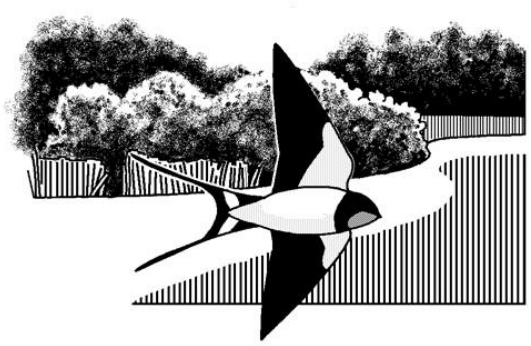

National Vegetation Classification survey of

Blo' Norton Fen SSSI

Including Betty's Fen

Undertaken on behalf of the Little Ouse Headwaters Project by

OHES ENVIRONMENTAL

With Funding from

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National Vegetation Classification survey of

Blo' Norton Fen SSSI

Including Betty's Fen

By OHES Environmental on behalf of:

Dr Helen Smith

Little Ouse Headwaters Project

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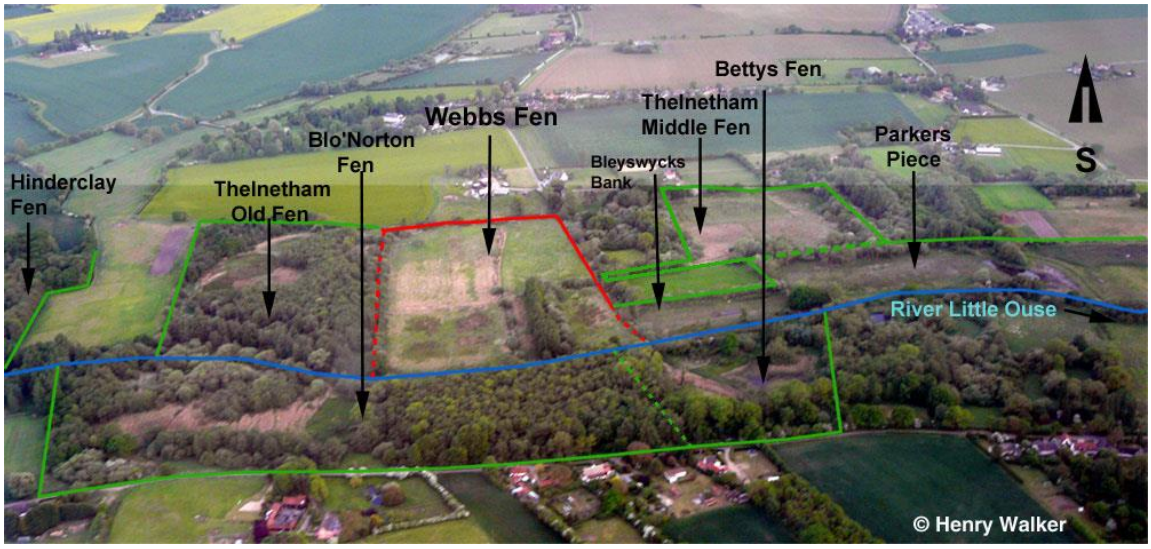
CONTENTS

1. INTRODUCTION

1.1 The site

Blo-Norton and Betty's Fens are two units of the Blo'Norton and Thelnetham Fens Site of Special Scientific Interest (SSSI) and form part of the Waveney and Little Ouse Valley Fens Special Area of Conservation (SAC) on the eastern edge of Breckland[1]. These fens are situated between Blo' Norton and Thelnetham near the head of the westerly flowing Little Ouse. This mire system has developed just over a mile from Redgrave–Lopham Fen but is separate from it. The fens lie on the north side of this shallow broad valley, as shown in Figure 1.

Figure 1. Site location



According to the SSSI Notification (given in full in Appendix 1), these two fens are of interest mainly because of the plant communities associated with the areas of open fen, including those recently cleared by the Little Ouse Headwaters Project (LOHP). Additional interest is provided by the areas of carr woodland, particularly those areas that have developed in the wettest parts of the site.

As part of the Special Area of Conservation, the site contributes to a spectrum of calcareous fen vegetation, formally recognised through two categories included within the European Union's Habitat Directive, for which this area is considered to be one of the best in the United Kingdom[1]:

> **6410 *Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*)**
>
> This site represents M24 *Molinia caerulea* – *Cirsium dissectum* fen-meadow associated with spring-fed valley fen systems in East Anglia, where *Molinia* grassland

[1] http://jncc.defra.gov.uk/ProtectedSites/SACselection/n2kforms/UK0012882.pdf [accessed 18th July 2012]

is very rare. The ***Molinia* meadows** are found here in conjunction with M13 *Schoenus nigricans – Juncus subnodulosus* mire and **7210 calcareous fens with *Cladium mariscus***. Where the fen-meadow is grazed it is more species-rich, with frequent southern marsh-orchid *Dactylorhiza praetermissa*.

7210 Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae*

* Priority feature

This site occurs in the East Anglian centre of distribution of **calcareous fens** and contains very extensive *Cladium* beds, including managed examples, as well as stands in contact zones between small sedge mire and species-poor *Cladium*. The habitat type here occurs in a different hydrological situation to the Broads – spring-fed valley fen rather than flood-plain mire.

The area of fen least affected by drainage occurs at the eastern end of Blo'Norton Fen and still supports calcareous valley fen vegetation with plants such as black bog rush *Schoenus nigricans*, saw sedge *Cladium mariscus*, which is dominant in some parts, and purple moor grass *Molinia caerulea*. A very large number of plant species are associated with this area, which strongly reflects the influence of groundwater in its composition. An early stage of this kind of vegetation has also appeared in the shallow peat pools created in Betty's Fen.

The types of vegetation found at both fens have been documented by Sylvia Haslam (1965), and is directly referred to in the Nature Conservation Review undertaken by the Nature Conservancy Council (Ratcliffe 1977) and in the National Vegetation Classification (Rodwell 1991a,b-2000a). More recently, Blo'Norton Fen is referred to by Wheeler et al. (2009) in their exposition of the types of water supply mechanisms that maintain groundwater-dependent vegetation.

Restoration activities in recent years by the Project, including cutting of the fen vegetation, have rejuvenated large areas of the valley floor and stimulated the development of the early successional stages of this kind of vegetation.

1.2 The brief

As part of the programme of habitat restoration planned by LOHP, OHES Environmental has been asked to conduct a detailed vegetation survey of all habitats at Blo'Norton and Betty's Fens, using the National Vegetation Classification, and to interpret the results.

The survey results will provide both a record of the types of vegetation at this stage in the programme, and will also allow some broad comparisons with regional (e.g. Haslam's work) and national vegetation types (Rodwell's NVC) and their hydrological requirements (Wheeler et al.).

2. METHODOLOGY

The National Vegetation Classification (NVC) is the common standard for defining types of vegetation and describing them within a British and European context (JNCC 2012[2]). The classification is widely used by Natural England in the context of SSSI designation and assessment and in meeting their European obligations through implementing the Habitats Directive. Given the international significance of calcareous fen vegetation and the encompassing SAC designation, the NVC has been employed to describe the vegetation of much of the Little Ouse valley and its immediate surroundings, including other LOHP sites.

The survey methodology is described in detail in Rodwell (2006). In summary, the types of vegetation at Blo'Norton and Betty's Fens are distinguished by the broad class of habitat (e.g. open fen and woodland) and by their plant species composition. The main vegetation types are described by selecting a number of representative plots (usually of 2 x 2 metres for open fen and 50 x 50 metres for woodland). Each plot is assessed for the presence and areal cover of all plants and ground mosses - using the Domin cover-abundance scale - and for other attributes such as height of the vegetation and the amount of bare ground or depth of standing water. Species authorities follow Stace (2010) for higher plants and Hill et al. (2008) for bryophytes.

The sample plots for each vegetation type are then grouped together by their similarity – as Tables 2-4, 6-11 and 13-16 in section 3. Each species in a table is given a constancy score (from I to V) to show how frequently it tends to occur in that kind of vegetation on the fens. The tables are then compared with the published NVC accounts (Rodwell 1991a,b-2000a).

In section 4, an interpretation of the site's vegetation is developed using the published accounts, other fieldwork in the area and also knowledge from examining similar kinds of vegetation elsewhere.

[2] c.f. http://jncc.defra.gov.uk/page-4259 [accessed 18th July 2012]

3. RESULTS

The survey was undertaken during July 2012, following an extended period of high rainfall in the previous month. No constraints to fieldwork were encountered, though areas of the wettest woodland interiors of Blo'Norton Fen and the deep water in the centre of the peat pools on Betty's Fen were not accessed.

The survey results are presented in three sections:

3.1 Woodland types
3.2 Betty's Fen open fen communities
3.3 Blo'Norton Fen open fen communities

A brief account is given of all vegetation types recorded, which are listed in Tables 1, 5 and 12 within the text. For convenience, all vegetation community tables are given at the end of the results section. The distribution of the recorded vegetation stands is shown in Figure 2, found at the end of the report.

3.1 Woodland types

Four distinct woodland types were identified on Betty's and Blo-Norton Fens, listed in Table 1, each occupying a distinct position within the site.

Table 1. Woodland NVC communities

Community	Sub-community
W2 *Salix cinerea-Betula pubescens-Phragmites australis* woodland	a *Alnus glutinosa-Filipendula ulmaria*
W5 *Alnus glutinosa-Carex paniculata* woodland	a *Phragmites australis*
W6 *Alnus glutinosa-Urtica dioica* woodland	a Typical b *Salix fragilis*
W10 *Quercus robur-Pteridium aquilinum-Rubus fruticosus* woodland	d *Holcus lanatus*
MG1 *Arrhenatherum elatius* grassland	c *Filipendula ulmaria*
OV24 *Urtica dioica-Galium aparine*	a Typical

In the wetter areas of woodland, particularly the large block separating the two fens between the river and the upland margin, the extent of swamp alderwood is usually clearly marked by the sedge and reed beds field layer that define it (Table 2). Lesser Pond-sedge *Carex acutiformis* is the typical dominant, usually accompanied by reed and fen species, beneath a mixed canopy of ash and alder. This vegetation-type is assigned to the *Phragmites* sub-community of W5 *Alnus-Carex* woodland, but one of the character species, Greater Tussock sedge *Carex paniculata*, is very infrequent; it can be seen in low numbers at the northern end of the central boardwalk crossing the valley. More typical of this site, however, are the numerous small peat diggings,

which often support small stands of Yellow Iris *Iris pseudacorus* - often growing with Bittersweet *Solanum dulcamara* - and Hemp Agrimony *Eupatorium cannabinum* clustering on the slightly raised ground at their margins.

Lesser Pond sedge beneath a mixed Alder-Ash canopy [W5a woodland]

Over much of the valley, the upslope margin of the swamp alderwood is very abrupt, particularly on the northern side of Blo'Norton Fen, though transitional areas do occur where nettle and particularly Remote sedge *Carex remota* can become very common, especially on rather on drier peat surfaces, as recorded in Plot F26.

Table 2 also records an example of W2 fen carr, a colonising wetland scrub typically represented by Grey Willow *Salix cinerea*, which develops over wet open fen. Due to the restoration works on these sites, little of this fen carr is present, and it is restricted to the south side of the open fen on Blo'Norton Fen. Here, coalescing bushes are separated by patches of reed fen which, in the developing shade, rapidly approach the composition of reed and sedges found in the fen carr, as shown in Plot F39. The gradation of fen carr into swamp alderwood can be seen by comparing Plot F39 with an immature stand of W5 *Alnus-Carex* woodland (Plots 37 and 38), which has an even-aged canopy of alder poles.

On the northern margin of the fen alderwood, the sedge-reed field layer gives way along a sinuous edge to a more eutrophile flora of nettles, accompanied by Ground-ivy *Glechoma hederacea* and Cleavers *Galium aparine*. This is a drier type of woodland, grading to the upland. Alder and Ash remain common in the canopy, but are often mingled with Oak and sometimes Silver Birch. The abundance of Nettle is typical of this W6 *Alnus-Urtica* woodland type, as is the reduction in the frequency or presence of fen species (Table 3). This dry alderwood extends as the Typical sub-community along much of the northern margin of both Betty's and Blo'Norton Fens, usually with a full canopy, though patches of the understorey scrub dominate in discrete patches along Fen Road. The stand in Betty's Wood shows considerable variation in species

composition across the short slope and rush pasture and fen meadow species compliment the typical flora beneath a patchy canopy where the woodland abuts open fen.

Several areas along Fen Road have not scrubbed over (Table 4) and, where unmanaged, have developed into thick swathes of OV24 *Urtica-Galium* vegetation, where nettle is co-joined with a suite of grasses and herbs from the locale. The western and eastern areas favour colonists from rank fen, and the western area, in particular, grades into S26 *Phragmites-Urtica* tall-herb fen as reed penetrates onto drier ground from the open fen. The central area, however, is now routinely mown and raked and can currently be accommodated within the *Filipendula ulmaria* sub-community of MG1 *Arrhenatherum* grassland. This type of vegetation may be a transitional stage to eutrophic fen meadow if routine management is continued.

Along the southern margin of the sites, beside the River Little Ouse, the canopies of both W5 and W6 communities break up and give way to a fringe of scrub on drier ground with a nettle-dominated field layer. Much of the scrub is *Salix cinerea*, though other salices, notably Osier *S. viminalis* (Plot 30) and occasional Almond Willow *S. triandra* are present. The scrub is often overstood by recently managed Crack Willow *Salix fragilis* pollards[3]. Although it shares much of the physiognomy of W2 *Salix-Betula-Phragmites* fen carr, this type of scrub is much drier and more closely resembles a linear form of the *Salix fragilis* sub-community of W6 *Alnus-Urtica* woodland (Table 3).

Low-lying terrace sands extend onto the eastern edge of Blo'Norton Fen as a degraded and scalloped edge to the calcareous mire stands described in section 3.3. The woodland that has developed on the terrace edge is dominated by Oak and Birch, with an occasional understorey of Birch and Oak saplings and a sparse ground flora. Several Gorse *Ulex europaeus* bushes form the margin of the junction with mire vegetation. The stand is assigned to the *Holcus lanatus* sub-community of W10 *Quercus-Pteridium-Rubus* woodland (Table 3) though, as with the terrace margin woods of Hinderclay, it could have derived from damper forms of Oak-Birch woodland.

3.2 Betty's Fen open fen communities

Betty's Fen lacks the extensive areas of fen woodland found at Blo'Norton Fen, and restoration has extended the area of open fen to the edge of W6 *Alnus-Urtica* woodland stands to the north and south, though the site abuts the wetter W5 *Alnus-Carex* woodland to the west and east. The wet character of parts of this central open area is evident from the types of fen vegetation recorded, as listed in Table 5.

A reasonably coherent stand of fen meadow occurs along the northern margin of the open fen, and extends around the western and eastern edges. Blunt-flowered Rush *Juncus subnodulosus* and other Junci species form constants defining the vegetation, which is largely overgrown with reed and accompanied with scattered eutrophiles, such as Nettle and Creeping Thistle *Cirsium arvense*, as well as a core of more typical fen species, including Water Mint *Mentha aquatica* and

[3] Please note that the taxonomy of this 'species' is the subject of current debate.

Tufted sedge *Carex elata*. Yorkshire Fog *Holcus lanatus* and Red Fescue *Festuca rubra* are also frequent in the understorey, suggesting that this vegetation developed from grazed land rather than long-standing reedbed. Both *J. subnodulosus* and *C. elata* are typically associated with calcareous mires. Although overstood by reed, the stand is assigned to the Typical sub-community of M22 *Juncus-Cirsium* fen-meadow, and Plots B3 and B4 (Table 6) are physiognomically close to the typical structure of this vegetation.

Table 5. NVC communities of open fen in Betty's Fen

Community	**Sub-community**	
MG10 *Holcus lanatus-Juncus effusus* rush-pasture	b	*Juncus inflexus*
M22 *Juncus subnodulosus-Cirsium palustre* fen-meadow	a	Typical
	d	*Iris pseudacorus*
S4 *Phragmites australis* swamp	BS(e)	*Utricularia vulgaris-Potamogeton coloratus-Hydrocharis morsus-ranae*
S26 *Phragmites australis-Urtica dioica* reed-bed	d	*Epilobium hirsutum*
OV26 *Epilobium hirsutum* community	b	*Phragmites australis-Iris pseudacorus*

The stand has an abrupt edge with the recent peat pit diggings on either side of the spoil bund that now forms a raised pathway through the Fen. Fragments of fen-meadow also occur in wet ground around the excavation in the central part of the open fen, and these more closely represent the *Iris* sub-community (Table 7). Reedswamp has now colonised much of the open water and is often so dense that few associate species are present. However, extensive patches of the Nationally Scarce Fen Pondweed *Potamogeton coloratus* and less commonly Stone algae *Chara* species persist where shade levels are not too low. The potential vegetation of shallow open waters is best expressed at the western end of the excavations (Plot B6, Table 8), where occasional Cyperus sedge *Carex pseudocyperus* and Long-stalked Yellow sedge *C. lepidocarpa* occur.

Potamogeton coloratus is recognised as a constituent species of Alkaline Fens (Curtis et al. 2009) and is sometimes raised to the status of community dominant (e.g. as Potamogetonetum colorati Allorge 1922 in Germany and France). Wheeler (1980) recognised the species as an early colonist of calcium-rich peat pools, particularly in valley fens, as part of his Schoeno-Juncetum subnodulosi (Allorge 1922) association[4]. This wet successional stage is subsumed within the *Caltha palustris-Galium uliginosum* sub-community of M13 mire in the NVC. However, in the absence of many indicators of this kind of mire in what is structurally a simple reedswamp, the stand is best referred to a proposed new sub-community of S4 *Phragmites* swamp recognised in Broadland fens, the *Utricularia-Potamogeton-Hydrocharis* sub-community (ELP 2010).

The surrounding fens to the southwest, southeast and east of the excavations tend to be rather species-poor, dry stands, occurring in situations in the valley where forms of W6 *Alnus-Urtica* woodland have developed elsewhere on the site. To the southwest and south, a dry Reed Sweet-grass *Glyceria maxima* stand (Table 9) retains few fen species and extends as far as the fringing dry *Salix cinerea* scrub. The vegetation is often lodged and supports a thick layer of plant litter. It

[4] As subassociation caricetosum rostratae Wheeler 1975 Species-group 15, with *Utricularia* species.

is assigned within the *Epilobium* sub-community of the S26 *Phragmites-Urtica* reedbed, a rather species-poor kind of dry reedfen where *G. maxima* often gains dominance. To its east and across the new bund, the reedfen alters character into a grassy sedgebed overstood by reed. Nettle and Creeping thistle are both frequent in this dry fen, and few fen species are present. Shade-tolerant sedges are a noticeable feature beneath the reed canopy and, alongside Greater Pond-sedge *Carex riparia*, both *C. elata* and *C. paniculata* are present. In terms of species composition, the stand barely resembles a reedbed and is much closer to the typically drier *Phragmites-Iris* sub-community of OV26 *Epilobium hirsutum* vegetation (Table 10). Much of its western margin abuts one of the new peat pools, but to the north and east it shares a boundary with the similarly grassy M22 *Juncus-Cirsium* fen-meadow that extends around the northeast side of the open fen.

Near the southern margin of Betty's Fen, the open fen gives way through patches of M22d fen meadow to slightly raised ground occupied by rush-pasture (B14 and B15, Table 11). Yorkshire Fog is typically dominant and both types of vegetation share a number of species. The latter, however, lacks fen species and is assigned to the *Juncus inflexus* sub-community of MG10 *Holcus-Juncus* rush-pasture.

3.3 Blo'Norton Fen open fen communities

In contrast to Betty's Fen, Blo'Norton Fen retains a strong indication in the vegetation that the wetland is still partly fed by calcareous groundwater. As shown in Table 12, several of the vegetation-types support fenland calciphiles, including Saw sedge *Cladium mariscus*, *Purple Moor-grass Molinia caerulea* and Black Bog-rush *Schoenus nigricans*.

Table 12. NVC communities of open fen in Blo'Norton Fen

Community	Sub-community	
Holcus-Molinia vegetation		n/a
M13 *Schoenus nigricans-Juncus subnodulosus* mire	a	*Festuca rubra-Juncus acutiflorus*
	c	*Caltha palustris-Galium uliginosum*
S25 *Phragmites australis-Eupatorium cannabinum* tall-herb fen	c	*Cladium mariscus*
S25 Intermediate to: S1 *Carex elata* swamp		n/a

The key character of the open fen at Blo'Norton Fen is brought out by the presence and distribution of Tufted Sedge *Carex elata* and *Cladium mariscus*. The former appears to extend from Betty's Fen as scattered individuals within the swamp alderwood (Plots F26 and F27) to form a patchy dominant in the western half of the open fen. It may be associated here with old peat diggings and certainly some parts of the stand are spongy hollows in the peat surface. In such situations, dominance of the sedge can be characterised as S1 *Carex elata* swamp. However, the current species composition of this vegetation, where Tufted Sedge can nevertheless be abundant (e.g. Plots F32 and F34 in Table 13), is rather closer to the more mixed species S25 *Phragmites-Eupatorium* tall-herb fen, and the stand is regarded as closer to the latter but quite possibly having developed from the former.

Saw Sedge is encountered throughout the eastern half of the open fen, either as scattered individuals or small, thick patches. *Carex elata* persists as an associate in the western part of this stand, and the species composition signals rather calcareous fen vegetation referred to the *Cladium* sub-community of S25 *Phragmites-Eupatorium* tall-herb fen in the central part of the open fen area (Table 14), though the character species is sometimes overwhelmed by Blunt-flowered Rush and the tall growth of the reed canopy.

Both forms of S25 fen lack the suite of eutrophile species that are a feature of the open fen on Betty's Fen.

In a localised area at the eastern end of the open fen, the increasingly stunted Saw Sedge emerges from the reed cover of the S25 fen into a zone of seepage tracks and a recent peat digging, understood to be associated with groundwater seepage. This is the key habitat feature of the fen and is of international significance, supporting a suite of calcareous mire species, most frequently Marsh Lousewort *Pedicularis palustris* and Long-stalked Yellow sedge *Carex lepidocarpa*. These species help define the extent of this area of low-growing vegetation, which is also distinctive for the presence (often in small numbers) of a large group of associates, including Marsh Helleborine *Epipactis palustris*, Bog Pimpernel *Anagallis tenella* and Parsley Water-dropwort *Oenanthe lachenalii*, in this example of valleyhead mire, the *Caltha-Galium* sub-community of M13 *Schoenus-Juncus* vegetation (Table 15).

Blo'Norton Fen: shallow scrape with Fontinalis antipyretica

The scrape on the peat surface of this stand forms a rectangular body of shallow open water amongst remnant patches of untouched mire vegetation. As shown in plots F13-15 in Table 15, the overall species composition of the scrape including these remnant patches is very similar to the surrounding vegetation. The deeper submerged areas, however, are carpeted with the moss *Calliergonella cuspidata*, with sprawls of Water Moss *Fontinalis antipyretica*. This species is more typically recorded from flowing streams but can feature in the shallow waters of calcareous pits (Porley and Hodgetts 2005; Sugier 2006). It has a very limited distribution in East Anglia but is know from the tidal reaches of the River Waveney (Fisk 2010) and the eastern margin of Fenland near the Cambridgeshire border (Whitehouse 1964).

Of additional interest, where the eastern margin of the mire abuts the sandy terrace, a small stand of very species-rich mire has developed. This has limited species in common with the *Caltha-Galium* sub-community, and is best assigned to the *Festuca-Juncus* form of M13 mire (Table 16). Here, *Molinia caerulea* is particularly evident in a grassy sward beside a small patch of gorse scrub, with associates including Velvet Bent *Agrostis canina* and Tormentil *Potentilla erecta*. A much simpler stand of *Molinia* and *A. canina* occurs in a rather drier situation on the terrace a few metres to the north, which is simply described as *Molinia caerulea* vegetation (c.f. Rodwell et al. 2000b, p41).

3.4 Vegetation community tables

[Overleaf]

Table 2. Community composition of fen alderwood (W5a) and fen carr (W2a)

	B7	B10	F20	F26	F27	F28	F29	F37	F38	F44			F39
Canopy layer													
Alnus glutinosa	7	1	10	5	8	8	7	9	10	10	V	(1-10)	
Fraxinus excelsior	8	4		7	8	8	8	4	1	4	V	(1-8)	
Salix fragilis		8									I	(8)	
Betula pubescens			4								I	(4)	
Acer pseudoplatanus				1							I	(1)	
Shrub layer													
Salix cinerea	4		2	8	1	1	4	1	1		IV	(1-4)	10
Fraxinus excelsior sapling	5		4	4	2	2	5			2	IV	(2-5)	
Alnus glutinosa sapling	2	2			1		1	2	1	1	IV	(1-2)	
Crataegus monogyna	4	1			1	1	1			1	III	(1-4)	
Ribes rubrum		1				1	1			1	II	(1)	
Salix fragilis sapling	1	5									I	(1-5)	
Rhamnus cathartica		1			4						I	(1-4)	
Viburnum opulus						1	1				I	(1)	
Ribes nigrum										2	I	(2)	
Quercus robur sapling				1							I	(1)	
Field and ground layer													
Carex acutiformis	7	7	10	5	8	9	10	9	7	10	V	(5-10)	9
Kindbergia praelonga	8	7	4	4	4	2	2	2	1	5	V	(1-8)	
Eupatorium cannabinum		2	1	4	2	1	3	4	3	3	V	(1-4)	2
Solanum dulcamara	4	3	1	2	1	2	3	2		2	V	(1-4)	2
Phragmites australis			2	3	3	4	2	6	8	3	IV	(2-8)	4
Brachythecium rutabulum			2	4		1	3	1	2	2	IV	(1-4)	
Filipendula ulmaria			2		2	1	2	1	1	1	III	(1-2)	
Iris pseudacorus	1			3	4		1			3	III	(1-4)	
Geranium robertianum				2	3	1	2			1	III	(1-3)	
Carex riparia	6	7		3		2					II	(2-7)	
Poa trivialis	2		2	3		2					II	(2-3)	
Mentha aquatica	1	2						1		3	II	(1-7)	
Fraxinus excelsior seedling				3	1	2			1		II	(1-3)	
Urtica dioica	1	3		2						1	II	(1-3)	
Agrostis stolonifera					5	3	3				II	(3-5)	

Cont'd	B7	B10	F20	F26	F27	F28	F29	F37	F38	F44			F39
Carex remota	3			8			1				II	(1-8)	
Carex elata				1	3			5			II	(1-5)	4
Lycopus europaeus	1	2					2				II	(1-2)	
Stachys sylvatica				2		1	1				II	(1-2)	
Dryopteris dilatata	1	1								2	II	(1-2)	
Lythrum salicaria						1	1	1			II	(1)	
Angelica sylvestris						1	1			1	II	(1)	
Myosotis scorpioides	2	5									I	(2-5)	
Oxyrrhynchium speciosum		2							3		I	(2-3)	
Ajuga reptans						1	3				I	(1-3)	
Lysimachia nemorum	1	3									I	(1-3)	
Geum urbanum					2		1				I	(1-2)	
Brachythecium rivulare								1	2		I	(1-2)	
Galium palustre	1			1							I	(1)	1
Hedera helix					1	1					I	(1)	
Rhizomnium punctatum			1							1	I	(1)	
Glyceria maxima						4					I	(4)	
Equisetum palustre							3				I	(3)	
Cardamine pratensis	3										I	(3)	
Calystegia sepium				2							I	(2)	
Tamus communis							2				I	(2)	
Holcus lanatus	2										I	(2)	
Mnium hornum	2										I	(2)	
Galium aparine				1							I	(1)	
Glechoma hederacea						1					I	(1)	
Betula pubescens seedling								1			I	(1)	
Cirsium palustre								1			I	(1)	
Scutellaria galericulata								1			I	(1)	
Rubus fruticosus agg	1										I	(1)	
Crataegus monogyna seedling							1				I	(1)	
Ranunculus repens							1				I	(1)	
Salix cinerea seedling			1								I	(1)	
Rumex sanguineus	1										I	(1)	
No. of species	26	20	14	24	20	26	29	18	13	21		Av. 21.1	7

Table 3. Community composition of the dry alderwoods (W6a, W6b) and oak-birch woodland (W10d)

	B1	B2	F24	F25	F42	F43			B17	B25	F30	F40	F41			F45
Canopy layer																
Alnus glutinosa	2		7	6	10	9	V	(2-10)			4			I	(4)	
Fraxinus excelsior	8	8	4			5	IV	(4-8)								
Quercus robur	6		8	4			III	(4-8)								7
Betula pendula				4			I	(4)								8
Acer pseudoplatanus		2					I	(2)								
Salix fragilis										4	4		8	III	(4-8)	
Shrub layer																
Sambucus nigra	4			4	8	5	IV	(4-8)	4	6				II	(4-6)	
Crataegus monogyna	5	4	1	4			IV	(1-5)								
Salix cinerea		5		9		1	III	(1-9)	5	4	8	10	6	V	(4-10)	1
Fraxinus excelsior sapling		1	1				II	(1)								
Quercus robur sapling			4				I	(4)								2
Ribes rubrum				1			I	(1)								
Fagus sylvatica sapling			1				I	(1)								
Salix viminalis											8			I	(8)	
Alnus glutinosa sapling												1		I	(1)	
Prunus spinosa									4					I	(4)	
Betula pendula sapling																2
Field and ground layer																
Glechoma hederacea	5	4	8	5	8	7	V	(4-8)	3		4	5		III	(3-5)	5
Urtica dioica	9	8	3	10	8	8	V	(3-10)	7	10	6	10	9	V	(6-10)	1
Geranium robertianum	2	2	2	3	3	4	V	(2-4)								2
Kindbergia praelonga	2	3	3	2	3	2	V	(2-3)					3	I	(3)	4
Galium aparine	6	5	1	1	1	4	V	(1-6)	6	2	1	2		IV	(1-6)	
Brachythecium rutabulum	2	1	2	2	4	3	V	(1-4)	5					I	(5)	1
Agrostis stolonifera			5	4	6	6	IV	(4-6)			4	5		II	(4-5)	
Stachys sylvatica	1	2		1		1	IV	(1-2)								
Phragmites australis	2	4	6				III	(2-6)		2	7	4	3	IV	(2-7)	2
Fraxinus excelsior seedling		1	2	2			III	(1-2)								1
Arctium minus agg	1				2	2	III	(1-2)								
Solanum dulcamara	1				2	1	III	(1-2)		1		1		II	(1)	
Carex acutiformis			3		3		II	(3)			4	2	3	III	(2-4)	
Eupatorium cannabinum	4	2					II	(2-4)	2		2			II	(2)	
Poa trivialis	3	2					II	(2-3)								

Cont'd	B1	B2	F24	F25	F42	F43			B17	B25	F30	F40	F41			F45
Hedera helix				2		2	II	(2)								
Alliaria petiolata					2	2	II	(2)								
Rubus idaeus			3	1			II	(1-3)								
Dryopteris dilatata			2	1			II	(1-2)								1
Rubus fruticosus agg			1		1		II	(1)	4		2			II	(2-4)	1
Stellaria media		1		1			II	(1)								1
Glyceria maxima	4						I	(4)			3	3	3	III	(3)	
Holcus lanatus			4				I	(4)								4
Carex remota		3					I	(3)								
Humulus lupulus			2				I	(2)			2	2		II	(2)	
Calystegia sepium	2						I	(2)		3				I	(3)	
Cirsium arvense		2					I	(2)	3	3				II	(3)	
Arrhenatherum elatius			2				I	(2)			2			I	(2)	
Lapsana communis						2	I	(2)								1
Lycopus europaeus		2					I	(2)								
Galeopsis tetrahit agg		2					I	(2)								
Scutellaria galericulata		1					I	(1)								
Sorbus aucuparia seedling			1				I	(1)								
Rumex sanguineus	1						I	(1)								
Juncus effusus		1					I	(1)								
Juncus inflexus		1					I	(1)								
Myosoton aquaticum		1					I	(1)								
Plagiomnium undulatum		1					I	(1)								
Phalaris arundinacea											3	2		II	(2-3)	
Dicranella heteromalla																3
Hypnum cupressiforme																3
Agrostis capillaris																2
Campylopus pyriformis																2
Lonicera periclymenum																2
Filipendula ulmaria													1	I	(1)	
Cirsium palustre																1
Mnium hornum																1
Betula pendula seedling																1
Dryopteris carthusiana																1
Quercus robur seedling																1
No. of species	20	26	24	20	13	17		Av. 20	10	9	16	12	8	36	Av. 11.0	27

Table 4. Community composition of open vegetation along Fen Road (a) OV24a and (b) MG1c

(a)	F22	F23		
Urtica dioica	9	8	2	(8-9)
Poa trivialis	6	7	2	(6-7)
Galium aparine	7	6	2	(6-7)
Phragmites australis	5	7	2	(5-7)
Agrostis stolonifera	4	4	2	(4)
Cirsium palustre		1	1	(1)
Heracleum sphondylium		1	1	(1)
Phalaris arundinacea		1	1	(1)
Galeopsis tetrahit agg	1		1	(1)
Sward height (cm)	120	120		
Sward cover (%)	100	100		
Bryophyte cover (%)	0	0		
Litter cover (%)	70	70		
Bare ground (%)	0	0		
Water depth (cm)	0	0		
No. of species	6	8		Av. 7.0

(b)	F1	F2	F3	F4	F5	F7	F21		
Holcus lanatus	7	6	7	5	8	8	8	V	(5-8)
Arrhenatherum elatius	7	8	6	8	5	4	4	V	(4-8)
Phragmites australis	3	4	3	4	6	3	2	V	(3-6)
Filipendula ulmaria	3	1	2	2	2	3	3	V	(1-3)
Glechoma hederacea	3	3	2		3	3	3	V	(2-3)
Galium aparine	1	1	1	1		2	5	V	(1-5)
Carex acutiformis		4	7	4	2	3		IV	(2-7)
Poa trivialis	2	3		5		5	6	IV	(2-6)
Kindbergia praelonga	4	2		4		5	2	IV	(2-5)
Galeopsis tetrahit agg	2	2			1		3	III	(1-3)
Vicia cracca	2	1	1				2	III	(1-2)
Elytrigia repens		2		2			7	III	(2-7)
Agrostis stolonifera				2		3	3	III	(2-3)
Brachythecium rutabulum		2	2		1			III	(1-2)
Dactylis glomerata	2	1					1	III	(1-2)
Lathyrus pratensis	2	1	1					III	(1-2)
Ranunculus repens				3			2	II	(2-3)
Urtica dioica						1	4	II	(1-4)
Cirsium palustre			1			3		II	(1-3)
Angelica sylvestris						3		I	(3)
Phalaris arundinacea	3							I	(3)
Poa pratensis						1		I	(1)
Heracleum sphondylium							1	I	(1)
Carex riparia							1	I	(1)
Deschampsia cespitosa						1		I	(1)
Myosotis arvensis		1						I	(1)
Sonchus oleraceus		1						I	(1)
Sward height (cm)	100	100	100	110	90	90	90		
Sward cover (%)	100	100	100	100	95	95	95		
Bryophyte cover (%)	5	2	2	10	1	15	2		
Litter cover (%)	60	70	70	60	70	60	70		
Bare ground (%)	0	0	0	0	0	0	0		
Water depth (cm)	0	0	0	0	0	0	0		
No. of species	13	17	11	11	8	15	17		Av. 13.1

Table 6. Community composition of M22a fen meadow vegetation

	B3	B4	B23	B24	B28	B30		
Juncus subnodulosus	9	9	2	9	8	4	V	(2-9)
Holcus lanatus	6	5	4	2	7	3	V	(2-7)
Urtica dioica	3	2	3	3	2	3	V	(2-3)
Juncus effusus	1	4	1	1	2	4	V	(1-4)
Juncus inflexus	1	2	2	1	1	1	V	(1-2)
Phragmites australis	3		9	8	7	10	V	(3-10)
Carex riparia	3	1	6	4		4	V	(1-6)
Mentha aquatica	2	2	2	3	3		V	(2-3)
Carex remota	2	1	3		3	2	V	(1-3)
Festuca rubra	5	5			6	7	IV	(5-7)
Cirsium arvense	5	4	2			2	IV	(2-5)
Carex elata	2		2		5	3	IV	(2-5)
Brachythecium rivulare	4	5			1	1	IV	(1-5)
Cardamine pratensis	3	3	2	2			IV	(2-3)
Phalaris arundinacea		3	2	3		2	IV	(2-3)
Cirsium palustre	3	1			2	2	IV	(1-3)
Filipendula ulmaria			2	1	2	1	IV	(1-2)
Iris pseudacorus	1	1	2	1			IV	(1-2)
Galium aparine	1	1	1			2	IV	(1-2)
Leptodictyum riparium			2		2	2	III	(2)
Angelica sylvestris		1		1		3	III	(1-3)
Galium uliginosum	2	2			1		III	(1-2)
Lythrum salicaria	1			1	2		III	(1-2)
Agrostis stolonifera					4	5	II	(4-5)
Galium palustre					3	6	II	(3-6)
Lotus pedunculatus	3	3					II	(3)
Glyceria maxima			2	6			II	(2-6)
Glechoma hederacea	4	2					II	(2-4)
Oxyrrhynchium speciosum	3				1		II	(1-3)
Vicia cracca	3	1					II	(1-3)
Carex acutiformis		1		2			II	(1-2)
Arrhenatherum elatius		1			2		II	(1-2)
Ranunculus repens	2	1					II	(1-2)
Lychnis flos-cuculi		1		1			II	(1)
Stachys sylvatica		1		1			II	(1)
Brachythecium rutabulum						2	I	(2)
Cratoneuron filicinum	2						I	(2)
Geranium robertianum	2						I	(2)
Berula erecta			2				I	(2)
Carex paniculata						1	I	(1)
Cerastium fontanum	1						I	(1)
Poa trivialis				1			I	(1)
Carex hirta	1						I	(1)
Sward height (cm)	70	70	190	200	170	190		
Sward cover (%)	95	95	95	95	95	100		
Bryophyte cover (%)	10	15	1	0	2	3		
Litter cover (%)	40	40	20	20	50	50		
Bare ground (%)	20	20	50	50	20	20		
Water depth (cm)	0	0	3	4	1	1		
No. of species	28	26	19	19	20	22		Av.22.3

Table 7. Community composition of M22d fen meadow vegetation

	B5	B18	B19		
Phragmites australis	4	4	3	3	(3-4)
Carex acutiformis	8	5	2	3	(2-8)
Carex elata	2	5	2	3	(2-5)
Cirsium arvense	4	2	2	3	(2-4)
Galium aparine	5	1	2	3	(1-5)
Leptodictyum riparium	1	2	1	3	(1-2)
Iris pseudacorus	1	1	1	3	(1)
Holcus lanatus		8	9	2	(8-9)
Poa trivialis	3		3	2	(3)
Festuca rubra	2		3	2	(2-3)
Oxyrrhynchium speciosum		3	2	2	(2-3)
Glechoma hederacea		2	2	2	(2)
Amblystegium serpens		2	2	2	(2)
Solanum dulcamara	6		1	2	(1-6)
Urtica dioica	3		1	2	(1-3)
Filipendula ulmaria		1	2	2	(1-2)
Eupatorium cannabinum	2		1	2	(1-2)
Anisantha sterilis		2	1	2	(1-2)
Galeopsis tetrahit agg	1		1	2	(1)
Myosotis scorpioides	3			1	(3)
Ranunculus repens		3		1	(3)
Kindbergia praelonga	2			1	(2)
Juncus effusus			2	1	(2)
Juncus inflexus			2	1	(2)
Glyceria maxima	1			1	(1)
Mentha aquatica	1			1	(1)
Myosoton aquaticum	1			1	(1)
Calystegia sepium		1		1	(1)
Carex remota		1		1	(1)
Calliergonella cuspidatum		1		1	(1)
Humulus lupulus			1	1	(1)
Phalaris arundinacea			1	1	(1)
Cardamine pratensis			1	1	(1)
Lapsana communis			1	1	(1)
Sonchus arvensis			1	1	(1)
Sonchus asper			1	1	(1)
Sward height (cm)	80	40	40		
Sward cover (%)	95	90	95		
Bryophyte cover (%)	2	5	5		
Litter cover (%)	70	30	30		
Bare ground (%)	0	35	35		
Water depth (cm)	4	0	0		
No. of species	18	17	27		Av. 20.7

Table 8. Community composition of S4 BS(e) reedswamp

	B6	B16	B20	B21	B22		
Phragmites australis	4	9	10	10	8	V	(4-10)
Juncus subnodulosus	6	9	3	6	5	V	(3-9)
Mentha aquatica	4	3	3	5	5	V	(3-5)
Lycopus europaeus	3	2	3	3	3	V	(2-3)
Potamogeton coloratus	7		10	5	8	IV	(5-10)
Lythrum salicaria	2		1	1	1	IV	(1-2)
Galium palustre	1	1				II	(1)
Juncus effusus		4				I	(4)
Carex pseudocyperus	3					I	(3)
Carex acutiformis	2					I	(2)
Berula erecta			2			I	(2)
Ranunculus flammula	2					I	(2)
Glyceria maxima			1			I	(1)
Solanum dulcamara			1			I	(1)
Carex lepidocarpa	1					I	(1)
Sward height (cm)	110	205	200	210	205		
Sward cover (%)	40	95	100	100	85		
Bryophyte cover (%)	0	0	0	0	0		
Litter cover (%)	0	3	10	10	5		
Bare ground (%)	90	70	60	60	70		
Water depth (cm)	15	7	8	8	20		
No. of species	11	6	9	6	6		Av. 7.6

Table 9. Community composition of the dry Glyceria maxima stand (S26d)

	B8	B9	B11	B12	B13		
Glyceria maxima	7	8	10	10	10	V	(4-10)
Urtica dioica	6	4	3	4	7	V	(3-7)
Galium aparine	3	3	2	4	5	V	(2-5)
Cirsium arvense	5	3		3	2	IV	(2-5)
Eupatorium cannabinum	4	6	4	1		IV	(1-6)
Phragmites australis	2	8		3		III	(2-8)
Myosotis laxa caespitosa			1	2	1	III	(1-2)
Galeopsis tetrahit agg	1			1	1	III	(1)
Carex acutiformis	7			5		II	(5-7)
Solanum dulcamara		6				I	(6)
Phalaris arundinacea			5			I	(5)
Poa trivialis					2	I	(2)
Glechoma hederacea					2	I	(2)
Vicia cracca				2		I	(2)
Holcus lanatus					1	I	(1)
Filipendula ulmaria			1			I	(1)
Sward height (cm)	190	210	205	200	200		
Sward cover (%)	90	100	100	100	100		
Bryophyte cover (%)	0	0	0	0	0		
Litter cover (%)	70	70	70	70	70		
Bare ground (%)	0	0	0	0	0		
Water depth (cm)	0	0	0	0	0		
No. of species	8	7	7	10	9		Av. 8.2

Table 10. Community composition of the grassy tall-herb fen (OV26b)

	B26	B27	B29	B31	B32	B33		
Phragmites australis	7	8	9	9	9	9	V	(7-9)
Urtica dioica	8	7	3	6	3	6	V	(3-8)
Agrostis stolonifera	6	3	7	4	6	5	V	(3-7)
Poa trivialis	4	2	6	3	8	4	V	(2-8)
Calystegia sepium	6	4	3		4	3	V	(3-6)
Cirsium arvense	2	5	2		3	3	V	(2-5)
Carex riparia	3	2	3	4		4	V	(2-4)
Eupatorium cannabinum	2		1	6	1	3	V	(1-6)
Galium aparine	5	6		4		4	IV	(4-6)
Phalaris arundinacea	1	2	4			2	IV	(1-4)
Humulus lupulus		2		2		3	III	(2-3)
Festuca rubra					4		I	(4)
Glyceria maxima		3					I	(3)
Carex acutiformis				3			I	(3)
Filipendula ulmaria			2				I	(2)
Cirsium palustre					2		I	(2)
Carex elata					1		I	(1)
Iris pseudacorus	1						I	(1)
Juncus effusus					1		I	(1)
Conium maculatum		1					I	(1)
Scutellaria galericulata			1				I	(1)
Typha latifolia			1				I	(1)
Tamus communis						1	I	(1)
Cirsium vulgare					1		I	(1)
Sward height (cm)	190	180	200	205	205	205		
Sward cover (%)	100	100	100	100	100	100		
Bryophyte cover (%)	0	0	0	0	0	0		
Litter cover (%)	25	25	30	25	20	25		
Bare ground (%)	40	40	40	40	50	40		
Water depth (cm)	1	0	0	0	0	1		
No. of species	11	12	12	9	12	12		Av. 11.3

Table 11. Community composition of the rush-pasture stand (MG10b)

	B14	B15		
Holcus lanatus	8	9	2	(8-9)
Juncus effusus	6	4	2	(4-6)
Poa trivialis	4	4	2	(4)
Juncus inflexus	7	3	2	(3-7)
Cirsium arvense	3	6	2	(3-6)
Urtica dioica	3	3	2	(3)
Ranunculus repens	2	3	2	(2-3)
Agrostis stolonifera	2	3	2	(2-3)
Glechoma hederacea	2	1	2	(1-2)
Galium aparine	1	1	2	(1)
Oxyrrhynchium speciosum	3		1	(3)
Cardamine pratensis		2	1	(2)
Festuca rubra	2		1	(2)
Leptodictyum riparium	2		1	(2)
Rumex conglomeratus		2	1	(2)
Phragmites australis	1		1	(1)
Iris pseudacorus	1		1	(1)
Carex remota		1	1	(1)
Galeopsis tetrahit agg.	1		1	(1)
Kindbergia praelonga		1	1	(1)
Sward height (cm)	70	75		
Sward cover (%)	95	100		
Bryophyte cover (%)	3	1		
Litter cover (%)	50	50		
Bare ground (%)	20	20		
Water depth (cm)	0	0		
No. of species	16	14		Av. 15.0

Table 13. Carex elata tall-herb fen (Intermediate S25-S1)

	F31	F32	F34		
Carex elata	6	10	10	3	(6-10)
Phragmites australis	10	6	9	3	(6-10)
Carex acutiformis	4	2	2	3	(2-4)
Eupatorium cannabinum	3	3	2	3	(2-3)
Mentha aquatica	2	2	2	3	(2)
Solanum dulcamara	2	1	1	3	(1-2)
Brachythecium rutabulum	2	5		2	(2-5)
Equisetum palustre	3	1		2	(1-3)
Galium palustre	2	1		2	(1-2)
Filipendula ulmaria	1		1	2	(1)
Fraxinus excelsior seedling	1	1		2	(1)
Scutellaria galericulata		1	1	2	(1)
Typha latifolia		1	1	2	(1)
Humulus lupulus	3			1	(3)
Calliergonella cuspidatum			2	1	(2)
Calystegia sepium			2	1	(2)
Lythrum salicaria			2	1	(2)
Oxyrrhynchium speciosum			1	1	(1)
Galium aparine	1			1	(1)
Dryopteris carthusiana	1			1	(1)
Crataegus monogyna sapling		1		1	(1)
Viburnum opulus sapling		1		1	(1)
Fraxinus excelsior sapling		1		1	(1)
Epilobium palustre	1			1	(1)
Sward height (cm)	205	170	170		
Sward cover (%)	100	100	100		
Bryophyte cover (%)	2	15	2		
Litter cover (%)	60	50	60		
Bare ground (%)	5	5	5		
Water depth (cm)	0	2	2		
No. of species	15	15	13		Av. 14.3

Table 14. Community composition of the Cladium mariscus tall-herb fen (S25c)

	F16	F17	F18	F19	F33	F35	F36		
Phragmites australis	6	10	10	7	10	7	5	V	(5-10)
Cladium mariscus	6	1	3	3	2	4	6	V	(1-6)
Eupatorium cannabinum	3	4	1	4	3	3	4	V	(1-4)
Filipendula ulmaria	1	1	1	1	2	1	2	V	(1-2)
Juncus subnodulosus	9		7	9	5	9	8	V	(5-9)
Mentha aquatica	3		4	4	3	3	3	V	(3-4)
Calliergonella cuspidatum	5	4	2	4	3	4		V	(2-5)
Galium uliginosum	2		3	2	2	2	2	V	(2-3)
Brachythecium rutabulum		2	2	2	1	1	2	V	(1-2)
Equisetum palustre	2	2	2		1	2		IV	(1-2)
Lythrum salicaria	1				2	1	1	III	(1-2)
Carex elata					4	4	6	III	(4-6)
Galium palustre		2				2	1	III	(1-2)
Cirsium palustre	2			1	1			III	(1-2)
Holcus lanatus	4							1	(4)
Oxyrrhynchium speciosum	2							1	(2)
Calystegia sepium				2				1	(2)
Phalaris arundinacea							2	1	(2)
Carex acutiformis						2		1	(2)
Sanguisorba officinalis	2							1	(2)
Solanum dulcamara		2						1	(2)
Molinia caerulea				1				1	(1)
Potentilla erecta	1							1	(1)
Lychnis flos-cuculi	1							1	(1)
Poa trivialis	1							1	(1)
Salix cinerea sapling					1			1	(1)
Betonica officinalis			1					1	(1)
Sward height (cm)	170	210	210	170	205	160	190		
Sward cover (%)	95	100	100	95	100	95	90		
Bryophyte cover (%)	20	10	2	10	5	10	2		
Litter cover (%)	10	10	30	10	20	10	40		
Bare ground (%)	40	50	40	40	50	50	30		
Water depth (cm)	0	5	10	0	0	2	2		
No. of species	17	9	11	12	14	14	12		Av. 12.7

Table 15. Community composition of the valleyhead mire (M13c)

	F9	F12	F13	F14	F15		
Calliergonella cuspidatum	10	8	10	8	5	V	(5-10)
Cladium mariscus	4	6	6	4	5	V	(4-6)
Juncus subnodulosus	9	7	7	3	3	V	(3-9)
Mentha aquatica	5	3	5	2	2	V	(2-5)
Equisetum palustre	2	2	3	2	4	V	(2-4)
Pedicularis palustris	4	1	4	5	5	V	(1-5)
Phragmites australis	4	3	2	1	4	V	(1-4)
Galium uliginosum	4	2	2	1	2	V	(1-4)
Filipendula ulmaria	2	1	3	1	1	V	(1-3)
Carex lepidocarpa	3	5	1	2		IV	(1-5)
Eupatorium cannabinum	2	3	3		1	IV	(1-3)
Salix cinerea seedling		2	1	2	3	IV	(1-3)
Alnus glutinosa seedling	1	1	2		2	IV	(1-2)
Angelica sylvestris	2	1		1	1	IV	(1-2)
Cirsium palustre	5	5	6			III	(5-6)
Fontinalis antipyretica			4	6	4	III	(4-6)
Schoenus nigricans		4		1	1	III	(1-4)
Holcus lanatus	3	3			1	III	(1-3)
Carex panicea	3			1	1	III	(1-3)
Oenanthe lachenalii	1	1			1	III	(1)
Hydrocotyle vulgaris				3	3	II	(3)
Carex elata	2	5				II	(2-5)
Scutellaria galericulata		2	2			II	(2)
Juncus articulatus	2	2				II	(2)
Festuca rubra		5		1		II	(1-5)
Fissidens adianthoides		1	1			II	(1)
Anagallis tenella		6				I	(6)
Agrostis canina		4				I	(4)
Calamagrostis canescens		4				I	(4)
Campylium stellatum	4					I	(4)
Brachythecium rutabulum			2			I	(2)
Molinia caerulea				1		I	(1)
Cratoneuron filicinum				1		I	(1)
Calystegia sepium		1				I	(1)
Fraxinus excelsior seedling		1				I	(1)
Betula pubescens seedling		1				I	(1)
Valeriana dioica					1	I	(1)
Chara vulgaris					1	I	(1)
Sanguisorba officinalis			1			I	(1)
Pellia endiviifolia			1			I	(1)
Lythrum salicaria				1		I	(1)
Dryopteris carthusiana	1					I	(1)
Sward height (cm)	80	80	30	30	30		
Sward cover (%)	100	95	100	80	60		
Bryophyte cover (%)	95	60	95	65	20		
Litter cover (%)	5	5	5	0	0		
Bare ground (%)	30	40	30	40	50		
Water depth (cm)	2	0	8	10	8		
No. of species	21	29	20	20	21		Av. 22.2

Table 16. Community composition of the valleyhead mire fringe (M13a) and Molinia caerulea vegetation

	F10	F11			F6	F8		
Molinia caerulea	6	6	2	(6)	5	2	2	(2-5)
Cirsium palustre	5	6	2	(5-6)				
Holcus lanatus	4	7	2	(4-7)	8	9	2	(8-9)
Festuca rubra	7	4	2	(4-7)				
Agrostis canina	6	4	2	(4-6)	7	7	2	(7)
Phragmites australis	3	4	2	(3-4)	3		1	(3)
Kindbergia praelonga	2	4	2	(2-4)				
Eupatorium cannabinum	4	2	2	(2-4)				
Galium uliginosum	3	2	2	(2-3)				
Angelica sylvestris	2	3	2	(2-3)				
Lotus pedunculatus	3	2	2	(2-3)				
Mentha aquatica	2	2	2	(2)				
Potentilla erecta	1	2	2	(1-2)		3	1	(3)
Pseudoscleropodium purum	2	1	2	(1-2)		1	1	(1)
Equisetum palustre	1	2	2	(1-2)				
Ulex europaeus seedling	1	2	2	(1-2)				
Cratoneuron filicinum	2	1	2	(1-2)				
Vicia cracca	1	1	2	(1)				
Quercus robur seedling	1	1	2	(1)				
Juncus subnodulosus		3	1	(3)				
Anthoxanthum odoratum		3	1	(3)				
Oxyrrhynchium speciosum	3		1	(3)				
Bryum pseudotriquetrum	3		1	(3)				
Agrostis stolonifera		2	1	(2)				
Calliergonella cuspidatum		2	1	(2)				
Hydrocotyle vulgaris		2	1	(2)				
Anagallis tenella	2		1	(2)				
Calystegia sepium	2		1	(2)				
Rhynchostegium confertum	2		1	(2)				
Lonicera periclymenum	2		1	(2)				
Filipendula ulmaria		1	1	(1)				
Schoenus nigricans		1	1	(1)				
Lychnis flos-cuculi		1	1	(1)				
Lophocolea bidentata sl		1	1	(1)				
Cardamine pratensis		1	1	(1)				
Briza media		1	1	(1)				
Luzula multiflora		1	1	(1)				
Urtica dioica	1		1	(1)				
Arrhenatherum elatius	1		1	(1)				
Fissidens adianthoides	1		1	(1)				
Fraxinus excelsior seedling	1		1	(1)				
Juncus effusus					1	2	2	(1-2)
Rubus fruticosus agg						2	1	(2)
Poa pratensis					2		1	(2)
Betula pubescens seedling						1	1	(1)
Hypnum cupressiforme						1	1	(1)
Danthonia decumbens						1	1	(1)
Brachythecium rutabulum					1		1	(1)
Sward height (cm)	35	40			30	35		
Sward cover (%)	95	95			100	100		
Bryophyte cover (%)	5	10			1	1		
Litter cover (%)	20	15			10	5		
Bare ground (%)	40	40			50	50		
Water depth (cm)	0	0			0	0		
No. of species	29	31		Av. 30.0	7	10		Av. 8.5

4. INTERPRETATION

Blo'Norton and Betty's Fen occupy the northern part of the extensive Blo'Norton-Thelnetham peat body, believed to overlie the remains of a calcareous mere (Tallentire 1969). Mathers et al. (1993) map the peat body as intruding across the low-lying First Terrace and abutting Head deposits at the upland margin. Wheeler and Shaw (2003 in Wheeler, Shaw and Tanner 2009) confirm the widespread presence of shelly marls throughout the upper peats especially towards the margins and in places a 'quite thick basal layer of marly muds'.

In their classification of the water supply mechanisms for wetlands (WETMECS), Wheeler, Shaw and Tanner (2009) indicate three situations that may be present in the wetland areas of Blo'Norton and Betty's Fens:

WETMEC 9: Groundwater-Fed Bottoms	*WETMEC 9a: Wet Groundwater Bottoms*
	WETMEC 9b: Part-Drained Groundwater Bottoms
WETMEC 13: Seepage Percolation Basins	*WETMEC 13a: Seepage Percolation Surfaces*

The central belt of both fens is still clearly Type 9a. In Bettys' Fen, this supports the M22 fen-meadow stands that surround parts of the peat pools. All of the W5 *Alnus-Carex* woodland also lies in this 'Wet Groundwater Bottoms' type, along with the small area of W2 *Salix* scrub. Further into Blo'Norton Fen, the western and central parts of the open fen - with *Carex elata* passing to *Cladium mariscus* - indicate a potential transition zone as Type 9a increasing reflects the influence of groundwater seepage. The eastern third of the open fen, centred on the calcareous mire with Marsh Lousewort, is the only area understood to conform with natural Type 13a, though the recent peat diggings may represent temporary semi-natural patches of this water supply type, as former peat pits on the site are likely to have done. The shallow hand-dug scrape within the calcareous mire stand perhaps most clearly demonstrates the potential of this technique as a restoration tool for the groundwater-dependent valley-head communities. One particular area where re-connection with Type 13a may be developed further is in the drier areas of peat in the neighbouring S25c fen, where seed sources can readily colonise from the adjacent mire.

Rodwell (1991b, p134) provides a diagram of the typical disposition of M13 *Schoenus-Juncus* mire in calcareous valleyhead fens, and shows the presence of M24 *Molinia-Cirsium* fen-meadow around its margins in close juxtaposition to S25c *Phragmites-Eupatorium* tall-herb fen, which is currently in this position. The scattered *Juncus subnodulosus* and *Molinia* tussocks and other fen meadow species within the eastern end of the S25c stand suggest that M24 fen-meadow may develop on the margins of the calcareous mire as continued management subdues the reed canopy of the tall-herb fen. The development of fen-meadow from reed-dominated stands was clearly demonstrated by Godwin's (1941) mowing experiments at Wicken Fen, Cambridgeshire.

The margins of the valley support thin fringes of moist woodland and mire, as well as the relict strip of *Molinia* vegetation at its northeast corner. As the peat clearly ascends over the toeslopes of the valley edge, it is quite likely that as the watertable has fallen over the years, the surface of the peat has itself retreated, leaving behind these relics of former conditions. The *Molinia* vegetation and small patches of W10 woodland may represent remnants of types of wetland no longer present on the site.

The third WETMECS type, 'Part-Drained Groundwater Bottom' represents a situation well understood by Haslam (1965) and subsequent authors. She describes types of dry tall-herb fen from many Breck valley fens, typically dominated by combinations of Reed Sweet-grass, Reed Canary grass *Phalaris arundinacea* and Nettle, recorded here as S26 *Phragmites-Urtica* fen and OV26 *Epilobium hirsutum* vegetation. It is therefore probable that the Little Ouse has drained the margin of the valleyhead fen for many years – and this is borne out by the types of W6 *Alnus-Urtica* woodland that fringe the site. The Type 9b water supply mechanism indicates that floodwater or perched rainwater now provides a periodic water supply to the surface of these eutrophic fen types, which are much more prevalent in Betty's Fen and largely replaced by long-standing W6 *Alnus-Urtica* woodland on Blo'Norton Fen.

In summary, the survey has shown the extent to which the long-standing issue of river drainage has affected the vegetation along the southern side of the survey site, and the remaining more extensive area relatively unaffected by this process. As Haslam's (1965) paper demonstrates, draining of the riparian fen margin has been a general feature across Breckland *sensu lato*. Where it is appropriate to do so, restoration of fenland habitats may require the removal of surface peats to re-establish fen vegetation closer to the watertable. However, a buffer of intact peat needs to be retained between Types 9a and 9b to ensure that river drainage does not affect the supply of calcareous groundwater evident at the valleyhead in Blo'Norton Fen and the peat pools in Betty's Fen.

Notwithstanding, the programme of fen restoration carried out by LOHP has had a markedly positive effect on the condition of the vegetation communities of both fens. The excavations on Betty's Fen have initiated the early stages of the fen hydrosere in connection to calcareous groundwaters and led to rapid colonisation by the Nationally Scarce Fen Pondweed. They have also provided a locus for potential expansion of Cyperus and Long-stalked yellow sedges, both character species of calcareous wetlands. This form of restoration management on both fens is complimented by the programme of cutting management to clear scrub from the open fen and rejuvenate the mire, fen-meadow and tall-herb fen stands. In Blo'Norton Fen, the re-development of calcareous mire communities from the available species pool reinforces the significance of these fens within the whole SAC site. It is hoped that continued management will promote the assemblage of M24 *Molinia-Cirsium* fen-meadow around the fringes of the seepage area, and continue to define and enrich the large stand of S25-related fen extending from it.

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Figure 2. Distribution of the recorded vegetation stands and samples

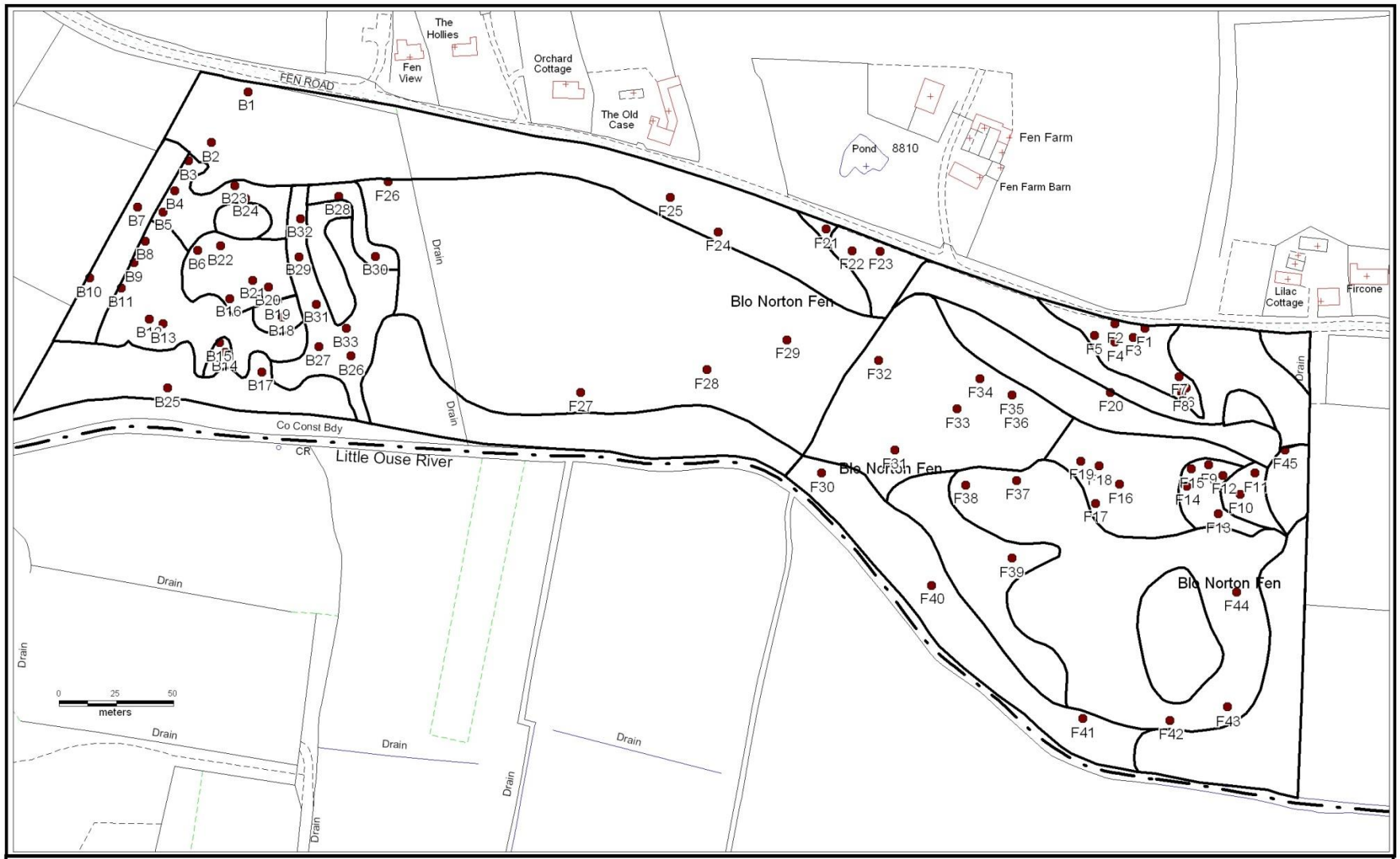
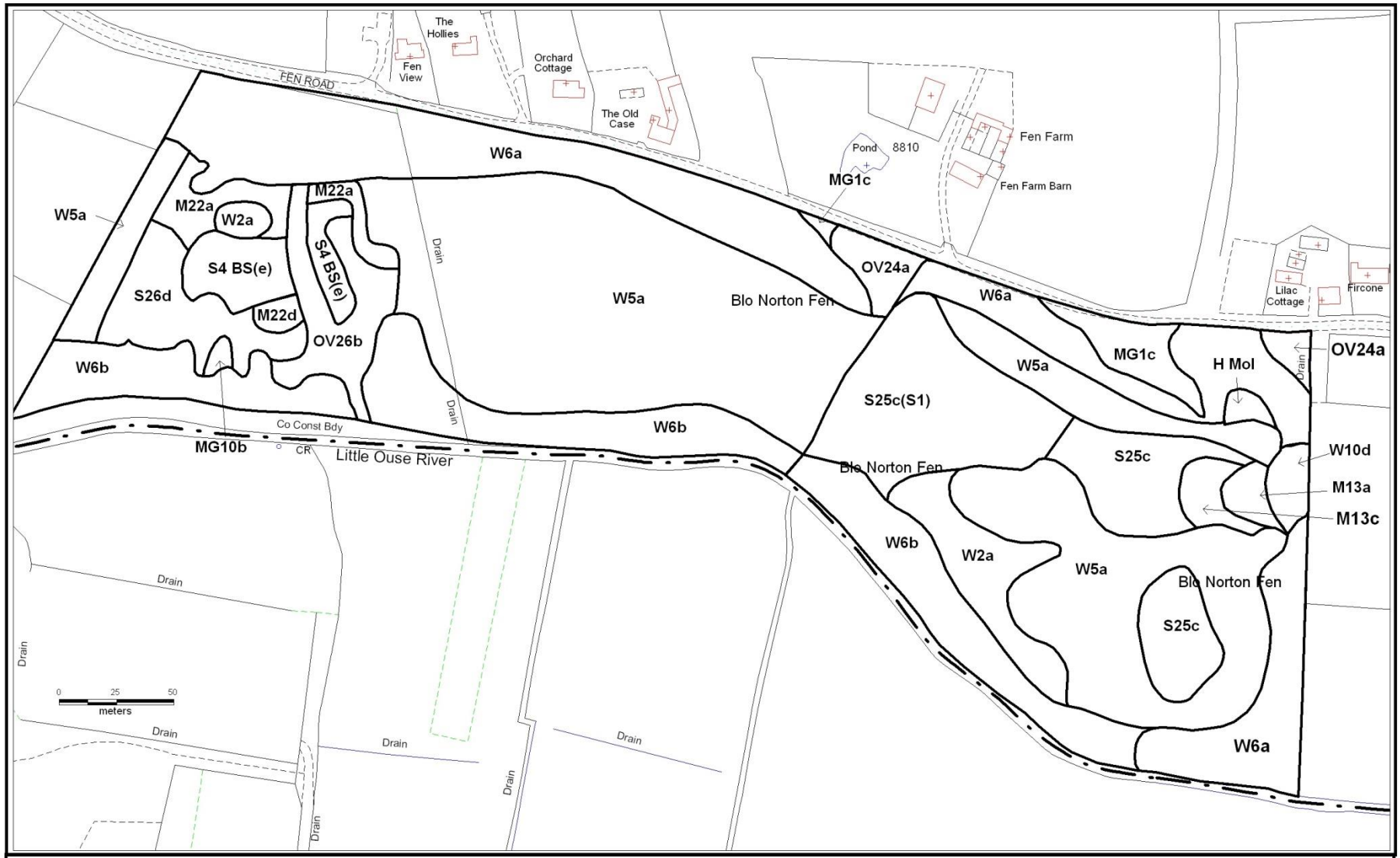


Figure 2. Distribution of NVC communities at Blo' Norton and Betty's Fens



Stand locations for Blo-Norton Fen

W6a = Stand code

Appendix 1. SSSI Notification

COUNTY: SUFFOLK/NORFOLK SITE NAME: BLO' NORTON AND THELNETHAM FEN

DISTRICT:

Status: Site of Special Scientific Interest (SSSI) notified under Section 28 of the Wildlife and Countryside Act 1981.

Local Planning Authority: Breckland District Council, St Edmundsbury District Council

National Grid Reference: TM 017790 Area: 21.03 (ha.) 51.97 (ac.)

Ordnance Survey Sheet 1;50,000: 144 1:10,000: TM 07 NW

Date Notified (Under 1949 Act): 1959 Date of Last Revision: 1972

Date Notified (Under 1981 Act): 1983 Date of Last Revision: –

Other Information:
The boundary has been modified by the deletion of Hinderclay Fen and of some arable land. Part of the site is managed as a nature reserve by the Suffolk Trust for Nature Conservation.

Reasons for Notification:
This site is of interest mainly because of the plant communities associated with the remaining areas of open fen. Additional interest is provided by the areas of carr woodland and by some of the meadows adjacent to the fen.

The areas of fen least affected by drainage still support calcareous valley fen vegetation with plants such as black bog rush *Schoenus nigricans*, saw sedge *Cladium mariscus*, which is dominant in some parts, and purple moor grass *Molinia caerulea*. A very large number of plant species are associated with these areas, notably 'Fen Orchid' *Dactylorchis praetermissa*, devil's bit scabious *Succisa pratensis*, long-stalked yellow sedge *Carex lepidocarpa* quaking grass *Briza media*, a small colony of grass of parnassus *Parnassia palustris* and a number of rare mosses. In other parts of the fen, where there is some drying-out in summer, this type of vegetation is replaced by taller vegetation dominated by reed *Phragmites australis* and meadowsweet *Filipendula ulmaria*. This vegetation has a different range of associated species including plants such as hemp agrimony *Eupatorium cannabinum*, purple loosestrife *Lythrum salicaria* and great hairy willowherb *Epilobium hirsutum*.

Woodland and scrub have invaded quite large areas of all three fens. The scrub consists mostly of dense sallow, whilst the woodland is mostly alder carr, with ash and oak on the drier parts of Blo' Norton Fen. Beneath the woodland canopy, the ground vegetation is made up of a restricted range of fen plants and weedy species such as nettle and cleavers.

In order to provide some control over the water table in the fen areas the site boundary also encompasses several small fields and ditches. These are of some interest in their own interest with plants such as ragged robin *Lychnis flos-cuculi*, marsh marigold *Caltha palustris* and Marsh thistle *Cirsium palustre* and purple loosestrife all occurring in considerable numbers.

Appendix 2. Location of survey sample plots with allocated NVC codes

Plot	Easting	Northing	NVC Code
Blo'Norton Fen			
F1	01995	79027	MG1c
F2	01982	79029	MG1c
F3	01990	79023	MG1c
F4	01982	79021	MG1c
F5	01973	79024	MG1c
F6	02013	79001	H-Mol
F7	02010	79006	MG1c
F8	02011	78999	H-Mol
F9	02015	78978	M13c
F10	02024	78969	M13a
F11	02028	78969	M13a
F12	02022	78966	M13c
F13	02014	78964	M13c
F14	02003	78973	M13c
F15	02004	78978	M13c
F16	01984	78959	S25c
F17	01965	78949	S25c
F18	01975	78967	S25c
F19	01967	78969	S25c
F20	01980	78999	W5a
F21	01872	79069	MG1c
F22	01878	79071	OV24a
F23	01885	79072	OV24a
F24	01809	79069	W6a
F25	01788	79084	W6a
F26	01665	79091	W5a
F27	01749	78999	W5a
F28	01804	79009	W5a
F29	01839	79022	W5a
F30	01854	78964	W6b
F31	01886	78974	S25c (S1)
F32	01879	79013	S25c (S1)
F33	01913	78992	S25c
F34	01923	79005	S25c (S1)
F35	01937	78998	S25c
F36	01939	78992	S25c
F37	01939	78971	W5a
F38	01917	78970	W5a
F39	01937	78927	W2a

Plot	Easting	Northing	NVC Code
Blo'Norton Fen [cont'd]			
F40	01902	78915	W6b
F41	01968	78857	W6b
F42	02006	78856	W6a
F43	02031	78862	W6a
F44	02035	78912	W5a
F45	02056	78974	W10d
Betty's Fen			
B1	01604	79130	W6a
B2	01588	79108	W6a
B3	01578	79100	M22a
B4	01572	79087	M22a
B5	01562	79078	M22d
B6	01575	79070	S4 BSe
B7	01550	79082	W5a
B8	01553	79067	S26d
B9	01550	79057	S26d
B10	01535	79049	W5a
B11	01547	79045	S26d
B12	01561	79031	S26d
B13	01567	79029	S26d
B14	01596	79027	MG10b
B15	01593	79029	MG10b
B16	01596	79040	S4 BSe
B17	01610	79008	W6b
B18	01619	79032	M22d
B19	01617	79039	M22d
B20	01613	79045	S4 BSe
B21	01606	79048	S4 BSe
B22	01592	79063	S4 BSe
B23	01598	79100	M22a
B24	01602	79080	M22a
B25	01569	79001	W6b
B26	01649	79015	OV26b
B27	01635	79019	OV26b
B28	01637	79076	M22a
B29	01636	79066	OV26b
B30	01652	79052	M22a
B31	01641	79040	OV26b
B32	01637	79075	OV26b
B33	01647	79027	OV26b

Appendix 3. Species list for Blo'Norton and Betty's Fen

This list is primarily a record of species recorded within plots selected for the NVC survey. Additional species are included where these have been noted during fieldwork. The compilation is intended as a contribution to the total species list of plants for the site.

Scientific name	Common Name
Higher plants	
Acer pseudoplatanus	Sycamore
Agrostis canina	Velvet Bent
Agrostis capillaris	Common Bent
Agrostis stolonifera	Creeping Bent
Ajuga reptans	Bugle
Alliaria petiolata	Garlic Mustard
Alnus glutinosa	Alder
Anagallis arvensis	Scarlet Pimpernel
Anagallis tenella	Bog Pimpernel
Angelica sylvestris	Wild Angelica
Anisantha sterilis	Barren Brome
Anthoxanthum odoratum	Sweet Vernal-grass
Anthriscus sylvestris	Cow Parsley
Apium nodiflorum	Fool's-water-cress
Arctium minus agg.	Lesser Burdock
Arrhenatherum elatius	False Oat-Grass
Ballota nigra	Black Horehound
Berula erecta	Lesser Water-parsnip
Betonica officinalis	Betony
Betula pendula	Silver Birch
Betula pubescens	Downy Birch
Brachypodium sylvaticum	False-brome
Briza media	Quaking-grass
Bryonia dioica	White Bryony
Callitriche agg.	Water-starwort
Caltha palustris	Marsh-marigold
Calystegia sepium	Hedge Bindweed
Campanula rotundifolia	Harebell
Cardamine pratensis	Cuckooflower
Carex acutiformis	Lesser Pond-sedge
Carex elata	Tufted-sedge
Carex flacca	Glaucous Sedge
Carex lepidocarpa	Long-stalked Yellow-sedge
Carex panicea	Carnation Sedge
Carex paniculata	Greater Tussock Sedge
Carex pseudocyperus	Cyperus Sedge
Carex remota	Remote Sedge
Carex riparia	Greater Pond-sedge
Centaurea nigra	Common Knapweed
Cerastium fontanum	Common Mouse-ear
Chara hispida	Bristly Stonewort
Chara virgata	Delicate Stonewort
Chara vulgaris	Common Stonewort
Cirsium arvense	Creeping Thistle
Cirsium palustre	Marsh Thistle

Scientific name	Common Name
Cirsium vulgare	Spear Thistle
Cladium mariscus	Great Fen-sedge
Conium maculatum	Hemlock
Crataegus monogyna	Hawthorn
Dactylis glomerata	Cock's-foot
Dactylorhiza praetermissa	Southern Marsh-orchid
Danthonia decumbens	Heath Grass
Deschampsia cespitosa subsp. *cespitosa*	Tufted Hair-grass
Dryopteris carthusiana	Narrow Buckler-Fern
Dryopteris dilatata	Broad Buckler-fern
Dryopteris filix-mas	Male-fern
Elytrigia repens subsp. *repens*	Common Couch
Epilobium hirsutum	Great Willowherb
Equisetum palustre	Marsh Horsetail
Eupatorium cannabinum	Hemp-agrimony
Fagus sylvatica	Beech
Festuca ovina	Sheep's-fescue
Festuca rubra	Red Fescue
Filipendula ulmaria	Meadowsweet
Fraxinus excelsior	Ash
Galeopsis tetrahit agg.	Common Hemp-nettle
Galium aparine	Cleavers
Galium palustre	Marsh Bedstraw
Galium uliginosum	Fen Bedstraw
Geranium robertianum	Herb-Robert
Geum urbanum	Wood Avens
Glechoma hederacea	Ground-ivy
Glyceria maxima	Reed Sweet-grass
Gymnadenia densiflora	Marsh Fragrant-orchid
Hedera helix	Common Ivy
Heracleum sphondylium	Hogweed
Holcus lanatus	Yorkshire-fog
Holcus mollis	Creeping Soft-grass
Humulus lupulus	Hop
Hydrocotyle vulgaris	Marsh Pennywort
Hypericum tetrapterum	Square-stalked St John's-wort
Iris pseudacorus	Yellow Iris
Juncus articulatus	Jointed Rush
Juncus effusus	Soft-rush
Juncus inflexus	Hard Rush
Juncus subnodulosus	Blunt-flowered Rush
Lamiastrum galeobdolon subsp. *argentatum*	Garden Yellow-archangel
Lapsana communis	Nipplewort
Lathyrus pratensis	Meadow Vetchling
Lemna minor	Common Duckweed
Ligustrum vulgare	Wild Privet
Lonicera periclymenum	Honeysuckle
Lotus pedunculatus	Greater Bird's-foot-trefoil
Myosotis laxa subsp. *cespitosa*	Tufted Forget-me-not
Myosotis scorpioides	Water Forget-me-not
Myosoton aquaticum	Water Chickweed
Oenanthe lachenalii	Parsley Water-dropwort
Pedicularis palustris	Marsh Lousewort
Phalaris arundinacea	Reed Canary-grass
Phragmites australis	Common Reed

Scientific name	Common Name
Luzula multiflora	Heath Wood-rush
Lychnis flos-cuculi	Ragged-Robin
Lycopus europaeus	Gypsywort
Lysimachia nemorum	Yellow pimpernel
Lythrum salicaria	Purple-loosestrife
Mentha aquatica	Water Mint
Molinia caerulea	Purple Moor-grass
Myosotis arvensis	Field Forget-me-not
Poa pratensis agg.	Smooth Meadow-grass
Poa trivialis	Rough Meadow-grass
Potamogeton coloratus	Fen Pondweed
Potentilla erecta	Tormentil
Prunus avium	Wild Cherry
Prunus spinosa	Blackthorn
Quercus robur	Pedunculate Oak
Ranunculus flammula	Lesser Spearwort
Ranunculus repens	Creeping Buttercup
Rhamnus cathartica	Buckthorn
Ribes nigrum	Black Currant
Ribes rubrum	Red Currant
Ribes uva-crispa	Gooseberry
Rorippa nasturtium-aquaticum	Water-cress
Rosa canina agg.	Dog-rose
Rubus fruticosus agg.	Bramble
Rubus idaeus	Raspberry
Rumex conglomeratus	Clustered Dock
Rumex sanguineus	Wood Dock
Salix alba	White Willow
Salix cinerea	Grey Willow
Salix fragilis	Crack-willow
Salix triandra	Almond Willow
Salix viminalis	Osier
Sambucus nigra	Elder
Sanguisorba officinalis	Great Burnet
Schoenus nigricans	Black Bog-rush
Scrophularia auriculata	Water Figwort
Scutellaria galericulata	Skullcap
Solanum dulcamara	Bittersweet
Sonchus arvensis	Perennial Sow-thistle
Sonchus asper	Prickly Sow-thistle
Sonchus oleraceus	Smooth Sow-thistle
Sparganium erectum	Branched Bur-reed
Stachys palustris	Marsh Woundwort
Stachys sylvatica	Hedge Woundwort
Stellaria media	Common Chickweed
Tamus communis	Black Bryony
Thalictrum flavum	Common Meadow-rue
Typha latifolia	Bulrush
Ulex europaeus	Gorse
Urtica dioica	Common Nettle
Valeriana dioica	Marsh Valerian
Valeriana officinalis	Common Valerian
Veronica beccabunga	Brooklime
Veronica catenata	Pink Water-speedwell
Veronica chamaedrys	Germander Speedwell

Scientific name	Common Name
Viburnum opulus	Guelder-rose
Vicia cracca	Tufted Vetch
Bryophytes	
Amblystegium serpens	Creeping Feather-moss
Atrichum undulatum	Common Smoothcap
Brachythecium rivulare	River Feather-moss
Brachythecium rutabulum	Rough-stalked Feather-moss
Bryum pseudotriquetrum	Marsh Bryum
Calliergonella cuspidata	Pointed Spear-moss
Campylium stellatum var. *stellatum*	Yellow Starry Feather-moss
Campylopus pyriformis	Dwarf Swan-neck Moss
Cratoneuron filicinum	Fern-leaved Hook-moss
Dicranella heteromalla	Silky Forklet-moss
Drepanocladus aduncus	Kneiff's Hook-moss
Fissidens adianthoides	Maidenhair Pocket-moss
Fontinalis antipyretica	Greater Water Moss
Hypnum cupressiforme	Cypress-leaved Plait-moss
Kindbergia praelonga	Common Feather-moss
Leptodictyum riparium	Kneiff's Feather-moss
Lophocolea bidentata s.l.	Bifid Crestwort
Mnium hornum	Swan's-neck Thyme-moss
Oxyrrhynchium speciosum	Showy Feather-moss
Pellia endiviifolia	Endive Pellia
Plagiomnium elatum	Tall Thyme-moss
Plagiomnium undulatum	Hart's-tongue Thyme-moss
Polytrichastrum formosum	Bank Haircap
Pseudoscleropodium purum	Neat Feather-moss
Rhizomnium punctatum	Dotted Thyme-moss
Rhynchostegium confertum	Clustered Feather-moss