition Mires
- Tussock Sedge Fen
- Marl Flushes
- Poached and Disturbed Habitats
- Bog Woodland
- Alder Moor
- Wet lawns
- Temporary and permanent pools
- Temporary Headwater Streams
- Fast and slow flowing Oligotrophic Streams
- Fast and slow flowing Mesotrophic Streams
- Incised Woodland Streams

Baseline mapping may also include non-priority habitats such as coniferous woodland if relevant to the restoration. Mapping should be fine scale, for example at the level of $25m^2$ for most habitats, but it may be necessary to map mosaics (e.g. wet lawn and wet heath). More fine-grained habitat (flushes, soakways, pools etc) should be mapped at a smaller scale if necessary.

As part of the habitat mapping, it is recommended that the locations of target notes from pre-restoration surveys are revisited and re-photographed. An assessment should be made about which locations are most appropriate to visit in the context of the restoration, as not all will be relevant.

The length of time needed for fieldwork is very dependent on the terrain and complexity of the habitat mosaic. As a rough estimate, about 250 ha may be achieved within a day. The length of time required for digitizing will again depend on the complexity of the habitats encountered, but in general is likely to take a similar amount of time (including providing field maps for the next step). The time required for each quadrat will depend on the complexity of the vegetation and the distance

between quadrats. It is estimated that about 18 quadrats can be recorded by one person in a day in this context.

Analysis

Habitats should be mapped in GIS to allow analysis and to provide field maps for habitat quality monitoring. Extraction of key data from the GIS including overall areas of habitat and patch size and number will allow a comparison of pre and post restoration habitat area and distribution. Use of GIS would facilitate the identification of the type of habitat that expanding/new habitats have replaced, if required. Before/after photographs may be used to illustrate change.

Habitat quality – quadrats

Habitat quality should be investigated through stratified random sampling using quadrats to record the percentage cover of different species (also bare ground and plant litter) within each habitat type. This is approach is proposed due to the difficulty of establishing permanent plots in a restoration landscape, and the possibility of missing patchily distributed key mesohabitats if a transect-based approach (at right angles to the flow of water) is taken.

A minimum of 10 quadrats per habitat type is recommended, but this should be increased if the habitat is particularly heterogenous. Similarly, it may be necessary to decrease it if the habitat is very limited in extent (e.g. bog pools, soakways, flushes etc.). Quadrats within dry and wet heath, valley bog, transition mire, lawns and woodland flora should be 2m x 2m. A smaller 1m x 1m quadrat (or a 1m x 4m quadrat) may be needed for habitats likely to occur in small patches such as bog pools, soakways, flushes etc. A measure of vegetation bulk[6] should also be recorded (this provides an indication of the density of vegetation rather than simply the height of the tallest plant). Any notable species within the habitat should also be noted and a grid reference recorded. Where quadrats fall within transitional vegetation (e.g. between Valley Bog and Wet Heath), this should be noted and taken into consideration in the analysis – transitional habitat should not be excluded, as it may be where change is taking place. A single photograph should be taken from a predefined point (e.g. south west corner of each quadrat) to help with interpretation and record the context of the quadrat in the surrounding habitat (multiple photos create a large dataset which often become unmanageable).

A description of each habitat should also be made in the field, as this will help with interpretation and can include elements (species or vegetation structure) that may have fallen outside of the samples.

For each quadrat, the following information should be recorded:

- % cover of each species present (using 0.5% for anything under 1% cover)
- % cover of bare ground, water, plant litter and dung
- Vegetation volume using a drop disc (weight 200g)
- Grid reference (SW corner)
- Size of quadrat
- Photograph (from S edge showing some habitat beyond, rather than straight down)

[6] E.g. using a drop disk which entails dropping a disk of known weight (e.g. 200g) down a central pole and measuring the height from the ground at which it settles.

Analysis

Useful statistics are likely to be the average cover of different plant groups (e.g. dwarf shrubs, graminoids, herbs, bryophytes), the average species richness, the presence of rare or priority species, and the average cover of bare ground and litter and sward height. Creating 'reference values' against which quadrat data could be compared would not only be a very substantial piece of work, it would also be misleading, as the aim of restorations is to improve the quality of habitat (where relevant) through re-wetting and this will potentially result in different proportions of species in different situations. However, variables such as species diversity, cover of graminoids and bare ground give a useful indication of the state of the vegetation that can then be interpreted with reference to the descriptions of quintessential habitat types provided in the New Forest Freshwater and Wetlands Restoration Plan.

Where pre-restoration surveys exist, any changes in the variables recorded can be identified and interpreted in the context of the measures of success. Useful statistical tests may be T-tests or Analysis of variance - the exact approach will depend on the diversity within the data. Ordination techniques may also be useful to investigate the significance of changes in vegetation composition, but are not a necessity.

Narrative

The data and subsequent analysis should be used to create narrative of change, highlighting key developments and how these relate to the pre-determined measures of success. This should take into account the time since restoration and should highlight any areas of concern where ongoing restoration work may be needed. Ideally it would also use the results of geomorphological monitoring to set the context for any changes observed. The production of a narrative is a vital part of any monitoring and should not be overlooked.