Oxfordshire Fens Project Hinksey Heights Monitoring Report 2019

David Morris

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Executive summary

The Oxfordshire Fens Project began work in August 2018 to restore alkaline fen habitat to Hinksey Heights Nature Reserve. To date this has involved the management of vegetation and introduction to the site of plant species characteristic of alkaline fen.

This report presents the results of vegetation monitoring to record the progress of restoration. The design of the monitoring, a method to assess the development of vegetation and how these have been applied to Hinksey Heights Nature Reserve are described. The monitoring comprises a protocol to be carried out annually for at the least the first five years of restoration, including:

- 30 fixed 1m x 1m vegetation plots, with 5 control plots in unmanaged areas and 25 in areas subject to restoration;
- plant species lists for restoration areas; and
- monitoring of plant species introductions.

The results of the pre-restoration monitoring recorded in July 2018 and results recorded in August 2019 following the start of restoration are detailed. The monitoring in 2019 found that a number of plant species of alkaline fen had emerged from the seed bank since restoration works began, such as blunt-flowered rush (*Juncus subnodulosus*) and fen bedstraw (*Galium uliginosum*), and that several of the plant species introduced had become well-established, such as marsh lousewort (*Pedicularis palustris*) and parsley water dropwort (*Oenanthe lachenalii*).

Progress to meet the targets was found to be limited, particularly in relation to vegetation composition, but this was to be expected after only one year of restoration. However, management of vegetation has reduced the dominance of species such as common reed (*Phragmites australis*) and reduced the height of the vegetation to within target levels in one management area.

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1. Introduction

1.1. Project background

The Oxfordshire Fens Project is undertaking habitat restoration work to re-establish alkaline fen at Hinksey Heights. The project area is located between the Hinksey Heights Golf Club and North Hinksey (grid reference SP 493 043), situated in a valley draining the high ground of the mid-vale ridge to the west of Oxford (Figure 1.1).

A baseline study of the project area was undertaken to gather information about the project area and form a basis for decisions about restoration works. This was completed in May 2019 (Oxfordshire Fens Project, 2019).

Restoration work at Hinksey Heights began in August 2018 and is currently focused in two areas, located on the north and south sides of the main valley within the project area (Figure 1.1). Before restoration works, these areas had not been managed for decades and comprised tall-herb fen dominated by common reed (*Phragmites australis*). Restoration works have focused on initial clearance of this vegetation and management of re-growth to promote the development of alkaline fen and more diverse rich-fen habitats.

1.2. Alkaline fen

The objective of restoration works is to restore alkaline fen to Hinksey Heights. Alkaline fen is a habitat listed on Annex I of the Habitat Directive¹, a list of natural habitats requiring conservation across the European Union. The *Interpretation Manual of European Union Habitats* (European Commission, 2013) provides the following description of alkaline fen²:

[Alkaline fens are wetlands] mostly or largely occupied by peat- or tufa-producing small sedge and brown moss communities developed on soils permanently waterlogged, with a soligenous or topogenous base-rich, often calcareous water supply, and with the water table at, or slightly above or below, the substratum. Peat formation, when it occurs, is infra-aquatic. Calciphile small sedges and other Cyperaceae usually dominate the mire communities, which belong to the *Caricion davallianae*, characterised by a usually prominent "brown moss" carpet formed by *Campylium stellatum*, … [*Palustriella commutata*], [*Calliergonella cuspidata*], *Ctenidium molluscum, Fissidens adianthoides, Bryum pseudotriquetrum* and others, a grasslike growth of *Schoenus nigricans*, … *Eriophorum latifolium*, … [*Carex*] *lepidocarpa*, *C. hostiana*, *C. panicea*, *Juncus subnodulosus*, … *Eleocharis quinqueflora*, and a very rich herbaceous flora including … *Dactylorhiza incarnata*, … *Epipactis palustris* [and] *Pinguicula vulgaris*.

In Oxfordshire, alkaline fen comprises vegetation referable to the following plant communities of the National Vegetation Classification (Rodwell, 1991):

¹ Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora.

² Species that do not occur in Oxfordshire have been omitted from the quoted description. The scientific names of plants listed have been amended to conform to the taxonomic reference cited in this report.

- M9 Carex rostrata-Calliergonella cuspidata/giganteum mire;
- M10 Carex dioica-Pinguicula vulgaris mire; and
- M13 Schoenus nigricans-Juncus subnodulosus mire.

In addition, degraded alkaline fen habitat may be represented by M22 *Juncus subnodulosus-Cirsium palustre* fen meadow where this plant community has some of the features of alkaline fen.

1.3. Purpose and structure of this report

The purpose of this report is to describe the design of vegetation monitoring initiated at Hinksey in July 2018 to monitor the progress of habitat restoration toward alkaline fen and to present the results of monitoring up to August 2019.

The monitoring design is described in Section 2. Full results of the monitoring are provided in Appendix 1 and summarised in Section 3.

1.4. Acknowledgements

The restoration work and monitoring at Hinksey Heights is being funded by the Trust for Oxfordshire's Environment 2.

Many thanks to volunteers Kathy Warden and Robert Gray for their help to complete the monitoring during 2019.



2. Monitoring design

2.1. Objectives

Monitoring of the restoration areas at Hinksey Heights will aim to:

- provide a record of the development of habitat subject to restoration;
- provide information to determine the success of restoration works; and
- direct decisions about restoration and management.

Monitoring has been designed to fulfil the above objectives, and measurable targets have been identified. These are described below.

2.2. Design

Monitoring plots

Vegetation monitoring will be based on fixed 1m x 1m plots as follows:

- plots will be recorded annually at approximately the same date for at least the first five years following restoration works;
- plots will be recorded following a fixed recording scheme based on vascular plant and bryophytes presence and abundance;
- plots will be representative of stands of vegetation of interest and locations will minimise bias, e.g. by random locations or transects;
- plots will be located and marked so that they can be accurately relocated;
- plots will be established within areas to be restored, with additional control plots and plots to sample different management treatments as required;
- at least a subset of plots will be recorded before restoration works; and
- the sample size should be large enough to detect statistically meaningful change, e.g. a minimum of at least five plots per management treatment.

For each monitoring plot the following will be recorded when the plot is first established:

- accurately georeferenced location, e.g. using the waypoint averaging function on a GPS unit;
- depth of peat to the nearest 5cm (recorded as 0cm if absent);
- presence of tufa ('yes' or 'no'); and
- whether the plot is located on a spring ('yes' or 'no').

Prior to restoration work it may not be possible to accurately record all the above parameters as ground conditions may be obscured. However, this information can be recorded later once restoration management has begun and ground conditions can be better assessed.

Within each plot the following will be recorded annually:

- the date of the record;
- all bryophyte taxa within the plot, following the nomenclature of Hill et al. (2008);
- all vascular plant taxa within the plot, following the nomenclature of Stace (2010);
- the cover-abundance of each plant taxon using the Domin scale (Table 2.1);
- vegetation height, measured to the nearest 5cm, as the height of the 'leaf canopy' of the tallest tier of vegetation, or as an approximate average where this is uneven;
- percentage of bare ground (i.e. peat, tufa or mineral soil not covered in vegetation or litter) within the plot, to the nearest 1%;
- percentage cover of litter to the nearest 1%;
- percentage cover of bryophytes to the nearest 1%; and
- NVC plant community with which the plot is judged to have the closest affinity.

Additional parameters could be recorded regularly as required, e.g. water chemistry (pH, [CaCO₃], [NO₃⁻], [PO₄³⁻] etc.).

Domin score	Percentage cover	Domin score	Percentage cover
10	91-100%	5	11-25%
9	76-90%	4	4-10%
8	51-75%	3	<4% many individuals
7	34-50%	2	<4% several individuals
6	26-33%	1	<4% few individuals

Table 2.1. The Domin scale of cover-abundance

Species lists

In addition to monitoring plots, complete lists of vascular plants and bryophytes within restoration areas will be complied each year. The relative frequency of each taxon recorded will be given a qualitative score using the DAFOR scale ('dominant', 'frequent', 'occasional', 'rare').

Fixed point photography

To provide a visual record of vegetation change, photographs will be taken annually from the same point within restoration areas. Photographs will be taken on approximately the same date each year.

Species introductions

As part of monitoring, any plant species introduced as part of restoration works will be accurately recorded. For any introduction the following will be recorded:

- species introduced;
- grid reference and description of location of introduction;
- date of introduction;

- type of propagule introduced (e.g. seed);
- method of introduction;
- source of the propagule introduced (e.g. green hay);
- outcome of the introduction determined during monitoring visits (e.g. plants established, their stage and numbers); and
- any additional notes on the introduction and its outcome.

2.3. Targets

Targets for the restoration works based on the target habitat of alkaline fen (described in Section 1.2) and above monitoring design are given in Table 2.2. The targets should be applied to assess progress with habitat restoration as follows:

- the criteria for the targets should be applied to whole management units;
- data gathered during vegetation monitoring should be assessed against the targets on an annual basis;
- where the criteria for a target are successfully met, then the management unit scores one point; and
- the total number of points can be used to determine progress with restoration over the monitoring period.

The targets will be refined by applying this assessment methodology to examples of alkaline fen habitat at sites Oxfordshire considered by the Oxfordshire Fens Project to provide a suitable target for habitat restoration.

Table 2.2. Targets for restoration of vegetation to plant communities of alkaline fen and related habitats. Species composition based on floristic tables from Rodwell (1991) adapted to Oxfordshire. Constant species are those recorded in more than 60% of monitoring plots, frequent species in 40-60% of plots, rare species in up to 20% of plots.

Target			Criteria	
S	S	Grasses, sedges and rushes	 Target 1.1 – At least two of the following a Carex panicea Carex rostrata Eriophorum angustifolium Juncus subnodulosus Molinia caerulea Schoenus nigricans 	re constant: And at least two of the following are frequent: • Carex disticha • Carex flacca • Carex lepidocarpa • Carex nigra
Vascular plant	Typical specie	Forbs	 Target 1.2 – At least four of the following are constant: <i>Cirsium palustre</i> <i>Equisetum palustre</i> <i>Filipendula ulmaria</i> <i>Galium palustre</i> <i>Lotus pedunculatus</i> <i>Mentha aquatica</i> <i>Menyanthes trifoliata</i> <i>Potentilla erecta</i> <i>Succisa pratensis</i> 	 And at least four of the following are frequent: Anagallis tenella Angelica sylvestris Caltha palustris Cardamine pratensis Equisetum fluviatile Festuca rubra Galium uliginosum Hydrocotyle vulgaris Lathyrus pratensis Silene flos-cuculi Pedicularis palustris Ranunculus acris Valeriana dioica Vicia cracca

Target		Criteria					
		Target 1.3 – At least one of the following species is present within a monitored area:					
	Rare species	 Agrostis canina Carex distans Carex dioica Carex hostiana Carex pulicaris Cirsium dissectum Dactylorhiza incarnata Dactylorhiza maculata Dactylorhiza maculata Dactylorhiza maculata Dactylorhiza praetermissa Dactylorhiza praetermissa Dactylorhiza maculata Dactylorhiza praetermissa Dactylorhiza maculata Dactylorhiza praetermissa Dactylorhiza maculata Dactylorhiza praetermissa Dactylorhiza maculata 					
	Negative indicators	Target 1.4 – Average cover by any or all of the following species does not exceed 50%: • Carex acutiformis • Epilobium hirsutum • Eupatorium cannabinum • Filipendula ulmaria • Juncus inflexus • Phragmites australis • Typha latifolia • Urtica dioica Target 1.5 – Weedy non-wetland plants indicative of disturbance (e.g. Cirsium arvense, Crepis biennis) are absent or rare within plots					
		Target 1.6 – Invasive non-native plants (e.g. Impatiens glandulifera, I. parviflora) are absent from a monitoring area					

Target		Criteria					
Bryophytes	Typical species	 Target 2.1 – At least two of the following brown moss and liverwort species are constant and at least one further species frequent: Aneura pinguis Calliergon giganteum Calliergonella cuspidatum Campylium stellatum Cratoneuron filicinum Fissidens adianthoides Palustriella commutata Pellia endiviifolia Scorpidium cossonii 					
	Bryophyte abundance	Target 2.2 – Average total cover by the above brown moss and liverwort species should be in the range 30-70%					
	Negative indicators	 Target 2.3 – The following weedy and woodland bryophyte species are absent or rare: Brachythecium rutabulum Hypnum cupressiforme Kindbergia praelonga Oxyrrhynchium hians Plagiomnium undulatum 					

Target		Criteria		
ucture	Vegetation height	Target 3.1 – Average vegetation height is in the range 0.3-0.7m		
Vegetation str	Litter	Target 3.2 – Average litter cover is less than 30%		
	Bare ground	Target 3.3 – Average percentage of bare ground in the range 5-15%		

2.4. Implementation at Hinksey Heights

Vegetation monitoring plots have been set up at Hinksey Heights to monitor the development of vegetation in the two restoration areas, following the design described above. A total of 30 plots were established, located along four transects, two each crossing the northern and southern restoration areas (Figure 2.1). Transect 1 was set up on 21st July 2018 and transects 2, 3 and 4 were set up on 10th August 2019. Five of the 11 plots along Transect 1 were located in an area not subject to restoration works, to provide a comparison with treated areas. The plots were marked using 1m bamboo canes with orange fluorescent tape on the upper end.

Transects were oriented approximately west to east along the length of the main valley, with plots located with their northern or southern edges along the transect line and the north-western or south-western corner spaced along the transect at 10m intervals and numbered west to east. Plots were located on the northern or southern side at random, to capture springs or to avoid trampled areas or scrub present when the plots were first recorded. Full details of monitoring transects and plots are given in Table A2.5.





3. Monitoring results

The results recorded from monitoring of plots over 2018 and 2019, and species lists and photographs collected in 2019 are provided in Appendix 1. Details of species introductions recorded are provided in Appendix 2.

An assessment of the results from the vegetation monitoring plots against the targets set out in Section 2.1 is provided in Table 3.1.

As would be expected after only one season of restoration work, progress toward the targets is limited. However, continued cutting of vegetation has reduced the dominance in the northern restoration area of species such as common reed (*Phragmites australis*) and reduced the height of the vegetation to within target levels.

Although the vegetation in both restoration areas has yet to develop the characteristic vegetation composition of alkaline fen, a diversity of wetland plants was recorded from the two restoration areas in 2019. This included alkaline fen species that had likely regenerated from the seedbank such as blunt-flowered rush (*Juncus subnodulosus*) and fen bedstraw (*Galium uliginosum*) in the northern restoration area. Half of the species that had been introduced to the northern restoration area had established (Table A2.5), notably marsh lousewort (*Pedicularis palustris*) and parsley water dropwort (*Oenanthe lachenalii*). Seed of the former species had germinated in many places in the northern restoration area and both species were abundant in the spring next to the boardwalk (plot T1Q10).

Table 3.1. Assessment of 2019 monitoring results against targets for restoration to alkaline fen. Score of 1 indicates the restoration area meets the criteria for a target, a score of 0 that it does not.

Tannat				Restoration area		
Targe	rarget				Southern	
	Typical	Grasses, sedges and rushes	Target 1.1	0	0	
nts	species	Forbs	Target 1.2	0	0	
ar pla	Rare	species	Target 1.3	1	0	
Vascul			Target 1.4	1	0	
	Negative indicators		Target 1.5	0	1	
			Target 1.6	0	0	
es	Туріс	al species	Target 2.1	0	0	
yophy	Bryophyt	e abundance	Target 2.2	0	0	
B	Negative indicators		Target 2.3	1	0	
e u	Vegetation height		Target 3.1	1	0	
egetation	Litter		Target 3.2	0	1	
Ve	Bare ground		Target 3.3	0	1	
			Total	4	3	

4.References

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Rodwell, J., 1991. *British Plant Communities. Volume 2. Mires and Heaths.* Cambridge: Cambridge University Press.

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Appendix 1. Monitoring results

Table A2.2. Plants recorded from restoration areas at Hinksey Heights during vegetation monitoring on 10th August 2019. The origins of species characteristic of alkaline fen and related vegetation are noted.

Taxon	Restoration area		Note
	Northern	Southern	
Mosses			
Brachythecium rutabulum	F	-	
Bryum capillare	R	-	
Cratoneuron filicinum	R	-	
Oxyrrhynchium hians	R	F	
Plagiomnium rostratum	R	-	
Plagiomnium undulatum	-	F	
Ferns and horsetails			
Dryopteris filix-mas	R	R	
Equisetum arvense	-	R	
Equisetum palustre	R	-	
Equisetum telmateia	R	F	
Flowering plants			
Agrostis stolonifera	R	-	
Anagallis tenella	R	-	Introduced
Angelica sylvestris	R	0	
Arctium minus sens. lat.	R	-	
Arrhenatherum elatius	R	-	
Brachypodium sylvaticum	R	R	
Bromopsis ramosa	-	R	
Caltha palustris	-	R	Single-leaved seedling in plot T4Q1
Cardamine flexuosa	R	R	
Carex acutiformis	-	A	
Carex pendula	0	-	
Cerastium fontanum	R	-	
Circaea lutetiana	R	-	
Cirsium arvense	R	R	
Cirsium palustre	0	R	
Cirsium vulgare	0	-	
Conyza canadensis	R	-	
Crepis biennis	0	-	
Crepis capillaris	R	-	
Daucus carota	R	-	
Deschampsia cespitosa	R	-	
Epilobium ciliatum	R	-	
Epilobium hirsutum	R	-	
Epilobium obscurum	R	-	
Epilobium parviflorum	0	-	

Taxon	Restoration area		Noto
	Northern	Southern	note
Eupatorium cannabinum	A	A	Present prior to restoration works
Filipendula ulmaria	0	-	Introduced
Galium aparine	R	-	
Galium uliginosum	R	-	Germinated from seedbank
Geranium robertianum	R	R	
Glechoma hederacea	R	R	
Helminthotheca echioides	0	-	
Heracleum sphondylium	R	-	
Holcus lanatus	R	-	
Hypericum tetrapterum	R	-	Germinated from seedbank
Impatiens parviflora	F	F	
Juncus articulatus	R	-	Germinated from seedbank
Juncus bufonius	R	-	
Juncus inflexus	R	-	Germinated from seedbank
Juncus subnodulosus	R	-	Germinated from seedbank
Leucanthemum vulgare	R	-	
Lotus pedunculatus	R	-	Introduced
Moehringia trinervia	R	-	
Myosotis arvensis	R	-	
Odontites vernus	R	-	
Oenanthe lachenalii	R	-	Introduced
Pedicularis palustris	0	-	Introduced
Pellia endiviifolia	-	R	
Phragmites australis	D	D	
Plantago lanceolata	R	-	
Plantago major	R	-	
Poa trivialis	R	-	
Ranunculus repens	R	-	
Rosa sp.	R	-	
Rubus ulmifolius	-	R	
Schedonorus giganteus	R	R	
Scrophularia auriculata	F	-	
Senecio jacobaea	R	-	
Senecio vulgaris	R	-	
Solanum dulcamara	R	-	
Sonchus asper	F	-	
Symphytum officinale	R	0	
Taraxacum agg.	0	-	
Urtica dioica	0	-	
Valeriana officinalis subsp. sambucifolia	-	R	Present prior to restoration works
Veronica beccabunga	R	-	
Vicia cracca	R	R	Germinated from seedbank
Vicia tetrasperma	R	-	

Transect	Date set up	Plot	Distance (m)	Easting	Northing	Transect side (North / South)	Hydrology
1	21/07/2018	T1Q1	0	449414.48	204505.18	North	-
		T1Q2	10	449423.82	204508.49	South	-
		T1Q3	20	449433.88	204511.15	South	-
		T1Q4	30	449442.26	204516.01	North	-
		T1Q5	40	449451.48	204519.55	South	-
		T1Q6	50	449461.17	204523.87	South	-
		T1Q7	60	449471.71	204526.53	South	-
		T1Q8	70	449481.07	204529.74	South	-
		T1Q9	80	449489.52	204534.60	North	-
		T1Q10	90	449498.42	204536.03	South	Spring
		T1Q11	100	449507.81	204539.24	South	-
2	10/08/2019	T2Q1	10	449455.98	204539.17	South	Spring
		T2Q2	20	449466.04	204542.05	North	-
		T2Q3	30	449475.56	204543.25	North	-
		T2Q4	40	449487.55	204545.37	North	-
		T2Q5	49	449505.94	204550.11	South	-
3	10/08/2019	T3Q1	0	449407.81	204444.71	North	-
		T3Q2	10	449416.41	204440.46	South	-
		T3Q3	20	449426.44	204439.22	South	-
		T3Q4	30	449435.58	204436.86	South	-
		T3Q5	40	449446.02	204435.63	South	-
		T3Q6	50	449455.91	204433.95	North	-
		T3Q7	60	449465.32	204431.59	North	-
		T3Q8	70	449473.78	204428.11	South	-
		T3Q9	80	449481.50	204422.41	South	-
4	10/08/2019	T4Q1	0	449393.56	204425.44	South	-
		T4Q2	10	449403.22	204426.53	South	-
		T4Q3	20	449412.62	204425.85	South	-
		T4Q4	30	449422.58	204423.72	South	-
		T4Q5	40	449432.56	204419.92	South	-

Table A2.4. Results of vegetation monitoring at Hinksey Heights, recorded on visits during 2018 and 2019.

											No	orthern	restorat	ion area																		Sot	hern res	toration a	area					
				T1 T2													T3 T4																							
													_		-				-					_																
	5	3	ĉ	¥	č	3		0 0	6	3	ő		0 2		ő		O9		õ		ð	8	03	Ö	04	Q5	ð	03	ő	Ö	Ø5	00	۵7	ő	ő	ð	03	ő	04	Ö2
Taxon	21/07/2018	10/08/2019	21/07/2018	10/08/2019	21/07/2018	10/08/2019	21/07/2018	10/08/2019	21/07/2018	10/08/2019	21/07/2018	10/08/2019	21/07/2018	10/08/2019	21/07/2018	10/08/2019	21/07/2018	10/08/2019	21/07/2018	10/08/2019	10/08/2019	10/08/2019	10/08/2019	10/08/2019	10/08/2019	10/08/2019	10/08/2019	10/08/2019	10/08/2019	10/08/2019	10/08/2019	10/08/2019	10/08/2019	10/08/2019	10/08/2019	10/08/2019	10/08/2019	10/08/2019	10/08/2019	10/08/2019
Agrostis stolonifera	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Angelica sylvestris	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	1	-	1	1	1	-	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Arctium minus sens. lat.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Betula sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Brachypodium sylvaticum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Brachythecium rutabulum	1	-	1	4	1	1	1	7	1	1	-	3	-	2	-	2	-	-	-	5	3	4	1	-	3	2	-	8	1	2	8	1	6	1	3	1	-	-	-	-
Bromopsis ramosa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Bryum capillare	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Caltha palustris	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
Calystegia sepium	2	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cardamine flexuosa	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	1	-	-	-	-	-	-	3	-	-	-	-	-	1	-	1	-	-	-
Carex acutiformis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	6	7	-	5	5	3	4	-	-	-	-	-	-
Carex pendula	6	5	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	1	-	5	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Circaea lutetiana	3	2	2	1	-	-	1	2	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	2
Cirsium arvense	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cirsium palustre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	1	-	1	-	-	1	-	2	-	-	-	-	-	-
Cirsium vulgare	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-
Conyza canadensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Crepis biennis	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	1	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Crepis capillaris	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dryopteris filix-mas	-	1	-	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Epilobium hirsutum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7	-	-	-	-	-	-	4	-	-	-	1	-	-	-	-	1	-	-	-	-	-
Epilobium parviflorum	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	1	1	-	-	1	3	1	-	1	-	-	-	-	-	1	-	-	-	-	-	-
Epilobium sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Equisetum arvense	-	-	1	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-
Equisetum telmateia	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	4	-	1	1	-	1	-	-	-	-	-	4	-	-
Eupatorium cannabinum	1	1	9	7	9	9	1	5	-	-	9	9	-	7	-	4	-	4	6	4	3	4	2	1	2	1	8	8	10	5	7	7	7	10	6	9	6	9	3	10
Filipendula ulmaria	1	1	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	1	-	-	-	-	•	•	-	-	-	-	-	-		-	-	-
Fraxinus excelsior	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1		-	-	-	1	•	•	-	1	-	-	-	-		-	-	-
Galium aparine	-	-	2	1	-	1	3	1	-	2	-	1	5	-	4	-	1	1	2	-	-	-	-	-	-	-	1	-	-	-	-	-	-	4	1	1		1	-	-
Gailum uliginosum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-
Heracleum sphondulium	-	-	-	-	-	-	-	-	-	-	-	1	-		-		-	1	-	-	-		-	-	-	-	-	-	-	-	-	1	-	-	-	-		-	-	-
Helaus Japatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-
Hypericum tetranterum		-	-	-	-	-	-	-		-	-	-	-	-	-	2	-	-	-	-	-	2	-	-	4	-	-	-	-	-	-	-	-	-	-	-		-	-	-
Impatiens panyiflora		_	3	1	7	1	9	6	6	0	2	1	8		7	1	5	_	7	2	4	2	1	2	_	2	5	_	1	_	_	_		3	3	_	1	2	1	1
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Juncus bufonius	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		1	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Juncus inflexus	-	-	-	-	-	-	-	-		-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Juncus subnodulosus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kindbergia praelonga	-	4	2	-	-	5	3	-	2	-	-	-	-	-	1	-	-	-	-	-	-	-	-		-	-	5	-	-	-	-	-	6	-	1	-	-	-	-	8
Lophocolea bidentata	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lotus pedunculatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mercurialis perennis	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Myosotis arvensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oenanthe lachenalii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oxyrrhynchium hians	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	1	-	-	2	-	-	3	4	-	-	-	-	1	-	-
Pedicularis palustris	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7	1	5	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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		Northern restoration area														Sothern restoration area																								
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Taxon	21/07/2018	10/08/2019	21/07/2018	10/08/2019	21/07/2018	10/08/2019	21/07/2018	10/08/2019	21/07/2018	10/08/2019	21/07/2018	10/08/2019	21/07/2018	10/08/2019	21/07/2018	10/08/2019	21/07/2018	10/08/2019	21/07/2018	10/08/2019	10/08/2019	10/08/2019	10/08/2019	10/08/2019	10/08/2019	10/08/2019	10/08/2019	10/08/2019	10/08/2019	10/08/2019	10/08/2019	10/08/2019	10/08/2019	10/08/2019	10/08/2019	10/08/2019	10/08/2019	10/08/2019	10/08/2019	10/08/2019
Persicaria amphibia	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phragmites australis	7	9	10	8	10	4	9	6	9	10	10	4	9	6	9	5	10	4	10	6	6	5	5	6	7	9	7	7	5	9	5	3	3	6	9	9	10	10	10	6
Plagiomnium rostratum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Plagiomnium undulatum	4	4	3	1	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4	3	10	9	-	-	-	-	-
Poa trivialis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ranunculus repens	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rosa sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rubus fruticosus agg.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Rubus ulmifolius	6	5	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Schedonorus giganteus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Scorzoneroides autumnalis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Scrophularia auriculata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	6	-	3	2	1	1	-	4	-	-	3	-	-	4	3	1	-	1	1	1	-	-	2
Senecio vulgaris	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Solanum dulcamara	-	-	-	-	-	-	1	4	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	1	-	-	-
Sonchus asper	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	1	1	1	-	1	1	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-
Symphytum officinale	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	7	-	-	-	-	-	-	-	-	-
Taraxacum agg.	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	1	-	1	-	-	1	-	-	1	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Urtica dioica	-	-	2	1	-	-	1	2	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	3	3	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Veronica beccabunga	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vicia cracca	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-
Vicia tetrasperma	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NVC	S25a	S25a	S25a	S25a	S25a	S25a	S25a	S25a	S25a	S25a	S25a	-	S25a	-	S25a	-	S25a	-	S25a	-	-	S25a	S25a	S25a	S25a	S26d	S25a													
Height (cm)	190	190	190	165	189	130	192	165	205	155	188	20	190	30	180	50	189	45	200	35	55	15	35	45	30	110	140	100	75	75	40	45	35	150	155	155	155	155	155	110
Bare ground (%)	0	0	0	0	0	0	0	0	0	0	0	60	0	40	0	70	0	8	0	6	60	40	25	30	30	60	3	5	5	80	5	40	5	0	1	15	3	5	10	0
Litter (%)	100	100	100	100	100	100	100	100	100	100	100	25	100	40	100	15	100	55	100	6	5	30	75	60	40	15	25	45	0	0	15	0	1	7	0	30	80	15	45	10
Bryophytes (%)	2	5	2	6	1	5	2	45	1	1	0	1	0	2	1	1	0	0	0	15	3	6	0	0	2	1	15	60	1	1	65	15	80	95	95	0	0	0	0	0



Photograph 1. Northern restoration area. Taken from point where Transect 1 crosses the boardwalk.

Appendix 2. Species introductions

Table A2.5. Plant species introduced to Hinksey Heights restoration areas between August 2018 and August 2019

Restoration area	Taxon	Grid reference	Introduction date	Propagule	Method	Source	Introduction note	Outcome	Outcome note
Northern	Vicia cracca	SP 49468 04547	11/08/2019	Green hay	Strewn	OPT grassland, South Hinksey	Many adult fruiting plants picked from OPT field to north and spread onto top of slope in northern restoration area (small population already present at bottom of slope) by Dr Judy Webb	NA	NA
Northern	Pedicularis palustris	SP 49498 04541	November 2018	Seed	Sown	Lye Valley SSSI	Dead fruiting plants collected during SSSI management and seed scattered in springs and across northern part of restoration area by volunteers	Established	Many plants germinated and established as first year rosettes during 2019
Northern	Oenanthe Iachenalii	SP 49498 04541	November 2018	Seed	Sown	Lye Valley SSSI	Seed collected and spread into spring by boardwalk by Dr Judy Webb	Established	Many plants in spring by boardwalk, some flowering 10/08/2019
Northern	Lotus pedunculatus	SP 49498 04541	November 2018	Seed	Sown	Lye Valley SSSI	Seed collected and spread into spring by boardwalk by Dr Judy Webb	Established	A few small plants in quadrat T1Q10 10/08/2019
Northern	Pulicaria dysenterica	SP 49498 04541	09/12/2018	Seed	Sown	Milham Ford Nature Park	Seed collected and spread into spring by boardwalk by Dr Judy Webb	Not seen	
Northern	Anagallis tenella	SP 49454 04542	November 2018	Adults	Planted	Lye Valley SSSI	Fragments of adult plants raked up during SSSI management, and planted into restoration area by volunteers	Established	Small patches established in spring in NW corner of restoration area 10/08/2019
Northern	Lythrum salicaria	SP 49498 04541	November 2018	Seed	Sown	Milham Ford Nature Park	Seed collected and spread into spring by boardwalk by Dr Judy Webb	Not seen	NA
Northern	Succisa pratensis	SP 49498 04541	November 2018	Seed	Sown	Almond's Farm and Burnt Mill Fields LWS	Seed collected and spread into spring by boardwalk by Dr Judy Webb	Not seen	NA
Northern	Molinia caerulea	SP 49498 04541	November 2018	Seed	Sown	Lye Valley SSSI	Small handful of seed collected and spread into spring by boardwalk by Dr Judy Webb	Not seen	NA
Northern	Filipendula ulmaria	SP 49498 04541	November 2018	Seed	Sown	Lye Valley SSSI	A handful of seed collected and spread into spring by boardwalk by Dr Judy Webb	Established	Many small plants appeared in spring by boardwalk 10/08/2019