2012

Broads Fen Invertebrate Survey

Broads Authority
The Broads - a member of the National Park family

Arachne Ecology

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The survey is a Broads Authority initiative, undertaken by Arachne Ecology Limited, supported by the Broads Authority and working with the landowners in the Broads area.

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Published by

Broads Authority

Contents

SUMMARY

1. A range of invertebrate groups were sampled in 10 wetland compartments in the Norfolk Broads. Three compartments were part of the Buttle Marsh habitat creation project, two were within the South Fen rewetting project and the remaining five were in established fen. 549 species were recorded including two Red Listed species, 18 of conservation concern and 8 Broadland speciality species.
2. The results were analysed by exploring the relationships between species richness and the ecological continuity of the wetland, i.e. whether the compartment was established fen or had recently been created or enhanced by rewetting. Analysis of similarity and multivariate analysis were used to explore the response of assemblage species composition to the ecological continuity of the wetland. ISIS, a computer application being developed by Natural England for assessing invertebrate assemblages, was essential in identifying the invertebrate conservation interest of the wetland compartments.
3. As in the original Broads Fen Invertebrate Survey (Lott *et al*., 2010), two main invertebrate communities were identified. The true fen community is dominated by the permanent wet mire assemblage type (ISIS code W3) and is found in mires, where free water is retained in moss, tussocks and the peat surface. Aquatic, open water species (mainly ISIS code W2 but also some species with code W1) constitute a separate ecological group and are associated with boundary ditches. Both communities have conservation value.
4. There was little evidence within this data set of relationships between diversity, composition or conservation value of the invertebrate communities and ecological continuity of the wetland compartment. When species richness of indidivual taxonomic groups was investigated there was a significantly higher diversity of ground beetles and rove beetles in compartments with low ecological continuity. However, this did not indicate that the conservation value of the beetle community in newly created wetland is equivalent to that of old established fen. High diversity can occur in poor quality wetland if it supports few specialist wetland species and many generalist species that could not compete with the specialist species in a true fen habitat. The generalist species are unlikely to be of conservation concern.
5. Recording the presence of Broadland speciality species, as defined by Panter *et al.* (2011) or Lott *et al.* (2010), was not a sufficiently sensitive measure of assessing differences in the invertebrate conservation value of the compartments.
6. The survey results for individual compartments were broadly similar to the original Broads Fen Invertebrate Survey (Lott *et al.*, 2010). Rarity scores for the W3 (permanent wet mire) broad assemblage type ranged from 219 to 268 (211 to 341 in earlier surveys) and the scores for the W314 (reed fen and pool) and W313 (moss and tussock fen) specific assemblage types varied from 6 to 17 (7 to 22 in earlier surveys) and from 2 to 10 (1 to 17 in earlier surveys) respectively. The W3 rarity score of 158 for the northern compartment at South Fen was the lowest obtained for any compartment assemblage in either survey by a significant margin.
7. The results of the current project can be used as a baseline for future monitoring at Buttle Marsh and South Fen, but only by following the same sampling protocol and using the same target taxa. It is recommended that the ISIS representation and rarity scores be used to monitor the conservation value of true fen invertebrate assemblages. It is also recommended that the open water community of boundary ditches be monitored separately using the same methodology.

INTRODUCTION

Over the last decade the high conservation value of the wetland invertebrate fauna of many sites in the Broads National Park has been established by field survey (e.g. Lott *et al*., 2002; Lott *et al*., 2010; Lee and Drake, 2011) and by desk study (Panter *et al.*, 2011). Most of the field work sites have been in areas of relatively high quality wetland habitat demonstrating long ecological continuity. Few, if any, invertebrate surveys have been undertaken on sites where fen habitats have been recently created or where work is underway to restore wetland habitat quality in the Broads. Some studies of ground beetle assemblages on recreated wetland in the Cambridgeshire Fens (Doberski and Lyle, 2002; Martay *et al*., 2011) ought to have provided insight into the impacts of habitat creation in the Broads but sampling was restricted to pitfall trapping and failed to collect many component species of true wetland assemblages. Of more value is the Bringing Reedbeds to Life work reported by the RSPB (Hardmann, 2011), which involved a wider range of sampling techniques and target taxa and this way was comparable to the Broads Fen Invertebrates Survey (Lott *et al*., 2010). Hickling Broad was one of the three sites included in the RSPB invertebrate monitoring where reedbed created in 1998 was compared with much older, adjacent habitat.

Two habitat improvement projects currently being undertaken by the Broads Authority are the creation of wetland at Buttle Marsh, Ludham and the rewetting of grazing marsh at South Fen, East Ruston. The Buttle Marsh project involves reed-bed creation, re-profiling dykes to make them more wildlife friendly, and creating at least six shallow lagoons on 42 hectares of former arable land as part of a European Union LIFE project. At South Fen the project aims to enhance the biodiversity interest of the grazing marsh by raising water levels thus creating shallow areas of surface water during the winter. This will favour the growth of fen vegetation, such as reed, and reduce the dominance of competitive species, such as marshland grasses and common rushes. Grazing is continuing in summer and early autumn thus creating a variation in vegetation structure (Trehane and Kelly, 2008).

There is little information available on the ability of individual species of wetland invertebrate and, more importantly, specific wetland assemblages, to colonise newly created or restored habitat. Whilst the vegetation may soon reach a stage where it appears to be typical of high quality fen it is unknown whether the quality of the invertebrate assemblages will improve at a similar rate. It has been suggested that high quality fen assemblages are the equivalent of ancient woodland assemblages in terms of the ecological continuity required for the development of the community (Dr Keith Alexander, pers. comm.). The research described below was designed to allow long term monitoring of invertebrate assemblages on the two sites, Buttle Marsh and South Fen, described above with the initial results reported here providing the baseline data for longitudinal studies. The research also allowed comparsion of the invertebrate assemblages at Buttle Marsh and South Fen with more established sites surveyed in 2012 and with the sites surveyed by Lott *et al.* (2010).

Site quality evaluation, or more precisely, assemblage quality evaluation, is not only of value for selecting sites for conservation action, but also for monitoring their protection, restoration and creation. Species rarity has traditionally been an important

parameter for evaluating conservation quality. An alternative approach is to evaluate an assemblage according to how typical it is of an intrinsically interesting assemblage type or habitat. The fieldwork reported was designed to collect the data required to evaluate the type and conservation value of the invertebrate assemblages sampled.

In summary, the aims of the research were:

- to assess the invertebrate assemblages of some fens and fen meadows which have few records but are likely to support a wider variety of species;
- to provide more baseline information on some fen habitat creation / restoration projects.

METHODS

The reported work adopted the statistically robust methods for site selection, sampling and analysis as used in the Broads Fen Invertebrate Survey (Lott *et al*., 2010).

Sampling of invertebrates

A total of 30 samples of each of the target groups from ten fen or fen meadow compartments, i.e. three samples per target group per compartment, were taken. The invertebrate groups targeted are listed in tables 1 and 2.

Table 1. Schedule of invertebrate groups sampled in 2012

Group	*Sampling method*	*Time of visits*	*No. samples*
aquatic insects (water beetles & water bugs)	pond-netting	July	30
Araneae (spiders)	sweep-netting & suction-sampling	June/July & September	30
Auchenorrhyncha (hoppers)	sweep-netting & suction-sampling	June/July & August	30
Carabidae & Staphylinidae (ground beetles & rove beetles)	ground-searching	June/July	30
Diptera (two-winged flies)	sweep-netting & suction-sampling	July	30

Time-standardised methods of ground-searching, pond-netting, sweep-netting and suction sampling were used for sampling assemblages of each of the target groups (for details of techniques see Drake *et al.* (2007) but suction samples were of three minutes duration). Adoption of these fieldwork methods yielded the comparable samples required for statistical analysis and also fulfiled the requirements of baseline data for further monitoring. The use of these methods in 2012 is summarised in table 1. The timing of sampling visits was generally later in the year than the visits undertaken by Lott *et al.* (2010) due to the poor weather in 2012.

Table 2. Target Diptera families

Aulacigastridae	Dolichopodidae	Opomyzidae	Stratiomyidae
Chamaemyiidae	Empididae	Psilidae	Syrphidae
Chaoboridae	Ephydridae	Ptychopteridae	Tabanidae
Culicidae	Hybotidae	Rhagionidae	Tephritidae
Diastatidae	Limoniidae	Scathophagidae	Therevidae
Dixidae	Lonchopteridae	Sciomyzidae	Tipulidae
	Micropezidae	Sepsidae	Ulidiidae

Selection of fen / fen meadow compartments

Ten compartments were selected for sampling in agreement with the Broads Authority senior ecologist. Half of the compartments, three on Buttle Marsh and two on South Fen, were part of fen habitat creation / restoration programmes in order to ensure that the second objective of the project could be met. The remaining sampling locations were at Decoy Carr, Kings Fen and Whittlingham Marsh (three compartments). Details of each sampling location are given in Appendix 1.

Ideally one sample was to be taken from somewhere in the centre of each compartment, one from an abandoned ditch within the compartment and one from the edge of a boundary ditch. This was the method used by Lott *et al.* (2010). However, as in the earlier study, it was not possible to locate abandoned ditches in every compartment.

Analysis

Four types of analysis were carried out on the species lists generated.

For each of the 30 samples, a series of species richness values were counted as the total number of species recorded in each target group. These values did not include species from non-target groups nor did they include species from target groups recorded only outside of standardised sampling. Species richness is notoriously sensitive to inequalities in sampling effort, but this factor has been minimised in this project by the adoption of standardised sampling protocols.

Species richness is a simple, but effective species diversity measure and it can be a powerful tool for interpreting how invertebrate assemblages respond to environmental factors. However, species richness provides no information on the individual species present. Two sites may well share the same species richness but have none of these species in common. To assess the structure of the invertebrate communities further the similarities of the species lists obtained were investigated using the Bray-Curtis measure of similarity. This index provides a simple measure of the number of species in common between two lists of species. The statistical significance of the similarities was tested for the newly created / restored habitat versus the long established sites, by Analysis of Similarities (ANOSIM) using the CAP software package distributed by Pisces Conservation Ltd.

A Principal Components Analysis (PCA) was carried out on the species lists in order to explore relationships between the species assemblages present in each compartment in an attempt to gain further insight into underlying factors influencing community structures. This is a method for reducing the complex, multidimensional community

data collected in the field to a simpler, two dimensional plot where the most similar assemblages will appear closest together. Rare species occurring in only a single sample were removed from the data before analysis. The analysis used the covariance matrix.

It must be recognised that species richness is not a straightforward measure of conservation value. An assemblage may contain a large number of widespread species that do not necessarily represent conservation priorities. Nor does PCA make any assessment of the conservation value of the species assemblages. For assessing conservation value, scores are usually assigned to individual species within an assemblage and aggregated in some way to produce a score for the whole assemblage. ISIS (Invertebrate Species-habitat Information System) is a computer application developed by Natural England for assessing invertebrate assemblages in this way. It interprets species lists by recognising assemblage types and scoring each assemblage type according to its conservation value. ISIS assemblage types are defined by species composition but labelled according to their favoured habitat in terms that are meaningful to non-specialists. Two hierarchical levels of assemblage type are recognised:

Broad Assemblage Types (BATs) are characterised by more widespread species. They can be expressed in lists from a wide range of sites. Their classification reflects environmental factors such as hydrology and disturbance-succession cycles that have an important effect on invertebrate assemblages. ISIS summarises the relative representation of each BAT within the sampled assemblage and evaluates the conservation value of each BAT using a rarity score calculated according to individual rarity values of its constituent species. A rarity score is only calculated if there are sufficient (15) species assigned to a BAT in order that the effects of sampling effort on the score are reduced.

The most narrowly defined level, Specific Assemblage Types (SATs), are characterised by species found within a narrower range of habitats or dependant on a very specific resource and are considered to have intrinsic conservation value. In general, they are only well expressed in lists from sites with conservation value.

ISIS analyses were carried out on the pooled standardised samples from within each compartment using data for all target groups together. The version used was ISIS 2010.

RESULTS

Species recorded

The species recorded from the taxonomic groups targeted are listed in appendix 2. 549 species from the target groups were recorded in standardised samples. This figure excludes non-target group species and also target group species recorded exclusively on a casual basis. An additional 19-21 species from target groups were recorded casually. These additional species are listed in appendix 2 also but were not included in the analysis. A few taxa were represented by female specimens only and the precise species could not be determined. These taxa were not included in the ISIS analysis. However, where the taxa were clearly distinct from those already identified in a sample, they were included in species lists for the purposes of further analysis of

species richness and community data. A separate document has been provided to the Broads Authority senior ecologist giving full details of all target and non-target species records from the project.

The list of species recorded includes a number of species of conservation concern. The allocation of conservation status to invertebrate taxa is in a state of flux at present. The uncommon species in most groups have either a Red Data Book status allocated using pre 1994 IUCN guidelines or a national scarcity status based on their geographical distribution, i.e. the number of hectads from which they had been recorded at the time of assessment. Many taxa are now in the process of being reassessed using post 2001 IUCN guidelines. Aside from the changes in status that reassessment will inevitably entail, the change of emphasis in the IUCN guidelines in identifying threat rather than scarcity is likely to result in significant changes to the species appearing on the Red List. A further complication is the potential for confusion through the different meanings of the categories Endangered and Vulnerable in the two systems. For these reasons this report will only refer to the official conservation status of the species of water beetle where a reassessment using the 2001 IUCN guidelines has already been published (Foster, 2010). Other target group species that officially have Red Data Book or Nationally Notable A status will be referred to jointly as being 'rare'.

Table 3. Species of conservation concern recorded in standardised samples

Group	*Species*	*Status*
Water beetles	*Agabus striolatus*	Vulnerable
	Hydroporus scalesianus	Vulnerable
	Dryops anglicanus	Near Threatened
	Hydraena palustris	Near Threatened
	Hydrochus brevis	Near Threatened
	Hydrophilus piceus	Near Threatened
	Laccornis oblongus	Near Threatened
	Limnebius aluta	Near Threatened
Rove beetles	*Lathrobium rufipenne*	'rare'
	Quedius balticus	'rare'
Water bugs	*Microvelia buenoi*	'rare'
Diptera	*Antichaeta brevipennis*	'rare'
	Dicranomyia danica	'rare'
	Erioptera meijerei	'rare'
	Pherbellia argyra	'rare'
	Platypalpus pygialis	'rare'
	Sciomyza dryomyzina	'rare'
	Stenomicra cogani	'rare'
	Stenomicra delicata	'rare'
	Themira biloba	'rare'

The list of target species recorded includes two water beetles that are considered threatened, both of them Vulnerable. These diving beetles were collected from habitats typical of the respective species. *Agabus striolatus* occurs mostly in temporary, shaded pools in fen carr (Foster, 2010) and was collected at Decoy Carr

whilst *Hydroporus scalesianus* was found in a relatively small area of sphagnum bog at Kings Fen. Foster (2010) notes that the development of fen carr is beneficial to *Agabus striolatus* but cautions that succession to drier woodland would be detrimental so water levels must be kept high. Stochastic events resulting in habitat loss are a major threat to *Hydroporus scalesianus* on small, isolated sites such as Kings Fen as the beetle appears incapable of colonising new habitats unaided (Foster, 2010).

A further six species of water beetles that are Near Threatened were recorded during the survey. Additional rare species on the list include two rove beetles, a water bug and nine flies (see table 3). Although the recording of rare species was not a specific objective of the project, their presence in the ISIS analysis should make the results more relevant to a comparison of the conservation importance of established wetland versus more recently created or restored habitats.

The survey produced a number of other records that add significantly to the conservation importance of specific sites but will not be reflected in the ISIS analysis as the species concerned are too recently discovered to be included in the latest update of the software. One of these species, *Notiphila subnigra*, was recognised by Lott *et al*. (2010) as being characteristic of Broadland fens. Although not listed as such by Lott *et al*. (2010), there is little doubt that *Platypalpus pygialis* is another Broadland fen specialist. Falk & Crossley (2005) give only one record of the fly but one of us (CMD) has collected it frequently in recent invertebrate surveys of the Broadland fens. Other species recorded during the current survey have been categorised as Broadland specialities by Panter *et al.* (2011) and / or Lott *et al.* (2010). These species are listed in table 4.

Table 4. Broadland speciality species recorded in standardised samples

Group	*Species*	*Entirely restricted*	*Largely restricted*	*Primary stronghold*	*Broadland species with restricted distribution in Britain*
		(Panter et al.*, 2011)*			*(Lott* et al.*, 2010)*
Water beetles	*Agabus striolatus*		●		●
	Hydrophilus piceus				●
Rove beetles	*Lathrobium rufipenne*			●	●
	Quedius balticus			●	●
Water bugs	*Microvelia buenoi*		●		●
Diptera	*Notiphila subnigra*				●
	Platypalpus pygialis	●			
	Stenomicra delicata				●

The occurrence of species of conservation concern and Broadland speciality species at each of the sample sites is shown in table 5. Table 5 also lists three species of true fly that are noteworthy even though they do not fall into the above mentioned categories. These taxa are *Diastata vagans,* a scarce Scottish species with just a few strange outliers in England and recorded widely from Whitlingham Marsh in 2012; *Geomyza majuscula,* normally a rare species that surprisingly was abundant and widespread in

2012 and *Geomyza nartshukae*, a recently described species that was recorded from Decoy Carr only. One of us (CMD) did record *Diastata vagans* at Sutton Fen and Hickling in earlier surveys, but it is clearly patchily distributed and its ecology is unclear. In previous surveys *Geomyza majuscula* has been recorded from Sutton Fen also but from no other sites in Broadland. The fly was collected from six compartments in total in 2012, half in established fen and the other three in restored / enhanced habitat.

Table 5. Recorded distribution of Broadland speciality species, species of conservation concern and some other noteworthy species

Group	*Species*	*Buttle 1*	*Buttle 2*	*Buttle 4*	*South N*	*South S*	*Kings Fen*	*Decoy Carr*	*Whitlingham 12*	*Whitlingham 15*	*Whitlingham 16*
Water beetles	*Agabus striolatus*							●			
	Dryops anglicanus							●			
	Hydraena palustris	●									
	Hydrochus brevis	●									
	Hydrophilus piceus	●	●		●	●					
	Hydroporus scalesianus						●				
	Laccornis oblongus		●								
	Limnebius aluta	●	●	●						●	●
Rove beetles	*Lathrobium rufipenne*			●							
	Quedius balticus	●						●			
Water bugs	*Microvelia buenoi*						●			●	
Diptera	*Antichaeta brevipennis*							●			
	Dicranomyia danica		●								
	Erioptera meijerei	●				●	●		●		●
	Notiphila subnigra					●	●	●			
	Pherbellia argyra		●								
	Platypalpus pygialis					●					
	Sciomyza dryomyzina					●					●
	Stenomicra cogani	●				●	●		●	●	●
	Stenomicra delicata								●	●	●
	Themira biloba									●	
Noteworthy Diptera	*Diastata vagans*								●	●	●
	Geomyza majuscula	●		●		●	●			●	●
	Geomyza nartshukae							●			

The highest number of ‘characteristic’ species, i.e. species of conservation concern, Broadland speciality species and noteworthy species, was recorded from Buttle Marsh compartment 1. Just one of these species, the water beetle *Hydrophilus piceus*, was recorded from the northern compartment of South Fen. *Hydrophilus piceus* is a typical inhabitant of good quality Broadland ditches and as such can be found in grazing marsh as well as true fen. Indeed the deep ditches of some true fen may not be suitable for the beetle. Therefore, the ecology of *Hydrophilus piceus* explains the

presence of a fenland specialist in apparently unsuitable habitat. The number of species recorded from a compartment shows less variation between the established wetland compartments than between those on South Fen and Buttle Marsh. However, there is no evidence that the established fen compartments support more species of conservation concern or more Broadland speciality species.

Species richness

Summary statistics for numbers of species recorded are given in tables 6 and 7. The average number of Auchenorrhyncha species recorded in each sample was very low and this will have compromised the suitability of the results for some of the analyses carried out.

Table 6. Total species richness of target groups in each fen compartment

Target group	*Buttle 1*	*Buttle 2*	*Buttle 4*	*South N*	*South S*	*Kings Fen*	*Decoy Carr*	*Whitlingham 12*	*Whitlingham 15*	*Whitlingham 16*
Aquatic beetles & bugs	42	49	42	37	30	42	22	20	26	34
Araneae	16	17	18	24	26	22	18	18	14	14
Carabidae & Staphylinidae	28	29	26	24	13	21	18	19	18	18
Diptera	70	89	96	92	99	102	102	101	95	93
Auchenorrhyncha	4	3	7	8	7	6	5	7	5	5
All groups	160	187	189	185	175	193	165	165	158	164

The highest value for species richness was recorded from the established fen compartment at Kings Fen, the lowest value from the established fen of Whitlingham Marsh compartment 15. However, an initial examination of the data in table 6 suggests that the recreated / restored wetland compartments generally have higher species richness than established fen compartments. A more robust analysis of the differences requires examination of variations in species richness between the individual samples.

Table 7. Species richness statistics for whole data set of 30 samples

Target group	*total S (γ-diversity)*	*mean sample S (α-diversity)*
Aquatic beetles & bugs	100	16.1
Araneae	71	9.1
Auchenorrhyncha	32	3.1
Carabidae & Staphylinidae	76	9.6
Diptera	283	49.6

Variations in species richness between samples collected from newly created / restored wetland and long established fen are shown in figure 1. The statistical

significance of these variations of species richness can be assessed using the non-parametric Mann-Whitney U Test. This is a test that compares the rankings of values of sample species richness between classes of samples. The test generates a test statistic and a figure for the probability that the observed difference in rankings could be generated by chance.

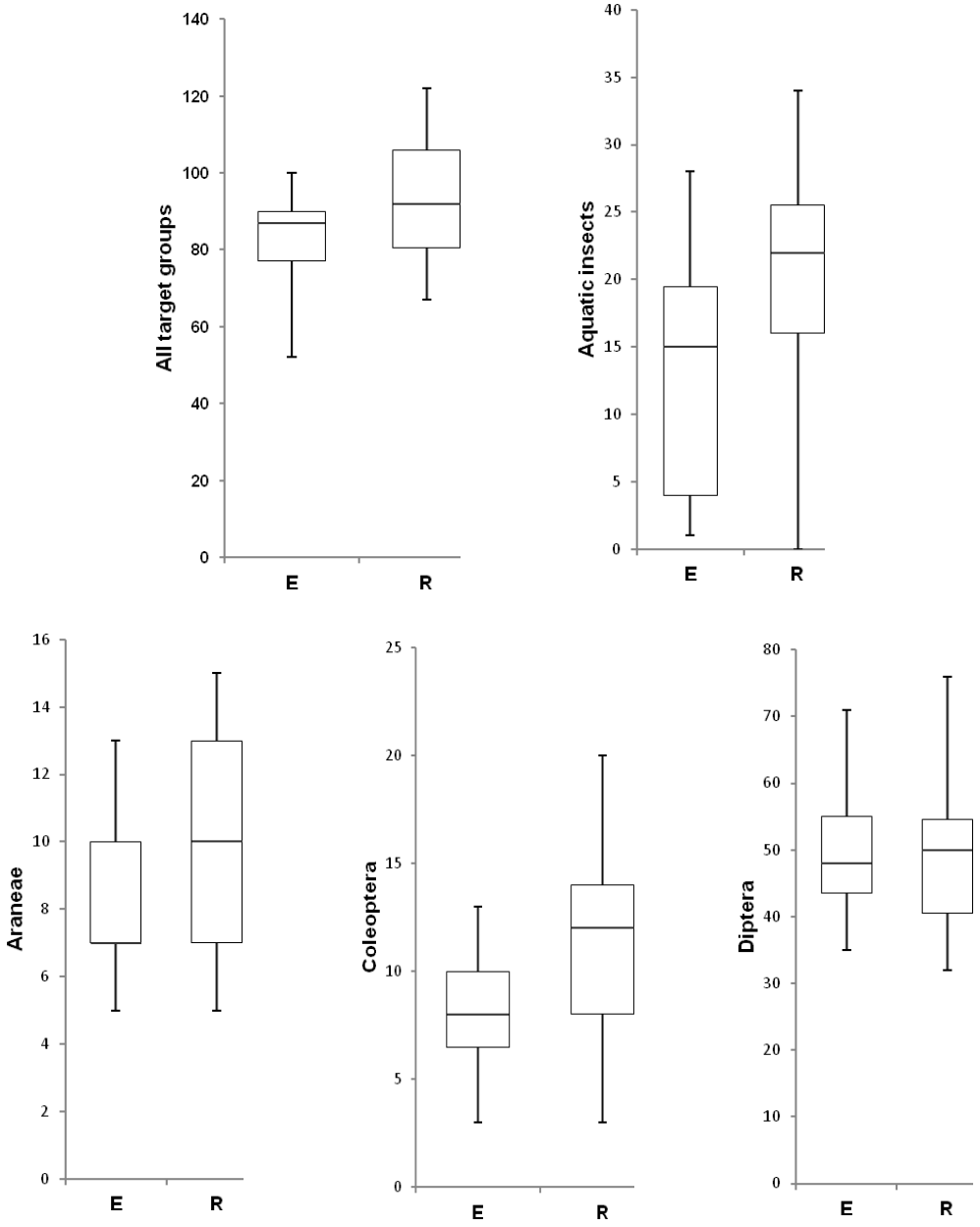

Figure 1: Box plots for numbers of species in samples of various target groups according to whether sample sites were established fen or recently created / restored wetland (E = established fen, R = recently created / restored wetland; in box plots the central line represents the median value; the box contains the two middle 25% quartiles representing half of all the values recorded; the whiskers represent the spread between minimum and maximum values)

The observed differences in species richness in response to the ecological continuity of the wetland were not significant for most groups (see table 8). Only ground and

rove beetle (Carabidae & Staphylinidae) species richness showed a significant response at a low level (Mann-Whitney U test statistic = 59.0, $p<0.05$). Although the significantly higher species richness for the recently created / restored wetland may seem surprising, it must be remembered that species richness gives no information on the conservation value or ecology of the species involved. High species richness may be found in poor quality wetland that supports few specialist wetland species and many generalist species that could not compete with the specialist species in a true fen habitat. The generalist species are unlikely to be of conservation concern so there would be no link between species richness and conservation value. This issue is seen at Buttle Marsh compartment 1 where despite supporting the highest number of species of conservation concern it has the second lowest total species richness. Therefore further analysis by ISIS is required to investigate the ecological associations of the invertebrate assemblages, especially the beetle communities, before the result of the Mann-Whitney U Test result can be explained.

Table 8. Total species richness of target groups in established fen (E) and recently created / restored wetland (R) and Mann-Whitney U test statistic for differences in median species richness of samples (probabilities of such values being generated by chance are represented by asterisks where ** = $p < 0.01$; * = $p < 0.05$; values in italics represent no significant difference)

Target group	*E*	*R*	*U*
All groups	422	402	*79.0*
Aquatic beetles & bugs	67	83	*79.5*
Araneae	66	46	*77.0*
Carabidae & Staphylinidae	55	61	**59.0***
Diptera	203	185	*103.0*
Auchenorrhyncha	21	18	*95.5*

Further examination of the ground beetle and rove beetle species lists for each compartment confirms that the most species rich communities are those of Buttle Marsh and the northern compartment of South Fen. Analysis using ISIS reveals that the W3 permanent wet mire and W2 mineral marsh & open water assemblages dominate all of the beetle communities. The communities of Buttle Marsh compartments 1 and 2 contain the largest numbers of these wetland specialist species. The F2 grassland & scrub matrix assemblage is present also, as a minor component of the beetle community in every compartment. The communities of Kings Fen, Buttle Marsh compartment 4 and the northern compartment of South Fen support the largest numbers of these non-wetland species. This suggests that the Mann-Whitney U test result is due to the development of rich wetland beetle assemblages in Buttle Marsh compartments 1 and 2 combined with the retention of some diverse grassland assemblages in Buttle Marsh compartment 4 and the northern compartment of South Fen.

Analysis of Similarity (ANOSIM)

Similarity values between the samples from differently aged wetland are shown in table 9. Values closer to unity indicate samples with the highest level of similarity.

Most of the invertebrate communities appear to have relatively low similarities with those from the other samples, even those taken in close geographical proximity. The

exception to this is the community from the northern compartment of South Fen which shows a relatively high similarity with all of the other sampled communities. The absence of species of conservation concern in the northern compartment of South Fen (see table 5) suggests the community here includes many eurytopic species requiring environmental conditions likely to be present in all of the sampled compartments. Analysis by ISIS identifies the prescence of more specific wetland assemblages but these are represented by very few species (see appendix 4) supporting the idea that most of the species are eurytopic.

The Bray-Curtis values shown in table 9 were used to test the statistical significance of placing the wetland invertebrate communities into two groups depending on

Table 9. Bray-Curtis similarity values for pairwise comparisons of invertebrate communities in estlablished fen and restored or recreated wetland

	Established fen compartments				Recreated or restored wetland compatments				
	Kings	Whit 12	Whit 15	Whit 16	Buttle 1	Buttle 2	Buttle 4	South N	South S
Decoy	0.767	0.754	0.745	0.735	0.785	0.757	0.717	0.838	0.821
Kings		0.690	0.764	0.659	0.704	0.698	0.680	0.861	0.802
Whit 12			0.510	0.440	0.614	0.616	0.591	0.865	0.661
Whit 15				0.517	0.684	0.722	0.617	0.887	0.673
Whit 16					0.604	0.642	0.599	0.874	0.739
Buttle 1						0.483	0.479	0.886	0.785
Buttle 2							0.561	0.833	0.738
Buttle 4								0.794	0.687
South N									0.609

whether they were present in established wetland or in recreated / restored wetland. The global ANOSIM test statistic of R=0.172 (p=0.004, 1000 randomisations) indicated that the communities in each group were no more similar than if they had been collected randomly from wetlands.

Principal Components Analysis (PCA)

Ordination of the community data shows no evidence of groupings based on the ecological continuity of a wetland compartment (see figure 2). Most of the compartment samples are in a single cluster supporting the results of the community similarity analysis above. The first two axes of the ordination explain more than a third of the variability in the data collected (see table 10).

Table 10. Eigenvalues for the first three axes of the PCA undertaken on the invertebrate community data from wetlands in 2012

Principal Axis	*Eigenvalue*	*Cumulative % of total variance*
1	96180	26.20
2	49516	39.68
3	44346	51.76

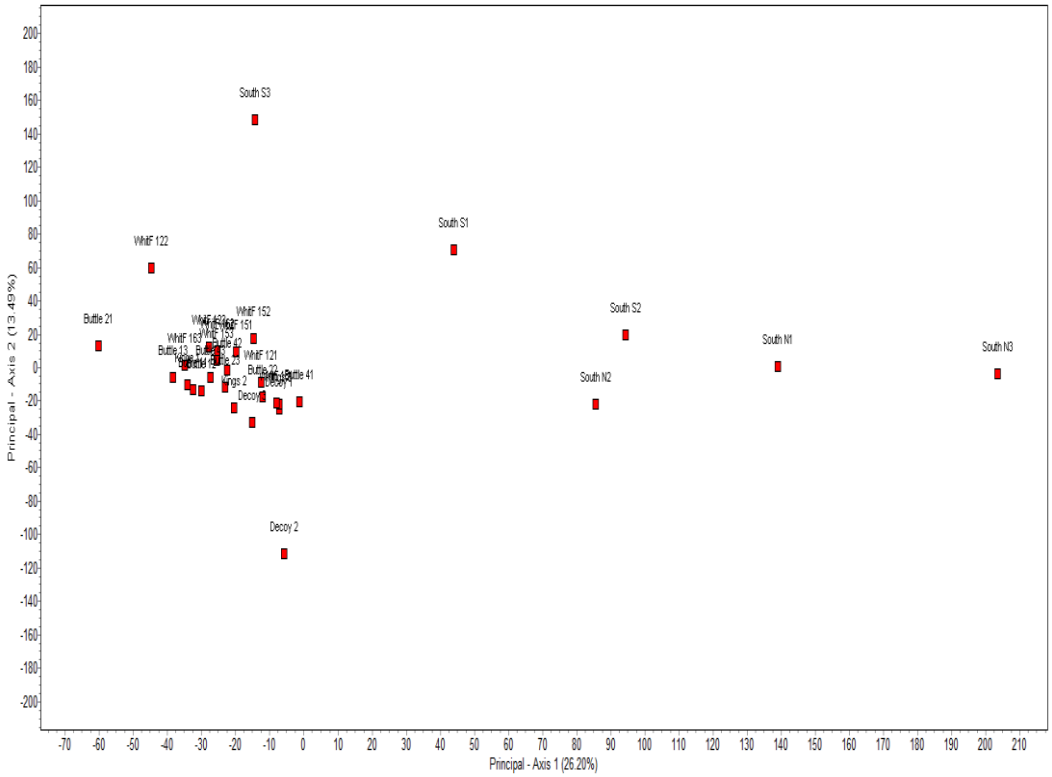

Figure 2: Principal Components Analysis (PCA) plot of samples collected in 2012 from wetland invertebrate communities. (The proximity of data points indicates similarity of communities)

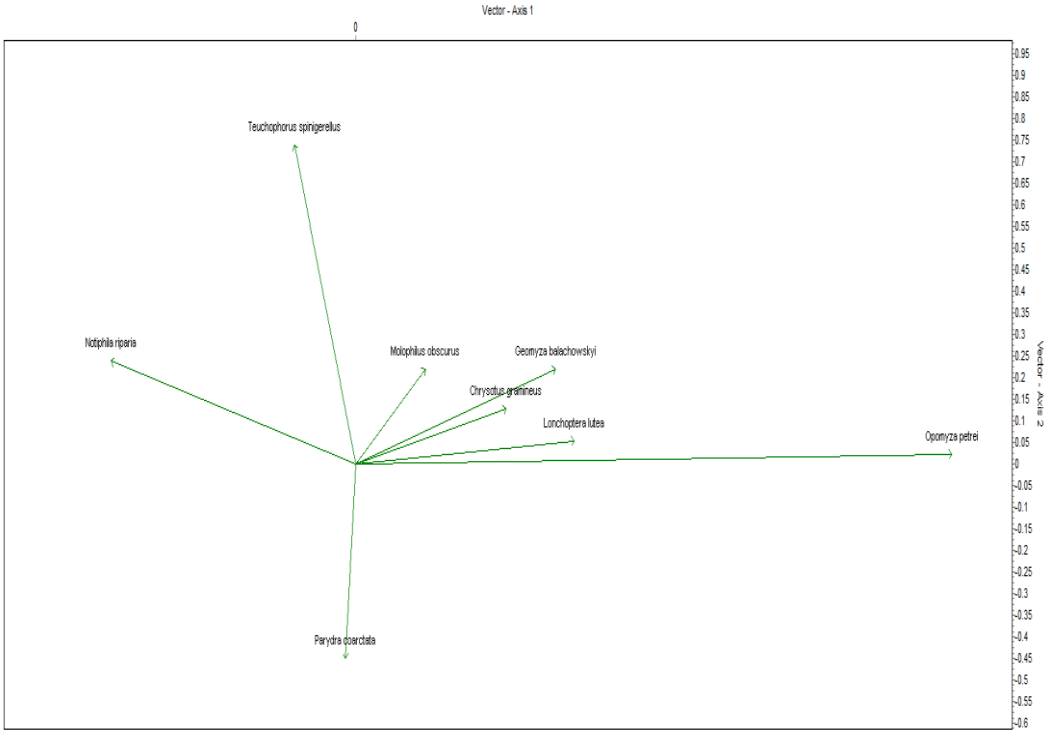

Figure 3: The 8 largest Eigenvectors for the invertebrate species variables calculated by PCA.

Away from the central cluster, principal axis 1 separates most of the South Fen samples from the remaining samples. One possible reason for this distribution can be found in the management history of the sites. South Fen is a grazing marsh in contrast to the cut or unmanaged fen of the other sites. The fluctuating water level leads to temporary drying out of the surface of grazing marsh. Even temporary drying of the surface can be expected to discriminate against true fen species and increase the proportion of damp grassland and mineral marsh species in the invertebrate assemblage.

If this is a correct explanation then the underlying environmental factor described by principal axis 1 would be the hydrology. Examination of the PCA plot of the invertebrate species Eigenvectors (see figure 3) provides some evidence supporting this interpretation. The four Eigenvectors lying most parallel to and in a positive direction along along axis 1 represent species found solely or mostly in samples from South Fen. These species, all diptera, either have no specific habitat association (*Chrysotus gramineus, Lonchoptera lutea*) or are part of a drier, field layer assemblage (*Geomyza balachowskyi, Opomyza petrei*). The Eigenvector lying in the most negative direction along axis 1 represents a species found rarely in samples from South Fen. The larvae of the species in question, *Notiphila riparia*, are probably aquatic and the adult fly is associated with pools and ditches. The importance of hydrology over management in determining the invertebrate community present was highlighted by Lott *et al.* (2010).

The separation of samples on principal axis 2 is less clear. Only two samples are strongly separated; one from a ditch margin on South Fen and the other from an area of shaded, bare mud at Decoy Carr. The species Eigenvectors (see figure 3) for *Teuchophorus spingerellus* (permanent wet mire) and *Parydra coarctata* (bare mud by water) suggest that principal axis 2 may be related to some other aspect of hydrological conditions. However, if an aspect of hydrology is the key environmental driver underlying axis 2 it is not clear why other samples were not separated more strongly along the axis.

Analysis using ISIS

Broad assemblage types (BATs)

The scores relating to wetland BATs for each compartment are listed in appendix 3. Even on South Fen the W3 assemblage type (permanent wet mire) dominated all the compartment assemblages according to their representation scores. Lott *et al*. (2010) recommended that this assemblage type should be counted as the priority assemblage type in fens. In all cases, the W2 assemblage type (mineral marsh and open water) was the second most important component of compartment assemblages.

The W3 rarity score indicates the conservation value of the permanent wet mire component of Broadland invertebrate assemblages. The W3 rarity score for all but one of the compartments surveyed in 2012 falls into the lowest of the three bands (<250) used by Lott *et al.* (2010). The W3 rarity score of 158 for the South Fen north compartment assemblage was substantially lower than the score for any other compartment assemblage both in this and the earlier survey. This low score further supports the view that the past management of the hydrology of South Fen has been detrimental to the permanent wet mire invertebrate assemblages.

The only assemblages sampled in 2012 that produced a W3 rarity score greater than 250 were those of Buttle Marsh compartment 1 (268) and Whitlingham Marsh compartment 16 (258). Although a moderate rather than a high score, examination of appendix 3 shows that the invertebrate conservation value of Buttle Marsh compartment 1 is already comparable to that of established fen compartments at Hickling Broad, Strumpshaw Fen and Woodbastwick Fen.

Specific assemblage types (SATs)
The important SATs recorded for each compartment are listed in appendix 4. The most widely recorded SATs were W314 (reed fen and pool) and W313 (moss and tussock fen). Wetland SATs recorded at much lower levels of representation included W312 (Sphagnum bog), W221 (undisturbed fluctuating marsh), W211 (open water on disturbed sediment) and W126 (seepage).

The SAT scores are simple species richness values counting only those species with the very narrow habitat preferences described by the SAT label. The W314 (reed fen and pool) assemblage was the most speciose assemblage recorded in all compartments and exceeded the threshold for a nationally important assemblage everywhere but the northern compartment of South Fen. The number of W313 (moss and tussock fen) species was more variable between sites but exceeded the threshold for a nationally important assemblage on all three compartments at Buttle Marsh in addition to Decoy Carr and Whitlingham Marsh compartment 16. The SAT scores were similar to those reported by Lott *et al*. (2010) for other Broadland fen compartments. The W314 (reed fen and pool) SAT score for South Fen north was particularly low and was most comparable to the scores for grazing marshes along the River Yare. This low SAT score again emphasises the negative impact that past management of hydrology has had on the assemblages associated with permanently wet conditions.

Although not comparable with the very high quality assemblages found on Catfield Fen, the invertebrate communities of Buttle Marsh compartments 1 and 2 already include W314 (reed fen and pool) and W313 (moss and tussock fen) assemblages that are nationally important. They are the equivalent of, or better than, those found in most compartments in earlier surveys. The RSPB Bringing Reedbeds to Life project (Hardmann, 2011) reached similar conclusions with the overall species richness and number of reedbed and wetland specialist Diptera and moths being similar in newly restored and existing reedbed although older reedbed had more species of high conservation status.

CONCLUSIONS

Invertebrate conservation value of fen compartments surveyed

During the reported work 549 species from the target groups were recorded in standardised samples. The species richness of the ten compartments surveyed varied between 158 and 193 but the number of species present was not related to the conservation value of the compartment as measured by the presence of Broadland speciality invertebrate species or by species of conservation concern.

Every compartment surveyed supported at least one Broadland speciality species. The highest number of Broadland speciality species (3) was recorded at Decoy Carr.

Species of conservation concern were found at every location surveyed apart from the northern compartment of South Fen. The number of species of conservation concern varied between two at Buttle Marsh compartment 4 and six at Buttle Marsh compartment 1. Recording the presence of Broadland speciality species was not a sufficiently sensitive measure of assessing differences in the invertebrate conservation value of the sites.

The invertebrate community of every compartment surveyed was dominated by the wetland assemblages associated with permanent wet mire (ISIS code W3). The specific assemblages of reed fen and pool (ISIS code W314) and moss and tussock fen (ISIS code W313) were represented in every area surveyed. The mineral marsh and open water assemblage (ISIS code W2) was present in every compartment also. BAT rarity scores for the W3 assemblage ranged from 158 at South Fen north compartment to 268 at Buttle Marsh compartment 1. The rarity score exceeded the threshold for a nationally important permanent wet mire assemblage on all compartments except the northern compartment of South Fen. The SAT score for the W314 (reed fen and pool) assemblage also exceeded the threshold for national importance on all compartments except the northern compartment of South Fen.

The survey results for individual compartments were broadly similar to those obtained for 40 different fen compartments between 2007 and 2009 by Lott *et al.* (2010). The dominance of the W3 (permanent wet mire) and W2 (mineral marsh & open water) broad assemblages and the importance of the W314 (reed fen and pool) and W313 (moss and tussock fen) specific assemblages was shared with that study. The W3 BAT rarity score for the compartments surveyed in 2012 compared with the low to middle band of those surveyed earlier although the score of 158 for the northern compartment at South Fen was the lowest obtained for any compartment assemblage in either survey by a significant margin. The range of SAT scores for each of the wetland assemblages was similar to those reported by Lott *et al*. (2010) for other Broadland fen compartments.

It should be noted that the standardised field protocol and analysis of the data by ISIS was able to provide comparable information to Lott et al. (2010) despite the limitations imposed by the cool and wet conditions throughout the field season of 2012.

Invertebrate communities of recreated and restored wetland

There was little evidence of any differences in the invertebrate communities found in the established fen compartments as opposed to the restored or recreated wetland. The invertebrate communities of each group of compartments were no more similar to each other than they were to the communities of the other compartments (ANOSIM test statistic $R=0.172$, $p=0.004$, 1000 randomisations). When the species richness of indidivual taxonomic groups was investigated there was a significantly higher diversity of ground beetles and rove beetles in the compartments with restored or recreated wetland (Mann-Whitney U test statistic = 59.0, $p<0.05$). Further examination of the data suggests that the difference is due to the development of especially diverse wetland beetle assemblages in Buttle Marsh compartments 1 and 2 combined with the retention of some diverse grassland assemblages in Buttle Marsh compartment 4 and the northern compartment of South Fen.

The wetland recreation at Buttle Marsh appears to have been successful in providing suitable habitat for Broadland invertebrates. Compartment 1 already appears to support a Broadland invertebrate community equivalent to nationally important sites such as Woodbastwick Fen as measured by the quality of the W3 (permanent wet mire) BAT and the W314 (reed fen and pool) and W313 (moss and tussock fen) SATs.

There does appear to be a difference in the conservation value (as measured by ISIS) of the wetland invertebrate communities of the different compartments at Buttle Marsh with compartment 4 being of lower value than compartments 1 and 2. Although no environmental measurements were taken, field observation suggested that, at least seasonally, compartment 4 was drying out at the surface. This would be detrimental to the invertebrates of the permanent wet mire (ISIS code W3) assemblage and would explain the lower conservation value. Seasonal surface drying at South Fen, especially in the northern compartment, appears to have had an even more negative impact on the Broadland invertebrates.

Future monitoring programmes

The current project has provided ISIS representation scores for the W3 permanent wet mire assemblage type on each compartment surveyed. This can be used to monitor how the balance between different assemblage types is responding to changes in hydrology as a result of the management of Buttle Marsh and South Fen. The rarity score for the W3 permanent wet mire assemblage type can be used to monitor conservation interest associated with the true fen community. Following Lott *et al*. (2010), it is recommended that these scores be used in any future monitoring programme dealing with the conservation interest of true fen invertebrates in areas of wetland recreation or restoration in the Broads.

The results of the current project can be used as a baseline for any future monitoring programme at Buttle Marsh and South Fen, but only by following the same sampling protocol and using the same target taxa. Some groups such as spiders and hoppers appeared to contribute very little to the overall analysis but there is no guarantee that ISIS would work as well on a reduced set of target taxa and any changes to sampling methods would invalidate the results of the current project as a baseline. Fluctuations in the populations of many invertebrates over a range of time scales would dictate that monitoring should ideally be annual in order to differentiate real change from such fluctuations. However, an acceptable compromise between the robustness of the data and the financial costs would involve a survey every 3-5 years.

The open water community of the boundary ditches would need to be monitored separately as they will respond differently to changes in management regimes. The same methods using the ISIS W2 and W1 representation scores can be used.

ACKNOWLEDGMENTS

Andrea Kelly (Broads Authority) acted as project officer and selected the compartments to be surveyed.

Dr Keith Alexander kindly discussed his thoughts on ecological continuity and old fen habitats.

Terrestrial beetles were sampled and identified by Geoff Nobes. Aquatic invertebrates and Diptera were sampled and identified by Martin Drake. Spiders and Auchenorryhncha were sampled and identified by Paul Lee.

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Appendix 1: List of all sample sites

Compartment	*Grid reference*	*Habitat description*
Buttle Marsh 1.1	TG36521824	reeds in shallow water
Buttle Marsh 1.2	TG36471824	dense reed over shallow water
Buttle Marsh 1.3	TG36561823	steep-sided ditch by fen
Buttle Marsh 2.1	TG36451812	*Typha* swamp in 25cm of water
Buttle Marsh 2.2	TG36441808	*Typha* swamp in 15cm water
Buttle Marsh 2.3	TG36491811	ditch by fen
Buttle Marsh 4.1	TG36441792	damp rush-dominated marsh
Buttle Marsh 4.2	TG36451797	deep reed-edged ditch by fen
Buttle Marsh 4.3	TG36541793	reed-dominated ditch margin
Decoy Carr 1	TG40560939	reed and *Cladium* fen
Decoy Carr 2	TG40550947	wet peat in recently cleared carr
Decoy Carr 3	TG40550937	reed-choked ditch under alders and willow
Kings Fen 1	TG34322831	acid mire
Kings Fen 2	TG34232809	swamp at lake margin
Kings Fen 3	TG33942801	deep slow-flowing drain
South Fen north 1	TG34902635	grazed *Juncus* and *Holcus* pasture
South Fen north 2	TG34902632	wet depressions in grazed fen
South Fen north 3	TG34932633	ditch in grazed fen
South Fen south 1	TG34832578	mixed monocot fen (short reed, *Calamagrostis*)
South Fen south 2	TG34862584	mixed short monocot fen
South Fen south 3	TG34792577	ditch in fen
Whitlingham Marsh 12.1	TG27750810	*Carex* marsh, almost dry
Whitlingham Marsh 12.2	TG27810812	*Carex* swamp
Whitlingham Marsh 12.3	TG27810813	ditch in derelict fen
Whitlingham Marsh 15.1	TG28220795	tall reedbed
Whitlingham Marsh 15.2	TG28200793	tall reed & scrub
Whitlingham Marsh 15.3	TG28310792	*Typha*-dominated ditch in fen
Whitlingham Marsh 16.1	TG28120784	mixed species fen
Whitlingham Marsh 16.2	TG28120788	*Typha*-dominated ditch in neglected fen
Whitlingham Marsh 16.3	TG28070786	*Typha*-dominated ditch in neglected fen

Appendix 2: List of species recorded 2012

ISIS BAT codes: 0 = unclassified, A1 = Arboreal canopy, A2 = wood decay, F1 = unshaded early successional mosaic, F2 = grassland & scrub matrix, F3 = shaded field & ground layer, M3 = saltmarsh, estuary & mudflat, W1 = flowing water, W2 = mineral marsh & open water, W3 = permanent wet mire, #N/A = not in ISIS database.

ISIS SAT codes: W211 = open water on disturbed sediments, W221 = undisturbed fluctuating marsh, W312 = Sphagnum bog, W313 = moss and tussock fen, W314 = reed fen and pools.

ISIS rarity scores for target groups are based on recently recorded range size in Britain, where these are accessible. Scores of 8 or 16 are more or less equivalent, as far as they can be, to national red data book status or a nationally scarce grade A designation; a score of 4 is roughly equivalent to a nationally scarce grade B designation.

Group	*Species*	*No. samples*	*No. specimens*	*ISIS BAT code*	*ISIS SAT code*	*ISIS Rarity Score*
Carabidae	*Acupalpus dubius*	17	95	W3		1
	Acupalpus parvulus	2	3	W3		2
	Agonum emarginatum	1	2	W2		2
	Agonum fuliginosum	6	11	W2		1
	Agonum gracile	3	4	W3		2
	Agonum thoreyi	17	33	W3		1
	Amara communis	1	1	F2		2
	Anchomenus dorsalis	-	1	F1		1
	Badister dilatatus	3	3	W2	W221	4
	Bembidion assimile	5	7	W2		2
	Bembidion guttula	-	1	W2		1
	Bembidion mannerheimii	3	3	F2		2
	Bradycellus harpalinus	4	8	F2		1
	Demetrias imperialis	3	5	W3	W314	4
	Dyschirius globosus	1	1	W3		2
	Dyschirius luedersi	1	1	W2		2
	Elaphrus cupreus	2	10	W2		1
	Harpalus rufipes	1	1	0		1
	Leistus ferrugineus	1	1	F2		1
	Leistus terminatus	3	5	F2		1
	Loricera pilicornis	6	18	0		1
	Notiophilus biguttatus	1	1	0		1
	Odacantha melanura	4	6	W3	W314	4
	Oodes helopioides	1	1	W3	W314	4
	Oxypselaphus obscurus	-	1	W2		2
	Paradromius linearis	1	1	F2		1
	Paradromius longiceps	2	2	W3	W314	4
	Philorhizus melanocephalus	2	2	F1		1
	Pterostichus diligens	11	16	W3		1
	Pterostichus minor	10	12	W3		1
	Pterostichus melanarius	-	1	F2		1
	Pterostichus nigrita	1	1	W2		1
	Pterostichus rhaeticus	4	6	F2		1
	Pterostichus strenuus	10	19	F2		1
	Pterostichus vernalis	3	3	F2		2
	Stenolophus mixtus	8	26	W2		1
	Trichocellus placidus	4	8	W3		2

Group	Species	No. samples	No. specimens	ISIS BAT code	ISIS SAT code	ISIS Rarity Score
Staphylinidae	*Anotylus rugosus*	2	3	W2		1
	Atheta graminicola	2	2	W2		1
	Bisnius fimetarius	-	1	F2		1
	Deubelia picina	2	7	W3	W314	2
	Erichsonius cinerascens	5	7	W3		2
	Euaesthetus ruficapillus	1	2	W3	W313	2
	Gabrius breviventer	1	1	W2		1
	Lathrobium brunnipes	6	9	0		1
	Lathrobium elongatum	3	4	W3		2
	Lathrobium impressum	-	1	W2	W221	2
	Lathrobium rufipenne	2	3	W3	W313	16
	Lesteva heeri	1	1	W2		1
	Lesteva sicula	1	1	W2		1
	Myllaena dubia	1	4	W3		1
	Myllaena minuta	2	2	W3		2
	Ocyusa maura	7	10	W2		2
	Ocyusa picina	8	17	W3	W314	2
	Olophrum fuscum	3	3	W3	W312	4
	Olophrum piceum	-	1	F2		1
	Paederus riparius	20	61	W3	W314	2
	Philonthus fumarius	6	15	W3	W313	4
	Philonthus micans	2	4	W2		2
	Plataraea brunnea	1	1	0		2
	Quedius balticus	2	5	W3	W314	16
	Quedius boops group	-	1	#N/A		#N/A
	Quedius fuliginosus	3	3	W2		1
	Quedius maurorufus	1	1	W1		1
	Rugilus erichsoni	3	3	W3		2
	Rybaxis longicornis	-	1	W2		1
	Staphylinus erythropterus	1	1	F2		2
	Stenus bifoveolatus	2	2	W3		1
	Stenus bimaculatus	10	16	W2		1
	Stenus binotatus	1	1	W2		1
	Stenus brunnipes	-	1	0		1
	Stenus carbonarius	3	3	W3	W314	4
	Stenus cicindeloides	6	16	W2		1
	Stenus clavicornis	-	1	F2		1
	Stenus fulvicornis	-	6	F2		1
	Stenus impressus	-	1	0		1
	Stenus juno	13	16	W2		1
	Stenus latifrons	5	5	W3		1
	Stenus lustrator	1	1	W3		4
	Stenus nitens	2	2	W3		2
	Stenus nitidiusculus	1	1	W3		1
	Stenus pallipes	-	1	W2	W221	4
	Stenus palustris	3	6	W3	W313	4
	Stenus providus	-	1	W2		1
	Stenus solutus	4	8	W3	W314	2
	Tachinus marginellus	1	2	F2		1
	Tachyporus chrysomelinus	-	1	F2		1
	Tachyporus hypnorum	1	1	F2		1
	Tachyporus pallidus	3	3	W2		2
	Tachyporus solutus	2	4	F2		1

Staphylinidae (cont.)	*Trissemus impressus*	2	5	W3	W313	4
	Xantholinus linearis	1	1	F2		1

Group	*Species*	*No. samples*	*No. specimens*	*ISIS BAT code*	*ISIS SAT code*	*ISIS Rarity Score*
Water beetles	*Acilius sulcatus*	1	1	W3		1
	Agabus bipustulatus	9	28	W2		1
	Agabus didymus	1	3	W1		1
	Agabus striolatus	2	6	W3	W313	8
	Agabus sturmii	12	38	W2		1
	Agabus unguicularis	4	22	W3	W313	2
	Anacaena bipustulata	1	1	W2	W211	2
	Anacaena globulus	10	28	W2		1
	Anacaena limbata	26	403	W2		1
	Anacaena lutescens	6	19	W3		1
	Cercyon convexiusculus	10	51	W2		2
	Cercyon marinus	3	3	W2		2
	Cercyon sternalis	10	42	W3		2
	Cercyon tristis	3	4	W2		2
	Cercyon ustulatus	1	1	W2		2
	Coelostoma orbiculare	6	15	W3		2
	Colymbetes fuscus	6	8	W2		1
	Cymbiodyta marginellus	9	88	W3		2
	Dryops anglicanus	2	13	W3	W313	8
	Dryops luridus	1	1	W2		1
	Dytiscus circumcinctus	1	1	W2	W211	4
	Enochrus coarctatus	7	25	W3		2
	Enochrus testaceus	4	6	W2		2
	Graptodytes granularis	2	12	W3	W313	2
	Gyrinus aerates	1	2	W2	W212	4
	Gyrinus marinus	7	25	W2		2
	Gyrinus substriatus	2	2	W2		1
	Haliplus confinis	1	3	W2		2
	Haliplus flavicollis	1	1	W2		2
	Haliplus lineatocollis	3	4	W1		1
	Haliplus ruficollis	4	7	W2		1
	Helochares lividus	2	7	W2	W211	2
	Helochares punctatus	1	2	W3	W312	2
	Helophorus aequalis	6	7	W2		1
	Helophorus brevipalpis	6	23	W2		1
	Helophorus flavipes	3	7	W3		1
	Helophorus minutus	1	1	W2		1
	Helophorus obscurus	1	3	W2		1
	Hydaticus seminiger	7	15	W3	W313	2
	Hydaticus transversalis	3	4	W3	W314	4
	Hydraena palustris	2	4	W3	W313	16
	Hydraena riparia	7	12	W2		2
	Hydraena testacea	5	64	W2		4
	Hydrobius fuscipes	11	38	W2		1
	Hydrochus angustatus	5	19	W3		4
	Hydrochus brevis	1	1	W3	W313	4
	Hydrophilus piceus	4	5	W3	W314	4
	Hydroporus angustatus	15	97	W2		1
	Hydroporus incognitus	6	25	W2		1
	Hydroporus memnonius	14	57	W3		1
	Hydroporus neglectus	3	32	W3		4
	Hydroporus nigrita	2	4	W3		1

Water beetles (cont.)	*Hydroporus palustris*	7	17	W2		1
	Hydroporus planus	2	4	W2		1
	Hydroporus pubescens	3	16	W3		1
	Hydroporus scalesianus	1	3	W3	W313	8
	Hydroporus striola	7	25	W3		1
	Hygrobia hermanni	1	1	W2		2
	Hygrotus decoratus	1	2	W3	W313	4
	Hygrotus impressopunctatus	1	4	W3		1
	Hygrotus inaequalis	7	13	W2		1
	Hyphydrus ovatus	12	32	W2		1
	Ilybius ater	5	7	W2		1
	Ilybius fenestratus	4	9	W2	W211	2
	Ilybius fuliginosus	1	1	W2		1
	Ilybius guttiger	2	3	W3	W313	2
	Ilybius quadriguttatus	8	11	W3		2
	Laccobius bipunctatus	6	29	W2		1
	Laccobius minutus	1	1	W2		1
	Laccophilus hyalinus	3	5	W1		2
	Laccophilus minutus	3	5	W2		1
	Laccornis oblongus	2	2	W3	W313	4
	Limnebius aluta	7	52	W3	W313	8
	Limnebius truncatellus	4	5	W1		1
	Liopterus haemorrhoidalis	4	9	W3		2
	Noterus clavicornis	8	47	W2		1
	Noterus crassicornis	8	39	W3	W314	2
	Ochthebius dilatatus	1	1	W2		2
	Ochthebius minimus	13	154	W2		1
	Peltodytes caesus	2	2	W2	W211	2
	Rhantus exsoletus	7	13	W3		2
	Rhantus grapii	11	32	W3	W313	2
	Rhantus suturalis	2	3	W2	W211	2
	Stictotarsus duodecimpustulatus	1	2	W1		1
	Suphrodytes dorsalis s.l.	3	6	W3		2

Group	*Species*	*No. samples*	*No. specimens*	*ISIS BAT code*	*ISIS SAT code*	*ISIS Rarity Score*
Water bugs	*Corixa dentipes*	1	1	W2		2
	Corixa punctata	3	5	W2		1
	Gerris lacustris	5	9	W2		1
	Gerris odontogaster	6	16	W2		1
	Hebrus ruficeps	1	1	W3		2
	Hesperocorixa linnaei	3	5	W2		1
	Hesperocorixa sahlbergi	9	16	W2		1
	Hydrometra stagnorum	1	1	W2		1
	Ilyocoris cimicoides	8	8	W2		1
	Microvelia buenoi	2	2	W3	W314	8
	Microvelia reticulata	6	27	W2		1
	Nepa cinerea	9	10	W2		1
	Plea minutissima	1	2	W2	W211	1
	Ranatra linearis	4	5	W2	W211	2

Group	Species	No. samples	No. specimens	ISIS BAT code	ISIS SAT code	ISIS Rarity Score
Diptera – craneflies	*Cheilotrichia imbuta*	9	20	W1		4
(Limoniidae	*Dicranomyia danica*	1	1	W2		8
+ Ptychopteridae	*Dicranomyia lucida*	2	2	W1		4
+ Tipulidae)	*Dicranophragma minuscula*	1	1	#N/A		#N/A
	Dicranophragma nemorale	2	4	W1		1
	Dicranophragma separatum	12	35	W3		1
	Ellipteroides lateralis	3	7	W1		2
	Erioconopa trivialis	8	60	W3		1
	Erioptera flavata	5	15	W3		2
	Erioptera fuscipennis	2	3	W3		1
	Erioptera meijerei	6	10	W3	W314	16
	Erioptera squalida	3	4	W3	W314	2
	Helius flavus	20	100	W3		2
	Helius longirostris	4	7	W2		1
	Helius pallirostris	10	24	W3	W314	4
	Limonia macrostigma	1	1	W1		1
	Molophilus bihamatus	2	3	W1	W126	4
	Molophilus medius	11	138	W1		1
	Molophilus obscurus	14	213	W1		1
	Molophilus pleuralis	5	10	W3		2
	Nigrotipula nigra	2	3	W3		2
	Ormosia nodulosa	1	2	F3		1
	Phylidorea ferruginea	13	35	W3		1
	Phylidorea fulvonervosa	10	18	W3		1
	Pilaria discicollis	3	3	W2		1
	Pilaria scutellata	6	7	W3		4
	Prionocera turcica	2	20	W3		2
	Ptychoptera contaminata	5	7	W2		2
	Ptychoptera minuta	13	73	W3	W314	2
	Symplecta hybrida	1	2	W1		2
	Symplecta stictica	1	1	W2		1
	Tipula fascipennis	2	2	F2		1
	Tipula lateralis	1	1	W1		1
Diptera - Anthomyzidae	*Anagnota bicolor*	18	111	W3		4
	Anthomyza collini	26	586	W3		0
	Anthomyza dissors	3	6	W3		0
	Anthomyza elbergi	1	1	F2		0
	Anthomyza gracilis	13	43	0		1
	Anthomyza neglecta	20	106	W3		0
	Anthomyza paraneglecta	5	16	0		0
	Stiphrosoma cingulatum	13	47	W3		2
	Stiphrosoma sabulosum	1	5	F2		0
	Typhamyza bifasciata	4	14	W3	W314	4
Diptera - Aulacigastridae	*Stenomicra cogani*	10	33	W3	W313	8
	Stenomicra delicata	5	6	W3	W314	16
Diptera - Chamaemyiidae	*Chamaemyia polystigma*	9	46	F2		1
Diptera - Chaoboridae	*Chaoborus crystallinus*	6	23	W2		0
	Chaoborus flavicans	1	1	W2		0
	Chaoborus pallidus	1	1	W3		0
Diptera - Culicidae	*Aedes cinereus*	3	3	W2		2

	Anopheles atroparvus / messeae	-	3	#N/A		#N/A
	Anopheles claviger	-	4	W2		1
	Coquillettidia richiardii	3	5	W3		1
	Culex pipiens	1	1	W2		1
	Culiseta annulata group	6	8	#N/A		#N/A
	Ochlerotatus cantans	1	1	W2		1
Diptera - Diastatidae	*Campichoeta obscuripennis*	16	198	F2		1
	Diastata adusta	11	19	0		1
	Diastata costata	4	14	F2		0
	Diastata vagans	3	6	F3		4
Diptera - Dixidae	*Dixella amphibia*	5	9	W3		1
	Dixella attica/autumnalis	-	13	#N/A		#N/A
	Dixella autumnalis	18	124	0		2
	Dixella serotina	10	134	W3	W314	2
Diptera - Dolichopodidae	*Achalcus britannicus*	3	4	W3		0
	Achalcus cinereus	13	29	W3		2
	Achalcus flavicollis	20	257	W3		2
	Achalcus thalhammeri	1	1	W3		0
	Achalcus vaillanti	14	59	W3	W314	0
	Anepsiomyia flaviventris	2	2	W1		2
	Argyra argyria	1	1	W1		1
	Argyra elongata	7	22	W3		2
	Argyra leucocephala	1	1	W1		1
	Argyra vestita	14	120	W3		2
	Campsicnemus curvipes	6	14	W1		1
	Campsicnemus pusillus	1	2	W3		2
	Campsicnemus scambus	22	123	W3		1
	Chrysotus cilipes	6	23	W3		1
	Chrysotus gramineus	15	185	0		1
	Diaphorus nigricans	1	10	W3		2
	Dolichopus brevipennis	6	32	W3		2
	Dolichopus festivus	1	1	W2		1
	Dolichopus longitarsis	4	12	W3		2
	D. nubilus / latilimbatus ♀	1	2	#N/A		#N/A
	Dolichopus pennatus	6	8	W1		1
	Dolichopus picipes	1	1	W1		2
	Dolichopus plumipes	11	92	W2		1
	Dolichopus popularis	8	17	W1		1
	Dolichopus signatus	2	8	W3		2
	Dolichopus simplex	5	138	W2		1
	Dolichopus trivialis	2	2	0		1
	Dolichopus ungulatus	2	3	W2		1
	Dolichopus urbanus	6	21	W1		1
	Ethiromyia chalybea	16	97	W3		2
	Gymnopternus aerosus	12	201	W3		1
	Gymnopternus assimilis	11	69	W3	W314	2
	Gymnopternus blankaartensis	4	10	W3	W314	0
	Gymnopternus cupreus	1	1	W1		2
	Gymnopternus metallicus	1	1	W1		1
	Gymnopternus silvestris	3	6	W1		2
	Hercostomus nanus	3	9	W1		2
	Hydrophorus bipunctatus	1	5	W1		1
	Lamprochromus bifasciatus	8	80	W3		2
	Poecilobothrus chrysozygos	2	5	W1		2
	Poecilobothrus nobilitatus	3	3	W2		1
	Rhaphium auctum	1	1	W1		2
	Rhaphium caliginosum	1	2	W1		1
	Rhaphium fasciatum	3	10	W3		2
	Sciapus longulus	1	1	W2		2

	Sympycnus aeneicoxa	1	3	W3		1
	Sympycnus desoutteri	5	20	W2		1
	Syntormon bicolorellum	1	6	W3		2
	Syntormon denticulatum	1	1	W1		2
	Syntormon pallipes	1	1	W1		1
	Syntormon pumilum	5	17	W3		2
	Syntormon tarsatum	1	1	W3		2
	Teuchophorus spinigerellus	19	563	W3		2
	Thrypticus laetus	1	2	W3		2
	Xanthochlorus ornatus	1	1	0		2
Diptera - Empididae	*Chelipoda albiseta*	3	13	W1		2
	Chelipoda vocatoria	1	1	W1		2
	Dolichocephala irrorata	1	5	W1		1
	Empis aestiva	2	2	0		1
	Empis albinervis	1	1	0		2
	Empis livida	3	12	0		1
	Hemerodromia raptoria	3	4	W1		2
	Hilara chorica	7	83	0		1
	Hilara nigrina	5	22	0		2
	Hilara pseudocornicula	3	3	W3		2
	Hilara quadriseta	7	17	W3		4
	Hilara rejecta	1	2	W1		2
	Phyllodromia melanocephala	5	51	F3		1
	Rhamphomyia caliginosa	4	17	0		4
	Rhamphomyia nigripennis	2	2	F3		1
Diptera - Ephydridae	*Axysta cesta*	5	7	W3		2
	Coenia curvicauda	3	9	W3		1
	Coenia palustris	13	99	W3		1
	Discocerina obscurella	1	10	W2		1
	Ditrichophora fuscella	2	15	W1		1
	Gymnoclasiopa plumosa	1	1	0		2
	Hyadina guttata	4	6	0		1
	Hyadina humeralis	4	12	0		1
	Hyadina rufipes	3	6	0		1
	Hydrellia albilabris	1	1	W3		1
	Hydrellia griseola	11	105	0		1
	Hydrellia maura	8	49	0		1
	Hydrellia nigricans	2	24	W3		1
	Hydrellia thoracica	2	2	W3		1
	Ilythea spilota	4	9	0		1
	Limnellia fallax	1	1	W3		2
	Limnellia quadrata	2	4	W3		1
	Limnellia surturi	2	3	0		1
	Notiphila caudata	9	24	W3		1
	Notiphila cinerea	7	84	W2		1
	Notiphila dorsata	5	13	W3		1
	Notiphila graecula	4	10	W2		1
	Notiphila maculata	16	61	W3		1
	Notiphila nigricornis	1	1	W3		1
	Notiphila riparia	19	849	W3		1
	Notiphila subnigra	6	92	W3	W314	4
	Parydra aquila	1	1	W2		1
	Parydra coarctata	3	202	W1		1
	Parydra fossarum	8	36	W2		1
	Parydra hecate	2	5	W3		2
	Parydra littoralis	2	4	W1		1
	Parydra pusilla	18	70	W3		2
	Parydra quadripunctata	4	18	W2		1
	Pelina aenea	1	1	W3		1
	Pelina similis	3	10	W3		1

	Pelina subtruncata	1	1	W3		2
	Philotelma nigripenne	8	11	0		2
	Scatella stagnalis	6	36	W2		1
	Scatella tenuicosta	12	67	W3		1
	Scatophila noctula	2	8	0		0
Diptera - Hybotidae	*Bicellaria mera*	1	2	W3		4
	Bicellaria vana	2	2	0		1
	Drapetis ephippiata	5	10	0		2
	Drapetis humilis	1	1	0		2
	Hybos femoratus	14	84	F2		1
	Platypalpus albiseta	2	2	0		2
	Platypalpus calceatus	1	2	F2		1
	Platypalpus clarandus	1	1	0		1
	Platypalpus commutatus	1	1	0		4
	Platypalpus cursitans	8	16	F2		1
	Platypalpus interstinctus	1	1	W1		2
	Platypalpus kirtlingensis	1	1	W3		0
	Platypalpus longiseta	5	6	0		1
	Platypalpus pallidicornis	22	138	W3		2
	Platypalpus pallidiventris	21	57	0		1
	Platypalpus pseudofulvipes	2	2	F2		1
	Platypalpus pygialis	1	1	0		0
	Stilpon graminum	11	25	F2		1
	Tachydromia aemula	2	2	0		1
	Tachydromia umbrarum	1	1	0		0
	Trichina clavipes	1	1	F3		1
Diptera - Lauxaniidae	*Calliopum aeneum*	5	8	F3		1
	Calliopum elisae	3	9	0		2
	Meiosimyza decipiens	12	33	0		1
	Meiosimyza rorida	2	2	F3		1
	Minettia rivosa	6	10	0		1
	Trigonometopus frontalis	10	25	0		2
Diptera - Lonchopteridae	*Lonchoptera bifurcata*	14	71	0		1
	Lonchoptera lutea	30	647	0		1
	Lonchoptera nitidifrons	1	2	W3	W314	2
	Lonchoptera scutellata	9	21	W3	W314	4
Diptera - Micropezidae	*Neria cibaria*	1	1	0		1
Diptera - Opomyzidae	*Geomyza balachowskyi*	16	294	F2		1
	Geomyza majuscula	8	37	W3		4
	Geomyza nartshukae	1	1	F2		0
	Geomyza subnigra	1	1	F2		2
	Geomyza tripunctata	14	53	F2		1
	Opomyza florum	6	13	F2		1
	Opomyza germinationis	18	39	F2		1
	Opomyza petrei	14	495	F2		1
Diptera - Rhagionidae	*Chrysopilus asiliformis*	1	1	F2		1
	Chrysopilus cristatus	17	69	W3		1
	Rhagio scolopaceus	3	10	F2		1
Diptera - Scathophagidae	*Chaetosa punctipes*	4	5	W3		2
	Cleigastra apicalis	10	17	W3		2
	Cordilura ciliata	4	5	W3		2
	Cordilura pubera	1	2	W3		1
	Norellisoma spinimanum	2	4	F2		1
	Scathophaga furcata	2	2	F2		1

	Scathophaga inquinata	2	5	F2		1
	Scathophaga stercoraria	7	75	F2		1
	Scathophaga suilla	7	11	F2		1
	Trichopalpus fraternus	1	1	W3		2
Diptera - Sciomyzidae	*Antichaeta brevipennis*	1	2	W3	W314	16
	Elgiva cucularia	1	3	W3		2
	Elgiva solicita	13	37	W3		1
	Hydromya dorsalis	2	2	W2		1
	Ilione albiseta	1	1	W3		1
	Limnia paludicola	8	33	W3		1
	Limnia unguicornis	1	2	0		1
	Pherbellia albocostata	3	4	F3		1
	Pherbellia argyra	1	1	W3	W314	16
	Pherbellia cinerella	1	1	F2		1
	Pherbellia dubia	1	1	F3		1
	Pherbellia schoenherri	17	41	W3		2
	Pherbina coryleti	13	30	W2		1
	Psacadina verbekei	2	4	W3		4
	Pteromicra angustipennis	4	6	W3		2
	Sciomyza dryomyzina	2	2	W3		16
	Sciomyza simplex	1	1	W3		4
	Sepedon sphegea	6	8	W3		2
	Sepedon spinipes	5	19	W3	W314	2
	Tetanocera arrogans	7	10	W3	W314	2
	Tetanocera elata	9	13	F2		1
	Tetanocera ferruginea	2	2	W3		1
	Tetanocera fuscinervis	3	4	W3		2
	Trypetoptera punctulata	1	1	F2		1
Diptera - Sepsidae	*Nemopoda nitidula*	3	3	F2		1
	Saltella sphondylii	1	1	F2		1
	Sepsis cynipsea	3	6	0		1
	Sepsis flavimana	5	26	0		1
	Sepsis fulgens	6	13	0		1
	Sepsis punctum	6	15	0		1
	Sepsis violacea	2	2	0		1
	Themira annulipes	7	21	W3		1
	Themira biloba	1	16	W3		4
	Themira lucida	2	27	0		1
	Themira superba	1	2	0		2
Diptera - Stratiomyidae	*Beris morrisii*	1	1	F3		2
	Beris vallata	13	55	F2		1
	Chloromyia formosa	5	20	F2		1
	Nemotelus nigrinus	1	1	W3		2
	Nemotelus pantherinus	9	12	W3		2
	Odontomyia ornata	-	2	W3	W314	16
	Oplodontha viridula	4	5	W3	W314	2
	Oxycera nigricornis	1	1	W1		2
	Sargus iridatus	1	1	F2		1
Diptera - Syrphidae	*Anasimyia contracta*	3	5	W2		2
	Anasimyia lineata	1	1	W3		2
	Episyrphus balteatus	3	8	0		1
	Eristalis interruptus	1	1	W3		1
	Eristalis intricarius	1	1	W3		1
	Eristalis tenax	1	1	W3		1
	Eupeodes corollae	1	1	F1		1
	Helophilus pendulus	3	3	W3		1
	Helophilus trivittatus	-	1	0		2
	Melanostoma mellinum	7	15	0		1

	Neoascia tenur	20	118	W3		2
	Platycheirus albimanus	1	1	0		1
	Platycheirus angustatus	5	8	F2		1
	Platycheirus clypeatus	1	1	F2		1
	Platycheirus occultus	3	6	W3		2
	Syrphus ribesii	1	1	0		1
	Syrphus torvus	1	1	0		1
	Syrphus vitripennis	1	1	A1		1
	Tropidia scita	4	7	W3		2
Diptera - Tabanidae	*Chrysops relictus*	2	2	W3		1
	Chrysops viduatus	1	1	W3		2
	Haematopota pluvialis	19	65	W3		1
Diptera - Tephritidae	*Anomoia purmunda*	1	1	A1		2
	Philophylla caesio	1	1	F2		2
	Tephritis vespertina	1	1	F2		4
	Terellia tussilaginis	1	1	F1		1
	Trypeta zoe	2	2	F1		1
Diptera - Ulidiidae	*Melieria crassipennis*	8	16	W3		2
	Melieria omissa	1	2	W2		2

Group	*Species*	*No. samples*	*No. specimens*	*ISIS BAT code*	*ISIS SAT code*	*ISIS Rarity Score*
Hoppers	*Alnetoidea alneti*	1	1	A1		1
(Auchenorrhyncha)	*Aphrodes makarovi*	3	3	F2		1
	Aphrophora alni	3	4	0		1
	Aphrophora major	2	5	W3		4
	Athysanus argentarius	1	1	F2		2
	Cercopis vulnerata	1	1	F2		1
	Cicadella viridis	7	15	W3		1
	Cicadula flori	6	8	W3		4
	Cicadula frontalis	6	10	W3		1
	Cicadula persimilis	1	1	F2		1
	Cixius nervosus	4	6	0		1
	Conomelus anceps	6	16	W3		1
	Conosanus obsoletus	4	4	F2		1
	Delphax pulchellus	3	4	W3		1
	Erzaleus metrius	4	9	W2		2
	Eupteryx urticae	1	1	F2		1
	Florodelphax paryphasma	1	2	W3		4
	Javesella pellucida	4	4	F2		1
	Kelisia punctulum	1	1	W3		2
	Macrosteles viridigriseus	1	1	F2		1
	Megamelodes lequesnei	1	1	W3		4
	Megamelus notula	2	2	W3		1
	Megophthalmus scanicus	1	1	F2		1
	Neophilaenus lineatus	19	77	F2		1
	Paradelphacodes paludosa	1	1	W3	W312	4
	Paralimnus phragmitis	1	1	W3		4
	Philaenus spumarius	18	39	0		1
	Stenocranus major	1	1	W2		2
	Stroggylocephalus agrestis	1	1	W3		2

Group	Species	No. samples	No. specimens	ISIS BAT code	ISIS SAT code	ISIS Rarity Score
Spiders (Araneae)	*Agelena labyrinthica*	1	5	F2		1
	Anelosimus vittatus	3	3	A1		1
	Antistea elegans	1	1	W3		2
	Araneus diadematus	4	5	0		1
	Araneus quadratus	6	7	0		1
	Baryphyma pratense	2	2	W2		2
	Baryphyma trifrons	15	52	W3		2
	Bathyphantes approximatus	7	7	W3		2
	Bathyphantes gracilis	9	23	0		1
	Bathyphantes parvulus	1	1	F2		1
	Cheiracanthium erraticum	1	1	F2		1
	Clubiona lutescens	1	1	0		1
	Clubiona phragmitis	19	36	W3		2
	Clubiona reclusa	5	5	W3		1
	Clubiona stagnatilis	8	19	W3		1
	Clubiona subtilis	1	3	W3		2
	Dictyna arundinacea	3	6	F2		1
	Diplostyla concolor	2	2	0		1
	Donacochara speciosa	2	2	W3		4
	Enoplognatha ovata	2	3	F2		1
	Entelecara omissa	1	1	W3		4
	Erigone atra	8	11	0		1
	Gnathonarium dentatum	5	11	W3		1
	Gongylidiellum vivum	1	3	F2		1
	Gongylidium rufipes	1	1	F3		1
	Hypomma bituberculatum	14	37	W2		1
	Hypomma fulvum	4	6	W3		4
	Kaestneria dorsalis	1	2	F2		1
	Kaestneria pullata	3	7	W3		1
	Larinioides cornutus	18	39	W3		1
	Lepthyphantes ericaeus	2	2	F2		1
	Lepthyphantes pallidus	1	2	F2		2
	Lepthyphantes tenuis	22	75	0		1
	Linyphia hortensis	1	1	F3		1
	Linyphia triangularis	3	3	0		1
	Marpissa radiata	2	3	W3		4
	Metellina segmentata	5	9	0		1
	Micrargus herbigradus	1	1	F3		1
	Microlinyphia impigra	2	2	W3		2
	Neottiura bimaculata	2	2	0		1
	Neriene clathrata	1	1	F2		1
	Oedothorax agrestis	1	2	W3		2
	Oedothorax fuscus	2	2	0		1
	Oedothorax gibbosus	2	3	W3		1
	Oedothorax retusus	5	10	0		1
	Pachygnatha clercki	8	8	W3		1
	Pardosa amentata	3	5	W3		1
	Pardosa prativaga	4	6	F2		1
	Pardosa pullata	1	1	F2		1
	Pirata hygrophilus	3	3	W3		1
	Pirata piraticus	1	2	W3		2
	Pirata piscatorius	1	1	W3		2
	Pisaura mirabilis	6	7	F2		1
	Pocadicnemis juncea	2	2	F2		1

Spiders (cont.)	*Porrhomma pygmaeum*	3	3	0	1
	Rugathodes instabilis	1	1	W3	2
	Savignia frontata	2	3	F2	1
	Tetragnatha extensa	7	12	W3	1
	Tetragnatha montana	7	8	W3	2
	Theridion impressum	2	3	F2	2
	Theridion sisyphium	1	1	F2	1
	Tibellus maritimus	1	3	F2	2
	Walckenaeria unicornis	1	1	F2	1
	Walckenaeria vigilax	1	1	F2	2
	Xysticus kochi	10	18	F1	2
	Xysticus ulmi	2	3	W3	2
	Zora spinimana	1	1	0	1

Appendix 3: Scores for ISIS wetland broad assemblage types by compartment

W3 = permanent wet mire, W2 = mineral marsh & open water, W1 = flowing water; representation score = percentage of species that are characteristic of BAT; rarity score = average species rarity score for species characteristic of BAT.

Table includes all compartments sampled by Lott *et al.* (2010) for comparison. Compartments surveyed in 2012 are in bold type.

	W3		*W2*	*W1*
Compartment	*Representation (1-100)*	*Rarity score*	*Representation (1-100)*	
Barton Fen 1	57	254	25	3
Barton Fen 3	56	305	25	5
Buttle Marsh 1	**56**	**268**	**26**	**3**
Buttle Marsh 2	**52**	**229**	**26**	**2**
Buttle Marsh 4	**41**	**219**	**25**	**4**
Catfield Fen (BC) 1	63	341	18	4
Catfield Fen (BC) 2	66	337	17	2
Catfield Fen 3	57	291	21	4
Catfield Great Fen 1	63	300	17	7
Catfield Great Fen 2	71	339	15	4
Common Fen	62	261	14	3
Decoy Carr	**42**	**239**	**17**	**8**
Ebb and Flow	56	286	21	5
Hassingham Fen 1	56	262	23	10
Hassingham Fen 2	52	238	28	4
Hickling Broad (Bygraves Marsh)	66	267	17	1
Hickling Broad 1	57	272	19	4
Hickling Broad 2 (Skoyles Marsh)	52	240	20	3
Hickling Broad 3 (Lings Mill)	62	237	20	3
Hickling Broad 4 (Lings Mill)	48	260	22	6
Hickling Broad 5 (Lings Mill)	64	230	16	3
Hickling Broad 6 (The Smea)	53	217	20	4
Horning Marsh Farm	60	305	17	5
How Hill (opposite bank)	58	259	27	1
Hulver Ground	49	211	23	4
Kings Fen	**40**	**222**	**19**	**7**
Kirby Marsh	41	229	20	8
Little Reedham	55	275	17	8
Meadow Dyke	62	300	20	2
Reedham Marsh	54	264	18	7
Rockland Island	54	211	14	11
Sharp Street	63	302	21	2
Snipe Marsh	53	232	19	4
South Fen north	**33**	**158**	**23**	**4**
South Fen south	**46**	**230**	**17**	**3**
Stalham Fen	43	215	20	7
Strumpshaw Fen 1	58	274	21	6
Strumpshaw Fen 2	54	259	23	3

Surlingham Church Marsh	50	232	15	10
Surlingham Broad	40	233	20	14
Surlingham Marsh	53	218	9	10
Sutton Fen	61	302	15	6
Turf Fen	63	323	21	4
Upton Fen	55	263	11	9
Whitlingham Marsh 12	**49**	**235**	**16**	**6**
Whitlingham Marsh 15	**46**	**242**	**17**	**7**
Whitlingham Marsh 16	**48**	**258**	**15**	**6**
Woodbastwick Fen 1	61	223	20	2
Woodbastwick Fen 2	60	254	19	3
Woodbastwick Fen 3	62	277	18	3

Appendix 4: Species numbers for ISIS specific assemblage types by compartment

W314 = reed-fen and pools, W313 = moss & tussock fen, W312 = Sphagnum bog, W221 = undisturbed fluctuating marsh, W211 = open water on disturbed sediments, W126 = seepage.

Table includes all compartments sampled by Lott *et al.* (2010) for comparison. Compartments surveyed in 2012 are in bold type.

* indicates assemblages of national importance

Compartment	*W314*	*W313*	*W312*	*W221*	*W211*	*W126*
Barton Fen 1	12*	5*			3	
Barton Fen 3	13*	2	1	1		
Buttle Marsh 1	**15***	**10***	**1**		**3**	
Buttle Marsh 2	**17***	**10***	**1**	**1**	**2**	
Buttle Marsh 4	**11***	**5***		**1**	**2**	
Catfield Fen (BC) 1	22*	9*	1		1	
Catfield Fen (BC) 2	21*	17*				
Catfield Fen 3	13*	6*	1		2	
Catfield Great Fen 1	18*	8*		1		
Catfield Great Fen 2	16*	13*	1			
Common Fen	10*	7*			2	
Decoy Carr	**11***	**5***				**1**
Ebb and Flow	14*	4		1	1	
Hassingham Fen 1	11*	1				
Hassingham Fen 2	10*	1			1	
Hickling Broad (Bygraves Marsh)	8	2				
Hickling Broad 1	15*	4	1		1	
Hickling Broad 2 (Skoyles Marsh)	12*	4		2		
Hickling Broad 3 (Lings Mill)	10*	8*			2	
Hickling Broad 4 (Lings Mill)	21*	8*		1	3	
Hickling Broad 5 (Lings Mill)	12*	5*			1	
Hickling Broad 6 (The Smea)	9	5*			1	
Horning Marsh Farm	18*	4	1		1	1
How Hill (opposite bank)	14*	8*			1	
Hulver Ground	12*	6*			1	
Kings Fen	**10***	**4**	**1**		**2**	
Kirby Marsh	13*	2		1		1
Little Reedham	11*	5*	1			1
Meadow Dyke	14*	1			1	
Reedham Marsh	19*	2		1	1	
Rockland Island	7	4		2		
Sharp Street	13*	15*			1	
Snipe Marsh	16*	10*		1	2	
South Fen north	**6**	**2**	**1**		**2**	
South Fen south	**13***	**3**				
Stalham Fen	12*	5*	2		1	

Strumpshaw Fen 1	13*	5*	1	2		1
Strumpshaw Fen 2	14*	6*		2		
Surlingham Church Marsh	15*	3				2
Surlingham Broad	14*	1		3*		4
Surlingham Marsh	8	2				
Sutton Fen	19*	10*				
Turf Fen	17*	6*				
Upton Fen	13*	5*		1	1	1
Whitlingham Marsh 12	**15***	**2**	**1**			
Whitlingham Marsh 15	**11***	**3**			**1**	**1**
Whitlingham Marsh 16	**16***	**5***				
Woodbastwick Fen 1	9	11*		2		
Woodbastwick Fen 2	12*	8*		1		
Woodbastwick Fen 3	13*	7*	1		1	1