Condition Assessment at Catfield Fen: consideration of recent trends in distribution of Potamogeton and Liparis in Unit 3.

1. Background

This paper has been prepared following the Condition Assessment of Catfield Fen by Natural England (NE) in early July 2013 which reported that Unit 3 is in Unfavourable Recovering condition with a hydrological threat. Since the Condition Assessment was carried out, investigations by Parmenter, Barendregt and RSPB have indicated that Units 3 and 11 of Catfield Fen are **in decline**. This supports earlier arguments that Condition Assessment is not a suitable tool to assess and monitor eco-hydrological change.

It is significant in this respect, that the Joint Nature Conservation Committee (JNCC) Common Standards Monitoring (CSM) method was devised specifically for conservation assessment, rather than assessing ecological status. In essence, CSM is used to satisfy the requirement for legislative / regulatory reporting. However, 'Condition' is assessed with respect to features of the Site of Special Scientific Interest (SSSI), and not necessarily those which qualify the site as a Special Area of Conservation (SAC), although in some instances these will overlap.

In summary, 'Favourable Condition' relates only to specific, identified "features". A site may have other attributes of non-designated conservation interest which are not formally identified as features and are therefore not assessed, nor included in, the judgement of condition.

The significance of these points is illustrated in this paper, which focusses on Unit 3 of Catfield Fen, Norfolk, where there have been two important discoveries:

- Recent work has highlighted the mis-identification of a species preferring acidic conditions (*Potamogeton polygonifolius*) for a species with a preference for calcareous conditions (*Potamogeton coloratus*). *P. coloratus*, a nationally scarce plant species and a SSSI designated feature, has apparently been lost from the site.

- There is evidence of loss of part of the fen orchid *Liparis loeselii* colony at Catfield Fen, together with a significant area of the habitat which it favours, to an expanding area of *Sphagnum.* The fen orchid population in Unit 3 represents over 50% of the UK population, and thus its conservation is of critical importance.

2. Significance of Catfield Fen within the Broads SAC and Ant Broads and Marshes SSSI

The designated interest features (vascular plant species) of the Catfield Fen SSSI and SAC are tabulated below. The internal fen system at Catfield, which includes Unit 3, supports the main population of the SAC Annex II species fen orchid. It also supports the majority of the other fen species for which the SSSI was designated.

Individual designated interest features	SSSI designated interest features	SAC designated interest features	Present in internal fen system
SAC Annex II species that are a primary reason for selection of this site:			
Liparis loeselii Fen orchid	*	*	Y
SSSI Vascular Plant assemblage, fen marsh and swamp:	*		
Carex appropinquata Fibrous tussock-sedge			Y
Cicuta virosa Cowbane			Y
Dactyloriza traunsteineri Narrow-leaved marsh orchid			Y
Dryopteris cristata Crested buckler fern			Y
Liparis loesellii Fen orchid			Y
Peucedanum palustre Milk parsley			Y
Pyrola rotundifolia Round-leaved wintergreen			Y
Sonchus palustris Marsh sow-thistle			Y
Sium latifolium Great water parsnip			Y
Thelypteris palustris Marsh fern			Y
SSSI Vascular Plant Assemblage: standing open water	*		
Potamogeton coloratus Fen pondweed			Y
Stratiotes aloides Water soldier			Y

The distribution of these species is monitored through the Condition Assessment process. With the exception of *Liparis loeselii*, for which minimum viable populations must be maintained (reflecting the national and international importance of this species) the species population objectives of the Condition Assessment solely consider presence or absence of key species. The Condition Assessment would therefore not identify trends within species populations, for example reduction in calciphiles or increase in 'dryness indicator species'. Hence the Condition Assessment cannot be used to identify hydrological change. The deficiencies in this approach are illustrated by recent findings at Catfield Sedge Fen (Unit 3) as outlined below.

3. Potamogeton coloratus in Unit 3

The Condition Assessment of Unit 3 (Butterfly Conservation land) undertaken by NE in early July 2013, identified and mapped stands of *Potamogeton coloratus* within Catfield Sedge Fen. Although described as a feature of the standing open water habitats within the SSSI, this species typically grows within shallow pools and runnels on the surface of the fen.

In late 2013, Dr Parmenter observed that stands of *Potamogeton* at Catfield Sedge Fen all appeared to be *Potamogeton polygonifolius*, rather than *P coloratus*. Further investigation was carried out in May and June 2014, and all sampled stands were found to support *P polygonifolius* (see Annex 1). A thorough search was undertaken of all areas within the internal fen system at Catfield Fen in which *P*

coloratus had been identified by NE in 2013, and all these areas were proved to support *P polygonifolius,* with no *P coloratus* in evidence.

The significance of these observations lies in the habitat requirements of the two species. *P coloratus* and *P polygonifolius* occupy separate ecological niches and require a different range in pH (see Annex 3). *P polygonifolius* has a marked preference for acid water, of pH6.11 or less. It will tolerate a maximum pH of 6.84). In contrast, *P coloratus* is a calciphile and will not tolerate conditions where the water pH is below 6.62.

Annex 2 indicates the stands of *P coloratus* mapped during the NE 2013 Condition Assessment and the findings of the 2014 survey by Dr Parmenter.

Potamogeton polygonifolius appears to have been first recorded at Catfield Fen in 1974 (see Annex 4). However, it has never been commonly encountered, and only three records of the species have been submitted for the wider fen system (both external and internal).

The decline and subsequent apparent total loss of *P. coloratus* at Sedge Fen was not identified in the 2013 Condition Assessment, and it seems highly likely that *P polygonifolius* was misidentified as *P coloratus* during the Condition Assessment.

There is little doubt that *P coloratus* was once the most commonly occurring of the two species within the internal system at Catfield, and it may have been the only one of the two species present. There are, for example, herbarium specimens and verified records of *Potamogeton coloratus* at the site which date back to the 1970's. The replacement of *P coloratus* by *P polygonifolius* at Catfield suggests that prevailing conditions at the fen surface (and notably the water which irrigates the fen), are typically acidic rather than calcareous. While the fen was surface wet at the time of survey in June 2014, it appears highly likely that the water irrigating the fen is derived mainly from rainwater rather than groundwater.

Given the differences between the water chemistry requirements of the two species, and current concern about the hydrological status of the site, the mis-identification of the species with a preference for acidic conditions (*P polygonifolius*) for the calciphile (*P coloratus*) is important.

The implications of these findings is that the pH of the surface water at Sedge Fen where *Potamogeton coloratus* was previously recorded is now typically below 6.62, and probably rather lower. Annex 5 shows pH data from across the internal system. The eastern half of Sedge Fen, including the area where *Potamogeton coloratus* was previously recorded, has pH values of less than 6.5, making it unsuitable for *P coloratus*. Only 4 of the 20 sample points recorded had pH values in excess of 6.62, which is the absolute minimum pH at which *P coloratus* will grow.

It is possible, therefore, that *P coloratus* is now absent as a fen species from the internal system as a whole.

4. Liparis loeselii in Unit 3

There are two distinct races of the endangered[1] fen orchid, *Liparis loeselii*, in the UK, of which the fenland form, var *loeselii,* is confined to the northern part of the Norfolk Broadland.

Catfield Fen and Sutton Fen are two of the most important examples of unpolluted valley fen habitat in Western Europe[2], and together support around 95% of the fenland form of the species. Both sites are considered to be at hydrological risk, with a hydrological threat category having been recently ascribed to the Catfield site by Natural England

[1] Cheffings, C. & Farrell, L. 2006 *IUCN Criterion: A2c;C2a(i). Source: The Vascular Plant Red Data List for Great Britain*. IUCN.
[2] English Nature 1989 Ant Broads and Marshes SSSI citation: at http://www.english-nature.org.uk/citation/citation_photo/1000501.pdf

Catfield Fen supports over 50% of the population of var *loeselii* and is the largest and most important colony of this species in the UK. There are two further sites for this plant in the UK, one of which, Sutton Fen, is also potentially threatened by water abstraction. Together, these two sites support around 95% of the UK population. At a UK level, JNCC consider the fen orchid to be in a 'Bad' conservation status[3] due to its declining range (a short term decrease of over 1% per year, with the range also considered to be declining in the longer term).

The JNCC report concluded that both the range status and population status for this species is 'Bad': The range was assessed as 'Bad', because the surface area of the range is more than 10% below the Favourable Reference Value for range, and the short term trend is declining by more than 1% per year. The population was also assessed as 'Bad' because the population is declining by more than 1% per year and the population estimate is less than the Favourable Reference Value.

It is unknown whether the amount of habitat in the UK is sufficient to support a viable population of the species. For this reason, conservation of every site at which the species is extant in favourable condition for the species is of critical importance (notably Catfield Fen and Sutton Fen). Hydrological change is a key risk factor for the species[4].

Recent work by Richard Mason of the RSPB[5] has demonstrated that between 1986 and 2014, the *Sphagnum* dominated area on the Butterfly Conservation land at Catfield has advanced considerably (see maps at Annex 6) and has advanced onto the main Catfield fen orchid colony, with an attendant loss of individual *Liparis* plants. The Sphagnum dominated area mapped by the RSPB in 2014 is shown in Annex 7 and compared with the *Liparis* population mapped in a 2013 RSPB monitoring survey.

The area of overlap, where *Liparis* is found within the *Sphagnum* dominated area is the fringe of the *Sphagnum* dominated area, where *Sphagnum* cover is not yet 100%. In 2013 a single fen orchid plant was found growing within *Sphagnum*, and this was non-flowering, noticeably stunted and yellow. This is the only record globally of a *Liparis loeselii* plant growing on pure *Sphagnum* moss. This plant was not re-found in 2014, despite searching, and is assumed to have been lost.

A recent survey of the fen orchid population undertaken by the RSPB in June 2014 indicates that there may have been some further loss of individual *Liparis* plants since the previous year's survey (Richard Mason, RSPB, pers. comm.). This single colony supports over 50% of the known UK fen population of fen orchid.

The change has also resulted in the loss of over 1ha of the valuable S24e sub-community; the community where fen orchid typically occurs. Thus, the area of suitable habitat for *Liparis loeselii* to retreat into is reducing and is already limited. If the current trend of *Sphagnum* expansion at the site were to continue, then it is likely that a significant proportion of the population will be lost in the short to medium term (est. <10 years).

Historic and ongoing groundwater abstraction may play a causative / additive role in increasing the proportion of rain water to mineral-enriched water within the rooting zone close to the fen surface. This could result in a decrease in pH, and increases vulnerability to drought (the fen will be more likely to experience drying, and enhanced nutrient availability through organic matter decomposition). Reduced groundwater input is therefore likely to increase the rate at which *Sphagnum* can spreads, through a reduction in base-rich water close to the fen surface. It is possible that local water

[3] JNCC 2013 *Third Report by the United Kingdom under Article 17 on the implementation of the Directive from January 2007 to December 2012 Conservation status assessment for Species: S1903 - Fen orchid (Liparis loeselii)* http://jncc.defra.gov.uk/pdf/Article17Consult_20131010/S1903_UK.pdf.

[4] JNCC 2013 *Third Report by the United Kingdom under Article 17 on the implementation of the Directive from January 2007 to December 2012 Conservation status assessment for Species: S1903 - Fen orchid (Liparis loeselii)*

[5] Mason, R.A. 2014 An assessment of sphagnum moss and Fen orchid on Mill Marsh West and Mill Marsh East at Butterfly Conservation Catfield Fen. Unpublished, Royal Society For The Protection of Birds, 2014

abstraction is accelerating this process. A further risk to the population of this plant is the very narrow pH range over which it occurs: it will not tolerate a water pH in excess of 6.59 or below 6.38.

It is notable that the 2013 Condition Assessment failed to identify the risk to the *Liparis* population from the expanding *Sphagnum* dominated community. As noted in a separate paper[6], fen condition assessment does not look at changes in the boundaries of NVC communities at a unit level, and this is considered to be a major shortcoming of the routine monitoring programme.

5. Implications of recorded surface acidification for other species

A brief pH survey of the surface waters of the internal fen system was undertaken on 20th June 2014. Survey coverage is shown at Annex 5. The survey used a handheld Hanna pHep meter, which automatically compensates for temperature. Measurements were undertaken at approximately 1cm below the water surface in shallow pools and runnels across Units 3 and 11 of the internal system. A grid reference for each sample location was recorded using a WAAS enabled Garmin GPSMap 60CS. The Fenside area of Unit 3 was not surveyed due to access difficulties and hazardous ground. Survey of the underlying peat was not carried out. It is recognised that this survey is not comprehensive, and moreover only a 'snapshot in time' and that the pH is likely to vary according to season and rainfall, but nevertheless in the absence of pH monitoring data, it provides a helpful insight into the chemistry of waters currently irrigating the fen.

The pH survey found that the majority of the points sampled (14 of 20) had a surface water pH of less than 6.5 and nowhere was the pH in excess of 7.0. Almost half of the points sampled had a pH of c6.25 or less (refer also to Annex 5). The survey was undertaken in late June 2014, following a period of 4 weeks with little rainfall, and so the water balance would have tended towards the more alkaline end of the spectrum (groundwater as opposed to rainwater).

Annex 3 gives pH tolerance limits of some of the species for which the site is designated (where data are available[7]). It is of particular concern that the fen orchid, a SAC designated species, which has a very narrow tolerance range in terms of its water pH preferences, will not tolerate water pH below 6.38. The results of the pH survey (Annex 5), taken together with the finding that *P polygonifolius* appears to have has replaced *P coloratus* at Catfield, indicates that *Liparis* within the internal system is now highly vulnerable to the decreasing base-status of the water irrigating the fen.

Several of the other species for which the SSSI is designated, and which occur within the internal system, including *Carex appropinquata, Dactylorhiza traunsteineroides* and *Pyrola rotundifolia,* also exhibit a preference for slightly more base-rich conditions and could also be at risk if the current trend continues.

The manner in which groundwater abstraction influences the groundwater-rainwater balance in Broadland fen systems could have similar implications for other local calcareous fen sites.

6. Condition Assessment

The September 2013 Condition Assessment of Catfield Fen Unit 3 (Butterfly Conservation land) carried out by NE found that the notified features are currently in *"... unfavourable recovering condition. Site is currently recovering due to the recent and proposed work on scrub clearance. Increase in Sphagnum (and unnamed 'associates') have been identified, and are consistent with independent work carried out in 2013 by RSPB. This observed change is now registered as a threat, and work is ongoing to identify the causal factor. Formal recognition of threat to the site indicates*

[6] Parmenter, J M 2014 *Use of Condition Assessment at Catfield Fen.* Unpublished report on behalf of the Catfield Hall Estate
[7] http://www.ecoflora.co.uk/

that hydrological changes might be a cause, and therefore there is uncertainty that renewal of abstraction licences would have no adverse effect on the integrity of the European site."

NE was requested to supply the detailed criteria against which condition is assessed, and the data from each condition assessment survey (since the condition assessment process began) for Units 3 and 11 of Ant Broads and Marshes SSSI on 21st November 2013.

With the exception of *Liparis loeselii*, the species population objectives solely consider presence or absence of key species. Consequently they would not identify trends within species populations, for example reduction in calciphiles or increase in 'dryness indicator species' and hence could not be used to identify hydrological change. Notably, there has been a significant loss of *Potamogeton coloratus* on the Butterfly Conservation land, with former populations at Sedge Fen having been completely replaced by *P polygonifolius*, which indicates a shift towards acidic rather than calcareous conditions. This change was not identified in the 2013 Condition Assessment, which mis-identified *P polygonifolius* as *P coloratus.* Consideration of replicated quadrat data from 2007-2012 further showed that of the 8 indicator species used to assess species objectives which occur within Unit 3, 5 had declined.

A similar exercise comparing 1991 and 2013 data from Catfield Unit 11 (Catfield Hall Estate) showed that 4 out of 5 indicator species had shown significant decline. The Condition Assessment failed to identify these trends in vegetation change.

At Sutton Fen, which is under broadly similar management regimes to Catfield Unit 3, all indicator species present at this site have increased (Richard Mason, RSPB, pers. comm.).

The above paragraphs highlight several key failings of the Condition Assessment process. The majority of the factors considered in the site-specific definitions are concerned with identifying unfavourable management and/or physical damage. Common Standards Monitoring (CSM) will identify major change, but it is not sufficiently sensitive to detect the early stages of deterioration, or minor, but potentially highly significant variations in plant species distribution. CSM, was neither designed nor intended as a mechanism by which harmful hydrological change might be identified in its early stages.

CONCLUSIONS

Catfield Fen and Sutton Fen are two of the most important examples of unpolluted valley fen habitat in Western Europe[8], and together support around 95% of the fenland form of *Liparis loeselii.* Both sites are considered to be at hydrological risk, with a hydrological threat category having been recently ascribed to the Catfield site by Natural England

Liparis loeselii var *loeselii* appears to be at urgent risk from the continuing expansion of *Sphagnum* communities in Unit 3 at Catfield Fen, which supports the largest and most important colony of this species in the UK (over 50% of the UK population). The expansion in *Sphagnum* is highly likely to reflect the reduced availability of calcium-rich water at the fen surface. A further threat to *Liparis* in the internal fen system is the acidification of the surface waters. *Liparis* will not tolerate water below pH 6.38, and so is very vulnerable to a trend which has already seen the calciphile *Potamogeton coloratus* replaced by the acidophile *Potamogeton polygonifolius*.

It is notable that the 2013 Condition Assessment failed to identify the risk to the *Liparis* population from the expanding *Sphagnum* dominated community. As noted separately[9], fen condition assessment does not look at changes in the boundaries of NVC communities at a unit level, and this is a major shortcoming of the process.

[8] English Nature 1989 Ant Broads and Marshes SSSI citation: at http://www.english-nature.org.uk/citation/citation_photo/1000501.pdf

[9] Parmenter, J M 2014 *Use of Condition Assessment at Catfield Fen.* Unpublished report on behalf of the Catfield Hall Estate.

The decline and subsequent apparent total loss of *P. coloratus* at Sedge Fen was not identified in the 2013 Condition Assessment, and it is assumed that *P polygonifolius was* misidentified as *P coloratus* during the Condition Assessment.

The Conservation Objectives and definitions of favourable condition for features on the SSSI may be used to inform the scope and nature of any 'appropriate assessment' under the Habitats Regulations. **However, appropriate assessment also requires consideration of issues specific to the individual plan or project**. **The habitat quality definitions used in Condition Assessment do not by themselves provide a comprehensive basis on which to assess plans and projects as required under Regulations 20-21, 24, 48-50 and 54 – 85, and further, are tailored towards assessment of management condition: they are not designed as a tool to assess hydrological change**.

Favourable Condition may therefore meet the requirements of SSSI surveillance, but it does not provide evidence to support the detailed assessment required to judge the impact of water abstraction on fen sites around the Broads.

Our interpretation of the Habitats Regulations is therefore that, given the evidence of habitat deterioration and vegetation change, taken in combination with the shortcomings of the Environment Agency's hydrological model, **the precautionary principle must be applied as a likely significant adverse effect could result from further water abstraction**. **Where there is doubt, the competent authority may not give a permission.**

There is enough hard evidence of habitat deterioration, loss of key indicator species and enough uncertainty as to the scale of the abstraction impact to recommend that abstraction cease.

***Potamogeton* samples, Catfield Sedge Fen, collected 15-06-14**

SAMPLE 1 (CATFIELD)	Collected (JMP, TLP) from 2 adjacent large stands on boggy path next to N-S ditch TG 36790 21328
	• Plants crowded, with leaves emergent from water • Floating leaves markedly coriaceous, pink-orange or green, becoming more opaque with increasing maturity • Secondary venation not visible on more mature floating leaves • Petioles of floating leaves >0.5x as long as leaf blade (often in excess of length of leaf blade) • Seeds still green and immature, however largest seed on most developed fruiting body for each plant collected measured in excess of 1.9mm
	CONCLUSION – *Potamogeton polygonifolius*
	VERIFIED – R E Ellis (vice-county recorder), 21/06/14
SAMPLE 2 (CATFIELD)	Collected (JMP, TLP) from large stand on path leading into Sedge Fen from NE, soon after entering site. TG 36775 21353
	• Plants crowded, with leaves emergent from water • Floating leaves markedly coriaceous, pink-orange or green, becoming more opaque with increasing maturity • Secondary venation not visible on more mature floating leaves • Petioles of floating leaves >0.5x as long as leaf blade (often in excess of length of leaf blade) • Petioles of floating leaves slightly widening towards blade, but significantly <2x width at stem • Seeds still green and immature, however largest seed on most developed fruiting body for each plant collected measured in excess of 2mm
	CONCLUSION – *Potamogeton polygonifolius*
	VERIFIED – R E Ellis (vice-county recorder), 21/06/14

SAMPLE 3 (CATFIELD)	Collected (JMP, TLP) from various smaller stands throughout NE quadrant of Sedge Fen, Catfield. Stands less open and more shaded than at 1 and 2. TG 36771 21332; TG 36769 21328; TG 36768 21325; TG 36748 21293; TG 36767 21295; TG 36772 21335
	• Plants crowded, with numerous leaves emergent from water • Floating leaves markedly coriaceous, typically green, becoming more opaque with increasing maturity • Secondary venation not visible on more mature floating leaves • Petioles of floating leaves >0.5x as long as leaf blade (often in excess of length of leaf blade) • Seeds still green and immature, however largest seed on most developed fruiting body for each plant collected measured in excess of 1.9mm • Mature seed found at TG 36772 21335 (possibly 2013 season). Nutlet size in excess of 2.5mm.
	CONCLUSION – *Potamogeton polygonifolius*
	VERIFIED – R E Ellis (vice-county recorder), 21/06/14
SAMPLE 4 (SUTTON FEN)	Collected (Richard Mason, RSPB) from large stand in shallow dyke around old decoy pool in Sutton Fen TG 36904 22866
	• Plants not apparently crowded, leaves not emergent from water • Floating leaves translucent, brown-green • All leaves (floating and submerged) of similar texture and translucency • Secondary venation clearly visible on all leaves • Petioles of floating (and all) leaves <0.5x as long as leaf blade • Seeds still green and immature, however largest seed on most developed fruiting body measured 1.5mm
	CONCLUSION – *Potamogeton coloratus*
	VERIFIED – R E Ellis (vice-county recorder), 21/06/14

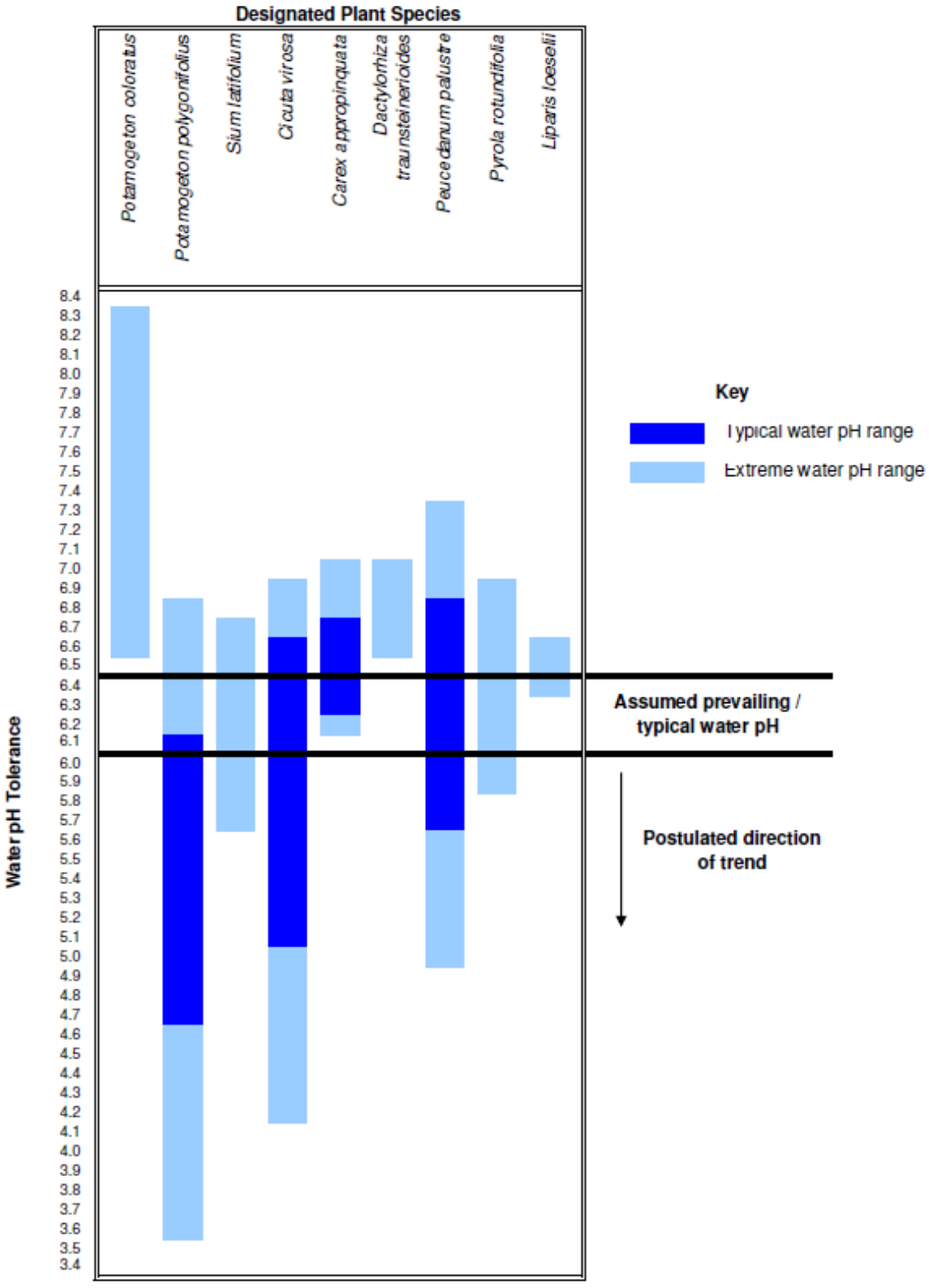
Specimens have been preserved and will be deposited in Norwich Castle Museum herbarium, for future reference.

Dr J.M. Parmenter CEnv
The Landscape Partnership
23-06-14

ANNEX 2 – Mapping of Potamogeton sample points and stands

Coverage of *P.coloratus* taken from image provided by Natural England. Base map obtained from Google Earth ©

ANNEX 3 – pH tolerance limits of selected fen species

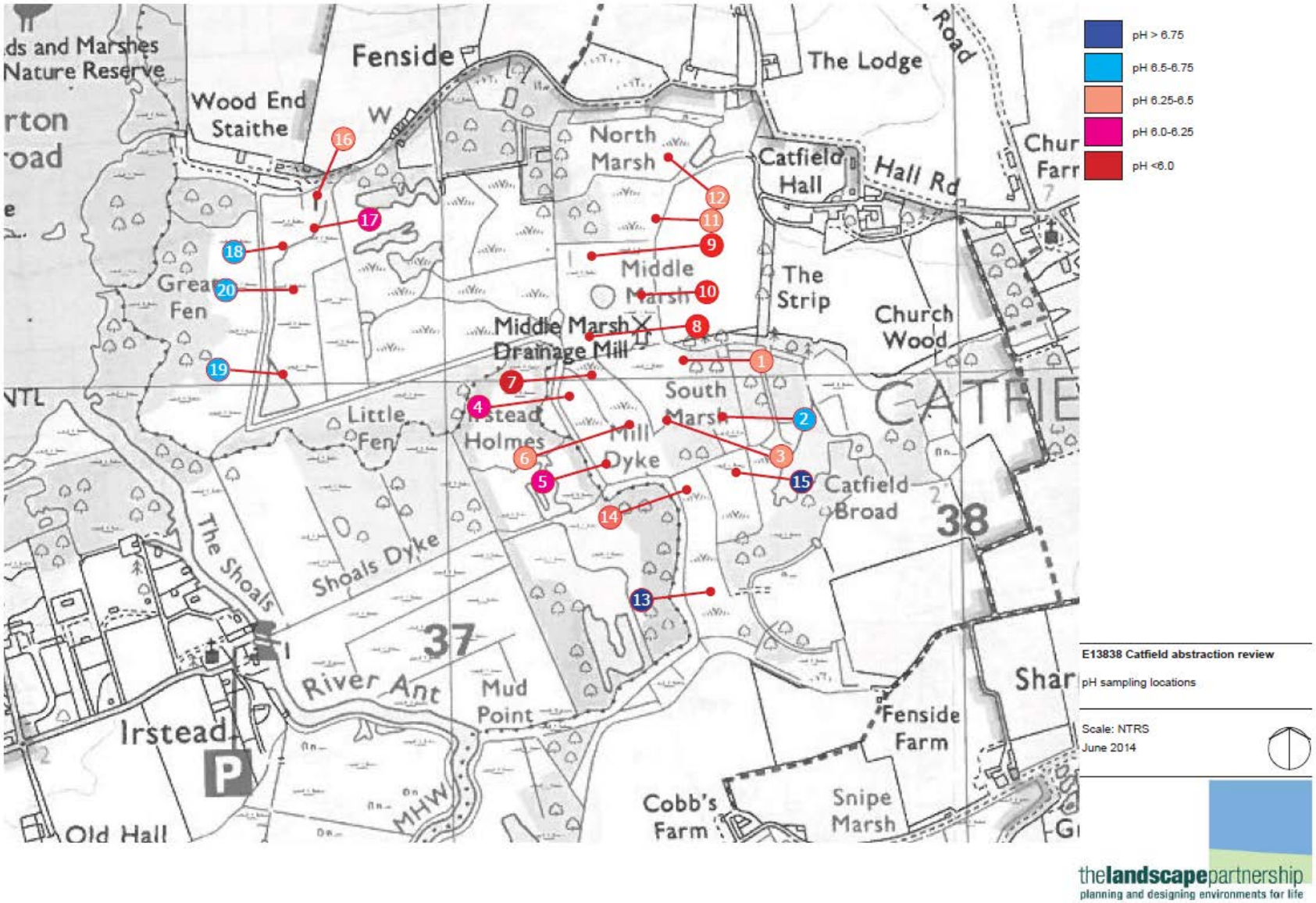


pH ranges taken from http://www.ecoflora.co.uk/

ANNEX 4 – Records of P coloratus and P polygonifolius from Catfield Fen

taxon	recorder	determiner	placename	gridref	date	IN HRBM?
Potamogeton polygonifolius	Driscoll, R.J	Dandy, J.E.	Catfield	TG32Q	1974	YES
Potamogeton polygonifolius	Jermy, A.C.	Dandy, J.E.;Taylor, G.	Catfield,Gt Fen	TG367214	27/05/1979	YES
Potamogeton polygonifolius	Ellis, R.W.;Leaney, R.M.;Aldridge, H.E.;Roberts, C.;Robson, C.	Ellis, R.W.	Catfield Fen (BC Fenside)	TG37092149	09/07/2009	
Potamogeton coloratus	Wheeler, B.D.		Catfield Great Fen	TG365213	14/07/1974	
Potamogeton coloratus	Lambley, P W	Preston, C.D.	Catfield Fen	TG367214		YES
Potamogeton coloratus	Daniels, E.T.	Daniels, E.T.	Catfield Great Fen	TG363210	01/08/1975	
Potamogeton coloratus	Libbey, R.P.	Libbey, R.P.	Catfield Great Fen	TG32	11/07/1975	
Potamogeton coloratus	Libbey, R.P.	Preston, C.D.	Catfield Great Fen	TG32	11/07/1975	
Potamogeton coloratus	Daniels, E.T.		Catfield Great Fen	TG363210	01/08/1975	
Potamogeton coloratus	Daniels, E.T.	Swann, E.L.	Catfield Fen	TG3621	1976	
Potamogeton coloratus	Daniels, E.T.	Daniels, E.T.	Catfield Fen	TG3621	1976	
Potamogeton coloratus			VC27 East Norfolk	TG32Q	1986 - 1998	
Potamogeton coloratus			VC27 East Norfolk	TG32Q	1990 - 1999	
Potamogeton coloratus	Ellis, R.W.;BSBI	Ellis, R.W.;BSBI	Catfield Great Fen	TG3621	02/08/2003	

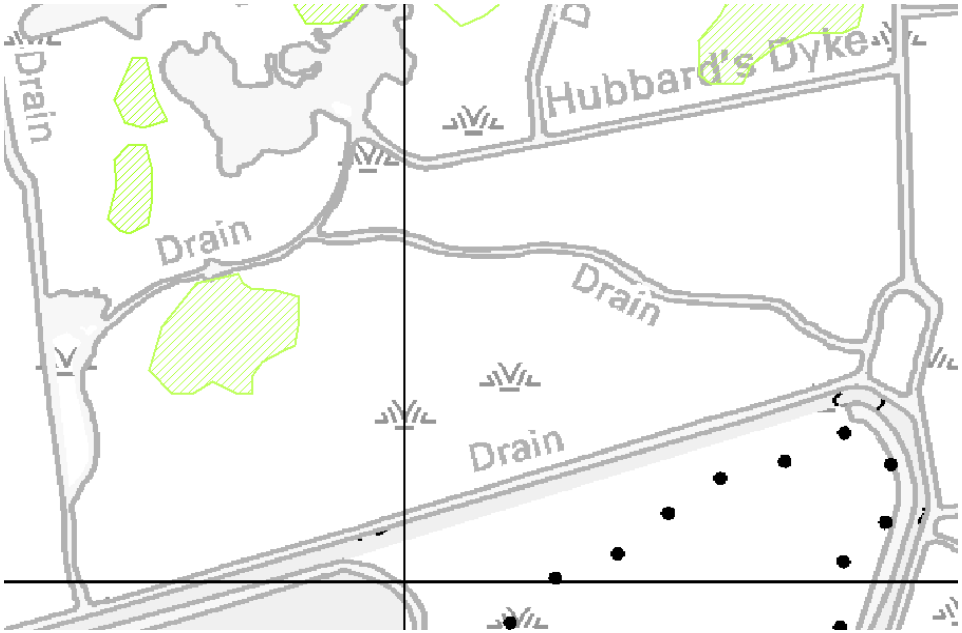
The above records were kindly supplied by the Norfolk County Vascular Plant Recorder



Sample point	pH	Grid Reference	GPS accuracy (m)	Notes
1	6.46	TG 37461 21028	7	Dry, rush dominated, fairly dry at surface
2	6.70	TG 37515 20922	7	Rush and myrica
3	6.42	TG 37403 20932	7	Mixed reed swamp
4	6.21	TG 37243 20961	5	Sphagnum
5	6.21	TG 37301 20853	7	Reed, rush, myrica, milk parsley
6	6.43	TG 37372 20866	9	Reed and fern. Standing water
7	5.92	TG 37301 20984	5	Edge of area of sphagnum. Fern and rush present
8	4.66	TG 37275 21064	6	Reed, myrica, fern. Dry.
9	5.05	TG 37269 21223	9	Reed, myrica, fern. Dry.
10	4.70	TG 37375 21194	6	Reed, myrica, fern. Dry.
11	6.43	TG 37357 21366	5	Managed reedbed. Dry
12	6.28	TG 37434 21432	5	Mixed fen
13	6.93	TG 37528 20584	6	Reed
14	6.27	TG 37472 20799	5	Managed reed with fern
15	6.91	TG 37537 20794	4	Wet reed
16	6.42	TG 36780 21348	6	Mixed fen. Wet
17	6.22	TG 36753 21303	6	Managed mixed fen. Wet
18	6.73	TG 36696 21280	7	Managed sedge. Wet
19	6.55	TG 36661 21048	10	Dense reed
20	6.71	TG 36710 21110	7	Dense reed

ANNEX 6 – Changes in Sphagnum distribution at Catfield Fen

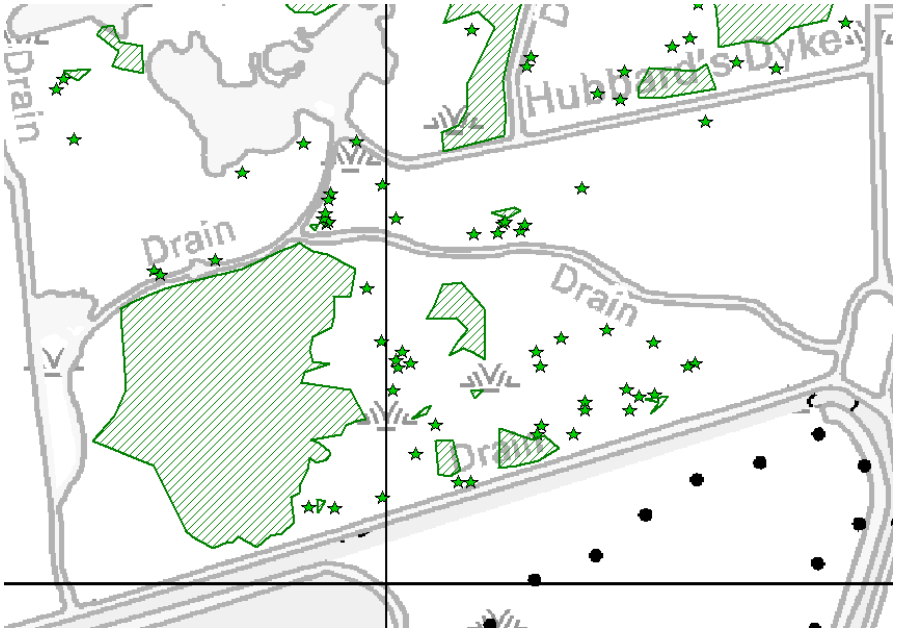
1986 Sphagnum cover



Area of Sphagnum mapped in 1986.

Green hatch = *Sphagnum – Dryopteris* community

2014 Sphagnum cover



Area of Sphagnum mapped in 2014.

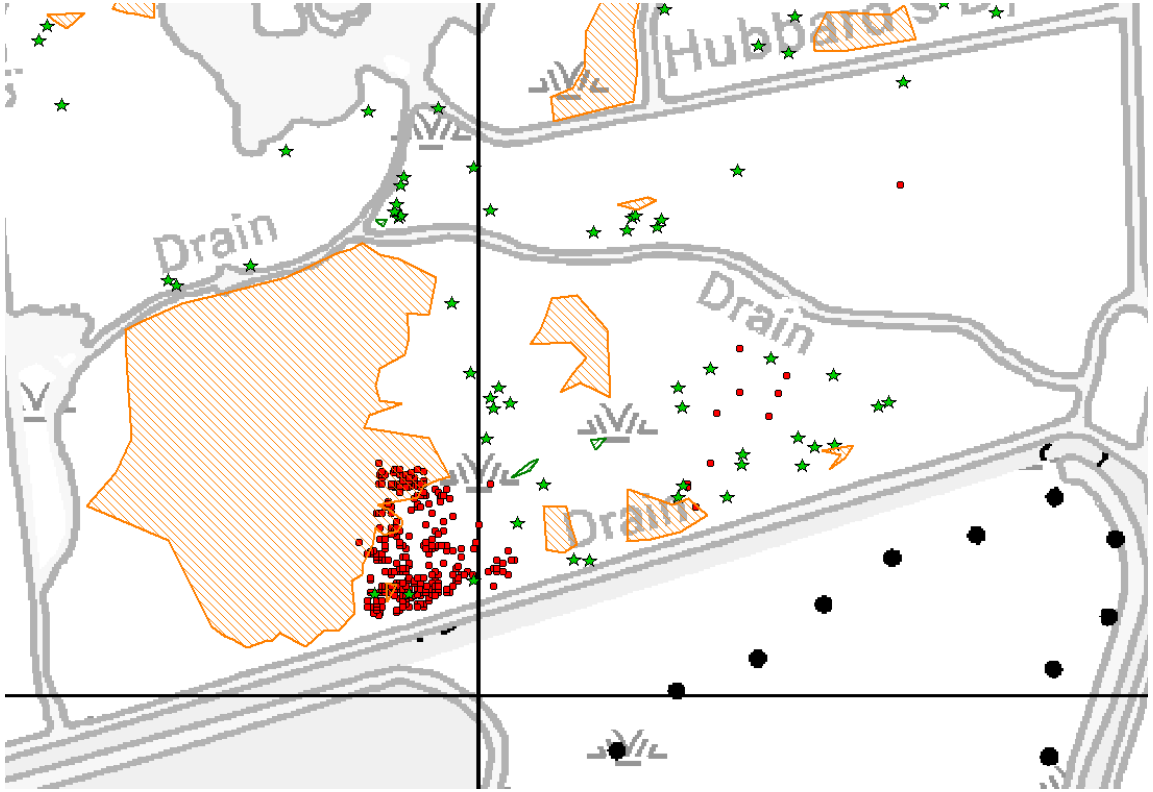
Green hatch = Sphagnum dominated.

Green stars = Sphagnum patch < 3m x 3m

Source: Mason, R.A. 2014 An assessment of sphagnum moss and Fen orchid on Mill Marsh West and Mill Marsh East at Butterfly Conservation Catfield Fen. Unpublished, Royal Society For The Protection of Birds, 2014

ANNEX 7 – Distribution of Sphagnum relative to Liparis at Catfield Fen

Sphagnum and Liparis distribution, 2013-14



Sphagnum cover and known *Liparis* population

Orange hatch = sphagnum dominated
Green star = sphagnum patch
Red dot = *Liparis* spike

Source: Mason, R.A. 2014 An assessment of sphagnum moss and Fen orchid on Mill Marsh West and Mill Marsh East at Butterfly Conservation Catfield Fen. Unpublished, Royal Society For The Protection of Birds, 2014