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New Forest Wetland Restoration Vegetation Monitoring: Harvestslade and Slufters, 2022.

Higher Level Stewardship Agreement.

The Verderers of the New Forest AG00300016

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Footprint Contract Reference: 702
Date: 22/11/2023, updated 25/03/2024
Version: Final
Recommended Citation: Lake, S., Shellswell, C., Wilson, P. & Caals, Z. (2023). New Forest Wetland Restoration Vegetation Monitoring: Harvestslade and Slufters 2022. Higher Level Stewardship Agreement. The Verderers of the New Forest AG00300016. Report by Footprint Ecology.

Summary

Harvestslade and Slufters are wetland sites in the New Forest that suffered significant historic modifications designed to increase the drainage of the surrounding land. This resulted in straightened, incised and destabilised watercourses with a lack of geomorphological diversity that exhibited limited interaction with their floodplains, with the loss and degradation of associated freshwater and wetland habitats and characteristic species assemblages they support.

At Slufters, under the Forest Plan objective to return the SSSI unit to open habitat, coniferous plantation shading the watercourse and wetland habitats was removed. From 2013, restoration work was carried out to reinstate remnant meanders, raise the watercourse bed, and remove encroaching trees and scrub that had developed on drained banks.

The draft New Forest Freshwater and Wetland Restoration plan (FWRP) 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. Post-restoration monitoring has been carried out at both Harvestslade and Slufters but this did not include habitat and vegetation monitoring, and does not provide an overall narrative of change at these sites. Therefore, Forestry England proposed that the monitoring approach laid out in the FWRP should be trialled at these sites, specifically the post-restoration habitat and vegetation monitoring that would provide evidence about the extent to which the restorations have been successful in restoring the natural processes that shape characteristic New Forest habitats and species.

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

Harvestlade and Slufters were found to support a range of wetland types including Floodplain Lawn, Oligotrophic Stream (including marginal and in-channel vegetation), Poached and Disturbed Habitat, Soakway, Valley Bog, Moor-grass Mire and Wet Heath. In general, these habitats aligned well with the descriptions of good quality habitat provided in the FWRP. Some were still transitional in nature, particularly at Slufters, where additional restoration work has recently been carried out.

The data provided will provide a useful baseline against which to compare the habitats and vegetation communities in the future. In addition, it was possible to make some comparisons with the pre-restoration situation using pre-restoration survey.

A number of recommendations for refining the proposed monitoring methods are made.

Contents

Acknowledgements

This work was commissioned by Jackie Kelly at Forestry England. Our thanks to Jackie for her support and guidance throughout and to Lorna Bailey-Towler also at Forestry England and Jackie for accompanying us on an initial site visit. Jenny Thomas, Sarah Oakley, Jackie Kelly and Suzannah Egleston provided comments on a draft and additional photographs were located by Suzannah Egleston. The methods used were based on those being developed for the New Forest Freshwater and Wetlands Restoration Plan, funded by Natural England and Forestry England.

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 canalisation 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. 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) (this plan will form part of the New Forest Freshwater and Wetland Restoration Plan, 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 recommended approaches. In 2022, Forestry England identified three sites where two of the suggested monitoring approaches, meso-habitat mapping and vegetation surveys could be trialled. Two of the sites had already undergone restoration and significant survey work had therefore been undertaken to inform the planning process. This survey work provides a description of the vegetation communities and protected/notable species present, but was not necessarily designed to provide a baseline for future monitoring. As a consequence, the meso-habitat mapping and vegetation survey proposed can be used to describe the current extent and quality of habitat, but cannot provide a direct 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 provide evidence of any change in extent of the specific meso-habitats that are an important feature of the New Forest wetlands. These include such quintessential New Forest habitats as poached and disturbed margins and ephemeral pools, and these are described fully within the New Forest Freshwater and Wetland Restoration Plan. 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 these 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, changes in the cover and diversity of Bog-mosses *Sphagnum* sp. in the mire, or presence of characteristic species such as Pillwort *Pilularia globulifera* in poached marginal habitat. For 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 variation found within the habitats.

[1] https://ukhab.org/

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. These are both large sites and the restoration required planning permission. Although a different approach has been taken in establishing baseline data at these sites, monitoring to assess the current extent and quality of different habitats will nonetheless be useful in supplying information for a narrative around the success of the restorations. This presents an opportunity to trial the specific techniques developed.

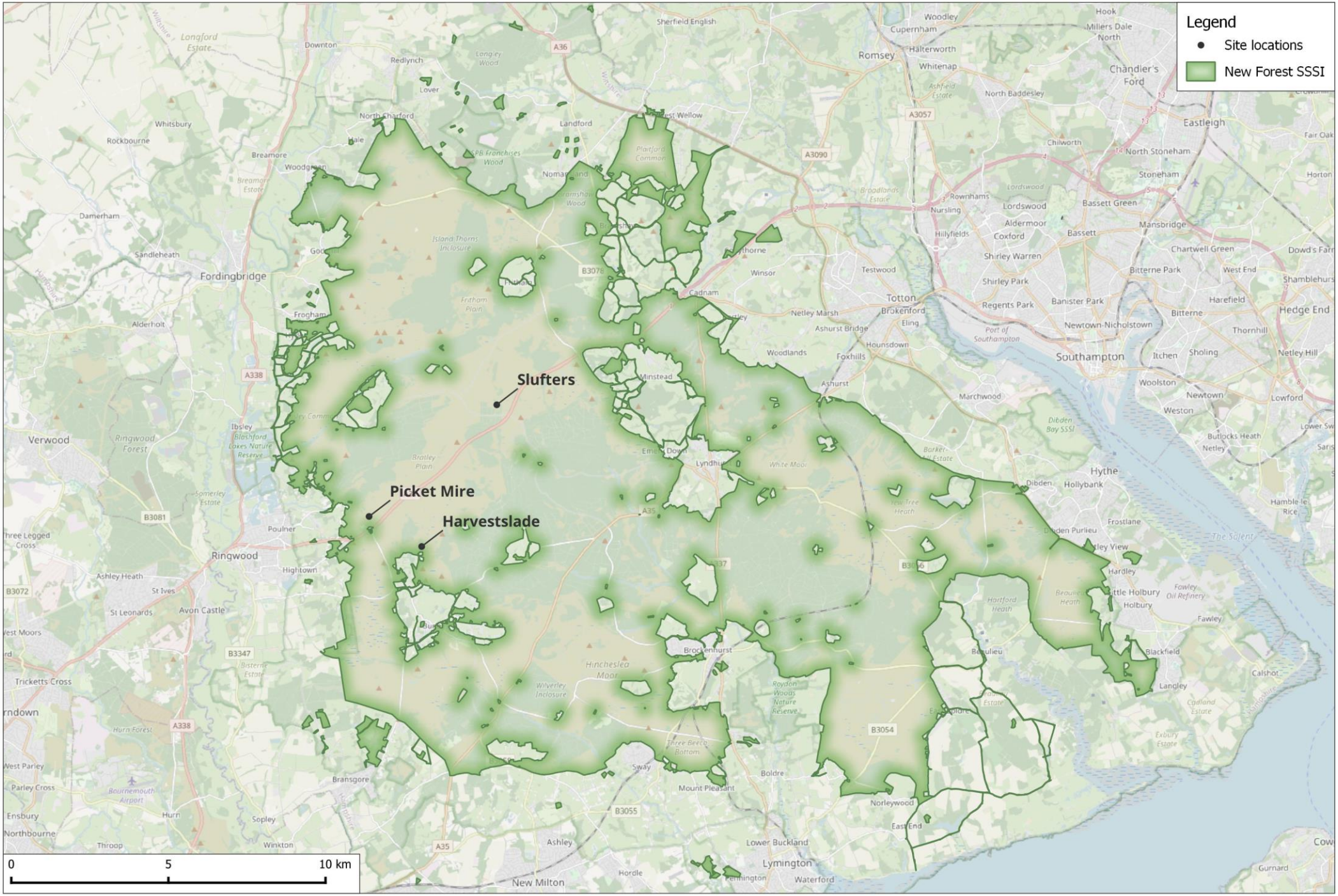
1.9 Picket Mire has been identified by Natural England as requiring restoration, and Forestry England is planning to progress work at this site in 2023. Picket Mire is a small site and the scale of the proposed restoration means that planning permission is not required. This site offers the first opportunity to follow the approach set out in the New Forest Freshwater and Wetlands Restoration Plan, including setting up habitat and vegetation monitoring.

1.10 This report details the post-restoration habitat and vegetation monitoring undertaken at Harvest Slade Bottom and Slufters (pre and post-restoration River Habitat Surveys have been carried out at both sites and fish and macroinvertebrates have also been reported on for Forestry England). This report draws some conclusions about what can be deduced from the 2022 habitat and vegetation monitoring and makes recommendations about both the approach used and further work needed to provide a narrative of change at these sites (the monitoring at Picket Mire is reported on separately, see Lake et al[2]. (2023)). The monitoring tests the approach set out in the Evidence and Monitoring Plan of mapping meso-habitats (to allow an assessment of changes in wetland habitats) and sampling the vegetation within these 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 Valley Bog, Soakway, Moor-grass Mire, Poached and Disturbed Habitat, Wet Lawns and also wet heath.

[2] https://www.hlsnewforest.org.uk/projects/surveys-and-monitoring/monitoring-wetland-restorations/botanical-surveys/

1.11 Geomorphological surveys were also carried out for Harvestslade and Slufters prior to and post restoration plus fish and macro-invertebrate surveys at Harvestslade. This monitoring is not considered as part of this report, which focusses on habitat and vegetation. The results of these surveys should however be considered together and interpreted to provide a narrative around the impacts of the restoration, as recommended in the Evidence and Monitoring Plan.

Map 1: Site locations



Harvestslade

1.12 Harvest Slade Bottom (SSSI unit 126) was in unfavourable condition[3] at the last assessment (2014) due to the effects of artificial drainage causing erosion within the mire, wet heath, grassland and woodland. The deeply incised channel resulted in inconsistent interaction with the floodplain, notable limited seasonal inundation of the wet lawns. Works were therefore carried out in August 2015 to prevent further erosion and drying out of the mire system and lawns including replacement of 316m of artificial drain with restored meanders and raising the existing bed of the channel for a length of 336m. Work included (see Map 2):

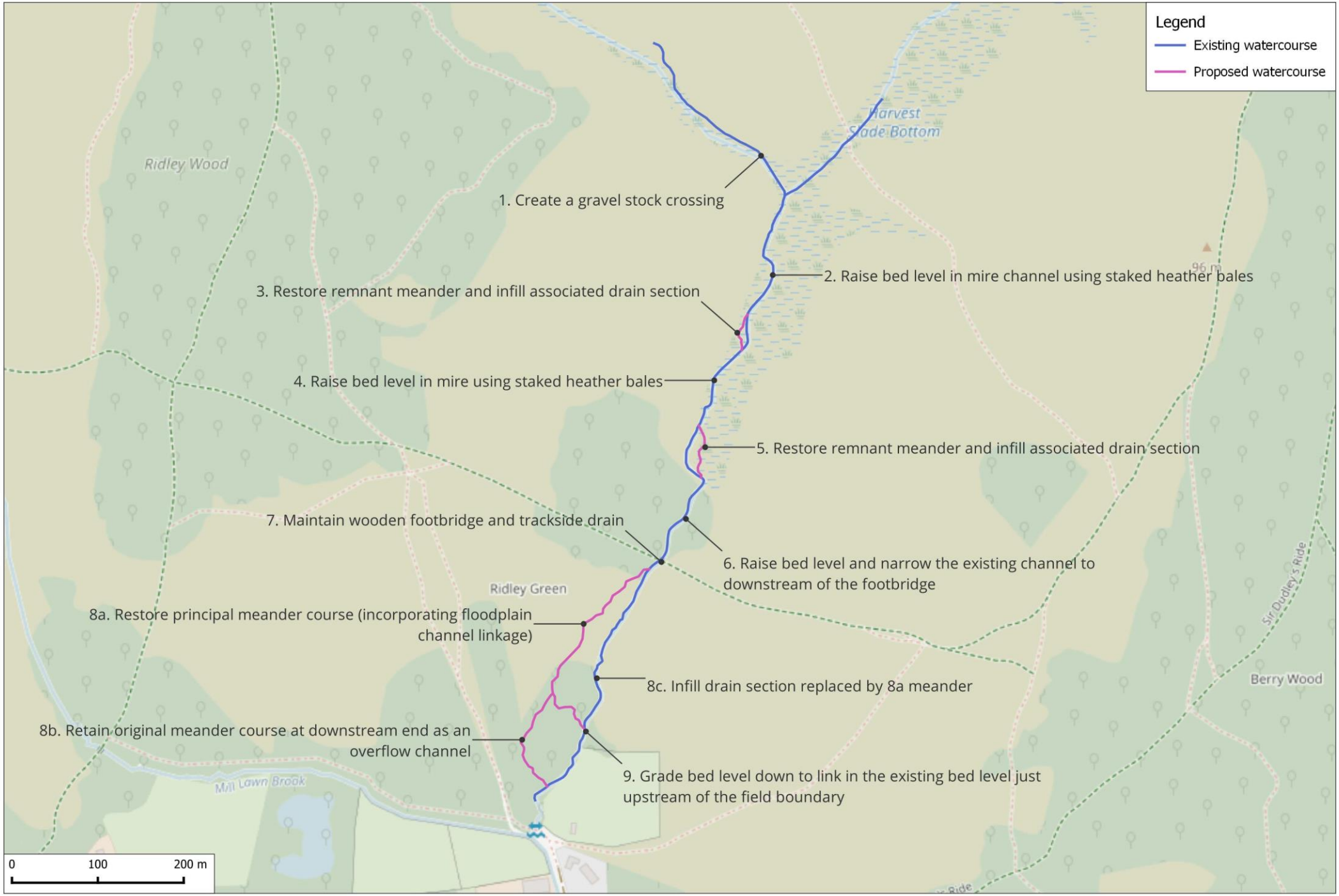
- Excavation/clearing out of natural meanders to redirect existing water flow (including vegetation translocations)
- Bed level raising (i.e. partial infill) of drainage channels using hoggin (as-dug gravel) and/or rejects (gravels over 20mm diameter)
- Installation of clay plugs to divert water flow into restored meanders
- Bed level raising using heather bales
- Complete infill of redundant drainage channel (including vegetation reinstatement)
- Construction of a gravel stock crossing.

1.13 Prior to the restoration, survey work carried out included a River Habitat Survey[4], a Phase 1 habitat survey plus a National Classification (NVC) survey of groundwater dependent terrestrial ecosystems (LUC & Cascade Consulting, 2014). A desk study indicated the need for protected species surveys (Water Vole) and surveys for Kingfisher nest burrows and signs of Otter activity were also carried out. A repeat RHS was carried out in 2021 (Bryden & Harrison, 2021), which concluded that the River Habitat Quality score had increased, showing the restorative works were successful in improving habitat condition. However, this focussed on the geomorphology of the river, and further information is required on the extent and quality of characteristic New Forest wetland habitats post-restoration.

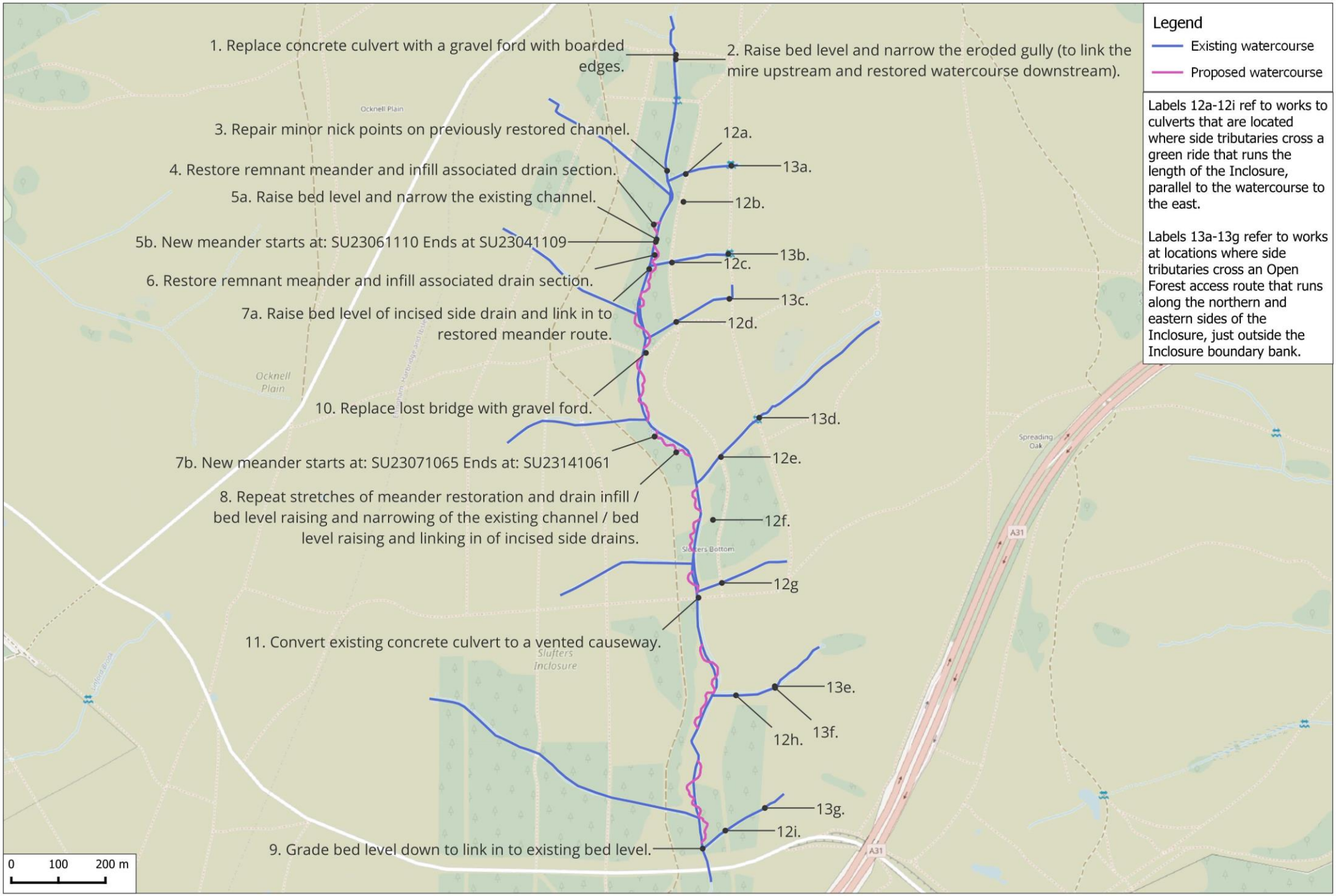
[3] https://designatedsites.naturalengland.org.uk/UnitDetail.aspx?UnitId=1027432

[4] This characterises the geomorphology of the watercourse within 500m survey sections using 50m subsections. It allows identification of the Habitat Modification Scores and Habitat Quality Assessment scores used by Environment Agency (LUC & Cascade Consulting, 2014)

Map 2: Restoration works carried out at Harvestslade



Map 3: Restoration works carried out at Slufters



Slufters

1.14 The North Slufters Inclosure (SSSI unit 113) was in unfavourable condition[5] at the last assessment in 2012 due to the effects of artificial drainage, which was creating headward erosion into the previously partially restored mire systems surrounding the Inclosure. There had been some progress with restoration of open habitat and reinstatement of grazing, but the main channel flowing through the inclosure was deeply incised for the majority of its length, resulting in limited seasonal inundation of the surrounding woodland, grassland, wet heath and mire habitats and inconsistent interaction with the floodplain. Some of the open areas had flushes and developing mire vegetation with characteristic plants including Common Spike-rush *Eleocharis palustris*, Marsh St John's Wort *Hypericum elodes,* Bog Pondweed *Potamogeton polygonifolius* Marsh Pennywort *Hydrocotyle vulgare* and Bog Pimpernel *Anagallis tenella*, but the extent of mire remained much reduced as a result of modification of drainage and afforestation and the cover of characteristic species such as bog-mosses *Sphagnum* spp. was low.

1.15 To improve the condition of the watercourse and associated wetlands, works were carried out to prevent further erosion and drying out of the mire system and to restore the watercourse (a tributary of the Bratley Water) to its original meandering course and to reconnect the watercourse to the floodplain. 996m of artificial drain were replaced with 1,219m of restored meander, the bed level was raised over a distance of 505m (between meanders) and 685m of side drains were partially filled to correspond with the bed level of the restored watercourse and safeguard the adjacent floodplain habitats.

1.16 Works included:

- Excavation/clearing out of natural meanders and excavation of new sections of meander to redirect existing water flow (including vegetation translocation) replacing 995m of drain with 1,219m of meander;
- Bed level raising and/ or narrowing (partial infill) of drainage channel using hoggin/ rejects (stones usually 40mm in diameter) and heather bales (505m of drain between meanders);
- Installation of clay plugs to divert water flow into restored meanders;
- Complete infill of redundant drainage channel (including vegetation reinstatement).

[5] https://designatedsites.naturalengland.org.uk/UnitDetail.aspx?UnitId=1027424

- The erosion point below the concrete culvert at the upstream end of the site was replaced with a vented causeway, and the eroded gully infilled. The gap in the Inclosure boundary bank was widened to improve connectivity and remove a pinch point for flows.

1.17 Prior to the restoration, survey work carried out included a RHS, a Phase 1 habitat survey plus an NVC survey of semi-natural and groundwater dependent vegetation, a macrophyte survey (LUC & Cascade Consulting, 2014). A repeat RHS was carried out in 2021 (Bryden et al., 2022), which concluded that the River Habitat Quality (RHQ) has also improved or been maintained throughout the surveyed reaches. However, this technique focussed on the hydromorphology and geomorphology of the watercourse and, as at Harvestslade, further information is required on the extent and quality of characteristic New Forest wetland habitats post-restoration.

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 comparisons of the extent 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 each of the sites. 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.

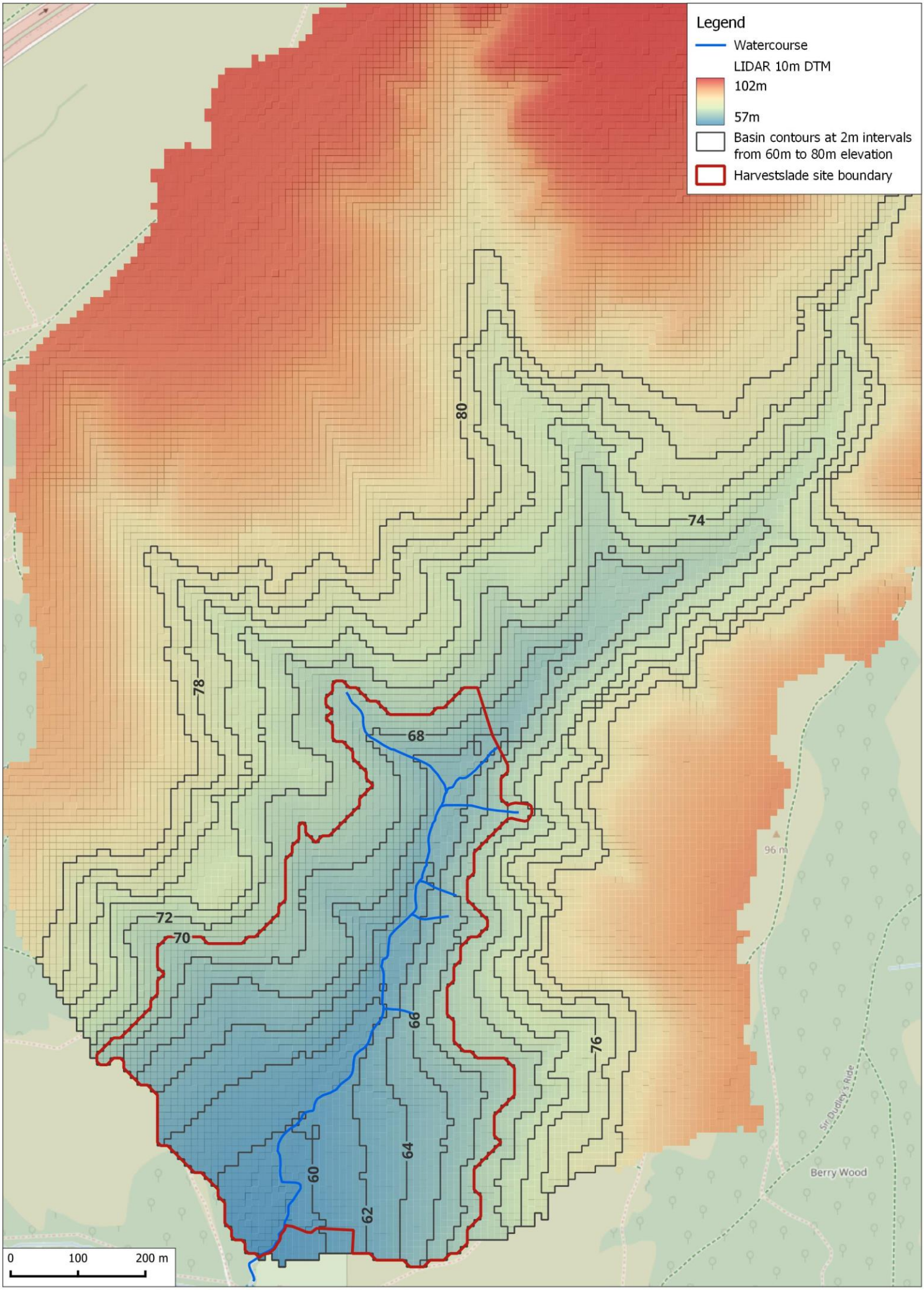
2.3 At Harvestslade, topography ranged from 57m elevation above sea level (downstream) to 65m (upstream). To encompass as much of the restoration area as possible, a boundary of 70m elevation was used (see Map 4)

2.4 At Slufters, topography ranged from 66m at the furthest point downstream to around 86m where the water begins to form a channel upstream. To encompass as much of the restoration area as possible, a boundary of 90m elevation was used for the site boundary (see Map 5).

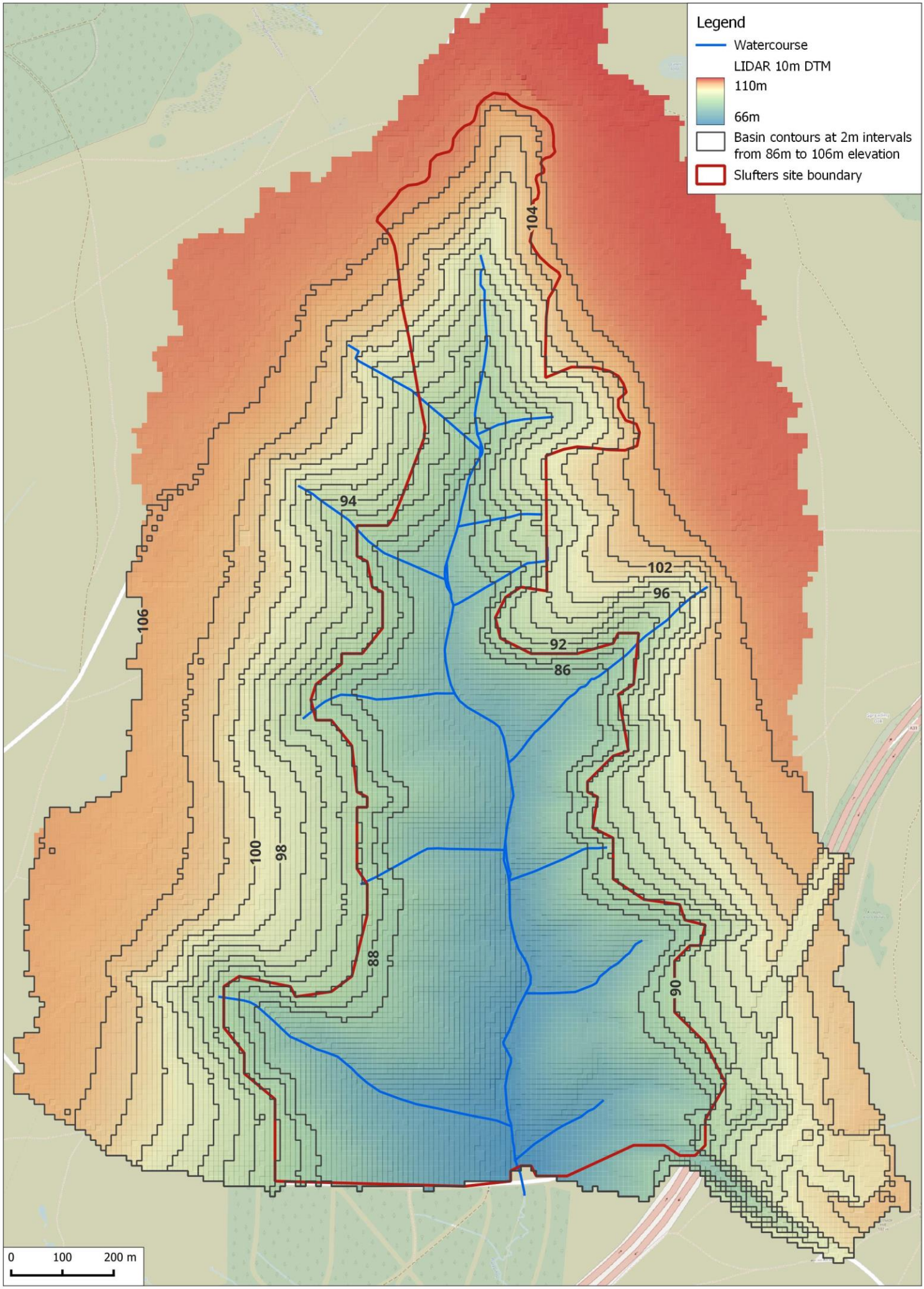
2.5 The boundaries were taken as indicative and were extended at locations where wetland and wet heath that may have been influenced by the restoration works would otherwise have been outside of the boundary. Conversely, these were in places curtailed where habitat was considered to be outside of the zone of influence of the restoration works. At Harvestslade, where the majority of the works were situated within the middle of the catchment, the crossing point in the upper catchment was taken as the monitoring boundary, as it was considered that water flow above this point would not have been influenced.

2.6 Vegetation monitoring focussed on wetland habitats plus wet heath. Areas of dry acid grassland, lowland dry heath and woodland were mapped (but not in more detail, see below).

Map 4: Height data used to identify a site boundary for Harvestslade



Map 5: Height data used to identify a site boundary for Slufters



Fixed point photography

2.7 Images are available from the 2014 pre-restoration surveys. However, these were images associated with target notes relating to representative examples of habitats or particular features of interest, rather than fixed-point photographs intended to provide a baseline for post restoration monitoring, The locations of relevant photos within the monitoring boundary were used as a basis for fixed-point photography in 2022. As these were limited, additional fixed points were established to enable future comparisons.

Meso-habitat mapping

2.8 Mapping was undertaken within the monitoring boundary using a combination of desk-based examination of aerial imagery combined with field work and were digitised using QGIS 3.22. Habitats were characterised by the typology defined by Neil Sanderson commissioned to inform the New Forest Freshwater and Wetlands Restoration Plan (in prep) (see Table 1). Field work was undertaken between 4th July and 17th August 2022.

Table 1: Habitats and meso-habitats present within the study areas at Harvestslade and Slufters. Habitats in bold are those described in the New Forest Freshwater and Wetlands Restoration Plan, which includes NVC equivalents (in prep).

New Forest habitats	Brief description	Included in the detailed vegetation monitoring
Dry coniferous woodland (plantation)	Coniferous plantation with an understory of Heather and Bracken.	
Dry broadleaved woodland	Generally dominated by Oak with a Bracken and acid grassland understory, with some Heather, Bramble and small areas of scrub.	
Deciduous scrub	A mix of scrub species including Willow sp. Hawthorn, Blackthorn, often with Bramble and young Silver Birch	
Bracken	Bracken dominated.	
Lowland dry heathland	Dominated by dwarf shrubs including Heather and Western Gorse, with Heath Grass, Wavy Hair-grass, Common Bent and Sweet Vernal-grass. There may be some patches of Bracken, scrub and woodland throughout the dry heath	
Lowland wet heathland	Cross-leaved heath, Bog Myrtle with Purple Moor-grass, Common Bent, Star Sedge, Green-ribbed Sedge, Heath Rush and Carnation Sedge.	✓
Lowland dry acid grassland	Dry, closely-grazed swards of Common Bent, Bristle Bent, Heath Grass and Sweet Vernal-grass, with Carnation Sedge, Sheep's Sorrel and Tormentil.	
Floodplain lawn	Closely-grazed grassland found adjacent to watercourses and dominated by Purple Moor-grass and Heath Grass with Velvet Bent and Jointed Rush. Herbs include Tormentil, Lesser Spearwort, Water-pepper, Smooth Hawk's-bit and Lesser Skullcap	✓
Floodplain lawn (under canopy)	A more ruderal community with Common Bent, Creeping Buttercup, Daisy, White Clover, Greater Plantain and Self-heal under a sparse oak canopy. Floodplain Lawn species present include Lesser Spearwort and Water-pepper. Areas disturbed by livestock appeared to recover more slowly due to shading.	✓
Valley Bog (including **Bog Pools**)	Characterised by Common Cotton-grass, White Beak-sedge, Bog Asphodel, Many-stemmed Spike-rush, Bog Pondweed, Round-leaved Sundew and Bog-mosses e.g. *Sphagnum papillosum.*	✓

New Forest habitats	Brief description	Included in the detailed vegetation monitoring
Soakways	Often linear, characterised by Marsh St John's-wort, Bog Asphodel, and Bog Pondweed, with Lesser Spearwort, Marsh Bedstraw, Common Yellow-sedge and Bog Pimpernel. Bog-mosses also present, particularly *Sphagnum cuspidatum*	✓
Poached and disturbed vegetation	A variable community found in Floodplain Lawn with Purple Moor-grass, Heath Grass, Lesser Spearwort, Sharp-flowered Rush, Marsh Thistle, Betony, Sweet-grass sp. Self-heal as well as Creeping Buttercup and White Clover. Pillwort was often associated with this habitat.	✓
Oligotrophic stream	Open water, with Bog Pondweed, Sharp-flowered Rush, Lesser Spearwort and Marsh Bedstraw. Margins typically support Floating Club-rush.	✓
Moor-grass mire	Dominated by Purple Moor-grass or Sharp-flowered Rush, often with Lesser Spearwort, Marsh St John's-wort, Bog Pimpernel and Marsh Bedstraw	✓
Reed-dominated habitat	Part of Moor-grass Mire, mapped separately due to distinct distribution.	✓

Detailed vegetation monitoring of wetland habitats

2.9 Using the habitat maps, random points were generated within the wetland meso-habitats as follows:

1. Polygons of the same meso-habitat type were merged and non wetland habitat deleted (wet heath was included).
2. Polygons were buffered internally by 10m, to ensure that each quadrat would be at least 10m from the edge of the polygon (to allow for mapping inaccuracies).
3. 15 random points were created within each habitat, with a minimum distance of 10 between points.

2.10 More points were created than were required so that any points that were found to fall within a different habitat to the one allocated (e.g. due to complex habitat mosaics) could be replaced by another random point. However, if required, surveyors moved points onto the nearest example of the habitat – for example, the extent of poached and disturbed habitat changed notably between early and late July due to drought conditions, which resulted in poached areas moving closer to the central axis of the stream.

2.11 The percentage cover of vascular plants, bryophytes and lichens were recorded from one 2m x 2m quadrat at each random point. Occasionally, linear quadrats of 1m x 4m or 0.5 x 8m were used (for example, for marginal or 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). Photographs of each quadrat were also taken for reference.

3. Results

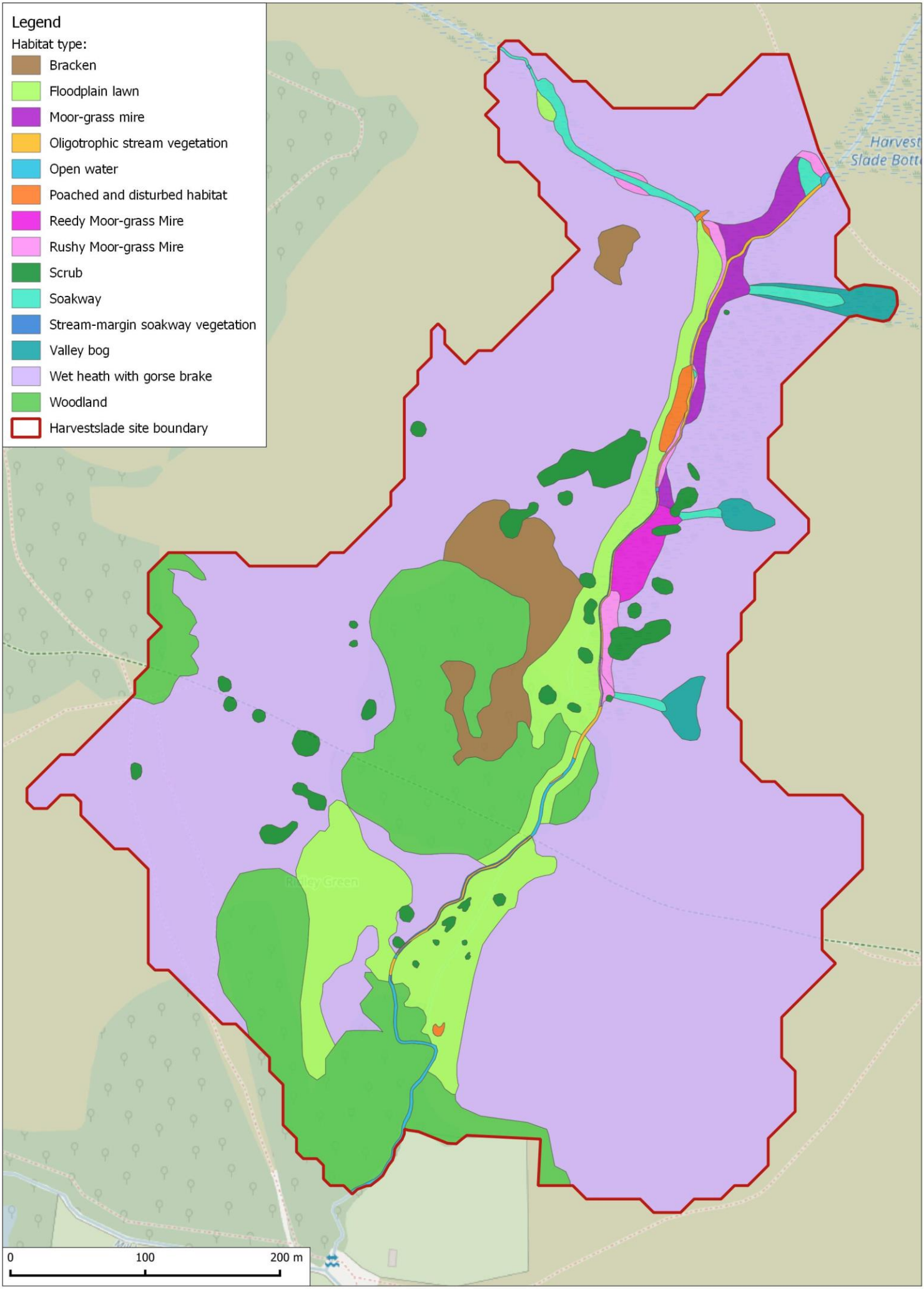
Meso-habitat mapping

3.1 Maps 6-7 show the results of the meso-habitat mapping at Harvestslade and Slufters.

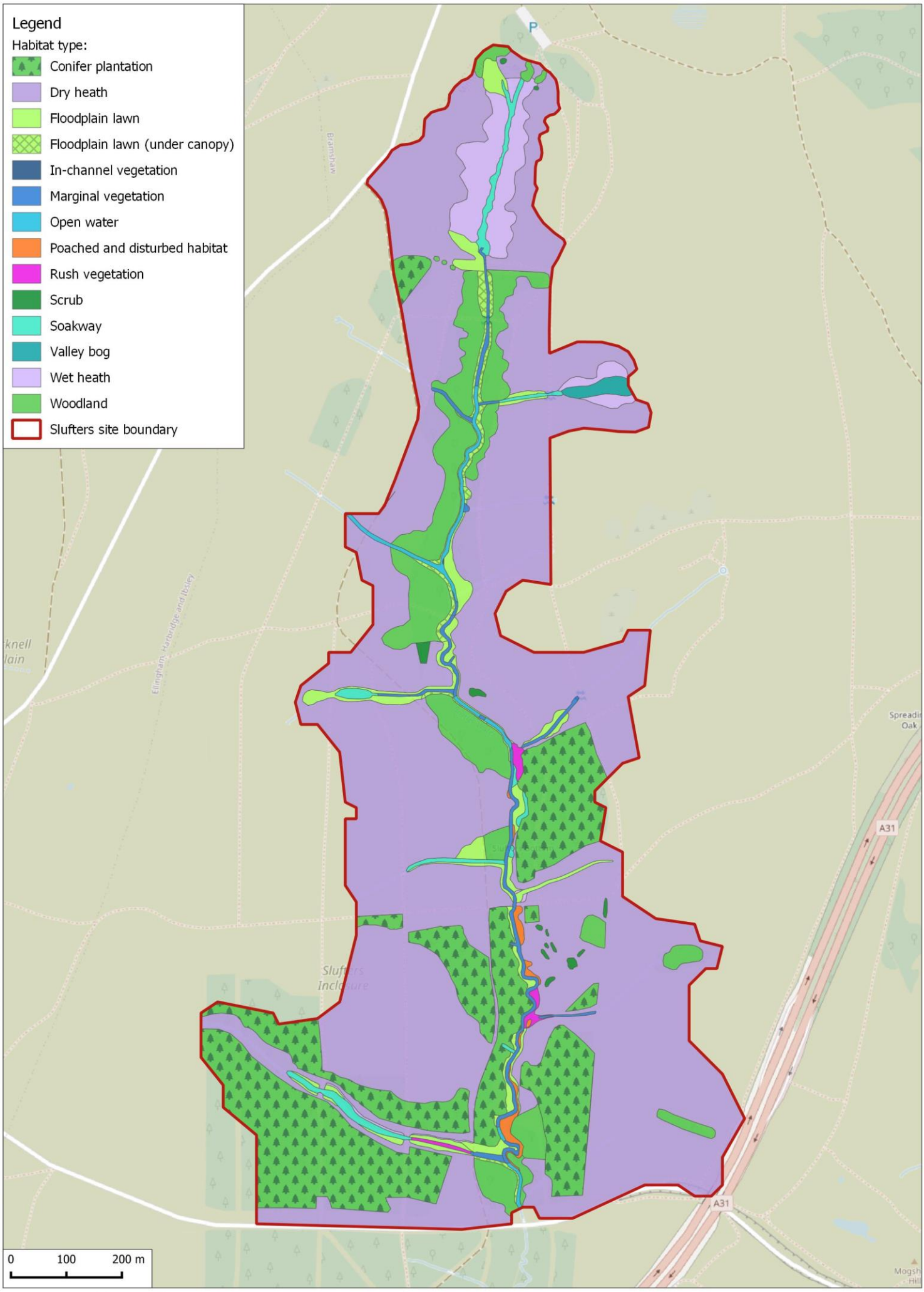
Table 2: The area of different meso-habitat and broader habitat types mapped at Harvestlade and Slufters in 2022. Meso-habitats as described in the Freshwater and Wetland Restoration Plan are in bold.

Meso-habitats	Harvestslade (ha)	Slufters (ha)
Bracken	0.94	-
Floodplain lawn	2.36	2.74 (of which 0.76 under canopy)
Fast-flowing nutrient poor stream (not vegetation)	0.09	0.39
Poached and disturbed habitat	0.08	0.29
Soakway (including marginal)	0.27	1.74
Valley bog	0.29	1.00
Moor-grass mire (including rush and reed dominated variants)	0.61	0.42
Wet heath (including gorse brake at Harvestslade)	20.19	
Transitional rush-dominated mire	-	0.25
Dry Heath	-	66.04
Scrub	0.61	0.23
Woodland	4.58	7.85
Open water	0.07	0.55
Coniferous plantation	-	18.41
Total	30.09	99.91

Map 6: Harvestslade habitats



Map 7: Slufters habitats



Vegetation

3.2 There are insufficient quadrat data from 2014 to enable a comparison of pre and post restoration habitat quality. However, Figures 1-2 and Tables 2-3 provide summary data from 2022 for key characteristics (sward bulk, species numbers and percentage cover of bare ground, plant litter, and key plant groups). The raw data are provided in an Excel spreadsheet accompanying this report.

Fixed-point photographs

3.3 It was intended that photos should be taken in 2022 at points where photos were taken in 2014 in order to provide a visual evidence-base of any changes over time. In practice, this was of limited use, as the photos taken in 2014 were intended to accompany target notes rather than to provide a baseline of features that were likely to change as a result of the restoration. As a consequence, many did not relate to the areas or features of the site that were likely to change and a small number of locations could not be re-found. A limited series of photographs with accompanying text is shown in Appendix 2.

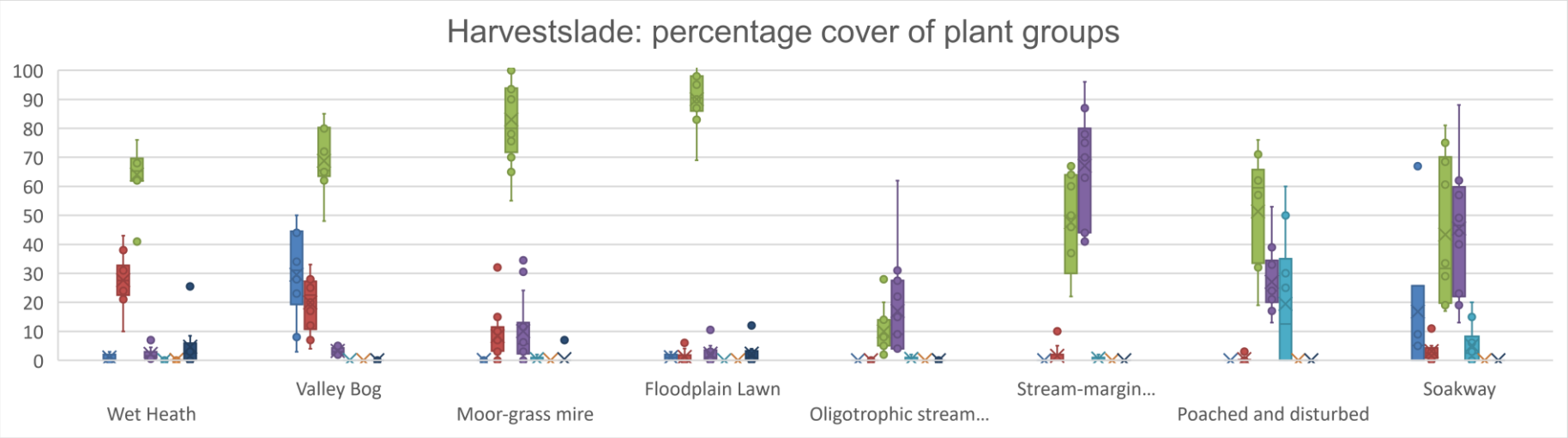


Figure 1: Box plots indicating the cover of different plant groups according to habitat type at Harvestslade (the solid box shows the interquartile range, with the median value represented by X. Whiskers indicate the minimum and maximum values.

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

Variable	Floodplain lawn	Oligotrophic stream (in channel)	Oligotrophic stream (marginal)	Poached and Disturbed	Soakway	Moor-grass Mire	Valley Bog	Wet Heath
Species richness	9.5 (+/-0.9)	4.5 (+/-0.37)	14.6 (+/-1.13)	10.6 (+/-0.96)	15.9 (+/-0.74)	9.1 (+/-0.7)	12.4 (+/-1.26)	12.4 (+/-1.14)
Bare ground / open water (%)	2.8 (+/-0.33)	74.5 (+/-5.6)	2.4 (+/-0.92)	17.5 (+/-4.77)	17.9 (+/-4)	13.53 (+/-2.19)	0.8 (+/-0.55)	3.3 (+/-0.83)
Vegetation bulk (cm)	3.3 (+/-0.3)	0 (+/-0)	13.1 (+/-3.64)	7.3 (+/-0.84)	12.1 (+/-1.23)	37.23 (+/-3.9)	20.3 (+/-1.61)	20.7 (+/-3.01)
Leaf litter (%)	0 (+/-0)	0 (+/-0)	0.5 (+/-0.5)	0 (+/-0)	0 (+/-0)	9.67 (+/-3.3)	31 (+/-4.88)	1 (+/-0.13)

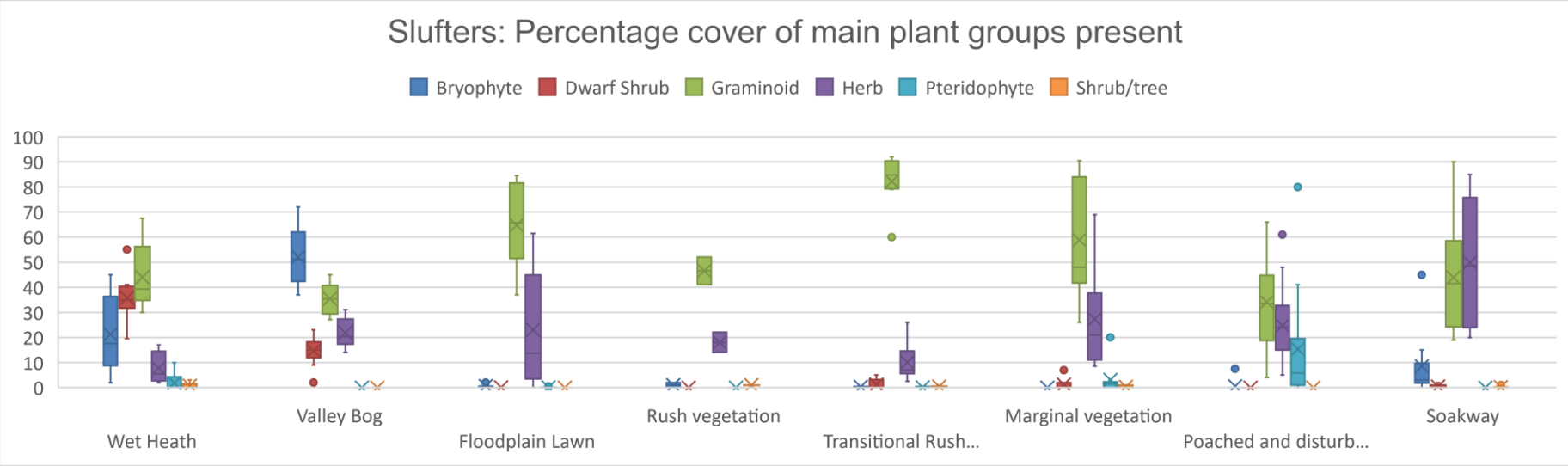


Figure 2: Box plots indicating the cover of different plant groups according to habitat type at Slufters (the solid box shows the interquartile range, with the median value represented by X. Whiskers indicate the minimum and maximum values.

Table 4: Species richness and other variables recorded from quadrats within each wetland habitat type surveyed at Slufters.

	Floodplain Lawn	Marginal vegetation	Poached	Transitional Rush-dominated Mire	Soakway	Valley bog	Wet heath
Bare ground / open water (%)	12.2 (+/-4.69)	17 (+/-5.26)	37.06 (+/-5.07)	14.9 (+/-5.24)	20.8 (+/-3.74)	0.9 (+/-0.46)	4.9 (+/-1.29)
Leaf litter (%)	0.6 (+/-0.19)	2.3 (+/-1.15)	0.41 (+/-0.23)	2.3 (+/-0.65)	0 (+/-0)	0 (+/-0)	2.7 (+/-1.69)
Dung (%)	1.28 (+/-0.45)	0 (+/-0)	0 (+/-0)	0 (+/-0)	0 (+/-0)	0 (+/-0)	1.85 (+/-0.49)
Deadwood (%)	0.75 (+/-0.37)	0.15 (+/-0.11)	0.13 (+/-0.11)	0.05 (+/-0.05)	0 (+/-0)	0 (+/-0)	0 (+/-0)
Vegetation bulk (cm)	2.2 (+/-0.33)	13.6 (+/-4.62)	7.13 (+/-1.4)	19.1 (+/-3.04)	10.5 (+/-0.98)	16.7 (+/-1.69)	21 (+/-2.49)
Species richness	12.8 (+/-1.11)	14.2 (+/-1.63)	19.38 (+/-1.71)	12.3 (+/-0.79)	11.2 (+/-1.11)	8.3 (+/-0.52)	12.9 (+/-1.39)

Table 5: Notable plant species recorded in 2014 and/or 2022 and their conservation status (see Stroh et al., 2014 Leach, 2021, Cheffings & Farrell, 2005) Based in species reported in 2014 plus additional species noted in 2022. S42 refers to 'Priority Species' listed under Section 42 of the NERC Act (2006).

Species	Status	Harvestslade 2014	Harvestslade 2022	Slufters 2014	Slufters 2022
Pillwort *Pilularia globulifera*	Nationally Scarce, S42; England RDB Vulnerable; GB RDB Least Concern	One patch recorded on western tributary	Extensive patch on main watercourse	Not recorded in survey (record from LERC)	Recorded in Poached and Disturbed habitat in at least 8 locations
Marsh St. John's-wort *Hypericum elodes*	England RDB Near Threatened; GB RDB Least Concern	Mentioned in text as occasional in marshy grassland	Frequent in Soakway, Oligotrophic Stream, Moor-grass Mire, Poached and Disturbed Habitat	Present in acid flushes	Frequent in Soakway, Poached and Disturbed Habitat, transitional rush-dominated mire
Petty Whin *Genista anglica*	England RDB Vulnerable; GB RDB Near Threatened	-	Several plants in Wet Heath near the northern bridge and on the eastern slope	-	-
Bladder Sedge *Carex vesicaria*	England RDB Vulnerable; GB RDB Least Concern	Present	Not recorded (previous location unknown)	-	-
Round-leaved Crowfoot *Ranunculus omiophyllus*	England RDB Least Concern; GB RDB Least Concern	-	-	Present in acid flushes	Noted in northern section but not within quadrats
Water-plantain *Alisma plantago-aquatica*	England RDB Least Concern; GB RDB Least Concern	-	-	Appropriate habitat limited	Not recorded
Autumn Lady's-tresses *Spiranthes spiralis*	England RDB Near Threatened; GB RDB Near Threatened	Present	Suitable habitat not surveyed	-	-
New Zealand Pigmyweed *Crassula helmsii*	INNS	-	-	Not recorded	Occasional within Oligotrophic Stream

Species	Status	Harvestslade 2014	Harvestslade 2022	Slufters 2014	Slufters 2022
Heath Star Moss *Campylopus introflexus*	INNS	-	-	In dry heath	Dry heath not surveyed

Species of note

3.4 Table 5 above provides a summary of notable species (including invasive non-native species – INNS) recorded at Harvestslade and Slufters in the 2014 and 2022 surveys. The criteria for inclusion of species in the 2014 list was not explicit, so the same species were included plus additional protected/notable species observed. Species on the England RSB list but widespread in the New Forest such as Heather have not been included. These species were not specifically searched for in 2022 and therefore may have been present but unrecorded if they were not within the wetland habitat patches surveyed.

3.5 Table 6 and Maps 9-10 show protected and notable species found within environmental record centre data (supplied by HBIC) for the restoration sites.

Table 6: Protected and notable species within local environmental record centre data (HBIC) for 100m grid squares overlapping with Harvestslade and Slufters.

Species	Status	Year	Notes
Harvestslade:			
Marsh Clubmoss *Lycopodiella inundata*	England RDB Endangered; GB RDB Endangered	1957; 2007; 2008.	1957 records near peat track above stream. 2007 records 30 plants by peat track and 2008 records state there were 40 plants. Grid reference: SU208055.
Petty Whin *Genista anglica*	England RDB Near Threatened; GB RDB Vulnerable	2010; 2014.	2010 records state scattering across damp heath on a south facing slope. Grid reference: SU204055.
Heath Fragrant-orchid *Gymnadenia borealis*	England RDB Data Deficient	1954	Records two large colonies on the grassy heath side of valley bottom. Grid reference: SU207060.
Slufters:			
Soft-leaved Sedge *Carex montana*	England RDB Least Concern; GB RDB Least Concern	1975	Two small colonies recorded on clay turf t the western side of open grass ride. Grid reference: SU229107.
Chaffweed *Centunculus minimus*	England RDB Endangered; GB RDB Near Threatened	1991	In muddy hollows of the old airfield. Grid reference: SU229116.
Chamomile *Chamaemelum nobile*	England RDB Vulnerable; GB RDB Vulnerable	2003; 2012.	2003 records state that plants were abundant on the ground to the north-east of the road. 2012 records state plants were found on heathy grassland. Grid reference: SU234098.
Cladonia incrassata	Least Concern, Nationally Scarce (from British lichen website)	2011	Grid reference: SU231115.

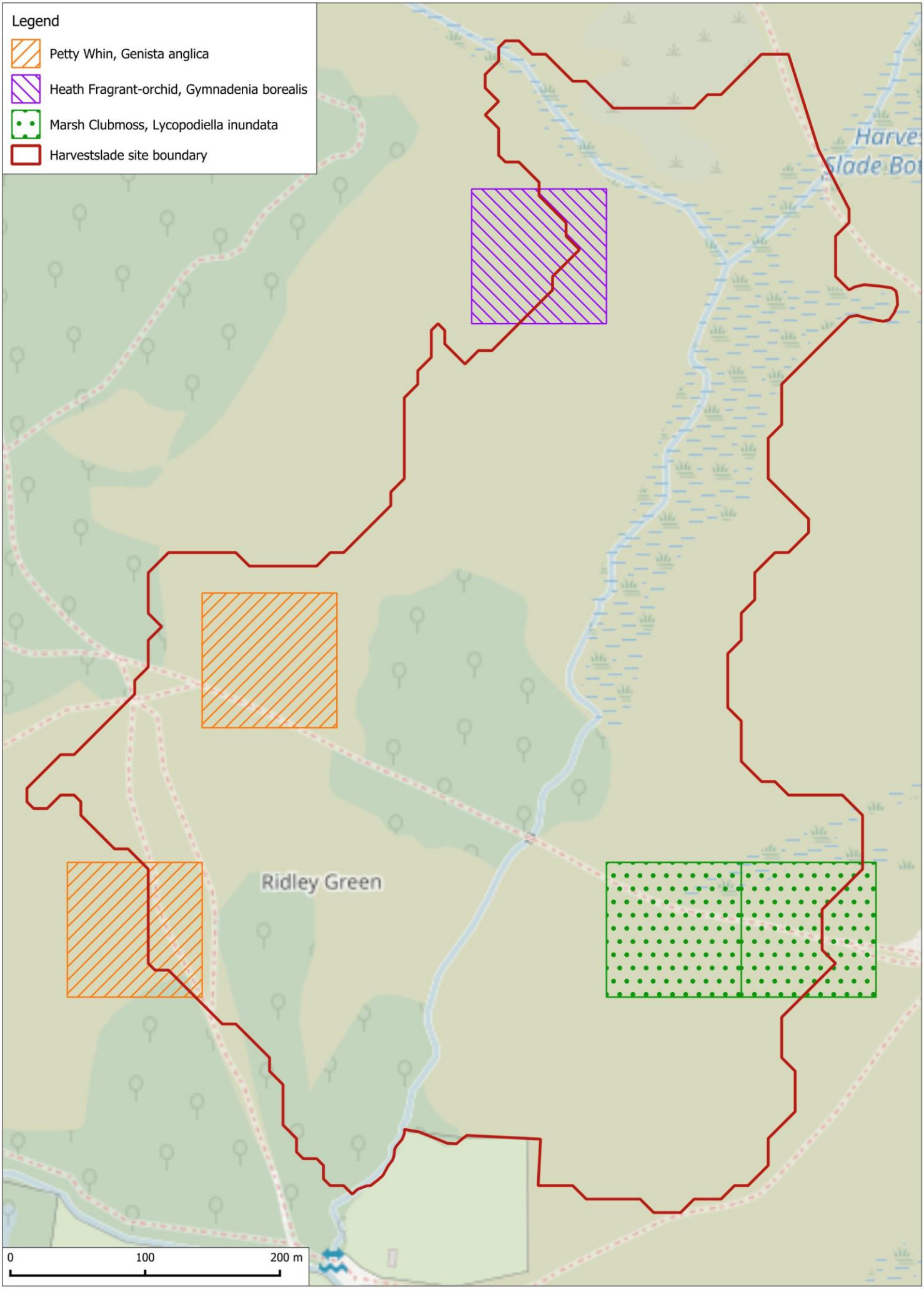
Species	Status	Year	Notes
Dodder *Cuscuta epithymum*	England RDB Vulnerable; GB RDB Vulnerable	2004	In a small quantity on eastern bank side of the road. Grid reference: SU235097.
English Sticky Eyebright *Euphrasia officinalis subsp. Anglica*	England RDB Endangered; GB RDB Endangered	2003; 2008.	Grid reference: SU235097; SU230118.
Upright Chickweed *Moenchia erecta*	England RDB Vulnerable; GB RDB Least Concern	1988; 2003.	2003 records states that plants were found over a plentiful area above the northern bank of an un-classified road. Grid reference: SU234098.
Round-leaved Dog-rose *Rosa obtusifolia*	England RDB Least Concern; GB RDB Least Concern	2004	Found amongst gorse scrub at the top of the bank to the eastern side of the road. Grid reference: SU235097.
Heath Pearlwort *Sagina subulate*	England RDB Near Threatened; GB RDB Least Concern	2002	More than 10 found on grassy mound from airfield. Grid reference: SU230118.
Strawberry Clover *Trifolium fragiferum*	England RDB Vulnerable; GB RDB Vulnerable	2002	Grid reference: SU232118.
Pale Dog-violet *Viola lacteal*	England RDB Endangered; GB RDB Vulnerable	1986; 1988; 2003.	1986 observation notes a few patches north of the road verge; 1988 finds a small group inside the fence by road; 2003 records state 20 plants were found in northern verge of minor road by the trees. Grid references as follows respectively: SU231097; SU234098; SU23270975.

3.6 Maps 9 and 10 show protected and notable species based on records held by the local environmental records centre, HBIC.

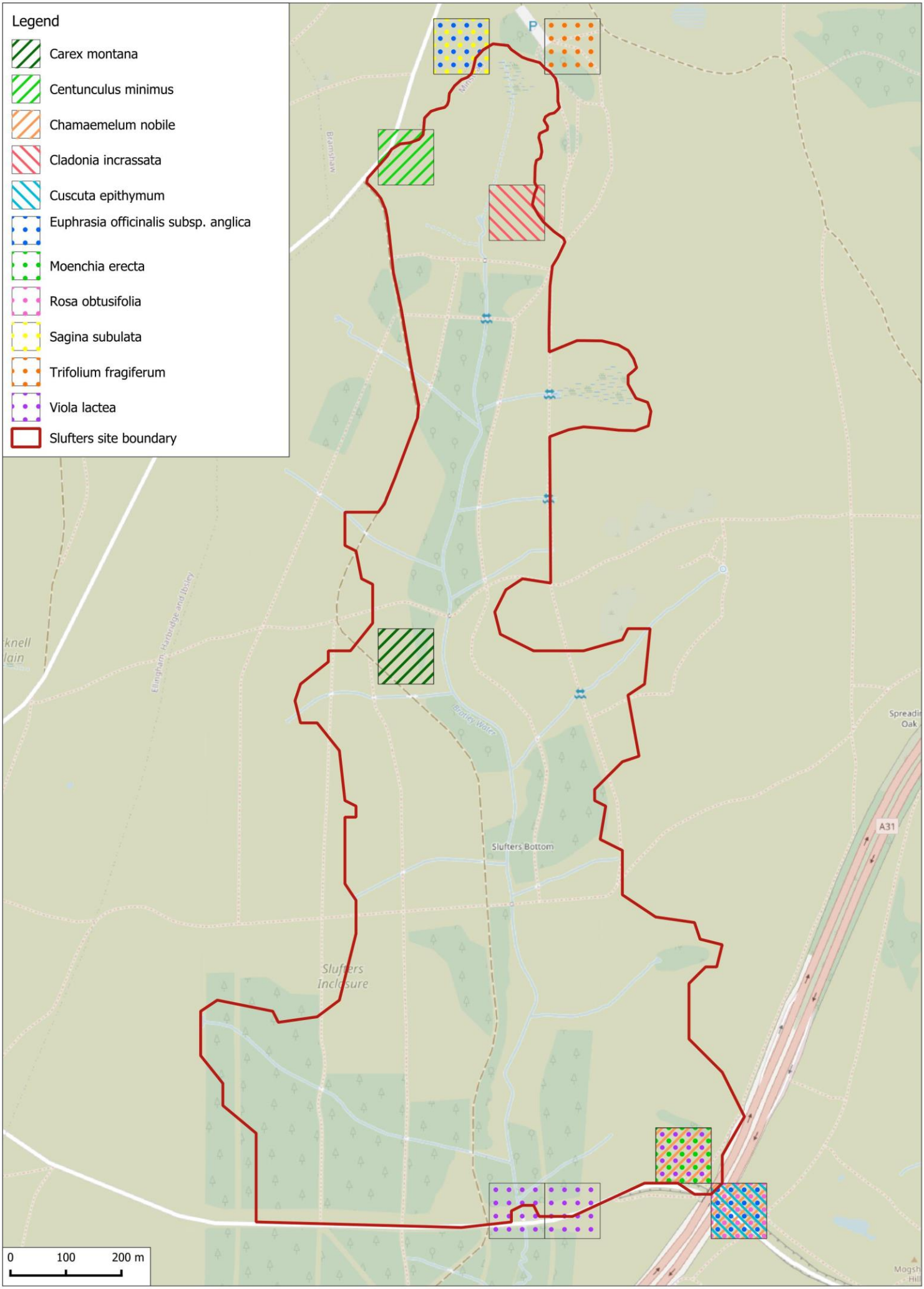
3.7 At Harvestslade, Petty Whin *Genista anglica* (recorded in 2010 and 2014), Heath Fragrant-orchid *Gymnadenia borealis* (1954) and Marsh Clubmoss *Lycopodiella inundata* (2008) were recorded. Petty Whin was still present in 2022, although in different locations. Marsh Clubmoss was not observed, although it was on a path that was not used during the surveys. Heath Fragrant-orchid was not recorded. The lack of recent records suggests it is no longer present.

3.8 Records from Slufters include a wider range of protected and notable species.

Map 9: Harvestslade protected and notable plant species (historic records)



Map 10: Slufters protected and notable plant and lichen species (historic records)



4. Discussion

4.1 Equivalent pre-restoration data against which post-restoration data could be compared are not available at Harvestslade and Slufters for habitat extent and composition. The data provided by the 2022 surveys will provide a baseline against which future change can be compared and some general comparisons with 2014 can be made.

4.2 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 overall diversity of habitats but to change the extent, distribution and quality of such habitats. For example, the presence of Pillwort in 2014 indicates that there was already a small amount of Poached and Disturbed habitat present so a measure of success for the restorations would be an increase in the area of this habitat and abundance and distribution of Pillwort, which is also indicative of improved channel structure and increased frequency of floodplain inundation.

Habitat type and extent

Harvestslade

4.3 At Harvestslade, a variety of wetland habitats characteristic of New Forest systems were recorded in 2022, including Valley Bog (both valley bottom mire and seepage step mires), Moor-grass Mire (both Purple Moor-grass *Molinia caerulea* and Sharp-flowered Rush *Juncus acutiflorus* dominated), Soakway, Poached and disturbed habitat (on the margins of the watercourse), marginal (including Soakway type vegetation) and in-channel Oligotrophic Stream habitats, Floodplain Lawn and Wet Heath. An ephemeral pool was also noted but was too small to map.

4.4 The target notes recorded from the 2014 survey indicate that Valley Bog, Soakway, and Oligotrophic Stream were present. Wetter areas of heathland were characterised as “humid” rather than wet, but included species such as Cross-leaved Heath *Erica tetralix* and Purple Moor-grass *Molinia caerulea*. Examination of the 2022 quadrat data indicates that the habitat is somewhat transitional, with species such as Bog Myrtle *Myrica gale*, Carnation Sedge *Carex panicea* and occasional records of typical wet heath bryophytes *Sphagnum tenellum* and *Leucobryum glaucum*, but also species typical of drier habitat such as *Hypnum jutlandicum* and Bell Heather *Erica cinerea*. The 2014

survey also mapped areas of Purple Moor-grass with Cross-leaved Heath, Articulated Rush *Juncus articulatus*, Few-flowered Spike-rush *Eleocharis quinqueflora* as "marshy grassland"; these areas were interpreted as Wet Heath in 2022 due to the amount of Dwarf Shrub present.

4.5 The use of "marshy grassland" in 2014 to describe variable vegetation dominated by Purple Moor-grass means that key habitats such as Valley Bog, Moor-grass Mire and Floodplain Lawn were not necessarily differentiated in 2014.

4.6 Examination of aerial imagery suggest that the area of Floodplain Lawn in the southern section (including a previously heavily eroded stock crossing) has increased. Removal of trees and restoration of a meander in this area has resulted in the development of marginal and in-channel oligotrophic vegetation. Further upstream, raising the bed level appears to have resulted in a probable increase in the area of Poached and Disturbed habitat supporting Pillwort.

Slufters

4.7 Five characteristic wetland habitats were identified at Slufters in 2022, including Wet Heath, Valley Bog (in the form of seepage step mires), Floodplain Lawn (some with open tree cover), Poached and Disturbed Habitat and Oligotrophic Stream (although much of this had dried out during the drought). However, some of the habitat recorded along the restored watercourse was less easy to relate to the habitats described in the FWRP and was transitional in nature. A transitional rush-dominated mire habitat (see Table 8) with characteristics of Soakway, Oligotrophic Stream vegetation and Moor-grass Mire was mapped separately from these communities and was found in wet conditions but where grazing had reduced the vegetation bulk. The area of Poached and Disturbed habitat increased markedly between the first visit (20th July 2022) and the last visit (17 August 2022) as the water receded (exposing in-channel vegetation) and livestock moved into the channel, creating Poached and Disturbed Habitat.

4.8 The NVC and Phase 1 surveys carried out in 2014 showed that much of the monitoring area was either still wooded with coniferous or broadleaved plantation or had recently been cleared. The woodland supported a Tufted Hair-grass *Deschampsia cespitosa* ground flora near the watercourse, with Bramble *Rubus* sp, Common Bent *Agrostis capillaris,* Wavy Hair-grass *Deschampsia flexuosa* and bryophytes in drier areas. Areas of cleared woodland supported Sheep's Fescue *Festuca ovina*, Common Bent *Agrostis*

capillaris, Bramble *Rubus sp* and Bracken *Pteridium aquilinum* with much bare ground and brash. Acid flushes were described (M29 and M30), which conform to Soakway occupying seepage step mires on the sloping valley sides above the watercourse. The dry heathland was described as humid, with Purple Moor-grass *Molinia caerulea*, Heather *Calluna vulgaris*, Cross-leaved Heath *Erica tetralix* and moss *Leucobryum glaucum* but no bog-mosses *Sphagnum spp*. There was no mention of vegetation equating to Floodplain Lawn, although dry acid grassland was mapped along the western tributary.

4.9 Differing objectives and approaches to the surveys in 2014 and 2022 make a direct comparison difficult, but it would appear that areas of dry acid grassland have re-wetted along the narrow floodplain which now supports wet lawn and a transitional rush-dominated mire habitat. Areas in the floodplain that previously supported woodland now also support closely grazed Floodplain Lawn (some with a tree canopy). There has been an increase in the area of Wet Heath and Poached and Disturbed Habitat and an assumed increase in Oligotrophic Stream vegetation.

Vegetation

4.10 Pre-restoration data about the composition of the vegetation against which post-restoration data can be directly compared are not available at Harvestslade and Slufters. However, Tables 5 and 6 provide a narrative about the vegetation of each habitat type in 2022 and compare this with information gleaned from the 2014 survey. An interpretation of how the current vegetation corresponds with that described in the New Forest Freshwater and Wetlands Restoration Plan (FWRP) and any apparent changes since 2014 is also given.

Table 7: Summary descriptions of habitats mapped and sampled at Harvestslade in 2022 with an interpretation of any changes since 2014 and similarity to habitats described in the New Forest Freshwater and Wetlands Restoration Plan.

Habitat type	2022	2014 target notes	Comparison with relevant New Forest "quintessential habitat" and interpretation
Wet Heath	Transitional, with heath species such as Bog Myrtle *Myrica gale*, Carnation Sedge *Carex panicea* and occasional records of typical wet heath bog-moss *Sphagnum tenellum* and *Leucobryum glaucum*, but also species typical of drier habitat such as *Hypnum jutlandicum* and Bell Heather *Erica cinerea.* (M16).	Described as "humid" heath and classified under dry heath, included species such as Cross-leaved Heath *Erica tetralix* and Purple Moor-grass *Molinia caerulea* but not Bog-mosses	In 2022 and 2014 the habitat conformed to the description of "humid heath". The lower-lying heath closest to the watercourse may have been somewhat wetter in character in 2022 than previously, with species such as *Sphagnum tenellum*, but comparable baseline data are not available to evidence this.
Valley Bog	A small seepage step mires along the eastern flank of the valley supporting Common Cottongrass *Eriophorum angustifolium*, White Beak-sedge *Rhynchospora alba,* bog mosses *Sphagnum papillosum. S. denticulatum, S. cuspidatum* and *S. palustre,* Round-leaved Sundew *Drosera rotundifolium*, Pale Butterwort *Pinguicula lusitanica* and Bog Asphodel *Narthecium ossifragum* together with Purple Moor-grass *Molinia caerulea*. One of the most	Valley Bog appears to have been encompassed by "marshy grassland" which included open stands with occasional Bog Asphodel, Carnation Sedge, Cross-leaved Heath, Star Sedge, Soft Rush and Round-leaved Sundew. A target note about the "grassland" becoming drier towards the watercourse hints at the presence of at least one seepage mire in 2014	The seepage step mire supported good quality Valley Bog habitat (M21a). These areas were not separately mapped or sampled in 2014, so it is not possible to definitively identify any changes in quality or extent. A decrease in drainage due to bed-level raising may have increased the extent/wetness of these seepage mires by reducing drainage downslope.

Habitat type	2022	2014 target notes	Comparison with relevant New Forest "quintessential habitat" and interpretation
	diverse habitats recorded (M21a)		
Moor-grass Mire	Mostly dominated by tussocky Purple Moor-grass and rushes (M25), with some Marsh St. John's-wort and Bog Myrtle. The presence of Bottle Sedge in some samples is indicative of particularly wet conditions. Rushier stands tended to include Poor Fen herbs such as Marsh Willowherb, Marsh Bedstraw, Marsh Pennywort, but without the characteristic mosses. Included a discrete stand of Common Reed.	Vegetation in valley bottoms dominated by Purple Moor-grass encompassed within the broad category "marshy grassland" equates to Moor-grass Mire, and was described as boggy and dominated by Purple Moor-grass with Heather or Bog Myrtle growing on tussocks. There is no mention of Common Reed (or of the species associated with Poor Fen), although Common Reed was noted some 500m further up the watershed in Soakway vegetation.	The presence of Common Reed may be indicative of overgrown flushed mire (i.e. with some base enrichment), although Common Reed (and Poor Fen species) may also result from slightly raised nutrient levels. However, it is not clear whether these species have colonised/expanded post-restoration. The presence of Bottle Sedge, not mentioned in this section of the site in the 2014 survey, provides some indication that this habitat may have become wetter.
Poached and Disturbed habitat	Characterised by Pillwort, Many-stalked Spike-rush and Floating Clubrush and Bulbous Rush. The presence of Marsh St. John's-wort, Bog Pondweed and Marsh Pennywort indicate the typically strong affinity with Soakway.	Not recorded in 2014, although Pillwort was recorded in one small areas within Soakway vegetation, which was probably Poached and Disturbed habitat.	This represents typical Poached and Disturbed habitat and appears to have increased in extent, although comparable data are not available.
Floodplain Lawn	Close-grazed swards of Heath Grass, Velvet Bent, Purple Moor-grass, Mat Grass, Carnation Sedge, Yellow Sedge with Meadow Thistle. Found in	Described as "marshy grassland" and therefore not differentiated from Moor-grass Mire and some Wet Heath. Target notes indicates heavily grazed Purple Moor-grass and Carnation Sedge with Cross-leaved Heath, Heather, Soft Rush	Habitat aligns well with the description of Purple Moor-grass Wet Lawn typical of less fertile and headwater floodplains. Aerial imagery indicates an increase in the area of Floodplain Lawn in the southern section (including a previously heavily

Habitat type	2022	2014 target notes	Comparison with relevant New Forest "quintessential habitat" and interpretation
	a narrow band along the western edge of the watercourse, where it rises rapidly into Gorse brake and humid heath. Also a larger area on both sides in the southern section, where it transitions to wet heath (M24c/M23a)	and Tormentil with *Sphagnum compactum,* indicating a transitional wet heath community	eroded stock crossing). Includes some ephemeral vegetation in what appear to be seasonal pools
Oligotrophic stream marginal and in-channel vegetation	A mix of soakway and mire vegetation (M29, M23c, M25) characterised by Marsh St. John's Wort, Sharp-flowered Rush and Bog Pondweed found on the shallow margins of the watercourse. In-channel vegetation is similar to marginal vegetation but with but with more Bog Pondweed and Floating Club-rush and occasional Branched Bur-reed.	Similar vegetation described at one point along the pre-restoration watercourse, with Bog Pondweed and rare Marsh St. John's wort and fringed with Purple Moor-grass.	Similar to Soakway (as described in the Restoration Plan), although some stands had frequent Purple Moor-grass and rush. This vegetation would not have been found where the banks were sheer prior to restoration. It readily develops following restoration and has probably expanded significantly where meanders have been restored and bed-level raised.

Table 8: Summary descriptions of habitats mapped and sampled at Slufters in 2022 with an interpretation of any changes since 2014 and similarity to habitats described in the New Forest Freshwater and Wetlands Restoration Plan.

Habitat type	2022	2014 target notes	Comparison with relevant New Forest "quintessential habitat" and interpretation
Wet Heath	Confined to the upper catchment and fringing the Valley Bog and western tributary. Characterised by Purple Moor-grass, Cross-leaved Heath, Heather and *Sphagnum denticulatum*	Not mapped. All heathland was described as dry, although this encompassed Humid Heath (H2c) with Purple Moor-grass and Heather. A transitional band with *Sphagnum denticulatum* was described in the upper catchment, but not mapped	Not described in the FWRP, but conforms to wet heath as described in the New Forest by Wright and Westerhoff (2001) (M16a). It falls at the wetter end of the gradation towards valley mire. Wet Heath may have developed or increased in areas previously mapped as humid heath, but the baseline evidence is not robust.
Valley Bog	A distinct area of 0.5ha recorded in a shallow tributary valley on the eastern valley side, characterised by abundant *Sphagnum denticulatum* and *S. papillosum* together with Common Cottongrass, White Beak-sedge, Bog Asphodel etc.	Recorded as acid flush in 2014	The Valley Bog fits well within the described habitat (M21a). It is difficult to judge whether the habitat had change significantly since 2014, when the same area was described as "acid flush" with an accompanying photo that shows much wetter soakway vegetation at a grid reference above the Valley Bog identified in 2022. It is not clear whether there was Valley Bog present in 2014.
Transitional rush-dominated mire	This transitional habitat included elements of Floodplain Lawn (M23a), Moor-grass Mire (M25c) and Soakway (M29), with abundant Sharp-flowered Rush, Soft Rush, Purple Moor-grass, Pondweed, Marsh St. John's-wort and small sedges. It was found in and along the	Not recorded in 2014	This habitat fits somewhere between Oligotrophic Stream, Moor-grass Mire and Soakway with characteristics of all three. The drought conditions increased grazing pressure on the habitat and converted some into Poached and Disturbed Habitat, while wetter areas were considered to be Oligotrophic Stream marginal vegetation. It appears to have developed along the watercourse since the restoration.

Habitat type	2022	2014 target notes	Comparison with relevant New Forest "quintessential habitat" and interpretation
	watercourse, much of which was dry at the time of survey.		
Poached and Disturbed habitat	Characterised by Pillwort, Floating Club-rush and Bulbous Rush and found along the watercourse margins The presence of Marsh St. John's-wort, Bog Pondweed and Marsh Pennywort indicates the typically strong affinity with Soakway.	Not recorded in 2014	This represents typical Poached and Disturbed habitat and appears to have developed along the watercourse since the restoration. The relationship with transitional rush-dominated mire is dynamic and depends on livestock pressure and water level.
Floodplain Lawn	Generally found in a narrow bank along the restored watercourse in slightly higher locations than the transitional rush mire, in some places under an open tree canopy. Characterised by short swards of Purple Moor-grass, Heath Grass, Common Bent and Red Fescue with small sedges and herbs. Mapped area included transitions to drier acid grassland in places.	Not recorded in 2014. Ground flora descriptions of the woodland do not include similar vegetation.	Aligns reasonably well with the FWRP descriptions, although transitions to more mesic acid grassland away from the watercourse are indicated by the presence of Common Bent and while species such as Daisy and White Clover indicate slightly higher nutrient levels. This habitat appears to have developed along the main channel since restoration and, together with Soakway and transitional rush dominated mire, has replaced acid grassland along the western tributary.
Oligotrophic stream	Much of the channel was dry at the time of the 2022 survey (which took place during a drought), but any vegetation that was clearly within or on the	The stream and its marginal and in-channel vegetation were not mapped in 2014 although a target note describes the main channel as supporting Bog Pondweed and Soft Rush.	Similar to Soakway (as described in FWRP), although the presence of Soft Rush indicates higher nutrient levels. It is assumed that this habitat was scarce previously due to the incised,

Habitat type	2022	2014 target notes	Comparison with relevant New Forest "quintessential habitat" and interpretation
	margins of the channel was included here (unless it was poached and included under Poached and Disturbed Habitat). It was characterised by Floating Club-rush, Sharp-flowered Rush, and Marsh St. John's-wort, Soft Rush and Water Mint.		straightened and shaded nature of the channel and has significantly increased.

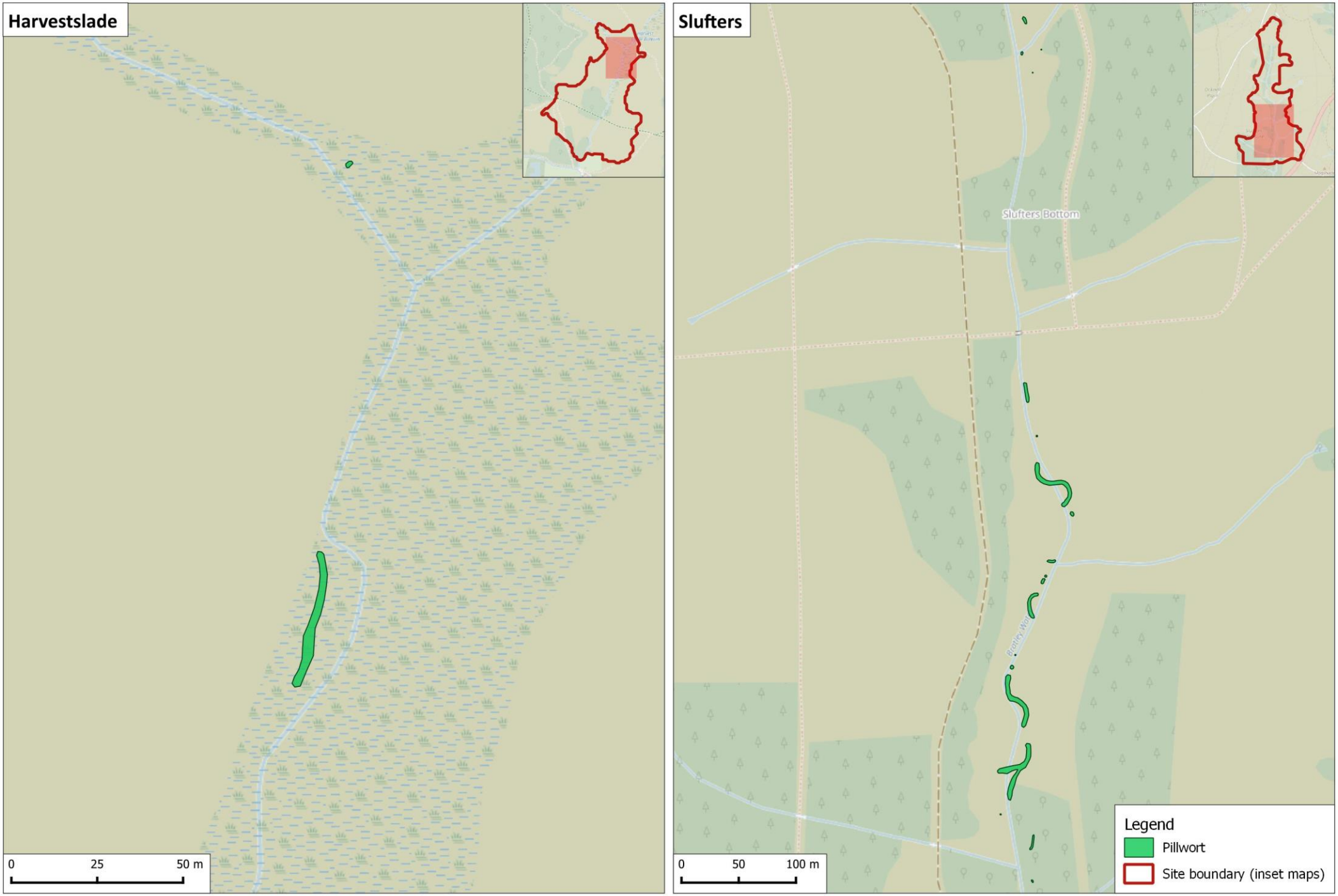
Species

4.11 At Harvestslade, there was a notable change in the apparent abundance of Pillwort (see Map 8). This was present at one location in the western tributary in 2014. In 2022 an area of about 10m x 10m containing at least 5 patches was also located along infilled channel in poached and disturbed habitat, with a 6th patch just downstream from the 2014 record. Marsh St. John's-wort *Hypericum elodes* was noted to be present in acid flushes in 2014. By 2022 it had apparently spread and was frequent in Poached and Disturbed Habitat and Oligotrophic Stream marginal vegetation and Moor-grass Mire in addition to Soakway (acid flush). A number of plants of Petty Whin *Genista anglica* were noted in wet heath in the northern section of the site in an area of wet heath just below the footbridge.

4.12 At Slufters, 19 patches of Pillwort were found in Poached and Disturbed Habitat in 2022. This species was not found in 2014, although the desk study included a record from the area. Species of note in 2014 included Marsh St. John's-wort *Hypericum elodes* and Round-leaved Crowfoot *Ranunculus omiophyllus* in acid flushes (i.e. Soakway) and Water Plantain *Alisma plantago-aquatica*, for which appropriate habitat was noted to be limited. In 2022, Marsh St. John's-wort was frequent in Soakway, Poached and Disturbed habitat, transitional rush-dominated mire and Oligotrophic Stream vegetation and it seems likely that this species has increased significantly. Water Plantain was not relocated in 2022. It is generally found in mesotrophic and eutrophic waterbodies and is a frequent colonist of newly created ponds, recently cleaned ditches etc. – it is not a characteristic species of good quality New Forest wetlands. Round-leaved Crowfoot was noted in the northern section of the site in 2022, but did not occur in any of the quadrats. Autumn Lady's-tresses was recorded in 2014 but suitable habitat was not surveyed in 2022. Bladder Sedge was also recorded, but was not relocated in 2022 (although the specific location was not known). This species is likely to have still been present within wetter areas of mire.

4.13 At Slufters, no alien native species were listed in 2014, although the presence of the moss *Campylopus introflexus* was noted in the dry heath. In 2022, *Crassula helmsii* was noted in the Oligotrophic Stream. No alien invasive species were noted in 2014 or 2022 at Harvestslade.

Map 8: Areas of Pillwort at Harvestslade and Slufters



5. Conclusions

5.1 Directly comparable pre- and post-restoration data are not available for Harvestslade and Slufters. However, a number of conclusions can be drawn based on the information available, including photographic evidence.

Harvestslade

5.2 Prior to restoration, the watercourse at Harvestslade was deeply incised and straightened, and the interaction with the floodplain was inconsistent. Figure 4 provides a view of the watercourse just downstream of the bridge before restoration (facing upstream). The watercourse is straight, deep and with no in-channel or marginal vegetation. The bankside vegetation is dry and there is no transitional zone, such as a shallow, poached margin.

Figure 3: The channel pre-restoration at Harvestslade (image sourced from Forestry England).

5.3 Following restoration, the character of the watercourse has changed substantially and there are also changes to the surrounding wetland habitats. Figure 4 provides a view of the new meandering channel in the

same area of the floodplain (facing downstream). The banks are shallow and support vegetation typical of Oligotrophic Stream, with Bog Pondweed and Marsh St. John's-wort and there is in-channel vegetation in the shallow watercourse. There is no incision or bankside spoil and it is clear that the water can spread out onto the adjacent Floodplain Lawn. The reinstated meander means that the extent of the in-channel, marginal and transitional vegetation has increased. There is light poaching along the bankside and Figure 5 shows a more extensive area of this Poached and Disturbed Habitat which supports a large population of Pillwort.

5.4 Figure 5 show the adjacent area of Floodplain Lawn in the winter of 2023. The floodplain has re-wetted and now supports Ephemeral Pools, another typical New Forest wetland habitat (there is no mention of this habitat at Harvestslade prior to the restoration).

5.5 There is no direct evidence in terms of the area and quality of habitat to show how the restoration is supporting the integrity of the associated Valley Mire. However, the slowed flow will reduce drainage and help maintain appropriate hydrological conditions.

Figure 4: Restored Oligotrophic Stream with marginal and in-channel vegetation at Harvestslade.

Figure 5: Poached and Disturbed Habitat supporting a significant population of Pillwort at Harvestslade

Figure 6: Re-wetted floodplain at Harvestslade, winter 2023.

Slufters

5.6 Before restoration, the watercourse running through Slufters was over-deepened and straightened, resulting in a disconnect with the floodplain and the loss of in-channel, marginal and floodplain features. As at Harvestslade, the incised banks meant that there was little marginal vegetation and no transition to Floodplain Lawn. Figure 7 shows a view of the channel before restoration, in which this is apparent.

Figure 7: The channel pre-restoration at Slufters (image sourced from Forestry England.

5.7 Following restoration, the channel is now more sinuous. The channel is no longer incised and the watercourse can connect with the floodplain. There is woody material in the stream and erosional and depositional features indicate that natural processes are functioning. Due to the more recent nature of the restoration interventions at Slufters, some of the habitats were transitional in nature at the time of the survey, but typical Oligotrophic Stream vegetation was frequent within the channel and the transition to adjacent Floodplain Lawn was intact (see Figure 8). Poached and Disturbed Habitat was frequent and in places supported Pillwort.

Figure 8: The channel in 2022, showing well developed marginal and in-channel vegetation and plenty of room for the water to spread laterally onto the floodplain.

6. Recommendations

6.1 This trial indicates that the combination of mapping meso-habitats specific to the New Forest freshwaters and wetlands combined with more detailed sampling of the vegetation in each habitat can provide useful information about the success of restorations. This is the case even where equivalent baseline data are not available, such as at Harvestslade and Slufters, where pre-restoration survey work was designed to describe the habitats and vegetation and note any potential constraints, rather than provide a baseline for future comparisons. The approach will be particularly useful when combined with fixed point photography and geomorphological surveys.

6.2 Although every effort was made to correctly identify and map the extent of each habitat, there is inevitably a degree of error when habitat patches are particularly small or linear or exist as part of a continuum or mosaic where it is hard to define boundaries. In addition, without prior knowledge of the restoration interventions, it can be hard to be sure about the exact location and extent of interventions and the potential zone of influence when setting

up the survey boundary. For example, at Slufters, it would have been useful to revisit and describe the small "acid flushes" previously identified under woodland cover on the slopes above the restored watercourse, which were outside the survey boundary.

6.3 Here, we make a number of recommendations below about the survey methods and subsequent data interpretation:

1. Spatial information about the restoration should be used to highlight key areas to include within the monitoring boundary. GIS layers for restorations would be very useful to enable detailed field maps based on aerial imagery to include the location and extent of interventions. These should be used in the field before sampling starts to ensure that the survey boundary is appropriate and takes into account wetland features further away from the watercourse itself, such as seepage step mires, which may not be visible from aerials or picked up using lidar data. Similarly, where pre-survey NVC or Phase 1 data are available, geospatial datasets would useful.

2. Vegetation data derived from sampling with quadrats was very useful in helping to interpret the vegetation in each habitat type. However, the vegetation was quite diverse, and an increased number of quadrats (15-20) would improve the representativeness of the data. This is particularly the case where vegetation has not yet fully "settled" post restoration and where fine-scale mosaics are present. For example, at Harvestslade, the Floodplain Lawn comprised an intimate mosaic of drier acid grassland grading into Floodplain Lawn. The wetter vegetation was preferentially sampled due to the focus on wetland habitats, but more comprehensive data incorporating the drier patches would be more useful in identifying the impact of re-wetting on these drier areas over time.

3. Features too small to map and sample, such as ephemeral pools should be recorded using mapped target notes to ensure that these features are not overlooked (such as the small pools in Floodplain Lawn at Harvestslade).

4. The habitat descriptions within the draft Freshwater and Wetland Restoration Plan were very useful in helping to identify characteristic freshwater and wetland mesohabitats. An additional description for Wet Heath would be useful as, although not technically a wetland habitat, this habitat can change in extent and character post restoration, as seen at Slufters. At intact sites, there is often a well-developed transition between Wet Heath and Valley Mire that is not found at drained sites.

5. Seepage step mires could usefully be separated out from valley bottom Valley Bog. Although when in good condition they can support very similar vegetation (e.g. M21a), they may respond differently to restorations, as they are perched above the watercourse.

6. In addition to mapping habitats and recording quadrat data, a written description of the site should be a formal component of the method, defining key features and providing context for the other survey components.

7. Familiarity with the site, its condition pre-restoration, and changes post-restoration can greatly enhance both the survey design and subsequent interpretation of the data. While staffing changes do not always make this possible, a site visit with people with long-term knowledge of the site should be prioritised wherever possible, particularly at sites where restoration work has already taken place. In addition, most existing restoration sites have abundant information, including case studies as well as reports, and wherever possible this should be made available.

8. The interpretations should take into account the dynamic nature of wetland habitats. For example, at Slufters, the initial mapping undertaken in early July included a small Oligotrophic Stream, approximately 0.5m wide with Floodplain Lawn, Soakway and some Poached and Disturbed Habitat. A fortnight later the stream was mostly dry with much more extensive poaching throughout the marginal stream habitat (where livestock were converging on the remaining wet areas), converting this into more extensive Poached and Disturbed Habitat. Consideration of the overall area of each habitat type should take this dynamism into account, and comparisons over time should taken into account potential variations. Poached and Disturbed habitat can, to some extent, be considered as a condition that can be imposted on other habitats (especially Floodplain Lawn).

9. Finally, 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 and taking into account photographic records. This will provide an holistic understanding of the post restoration changes.

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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.

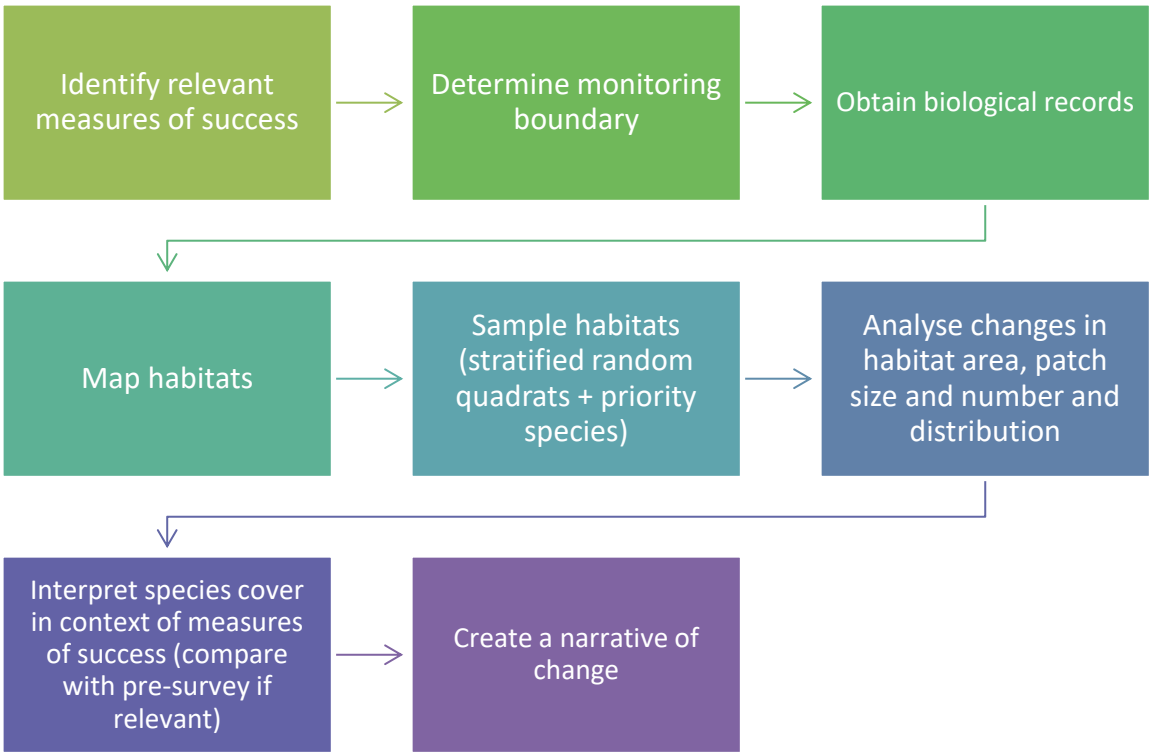

Figure 1: The steps required for vegetation monitoring are outlined below.

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[6], 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[72], 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).

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

[7] 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:

- Dry Heath (not included in habitat quality monitoring, see below)
- 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[8] 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)

[8] 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.

Appendix 2 – Fixed-point photographs

Harvestlade

Photo and Grid Refence	Description	2014	2022
H52 SU 20584 05610	An area of dry acid grassland merging into wet grassland towards the fluvial channel on the right of the picture. Wet and dry heathland is present within this area.		

A SU 20646 05537	Taken from the ford of the new channel facing upstream. The photograph shows the marginal vegetation that has developed along the edge of the channel.		
B SU 20793 05730	Facing east showing one of the step-mires arising in the valley. The white flowerheads are Cottongrass.		

C SU 20852 05933	View of the channel on the right of the photograph. This is an area where heather bales have raised the river bed and slowed water flow causing water to spill over creating a wet lawn which has been colonised by Pillwort (the bright green plant on the left side of the photo).		
D SU20883 06060	Facing east across the channel and showing the step-mires on the east side of the channel. The ground vegetation of the wet lawn is comprised of Marsh St John's-wort.		

H46 SU 20966 06117	Photo taken facing downstream from the bridge. Water flow has been slowed downstream creating a larger wetland area with Bottle Sedge, Sharp-flowered Rush and Cottongrass.		

Slufters

Photo and Grid Refence	Description	2014	2022
1 **SU** 23125 11667	Described as an acid flush in 2014 with Soakway vegetation.		

A SU23147 10311	Photo of the in-channel 'marginal' vegetation with Floating Clubrush, Sharp-flowered Rush and Water Mint. Photo taken facing north (up-stream).		
B SU 23000 11242	Photo taken close to the original S13 facing downstream to show the in-channel 'marginal' vegetation under the oak canopy. Marsh St John's-wort and Sharp-flowered Rush are dominant. Photo taken facing southeast viewing downstream of the flush		

C SU 23093 11468	Photo at the top of the catchment standing at the ford and showing the shingle that has been deposited in the stream bed. Photo taken facing south and downstream of the ford.		
D SU 23080 11201	Confluence of a flush with the main waterway showing the in-channel 'marginal' vegetation which is dominated by Marsh St John's-wort. Photo taken facing east and perpendicular to the main stream viewing the flush upstream.		
E SU 23032 10671	Main waterway showing the in-channel 'marginal' vegetation with Bog Pondweed, Sharp-flowered Rush and Marsh St John's-wort. The vegetation		

	covers the entirety of the channel at this point. Photo facing north and upstream of the main waterway, showing some of the meanders along the stream.		
F SU 23142 10553	Confluence of a flush with the main channel showing the Sharp-flowered Rush dominated habitat. The poached areas of the flush and a small location along the main channel supported Pillwort, and these are the furthest upstream colonies found in the 2022 survey. Photo taken facing northeast which is viewing upstream along the main channel and up the flush.		

G SU 23149 10266	Main channel which is poached along the sides by cattle grazing and supports a healthy population of Pillwort. The 'marginal' vegetation covers the entirety of the stream at this location. Photo taken facing south which is downstream along the main channel.		
H SU 23132 09871	Main channel which is almost covered with 'marginal' vegetation comprising of Sharp-flowered Rush, Lesser Spearwort, and Floating Clubrush. The sides have been poached support a large population of Pillwort (the bright green plant in the foreground). Photo taken facing north and viewing upstream along the main channel.		

I SU 23154 09775	Main channel which is incised at this point and relatively deep with no in-channel vegetation and the steep sides are dominated by Bracken and Bramble. Shingle has been placed in the channel to modify the flow. Photo taken at the bottom of the catchment adjacent to a post-and-wire fence marking the bottom of the restoration works. The photo is facing north, which is upstream along the main channel.		
J **SU23235** **11240**	The lowest point of the Valley Bog showing M21a type vegetation. The 2014 photo is nearby at but shows much Soakway vegetation – it may be above the Valley Bog Taken facing E from the foot of the Bog