Jonathan Graham
2 Cross Road, Whittlesey
Peterborough PE7 1LX
E mail: jonathan.graham@ntlworld.com

Martin Hammond
44 Stoneyhurst Avenue, Acklam
Middlesbrough, Cleveland TS5 4RE
E mail : martinhamondecology@gmail.com

Investigating ditch biodiversity and management practises in the arable landscape of the Ouse Washes Landscape Partnership Area :

a survey of vegetation and aquatic Coleoptera

Final Report, Jonathan Graham & Martin Hammond (28 April 2015)

Executive Summary

A survey of drainage ditches within the Ouse Washes Landscape Partnership Scheme (LPS) area was undertaken in June - July 2013 and 2014. The study area comprises farmland surrounding but outside of the Ouse Washes Site of Special Scientific Interest/Special Area of Conservation and where biodiversity is poorly recorded. Ditch plants and aquatic Coleoptera were chosen as indicators of the conservation value of drains.

A total of 175 ditch sample points were surveyed within eight Internal Drainage Board (IDB) districts comprising Over & Willingham (15), Bluntisham (eight), Haddenham Level Commissioners (12), Sutton & Mepal (32), Manea & Welney (22), Upwell (11), Stoke Ferry (nine) and Littleport & Downham (66).

One hundred and twenty drain plants, 118 bank plants and 122 water beetle species were recorded. Amongst these were many species of conservation concern. Plants included one categorised as Endangered in England, five classed as Vulnerable and two as Near Threatened as well as three Nationally Scarce species. Water beetles included one categorised as Vulnerable, four listed as Near Threatened and 18 categorised as Nationally Scarce. Ditches in the study area are shown to provide an important habitat for several species of aquatic Coleoptera which have their British stronghold in the Fens such as *Agabus undulatus*, *Hydrochus crenatus*, *Berosus luridus*, *Oulimnius major* and *O. rivularis*.

Ouse Washes LPS area drains are also shown to be important for other noteworthy fauna including common amphibians (Common Frog, Common Toad, Smooth Newt), Odonata and BAP species including Water Vole and Spined Loach.

In contrast to the “drain” flora, the “bank” flora of ditches contained no noteworthy plant species and comprised rough grassland dominated by False-oat *Arrhenatherum elatius* (68% cover). However, these grass banks are likely to be of wider biodiversity value, particularly for farmland birds.

For both ditch plants and water beetles, conservation value appears to be influenced by drain width, successional stage and water clarity: ditches of high biodiversity value tended to be larger (between 3 and 7m wide) and in an early successional stage with open water and good light penetration. These factors appear to be linked to intensity of (IDB) management (regular weed clearance, mild scraping of the bed and maintenance of high summer water levels for agricultural irrigation purposes). Plants, in particular, are shown to be strongly associated with larger (between 3 and 7m wide) drains with high water clarity. However, further statistical analysis is needed to understand better the effects of these variables for both plants and beetles.

There is a good correlation between number of ditch plant quality indicator species and number of water beetle quality indicator species. However, it should be noted that some important water beetle species were recorded in ditches with poorer plant assemblages and 7% of drains of conservation importance qualified for aquatic Coleoptera alone.

Whilst the species-richness and quality of the wetland plant assemblage is evidently closely linked to management, water beetle communities are more likely to reflect the quality of vegetation structure. For open water species such as whirligigs, algivorous water beetles and

larger diving beetles, regular management will be important in maintaining varied and structurally-complex aquatic vegetation. Many other taxa are, however, associated with the edges of the channel and depend more on the maintenance of refugia amongst the emergent fringe.

Drains of botanical importance occur generally within all land-use types but drains which are important for both plants and water beetles are relatively scarce in areas dominated by cereal (mainly winter wheat) growing. Areas of grazed pasture support an important concentration of ditches important for water beetles alone, highlighting the importance of this habitat, which includes significant areas of recently-created grazing marsh at Purls Bridge and Lady Fen.

All eight surveyed IDB areas had drains of conservation importance but four districts (Haddenham, Over & Willingham, Manea & Welney and Sutton & Mepal) have a proportionally higher number of drains of conservation importance.

The Buglife “five metrics” methodology has been applied to the survey dataset as a whole as well as to individual IDB districts for plants. The Ouse Washes LPS area as a whole has a similar score to the Buglife England & Wales (2010) data in regard to mean species conservation status and mean habitat quality scores and scores marginally better than the internal drains of the Ouse Washes SSSI in regard to mean habitat quality score.

A number of recommendations are provided for future survey work, potential ecological improvement works and feed back of survey results to land managers.

1 Introduction

1.1 The Ouse Washes Landscape Partnership Scheme (LPS) covers an area of nearly 200 square kilometers comprising land within and up to approximately 1km outside of the Ouse Washes. The LPS is located within the Fens, a very important area for biodiversity with 13,474 species including 27% (305 species) of UK Biodiversity Action Plan (UKBAP) priority species.

1.2 The Ouse Washes is an approximately 2,500 ha wetland site, designated as a Site of Special Scientific Interest (SSSI), Special Area of Conservation (SAC), Special Protection Area (SPA) and Ramsar Site. Its biodiversity is well known as a result of many historic and recent surveys. The significance of this and other designated Fenland sites has recently been confirmed by the *Fens Biodiversity Audit* (Mossman *et al.* 2012) which highlighted sites such as Wicken Fen, Woodwalton Fen and the Ouse Washes as extreme hotspots of both biodiversity and recording effort. However, the *Audit* also emphasised that the value of the wider landscape, and farmland in particular, is poorly understood.

1.3 To address this concern, the LPS identified ditches as an iconic but under-recorded landscape feature of the Fens and commissioned a survey of drains in the farmland surrounding the Ouse Washes. Ditch plants and water beetles were chosen as indicator groups for ditches and the project was partly proposed to test the methodology for collecting this data and resolve any data handling issues. It was also proposed that the project will provide a better understanding of how management activity affects both plant and water beetle assemblages, in order to inform future management.

1.4 Vascular plants, bryophytes and macro-algae are of obvious importance in any assessment of wetland biodiversity because many species are sensitive to environmental conditions and the conservation status and distribution of individual species is well known. Moreover, plants also provide much of the habitat structure upon which fauna depends. In still and slow-moving waters, aquatic Coleoptera are by far the most speciose group of aquatic macro-invertebrates which can be sampled readily using a pond-net (Pond Conservation, 2003) making them particularly useful in ecological assessment.

1.5 Jonathan Graham (plants) and Martin Hammond (water beetles) were commissioned to undertake ditch surveys in June and July 2013 and 2014.

2 Methodology

2.1 General

2.1.1 A survey methodology was adopted that follows a combination of approaches taken by Common Standards Monitoring (CSM) guidelines for ditches (JNCC, 2005) and the "Buglife methodology" for the survey of grazing marshes (Palmer *et al*. 2013).

2.1.2 A list of ditches to be surveyed was compiled by the authors in consultation with Cliff Carson (Environmental Officer to the Middle Level Commissioners), David Jordon (Haddenham Level Drainage Commissioners), Andrew Newton (engineer to the Ely Group of drainage boards) as well as a great many IDB board members and individual land owners. A variety of different ditch types were selected including very large drains (such as the Forty Foot Drain, Well Creek and the Cut-off Channel), medium sized and highly managed IDB drains as well as smaller field drains, many of which were unmanaged or infrequently managed. In each district, ditches were selected to achieve a good geographical spread though in practice some clustering occurred because of access permissions, accessibility and time constraints. In addition, a good proportion of the eastern section of the Ouse Washes LPS area (Littleport & Downham district) included parts of the "fen islands" of Sutton, Witcham and Coveney which had few available ditches.

2.1.3 A total of 175 ditch sample points were surveyed in eight Internal drainage Board (IDB) districts, comprising Bluntisham district (eight), Sutton & Mepal district (32), Manea & Welney district (22) and Upwell district (11) within the Middle Level Commissioners area (north-west of the Ouse Washes) and Over and Willingham district (15), Haddenham Level Commissioners district (12), Stoke Ferry district (nine) and Littleport & Downham district (66) within the South Level area (south-east of the Ouse Washes).

2.1.4 Map 1 shows the general location of the 175 sample points in relation to the Ouse Washes and Ouse Washes LPS area. Appendix 1 lists individual details for sample points and maps showing the precise location of sample points are given in Appendix 2. The vast majority of sample points are situated within the Ouse Washes LPS area except for a small number of sample points within Manea & Welney district that are situated just outside of the LPS boundary. In addition, a single sample point (S13, Ouse Washes Counter drain) is within the designated Ouse Washes Special Area of Conservation (SAC).

2.1.5 Survey work was undertaken on the 25 - 27 June and 02 - 04, 09, 10 - 11 July 2013 and 25-27 June, 2-3, 15-16 July 2014 during fine weather. An 8-figure grid reference was obtained for each sample point using a hand-held GPS unit accurate to within five metres and then ten metres either side of this point (i.e. a 20m sample stretch) was surveyed using measured paces.

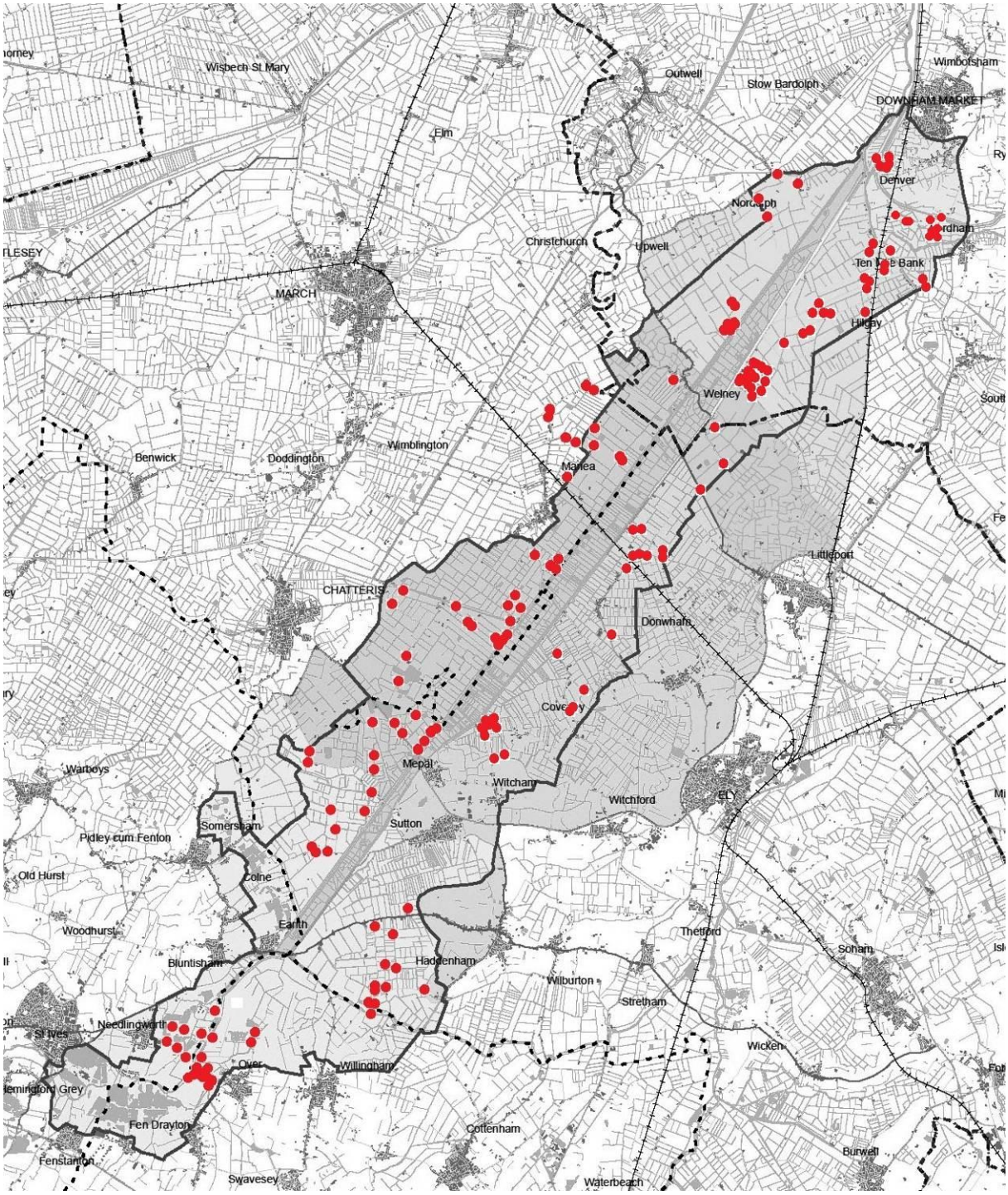
2.1.6 In addition to basic data recording such as date, grid reference etc., a number of other parameters were recorded including drain type, width of water in drain, water turbidity, angle of slope of bank, adjoining land use, presence or not of grazing, water depth and bed substrate. In addition, both water pH and conductivity were measured using a Hanna H1 9811-5 meter.

2.1.7 Successional stage (Early, Mid or Late) and management intensity (Low, Medium or High) was determined for each ditch sample based on percentage of emergent vegetation and open water, as well as discussion with IDB operators (for IDB drains) and individual farmers (for non IDB field drains). In practice, it was often impossible to establish precisely when any given drain was last managed.

2.1.8 In addition to plants and water beetles, other noteworthy species were recorded where appropriate, including UKBAP species such as Water Vole and Spined Loach.

2.1.9 Full field data for sample points has been digitised using the computer software Excel: a table with an extract is given for plants (Appendix 3) and aquatic Coleoptera (Appendix 4) to illustrate the format. Digital photographs for all sample points are provided in Appendix 5.

Map 1 General location of 175 ditch sample points in relation to the Ouse Washes and Ouse Washes Landscape Character area



▮ - Boundary of Ouse Washes Landscape Character area

● – Ditch sample points

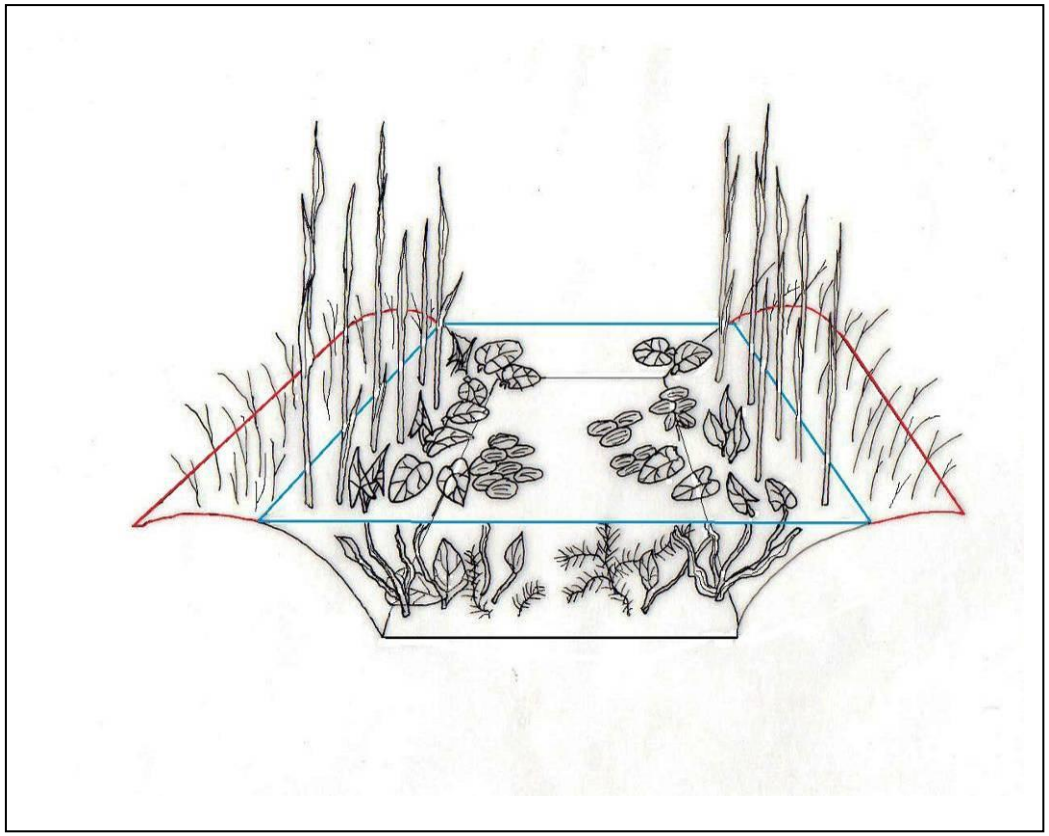
2.2 Methodology - plants

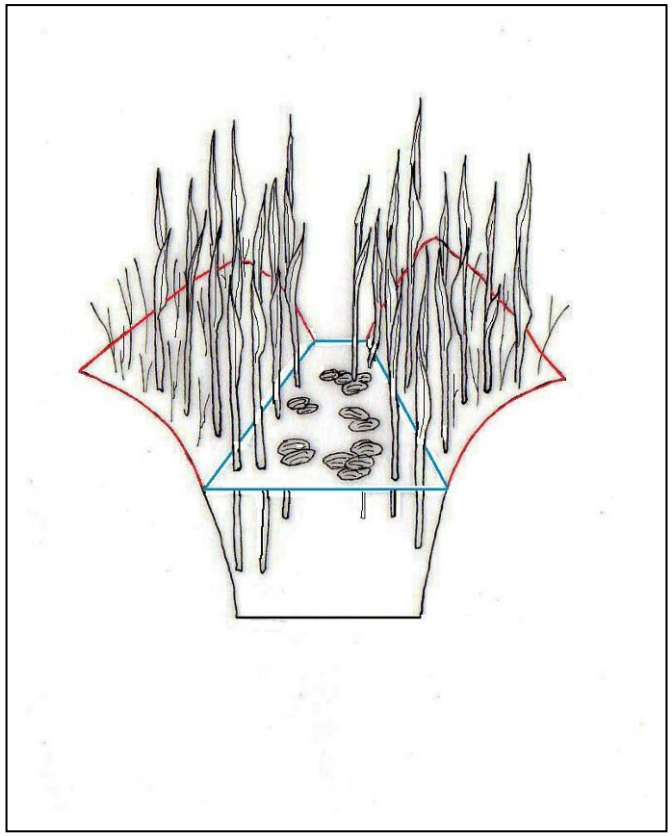
2.2.1 All macrophytes (including charophytes, bryophytes and macroscopic filamentous algae as well as vascular plants) were surveyed by sight and by use of a grapnel. Netting for water beetles also proved useful in locating some plants, especially floating liverworts. Percentage cover estimated for each species. Critical species (such as certain pondweed *Potamogeton* species, charophytes and filamentous algae) were collected and stored in small plastic bags before being checked later with a microscope.

2.2.2 Sampling plants in drainage channels and assessing cover levels can be difficult as aquatic plants occur in more than one stratum (i.e. submerged plants, plants with floating leaves and plants with emergent leaves). In addition, traditional terms for drain plants (such as emergent, submerged, floating or aquatic) can be misleading as drain plants are notoriously plastic and can sometimes fall within more than one of these categories. Consequently a simpler approach was adopted for fenland drain terminology following Redding (2013) with plants being recorded in two distinct categories. “Drain” species are defined as species occupying the water column or at its edge (such as traditionally-named emergents) whilst “bank” species are defined as species occurring above the water column (away from the water’s edge) up to the level top of the bank. The adoption of these two categories improved the collected data set by more consistently separating traditional “wetland and aquatic species” from “bank” species. This was particularly important for steep sided (60° angle) Fenland ditch banks which can have significant cover of some species (such as Common Reed *Phragmites australis* or Comfrey *Symphytum officinale*) above the water column and mixed with dry “bank” species such as False Oat-grass *Arrhenatherum elatius* and Charlock *Sinapis arvensis*. Figure 1 shows the distinction between the two recorded categories of “ditch“ and “bank” species for ditches with 45° and 60° angled banks.

A separate record was also made of percentage cover of floating plants (on the water’s surface) and bare substrate (of the drain bed) to resolve discrepancies for occasional drains that had 100% cover of floating plants and 100% bare substrate. Floating plants are defined as plants with the greater majority of leaves sitting on the water surface and include duckweeds (*Spirodela* and *Lemna* species with the exception of *L. trisulca*), Frogbit *Hydrocharis morsus-ranae*, Fringed Water-lily *Nymphoides peltata* and the liverworts *Ricciocarpos natans* and *Riccia fluitans*. Species with significant submerged leaves as well as floating leaves such as Yellow Water-lily *Nuphar lutea*, Broad-leaved Pondweed *Potamogeton natans* were not classed as floating plants (i.e. they contribute considerably to submerged plant cover).

Figure 1 Definition of “drain” and “bank” plants for a drain with a 45 degree angled bank (left) and for a drain with a 60 degree angled bank (right)





- “drain” plants

- “bank” plants

2.2.3 Care has been taken (based on a combination of local field experience and common sense) in recording casual species associated with the draw down zone of ditches with less than a 45 degree angled bank. For example, annuals such as Fat-hen *Chenopodium album*, Scentless Mayweed *Tripleurospermum inodorum* and Prickly Sow-thistle *Sonchus asper* were considered to be species more typical of the dry ditch banks and so have been included in the list of "bank" and not "drain" species.

2.2.4 Occasionally, young willows, other tree seedlings and planted trees occur on the banks of ditches. However, these species have only been recorded where they formed part of emergent vegetation on the slope but not the top of banks.

2.2.5 A number of critical plant taxa have been included in this survey. White-flowered *Nasturtium* (water-cress) species have only been recorded to species level where mature fruit was present (the character of flower size is considered unreliable in separating the two species, *Nasturtium officinale sensu stricto* and *N. microphyllum). Callitriche* (water-starwort) species have been named on the basis of microscopic examination of pollen (Lansdown, 2008) and/or the presence of semi-mature or mature fruits while a small number of infertile plants were recorded as the aggregate *Callitriche* sp. All records of Lesser Pondweed *Potamogeton pusillus*, Hair-like Pondweed *Potamogeton trichoides* and Small Pondweed *Potamogeton berchtoldii* are based on microscopic examination of stipules following Preston (1995).

2.3 Methodology - Coleoptera

2.3.1 Water beetles are not a unitary group of closely-related insects with a common evolutionary origin, but comprise members of diverse families which have adapted to life in water. For this reason there is no strict definition of what constitutes a water beetle. Therefore, the range of taxa recorded during this survey was extended beyond those listed in the brief to include reed beetles (members of the subfamily Donaciinae) and weevils (Erirhindae and Curculionidae) associated with submerged or emergent plants. This expanded set of taxa has been referred to collectively as "water beetles" or "aquatic Coleoptera" in this report. Including these additional taxa has added considerable value to the data, with several Nationally Scarce species recorded. Previous surveys have shown that some scarce weevils associated with water plants occur in ditches in the Cambridgeshire Fens including the Red List *Bagous tubulus* (Kirby & Lambert, 2003). Fortuitously, this survey coincided with the main adult emergence period for reed beetles and provided records of two species of conservation concern including the seriously declining *Donacia dentata*. Reed beetles and aquatic weevils are monphagous or oligophagous, feeding on specific host plants, so records correlate more directly with the botanical composition of the ditch flora than other water beetles which are predators or generalist scavengers/herbivores.

2.3.2 Sampling of water beetles took place within the same 20 metre transect used for plant recording. Sampling was exhaustive (rather than timed), continuing until no further species could be recognised in the net.

2.3.3 At each site, submerged and marginal vegetation was trawled vigorously using a standard long-handled pond net (as supplied by EFE Ltd) with a one mm mesh bag. Shallow-flooded marginal vegetation was trampled gently before netting. At suitable locations, submerged vegetation was gathered up using the net or a grapnel and left to drain in a tray. Whirligig beetles (*Gyrinus* species) swimming mid-channel presented a particular challenge in larger dykes but, with practice, a technique was developed for collecting these in a net attached to a cord. Binoculars were used to scan floating vegetation such as water-lilies in the middle of the channel for reed-beetles.

2.3.4 Water beetles were either identified in the field (for distinctive, widespread species) or preserved in tubes containing industrial de-natured alcohol. Beetles were usually obtained by emptying the contents of the net into a white polythene tray, but sometimes by picking them directly from the net bag. It was considered that bankside sorting was efficacious and preservation of bulk samples of invertebrates (as in Environment Agency biological monitoring) would probably result in relatively few additional records of water beetles but would greatly increase the time and cost of sorting in the laboratory.

2.3.5 Aquatic and emergent plants could be recorded by visual observation and use of a grapnel, allowing the vast majority of species present at each location to be recorded. By contrast, accessibility imposed considerable constraints on whether a representative water beetle list could be obtained for each site.

2.3.6 Some ditches allowed excellent access, especially shallow drains with gentle banks in cattle-grazed pasture as at RSPB Purls Bridge (M5 to M8), the Great Ouse floodplain near Over (O7 to O12) and WWT Lady Fen (LD48 to LD57). At these sites it was possible to wade the channel within the transect and obtain a representative sample of the beetles present. However, such ditches were a minority and, much more frequently, arable drains had very steep banks with little foothold at the base of the bank. Often there was then a vertical drop into deep water, so considerable caution was needed and sometimes samples could only be obtained from a few square metres of water margin.

2.3.7 At the time of the survey, many of the larger arable drains had raised water levels to facilitate irrigation. This enhanced recording of litter-layer species found amongst emergent vegetation at the edge of the channel (e.g. *Hydrochus*, *Cercyon*, *Berosus*, *Hydraena* and *Dryops* species) but in some cases it was impossible to net submerged in-channel vegetation effectively.

2.3.8 For these reasons, it would be misleading to claim that a comprehensive sample of aquatic Coleoptera was obtained at many locations and any interpretation of the data is subject to this caveat.

2.3.9 Larger diving beetles of the subfamily Dytiscinae are difficult to record in larger, deeper drains because they frequently evade hand-netting. Bottle-trapping is often much more efficacious in detecting these species. For this reason, 12 ditches were bottle-trapped in May 2014, separately from the main survey. The results have been reported in detail separately but the data has been incorporated into the findings presented in this report.

2.3.10 The netting of 'quadrats' (as outlined in the survey brief) proved difficult to apply given the enormous variability in accessibility. Instead, a protocol was adopted to sample each safely-accessible meso-habitat within the survey transect. Meso-habitats noted in Fenland drains include: submerged vascular vegetation; charophyte beds; algal mats; submerged hard surfaces (stones, timber or concrete posts and revetments); floating-leaved vegetation (e.g. lilies, Broad-leaved Pondweed stands, duckweed carpets); water within tall emergent vegetation and short/mixed emergent vegetation; flooded or saturated litter; submerged, shallow-flooded or wet moss; and exposed clay or silt just above and below the water line.

2.3.11 Agricultural drains in the Cambridgeshire Fens are generally difficult to access to sample aquatic invertebrates and pose significant safety hazards. In addition to the steepness of banks and sometimes precipitous drops into deep water below, bankside vegetation such as hemlock, nettles and brambles frequently makes sampling uncomfortable and difficult. Lone-working to sample aquatic invertebrates in these water bodies is intrinsically hazardous and cannot be recommended.

2.3.12 It is difficult to recommend an optimal seasonal period for recording water beetles in Fenland drains. In semi-natural fens with seasonal pool systems, late March to early May is the prime time as this coincides with the peak period of adult activity. In permanent, still or slow-moving water, late spring/early summer is generally considered to be the optimal period since water beetles are difficult to find in these habitats before vegetation has emerged: hence the Buglife methodology for ditch surveys advises that sampling "should start in the last week in April and ideally be completed by early June" (Palmer *et al*, 2013).

2.3.13 Whilst our surveys were conducted slightly later in the summer (late June – early July), a wide range of species was recorded including nearly all the water beetles detected in other surveys of farmland drains in Cambridgeshire (e.g. Kirby & Lambert, 2003; Drake, 2004). The bottle-trapping exercise in early May 2014 did produce more species at several sites and the Nationally Scarce burrowing water beetle *Noterus crassicornis* was detected more frequently than in the summer surveys but, overall, there was little indication of any marked seasonal bias. Moreover, for practical and safety reasons, we

needed to time our fieldwork to allow botanical and invertebrate surveys to be conducted on a single visit to each site.

Martin Hammond sampling a steep-sided IDB drain (M19, Manea & Welney district)

Results

3.1 Plants

3.1.1 One hundred and twenty drain plants and 118 bank plants have been recorded and these are listed in Tables 1 and 2 along with their conservation status in England as listed in *A Vascular Plant Red List for England* (Stroh *et al*, 2014). Nationally Scarce species (Leach & Rusbridge, 2006) are additionally highlighted along with GB status for stoneworts (Stewart, 2013) and UK BAP status. Taxa listed as 'Least Concern' are those that do not qualify as Critically Endangered, Endangered, Vulnerable or Near Threatened but this does not necessarily mean that they are widespread or common.

Table 1: Drain plant species recorded from sample points

SPECIES	English name	Status in England
Chlorophyta	Green algae	
Chara hispida var. *hispida*	Bristly Stonewort	Least Concern
Chara vulgaris	Common Stonewort	Least Concern
Cladophora	A macro green alga	n/a
Hydrodictyon reticulatum	Water Net	n/a
Tolypella glomerata	Clustered Stonewort	Nationally Scarce
Ulva flexuosus	A macro green alga	n/a
Xanthophyta	Yellow-green algae	
Vaucheria	A macro yellow-green alga	n/a
Bryophyta	Mosses, liverworts & hornworts	
Drepanocladus aduncus	Knieff's Hook-moss	Least Concern
Fontinalis antipyretica	Greater Water-moss	Least Concern
Oxyrrhynchium speciosum	Showy Feather-moss	Least Concern
Pellia sp. (non fertle plants)	*Pellia* species	Least Concern
Riccia fluitans	Floating Crystalwort	Least Concern
Ricciocarpos natans	Fringed Heartwort	Nationally Scarce
Calamophytes	Horsetails	
Equisetum arvense	Field Horestail	Least Concern
Angiosperms	Flowering plants	
Agrostis stolonifera	Creeping Bent	Least Concern
Alisma lanceolatum	Narrow-leaved Water-plantain	Least Concern
Alisma plantago-aquatica	Water-plantain	Least Concern
Alopecurus aequalis	Orange Foxtail	Least Concern
Alopecurus geniculatus	Marsh Foxtail	Least Concern
Angelica sylvestris	Wild Angelica	Least Concern
Apium nodiflorum	Fool's Watercress	Least Concern
Berula erecta	Lesser Water-parsnip	Least Concern
Bidens tripartita	Trifid Bur-marigold	Least Concern
Bolboschoenus maritimus	Sea Club-rush	Least Concern
Butomus umbellatus	Flowering Rush	Least Concern
Callitriche obtusangula	Blunt-fruited Water-starwort	Least Concern
Callitriche platycarpa	Various-leaved Water-starwort	Least Concern
Calystegia sepium	Hedge Bindweed	Least Concern
Cardamine pratensis	Cuckoo Flower	Least Concern

Carex acuta	Slender Tufted-sedge	Least Concern
Carex acutiformis	Lesser Pond-sedge	Least Concern
Carex disticha	Brown Sedege	Least Concern
Carex otrubae	False Fox-sedge	Least Concern
Carex riparia	Greater Pond-sedge	Least Concern
Ceratophyllum demersum	Ridged Hornwort	Least Concern
Crassula helmsii	New Zealand Pigmyweed	Non- native
Deschampsia cespitosa	Tufted Hair-grass	Least Concern
Eleocharis acicularis	Needle Spike-rush	Near Threatened
Eleocharis palustris	Common Spike-rush	Least Concern
Elodea canadensis	Canadian Waterweed	Non- native
Elodea nuttallii	Nuttall's Waterweed	Non- native
Epilobium hirsutum	Great Willowherb	Least Concern
Epilobium parviflorum	Hoary Willowherb	Least Concern
Epilobium tetragonum	Square-stalked Willowherb	Least Concern
Eupatorium cannabinum	Hemp-agrimony	Least Concern
Galium palustre ssp. elongatum	Common MarshBedstraw	Least Concern
Glyceria fluitans	Floating Sweet-grass	Least Concern
Glyceria maxima	Reed Sweet-grass	Least Concern
Hippuris vulgaris	Mare's-tail	Least Concern
Hottonia palustris	Water Violet	Vulnerable
Hydrocharis morsus-ranae	Frogbit	Vulnerable
Iris pseudacorus	Yellow Iris	Least Concern
Juncus articulatus	Jointed Rush	Least Concern
Juncus bufonius	Toad Rush	Least Concern
Juncus compressus	Round-fruited Rush	Vulnerable UKBAP
Juncus effusus	Soft Rush	Least Concern
Juncus inflexus	Hard Rush	Least Concern
Juncus subnodulosus	Blunt-flowered Rush	Least Concern
Lemna gibba	Fat Duckweed	Least Concern
Lemna minor	Common Duckweed	Least Concern
Lemna minuta	Least Duckweed	Invasive non-native
Lemna triscula	Ivy-leaved Duckweed	Least Concern
Lycopus europaeus	Gypsywort	Least Concern
Lysimachia nummularia	Creeping Jenny	Least Concern
Lythrum salicaria	Purple Loosestrife	Least Concern
Mentha aquatica	Water Mint	Least Concern
Myosotis scorpioides	Water Forget-me-not	Least Concern
Myriophyllum spicatum	Spiked Water-milfoil	Least Concern
Myriophyllum verticillatum	Whorled Water-milfoil	Near Threatened
Nasturtium microphyllum	Narrow-fruited Water-cress	Least Concern
Nasturtium officinale	Water-cress	Least Concern
Nuphar lutea	Yellow Water-lily	Least Concern
Nymphoides peltata	Fringed Water-lily	Least Concern (Nationally Scarce)
Oenanthe aquatica	Fine-leaved Water-dropwort	Least Concern
Oenanthe fistulosa	Tubular Water-dropwort	Vulnerable UKBAP Priority

		Species
Oenanthe fluviatilis	River Water-dropwort	Least Concern
Persicaria amphibia	Amphibious Bistort	Least Concern
Persicaria hydropiper	Water Pepper	Least Concern
Phalaris arundinacea	Reed Canary-grass	Least Concern
Phragmites australis	Common Reed	Least Concern
Potamogeton berchtoldii	Small Pondweed	Least Concern
Potamogeton crispus	Curled Pondweed	Least Concern
Potamogeton friesii	Flat-stalked Pondweed	Vulnerable (Nationally Scarce)
Potamogeton lucens	Shining Pondweed	Least Concern
Potamogeton natans	Broad-leaved Pondweed	Least Concern
Potamogeton pectinatus	Fennel Pondweed	Least Concern
Potamogeton perfoliatus	Perfoliate Pondweed	Least Concern
Potamogeton praelongus	Long-stalked Pondweed	Endangered
Potamogeton pusillus	Lesser Pondweed	Least Concern
Potamogeton trichoides	Hair-like Pondweed	Least Concern
Potamogeton x *salicifolius*	A hybrid pondweed	Local[1]
Ranunculus circinatus	Fan-leaved Water-crowfoot	Least Concern
Ranunculus repens	Creeping Buttercup	Least Concern
Ranunculus sceleratus	Celery-leaved Buttercup	Least Concern
Ranunculus trichophyllus	Thread-leaved Water-crowfoot	Least Concern
Rorippa amphibia	Great Yellow-cress	Least Concern
Rorippa palustris	Marsh Yellow-cress	Least Concern
Rorippa sylvestris	Creeping Yellow-cress	Least Concern
Rumex conglomeratus	Clustered Dock	Least Concern
Rumex hydrolapathum	Water Dock	Least Concern
Sagittaria sagittifolia	Arrowhead	Least Concern
Samolus valerandi	Brookweed	Least Concern
Schoenoplectus lacustris	Common Club-rush	Least Concern
Schoenoplectus tabernaemontani	Grey Club-rush	Least Concern
Scrophularuia auriculata	Water Figwort	Least Concern
Senecio aquaticus	Marsh Ragwort	Least Concern
Solanum dulcamara	Woody Nightshade	Least Concern
Sparganium emersum	Unbranched Bur-reed	Least Concern
Sparganium erectum	Branched Bur-reed	Least Concern
Spirodela polyrhiza	Greater Duckweed	Least Concern
Stachys palustris	Marsh Woundwort	Least Concern
Symphytum officinale	Comfrey	Least Concern
Thalictrum flavum	Common Meadow-rue	Least Concern
Typha angustifolia	Lesser Reedmace	Least Concern
Typha latifolia	Greater Reedmace	Least Concern
Utricularia vulgaris	Greater Bladderwort	Least Concern
Veronica anagallis-aquatica	Blue Water-speedwell	Least Concern
Veronica beccabunga	Brooklime	Least Concern
Veronica catenata	Pink Water-speedwell	Least Concern
Zannichellia palustris	Horned Pondweed	Least Concern

[1] This species is not included in Cheffings & Farrell 2005 but is considered a local species within a Cambridgeshire context.

Table 2: Bank plant species recorded from sample points		
SPECIES	**English name**	**Status in England**
Calamophytes	Horsetails	
Equisetum arvense	Field Horestail	Least Concern
Angiosperms	Flowering plants	Least Concern
Acer campestre	Field Maple	Least Concern
Acer pseudoplatanus (seedling)	Sycamore	Least Concern
Aegopodium podagraria	Ground Elder	Least Concern
Agrostis stolonifera	Creeping Bent	Least Concern
Allium vineale	Crow Garlic	Least Concern
Alopecurus geniculatus	Marsh Foxtail	Least Concern
Alopecurus pratensis	Meadow Foxtail	Least Concern
Anisantha steralis	Barren Brome	Least Concern
Anthriscus sylvestris	Cow Parsley	Least Concern
Arctium minus	Lesser Burdock	Least Concern
Arrhenatherum elatius	False-oat Grass	Least Concern
Artemisia vulgaris	Mugwort	Least Concern
Atriplex prostrata	Spear-leaved Orache	Least Concern
Ballota nigra ssp. meridionalis	Black Horehound	Least Concern
Barbarea vulgaris	CommonWintercress	Least Concern
Bidens tripartite	Trifid Bur-marigold	Least Concern
Bromus hordeaceous ssp. hordeaceus	Soft Brome	Least Concern
Bryonia dioica	White Bryony	Least Concern
Calamagrostis epigejos	Wood Small-reed	Least Concern
Calystegia sepium	Hedge Bindweed	Least Concern
Capsella bursa-pastoris	Shepherd's-purse	Least Concern
Carduus crispus	Welted Thistle	Least Concern
Carex hirta	Hairy Sedge	Least Concern
Catopodium rigidum	Fern-grass	Least Concern
Centaurea nigra	Common Knapweed	Least Concern
Chamerion angustifolium	Rosebay Willowherb	Least Concern
Chenopodium album	Fat-hen	Least Concern
Chenopodium ficifolium	Fig-leaved Goosefoot	Least Concern
Chenopodium polyspermum	Many-seeded Goosefoot	Least Concern
Cirsium arvense	Creeping Thistle	Least Concern
Cirsium vulgare	Spear Thistle	Least Concern
Conium maculatum	Hemlock	Least Concern
Convolvulus arvensis	Field Bindweed	Least Concern
Crataegus monogyna	Hawthorn	Least Concern
Crepis capillaries	Smooth Hawk's-beard	Least Concern
Cynosurus cristatus	Crested Dog's-tail	Least Concern
Dactylis glomerata	Cock's-foot	Least Concern
Deschampsia cespitosa	Tufted Hair-grass	Least Concern
Dipsacus fullanum	Teasel	Least Concern
Elytrigia repens	Couch	Least Concern
Epilobium hirsutum	Great Willowherb	Least Concern
Festuca rubra	Red Fescue	Least Concern
Filipendula ulmaria	Meadowsweet	Least Concern

Fraxinus excelsior	Ash	Least Concern
Galeopsis tetrahit	Common Hemp-nettle	Least Concern
Galium aparine	Cleavers	Least Concern
Geranium dissectum	Cut-leaved Crane's-bill	Least Concern
Glechoma hederacea	Ground Ivy	Least Concern
Helminthotheca echioides	Bristly Oxtoungue	Least Concern
Heraclium sphondylium	Hogweed	Least Concern
Holcus lanatus	Yorkshire Fog	Least Concern
Hordeum secalinum	Meadow Barley	Least Concern
Hypericum hirsutum	Hairy St John's-wort	Least Concern
Hypericum perforatum	Perforate St John's-wort	Least Concern
Hypochaeris radicata	Cat's-ear	Least Concern
Lactuca serriola	Prickly Lettuce	Least Concern
Lactuca virosa	Great Lettuce	Least Concern
Lamium album	White Dead-nettle	Least Concern
Lapsana communis	Nipplewort	Least Concern
Lepidium coronopus	Swinecress	Least Concern
Lepidium draba	Hoary Cress	Least Concern
Leucanthemum vulgare	Ox-eye Daisy	Least Concern
Linaria vulgaris	Common Toadflax	Least Concern
Linum usitatissimum	Flax	Least Concern
Lolium perenne	Perennial Rye-grass	Least Concern
Malva sylvestris	Common Mallow	Least Concern
Medicago lupulina	Black Meddick	Least Concern
Myosoton aquaticum	Water Chickweed	Least Concern
Papaver rhoeas	Field Poppy	Least Concern
Persicaria amphibia	Amphibious Bistort	Least Concern
Phalaris arundinacea	Reed Canary-grass	Least Concern
Phleum bertolonii	Small Timothy	Least Concern
Phleum pratense	Timothy	Least Concern
Phragmites australis	Common Reed	Least Concern
Plantago lanceolata	Ribwort Plantain	Least Concern
Plantago major ssp. intermedia	Greater Plantain	Least Concern
Poa trivialis	Rough Meadow-grass	Least Concern
Polygonum aviculare	Knotgrass	Least Concern
Polypogon monspeliensis	Annual Beard-grass	Least Concern
Potentilla anserina	Silverweed	Least Concern
Potentilla reptans	Creeping Cinquefoil	Least Concern
Prunella vulgaris	Self Heal	Least Concern
Prunus spinosa	Blackthorn	Least Concern
Pulicaria dysenterica	Common Fleabane	Least Concern
Ranunculus acris	Meadow Buttercup	Least Concern
Ranunculus repens	Creeping Buttercup	Least Concern
Rosa canina agg.	Dog Roses	Least Concern
Rubus fruticosus agg.	Brambles	Least Concern
Rumex acetosella	Sheep's Sorrel	Least Concern
Rumex conglomeratus	Clustered Dock	Least Concern
Rumex crispus	Curled Dock	Least Concern
Rumex obtusifolius	Broad-leaved Dock	Least Concern
Salix cinerea ssp. cinerea	Grey Sallow	Least Concern

Salix fragilis	Crack Willow	Least Concern
Sambucus nigra	Elder	Least Concern
Schedonorus arundinaceus	Tall Fescue	Least Concern
Schedonorus pratensis	Meadow Fescue	Least Concern
Senecio erucifolius	Hoary Ragwort	Least Concern
Senecio jacobaea	Common Ragwort	Least Concern
Silene latifolia	White Campion	Least Concern
Sinapis arvensis	Charlock	Least Concern
Sison amomum	Stone Parsely	Least Concern
Sisymbrium officinale	Comfrey	Least Concern
Solanum dulcamara	Woody Nightshade	Least Concern
Sonchus arvensis	Perennial Sowthistle	Least Concern
Sonchus asper	Prickly Sowthistle	Least Concern
Taraxacum sp.	Dandelion	Least Concern
Torilis japonica	Upright Hedge-parsley	Least Concern
Torilis nodosa	Knotted Hedge-parsley	Least Concern
Tragopogon pratensis	Goat's-beard	Least Concern
Trifolium dubium	Lesser Trefoil	Least Concern
Trifolium repens	White Clover	Least Concern
Tussilago farfara	Colt's-foot	Least Concern
Ulmus sp.	Elm	Least Concern
Urtica dioica	Stinging Nettle	Least Concern
Vicia sativa ssp. *segetalis*	Common Vetch	Least Concern
Vicia tetrasperma	Smooth Tare	Least Concern
Vulpia myorus	Rat's-tail Fescue	Least Concern

3.1.2 Figures 2 and 3 show occurrence of both "drain" and "bank" plant species within the 175 ditch sample points and Figures 4 and 5 show percentage cover of both "drain" and "bank" plant species within the 175 ditch sample points.

3.1.3 The "drain" flora is dominated by Common Reed *Phragmites australis* (12% cover), Blunt-fruited Water-starwort *Callitriche obtusangula* (11%) and Fat Duckweed *Lemna gibba* (4%). Other prominent species (1-3% cover) include Common Duckweed *Lemna minor*, Broad-leaved Pondweed *Potamogeton natans*, Fennel Pondweed *Potamogeton pectinatus*, Shining Pondweed *Potamogeton lucens* and the macro alga *Cladophora.* Bare substrate on the bed of ditches is also very significant (85%).

3.1.4 The majority of "drain" species (93%) occur in small quantity by area (<1% cover) but many of these are of frequent occurrence in the ditches surveyed. These include species such as Common Water-plantain *Alisma plantago-aquaticum* (present at 26% of sample points), Reed Sweet-grass *Glyceria maxima* (22%), Curled Pondweed *Potamogeton crispus* (16%), Arrowhead *Sagittaria sagittifolia* (12%) and Floating Crystalwort *Riccia fluitans* (11%). In addition, Branched Bur-reed *Sparganium erectum* occurred in 16% of sample points but only had a total cover of between 1-3%.

3.1.5 In contrast to 'drain' species, 'bank' plants which were frequent also tended to be abundant. Most notably, False Oat-grass *Arrhenatherum elatius* was not only the most ubiquitous species but also averaged 68% cover. Common Reed *Phragmites australis* is abundant (28% cover) along with three species at 8-11% cover (Creeping Bent *Agrostis stolonifera*, Couch *Elytrigia repens*, Nettle *Urtica dioica),* two species at 3-5% cover (Yorkshire Fog *Holcus lanatus*, Perennial Rye-grass *Lolium perenne*) along with six species at 1-3% cover (Cleavers *Galium aparine*, Hedge Bindweed *Calystegia sepium*, Cock's-foot *Dactylis glomerata*, Rough Meadow-grass *Poa trivialis*, Charlock *Sinapis arvensis*, Bramble *Rubus fruticosus* agg.) as well as a great many annuals (such as Field Poppy *Papaver rhoeas*, Prickly Sowthistle *Sonchus asper*, White Campion *Silene latifolia*.)

3.1.6 Non-native "drain" species were not widespread within the Ouse Washes LPS area. Nuttall's Waterweed *Elodea nuttalli* was most frequent, being found in 22% of sample points, varying by district from 9% in Manea & Welney district to 33% in Haddenham and 47% in Over & Willingham.

3.1.7 The high occurrence of *E. nuttalli* within both Haddenham and Over & Willingham districts likely relates to the hydrological connectivity with the River Great Ouse which has a high trophic status. Canadian Waterweed *Elodea canadensis* was considerably less frequent (6% of sample points in Sutton & Mepal district, 11% for Stoke Ferry, 16% for Haddenham) and a single submerged plant of New Zealand Pigmyweed *Crassula helmsii* was found in a single sample point within Sutton & Mepal district (S21).

3.1.8 Our observations suggest that the presence of *Elodea* species is not detrimental to native plant diversity in the study area, and the drains were remarkably free of aggressively invasive aliens such as Himalayan Balsam *Impatiens glandulifera*, Japanese Knotweed *Fallopia japonica*, Floating Pennywort *Hydrocotyle ranunculoides* and Parrot's Feather *Myriophyllum aquaticum*. The alien duckweed *Lemna minuta*, an increasing species nationally, was recorded from seven sample points.

Figure 2 Occurrence of "drain" plant species within the 175 sample points

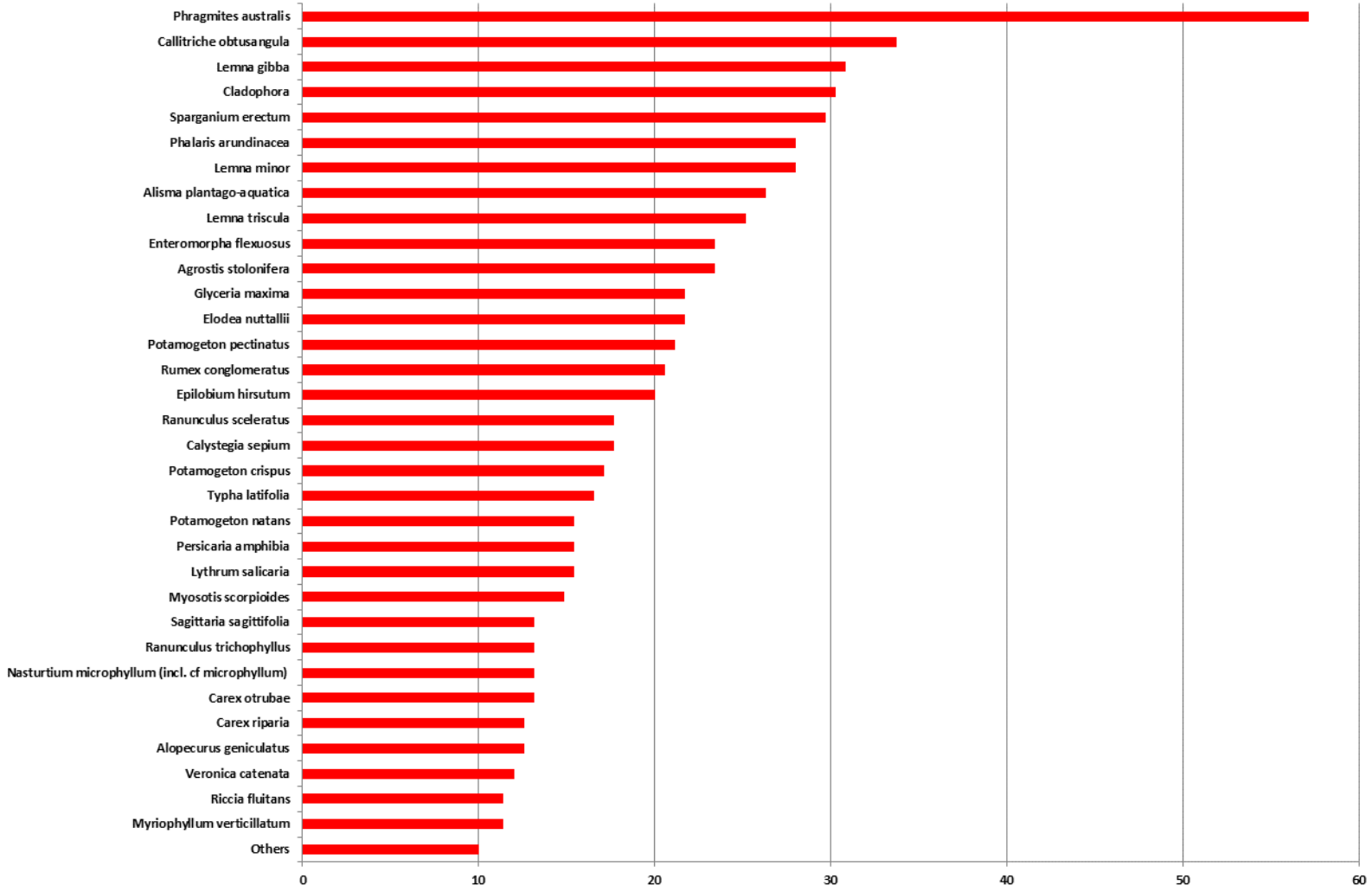


Figure 3 Occurrence of "bank" plant species within the 175 sample points

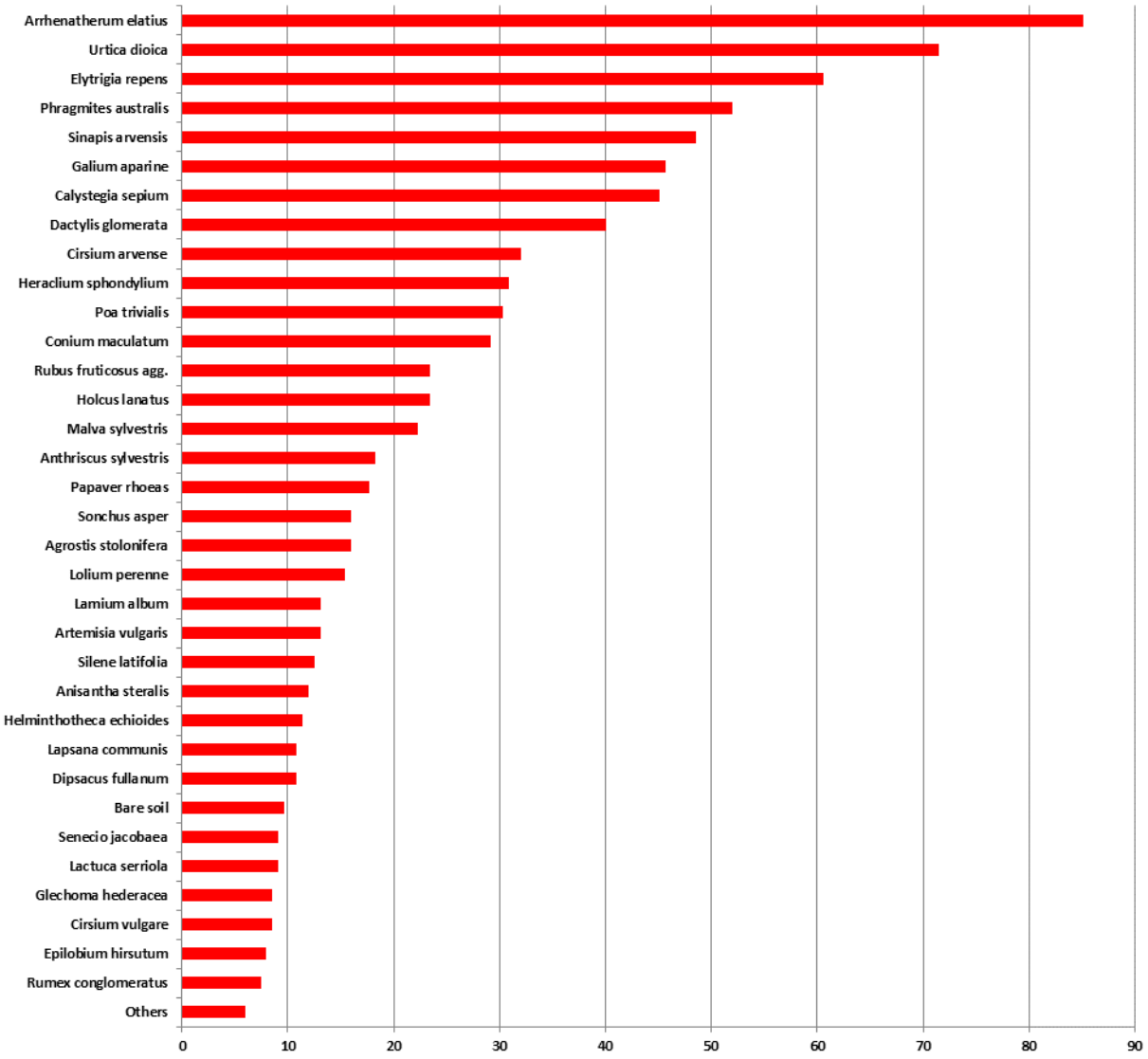


Figure 4 Occurrence of "drain" plant species by percentage cover

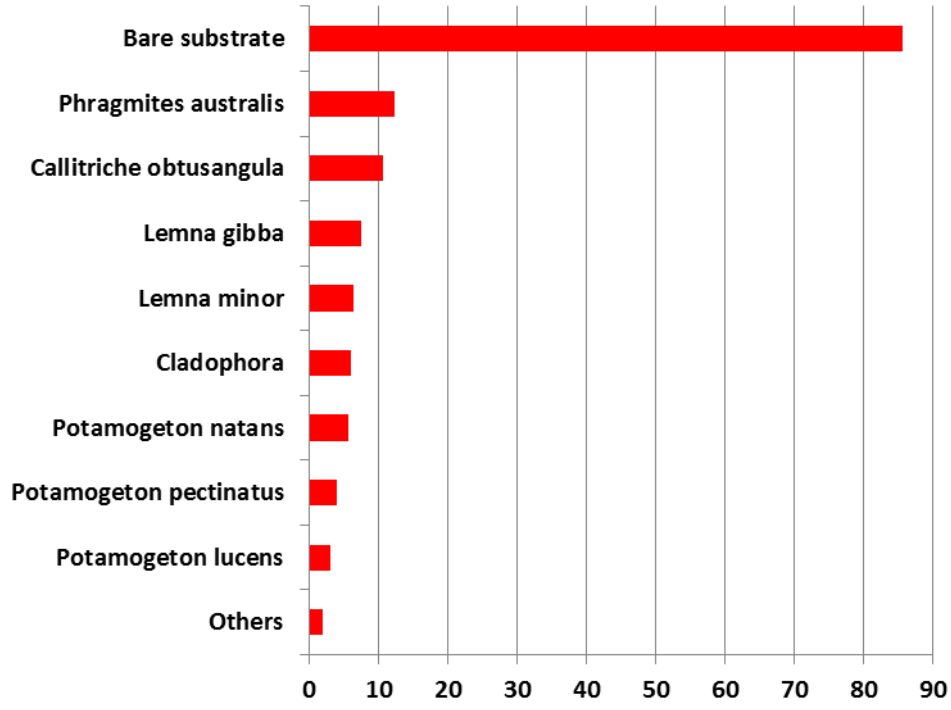
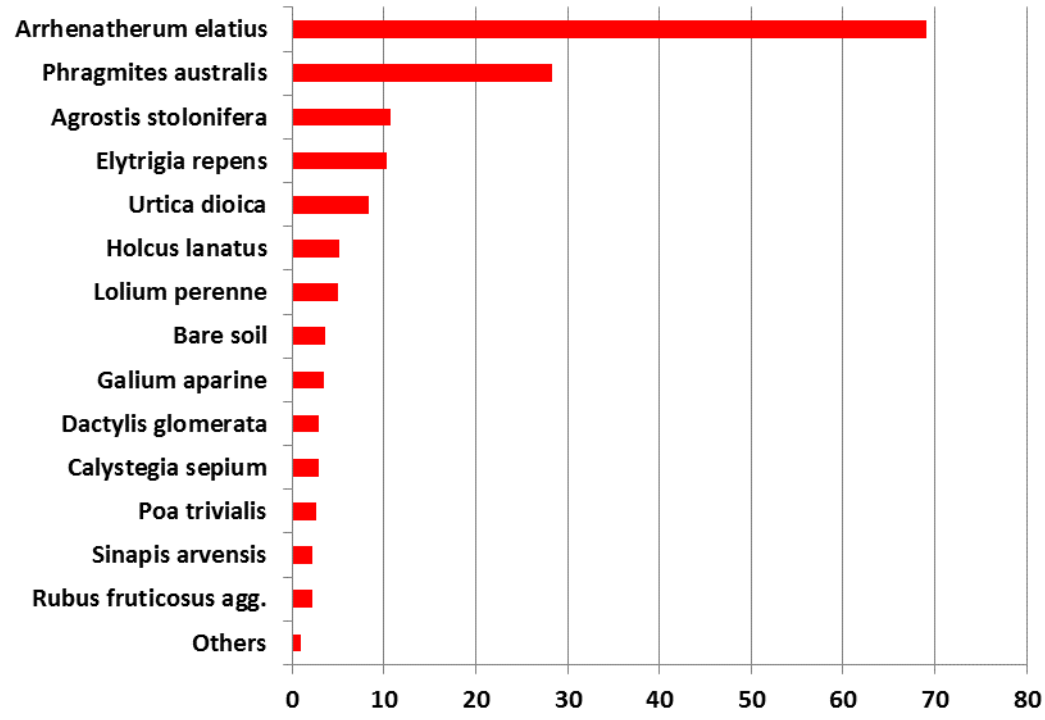


Figure 5 Occurrence of "bank" plant species by percentage cover



3.2 Aquatic Coleoptera

3.2.1 The survey produced 1,819 records of water beetles representing 122 species: a list of species in taxonomic order is provided in Table 3. One Vulnerable species, the reed-beetle *Donacia dentata* was recorded along with four species categorised as Near Threatened: the diving beetle *Agabus undulatus*, the great diving beetle *Dytiscus dimidiatus* and the scavenger water beetles *Hydrochus carinatus* and *Berosus luridus*.

3.2.2 Eighteen species recorded during the survey are currently categorised as Nationally Scarce[1]: the algivorous water beetles *Haliplus mucronatus* and *Peltodytes caesus*; the burrowing water beetle *Noterus crassicornis*; the diving beetles *Agabus conspersus*, *Rhantus frontalis*, *Hydaticus transversalis*, *Hygrotus parallelogrammus* and *Scarodytes halensis*; the scavenger water beetles *Enochrus quadripunctatus* and *Chaetarthria seminulum*; the riffle-beetles *Oulimnius major* and *O. rivularis*; the long-toed water beetle *Dryops similaris*; the reed-beetle *Donacia impressa*; the aquatic weevils *Eubrychius velutus*, *Bagous alismatis* and *Gymnetron villosulum*.

3.2.3 In 2013, 109 water beetle species were recorded from 100 sample sites. In 2014, a total of 97 species were detected: 85 during the main survey (of 75 sites) with an additional 12 during the bottle trapping survey (covering 12 sites). Thirteen species were found in 2014 which were not recorded the previous year, including five which are categorized as Nationally Scarce.

3.2.4 The Vulnerable *Donacia dentata* was recorded at one site in 2013. All four Near Threatened species were recorded in 2013 with three of these (*A. undulatus*, *H. carinatus* and *B. luridus*) found again in 2014. Thirteen Nationally Scarce species were recorded in 2013 with ten in the second year.

Table 3: Aquatic Coleoptera species recorded during the survey

SPECIES	**English name**	**GB status**[2]
GYRINIDAE	whirligig beetles	
Gyrinus marinus Gyllenhal, 1808		Widespread
Gyrinus substriatus Stephens, 1828	Common Whirligig	Widespread
HALIPLIDAE	algivorous water beetles	
Haliplus confinis Stephens, 1828		Widespread
Haliplus obliquus (Fabricius, 1787)		Widespread

[1] The conservation status of most water beetle families was reviewed by Foster (2010). The family Chrysomelidae, which includes the reed-beetles, has been reviewed by Hubble (2014). The most recent review including the aquatic weevil families was by Hyman & Parsons (1992).

[2] Species categorised as 'Local' are those listed as such in the ISIS table appended to the survey brief. For reed-beetles, marsh beetles and weevils, an informal assessment of status has been made for those species not listed by Hyman & Parsons (1992). The term 'widespread' has been used in preference to 'common' here because of the narrow definition of the 'Local' category in ISIS.

Haliplus fluviatilis Aubé, 1836		Widespread
Haliplus heydeni Wehncke, 1875		Local
Haliplus immaculatus Gerhardt, 1877		Widespread
Haliplus lineolatus Mannerheim, 1844		Widespread
Haliplus ruficollis (De Geer, 1774)		Widespread
Haliplus sibiricus Motschulsky, 1860		Widespread
Haliplus flavicollis Sturm, 1834		Widespread
Haliplus mucronatus Stephens, 1828		Nationally Scarce
Haliplus lineatocollis (Marsham, 1802)		Widespread
Peltodytes caesus (Duftschmid, 1805)		Nationally Scarce
NOTERIDAE	burrowing water beetles	
Noterus clavicornis (De Geer, 1774)		Widespread
Noterus crassicornis (O.F. Müller, 1776)		Nationally Scarce
HYGROBIIDAE	screech beetles	
Hygrobia hermanni (Fabricius, 1775)	Screech Beetle	Widespread
DYTISCIDAE	diving beetles	
Agabus sturmii (Gyllenhal, 1808)		Widespread
Agabus undulatus (Schrank, 1776)		Near Threatened
Agabus bipustulatus (Linnaeus, 1767)		Widespread
Agabus conspersus (Marsham, 1802)		Nationally Scarce
Agabus didymus (Olivier, 1795)		Widespread
Agabus nebulosus (Forster, 1771)		Widespread
Agabus paludosus (Fabricius, 1801)		Local
Ilybius ater (De Geer, 1774)		Widespread
Ilybius chalconatus (Panzer, 1796)		Local
Ilybius fuliginosus (Fabricius, 1792)		Widespread
Ilybius quadriguttatus (Lacordaire, 1835)		Widespread
Platambus maculatus (Linnaeus, 1758)		Widespread
Colymbetes fuscus (Linnaeus, 1758)		Widespread
Rhantus grapii (Gyllenhal, 1808)		Local
Rhantus exsoletus (Forster, 1771)		Widespread
Rhantus frontalis (Marsham, 1802)		Nationally Scarce
Rhantus suturalis (Macleay, 1825)		Local
Liopterus haemorrhoidalis (Fabricius, 1787)		Widespread
Dytiscus circumflexus Fabricius, 1801		Local
Dytiscus dimidiatus Bergsträsser, 1778		Near Threatened
Dytiscus marginalis Linnaeus, 1758	Great Diving Beetle	Widespread
Hydaticus transversalis (Pontoppidan, 1763)		Nationally Scarce
Hydroglyphus geminus (Fabricius, 1792)		Local
Graptodytes granularis (Linnaeus, 1767)		Local
Graptodytes pictus (Fabricius, 1787)		Widespread

Hydroporus angustatus Sturm, 1835		Widespread
Hydroporus discretus Fairmaire & Brisout de Barneville, 1859		Widespread
Hydroporus incognitus Sharp, 1869		Widespread
Hydroporus memnonius Nicolai, 1822		Widespread
Hydroporus palustris (Linnaeus, 1761)		Widespread
Hydroporus planus (Fabricius, 1782)		Widespread
Hydroporus pubescens (Gyllenhal, 1808)		Widespread
Hydroporus striola (Gyllenhal, 1826)		Widespread
Hydroporus tessellatus (Drapiez, 1819)		Widespread
Nebrioporus assimilis (Paykull, 1798)		Widespread
Nebrioporus elegans (Panzer, 1794)		Widespread
Porhydrus lineatus (Fabricius, 1775)		Widespread
Scarodytes halensis (Fabricius, 1787)		Nationally Scarce
Hygrotus inaequalis (Fabricius, 1777)		Widespread
Hygrotus versicolor (Schaller, 1783)		Widespread
Hygrotus impressopunctatus (Schaller, 1783)		Widespread
Hygrotus parallellogrammus (Ahrens, 1812)		Nationally Scarce
Hyphydrus ovatus (Linnaeus, 1761)		Widespread
Laccophilus hyalinus (De Geer, 1774)		Widespread
Laccophilus minutus (Linnaeus, 1758)		Widespread
HELOPHORIDAE		
Helophorus aequalis Thomson, 1868		Widespread
Helophorus brevipalpis Bedel		Widespread
Helophorus griseus Herbst, 1793		Local
Helophorus minutus Fabricius, 1775		Widespread
Helophorus obscurus Mulsant, 1844		Widespread
HYDROCHIDAE		
Hydrochus crenatus (Fabricius, 1792)		Near Threatened
HYDROPHILIDAE	scavenger water beetles	
Anacaena bipustulata (Marsham, 1802)		Local
Anacaena globulus (Paykull, 1798)		Widespread
Anacaena limbata (Fabricius, 1792)		Widespread
Anacaena lutescens (Stephens, 1829)		Widespread
Berosus affinis Brullé, 1835		Local
Berosus signaticollis (Charpentier, 1825)		Local
Berosus luridus (Linnaeus, 1761)		Near Threatened
Chaetarthria seminulum (Herbst, 1797)		Nationally Scarce
Cymbiodyta marginellus (Fabricius, 1792)		Widespread
Enochrus melanocephalus (Olivier, 1792)		Local
Enochrus quadripunctatus (Herbst, 1797)		Nationally Scarce
Enochrus testaceus (Fabricius, 1801)		Widespread
Helochares lividus (Forster, 1771)		Local

Hydrobius fuscipes (Linnaeus, 1758)		Widespread
Laccobius bipunctatus (Fabricius, 1775)		Widespread
Laccobius sinuatus Motschulsky, 1849		Local
Laccobius striatulus (Fabricius, 1801)		Widespread
Laccobius colon (Stephens, 1829)		Widespread
Laccobius minutus (Linnaeus, 1758)		Widespread
Cercyon convexiusculus Stephens, 1829		Local
Cercyon marinus Thomson, C.G., 1853		Widespread
Cercyon sternalis (Sharp, 1918)		Local
Cercyon tristis (Illiger, 1801)		Local
Cercyon ustulatus (Preyssler, 1790)		Local
HYDRAENIDAE	moss beetles	
Hydraena riparia Kugelann, 1794		Widespread
Hydraena testacea Curtis, 1830		Local
Limnebius nitidus (Marsham, 1802)		Local
Ochthebius bicolon Germar, 1824		Local
Ochthebius dilatatus Stephens, 1829		Widespread
Ochthebius minimus (Fabricius, 1792)		Widespread
DRYOPIDAE	long-toed water beetles	
Dryops luridus (Erichson, 1847)		Widespread
Dryops similaris Bollow, 1936		Nationally Scarce
ELMIDAE	riffle beetles	
Oulimnius major (Rey, 1889)		Nationally Scarce
Oulimnius rivularis (Rosenhauer, 1856)		Nationally Scarce
Oulimnius tuberculatus (Müller, P.W.J., 1806)		Widespread
SCIRTIDAE[3]	marsh beetles	
Contacyphon coarctatus Paykull, 1799		Local
Contacyphon laevipennis Tournier, 1868		Local
Contacyphon palustris Thomson, C.G., 1855		Local
Scirtes hemisphaericus (Linnaeus, 1758)		Local
CHRYSOMELIDAE: DONACIINAE	reed beetles	
Donacia clavipes Fabricius, 1792		Local
Donacia dentata Hoppe, 1795		Vulnerable
Donacia impressa Paykull, 1799		Nationally Scarce
Donacia semicuprea Panzer, 1796		Local
Donacia simplex Fabricius, 1775		Widespread
Donacia versicolorea (Brahm, 1791)		Local
Donacia vulgaris Zchach, 1788		Local
Plateumaris sericea Linnaeus, 1758		Widespread
ERIRHINIDAE	weevils	
Thryogenes festucae (Herbst, 1795)		Local
Thryogenes nereis (Paykull, 1800)		Local
Stenopelmus rufinasus Gyllenhal, 1836		Naturalised

[3] The genus name for all British species of *Cyphon* has recently changed to *Contacyphon* (see Zwick *et al*, 2013).

Tanysphyrus lemnae (Paykull, 1792)		Local
CURCULIONIDAE	weevils	
Gymnetron villosulum (Gyllenhal, 1838)		Nationally Scarce
Bagous alismatis (Marsham, 1802)		Nationally Scarce
Poophagus sisymbrii (Fabricius, 1777)		Widespread
Eubrychius velutus (Beck, 1817)		Nationally Scarce

3.2.5 Species recorded from at least a third of sample locations included the Common Whirligig (*Gyrinus substriatus*), the algivorous water beetle *Haliplus lineatocollis*, great diving beetle (*Dytiscus* sp.) larvae, the small diving beetles *Hydroporus palustris* and *Graptodytes pictus* and the scavenger water beetles *Helophorus minutus* and *Anacaena limbata*. Figure 6 shows the occurrence of aquatic Coleoptera within 175 sample points and Table 4 shows the occurrence of all species in descending order of frequency.

Figure 6 Occurrence of aquatic Coleoptera species within the 175 sample points

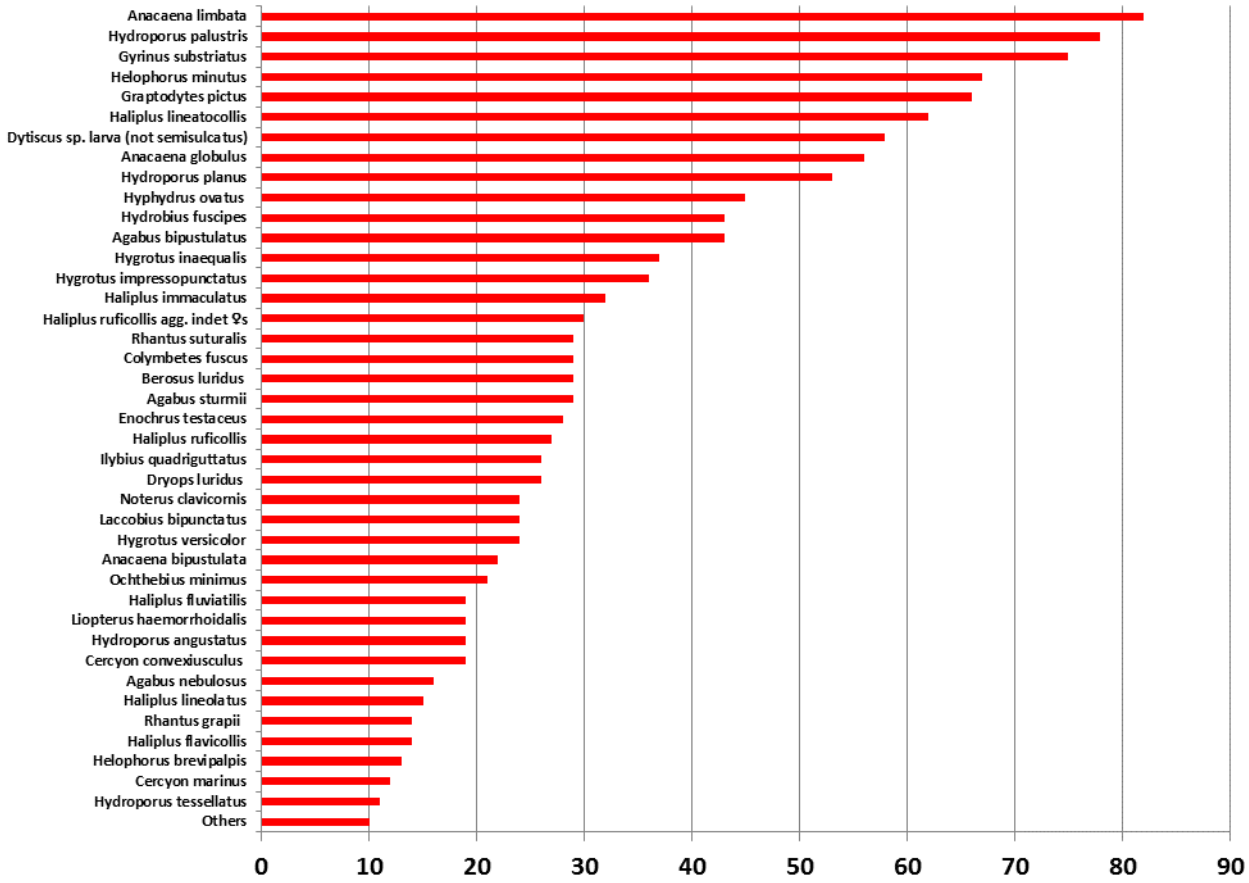


Table 4: Occurrence of aquatic Coleoptera in the 175 sample points					
Anacaena limbata	82	***Agabus conspersus***	8	*Ilybius chalconatus*	2
Hydroporus palustris	78	***Agabus undulatus***	8	***Scarodytes halensis***	2
Gyrinus substriatus	75	*Helochares lividus*	8	*Cercyon sternalis*	1
Helophorus minutus	67	***Hydrochus crenatus***	8	*Contacyphon palustris*	1
Graptodytes pictus	66	*Hygrobia hermanni*	8	***Donacia dentata***	1
Haliplus lineatocollis	62	*Nebrioporus elegans*	8	***Donacia impressa***	1
Dytiscus sp. larva (not *semisulcatus*)	58	*Cymbiodyta marginellus*	7	*Donacia versicolorea*	1
Anacaena globulus	56	*Donacia simplex*	7	***Dryops similaris***	1
Hydroporus planus	53	***Enochrus quadripunctatus***	7	*Graptodytes granularis*	1
Hyphydrus ovatus	45	*Gyrinus marinus*	7	*Haliplus confinis*	1
Agabus bipustulatus	43	*Haliplus heydeni*	7	***Haliplus mucronatus***	1
Hydrobius fuscipes	43	*Oulimnius* sp.	7	*Haliplus sibiricus*	1
Hygrotus inaequalis	37	*Haliplus obliquus*	6	*Helophorus obscurus*	**1**
Hygrotus impressopunctatus	36	*Berosus signaticollis*	6	*Hydroporus pubescens*	1
Haliplus immaculatus	32	***Chaetarthria seminulum***	6	***Hygrotus parallellogrammus***	**1**
Haliplus ruficollis agg. indet ♀s	30	*Donacia semicuprea*	6	*Limnebius nitidus*	1
Agabus sturmii	29	*Hydroporus incognitus*	6	*Nebrioporus assimilis*	1
Berosus luridus	29	*Ilybius ater*	6	*Ochthebius bicolon*	1
Colymbetes fuscus	29	*Laccophilus hyalinus*	6	*Oulimnius tuberculatus*	1
Rhantus suturalis	29	*Ochthebius dilatatus*	6	***Peltodytes caesus***	1
Enochrus testaceus	28	*Porhydrus lineatus*	6	*Platambus maculatus*	1
Haliplus ruficollis	27	*Dytiscus circumflexus*	**5**	*Plateumaris sericea*	1
Dryops luridus	26	***Gymnetron villosulum***	5	*Rhantus exsoletus*	**1**
Ilybius quadriguttatus	26	*Hydraena riparia*	5	***Rhantus frontalis***	1
Hygrotus versicolor	24	***Noterus crassicornis***	5	*Scirtes hemisphaericus*	1
Laccobius bipunctatus	24	***Oulimnius rivularis***	5	*Stenopelmus rufinasus*	1
Noterus clavicornis	24	*Agabus didymus*	4	*Thryogenes festucae*	1
Anacaena bipustulata	22	*Cercyon tristis*	4	*Thryogenes nereis*	1
Ochthebius minimus	21	*Donacia vulgaris*	4		
Cercyon convexiusculus	19	***Hydaticus transversalis***	4		
Hydroporus angustatus	19	*Ilybius fuliginosus*	4		
Liopterus haemorrhoidalis	19	*Laccobius minutus*	4		
Haliplus fluviatilis	19	***Oulimnius major***	4		
Agabus nebulosus	16	*Poophagus sisymbrii*	4		
Haliplus lineolatus	15	*Anacaena lutescens*	3		
Haliplus flavicollis	14	*Donacia clavipes*	3		
Rhantus grapii	14	***Eubrychius velutus***	3		
Helophorus brevipalpis	13	*Helophorus aequalis*	3		
Cercyon marinus	12	*Hydroporus discretus*	3		

Hydroporus tessellatus	11	*Hydroporus memnonius*	3		
Berosus affinis	10	*Laccobius sinuatus*	3		
Dytiscus marginalis	10	*Agabus paludosus*	2		
Laccobius striatulus	10	***Bagous alismatis***	2		
Laccophilus minutus	10	*Cercyon ustulatus*	2		
Tanysphyrus lemnae	10	*Contacyphon coarctatus*	**2**		
Helophorus griseus	9	*Contayphon laevipennis*	2		
Hydraena testacea	9	***Dytiscus dimidiatus***	2		
Laccobius colon	9	*Enochrus melanocephalus*	2		

GB Near Threatened species

GB Vulnerable species

GB Nationally Scarce species

3.3 Relationship between wetland plants and water beetles

One would not expect a direct relationship between ditch plants and water beetles, since only the reed-beetles and weevils are associated with specific food-plants. However, the number of water beetle species showed a moderately strong statistical correlation with species-richness for wetland plants (Pearson's rank correlation $r = 0.40$)[4]. There was a similar correlation ($r = 0.41$) between the number of 'quality' ditch plant species per site and the number of beetle species of conservation concern. There is, therefore, an indication that assemblages of wetland plants and beetles were reflecting some common influences.

[4] All correlation coefficients cited in this report have high significance values ($p < 0.01$)

4 Noteworthy Species

4.1 Plants

4.1.1 Long-stalked Pondweed *Potamogeton praelongus*

GB status: Near Threatened; English status: Endangered

Potamogeton praelongus usually grows in larger water bodies, particularly lakes, rivers, canals and major Fenland drains (Preston, 1995). Whilst not at risk in Scotland, it is now considered under serious threat in England with a 69% decline in distribution in England during the latter half of the 20th century (Stroh *et al*, 2014). This species has disappeared from many of its Cambridge sites since 1950 (Preston, 1995).

Potamogeton praelongus was recorded from a single sample point in Littleport & Downham district (LD15: Ely Ouse north of Ten Mile Bank), in a wide (33m) section of canalized river which has a high water level maintained upstream of the Denver Sluice complex. It was recorded from water with pH 8.1 and with an electrical conductivity of 1,010 µS. As only one site was sampled on the Ely Ouse upstream of Denver Sluice, the species may prove to be more widespread in this watercourse.

Potamogeton praelongus collected from the Ely Ouse (sample point LD15)

4.1.2 **Needle Spike-rush *Eleocharis acicularis***

GB status: Least Concern; English status: Near Threatened

Eleocharis acicularis has a scattered distribution in the UK (Stace, 2010) and is local in England occurring in and by pond or lake margins. Within the Fens, it typically occurs as submerged plants on the bed of drains and in these situations is very often sterile (Stace, 2010). Submerged plants were recorded from a single sample point (S15) at the margins of a large drain in close proximity to a pumping station.

4.1.3 **Whorled Water-milfoil *Myriophyllum verticillatum***

GB status: Vulnerable; English status: Near Threatened

Myriophyllum verticillatum is a local and declining plant of central and south-east England where it occurs in ponds, canals, ditches and rarely slow streams (Haslam, 1982). This species continues to decline (Preston *et al.*, 2002). It was recorded from 20 sample points with strong centres of distribution within the gravel substrate areas of Haddenham (H8-10) and Sutton & Mepal (S1, S3, S5, S8, S9, S24, S26 & S27) districts. Other smaller and outlying populations were recorded in the Manea & Welney (M1-3, M18), Upwell (U10), Stoke Ferry (SF9) and Littleport & Downham (LD8, 13 & 14) districts. In the Haddenham and Sutton & Mepal districts, locally dominant populations occur in IDB drains that are regularly weed-cut, providing the open surface water which this species requires.

Dominant stands of *Myriophyllum verticillatum* associated with *Potamogeton trichoides* and *Sagittaria sagittifolia* in open water of IDB drain (sample point H8)

4.1.4 **Water-violet *Hottonia palustris***

GB status: Least Concern; English status: Vulnerable

Although locally common in E England, *Hottonia palustris* has a scattered distribution in the rest of the UK (Stace, 2010) occurring in shallow ponds and ditches. It was recorded from 19 sample points with strong centres within Sutton & Mepal (S1, S3, S5, S8, S15, S16, S21, S26, S29 & S30) and Manea & Welney (M1, M4, M6-8) districts. Other smaller and outlying populations were recorded in Over & Willingham (O14 & O15) and Stoke Ferry (SF1 & SF4) districts.

4.1.5 **Round-fruited Rush *Juncus compressus***

GB status: Near Threatened; English status: Vulnerable

Juncus compressus is widespread but very local in England occurring in marshes, wet meadows and pastures. It has undergone a significant decline due to land drainage and the loss of permanent pastures (Preston *et al*, 2002). It was recorded from three sample points (O9, LD51 & LD54). At the Over site, it was recorded from the wet margin of a gentle sloping (<20°) ditch bank within cattle-grazed floodplain grassland on the south-east bank of the Great Ouse. The two Littleport & Downham district sites were similar (on gentle sloping grass banks within cattle-grazed pasture) but the pasture has been created within the last ten years as part of a conservation scheme (WWT Lady Fen, Welney).

4.1.6 **Flat-stalked Pondweed *Potamogeton friesii***

GB status: Near Threatened; English status: Vulnerable

Potamogeton friesii is a scarce pondweed which is most frequent in eastern England and is particularly characteristic of ditches, drains, canals and lowland rivers with calcareous and rather eutrophic water (Preston, 1995). It has declined due to the ecological deterioration of the canal network (Preston *et al.*, 2002). This plant was recorded from four sample points, all of which are large IDB or “main river” sites with a width of between six and 13m. It was found in the following districts: Sutton & Mepal (S24: Forty Foot River), Manea & Welney (M13: South Branch Drain), Upwell (U10: Well Creek) and Littleport & Downham (LD35: Pymore Main Drain). At all these sites, *Potamogeton friesii* is associated with a relatively rich assemblage of drain plants, particularly other *Potamogeton* species, in water that is base-rich (pH 7.7 to 7.9) with relatively high conductivity (1,090-3,950 µS/cm).

Prominent stands of *Potamogeton friesii* within the Forty Foot River (sample point S24)

4.1.7 **Frogbit *Hydrocharis morsus-ranae***

GB status: Vulnerable; English status: Vulnerable

Hydrocharis morsus-ranae was once a common plant in England associated with ponds and ditches within grazing marshes but has declined greatly with the loss of these habitats, principally as a result of conversion to arable and drainage schemes. It was recorded from five sample sites with a strong centre of distribution in Over & Willingham district (O7-9 & O12). Here, *Hydrocharis morsus-ranae* is associated with various duckweed species (*Lemna minor, Lemna gibba, Spirodela polyrhiza*) in IDB drains within cattle-grazed permanent grassland on the floodplain of the Great Ouse. These ditches are relatively eutrophic, have hydrological connectivity with the nutrient-rich water of the main river and are likely to be regularly recharged during the summer months via a series of slackers connected to the main river. A single outlying plant was recorded within Sutton & Mepal District, from the Forty Foot Drain (S24).

4.1.8 **Tubular Water-dropwort *Oenanthe fistulosa***

English status: Vulnerable

Oenanthe fistulosa is a local and declining species with a centre of distribution in south-east England where it occurs at the wet margins of ponds, ditches and canals. It has declined nationally due to agricultural improvement and land drainage (Preston *et al.*, 2002). This plant was recorded from two sample sites, the most significant population being associated with an IDB drain within the cattle-grazed floodplain of the Great Ouse (O10, Over & Willingham district). A second small population was recorded persisting

under dense reed fringe at the margins of an IDB drain in Sutton & Mepal district (S16, closely adjoining the north side of the Ouse Washes). *Oenanthe fistulosa* was also recorded in close proximity (but outside of) two further sample points (S3 and O9).

4.1.9 Fringed Water-lily *Nyphoides peltata*

GB status: Nationally Scarce

Nymphoides peltata occurs in ponds and slow rivers, with a native distribution centred on the fens of East Anglia and the Thames basin (Stace, 2010). Elsewhere it has a scattered distribution and is frequently naturalised. Populations in East Anglian Fenland drains (including all those surveyed as part of this survey) are generally considered to be native and native populations of *Nymphoides peltata* have a GB status of Nationally Scarce. This plant was recorded from two sample sites, the Ouse Washes Counter drain (S13) in Sutton & Mepal district and a 12m wide drain adjoining a pump house near Pymore (LD42) in Littleport & Downham district.

4.1.10 Clustered stonewort, *Tolypella glomerata*

GB status: Nationally Scarce

Tolypella glomerata is a widespread, but scarce and apparently declining stonewort (John, Whitton & Brook, 2002). It is often a winter annual visible from October to May, but persisting at some sites throughout the year, particularly in deeper water. It was recorded in quantity on the bed of Adventurer's Head Drain, an IDB watercourse in Haddenham district (H9) supporting a rich assemblage of aquatic plants; and also in a field drain at Fordham Fen (SF5) in Stoke Ferry district (photo, left).

4.1.11 Fringed Heartwort, *Ricciocarpos natans*

GB status: Nationally Scarce

Ricciocarpos natans is a southern species of thalloid liverwort found floating in mineral-rich pools, ditches, canals and drains, often where the water is calcareous, or on mud at the water's edge (Atherton *et. al.*, 2010). Bosanquet (2014) reports that this species has

"declined substantially", with post-1990 records from only around 40 sites. It was recorded from open water in a single field drain on Hilgay Fen (LD21), associated with *Lemna gibba*.

Ricciocarpos natans, collected from a field drain on Hilgay Fen.

4.1.12 **Other plant species important in a local (Fenland) context**.

A number of other plant species recorded during the survey are considered notable in a regional (Fenland) context, based on an interim data set of 122,000 records collated for the *Fenland Flora* project (Graham & Mountford, unpublished). These are either uncommon species in Fenland as a whole, species thought to be declining regionally or represented by significant populations within individual sample points. These include Broad-leaved Pondweed *Potamogeton natans* (15%), the floating liverwort *Riccia fluitans* (11%), Shining Pondweed *Potamogeton lucens,* Hair-like Pondweed *Potamogeton trichoides* and Fan-leaved Water-crowfoot *Ranunculus circinatus* (all 10%), Lesser Pondweed *Potamogeton pusillus* (9%), Fine-leaved Water-dropwort *Oenanthe aquatica* (6%), Water Dock *Rumex hydrolapathum* (3%), Orange Foxtail *Alopecurus aequalis* and Greater Bladderwort *Utricularia vulgaris* (both 2%), Narrow-leaved Water-plantain *Alisma lanceolata* (1%) and Small Pondweed *Potamogeton berchtoldii* (both 1% of sample sites).

4.2 Aquatic Coleoptera

4.2.1 ***Haliplus mucronatus,*** an algivorous water beetle (Haliplidae)

GB status: Nationally Scarce

This browny-coloured *Haliplus* was found in good numbers in one ditch at Block Fen (S18, Sutton & Mepal district) on 27/06/2013. Here it was present in very shallow water

with patchy vegetation, rather than in more densely-vegetated parts of the same drain. *Haliplus mucronatus* has a very restricted British distribution concentrated in eastern England from Kent to the Humber, with a small number of outlying sites in the Gwent and Somerset Levels. In a survey of 101 farmland ditches in Cambridgeshire in 2002, Kirby & Lambert (2003) recorded it from a single location at Tick Fen.

4.2.2 ***Peltodytes caesus***, an algivorous water beetle (Haliplidae)

GB status: Nationally Scarce

This is a scarce beetle of base-rich ponds and ditches found in the coastal counties between Hampshire and the Wash, in the levels at either side of the Bristol Channel and inland in the Home Counties (Foster & Friday, 2011). It is closely associated with grazing marsh drains (Drake, 2004a).

During this survey, a single larva was collected from ditch LD48 at WWT Lady Fen. In a survey of the Ouse Washes SSSI in 2004, Martin Drake found *Peltodytes caesus* in a single pond near Mepal. Kirby & Lambert (2003) did not find this species in their 2002 survey of farmland ditches in the Cambridgeshire Fens.

4.2.3 ***Noterus crassicornis***, a burrowing water beetle (Noteridae)

GB status: Nationally Scarce

This small, brown, bullet-shaped beetle has a very patchy, 'semi-relict' distribution associated with lowland fenland areas. Its principal centres are the coastal grazing levels of south-east England; East Anglia; the Trent Valley and Humberhead Levels; the Cheshire Plain and Anglesey. *Noterus crassicornis* is flightless, having markedly reduced wings, and is probably a good indicator of historic (though often highly modified) wetland landscapes. This species occurs both in primary wetlands (such as natural meres and pingos) and in secondary habitats such as ditches, ponds and borrow-pits on drained fenland. In 2013, *N. crassicornis* was recorded from just two ditches (B7 & H2) but it was found at three further sites (H8, LD18 and O15) during the May 2014 survey. Although this suggests that the species may be more readily detected in spring, it is clearly local and uncommon in the study area.

Noterus crassicornis was recorded from the RSPB Ouse Washes reserve in 1992 and 1993 (per Drake, 2004b). Kirby & Lambert (2003) recorded it from six locations (out of 101 sampled) in a survey of farmland ditches in Cambridgeshire in 2002.

4.2.4 ***Agabus conspersus***, a diving beetle (Dytiscidae)

GB status: Nationally Scarce

This mid-sized diving beetle is a brackish water specialist occurring locally in upper saltmarsh pools and coastal drains and ponds as far north as County Durham in the east and the Solway estuary in the west. Inland records are rare, though it has been collected from gypsum subsidence pools in Nottinghamshire (Merritt, 2006) whilst Kirby & Lambert (2003) reported it from one ditch at Kingsland and three at Tick Fen in Cambridgeshire. It is therefore notable that *Agabus conspersus* was found in eight ditches at WWT Lady Fen in 2014, often in large numbers. This site clearly supports a sizeable and well-established breeding population. Electrical conductivity readings ranged from 2,530 to 4,680µS/cm, with a mean value of 3,800µS/cm: these values demonstrate an unusually high ionic content for inland waters, comparable to non-tidal waters close to estuaries.

Interestingly, Martin Drake (2004b) collected a single specimen of *A. conspersus* from a ditch in the Pymore section of the RSPB Ouse Washes reserve, so it may have been established in the area for some time.

4.2.5 ***Agabus undulatus***, a diving beetle (Dytiscidae)

GB status: Near Threatened

bus undulatus occurs principally in counties around the Wash with rds extending from Wicken Fen in south to the Donnington area of th Lincolnshire in the north; nbridgeshire represents its national nghold, though it occurs also in ckland. This species has disappeared n outlying sites in southern and stern England and survives cariously at a single northern station r York.

During the present survey, this attractively-marked diving beetle was found at nine locations: in adjacent ditch sections at Langwood Fen (S26/S27) and at Long Lane, Over (O14/O15); at Upwell Fen (U9) and near Reed Fen Farm, Welney (U6); at Old Mill Drove (M1) and in two ditches on Fordham Fen (SF1 & SF4). Interestingly, *Agabus undulatus* was not listed by Drake (2004b) amongst the aquatic invertebrates recorded from the Ouse Washes SSSI. However, Kirby & Lambert (2003) recorded it from 17 locations (out of 101 sampled) in surveys of farmland ditches at Farcet Fen, Kingsland and Tick Fen in 2002. They state that it is "quite frequent" in drains in the Peterborough area.

In our study area, *Agabus undulatus* is evidently very local but sometimes present in large numbers (e.g. at Long Lane and Fordham Fen SF1). All sites were permanently-wet, regularly-managed arable or droveside drains. Like *Noterus crassicornis*, this beetle has reduced wings and is presumably flightless, so it is unlikely to colonise recently-created ditches except in close proximity to existing populations.

4.2.6 ***Rhantus frontalis***, a diving beetle (Dytiscidae)

GB status: Nationally Scarce

Rhantus frontalis is a mid-sized diving beetle with a very patchy British distribution centred on eastern Scotland, East Anglia, the Thames and North Kent Marshes, the Somerset Levels and Anglesey (Foster & Friday, 2011). It occurs in still waters with some exposed substrate and is closely associated with grazing marsh ditches (Drake, 2004a).

Two specimens were collected from ditch LD48 at WWT Lady Fen. In a survey of the Ouse Washes RSPB reserve in 2004, Martin Drake found *R. frontalis* at a single location in the Pymore section. Kirby & Lambert (2003) describe this species as fairly frequent in Cambridgeshire in ditches and mineral extraction sites but only found it in one out of 101 drains.

4.2.7 ***Hydaticus transversalis***, a diving beetle (Dytiscidae)

GB status: Nationally Scarce

This large, handsome diving beetle is confined to the Broads, the Fens and the levels at either side of the Severn estuary. It has disappeared from former northern sites in the Vale of York and Lincolnshire Outmarsh. *Hydaticus transversalis* inhabits vegetated, base-rich drains and ponds and has a strong association with grazing marsh ditches (Drake, 2004a).

Adults of this species were found at two locations in the Over & Willingham drainage district (O10 & O14) and at Adventurer's Head Drain near Aldreth (H8). A *Hydaticus* larva from a ditch at Langwood Fen (S26) was determined as this species by Professor Foster. Three of these four sites are arable or droveside drains, the other is on floodplain grazing marsh. Kirby & Lambert (2003) recorded *H. transversalis* from three locations at Farcet Fen and Kingsland in 2002.

4.2.8 ***Dytiscus dimidiatus***, a great diving beetle (Dytiscidae)

GB status: Near Threatened

Britain's largest dytiscid, *D. dimidiatus* is related to the common Great Diving Beetle (*Dytiscus marginalis*). It has a limited distribution focused on Kent, Norfolk, the Cambridgeshire/South Lincolnshire Fens and the levels at either side of the Severn estuary. Although it has increased in some parts of its range in recent years, as in Kent and West Norfolk, *D. dimidiatus* has been lost from northern outposts in the Vale of York and Humberhead Levels.

Dytiscus dimidiatus was recorded only from Bluntisham. One specimen was collected from a roadside ditch (B3) and three from a richly-vegetated drain on the inland side of the floodplain embankment (B7). Bottle-trapping at 12 widely-dispersed sites in May 2014 failed to produce any further specimens. This is usually an effective technique for detecting *Dytiscus* species, so the results suggest that *D. dimidiatus* is extremely localised within the study area. Drake (2004b) reported a single specimen from the RSPB Ouse Washes reserve, at Pymore. Kirby & Lambert (2003) did not record this species in a survey of 101 farmland drains in the Cambridgeshire Fens in 2002.

4.2.9 ***Scarodytes halensis***, a diving beetle (Dytiscidae)

GB status: Nationally Scarce

This small diving beetle has wing cases marked with lines and blotches over a pale ground colour, a pattern similar to other 'pioneer' dytiscids found on exposed mineral substrates with sparse vegetation. Its typical habitats are recently cleared ditches and mineral excavation pits but *S. halensis* has an unusual distribution, concentrated in the counties around the Wash.

A single specimen was collected from Ladyfen Drain near Ten Mile Bank (LD47) and the species was numerous in a newly-cut (or re-excavated) ditch at nearby WWT Bank Farm (LD61). Kirby & Lambert (2003) found *S. halensis* at two locations in their survey.

4.2.10 ***Hygrotus parallellogrammus***, a diving beetle (Dytiscidae)

GB status: Nationally Scarce

Like *Agabus conspersus*, this is a brackish water specialist: occasional inland reports are usually referable, on investigation, to the matt female *lineelus* form of its common relative *H. impressopunctatus*. It occurs very locally in suitable habitats around the Severn estuary and from Hampshire to the Humber (Foster & Friday, 2011). A single specimen collected from ditch LD48 at WWT Lady Fen was kindly confirmed by Professor Foster. The records of *H. parallellogrammus* and *A*. *conspersus* from this site provide evidence of a small but interesting brackish water element to the fauna of the Ouse Washes fringes. There do not appear to be any previous records of this species from the Washes or from farmland drains on the Cambridgeshire Fens. It is, however,

known from Dogsthorpe Star Pit at Peterborough, a flooded brick pit complex known for its brackish water elements (Crick *et al*, 2005).

4.2.11 ***Hydrochus crenatus,*** a scavenger water beetle (Hydrochidae)

GB status: Near Threatened

A small scavenger water beetle associated with reedy or mossy water margins in lowland fenland areas. *Hydrochus crenatus* has a very limited British distribution centred on Breckland and Fenland with very few outlying records (Foster, 2010; Foster *et al*, 2014). Although often associated with remnant fens, records from the present survey show that dykes in intensive arable farmland in the Sutton & Mepal IDB district are an important stronghold. This species was recorded from six drains there and was very plentiful at the margin of a large dyke at the Arthur Rickwood farm (S21). The only records elsewhere were from Long Lane near Over (O15) and a single specimen from a ditch at Coveney Byall Fen (LD33, the sole 2014 record). The Over site adjoins part of the RSPB/Hanson Ouse Fen wetland, suggesting good potential for colonisation of the new wetlands there.

Interestingly, *H. crenatus* was not listed by Drake (2004) as having been recorded from the RSPB Ouse Washes reserve. In a survey of 101 Cambridgeshire drains in 2002, Kirby & Lambert (2003) recorded it from just two sites at Tick Fen near Chatteris and one at Farcet Fen near Peterborough, whilst noting that it occurs also in gravel pits and clay pits in the north of the county. This does emphasise the importance of the Sutton & Mepal drainage district for this Fenland beetle.

4.2.12 ***Berosus luridus,*** a scavenger water beetle (Hydrophilidae)

GB status: Near Threatened

This mid-sized scavenger water beetle proved to be widespread in the study area, with records from 29 locations (16.6% of all sites). It was proportionately most frequent in Haddenham and Sutton & Mepal districts, where it was recorded respectively from 42% and 38% of ditches sampled. There were also a few records from Manea, Upwell and Littleport & Downham though none from Bluntisham, Over or Stoke Ferry. Although sometimes detected as single specimens, *B. luridus* was numerous at several locations. It was usually found in the reedy fringes of relatively ordinary arable drains and did not show a strong association with species-rich or high quality water beetle assemblages. It was very rarely found with its congeners *B. affinis* or *B. signaticollis*, which prefer more exposed, early successional habitats. *Berosus luridus* was not found on any grazing-marsh or conservation grassland sites.

The core distribution of this species appears to be the Somerset Levels, East Anglia and Fenland with two isolated Scottish populations; Foster *et al* (2014) observe that the centre of its distribution "lies in the old Cambridgeshire Levels and in the Brecks". *Berosus luridus* formerly occurred in several other areas and its British distribution has contracted considerably (Foster, 2010). Although described by Foster *et al* (*ibid*) as a species of "lowland ponds and slow drains with a peaty substratum", *B. luridus* was recorded from clay- or silt- bedded dykes during the present survey.

Berosus luridus was not listed by Drake (2004) as having been recorded from the RSPB Ouse Washes reserve. However, it was found at 14 out of 101 sites in Cambridgeshire in the 2002 ditch survey undertaken by Kirby & Lambert (2003). As with *Hydrochus crenatus* and *Agabus undulatus*, arable drains in the Cambridgeshire Fens represent a nationally-important stronghold for the species.

4.2.13 ***Chaetarthria seminulum*** a scavenger water beetle (Hydrophilidae)

GB status: Nationally Scarce

Chaetarthria are tiny, round hydrophilids. Until recently there was believed to be a single British species but it is now recognised that there are two: *C. seminulum* and the recently-described *C. simillima*. They appear to have relatively distinct distributions, *C. simillima* preferring upland seepages and mossy pools on lowland heaths and fens whilst *C. seminulum* is the typical species of silty or clayey water margins in the southern and eastern lowlands. Both were listed by Foster (2010) as Nationally Scarce.

Professor Foster determined *Chaetarthria* specimens from H8, S1, S3, S8, S9 and S17 as all referring to *C. seminulum*. Kirby & Lambert (2003) recorded *C. seminulum* sensu lato from a single ditch out of 101 surveyed in northern Cambridgeshire, whilst noting that it is "not rare" in the county as a whole.

4.2.14 ***Enochrus quadripunctatus***, a scavenger water beetle (Hydrophilidae)

GB status: Nationally Scarce

A mid-sized, brownish scavenger water beetle associated with clayey or silty water margins. Although older records are confused by taxonomic changes, the true *E. quadripunctatus* has a restricted British distribution strongly centred on the east of England; it appears to have extended its range in recent years (Foster *et al*, 2014). In 2013, it was recorded from single locations at RSPB Purls Bridge (M6) and the Great Ouse floodplain at Over (O11); in the second year, *E. quadripunctatus* was recorded from five ditches at WWT Lady Fen.

Drake (2004) collected this species from five widely spread ditches on the RSPB Ouse Washes reserve but Kirby & Lambert (2003) did not detect it in a survey of 101 farmland drains in northern Cambridgeshire. It may therefore have a significant population centre in and around the Washes, with foot-drains on recently-established arable-reversion grassland providing an important habitat.

4.2.15 ***Dryops similaris***, a long-toed water beetle (Dryopidae)

GB status: Nationally Scarce

The water beetles of the genus *Dryops* are a notoriously difficult group, identification of most species requiring careful microscopic examination of the male genital capsule. A single male *D. similaris* was determined by Professor Foster from North Fen Drain at Gall Fen (H2). This species is well-known from Fenland, extending into South Lincolnshire, but it appears to be rare in a national (GB) context. *Dryops similaris* occurs amongst emergent vegetation at the margins of base-rich standing water at low elevations.

4.2.16 ***Oulimnius major***, a riffle beetle (Elmidae)

GB status: Nationally Scarce

Oulimnius are small riffle-beetles, a family mostly associated with highly-oxygenated, fast-flowing water. Less typically, both *Oulimnius major* and *O. rivularis* are characteristic of slow-flowing, often canalised lowland watercourses and have very restricted British distributions. *Oulimnius major* extends from southern England north to the Lower Derwent Valley in East Yorkshire but with a strong concentration of records in the Fens. Specimens identified by Professor Foster came from the Ely Ouse north of Ten Mile Bank (LD15), large watercourses at Bishop's Land (M4) and Engine Drain near Fortrey's Hall (S15) and from a smaller dyke at Old Bedford Low Bank (S16). In a survey of agricultural drains in the Cambridgeshire Fens, Kirby & Lambert (2003) recorded this species only from Tick Fen near Chatteris, where it was collected from six stations.

It is likely that further survey of large, canal-like watercourses such as Well Creek, the various channels of the Great Ouse and the Cut-Off Channel would produce additional records of *O. major*.

4.2.17 ***Oulimnius rivularis***, a riffle beetle (Elmidae)

GB status: Nationally Scarce

Once thought extinct in Britain, *O. rivularis* was rediscovered in Cambridgeshire in 1986 in the Sixteen-Foot Drain (Foster & Bratton, 1986). There have been numerous records since then from the Fens, with more northerly populations around the New River Ancholme in north Lincolnshire and in a section of the Chesterfield Canal in Nottinghamshire (Merritt, 2006). Otherwise there appear to be just two outlying records from south-east England, one very old.

Specimens determined by Professor Foster came from five locations: Manea Fifties (M19), Adventurer's Head Drain (H8), Arthur Rickwood Farm (S22), Glover's Drain at Hilgay Fen (LD18) and the Ely Ouse north of Ten Mile Bank (LD15). These sites were all mid- to large- sized, deeper drains with a high proportion of open water. In a 2002 survey of agricultural drains in the Cambridgeshire Fens, Kirby & Lambert (2003) recorded this species only from Tick Fen, where it was detected at three locations.

Oulimnius specimens, being very small and sluggish, have a habit of vanishing after apparently being transferred to the collecting tube and females cannot always be determined with complete confidence. '*Oulimnius* sp.' records from five locations included probable female *O. rivularis* from two sites. It is thus likely that the survey data under-represents the distribution of both *O. major* and *O. rivularis* in the study area, and further sampling of larger watercourses would certainly provide additional records. Although these beetles are sometimes found in submerged weed beds, they were also found on, and probably prefer, hard surfaces such as timber or concrete revetment along the submerged footings of dyke banks. Both *O. major* and *O. rivularis* were collected from the Ely Ouse at sample point LD15 by scraping corrugated revetments.

4.2.18 ***Donacia dentata***, a reed beetle (Chrysomelidae)

GB status: Vulnerable

This rare reed-beetle is associated primarily with *Sagittaria sagittifolia* (Arrowhead) growing in dykes (Cox, 2007). There are very thinly scattered records south and east of a line between the Humber and Severn estuaries, and it appears to have declined markedly during the 20th century. During the survey, a single specimen was collected from Little Adventurer's Drain (H10). The main adult emergence period for *D. dentata* is late July through August (presumably coinciding with the emergence of aerial leaves in

arrowhead), so it could occur more widely in the study area. This is certainly a very significant record.

4.2.20 ***Donacia impressa***, a reed beetle (Chrysomelidae)

GB status: Nationally Scarce

Adults of this reed-beetle feed on the pollen of large sedges (*Carex* species) but *Schoenoplectus lacustris* (Common Club-rush) may be the principal larval foodplant (see Cox, 2007). It has a patchy distribution centred on the south-eastern half of Britain but with scattered records also around the western seaboard from Wales to the Hebrides. A single specimen was collected from a grazing marsh ditch on arable reversion land at RSPB Purls Bridge (M5).

4.2.21 ***Gymnetron villosulum***, Pink Water-speedwell Weevil (Curculionidae)

GB status: Nationally Scarce

The larvae of this uncommon weevil develop in the seed pods of *Veronica catenata* (Pink Water Speedwell). It has a localised distribution north to central Yorkshire. During this survey, *G. villosulum* was found at RSPB Purls Bridge (M6), two ditches on the Great Ouse floodplain near Over (O10 & O12) and two ditches at WWT Lady Fen (LD48 & LD57). All sites were shallow ditches in permanent grassland with fluctuating, cattle-grazed margins: such conditions are favourable to maintaining continuous populations of the host plant, an annual dependent on disturbance.

4.2.22 ***Bagous alismatis*** (Marsham, 1802), Water-plantain Weevil (Curculionidae)

GB status: Nationally Scarce

The larvae of this small, elongate weevil form blotch mines in the leaves of *Alisma plantago-aquatica* (Common Water Plantain); it has also been recorded on *Sagittaria sagittifolia* (Arrowhead) on the Continent (Morris, 2002). Professor Foster kindly identified specimens collected from Little Adventurer's Drain (H10) and Sutton West Fen (S9) in 2013. *Bagous alismatis* is the most widely-recorded British member of an enigmatic and elusive genus of wetland weevils. However, whilst it has been found widely as far north as southern Scotland, it is sufficiently uncommon to be categorised as Nationally Scarce (Hyman & Parsons, 1992)[5]. This species was recorded from the RSPB Ouse Washes reserve in 1993 (per Drake, 2004). It was collected from one location (at Farcet Fen) out of 101 sampled in northern Cambridgeshire by Kirby & Lambert (2003).

4.2.23 ***Eubrychius velutus*** (Beck, 1817), a water-milfoil weevil (Curculionidae)

GB status: Nationally Scarce

This is one of several fully-aquatic weevils which feed on *Myriophyllum* spp. (water-milfoils). *Eubrychius velutus* can fly (Morris, 2008) but it is actually more completely aquatic than most water beetles, spending its entire life-cycle (egg-larva-pupa-adult) on the submerged foliage of water-milfoil: almost all 'proper' water beetles at least pupate out of water.

During the survey, *E. velutus* was recorded from Old Mill Drove (M1), Adventurers Head Drain (H8) and Ladyfen Drain near Ten Mile Bank (LD47). At all three sites, *M. verticillatum* (Whorled Water-milfoil) was the only *Myriophyllum* recorded. *Eubrychius velutus* is widely but very thinly distributed in suitable habitats over much of Britain. Kirby & Lambert (2003) describe the species as "quite frequent" in Cambridgeshire and recorded it from three out of 101 ditches in their survey.

4.3 Other noteworthy species and noteworthy ditch plants recorded from near to (but outside of) sample points.

4.3.1 Evidence of **Water Vole *Arvicola terrestris*** (as latrines or active burrows) was recorded from 12 sample points (S6, M2, M21, U3, U4, U11, SF4, LD3, LD21, LD29-30 and LD41) with a notable presence in reed-fringed drains within Upwell district.

4.3.2 Records of amphibians had a notable association with the southern part of the Ouse Washes LPS area, especially the gravel substrates within the Haddenham and Sutton & Mepal districts. **Common Toad *Bufo bufo*** (as tadpoles or juveniles) was recorded from five sample points (B5, H2, H8, S9 and S17); **Common Frog *Rana temporaria*** (as tadpoles, juveniles or adults) was recorded from 6 (O2, H2, H8, H11, M5 and M6); **Smooth Newt *Lissotriton vulgaris*** (as larvae or adults) was recorded from 17 (O3, O6, O12, B8, H1, H2, S15, S21, S26, M7, M15, M16, SF9, LD29-30, LD38 and LD48).

4.3.3 **Ten-spined** and to a lesser extent **Three-spined Sticklebacks** were abundant in both IDB and smaller field drains throughout the Ouse Washes LPS area. **Ten-spined Stickleback *Pungitius pungitius*** was recorded from 74 sample points (42%) (O1, O6-8, O14, O15, B3, B5, B8, H2, H3, H6, H8, H9, H19, S19, S25, S26, S28, S31, M4-8, M10, M12, M14-16, M18, M21, U1-U7, U9, U11, SF2-4, SF6-7, LD3, LD5, LD7-8, LD12-13, LD17, LD25-26, LD29-30, LD34, LD38, LD40-41, LD43-44,LD46, LD48-54, LD56, LD58-59 and LD65). **Three-spined Stickleback *Gasterosteus aculeatus*** was recorded from 33 sample points (19%) (O5-O8, B4, H11, S5, S6, S8, M2, U1, SF5, SF7, LD4, LD6-9, LD12-13. LD21, LD23, LD25-27, LD30-32, LD35, LD39, LD46, LD49 and LD55).

4.3.4 **Spined Loach *Cobitis taenia*** is a European Protected Species. Two specimens were accidentally netted whilst sampling ditch Coleoptera at two locations (H2) in Haddenham district and (S3) in Sutton & Mepal district.

Spined loach *Cobitis taenia* accidentally netted whilst sampling ditch Coleoptera (sample point S3, Sutton & Mepal district)

4.3.4 **Stone Loach *Barbatula barbatula*** is a widespread and fairly frequent fish in clean, stony streams and rivers. A single specimen was netted whilst sampling a reed-filled field drain at Witcham Bridge Drove (LD26), an atypical habitat. Stone Loach does occur within the Great Ouse, and it is possible that it had been introduced to this drain with flood- or pumped- water from the main river.

Stone Loach *Barbatula barbatula* netted at Witcham Bridge Drove (sample point LD26, Littleport & Downham district)

4.3.5 The bladder snail ***Aplexa hypnorum*** was recorded from a single sample point: a reed-lined IDB drain at Manea Fifties (M19). This is considered to be a localized and declining mollusc.

4.3.6 **Water Spider *Argyroneta aquatica*** was recorded from eight sample points (H8, H9, S13, S30, M18, U5 and LD8-9). Although many spiders inhabit emergent vegetation or hunt over the surface film, this is the only species to live underwater. It is a local species, indicative of good water and habitat quality.

4.3.7 **Odonata.** Damselflies and dragonflies were plentiful around many ditches but records were only kept of the adults of two locally uncommon species: **Hairy Dragonfly *Brachytron pratense*** was observed at 5 sample points (B2, H2, S1, M17 & SF1); **Red-eyed Damselfly *Erythromma najas*** was noted from 4 sample points (H5, S13, S15 and SF9).

4.3.8 **Diptera**. The large, distinctive larvae of the Nationally Scarce soldierfly *Stratiomys singularior* (Stratiomyidae) were netted from one ditch near Welney (U5). This species occurs locally in coastal grazing marsh ditches from the south coast north to the Humber along with a few base-rich inland sites. It is widespread on the Ouse Washes RSPB reserve (Drake, 2004b).

4.3.9 **Houndstongue *Cynoglossum officinale*** is an uncommon plant within the Fens and very uncommon within the Ouse Washes LPS area (based on local knowledge). A colony of flowering plants was recorded from a cattle-grazed flood bank of the Old West River close to sample point H5 (Haddenham district).

4.3.10 **Marsh Stitchwort *Stellaria palustris*** is a local and declining plant of fen habitats. It has a GB and English conservation status of Vulnerable and is also a UKBAP Priority Species. Marsh Stitchwort was observed close to (but outside of) an IDB drain within the cattle-grazed floodplain of the Great Ouse at Over (O9).

5 Overview by Drainage District

5.1 Over & Willingham

5.1.1 Fifteen ditches in Over & Willingham drainage district were sampled on 10th July 2013. Two ditches were bottle-trapped and hand-netted again in May 2014.

8.1.2 A series of silty, eutrophic ditches close to the River Great Ouse (O1-O9), some of which had been cleared recently, were dominated by floating aquatics including duckweeds, (*Lemna minor, Lemna gibba, Spirodela polyrhiza*) and abundant macro-algae (*Cladophora, Ulva flexuosa*). Of note, however, was the presence of Frogbit *Hydrocharis morsus-ranae* at 5 sample points (O7-10, O12); this plant is categorized as Vulnerable in England. These eutrophic ditches supported a distinctly impoverished water beetle fauna. However, this did include a small number of pioneer species rarely found elsewhere during the survey (e.g. *Hydroglyphus geminus* and *Laccobius sinuatus*).

5.1.3 Ditch O9 was very bare, yielding only four species of water beetle, but the flora regenerating on recently dumped spoil was strongly suggestive of high quality rich-fen. This included species such as Common Marsh-bedstraw *Galium palustre* ssp. *elongatum*, Great Water Dock *Rumex hydrolapathum,* Creeping Jenny *Lysimachia nummularia* and Round-fruited Rush *Juncus compressus.* The latter is categorised as Vulnerable in England. A small population of Marsh Stitchwort *Stellaria palustris* (also Vulnerable in England) was also found in close proximity to this sample point. It is likely that this ditch would have supported a significant biota prior to recent wholesale clearance, and this was the one site where management appeared to have been conspicuously damaging.

5.1.4 Drains towards the inland edge of the river floodplain (O10-O12) appeared to be less eutrophicated and had gentle sloping (20° angled) banks which are lightly cattle-poached and dominated by Creeping Bent *Agrostis stolonifera* and Marsh Foxtail *Alopecurus geniculatus.* These drains supported a high quality water beetle fauna including several species characteristic of base-rich grazing marsh ditches. Nationally Scarce species included the large diving beetle *Hydaticus transversalis* (O10), the scavenger water beetle *Enochrus quadripunctatus* (O11) and the water-speedwell weevil *Gymnetron villosulum* (O10 & O12). Also of note were the uncommon hydrophilids *Berosus affinis* and *B. signaticollis*, as well as a substantial population of the Vulnerable plant Tubular Water-dropwort *Oenanthe fistulosa* (O10). When ditch O12 was re-visited during the May 2014 bottle-trapping survey, it appeared more eutrophicated, possibly as a result of fertiliser-spreading on surrounding pasture.

5.1.5 Sites O14 and O15 were on a drain at Long Lane north of Over village, adjoining the RSPB/Hanson Ouse Fen site. These had clear water dominated by large stands of Broad-leaved Pondweed *Potamogeton natans*, Water-violet *Hottonia palustris* and occasional

patches of Fan-leaved Water-crowfoot *Ranunculus circinatus*. Taken together, these two samples represent one of the highest quality water beetle assemblages recorded during the survey, yielding 37 species (35 at O15 alone). Amongst these were the Near Threatened *Agabus undulatus* and *Hydrochus crenatus* as well as the Nationally Scarce *Hydaticus transversalis* and *Noterus crassicornis*. These and other more widespread species reflect a strong lowland fenland element and this drain has the potential to be of regional significance for water beetles.

5.1.6 A total of 66 water beetle species were recorded from Over & Willingham district as a whole. These included the 'moss and tussock fen' (ISIS W313) specialists *Rhantus grapii*, *Hydrochus crenatus* and *Enochrus quadripunctatus*. However, it should be noted that these species are not as narrowly restricted to mossy fens as this category implies. The burrowing water beetle *Noterus crassicornis* and the diving beetles *Agabus undulatus* and *Hydaticus transversalis* are 'reedfen and pools' (W314) specialists. Four out of the 15 drains (27%) produced ISIS fen indicator species. By contrast, the floodplain ditches supported several beetles associated with open water over disturbed mineral sediments (ISIS SAT category W211) such as *Rhantus suturalis*, *Hydroglyphus geminus*, *Anacaena bipustulata*, *Helochares lividus* and *Enochrus melanocephalus* (*Laccobius sinuatus* might also be placed in this category). This reflects the recently disturbed character of these ditches, and also the effect of grazing and poaching by livestock.

5.1.17 Two ditches in this district can be classed as exceptionally species-rich for water beetles (i.e. they were amongst the richest 10% in the survey): Long Lane 'B' near Over (O15) and one of the Great Ouse floodplain drains (O12). Site O15 was the most species-rich in the whole survey. It also supported a beetle assemblage of exceptional quality, as measured by its Species Quality Index (SQI). Of those ditches for which SQI could be calculated (n = 12), four (30%) were of good quality and two (17%) were of very good quality.

5.1.18 Species Quality Score (SQS) is another metric for water beetle assemblage quality. Using this measure, Long Lane 'B' was the highest scoring site in the entire survey while ditch O12 on the Ouse floodplain was also in the top 10%. Another significant attribute of the Long Lane site was the presence together of four ISIS fen (W313/W314) indicators. As it ranked so highly on several metrics, this drain can be considered amongst the best in the study area in terms of its water beetle fauna.

5.2 **Bluntisham**

5.2.1 Eight ditches were sampled in this district on 25th June 2013, some others being too steep-sided to allow sampling. Land use is more mixed than in most of the Fens, with a mosaic of arable, grassland, floodplain grazing marsh, lane verges and gravel workings. Several mapped ditches had disappeared, presumably due to localised changes in water levels resulting from aggregate quarrying.

5.2.2 Many of the ditches were partly shaded and had a limited drain flora comprising small stands of Various-leaved Water-starwort *Callitriche platycarpa* and one sample point (B2) had a small flowering stand of Unbranched Bur-reed *Sparganium emersum*. Two gravel bedded drains (B4, B5) were dominated by stands of Narrow-fruited Watercress *Nasturtium microphyllum* and smaller species of duckweed (*Lemna minor*, *Lemna minuta*).

5.2.3 Ditch B6 had cattle poached margins with 3 species of yellow-cress (*Rorippa sylvestris*, *R. amphibia*, *R. palustris*) as well as occasional marginal stands of Greater Duckweed *Spirodela polyrhiza*. B6, B7 and B8 had good populations of Fine-leaved Water-dropwort *Oenanthe aquatica.*

5.2.4 Some 41 water beetle species were recorded. Noteworthy species included the Near Threatened great diving beetle *Dytiscus dimidiatus* and the Nationally Scarce burrowing water beetle *Noterus crassicornis*. These are both classified in ISIS as 'reedfen and pools' (W314) specialists. Two out of eight ditches (25%) produced ISIS indicator species.

5.2.5. More species-rich beetle lists were recorded from ditches B6, on the floodplain of the River Great Ouse, and B7 on the eastern boundary of Bluntisham Fen: both produced 15 species. B7 was notable for the presence of *D. dimidiatus* (three adults netted), *N. crassicornis* and several local species. *Dytiscus dimidiatus* was also found in a roadside ditch adjoining Overcote Lane (B3).

5.2.5 Bluntisham district did not produce any exceptionally species-rich ditches for water beetles. Species-poor assemblages were recorded for 38% of sites. Of those ditches for which the SQI of the water beetle assemblage could be calculated (*n*=5), two (40%) were of good quality and one was of very good quality.

5.3 Haddenham

5.3.1 The 12 ditches sampled in Haddenham Level Commissioners' drainage district had some of the richest aquatic macrophyte assemblages seen during the survey and were remarkable for the absence of Common Reed *Phragmites australis*. Many of the IDB drains had clear water (thought to be due to connection with ground water through gravel beds) and supported extensive populations of Broad-leaved Pondweed *Potamogeton natans*, Shining Pondweed *Potamogeton lucens* and Curled Pondweed *Potamogeton crispus*. Three sample points (H8, H9, H10) along two long and interconnected drains at Adventurer's Head were of particular note with large flowering populations of Hair-like Pondweed *Potamogeton trichoides*, Fan-leaved Water-crowfoot *Ranunculus circinatus,* Whorled Water-milfoil *Myriophyllum verticillatum*, the aquatic moss *Fontinalis antipyretica* (H11) and the National Scarce Clustered Stonewort *Tolypella glomerata* (H9). Orange Foxtail *Alopecurus aequalis* was also recoded of note at the water's edge of three sample sections (H2, H8 & H9).

5.3.2 The 12 Haddenham district drains produced 56 water beetle species. The Vulnerable reed beetle *Donacia dentata* was collected from Little Adventurer's Head Drain (H10). The Near Threatened scavenger water beetle *Berosus luridus* was recorded at five sites and was plentiful at two of these. Eight Nationally Scarce species included the burrowing water beetle *Noterus crassicornis* at two sites; the long-toed water beetle *Dryops similaris* at North Fen Drain (H2); the large diving beetle *Hydaticus transversalis*, the scavenger water beetle *Chaetarthria seminulum,* the riffle beetle *Oulimnius rivularis* and the aquatic weevil *Eubrychius velutus* at Adventurer's Head Drain (H8); and the water-plantain weevil *Bagous alismatis* at Gall's Drain (H11). This can be considered an exceptional concentration of rarities, although only *Noterus crassicornis* and *Hydaticus transversalis* are categorized as a 'reedfen and pools' (W314) specialist in ISIS. The local *Rhantus grapii*, recorded from H8 & H9, is classed as a specialist of moss and tussock fen (W313). Three out of the 12 drains (25%) produced ISIS fen indicator species.

5.3.3 Of all the districts surveyed, Haddenham had the highest proportion of very species-rich drains for water beetles (25%). North Fen Drove (H2) yielded 27 species including *Berosus luridus*, *Noterus crassicornis*, *Dryops similaris* and *Oulimnius* ?*rivularis*. The three sampling sites on Adventurer's Head Drain/ Little Adventurer's Drain (H8-H10) produced 35 species between them including *Noterus crassicornis*, *Hydaticus transversalis*, *Berosus luridus*, *Chaetarthria seminulum*, *Oulimnius rivularis*, *Eubrychius velutus* and *Donacia dentata*. As well as being of exceptional botanical quality, the Adventurer's Head Drain system is of outstanding interest for water beetles and likely to be of at least regional significance.

5.3.4 Of those ditches for which SQI could be calculated (*n*=11), six (55%) supported good quality water beetle assemblages. Haddenham had the highest proportion of such sites of all the districts surveyed. Three ditches (27%) had very good beetle assemblages and two (18%) were exceptionally good: Gall's Drain (H11) and Adventurer's Head Drain (H8).

5.3.5 Using another metric for water beetle assemblage quality, SQS, Adventurer's Head Drain (H8) and North Fen Drain (H2) were the second and third best sites in the survey. Another important attribute of H8 was the presence together of one Near Threatened and five Nationally Scarce species.

5.4 Sutton & Mepal

5.4.1 Large, trapezoidal drains characterise this Drainage District. Although intensive arable farming predominates, these often have clear water and support a rich macrophyte flora including extensive populations of Broad-leaved Pondweed *Potamogeton natans*, Shining Pondweed *Potamogeton lucens,* Curled Pondweed *Potamogeton crispus,* Hair-like Pondweed *Potamogeton trichoides*, Fine-leaved Water-dropwort *Oenanthe aquatica* (present as non flowering populations on the bed of IDB drains), Bristly

Stonewort *Chara hispida* var. *hispida* (S1, S21), Fan-leaved Water-crowfoot *Ranunculus circinatus,* Water-violet *Hottonia palustris* and Whorled Water-milfoil *Myriophyllum verticillatum.* It is presumed that clear water and the rich macrophyte flora reflects the influence of upwelling groundwater from the sands and gravels. Of particular note was a good population of Flat-stalked Pondweed *Potamogeton friesii* in the Forty Foot Drain (S24) along with a single plant of Frogbit *Hydrocharis morsus-ranae*. This was an intensively surveyed district with 32 sites sampled (12 watercourses on 26th June 2013, eight the following day and another 12 on 11th July 2013; two sites were re-visited during the May 2014 bottle-trapping survey).

5.4.2 Seventy nine water beetle species were recorded in total from the district. The Near Threatened scavenger water beetles *Hydrochus crenatus* and *Berosus luridus* were collected from marginal vegetation at six and 13 sites respectively. Although *B. luridus* was found widely during the survey, *H. crenatus* was largely confined to Sutton & Mepal, with just two records outside this district. The Near Threatened diving beetle *Agabus undulatus* was found in two adjoining drain sections at Langwood Fen (S26 & S27). Nationally Scarce species included the algivorous water beetle *Haliplus mucronatus* at Block Fen Drove (S18); a larva of the large diving beetle *Hydaticus transversalis* at Langwood Fen (S26); the tiny hydrophilid *Chaetarthria seminulum* at five locations; the riffle beetles *Oulimnius major* and *O. rivularis* at Engine Drain near Fortrey's Hall (S15) and Arthur Rickwood Farm (S22) respectively; and the water-plantain weevil *Bagous alismatis* at Sutton West Fen (S9). Even taking into account the large number of samples in this district, this represents an important and diverse list of aquatic Coleoptera.

5.4.3 Two of the water beetle species are categorized as 'moss and tussock fen' (ISIS W313) specialists: the diving beetle *Rhantus grapii* (recorded from seven sites) and the scavenger water beetle *Hydrochus crenatus* (six sites). However, both these species were associated primarily with reedy water margins during the present survey. The diving beetles *Agabus undulatus* and *Hydaticus transversalis* are listed as 'reedfen and pools' (W314) specialists. Thirteen out of the 32 drains (41%) produced ISIS fen indicator species, a markedly higher proportion than in other districts due to the frequency of *H. crenatus* and *R. grapii*.

5.4.4 Crooked Drain (S1) and ditches at Sutton West Fen (S9) and Blockmoor Fen (S3) were amongst the 10% most species-rich water beetle sites in the survey. However, the district supported only a small proportion of very species-rich drains (7%) and a relatively high proportion (56%) of species-poor ones.

5.4.5 Despite the relatively small number of species-rich drains for water beetles, Sutton & Mepal district includes numerous ditches with high quality assemblages of these insects, as assessed by Species Quality Index. Although this district provided only 18% of the sampling sites for the survey as a whole, it included nearly half the highest quality

beetle sites (those in the top 10% for SQI). Indeed, of all the districts surveyed, Sutton & Mepal supports the highest percentage of good, very good and exceptional quality water beetle assemblages. The apparent mis-match between species-richness and species quality in this district is partly attributable to the frequency of *Hydrochus crenatus* and *Berosus luridus* as well as a cluster of other species of conservation concern.

5.4.6 Of the 26 sites for which SQI could be calculated, 16 (61%) supported good quality assemblages, 15 (58%) had very good quality assemblages and six (23%) were of exceptional quality, i.e. the two sites at Arthur Rickwood Farm (S21 & 22), Engine Drain (S15), Sutton Meadlands (S10), Langwood Fen (S26), Sutton West Fen (S9) and Old Bedford Low Bank (S16).

5.4.7 Species Quality Score (SQS) provides an alternative measurement of water beetle assemblage quality. Again, Sutton & Mepal produced a disproportionate number of high-scoring ditches based on this metric: eight of the top 10% of sites (42%). Sutton West Fen (S9) was the fourth highest scoring site.

5.5 Manea & Welney

8.5.1 Twenty-two drains were sampled in Manea & Welney district on 2nd & 3rd July 2013. Many of the larger dykes produced unusually high electrical conductivity readings with frequent Fennel Pondweed *Potamogeton pectinatus* and the amphipod shrimp *Gammarus duebeni* (a species associated with mildly brackish water) occurring in at least five of the watercourses.

5.5.2 The Manea & Welney district arable drains were less botanically rich than some others, although IDB drains near Purls Bridge (M1,M2,M3) had good populations of Broad-leaved Pondweed *Potamogeton natans*, Whorled Water-milfoil *Myriophyllum verticillatum* and Fan-leaved Water-crowfoot *Ranunculus circinatus.* Two sample points were of interest in having marginal stands of the moss *Drepanocladus aduncus* whilst Small Pondweed *Potamogeton berchtoldii* was recorded from a single field drain (M12).

5.5.3 Ditches on the RSPB arable reversion fields were botanically rich (with Water-violet *Hottonia palustris* frequently being the dominant aquatic) and yielded a diverse water beetle fauna including 38 species, three of which are categorized as Nationally Scarce.

5.5.4 Seventy water beetle species were recorded from Manea & Welney district as a whole. Near Threatened species included the diving beetle *Agabus undulatus* at Old Mill Drove (M1) and the scavenger water beetle *Berosus luridus* at three sites. Nationally Scarce species included the scavenger water beetle *Enochrus quadripunctatus* at RSPB Purls Bridge (M6); the riffle beetles *Oulimnius major* and *O. rivularis* at Bishop's Land (M4) and Manea Fifties (M19) respectively; the reed beetle *Donacia impressa* at Purls Bridge

(M5); the water speedwell weevil *Gymnetron villosulum* at Purls Bridge (M6); and the water milfoil weevil *Eubrychius velutus* at Old Mill Drove (M1).

5.5.5 Two water beetles recorded from this district are listed in ISIS as being specialties of 'moss and tussock fen' (W313): the diving beetle *Rhantus grapii* (recorded from Manea Fifties and Day's Lode Road) and the hydrophilid *Enochrus quadripunctatus* (from Purls Bridge). Neither showed such an affinity during this survey. *Agabus undulatus* was the only 'reedfen and pools' (W314) specialist recorded from Manea & Welney district. Four out of the 22 drains (18%) produced ISIS fen indicator species.

5.5.6 Old Mill Drove (M1) and two of the ditches at RSPB Purls Bridge (M5 & M6) support exceptionally species-rich water beetle assemblages (i.e. these are amongst the richest 10% of sites in the survey). Some 14% of ditches were very species-rich while a relatively low proportion (38%) were species-poor.

5.5.7 Of the 20 ditches for which SQI could be calculated, nine (45%) supported good quality water beetle assemblages and two (10%) supported a very good quality assemblage. Old Mill Drove (M1) was amongst the highest scoring 10% of sites based on SQS, another measure of water beetle assemblage quality.

5.6 Upwell

5.6.1 Eleven ditches in Upwell district were sampled on 4th July 2013; one was re-visited during the bottle-trapping survey in May 2014. These were similar to the arable drains seen in Manea district, and many produced unusually high electrical conductivity readings. Generally, the drain flora was species-poor and dominated by Fennel Pondweed *Potamogeton pectinatus* and Ivy-leaved Duckweed *Lemna trisulca*. One notable exception was the 13 metre-wide Well Creek which supported Narrow-leaved Water-plantain *Alisma lanceolatum*, scattered stands of Flat-stalked Pondweed *Potamogeton friesii* and beds of Whorled Water-milfoil *Myriophyllum verticillatum.* This site was remarkable for the occurrence together of *Potamogeton friesii*, *P. pusillus* and *P. trichoides*. Small Pondweed *Potamogeton berchtoldii* (an uncommon and thought to be declining Fenland plant) was recorded from a single reed lined drain (U8).

5.6.2 A total of 48 water beetle species were recorded from Upwell district. Two locations produced the Near Threatened diving beetle *Agabus undulatus* with the scavenger water beetle *Berosus luridus* also found at two sites. The fauna was otherwise rather modest and typical of farmland drains in eastern England. The duckweed weevil *Tanysphyrus lemnae* and the small water beetle *Hydraena testacea* (a species of reedy water margins) were more frequent than elsewhere.

5.6.4 *Agabus undulatus* was the only 'reedfen and pools' (ISIS W314) specialist recorded from the Upwell samples. Therefore two out of the 11 drains (18%) produced ISIS fen indicator species.

5.6.5 Cross Drain (U1) and a drain near Cock Fen Farm (U4) support very species-rich water beetle assemblages (i.e. these are amongst the richest 10% of sites recorded in the survey). A relatively low proportion of ditches in Upwell district (27%) were classed as species-poor for water beetles.

5.6.6 Four ditches (36%) supported good quality water beetle assemblages in terms of SQI scores and one supported a very good quality assemblage.

5.6.7 A drain near Reed Fen Farm (U6) was amongst the highest scoring 10% of sites based on SQS, a different way of measuring water beetle assemblage quality.

5.7 Stoke Ferry

5.7.1 Only a small area of Stoke Ferry drainage district is represented within the study area, forming part of Fordham Fen. Nine watercourses were sampled on 25th June 2014, five of which were non-IDB field ditches. One sampling point was on the large, canal-like Cut-Off Channel (SF9). Generally, the drain flora was species-poor with occasional Blunt-fruited Water-starwort *Callitriche obtusangula*, Fennel Pondweed *Potamogeton pectinatus* and Ivy-leaved Duckweed *Lemna trisulca*. However, two drains (SF1 and SF4) were notable for their clear water and presence of good stands of Water-violet *Hottonia palustris* whilst one drain (SF5) supported the Nationally Scarce Clustered stonewort *Tolypella glomerata* along with Broad-leaved Pondweed *Potamogeton natans*, Thread-leaved Water-crowfoot *Ranunculus trichophyllus* and Canadian Water-weed *Elodea canadensis*.

5.7.2 A modest 37 water beetle species were recorded. The only species of conservation concern was the Near Threatened diving beetle *Agabus undulatus*, which was present in large numbers in ditch SF1 and in small numbers in SF4. This is categorised as a 'reedfen and pools' (ISIS W314) indicator species. Two uncommon and localised species, the diving beetle *Rhantus exsoletus* and the scavenger water beetle *Cercyon sternalis*, were recorded at their only locations during the survey, in ditches SF1 and SF8 respectively. The Cut-Off Channel produced three widespread reed-beetle species on emergent vegetation but merits more extensive survey as large watercourses were poorly represented in the survey.

5.7.3 None of the ditches in Stoke Ferry district could be classed as very species-rich for water beetles and this district had the highest proportion of species-poor sampling sites (67%), though this probably reflects the number of small field drains sampled on Fordham Fen.

5.7.4 Of the six ditches for which SQI could be calculated, two (33%) supported good quality water beetle assemblages and one supported a very good quality assemblage.

5.8 Littleport and Downham

5.8.1 This large drainage district covers much of the north of the study area, on both sides of the River Great Ouse. It is a predominantly arable district, with large areas of farmland lacking wet ditches. A total of 66 ditches were sampled in late June – early July 2014, with four sites also visited during the bottle-trapping survey.

5.8.2 Taken as a whole, Littleport and Downham district had a high proportion of species-poor ditches for water beetles (64%) and a low proportion of very species-rich ones (6%). Of the 54 ditches for which SQI could be calculated, 16 (30%) supported a good quality water beetle assemblage and eight (15%) supported a very good quality assemblage. Ten out of the 66 drains (15%) produced ISIS fen indicator species.

5.8.3 Because of the variability of ditch types and landscape, as well as the large area covered, Littleport & Downham district was sub-divided into five distinct areas:

Denver and the Ely Ouse (sample points LD1-5 & LD15): This included four narrow ditches bordering an area of rough grassland on the east side of the Great Ouse, immediately downstream of Denver Sluice. Also included were a sample from the adjacent channel (LD1) and another from the Ely Ouse upstream of Ten Mile Bank.

The deep water channel of the Ely Ouse (sample points LD1 & LD15) had a poor drain flora dominated by Yellow water-lilly *Nuphar lutea* with locally abundant macro algae (*Ulva flexuosa* and *Cladophora*). However, sample point LD15 was exceptional for the occurrence of Long-stalked Pondweed *Potamogeton praelongus*, which is classed as Endangered in England. The field drains (LD2-5) were reed-lined with a few bankside emergents typical of tall fen vegetation such as Purple loosestrife *Lythrum salicaria* and Comfrey *Symphytum officinale*. They supported no submerged aquatics other than occasional Ivy-leaved Duckweed *Lemna trisulca*.

Only 22 water beetles were recorded, the smaller ditches producing only widespread species. The sampling point on the Ely Ouse (LD15) was notable for the presence of the Nationally Scarce riffle-beetles *Oulimnius major* and *O. rivularis*. These are likely to be more widespread in the channel upstream of Denver Sluice. This sampling point produced an exceptional SQI score, although this was influenced by the relatively low number of species.

Hilgay Fen and West Fen (LD6-14, LD16-22 & LD47): These 17 drains were mainly in the open arable farmland between the eastern bank of the Washes and the River Great Ouse, but also included two adjoining Modney Bridge Road on Great West Fen, just east of the river.

This group of drains was remarkably similar floristically, being dominated by dense floating mats of Blunt-fruited Water-starwort *Callitriche obtusangula* and having good

water clarity. Plants associated with eutrophication such as Fat Duckweed *Lemna gibba*, Fennel Pondweed *Potamogeton pectinatus*, Rigid Hornwort *Ceratophyllum demersum* and macro algae generally occurred only in small amounts. A range of submerged aquatics were locally-frequent including Curled Pondweed *Potamogeton crispus* (5 samples), Fan-leaved Water-crowfoot *Ranunculus circinatus* (4 samples), Lesser Pondweed *Potamogeton pusillus* (6 samples), Hair-like Pondweed *Potamogeton trichoides* (4 samples) and the floating liverwort *Riccia fluitans* (10 samples). A single drain (LD21) was notable as the only site in the survey to yield Fringed Heartwort *Ricciocarpos natans*, a Nationally Scarce floating liverwort.

Thirty-nine water beetle species were found in this block. The Near Threatened *Berosus luridus* was caught in four field drains and was abundant in LD20. Nationally Scarce species included *Noterus crassicornis* and *Oulimnius rivularis* in Glover's Drain (LD18); and *Scarodytes halensis* and *Eubrychius velutus* in Ladyfen Drain (LD47). *Noterus crassicornis* is a W314 reedfen indicator whilst *Rhantus grapii*, recorded from LD21, is listed as a W313 moss and tussock fen indicator.

Ladyfen Drain (LD47) was amongst the 10% most species-rich water beetle sites recorded during the survey. A field drain south-west of Ouse Bridge Cottages (LD7) and another at Sedgedrove Farm (LD11) produced high SQI scores but this metric should be interpreted with caution since these supported relatively few water beetle species. Ladyfen Drain produced an exceptional SQS score.

Pymore (LD35-46): These 11 drains were situated between the Little Downham – Pymore road and the A1101. They included a mixture of minor drains and larger watercourses including Pymore Main Drain and Engine Basin.

This group of drains was notably eutrophic with poor water clarity and often had dominant floating mats of Fat Duckweed *Lemna gibba* and frequent macro algae (including *Vaucheria*) on the bed. Where duckweed mats were less dominant, occasional stands of Blunt-fruited Water-starwort *Callitriche obtusangula* have developed and, very locally, Lesser Pondweed *Potamogeton pusillus,* Hair-like Pondweed *Potamogeton trichoides* and the floating liverwort *Riccia fluitans* (5 samples). The Pymore Main Drain (LD35) was, however, exceptional with five *Potamogeton* species including Perfoliate Pondweed *Potamogeton perfoliatus* and Flat-stalked Pondweed *Potamogeton friesii*, a species listed as Vulnerable in England.

Thirty water beetle species were recorded including the Near Threatened *Berosus luridus* at Pymore Main Drain, LD35 and a ditch at Straight Furlong, LD36. *Oulimnius* netted at Main Drain and Engine Basin (LD42) were likely to be *O. major* or *O. rivularis*. The only record during the survey of the tiny diving beetle *Graptodytes granularis* was from Main Drain: this is classed as a 'moss and tussock fen' indicator (W313) in ISIS, though it can occur also in reedy water margins.

Pymore Main Drain supports a very species-rich water beetle assemblage (i.e. this is amongst the richest 10% of sites recorded in the survey). It also produced an exceptional SQI and SQS scores.

Witcham Hive and Byall Fens (LD23-34): This covers the area west of Witcham, Coveney village and Downham Hythe including Byall Fen, Great Dams Fen and Coveney Byall Fen. Twelve drains were included.

These drains are reed-fringed, shaded and floristically species poor. Water clarity was generally good but Fat Duckweed *Lemna gibba* was frequent and submerged aquatics limited to Blunt-fruited Water-starwort *Callitriche obtusangula* and Nuttall's Water-weed *Elodea nuttallii* (six samples). One drain at Coveney Byall Fen (LD33) was exceptional in having very high water clarity, being dominated by fruiting Shining Pondweed *Potamogeton lucens* (the only record from the Littleport & Downham district), frequent flowering stands of Fan-leaved Water-crowfoot *Ranunculus circinatus* and the floating liverwort *Riccia fluitans*. This watercourse was unusual as all of the closely connecting drains were either dry at the time of survey or species-poor with more discoloured water. This suggests that LD33 may be ground water fed. Stone Parsely *Sison amomum* was a more unusual bank species recorded from a single sample point (LD26).

Thirty-six water beetle species were recorded including a single specimen of the Near Threatened *Hydrochus crenatus* at Coveney Byall Fen (LD33). This species is categorised as a 'moss and tussock fen' (W313) indicator in ISIS, as is *Rhantus grapii*, which was recorded from LD29 at Byall Fen.

WWT Lady Fen/Bank Farm (LD48-66): These 18 drains were located within or bordering arable reversion grassland owned by the Wildfowl and Wetlands Trust (WWT). This has been established since 2008 with the aim of providing habitat for breeding waders displaced from the Ouse Washes by summer flooding. All but the most recently-established areas are cattle-grazed. Most of the sampling sites were on shallow 'foot drains', excavated for water level management and to provide foraging habitat for wetland birds (LD48-52, LD54-57, LD59 and LD62-63). However, pre-existing ditches were also included along with Ladyfen Drain on the south-east boundary of the site (LD53, LD58 and LD60-61). Some of the internal drains to the south-east of Bank Farm had only been excavated during the past year and were in an early successional stage.

The group of new drains (LD48-52, LD54-57, LD59 and LD62-63) had shallow, cattle-poached margins supporting flood plain grassland (NVC MG13) dominated by Creeping Bent *Agrostis stolonifera* and Marsh Foxtail *Alopecurus geniculatus*. A broad range of low emergents are present including Common Spike-rush *Eleocharis palustre*, Celery-leaved Buttercup *Ranunculus sceleratus*, Toad Rush *Juncus bufonius*, Brookweed *Samolus valerandi* (two samples), Blunt-flowered Rush *Juncus subnodulosus* (one

sample) and the Near Threatened Round-fruited Rush *Juncus compressus* (two samples). Water clarity was generally very good but only a relative small number of aquatics characteristic of fluctuating shallow drains were present including Blunt-fruited Water-starwort *Callitriche obtusangula,* Horned Pondweed *Zannichellia palustris* and Thread-leaved Water-crowfoot *Ranunculus trichophyllus.* The presence on the banks of several drains of Wood Small-reed *Calamagrostis epigejos* and Annual Beard-grass *Polypogon monspeliensis* is unusual but likely a result of these drains being relatively new (and still partially disturbed). The existing boundary drains (LD53, LD58 and LD60-61) contrast in being deeper and with steep banks, by having less clear water and being dominated by Fat Duckweed *Lemna gibba* and Blunt-fruited Water-starwort *Callitriche obtusangula*. A single sample (LD64) was of note for having a small fruiting stand of Lesser Pondweed *Potamogeton pusillus.*

Fifty-one water beetle species were recorded from WWT Lady Fen, seven of which are categorised as Nationally Scarce. These included the diving beetle *Agabus conspersus* from eight ditches, the scavenger water beetle *Enochrus quadripunctatus* from five and the Pink Water Speedwell weevil *Gymnetron villosulum* from two. The algivorous water beetle *Peltodytes caesus* and the diving beetles *Rhantus frontalis*, *Scarodytes halensis* and *Hygrotus parallellogrammus* were each collected from single locations. Both *A. conspersus* and *H. parallellogrammus* are brackish water specialists, with the site evidently supporting a large population of the former.

Several local water beetle species occur also, including *Dytiscus circumflexus*, *Enochrus melanocephalus*, *Laccobius sinuatus*, *Berosus signaticollis* and large numbers of *B. affinis*.

Two ditches (LD48 & 49) were exceptionally species-rich for water beetles (i.e. amongst the richest 10% of sites recorded in the survey). Ditch LD48 produced exceptional scores for the quality of its water beetle assemblage based on SQI *and* SQS; LD 57 also had an exceptional SQS score. Another outstanding attribute of LD48 was the presence of six Nationally Scarce species at a single sampling point.

6 Scoring of ditches based on quality indicator species and the distribution of ecologically important ditches within the Ouse Washes LPS area

6.1 Scoring of ditch sample points based on plant indicator species

6.1.1 Table 5 lists 20 quality indicator plant species comprising one Endangered, five Vulnerable and two Near Threatened (England Red List, Stroh *et. al*, 2014), four Nationally Scarce (Leach & Rusbridge, 2006 and Stewart, 2013) and nine local species. Local species have been selected on the basis of their association with macrophyte-rich drains based upon local knowledge.

Table 5: List of 20 quality indicator ditch plant species

Endangered and Vulnerable	*Potamogeton praelongus* (Endangered) *Juncus compressus* (Vunerable) *Hottonia palustris* (Vunerable) *Hydrocharis morsus-ranae* (Vunerable) *Oenanthe fistulosa* (Vunerable) *Potamogeton friesii* (Vunerable)
Near Threatened	*Myriophyllum verticillatum* (Near Threatened) *Eleocharis acicularis* (Near Threatened)
Nationally scarce	*Nymphoides peltata* (National scarce as native) *Ricciocarpos natans* (National scarce) *Tolypella glomerata* (National scarce)
Local	*Alisma lanceolatum (incl. Alisma cf lanceolatum)* *Chara hispida* var. *hispida* *Oenanthe fluviatilis* *Potamogeton lucens* *Potamogeton trichoides* *Potamogeton* x *salicifolius* *Ranunculus circinatus* *Riccia fluitans* *Utricularia vulgaris*

6.1.2 Figure 7 shows qualifying drains for plants (i.e. those with one to five qualifying species) and the proportion of Endangered, Near Threatened, Vunerable, Nationally scarce and local species and Figure 8 shows the number of qualifying plant species per IDB area (as a percentage proportion of samples per IDB area).

Figure 7 Qualifying drains for plants (i.e. those with one to five qualifying species) and the proportion of Near Threatened, Vunerable, Nationally scarce and local species

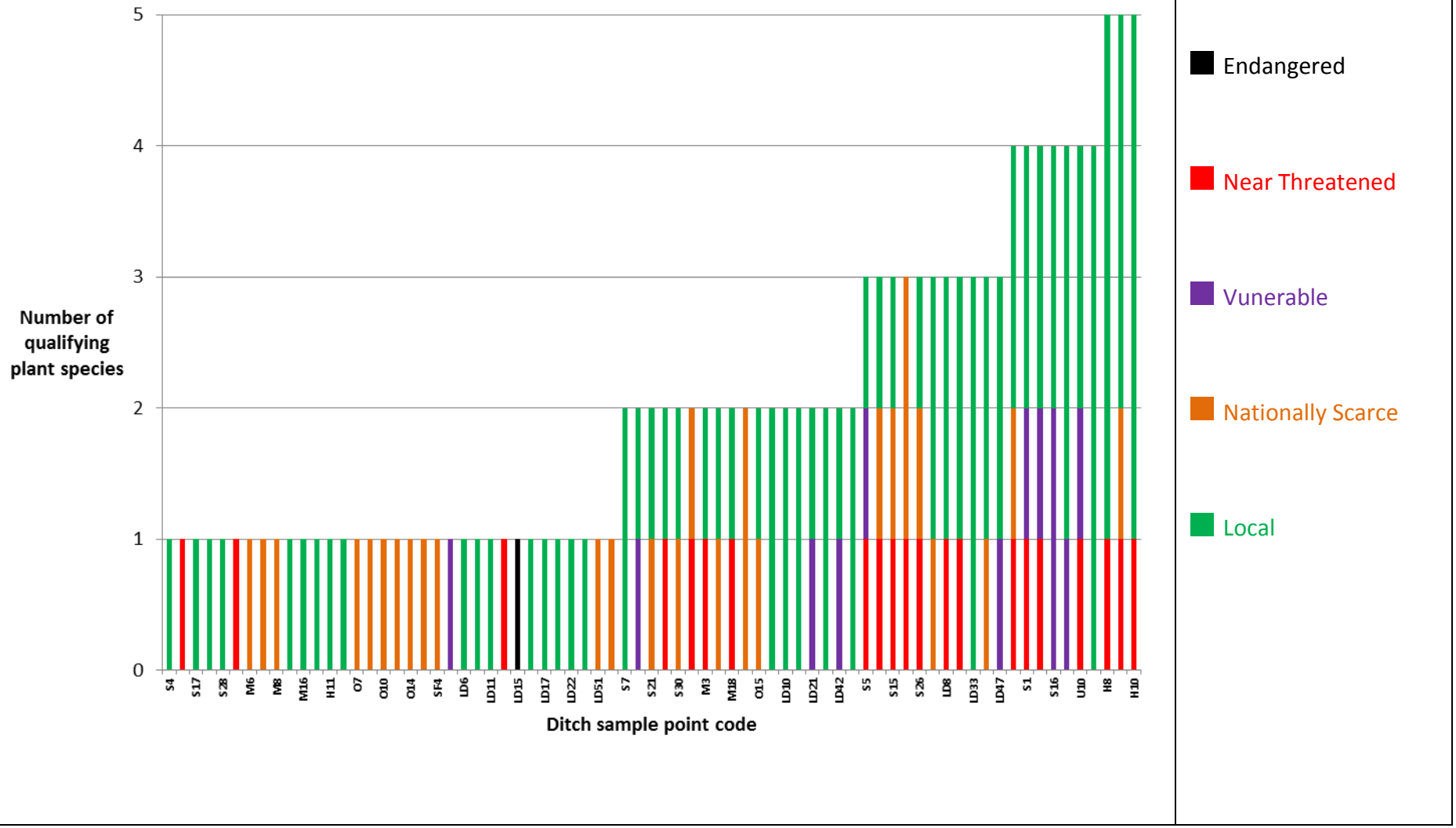
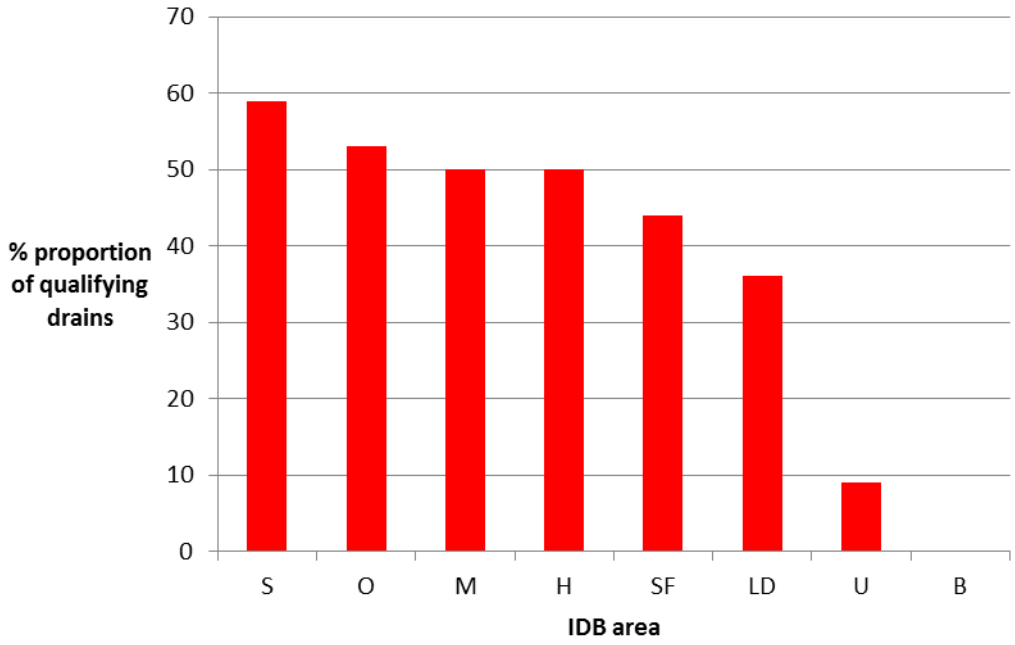


Figure 8 Number of qualifying drains for plants per IDB area (as percentage proportion of sampled drains per IDB area)



6.1.3 Out of 175 sampled drains in eight separate IDB areas, 73 (42%) have a least one qualifying plant species. There is general district order of increasing importance for plant quality indicator species which is Bluntisham: Upwell: Littleport & Downham: Stoke Ferry: Haddenham & Manea & Welney: Over & Willingham: Sutton & Mepal.

6.2 Scoring of ditch sample points based on aquatic Coleoptera indicator species

6.2.1 **WETSCORE (WETland Site COleoptera Record Evaluation)** is a method developed to assess the nature conservation quality of wetland habitats using aquatic Coleoptera (Foster, 1987; Foster & Eyre, 1992). The system is intended to be used in conjunction with the ecological classification of assemblages using multivariate analysis of a regional dataset. That is, it is a scoring system which allows comparison of sites supporting similar 'communities' of water beetles.

6.2.2 Each species recorded from a site is given an individual score based on its relative rarity in a national and regional context. The sum of individual species scores for the site is referred to as the **Species Quality Score (SQS)[6].** This can be divided by the **number of**

[6] Confusingly, the terms for these measures have been used differently in different versions of the methodology! Foster & Eyre (1992) use the term Species Quality Score (SQS) to denote the mean score per species, which is usually referred to elsewhere as the Species Quality Index (SQI) (e.g. in Drake *et al*, 2007). The aggregated points score is referred to by Foster & Eyre as "WET". We have used the term SQS as this is used in the Natural England guidance for site assessment using invertebrates (Drake *et al*, *ibid*).

species (NoS) to give the **Species Quality Index (SQI)**: a measure of the average 'quality' of the species recorded.

6.2.3 All SQI systems use a geometric progression of individual species quality scores in order to reflect differences in relative rarity and/or conservation status. For the purposes of this analysis, a commonly-adopted scoring system has been followed (Table 6). Individual species scores are shown in Table 7.

Table 6: Aquatic Coleoptera species scores used in the current assessment

Status	Species score
Widespread and common	1
Widespread but local	2
Uncommon: species listed as 'Local' in the ISIS methodology and species known to be rare in the Fens are included in this category	4
Nationally Scarce	8
Near Threatened	16
Red List (Vulnerable/Endangered/Critically Endangered)	32

Table 7: species scores for water beetles used in this assessment

species	score	species	score	species	score
GYRINIDAE		*Graptodytes pictus*	1	*Laccobius striatulus*	2
Gyrinus marinus	2	*Hydroporus angustatus*	1	*Laccobius colon*	1
Gyrinus substriatus	1	*Hydroporus discretus*	2	*Laccobius minutus*	1
HALIPLIDAE		*Hydroporus incognitus*	1	*Cercyon convexiusculus*	4
Haliplus confinis	2	*Hydroporus memnonius*	1	*Cercyon marinus*	2
Haliplus obliquus	2	*Hydroporus palustris*	1	*Cercyon sternalis*	4
Haliplus fluviatilis	1	*Hydroporus planus*	1	*Cercyon tristis*	4
Haliplus heydeni	4	*Hydroporus pubescens*	1	*Cercyon ustulatus*	4
Haliplus immaculatus	1	*Hydroporus striola*	2	**HYDRAENIDAE**	
Haliplus lineolatus	2	*Hydroporus tessellatus*	2	*Hydraena riparia*	1
Haliplus ruficollis	1	*Nebrioporus assimilis*	4	*Hydraena testacea*	4
Haliplus sibiricus	1	*Nebrioporus elegans*	1	*Limnebius nitidus*	4
Haliplus flavicollis	2	*Porhydrus lineatus*	2	*Ochthebius bicolon*	4
Haliplus mucronatus	8	*Scarodytes halensis*	8	*Ochthebius dilatatus*	2
Haliplus lineatocollis	1	*Hygrotus inaequalis*	1	*Ochthebius minimus*	1
Peltodytes caesus	8	*Hygrotus versicolor*	2	**DRYOPIDAE**	
NOTERIDAE		*Hygrotus impressopunctatus*	1	*Dryops luridus*	1
Noterus clavicornis	1	*Hygrotus parallellogrammus*	8	*Dryops similaris*	8
Noterus crassicornis	8	*Hyphydrus ovatus*	1	**ELMIDAE**	
HYGROBIIDAE		*Laccophilus hyalinus*	2	*Oulimnius major*	8
Hygrobia hermanni	2	*Laccophilus minutus*	1	*Oulimnius rivularis*	8
DYTISCIDAE		**HELOPHORIDAE**		*Oulimnius tuberculatus*	1
Agabus sturmii	1	*Helophorus aequalis*	1	**SCIRTIDAE**	
Agabus undulatus	16	*Helophorus brevipalpis*	1	*Contacyphon coarctatus*	2
Agabus bipustulatus	1	*Helophorus griseus*	4	*Contacyphon laevipennis*	2

Agabus conspersus	8	*Helophorus minutus*	1	*Contacyphon palustris*	2
Agabus didymus	2	*Helophorus obscurus*	1	*Scirtes hemisphaericus*	2
Agabus nebulosus	1	**HYDROCHIDAE**		**DONACIINAE**	
Agabus paludosus	2	*Hydrochus crenatus*	16	*Donacia clavipes*	4
Ilybius ater	1	**HYDROPHILIDAE**		*Donacia dentata*	32
Ilybius chalconatus	4	*Anacaena bipustulata*	4	*Donacia impressa*	8
Ilybius fuliginosus	1	*Anacaena globulus*	1	*Donacia semicuprea*	2
Ilybius quadriguttatus	2	*Anacaena limbata*	1	*Donacia simplex*	2
Platambus maculatus	2	*Anacaena lutescens*	1	*Donacia versicolorea*	2
Colymbetes fuscus	1	*Berosus affinis*	4	*Donacia vulgaris*	2
Rhantus grapii	4	*Berosus signaticollis*	4	*Plateumaris sericea*	2
Rhantus exsoletus	4	*Berosus luridus*	16	**ERIRHINIDAE**	
Rhantus frontalis	8	*Chaetarthria seminulum*	8	*Thryogenes festucae*	4
Rhantus suturalis	4	*Cymbiodyta marginellus*	2	*Thryogenes nereis*	4
Liopterus haemorrhoidalis	2	*Enochrus melanocephalus*	4	*Stenopelmus rufinasus*	1
Dytiscus circumflexus	4	*Enochrus quadripunctatus*	8	*Tanysphyrus lemnae*	1
Dytiscus dimidiatus	16	*Enochrus testaceus*	2	**CURCULIONIDAE**	
Dytiscus marginalis	1	*Helochares lividus*	4	*Gymnetron villosulum*	8
Hydaticus transversalis	8	*Hydrobius fuscipes*	1	*Bagous alismatis*	8
Hydroglyphus geminus	4	*Laccobius bipunctatus*	1	*Poophagus sisymbrii*	2
Graptodytes granularis	4	*Laccobius sinuatus*	4	*Eubrychius velutus*	8

6.2.4 These metrics (SQI, SQS, NoS) are different measures of the conservation quality of the water beetle fauna recorded from a site. They should be applied with caution, especially when comparing species lists that have not been allocated to different communities. Briefly:

- **Number of Species** is the simple measurement of species richness. Some habitats (e.g. acidic bog-pools) tend to have a naturally species-poor invertebrate fauna but good quality Fenland ditches are capable of supporting diverse assemblages.

- **Species Quality Index** is a measure of the mean (average) quality of the water beetle list for a site. Use of a mean figure is claimed to correct for differences in recording effort (Foster, 1997b). SQI works best for sites supporting a moderately diverse fauna: short species lists tend to be distorted by the presence of one or two scarcer species whilst long lists tend to converge on a 'middling' score due to the presence of many common species even when rarities are recorded.

- **Species Quality Score** reflects both the number of species and their individual scores. This metric is more influenced by recording effort than SQI but it highlights species-rich sites with a high proportion of less common species as well as sites with shorter lists supporting a high concentration of rarities.

6.2.5 In terms of **Number of Species (NoS)**, the water beetle data shows that between 0 and 35 species were recorded per sampling point, though only a single ditch produced no beetles. When additional records obtained during the bottle-trapping survey are excluded, the maximum number of species recorded on a single visit was 32.

6.2.6 For the whole dataset, the mean number of species per site is 9.84 and the median is 9. When additional records from the trapping survey are disregarded, the mean number is 9.4 but the median remains the same. As a simple measure, it can be said that ditches in the study area producing ten or more water beetle species during a single visit and using a similar sampling method are of above average species-richness.

6.2.7 Appendix 9 lists sites with nine or more species ranked by Number of Species (NoS). Ditches with 18 or more species represent the highest 10% of NoS scores for the whole dataset and can be regarded as **exceptional** (two sites, H8 and M1, would not meet this threshold if additional records were disregarded). These are listed in Table 8.

Table 8: The most species-rich ditches for water beetles

Ditch code	Name	NoS	Near Threatened (NT)/Nationally Scarce (NS) species
O15	Long Lane, N of Over (b)	35	2NT, 1 NS
H8	Adventurer's Head Drain (NW of Aldreth)	28	1 NT, 5 NS
S1	Crooked Drain, S of Mepal Outdoor Centre	28	1 NT, 1 NS
O12	Great Ouse floodplain, W of Over: Middle Fen NE boundary (b)	27	1 NS
H2	North Fen Drain at Dam Bank Bridge, Gall Fen	26	1 NT, 3 NS
M1	Old Mill Drove (nr old pumping stn), N of Welches	24	1 NT, 1 NS
LD48	Lady Fen 1, WWT Welney	22	6 NS
LD47	Ladyfen Drain at Station Road, SW of Ten Mile Bank	21	2 NS
M5	RSPB Purls Bridge	21	1 NS
S9	Sutton West Fen: N of Tubb's Drove	21	2 NT, 2 NS
LD49	Lady Fen 2, WWT Welney	20	2 NS
M6	RSPB Purls Bridge ('Godwit Fields')	20	2 NS
LD35	Main Drain at Common Bridge, Westmoor Common, Pymore	19	1 NT
S3	Blockmoor Fen, NE of Blockmoor Farm	19	1 NT, 1 NS
U4	Drain parallel to Old Bedford River, Welney	19	-
H9	Adventurer's Head Drain nr Clayton's Bridge (NW of Aldreth)	18	1 NT
U1	Cross Drain, SE of Cock Fen Farm	18	-

6.2.8 Fifteen of these 17 ditches support species of conservation concern, so species-rich ditches are also an important locus for scarce or threatened water beetles.

6.2.9 Very species-rich ditches (i.e. those listed in Table 8) are widely scattered across the study area with four in Littleport & Downham district, three each in Haddenham, Manea & Welney and Sutton & Mepal districts and two each in Over & Willingham and Upwell districts. There were none in Bluntisham or Stoke Ferry districts.

Proportionately, Haddenham supports the highest concentration of very species-rich ditches with another important cluster in Over & Willingham; there are relatively few in Littleport & Downham or Sutton & Mepal districts (Table 9).

Table 9: Distribution of the most species-rich ditches for water beetles by drainage district

Drainage district	Proportion of ditches supporting very species-rich water beetle assemblages (%)
Haddenham	25
Upwell	18
Manea	14
Over	13
Sutton	7
Littleport & Downham	6
Bluntisham	0
Stoke Ferry	0

6.2.10 Species-poor ditches, supporting less than the median number of water beetles species, were unevenly distributed (Table 10). Around two-thirds of the ditches sampled in Stoke Ferry and Littleport & Downham districts were species-poor but a much lower proportion in Bluntisham, Manea and Upwell. Since sampling sites were not randomly distributed and sample size varied between districts, these figures should be viewed with caution: however, they probably do reflect an underlying pattern.

Table 10: Distribution of the species-poor ditches for water beetles by drainage district

Drainage district	Proportion of ditches supporting species-poor water beetle assemblages (%)
Stoke Ferry	67
Littleport & Downham	64
Sutton	56
Over	53
Haddenham	42
Bluntisham	38
Manea	36
Upwell	27

6.2.11 When the 12 ditches in the bottle-trapping survey are considered, there was noticeable variation in the number of additional species recorded as a result of the additional visit. The most species-rich ditch in the survey (O15, Long Lane at Over) yielded only three additional species as a result of being re-visited. By contrast, the second most species-rich site, Adventurer's Head Drain (H8) produced 13 additional species when re-visited, including three species of conservation concern (*Hydaticus transversalis*, *Eubrychius velutus* and *Noterus crassicornis*). Grunty Fen Drain at Downham Hythe (LD34) produced

13 species when visited during the bottle-trapping exercise (all ditches were also hand-netted) but only two during the main survey. On average, a second visit produced 6.45 additional species.

6.2.12 An inherent problem with the **Species Quality Index (SQI)** metric is that short lists are liable to skewed by the presence of high-scoring species (Williams, 2000; Drake *et al*, 2007). In a test run of the survey data, by far the highest SQI score was for a ditch from which just two species were recorded, one of these being the Near Threatened *Berosus luridus*. Such a site is clearly not more valuable than one with *B. luridus* and 20 other species, but the latter would produce a much lower SQI.

6.2.13 This distorting effect can be reduced by stipulating a minimum number of species when an index value is to be calculated: Foster & Eyre (1992) suggested five but Drake *et al* (2007) recommend 15. For present purposes, it was decided to calculate SQI both for sites with five or more species (145 sites, 83% of the total) and for those supporting at least the median number of water beetle species (i.e. nine) (87 sites, 49% of the total). If the threshold recommended by Drake *et al* (2007) was adopted, only 36 sites could be assessed (21% of the total). The other metrics (NoS and SQS) have been calculated for the whole dataset.

6.2.14 Appendix 7 lists all sites with five or more species, ranked by SQI. Scores ranged from 1.0 to 4.64 with a mean of 2.02 and a median of 1.73. The best ≈10% of sites in this category were concentrated in Sutton & Mepal drainage district (seven of 15) with five in Littleport & Downham, two in Haddenham and one in Over.

6.2.15 The best ≈10% of sites had a SQI of 3.19 or above; a test run of all 175 sites gave the same figure whilst the figure for sites with ≥9 species was 3.27. This allows us to state with confidence that sites in the study area producing an SQI of 3.2 or more can be considered to support water beetle assemblages of **exceptional** quality.

6.2.16 The best 20% of sites have SQI scores of ≥ 2.71 (all sites), ≥ 2.81 (sites with five or more species) or ≥2.92 (sites with at least nine species). On this basis, sites with an SQI score of >2.7 can be considered to support **very good** quality water beetle assemblages.

6.2.17 Foster & Eyre (1992) suggest that an SQI of 2.0 or over indicates a 'good' quality site. On this basis, 40% of sites supporting at least five species and 57% of sites with nine or more species support good quality water beetle assemblages.

6.2.18 Good quality sites were distributed across all drainage districts, albeit unevenly. Table 10 summarises the proportion of high quality sites relative to the number of ditches within each district producing five or more species. Sutton & Mepal district had the highest proportion of good, very good *and* exceptional quality water beetle ditches, followed by Haddenham district.

Table 11: Distribution of high quality water beetle assemblages by drainage district			
Drainage district	**Percentage of ditches with 5 or more species supporting *exceptional* quality water beetle assemblages (SQI ≥ 3.2)**	**Percentage of ditches with 5 or more species supporting *very good* or *exceptional* quality water beetle assemblages (SQI ≥ 2.7)**	**Percentage of ditches with 5 or more species supporting *good* quality water beetle assemblages (SQI ≥ 2.0)**
Sutton	23	58	61
Haddenham	18	27	55
Littleport & Downham	9	15	30
Over	8	17	33
Manea	0	10	45
Bluntisham	0	20	40
Upwell	0	9	36
Stoke Ferry	0	17	33

6.2.19 Appendix 9 lists all sites with nine or more species ranked by SQI. The listed sites again produced SQIs ranging from 1.0 to 4.64. The best ≈10% of these sites were again concentrated in Sutton & Mepal district (five of nine sites) whereas Over and Littleport & Downham have only one each with two in Haddenham. It is noticeable that setting a threshold of nine species excludes a number of species-poor but high-scoring ditches in Littleport & Downham district.

6.2.20 **Species Quality Score (SQS)** is a metric which combines species-richness and species quality. It will be influenced by recording effort and accessibility. Appendix 10 lists all sites ranked by SQS. Scores vary from 0 to 100 with a mean of 21.2 and a median of 15. As a simple measure, sites sampled in a similar manner with an SQS of greater 21 can be considered 'above average' for the study area.

6.2.21 Sites with an SQS of 49 or above are within the best 10% using this metric. Because three sites score 49, the number of 'top' sites is 18. Eight of these are in Sutton & Mepal district, four in Littleport & Downham, two each in Over and Haddenham and one each in Bluntisham and Upwell.

6.2.22 The highest scoring 20% of sites all supported an above average number of species. However, some relatively high scoring sites yielded relatively few species but did support rarities: for example, ditch S22 (Arthur Rickwood Farm 'B') yielded only seven species but was within the top 25% of sites with an SQS of 32

6.2.23 Foster & Eyre (1992) observed that sites with an aggregated points score of >100 represented "top sites". However, their study included many large sites containing multiple water bodies. Only one site from this survey has a score of 100 (Long Lane at Over 'B', O15).

6.2.24 Three sites rank within the highest 10% for all three metrics (NoS, SQI and SQS): a ditch N of Tubbs Drove at Sutton West Fen (S9), Adventurers' Head Drain near Aldreth (H8) and Lady Fen 1 at WWT Welney (LD48).

6.2.25 The survey brief asked for samples to be evaluated based on the presence of species categorised in Natural England's ISIS methodology as indicators of 'moss and tussock fen' (Specific Assembly Type W313) and 'reedfen and pools' (SAT 314). The species allocated to these categories are shown in Table 12.

Table 12: ISIS fen indicator water beetle species recorded during the survey

ISIS SAT	W313 moss and tussock fen	W314 reedfen and pools
	Hydrochus crenatus *Enochrus quadripunctatus* *Graptodytes granularis* *Rhantus grapii*	*Agabus undulatus* *Dytiscus dimidiatus* *Hydaticus transversalis* *Noterus crassicornis*

6.2.26 For the dataset as a whole, 40 ditches (23%) supported one or more W313/314 indicator species. However, most of these yielded only one or two. The proportion of ditches supporting ISIS fen indicator species was between 15 and 27% for all districts except Sutton & Mepal, which was markedly higher at 41%. The site with the highest number of fen indicators was Long Lane 'B' near Over (O15), with two W313 and two W314 species.

6.2.27 However, the distribution of some species did not conform to the ISIS categories allocated to them: *Enochrus quadripunctatus*, for example, was found in silty or clayey ditch margins and showed no association with mossy or tussocky vegetation whilst *Hydrochus crenatus*, *Graptodytes granularis* and *Rhantus grapii* were all found in reedy marginal vegetation.

6.2.28 Sixty-three ditches (36%) yielded Nationally Scarce and/or Near Threatened water beetle species. A single site produced a Red List (Vulnerable) water beetle. No legally-protected or UK Biodiversity Action Plan Priority Species were recorded.

6.2.29 Forty-one sites (23%) produced Near Threatened species: 34 of these had a single species while seven yielded two. Forty ditches produced Nationally Scarce species: 27 produced one, nine produced two, two produced three and single ditches yielded five and six species.

6.2.30 Outstanding sites include Adventurers Head Drain near Aldreth (H8) with one Near Threatened and five Nationally Scarce species, and LD48 WWT Lady Fen with six Nationally Scarce species.

6.2.31 Species of conservation concern were not evenly distributed, with Sutton & Mepal and Haddenham drainage districts having the highest proportions of ditches supporting one or more species.

6.3 Distribution of drains of conservation importance

6.3.1 A list of drains of '**conservation importance**' has been produced by combining sample sites qualifying for plant species alone (as outlined in section 6.1), those qualifying for aquatic Coleoptera alone (as outlined in section 6.2) and those which qualifying for both plants and water beetles.

Due to the widespread occurrence of *Berosus luridus* in otherwise undistinguished drains, we have not defined important ditches for water beetles based simply on the presence of species of conservation concern. Instead, we have primarily defined important sites for water beetles using Species Quality Index, since this metric has been used widely in assessments of ecological quality in still water habitats. Consequently we have defined as important for water beetles all ditches with **very good** or **exceptional** SQI scores (see Paragraphs 6.2.15 and 6.2.16). However, this definition excluded some very species-rich ditches and sites with high cumulative Species Quality Scores. We therefore also included sites which ranked within the top 10% for both of these metrics. Based on the above definition, 42 ditches (24%) could be categorized as important for water beetles. Table 13 lists these drains of conservation importance that qualify for aquatic Coleoptera alone.

Table 13: Drains of conservation importance that qualify for aquatic Coleoptera alone

Code	Site name	Code	Site name
B7	Bluntisham Fen (eastern drain)	O14	Long Lane, N of Over (a)
H2	North Fen Drain at Dam Bank Bridge, Gall Fen	O15	Long Lane, N of Over (b)
H8	Adventurer's Head Drain, S of Third Bridge (NW of Aldreth)	S1	Crooked Drain, S of Mepal Outdoor Centre
H9	Adventurer's Head Drain nr Clayton's Bridge (NW of Aldreth)	S3	Blockmoor Fen, NE of Blockmoor Farm
H11	Gall's Drain nr Second Bridge, Gall Fen, Haddenham	S5	Crooked Drain adjacent Horseley Fen Middle Drove
LD7	field drain, SW of Ouse Bridge Cottages, Fordham Fen	S7	Sutton West Fen: New Cross Drove
LD11	field drain 1, N of Sedgedrove Farm, Hilgay Fen	S8	Sutton West Fen: N of Bedingham's Drove
LD15	Ely Ouse river, N of Ten Mile Bank	S9	Sutton West Fen: N of Tubb's Drove
LD35	Main Drain at Common Bridge, Westmoor Common, Pymore	S10	Sutton Meadlands: Meadlands Main Drove (nr microlight club)
LD47	Ladyfen Drain at Station Road, SW of Ten Mile Bank	S11	Sutton Meadlands: Meadlands North Drove
LD48	Lady Fen 1, WWT Welney	S15	Engine Drain, SW of Fortrey's Hall
LD49	Lady Fen 2, WWT Welney	S16	Old Bedford Low Bank: NE of Paradise Cottage

LD54	Lady Fen 7, WWT Welney	S17	Mepal Fen: drain at Black Bridge
LD55	Lady Fen 8, WWT Welney	S21	Arthur Rickwood Farm (a)
LD57	Lady Fen 10, WWT Welney	S22	Arthur Rickwood Farm (b)
M1	Old Mill Drove (nr old pumping stn), N of Welches	S26	Langwood Fen: E of Langwood Farm East (a)
M5	RSPB Purls Bridge	S29	Old Bedford Low Bank (a)
M6	RSPB Purls Bridge	S30	Old Bedford Low Bank (b)
M12	Manea Fifties: NE of Bond's Farm	SF1	Drain S of Twelve Acre Covert, Fordham Fen
M19	Manea Fifties: field drain adjacent Fifty Road	U6	Drain SE of Reed Fen Farm, Welney
O12	Great Ouse floodplain, W of Over: Middle Fen NE boundary (b)	U9	Upwell Fen, drain SE of Mill House

6.3.2 Using the above criteria, 85 samples (48%) qualify as drains of **conservation importance** comprising 43 (24%) that qualify for plant species alone, 30 (17%) that qualify for both plant and aquatic Coleoptera species and 12 (7%) that qualify for aquatic Coleoptera alone.

6.3.3 Figure 9 shows the number of drains of conservation importance per IDB District and Figure 10 shows the percentage proportion of drains of conservation importance per IDB District.

6.3.4 Seven of the 8 districts have drains of conservation importance for plants and water beetles and a single district (Bluntisham) has drains that qualify for aquatic Coleoptera alone. The locations of all drains of conservation importance within the Ouse Washes Landscape Partnership Area are shown in Appendix 2.

6.3.5 Four districts (Haddenham, Over & Willingham, Manea & Welney and Sutton & Mepal) have a proportionally higher number (50 to 65%) of drains of conservation importance.

Figure 9: Number of drains of conservation importance per IDB District

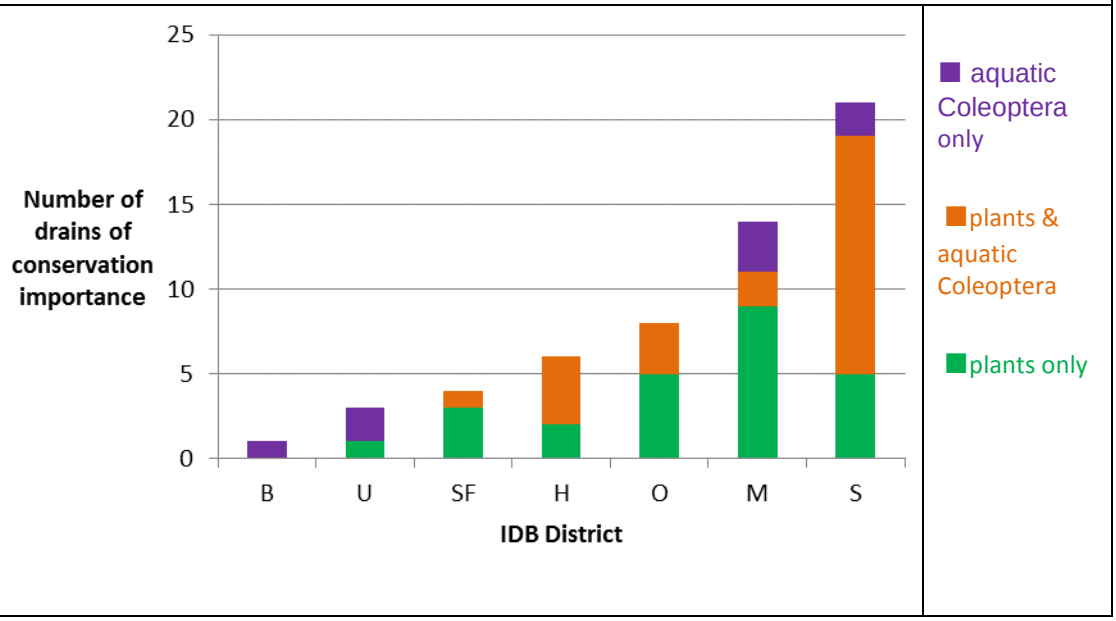
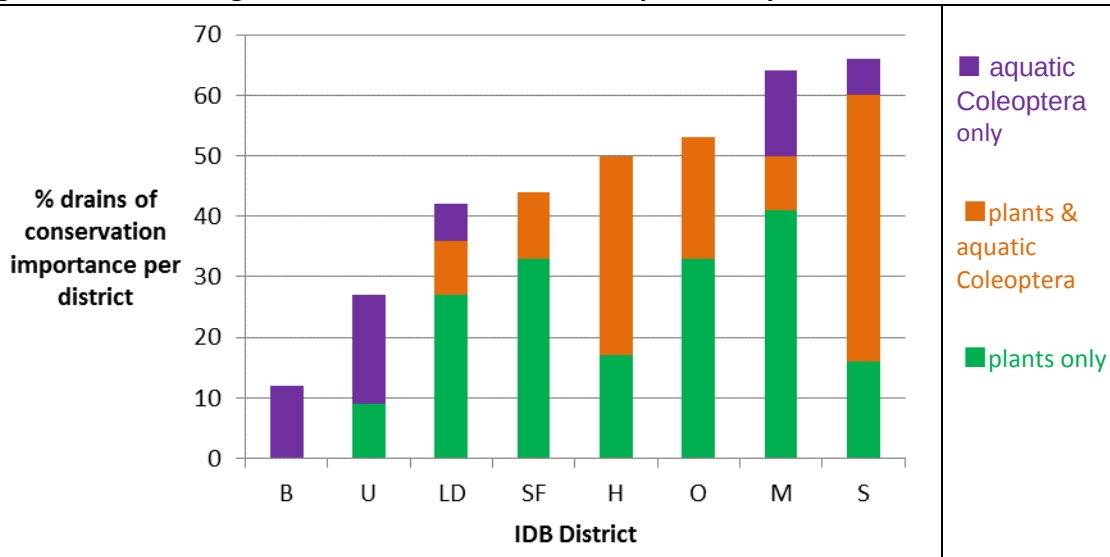


Figure 10: Percentage of drains of conservation importance per IDB District



7 Relationship between environmental factors and drains of conservation importance

7.1 A number of environmental parameters were recorded for each sample point including ditch bed substrate, width (water), successional stage, water pH and electrical conductivity, management intensity and adjacent land use. This section examines the influence of these factors on drains identified as being of conservation importance (section 6.3).

7.2 Ditch bed substrate

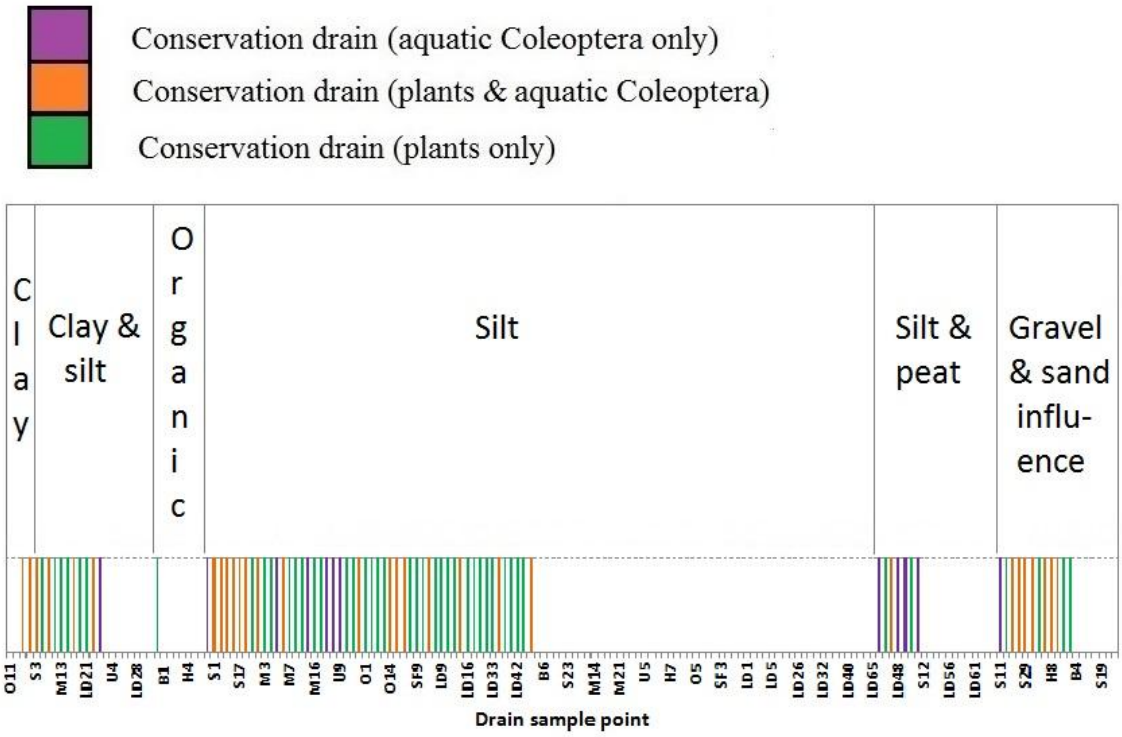
7.2.1 Historic ecological data suggests a correlation between arable ditch substrate type and richer macrophyte assemblages, with both sand & gravel or clay substrates being of noted importance (Mountford & Arnold, 2006). However, determining ditch substrate within the Ouse Washes LPS area was not straight forward in the field. The bed of many drains proved to be mixed (sand and gravel, gravel and silt, clay with silt for example) and the beds of numerous drains additionally had thin surface deposits of silt, ochre and sometimes organic detritus. It is possible that management practices such as regular scraping of drain beds contribute to the mixing of materials and strata (David Jordon, Haddenham Level Commissioners, pers. com.)

7.2.2 Drains were also encountered that had a bed substrate different from the dominant soil type of the surrounding farmland (for example, clay in a predominantly silt flood plain site or silt in a predominately sand and gravel area).

7.2.3 Figure 11 shows the relationship between broad drain bed substrate and drains of conservation importance for all sample points. It should be noted, however, that only "broad" drain bed substrate has been used and some ditches were recorded as having very mixed substrates, e.g. "Clay and silt (with some gravel and ochre)".

7.2.4 Drains of conservation importance were concentrated in Sutton & Mepal, Over & Willingham, Manea & Welney and Haddenham drainage districts. With the exception of Manea & Welney district, gravel substrates predominate within these districts. In addition, a high proportion of these drains had clear water whilst pH and electrical conductivity tended to be lower than elsewhere. These attributes are probably due to connectivity with ground water.

Figure 11: Relationship between broad drain bed substrate and drains of conservation importance for all sample points.



7.2.5 Analysis of recorded drain substrate type per sample point (Figure 11) does not show a strong relationship between substrate type and drains of conservation importance. This discrepancy likely relates to the often complex (mixed) nature of the substrates on the beds of drains and the fact that bed type does not always correspond exactly with underlying geology. However, a high proportion of drains with a sand or gravel influence (63%) are of conservation importance with many qualifying for both plants and water beetles.

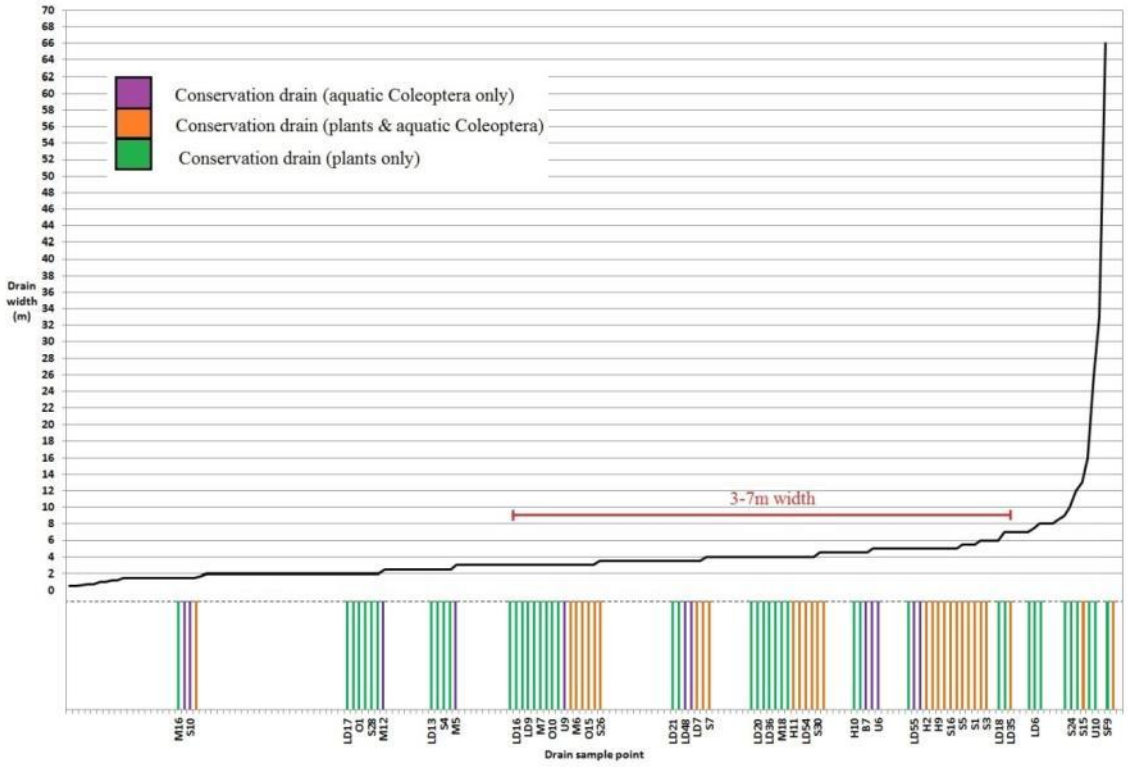
7.3 Ditch width (water)

7.3.1 Ditch water depth proved to be an unreliable character to asses as it was found to vary discontinuously across the area surveyed. IDB drains typically had a consistently maintained water depth or, during the survey period, had temporarily raised water levels to allow for irrigation of potatoes and other crops (in some drains, water levels had recently been raised by one metre or more). In contrast, smaller field drains typically had depths that were not maintained and could quickly draw down during periods of hot weather (which accounted for most of the survey period). Consequently, drain width (water) appears to be a more useful hydrological character.

7.3.2 Figure 12 shows drains of conservation importance plotted according to width. The relationship between ditch width and conservation quality is non-linear but the figure

shows that important drains for both plants and water beetles tend to be three to seven metres wide with 58 (68%) of all drains of conservation importance and 27 (90%) of drains qualifying for both plants and water beetles occurring within this width range. Kirby & Lambert (2003) similarly found that drains with a water width of 3.5m proved to be the most ecologically rich in a survey of 101 sites in northern Cambridgeshire in 2002.

Figure 12 Relationship between drain width (water) and drains of conservation importance for all sample points.



7.3.3 Further statistical analysis has been undertaken to investigate the relationship between drain width and plant and beetle species-richness. In Table 14, drains have been allocated to four categories of width. The analysis (using t-test) shows that there is a significant positive relationship (p = 0.022) between mean number of water beetle species and drain width for drains between 4 and 7.5 metres wide. There is a highly significant positive relationship (p = 0.000) between mean number of ditch plant species and drain width within the same category. There is significantly less relationship between mean number of water beetles or plants and other width categories. A separate correlation test indicated negligible correlation between ditch width and water beetle metrics (NoS, SQS and SQI) though SQI does appear to peak around five metres width. This is probably due to the spread of data rather than a lack of effect, and also the difficulty in sampling larger canal-like watercourses.

Table 14 Statistical analysis (average number of plants and water beetles per width category for sample points)

							Number of drains of conservation importance (%)			
	Plants			Beetles			Total	Plants only	Plants & beetles	Beetles only
Width category	Mean	SD	SE	Mean	SD	SE				
0 (0.6-1.7m)	7.17	3.96	0.83	9.30	4.77	0.99	17	4	4	9
1 (2-3.5m)	8.77	4.60	0.50	9.02	6.14	0.67	42	24	10	8
2 (4-7.5m)	12.70	6.20	0.83	11.64	6.65	0.89	66	27	32	7
3 (8-66m)	13.17	5.20	1.50	8.33	3.45	0.99	67	50	17	0

Beetle (width category 1 – 2) = - 2.62 SE = 1.11 t = -2.35 P-Value is 0.022323 [56 d.f. (2-tailed test)] = **Significant**	Plants (width category 1 – 2) = - 3.92 SE = 0.97 t = - 4.05 P-Value is 0.000159 [56 d.f. (2-tailed test)] = **Highly significant**

7.3.3 The reasons why relatively large (three to seven metre wide) drains are of conservation importance are complex. Larger sized drains tend to support more diverse plant assemblages and tend to be managed regularly (most being IDB drains), which prevents succession to reedswamp. The larger volume of water may also dilute pollutants more effectively than in small drains, thus maintaining water quality and clarity. Maintenance of high summer water levels in many larger drains for irrigation purposes will also protect submerged macrophytes from dehydration.

7.3.5 Few drains with a width (water) of less than three metres were of conservation importance and tended to be field drains that have a tendency to draw down during the summer months. Such drains have less available open water due to low intensity of management and are often encroached by emergent species, particularly Common Reed *Phragmites australis*.

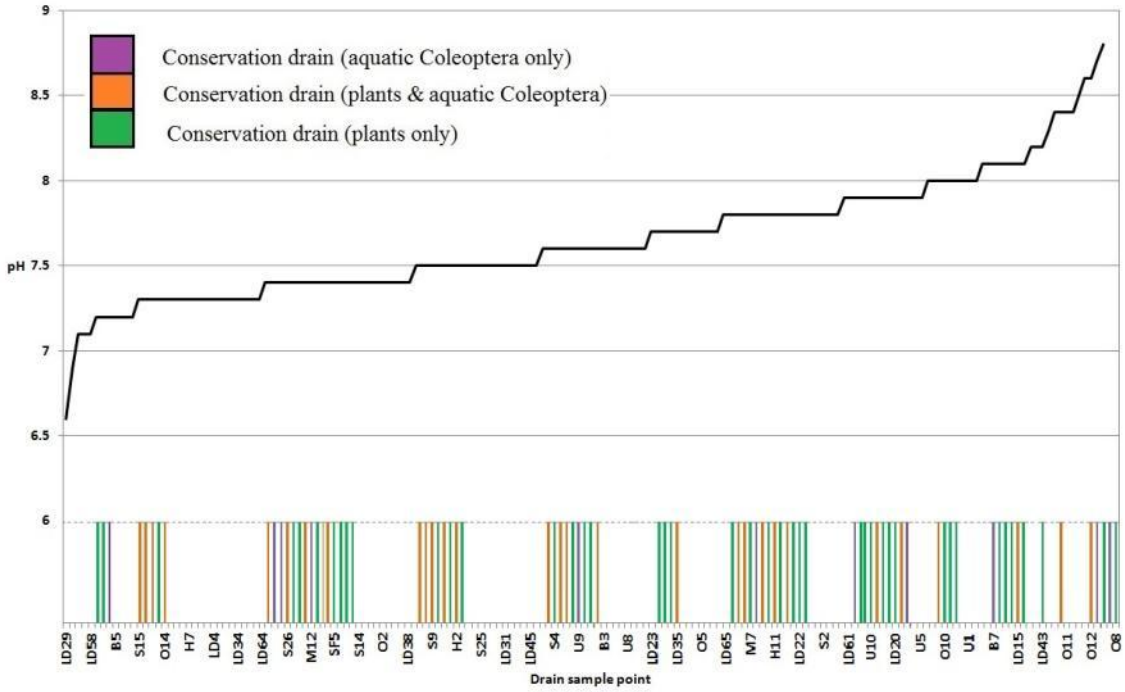
7.3.6 Drains with a width (water) of greater than seven metres are relatively few (13) and comprised only 7% of samples. Less of these drains are of conservation importance (compared with drains of three to seven meters width) and this is likely the result of nutrient loading associated with high flow (including the Ely Ouse, Cut-off Channel, Old West River and drains feeding into pump houses). However, these drains are important as three of the four sites for Flat-stalked Pondweed *Potamogeton friesii* were in these larger drains (S24 Forty Foot Drain, Sutton & Mepal district, U10 Well Creek, Upwell district and LD35 Pymore main drain, Littleport & Downham district) along with the only site for Long-stalked Pondweed *Potamogeton praelongus* (LD15, Ely Ouse, Littleport & Downham district). Very large drains were difficult to sample for water beetles but

appear to be important for species such as the Nationally Scarce *Oulimnius major* and *O. rivularis*. They may also be important for other aquatic invertebrates.

7.4 Water pH

7.4.1 Figure 13 shows the relationship between pH and drains of conservation importance for all sample points.

Figure 13: Relationship between pH and drains of conservation importance for all Sample points.



7.4.2 Water pH falls within a relatively narrow range for all sample points (predominantly between 7 and 8.5). Three sample points (S6, "Sutton West Fen", Sutton & Mepal district & LD28, LD29 "Byall Fen", Littleport & Downham district) produced anomalous and unstable readings which have been disregarded. These drains are all field drains that had a shallow water level at the time of survey and the anomalous pH readings are likely to be the result of algal photosynthesis in shallow water within direct sunlight.

7.4.3 It can be concluded that drains of conservation importance are spread across the range of recorded pH. However, analysis (using t-test) of average number of plants and beetles per sample against 3 categories of pH (Table 15) found there to be a significant relationship between average plant number ($p = 0.015$) and a higher range of pH (category 3 pH 8.0 – 8.8). The reasons for this are unclear.

Table 15 Statistical analysis (average number of plants and water beetles per pH category for sample points)

							Number of drains of conservation importance (%)			
	Plants			Beetles			Total	Plants only	Plants & beetles	Beetles only
pH category	Mean	SD	SE	Mean	SD	SE				
1 (c6.6 -7.4)	8.80	4.81	0.62	9.15	6.02	0.78	38	16	15	7
2 (7.5 - 7.9)	9.93	5.30	0.57	10.21	6.15	0.67	52	27	20	5
3 (8.0 - 8.8)	13.30	6.48	1.18	10.23	6.20	1.13	53	33	13	7

Plants (pH category 2 – 3) = 3.37
SE = 1.31
t = 2.56
P-Value is 0.015745 [assuming 30 d.f.
(2-tailed test)] = **Significant**

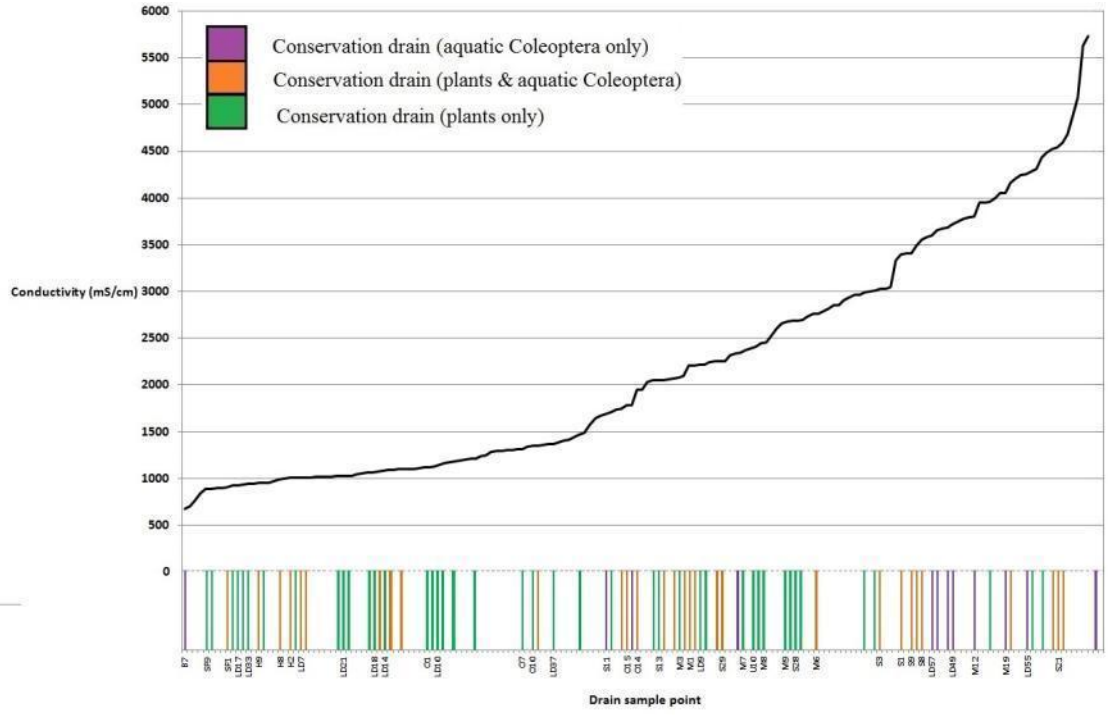
7.5 Water conductivity

7.5.1 Electrical conductivity is a measure of solute concentration and is sometimes used as a proxy indicator for nutrient status. However, this was clearly not the case in the ditches sampled during this study since all measurements were high for inland freshwaters, ranging from 900 to 5,600 µS/cm. This included drains with clear water supporting macrophytes associated with waters of relatively low macro-nutrient status such as *Utricularia vulgaris* and *Eleocharis acicularis*.

7.5.2 Figure 14 shows the relationship between conductivity and drains of conservation importance for all sample points.

7.5.3 Within the Ouse Washes LPS area there is a general pattern of increasing conductivity south-west to north-east following the line of the Ouse Washes towards The Wash. Readings of 800-3000 µS/cm are associated with gravel areas (Bluntisham, Over & Willingham and Sutton & Mepal districts), values of 3000-4500 µS/cm were obtained within Manea & Welney district and Littleport & Downham district while the highest readings (>5000 µS/cm) were from Upwell district. An exception to this pattern was observed in Stoke Ferry district which lies in close proximity to the tidal (Denver) end of the Ouse Washes but had conductivity readings under 2000 µS/cm.

Figure 14 Relationship between conductivity and drains of conservation importance for all sample points.



7.5.4 The reasons for high conductivity, particularly associated with Upwell district, are difficult to interpret and probably not related to surface water salinity despite close proximity to the Salters Lode and Well Creek drains which receive a small degree of hydrological influence from the tidal Great Ouse. Underlying estuarine sediments deposited prior to the great drainage efforts of the 17th century may be an influence: at two sites in Littleport & Downham district we found numerous well-preserved marine cockle shells in ditch dredgings.

7.5.5. There was a small and localized, but distinct, brackish water element to the ditch biota. The brackish water amphipod shrimp *Gammarus duebeni* was observed in numerous drains in Manea and Upwell districts whilst the diving beetles *Agabus conspersus* and *Hygrotus parallellogrammus* were recorded from WWT Lady Fen, along with Sea Club-rush *Bolboschoenus maritimus*. Drake (2004) noted the presence of a number of invertebrates typically associated with mildly brackish conditions on the RSPB Ouse Washes reserve.

Gammarus duebeni, a brackish-water amphipod recorded from drains in both Manea & Welney and Upwell districts

7.5.6 There is no clear correlation between conductivity and drains of conservation importance. However, a very high proportion of important drains qualifying for plants alone (88%) produced conductivity readings below 3500 µS/cm whilst a high proportion of important drains qualifying for water beetles alone (67%) occurred within the range of 3500 to 5730 µS/cm. Further statistical analysis (using t-test) confirms a strong positive relationship between number of water beetle species and conductivity (Table 16), i.e. mean NoS increases with conductivity. The reasons for this are unclear.

Table 16 Statistical analysis (average number of plants and water beetles per conductivity category for sample points)

							Number of drains of conservation importance (%)			
	Plants			Beetles			Total	Plants only	Plants & beetles	Beetles only
Conductivity category	Mean	SD	SE	Mean	SD	SE				
1 (680-1490)	11.13	5.74	0.65	8.51	6.08	0.69	44	31	12	1
2 (1570-2990)	9.48	4.87	0.66	10.26	6.11	0.83	55	30	20	5
3 (3000-5730)	9.09	5.79	0.88	11.77	5.64	0.86	44	7	21	16

Bettles (conductivity category 3 – 1) = 3.25
SE = 1.10
t = 2.95
P-Value is 0.005125 [assuming 43 d.f. (2-tailed test)] = **Highly significant**

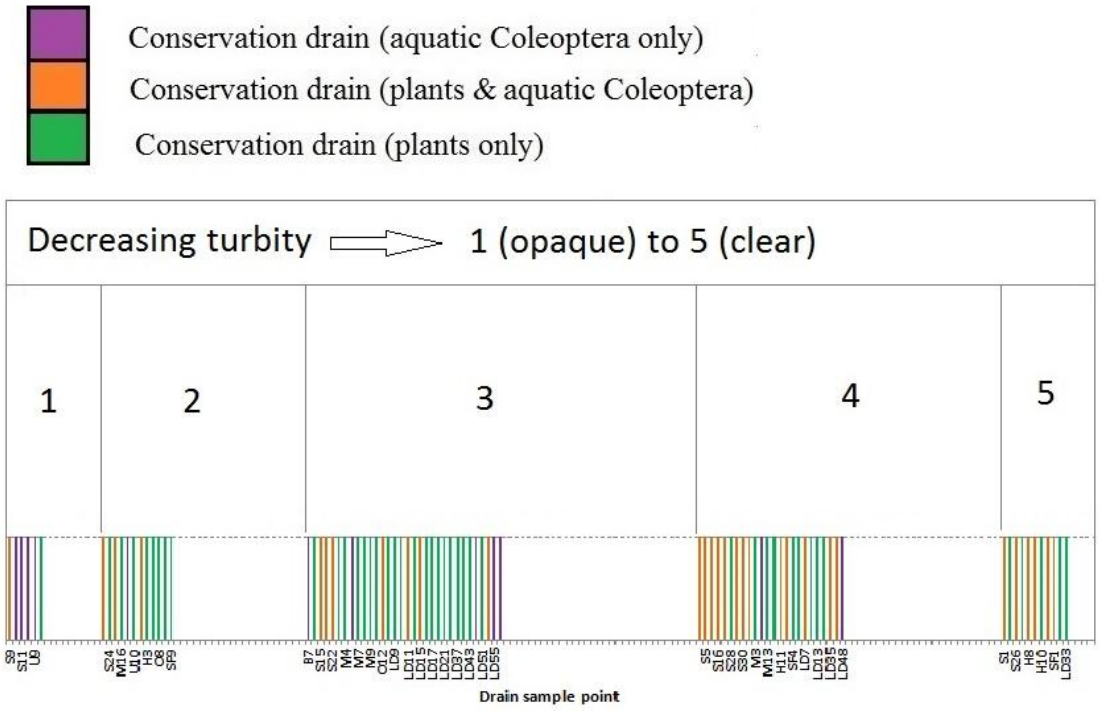
7.6 Turbidity

7.6.1 The measurement of turbidity is a good general field test of water quality (Marquis, 2005). In water bodies, high turbidity levels can reduce the amount of light reaching lower depths, which can inhibit growth of submerged aquatic plants and consequently affect species which are dependent on them including aquatic Coleoptera.

7.6.2 Turbitidy was assessed visually using 5 categories (1: opaque to 5: clear) and Figure 15 shows the relationship between decreasing turbity and number of drains of conservation importance for all sample points.

7.6.3 Figure 15 shows the relationship between turbidity and drains of conservation importance for all sample points. This suggests that drains which were important for both plants and water beetles tend to have clear water (categories 4 and 5). To investigate further this relationship, statistical analysis (using t-test) is provided in Table 17 for five categories of turbidity. A highly significant relationship exists between average plant number (p = 0.001) and clear water (turbidity category 5).

Figure 15 Relationship between turbidity and drains of conservation importance for all sample points.



7.6.4 Figure 15 also indicates a cluster of drains with turbid water which were important for water beetles alone. However, this is not statistically significant.

Table 17 Statistical analysis (average number of plants and water beetles per turbidity category for sample points)

							Number of drains of conservation importance (%)			
	Plants			Beetles			Total	Plants only	Plants & beetles	Beetles only
Width category	Mean	SD	SE	Mean	SD	SE				
1 (turbid)	6.47	3.91	1.01	10.53	6.00	1.55	40	7	7	26
2	11.06	6.81	1.19	9.03	5.85	1.02	33	24	9	0
3	9.81	5.32	0.67	9.33	5.39	0.68	49	31	11	7
4	9.59	4.62	0.66	9.43	5.41	0.77	48	18	26	4
5 (clear)	14.73	4.67	1.21	14.53	9.55	2.47	73	33	40	0

Plants (turbidity category 4 – 5) = - 5.14
SE = 1.37
t = - 3.74
P-Value is 0.001971 [assuming 15 d.f.
(2-tailed test)] = **Highly significant**

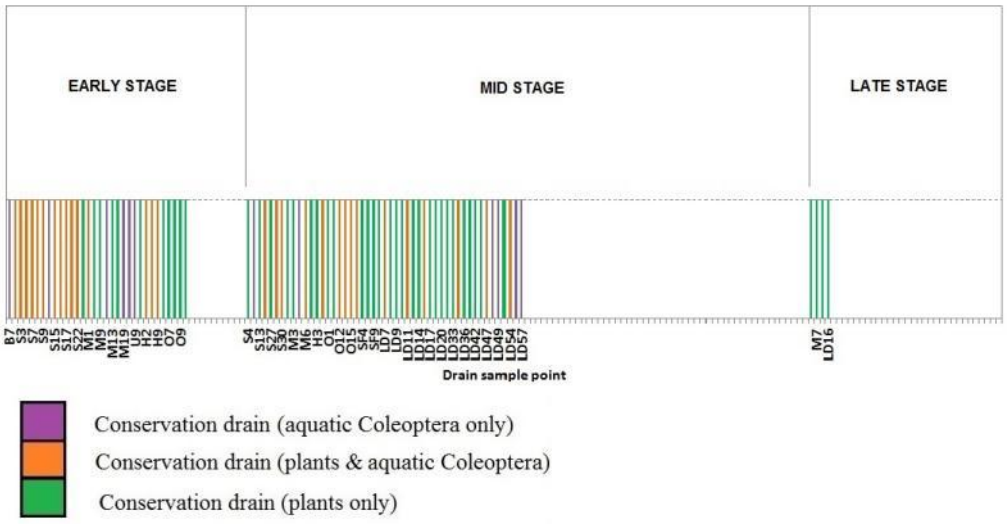
7.7 Ditch successional stage

7.7.1 Figure 16 shows the relationship between increasing drain successional stage and number of drains of conservation importance for all sample points. Early stage ditches are defined as those with a >70% clear central channel without tall emergent vegetation (typically *Phragmites* or *Sparganium erectum*) while late stage ditches are characterised by having no open channel and are completely dominated by tall emergent vegetation (most typically *Phragmites*). Mid stage ditches are classed as being between these two extremes. Early stage ditches often had open water but could also support dense floating mats of duckweed species (*Lemna* species and *Spirodela polyrhiza*) as well as macro algae (*Cladophora* and *Ulva flexuosus*).

7.7.2 It is apparent that drains of conservation importance are predominantly in the 'Early' or 'Mid' successional stage, with a high concentration of drains of conservation importance for both plants and water beetles associated with "Early" stage drains.

7.7.3 Practically all early stage drains were to 3 to 7.5m width IDB drains that receive annual management (weed clearance from central channel and/or dredging of the bed). These management practices, coupled with maintenance of high summer water levels for agricultural irrigation, provide open and deep water with good levels of light penetration that benefit many of the rarer plant species.

Figure 16 Relationship between increasing drain successional stage and number of drains of conservation importance for all sample points.



7.8 Management intensity

7.8.1 Management intensity was determined in 3 categories (Low, Medium and High) based upon discussions with IDBs, individual farmers and a site visit to Haddenham district to discuss the specific management (with David Jordon, Haddenham Level Commissioners).

7.8.2 Guidance for the conservation management of drainage ditches tends to point to a 4-10 year rotational cycle with examples of the ditches of the Somerset Levels & Moors managed on a 1−3 year rotation compared with ditches of the Broads ESA managed on a 4−10 year rotation (Mclaren *et al*., 2002). In contrast to this, a large proportion of drains within the Ouse Washes LPS area (including a high proportion of IDB drains) receive some sort of annual management such as weed clearance from central channel and/or dredging of the bed, usually from one side of the drain. However, in many cases this management takes the form of "a regular light touch" and drainage boards are encouraged to manage, where practical, a proportion of drains within a 2-3 year cycle (Carson, 2012).

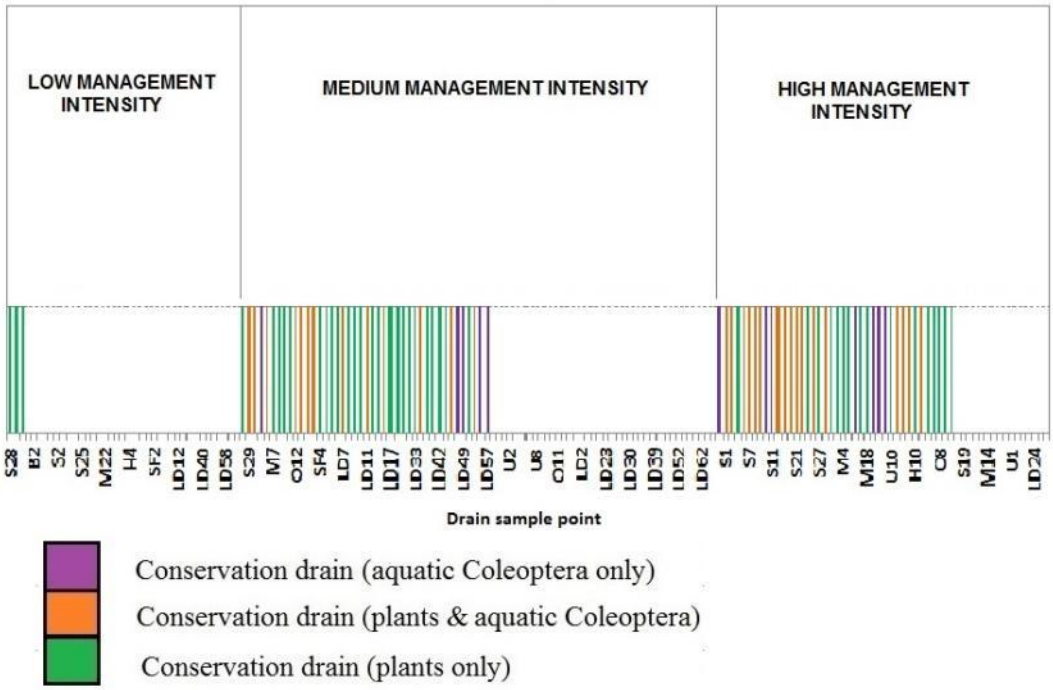
7.8.3 Some of the most botanically rich drains seen (such as those within the Haddenham and Sutton & Mepal districts) had dense stands of perennial pondweeds such as Broad-leaved Pondweed *Potamogeton natans* or Shining Pondweed *Potamogeton lucens* covering a large proportion of the bed and with stems reaching the water's surface. Many of these "mature" looking drains are weed cut annually (involving removal of weed from the majority of the central channel) whereupon these species regrow to the same extent each year. At the same time, these regular weed cuts create small

openings in the cover of broad-leaved species, allowing development of beds of submerged species such as Whorled Water-milfoil *Myriophyllum verticillatum* and Hair-like Pondweed *Potamogeton trichoides*. In addition, annual weed cuts appear to result in a mild annual scraping of the surface of the bed which removes larger organic detritus and exposes finer substrates which are known to be favoured by many aquatic plant species including pondweeds *Potamogeton* species (Preston, 1995).

7.8.4 Figure 17 (below) shows the relationship between increasing drain management intensity and number of drains of conservation importance for all sample sites. This shows that conservation importance correlates strongly with moderate to high management intensity: indeed a concentration of important drains (for both plants and water beetles) have a high level of management intensity.

7.8.5 Practically all of these intensively managed drains relate to 3 to 7m width IDB drains that receive annual management of some sort (weed clearance from central channel and/or dredging of the bed). These practices will benefit water beetles associated with permanent open water such as whirligigs (Gyrinidae), algivorous water beetles (Haliplidae), riffle beetles (Elmidae) and larger diving beetles (Dytiscidae). Many of these species favour the diverse and structurally-complex aquatic vegetation which is maintained by IDB management. However, other aquatic Coleoptera such as scavenger water beetles (Hydrophiloidea), moss beetles (Hydraenidae) and long-toed water beetles (Dryopidae) are associated with emergent vegetation at the edge of the channel and are likely to depend on maintenance of a less disturbed marginal fringe. Such species may, in effect, persist despite – rather than because of – ditch clearance; nonetheless their continuing presence at least confirms that management practices provide this continuity of marginal refugia.

Figure 17 Relationship between increasing drain management intensity and number of drains of conservation importance for all sample sites.



7.8.6 In Fenland drains, aquatic invertebrates associated with permanent open water benefit from regular removal of a proportion of the sediment and vegetation to prevent succession to reedswamp or development of dense floating vegetation. It is possible that regular removal of phosphate-rich sediment and plant biomass also helps maintain clear-water, mesotrophic conditions in some drains by reducing nutrient loads, though this remains hypothetical.

7.8.7 At the same time, management operations are liable to eradicate a large proportion of the invertebrate biomass. Very severe and uniform dredging has the potential to remove entire populations. A simple measurement of management intensity may therefore be less informative than an understanding of local management practices. In general terms, management which maintains patchy refugia of undisturbed in-channel vegetation is likely to be more beneficial to aquatic invertebrates than uniform clearance.

7.8.8 Some species of water beetles may have complicated life-cycle requirements, though these are generally poorly-known. As an example of a more specialised species, the rare reed beetle *Donacia dentata* has a two year life-cycle with larvae developing on the submerged parts of Arrowhead over two summers (Cox, 2007). Whilst regular management might be essential to maintain abundant arrowhead by preventing the channel from silting-up and becoming overgrown, intensive annual clearance could eliminate this species.

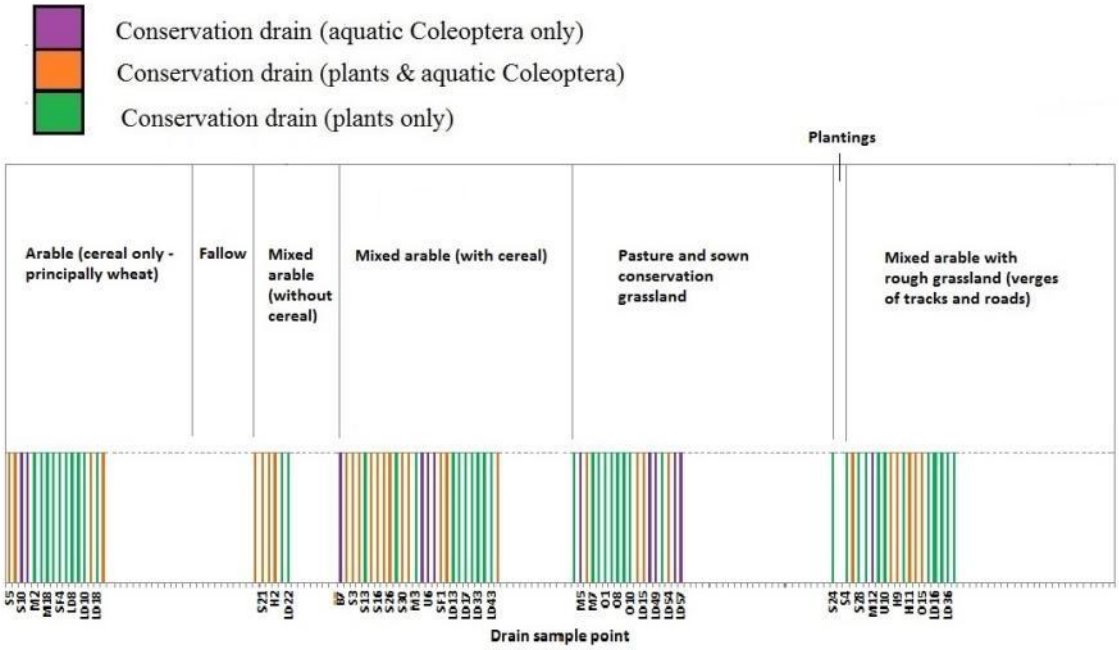
7.9 Adjacent land use

7.9.1 The Ouse Washes LPS area is situated within a highly productive arable region of eastern England and the principal land use adjoining sample points was mixed arable crops (particularly wheat, sugar beet and potatoes), which are traditionally farmed on a rotational basis. Occasionally, other crops were present including peas, beans, leeks and maize.

7.9.2 Permanent pasture within the LPS area is associated with rivers such as the Great Ouse (Bluntisham and Over & Willingham districts), Old West (Haddenham District) and Ely Ouse adjoining Denver Sluice (Littleport & Downham district). Also two relatively new but important areas of pasture are associated with conservation projects (the RSPB pilot project at Purls Bridge/Welches Dam in Manea & Welney district and WWT project at Lady Fen/Bank Farm in Littleport & Downham district).

7.9.3 Figure 17 shows the relationship between land use and number of drains of conservation importance for all sample sites. Drains of importance for plants alone occur generally within all land use types. However, drains important for both plants and water beetles are associated with mixed arable and are rarer in purely cereal (principally wheat) areas. In addition, a greater proportion of drains of conservation importance for water beetles alone are associated with areas of grazed pasture, reflecting the importance of this type of flood plain habitat.

Figure 18 Relationship between land use and number of drains of conservation importance for all sample sites.



7.10 Bank steepness

7.10.1 Statistically, there was a moderately strong negative relationship between the angle of the bank and ditch plant species-richness (r = - 0.4). There was also a modest negative correlation with water beetle species-richness (NoS) (r = -0.31). In other words, the steeper the bank, the fewer wetland plants and beetles tended to be recorded. In the case of water beetles, this may partly reflect the fact that steep-sided drains tended to be more difficult to sample with a hand-net but this is unlikely to have had a significant effect on plant recording.

7.10.2 Interestingly, there was a negligible correlation between the angle of the bank and either the quality of the water beetle assemblage (SQI) or the number of 'quality' plant species recorded. So, although steep-sided drains appear to support fewer wetland plants and beetles, this does not seem to influence the 'quality' of the assemblages.

7.11 Shade

7.11.1 All three water beetle metrics (NoS, SQS, SQI) showed a small negative correlation with direct shade (i.e. the percentage of the channel overhung by trees or shrubs). There was a small negative correlation with the number of 'quality' plant species though there was a negligible relationship with the number of ditch plant species overall. Relatively few of the drains we sampled were tree-lined, and this is probably not a significant influence in the open Fenland landscape.

8 Comparison of Ouse Washes LPS area sample points with other sites in England and Wales using the Buglife "five metrics" methodology for plants

8.1 The Invertebrate Conservation Trust Buglife has developed a methodology to assess ditch plant and invertebrate assemblages in England and Wales based on over 540 ditch samples from coastal and flood plain grazing marshes in Gwent, Anglesey, Somerset, Sussex, Kent, Essex, Suffolk and Norfolk (Palmer *et al*., 2013). This methodology centres on the five "metrics" of:

- Species Richness
- Species Conservation Status (SCS) as a species quality index
- Habitat Quality (relating to Ellenberg indicator values for nitrogen)
- Naturalness (i.e. the impact of introduced species), and
- Salinity Index.

This methodology allows assessment of both fauna and flora based on a sample of ditches without the need for comprehensive survey of a whole site.

8.2 Table 18 gives the following data for the five metrics (plant data only) based on plants listed in Table 1 of "A manual for the survey and evaluation of the aquatic plant and invertebrate assemblages of grazing marsh ditch systems - Version 6" (Palmer *et al.*, 2013) for:

1. Plant data from freshwater ditches in southern England and Wales (based on 462 samples, Buglife 2010);

2. Plant data from within the Ouse Washes Landscape Partnership Scheme (LPS) area (based on 175 samples);

3. Plant data from field ditches from within the Ouse Washes Site of Special Scientific Interest (SSSI) based on 100 random samples from 591 samples (Graham, 2011) which follow (repeat) sample sites and methodology devised by Cadbury et al. (2001);

4. Plant data from the Ouse Washes Counter (outer) drain – part of the Ouse Washes Special Area of Conservation (SAC) based on 9 samples (Lansdown 2011);

5. Plant data from the Ouse Washes Delph (inner) drain – part of the Ouse Washes Special Area of Conservation (SAC) based on 5 samples (Lansdown 2011);

This allows comparison of these 5 data sets.

Table 18: Comparison of the Buglife "five metrics" data (plant data only) for sites in England & Wales							
Site		**Number of samples**	**Mean species richness**	**Mean SCS score**	**Mean Habitat quality score**	**Mean Naturalness score**	**Mean plant salinity index**
Freshwater ditch samples, England & Wales (Buglife 2010)		462	11.9	1.4	1.7	-3.4	0.5
Ouse Washes LPS area, all districts (Graham & Hammond 2013)		175	8.5	1.1	1.6	-0.8	0.7
	Over & Willingham	15	10.3	1.4	1.9	-1.4	0.7
	Bluntisham	8	7.7	1.0	1.4	-1.1	0.3
	Haddenham	12	10.1	1.0	1.5	-1.3	0.3
	Sutton & Mepal	32	8.6	1.1	1.6	-0.8	0.5
	Manea & Welney	22	7.0	1.1	1.6	-0.3	0.7
	Upwell	11	6.8	1.0	1.7	0	1.5
	Stoke Ferry	9	7.1	1.0	1.5	-1.0	0.7
	Littleport & Downham	66	8.2	1.0	1.4	-0.6	1.0
Ouse Washes SSSI (Graham, 2011)		100	11.4	1.2	1.5	-1.2	0.4
Ouse Washes Counter (outer) drain SAC (Lansdown, 2011)		9	17.8	1.8	2.7	-4.2	0.8
Ouse Washes Delph (inner) drain SAC (Lansdown, 2011)		5	11.4	1.1	1.7	-5.6	0.5

8.3 Based on the Buglife “five metrics” methodology, the Ouse Washes LPS area as a whole compares favorably (having a similar score) to the Buglife England & Wales (2010) data in regard to mean SCS and mean habitat quality scores and scores marginally better than the internal drains of the Ouse Washes SSSI in regard to mean habitat quality score. However, all these sites score less than the Ouse Washes Counter drain (also part of the Ouse Washes SAC) which is a site of historic botanical richness due to hydrological connectivity to gravels in the Sutton & Mepal district and minimal hydrological influence from the highly eutrophic Great Ouse. The above average plant salinity index score for the LPS area relates to high individual scores for two districts that had sample points with high conductivity readings (Upwell and the Lady Fen/Bank Farm area within Littleport & Downham).

8.4 There is a small variation in mean species quality (SCS) between the eight districts with three districts (Over & Willingham, Sutton & Mepal and Manea & Welney) having proportionally higher scores. This compares favourably with the assessment of drains of conservation importance for plants alone (refer to section 6.1.3) which has highlighted two districts (Over & Willingham & Sutton & Mepal) as having a higher proportion of qualifying plant species.

9 Conclusions

9.1 The predominantly agricultural drains surveyed within the Ouse Washes LPS area have significant ecological value for their ditch plant and water beetle assemblages.

9.2 Many noteworthy species were recorded from across all eight districts surveyed. These included one Endangered, two Near Threatened, five Vulnerable and two Nationally Scarce plants as well as one Vulnerable, four Near Threatened and 18 Nationally Scarce aquatic Coleoptera. However, four districts (Haddenham, Over & Willingham, Manea & Welney and Sutton & Mepal) have a proportionally higher number of drains of conservation importance (qualifying for both plants and aquatic Coleoptera). In addition, 12 other plant species recorded during the survey are considered important in a local (Fenland) context. Drains were also shown to support BAP species such as Water Vole and Spined Loach as well as amphibians, Odonata and other wildlife.

9.3 In contrast to the "drain" flora, the "bank" flora of ditches had no noteworthy plant species and comprised rough grassland dominated by Common False-oat *Arrhenatherum elatius* (68% by area cover). However, it is considered that the linear rough grassland corridors of drain banks are an important habitat for a wider range of biodiversity including ground nesting birds and the high frequency of annual plants such as Charlock *Sinapis arvensis* (3% area cover) are likely to be important for seed eating birds such as Corn Bunting *Miliaria calandra* and Reed Bunting *Emberiza schoeniclus.*

9.4 Overall, drains of importance for both plants and aquatic Coleoptera tend to be moderately wide (three to seven metres) with low turbidity and early successional conditions. In addition, statistical analysis of plant metrics strongly supports a relationship between average number of plants and moderately wide (4 – 7.5 metres) drains, and also with clear water. However, some individual environmental parameters tended to show only weak associations with plant and beetle numbers and a more sophisticated analysis of the data using multivariate techniques would doubtless be informative.

9.5 The important factors of drain width, low turbidity and early successional conditions are directly linked to intensity of management. The majority of these high conservation value drains are IDB controlled and their importance for wetland plants is associated with regular weed clearance (often annually), mild scraping of the bed (often annually as part of dredging works or as part of weed removal) and maintenance of high summer water levels for irrigation purposes. However, the response of water beetles to ditch management is likely to be more variable than for wetland plants. Beetles requiring permanent open water are likely to benefit from regular management which maintains diverse and complex submerged vegetation structure, whereas those associated with the emergent fringe will depend on a continuity of less disturbed refugia at the edge of

the channel. Severe scouring of whole lengths of channel is likely to be particularly damaging for invertebrates in general.

9.6 There is a negative correlation between bank steepness and the number of wetland plant and water beetle species recorded (although there appears to be little effect on the 'quality' of these assemblages). As drains in the study area are typically steep-sided, this may significantly limit biodiversity as many plants and animals favour a graduated, fluctuating water margin.

9.7 Some 48% of the drains surveyed could be classed as being important for biodiversity. These included 43 (24%) which qualified for their botanical interest, 30 (17%) which qualified for both plants and water beetles and 12 (7%) that qualify for aquatic Coleoptera alone.

9.8 While drains of conservation importance for plants alone occur within all land use types, a greater proportion of drains which are important for both plants and water beetles are associated with mixed arable cropping and are rarer in purely cereal (principally wheat) areas. This may not be a constant factor since crop type is influenced by market conditions and farm rotations but there does appear to be a distinction between cereal farms and mixed arable enterprises in the Fens.

9.9 For water beetles alone, a greater proportion of important drains are associated with areas of grazed pasture, which reflects the importance of this type of flood plain habitat. Shallow foot drains on recently-created conservation grassland at RSPB Purls Bridge and WWT Welney were very notable for their water beetle fauna. These grazing marsh ditches supported different water beetle assemblages to arable drains and several species of conservation were restricted to this habitat.

9.10 All eight surveyed IDB areas had drains of conservation importance but four districts (Haddenham, Over & Willingham, Manea & Welney and Sutton & Mepal) have a proportionally higher number of drains of conservation importance (qualifying for both plants and aquatic Coleoptera).

9.11 The Buglife "five metrics" methodology has been applied to the survey dataset as a whole as well as to individual IDB districts for plants. The Ouse Washes LPS area as a whole compares favourably with (has a similar score) to the Buglife England & Wales (2010) data in regard to mean SCS and mean habitat quality scores and scores marginally better than the internal drains of the Ouse Washes SSSI in regard to mean habitat quality score.

10 Recommendations

10.1 Undertake plant and invertebrate surveys of other aquatic habitats such as agricultural reservoirs and gravel pits within the Ouse Washes LPS area to establish their ecological relationship to the ditch network.

10.2 This survey was based on 20 metre sampling points rather than whole drains. The results suggest that some individual ditches or ditch systems are of outstanding value for biodiversity, e.g. Long Lane at Over (O15), North Fen Drain (H2) and Adventurers' Head drain system (H8-H10). More comprehensive surveys of such sites, including a wider range of aquatic invertebrate taxa, would contribute substantially to improving our understanding of the highest quality Fenland drains.

10.3 The results of this survey suggest there may be potential conflicts between favourable management of ditches for plants on the one hand and invertebrates on the other: aquatic plants seem to benefit from the regular management which takes place in large IDB drains but some invertebrates may require a continuity of less disturbed habitat at the edges of the channel. One possible solution might be to create shallow berms or embayments alongside the dredged channel in selected locations, to increase the quantity and quality of marginal refugia. We recommend that this should be trialled on steep-sided drains in selected locations (perhaps on land owned by conservation organizations) and the results monitored. This would also enable us to validate the finding that steep banks limit ditch biodiversity.

10.4 Collate detailed records (with photographs) of local management practices for ecologically diverse drains by close working with IBD operators and land owners within individual IDB districts.

10.5 Provide feedback on the findings of this survey to IDBs and drain operators including site awareness training for ditch plant and Coleoptera species. The survey results could easily be used to provide information for IDB websites.

10.6 Expand this survey to include more extensive sampling of large, canal-like watercourses such as the Ely Ouse, Cut-Off Channel and Forty Foot River. These are a highly characteristic feature of the Fens but are under-represented in the survey data because work to date has concentrated on smaller watercourses. The limited data available indicates that larger channels are important for species of conservation such as Long-stalked Pondweed and rarer riffle beetles.

10.7 This survey has provided a large and robust dataset including environmental data for each sample point (water pH, electrical conductivity, substrate, ditch profile and dimensions) as well as plant and water beetle lists. This dataset is well-suited to analysis using multivariate statistical packages, which would help elucidate the relationship between ditch type, environmental factors and plant and beetle assemblages.

The dataset could also be used to develop a typology of wetland plant and beetle assemblages for Fenland drains. Although National Vegetation Classification (NVC) communities could be identified for each sample point, the NVC is not well suited for describing these ditches as many sample points featured mosaics of numerous individual communities. It would be relatively easy to propose a basic typology of ditch vegetation (e.g. duckweed- or water starwort- dominated sites, reed-choked ditches, species-rich submerged pondweed assemblages, larger eutrophic channels with Fennel Pondweed) but software such as TWINSPAN could be used to construct a more objective typology. Water beetle lists could also be analysed but might prove more problematic since many sites were poorly accessible for hand-netting, so some lists are likely to be unrepresentative.

One advantage of such a typology is that it could provide a useful tool for rapid assessment of ditch conservation value. This could potentially be used by IDBs and other land managers without necessarily requiring a detailed botanical survey. For example, drains with a diversity of submerged 'waterweeds' such as water-milfoils and linear-leaved pondweeds might be identified as a distinct ditch type with high conservation potential.

A simple manual or crib-sheet could be produced, identifying appropriate management for each type of ditch and also highlighting potential enhancement measures. A hypothetical example is given below.

Ditch type	**Summary**	**Conservation Value**	**Management**	**Enhancement**
Ditches with species-rich aquatic flora	Complex (multi-layered) submerged vegetation including water-milfoils and pondweeds, often with some in-stream emergent plants such as arrowhead. Such ditches are often fed by groundwater on sand/gravel soils.	High: this type of ditch provides habitat for special Fenland plants such as Whorled Water-milfoil and could support Spined Loach as well as a diverse invertebrate fauna.	Periodic removal of sediment and vegetation is important to prevent encroachment of reeds and may help remove excess nutrients. Slubbed material should be ploughed back into arable fields where possible rather than deposited on banks.	Whole-farm agri-environment schemes should safeguard species-rich ditches by creating or retaining buffer strips, avoiding spray drift and avoiding manure storage near ditches. Measures to protect groundwater such as nutrient-budgeting will be beneficial.
Grazing marsh ditches	Shallow drains on permanent pasture with varied bankside and aquatic vegetation.	High: this type of ditch is of high value for wetland birds and invertebrates, providing similar habitat to drains	Grazing and trampling by livestock is usually sufficient to maintain this type of ditch. Aim to maintain a patchy mosaic of tall	Retain shallow ditch profiles and avoid fencing. When raising water levels for conservation purposes, use the least nutrient-

		on the Ouse Washes SSSI.	emergents, short water-margin vegetation and grass mats.	enriched water source available. On improved grassland, consider agri-environment options for extensive grazing with reduced nutrient inputs.
Duckweed ditches	Small to mid-sized, sheltered ditches covered by rafts of Fat or Common Duckweed in high summer.	Low with poor plant and invertebrate diversity. NB: mixtures with Ivy-leaved Duckweed, Greater Duckweed or Frogbit are of higher value (see below).	Retention of shade such as reed fringes and occasional overhanging bushes or trees can help break-up duckweed carpets.	Catchment management to reduce nutrient inputs may allow gradual improvement of ditch condition.

Production of a ditch manual should be combined with a series of accessible training events for land managers/advisors (e.g. IDB staff, farmers, agronomists, agri-environment advisors).

11 Acknowledgements

The authors wish to thank Cliff Carson (for introductions to IDB staff and helping with access), David Jordon (for a site visit to Haddenham district to discuss ditch management practices), James Baker (for access to the RSPB's pilot project area adjoining the Ouse Washes), Leigh Marshall (for access to WWT Lady Fen), the eight IDBs (for access permission and information regarding ditch management practices), many individual land owners (for access permission and information regarding ditch management practices), Professor Garth Forster for identification and refereeing of critical Coleoptera species and Dr Mark Hill for his help with statistical analysis of the data set.

12 References

Atherton I., Bosanquet S. & Lawley M. 2010. *Mosses and liverworts of Britain and Ireland – a field guide*. British Bryological Society.

Bosanquet, S. 2014. Wildlife reports – Bryophytes. *British Wildlife*, **26** (1): 61-64.

Cadbury C.J., Prosser M. & Wallace H. 2001. *The ditch flora of the Ouse Washes (Cambridgeshire/Norfolk) 2001*. A report for the English Nature, Royal Society for the Protection of Birds and Wildfowl and Wetlands Trust.

Carson, C. 2012. *The Middle Level Internal Drainage Board Biodiversity Manual - Giving Wildlife an Edge – A guide to the management of drainage channels for biodiversity for the drainage boards of the Middle Level Biodiversity Action Plan Partnership*. Middle Level Commissioners.

Cheffings C. M. & Farrell L. 2005. *The vascular plant Red Data list for Great Britain*. Joint Nature Conservation Committee: Peterborough.

Cox, M.L. 2007. *Atlas of the seed and leaf beetles of Britain and Ireland*. Pisces Publications: Newbury.

Crick, M., Kirby, P. & Langton, T. 2005. Knottholes: the wildlife of Peterborough's claypits. *British Wildlife*, **16**: 413-421.

Crompton G. & Whitehouse H.L.K. 1983. *Annotated check list of the Flora of Cambridgeshire.* University Printing Services, Cambridge.

Drake, C.M. 2004a. *Grazing marsh assemblages and site classification using invertebrates*. English Nature Research Report No. 579. English Nature: Peterborough.

Drake, C.M. 2004b. A survey of the invertebrates of the Ouse Washes RSPB reserve. Unpublished report to RSPB.

Drake, C.M., Lott, D.A., Alexander, K.N.A. & Webb, J. 2007. *Surveying terrestrial and freshwater invertebrates for conservation evaluation*. Natural England Research Report NERR005. Natural England: Sheffield.

Foster, A. & Bratton, J. 1986. *Oulimnius rivularis* re-discovered. *Balfour-Browne Club Newsletter*, **36**: 1-2.

Foster, G.N. 1987. The use of Coleoptera records in assessing the conservation status of wetlands. Pp8-18 *in* Luff, M.L. (ed). *The use of invertebrates in site assessment for conservation*. University of Newcastle: Newcastle-upon-Tyne.

Foster, G.N. & Eyre, M.D. 1992. *Classification and ranking of water beetle communities*. Joint Nature Conservation Committee: Peterborough.

Foster, G.N 2010. *A review of the scarce and threatened Coleoptera of Great Britain: 3, water beetles of Great Britain* Joint Nature Conservation Committee: Peterborough.

Foster, G.N. & Friday, L.E. 2011. *Keys to adults of the water beetles of Britain and Ireland (Part 1)*. Handbooks for the Identification of British Insects, 4 (5b). Royal Entomological Society: London.

Foster, GN., Bilton, D.T. & Friday, L.E. 2014. *Keys to adults of the water beetles of Britain and Ireland (Part 2)*. Handbooks for the Identification of British Insects, 4 (5b). Royal Entomological Society: London.

Graham, J. J. 2011. A survey of the aquatic macrophytes associated with the drainage ditches of the Ouse Washes Site of Special Scientific Interest (SSSI). Unpublished report for Natural England.

Haslam, S., Sinker, C., Wolseley, P. 1975. *British Water Plants*. Field Studies Council.

Hubble, D.S. 2014. *A review of the scarce and threatened beetles of Great Britain: the leaf beetles and their alies*. Species Status No. 19. Natural England.

Hyman, P.S. & Parsons, M.S. 1992. *A review of the scarce and threatened Coleoptera of Great Britain: 1*. Joint Nature Conservation Committee: Peterborough.

Kirby, P. and Lambert, S. 2003. Fenland farm ditch surveys (Farcet Fen, Kingsland and Tick Fen). Unpublished report to Cambridgeshire Biodiversity Partnership.

John, D.M., Whitton, B.A, & Brook, A.J. 2002. *The freshwater algal flora of the British Isles*. Cambridge University Press: Cambridge.

J.N.C.C. 2005. *Common Standards Monitoring guidance for ditches*. Joint Nature Conservation Committee: Peterborough.

Lansdown, R.V. 2008. *A field guide to the riverine plants of Britain and Northern Ireland including selected vascular plants, bryophytes, lichens and algae*. Environment Agency, Thames Region.

Lansdown, R.V. 2011. Ribbon-leaved Water Plantain (*Alisma gramineum*) monitoring at the Ouse Washes. *Unpublished report for Natural England.*

Leach, S.J. & Rusbridge, D.J. 2006. *A tool for assessing the current conservation status of vascular plants on SSSIs in England.* English Nature Research Report 690. English Nature: Peterborough.

Marquis, P. 2005. *Streamline Watershed Management Bulletin, Vol. 9/No. 1.*

Mclaren, R., Riding., A., Lyons-Visser, H. 2002. The effectiveness of ditch management for wildlife in the Broads and Somerset Levels & Moors ESAs. ADAS report to DEFRA.

Merritt, R. (2006). *Atlas of the water beetles (Coleoptera) and water bugs (Hemiptera) of Derbyshire, Nottinghamshire and South Yorkshire, 1993-2005*. Sorby Record Special Series No. 14. Sorby Natural History Society: Sheffield.

Moore, J.A. 2005. *Charophytes of Great Britain & Ireland*. Botanical Society of the British Isles.

Morris, M.G. 2002. *True weevils (Part I). Coleoptera: Curculionidae. Handbooks for the Identification of British Insects, **5** (17b)*. Royal Entomological Society: London and Field Studies Council: Shrewsbury.

Morris, M.G. (2008). *True weevils (Part II). Coleoptera: Curculionidae, Ceutorhynchinae)*. Handbooks for the Identification of British Insects, **5** (17c). Field Studies Council: Shrewsbury [published for the Royal Entomological Society].

Mossman H. L., Panter C.J., Dolman P.M. 2012. *Fens Biodiversity Audit*. School of Environmental Sciences, University of East Anglia.

Mountford, O., Arnold, H. 2006. Aquatic plant diversity in arable ditches: scoping study. *A report for English Nature.*

Palmer. M, Drake. M and Stewart, N. 2013. *A manual for the survey and evaluation of the aquatic plant and invertebrate assemblages of grazing marsh ditch systems – Version 6*. Buglife: Peterborough.**Preston, C.D. 1995**. *Pondweeds of Great Britain & Ireland*. Botanical Society of the British Isles.

Ponds Conservation Trust. 2003. Aquatic ecosystems in the UK agricultural landscape. DEFRA Project PN0931. Ponds Conservation Trust report to DEFRA.

Preston, C.D., Pearman, D.A. & Dines, T.D. 2002. *New Atlas of the British & Irish flora*. Oxford University Press: Oxford.

Redding, M. 2013. Glossary of useful fenland IDB land drainage terms. Unpublished.

Stace, C. 2010. *New Flora of the British Isles*. Cambridge University Press: Cambridge.

Stewart, N. 2013. *Revised threat status of UK red list stoneworts*. JNCC (http://www.jncc.gov.uk/species/plants).

Stroh, P.A. , Leach, S.J. , August, T.A., Walker, K.J., Pearman, D.A., Rumsey, F.J., Harrower, C.A. Fay, M.F., Martin, J.P., Pankhurst, T., Preston, C.D. & Taylor, I. (2014). *A vascular plant Red List for England*. Botanical Society of Britain and Ireland: Bristol.

Williams, P. 2000. Some properties of rarity scores used in site quality assessment. *British Journal of Entomology and Natural History*, **13**: 73-86.

Zwick, P., Klausnitzer, B. & Ruta, R. 2013. *Contacyphon* Gozis, 1886 removed from synonymy (Coleoptera: Scirtidae) to accommodate species so far combined with the invalid name, *Cyphon* Paykull, 1799. *Entomologische Blätter für Biologie und Systematik der Käfer*, **109**: 337-353.

Appendix 1 List of drain sample points

Sample Code	Grid reference	Location	Type
O1	TL36307129	Drain W of Riverview Farm, NW of Over	IDB Drain
O2	TL36267129	Great Ouse floodplain, W of Over: drain N of Webb's Hole	IDB Drain
O3	TL36307100	Great Ouse floodplain, W of Over: Swavesey Drain	IDB Drain
O4	TL36377100	drain inland of Bedford Corporation Barrier Bank, W of Over	IDB Drain
O5	TL36247127	Great Ouse floodplain, W of Over: Webb's Hole	IDB Drain
O6	TL36187111	Great Ouse floodplain, W of Over: ditch adjacent river	IDB Drain
O7	TL36197100	Great Ouse floodplain, W of Over: Middle Fen NW boundary (a)	IDB Drain
O8	TL36127098	Great Ouse floodplain, W of Over: Middle Fen NW boundary (b)	IDB Drain
O9	TL35997063	Great Ouse floodplain, W of Over: Middle Fen W boundary	IDB Drain
O10	TL36357052	Great Ouse floodplain, W of Over: ditch NW of Middle Fen Drove	IDB Drain
O11	TL36467054	Great Ouse floodplain, W of Over: Middle Fen NE boundary (a)	IDB Drain
O12	TL36347074	Great Ouse floodplain, W of Over: Middle Fen NE boundary (b)	IDB Drain
O13	TL36307144	Ouse Fen Wash: ditch parallel to river	IDB Drain
O14	TL38117179	Long Lane, N of Over (a)	IDB Drain (adjoining Hanson – RSPB conservation area)
O15	TL38097200	Long Lane, N of Over (b)	IDB Drain
B1	TL35637136	SE of White Bridge Farm	IDB Drain
B2	TL35627153	Overcote Lane, E of Needingworth	IDB Drain
B3	TL35567158	Overcote Lane, opposite White Bridge Farm	Field drain (part of area where gravel as been quarried)
B4	TL35197223	Gravel workings, N of White Bridge (w)	IDB drain (part of area where gravel as been quarried)
B5	TL35787214	Gravel workings, N of White Bridge (e)	IDB drain (part of area where gravel as been quarried)
B6	TL36347192	Great Ouse flood plain (W bank), E of Needingworth	IDB Drain

B7	TL36337198	Bluntisham Fen (Eastern drain)	IDB Drain
B8	TL36827255	Queen's Grounds (Eastern drain), S of Brownshill Sluice	IDB Drain
H1	TL43937352	New Cut, W of Aldreth	IDB Drain
H2	TL42587347	North Fen Drain at Dam Bank Bridge, Gall Fen	IDB Drain
H3	TL42307372	Field drain by Long Drove, Lower Delphs, SE of Earith	IDB Drain
H4	TL42337356	Ditch adjacent Long Drove, Lower Delphs, SE of Earith	IDB Drain
H5	TL42147278	Old West River, SE of Earith	“Main River”, Old West (Great Ouse)
H6	TL42167337	W of Dam Bank Drove (a), Lower Delphs	IDB Drain
H7	TL42267334	W of Dam Bank Drove (b), Lower Delphs	IDB Drain
H8	TL42857543	Adventurer's Head Drain, S of Third Bridge (NW of Aldreth)	IDB Drain
H9	TL42937426	Adventurer's Head Drain nr Clayton's Bridge (NW of Aldreth)	IDB Drain
H10	TL42967425	Little Adventurer's Drain, Adventurer's Fen (NW of Aldreth)	IDB Drain
H11	TL43397606	Gall's Drain nr Second Bridge, Gall Fen, Haddenham	IDB Drain
H12	TL42187583	Long Drove, SW of Willow Farm, Adventurer's Head (W of Haddenham)	Field Drain
S1	TL42078256	Crooked Drain, S of Mepal Outdoor Centre	IDB Drain
S2	TL42158153	Blockmoor Fen, N of Blockmoor Farm	Field Drain
S3	TL42228111	Blockmoor Fen, NE of Blockmoor Farm	IDB Drain
S4	TL40018117	Long North Fen Drove	IDB Drain
S5	TL40038167	Crooked Drain adjacent to Horseley Fen Middle Drove	IDB Drain
S6	TL42178019	Sutton West Fen: E of Primrose Farm	IDB Drain
S7	TL41967950	Sutton West Fen: New Cross Drove	IDB Drain
S8	TL40927960	Sutton West Fen: N of Bedingham's Drove	IDB Drain
S9	TL40977920	Sutton West Fen: N of Tubb's Drove	IDB Drain
S10	TL40437822	Sutton Meadlands: Meadlands Main Drove (near microlight club)	IDB Drain
S11	TL40147832	Sutton Meadlands: Meadlands North Drove	IDB Drain
S12	TL40177828	Sutton Meadlands: Meadlands Main Drove (W of airfield)	Field Drain
S13	TL43698144	Ouse Washes SSSI Counterdrain, N of Mepal	IDB Drain
S14	TL43898179	Drain NE of Toll Farm, N of Mepal	Field Drain
S15	TL44078232	Engine Drain, SW of Fortrey's Hall	IDB Drain
S16	TL44268230	Old Bedford Low Bank: NE of Paradise Cottage	IDB Drain
S17	TL43088207	Mepal Fen: drain at Black Bridge	IDB Drain

S18	TL42798342	Block Fen Drove	IDB Drain (in close proximity to area of Block Fen where gravel is being quarried)
S19	TL42978635	Langwood Fen: Langwood Fen Drove	IDB Drain
S20	TL43548468	Langwood Fen: NE of Langwood Fen Farm	IDB Drain
S21	TL42898249	Arthur Rickwood Farm (a)	IDB Drain
S22	TL43478265	Arthur Rickwood Farm (b)	IDB Drain
S23	TL41688307	Horseley Fen: W of Mepal Outdoor Centre	IDB Drain
S24	TL43048706	Forty Foot Drain: N of Langwood Fen	"Main River", Forty Foot Drain
S25	TL44968644	Byall Fen, ESE of Warth's Hundred Farm	Field Drain
S26	TL45338570	Langwood Fen: E of Langwood Farm East (a)	IDB Drain
S27	TL45288573	Langwood Fen: E of Langwood Farm East (b)	IDB Drain
S28	TL45858604	Langwood Fen: SE of King's Farm (a)	IDB Drain
S29	TL46468526	Old Bedford Low Bank (a)	IDB Drain
S30	TL46498530	Old Bedford Low Bank (b)	IDB Drain
S31	TL46458530	Old Bedford Low Bank (field drain)	IDB Drain
S32	TL46608548	Langwood Fen: SE of King's Farm (b)	IDB Drain
M1	TL47248632	Old Mill Drove (nr old pumping station), N of Welches	IDB Drain
M2	TL46858661	Old Mill Drove (field drain A), Byall Fen	IDB Drain
M3	TL46848656	Old Mill Drove (field drain B), Byall Fen	IDB Drain
M4	TL48408794	Bishop's Land, NE of Purls Bridge (RSPB Pilot Project)	IDB Drain (RSPB Pilot Project)
M5	TL48358779	RSPB Purls Bridge (RSPB Pilot Project)	Field Drain (RSPB Pilot Project)
M6	TL48268770	RSPB Purls Bridge (RSPB Pilot Project)	Field Drain
M7	TL48038757	RSPB Purls Bridge (RSPB Pilot Project)	(RSPB Pilot Project)
M8	TL47968761	RSPB Purls Bridge (RSPB Pilot Project)	Field Drain
M9	TL47658816	Purls Bridge Drove, S of Manea	IDB Drain
M10	TL48609213	Adjacent B1093, Cranmore Lots Farm, Manea	IDB Drain
M11	TL48879199	Adjacent B1093, SE of Cranmore Lots Farm, Manea	IDB Drain

M12	TL49559175	Manea Fifties: NE of Bond's Farm	IDB Drain
M13	TL50329121	South Branch Drain, SE of Bond's Farm, Manea	IDB Drain
M14	TL503491200	Ditch adjacent South Branch Drain, Manea	Field Drain
M15	TL47979295	Adjacent Day's Lode Road, N of Manea	Field Drain
M16	TL47979290	Adjacent Day's Lode Road, N of Watering Hill Farm, Manea	Field Drain
M17	TL49259375	Fodder Fen Common, NE of Bottom Farm (a)	IDB Drain
M18	TL49309376	Fodder Fen Common, NE of Bottom Farm (b)	IDB Drain
M19	TL49299215	Manea Fifties: field drain adjacent Fifty Road	IDB Drain
M20	TL52269417	drain crossing B1100 (March Road), Welney	IDB Drain
M21	TL48629067	Cow Common, NW of Wisbech Road	IDB Drain
M22	TL46828588	Forty Foot Drain, Welches Dam	"Main River", Forty Foot Drain
U1	TL54359588	Cross Drain (nr pumping house), SE of Cock Fen Farm	IDB Drain
U2	TL54389589	Bank Drain, SE of Cock Fen Farm, Welney	IDB Drain
U3	TL54169569	Drain SE of Mill Bank, Welney	IDB Drain
U4	TL54229568	Drain parallel to Old Bedford River, SE of Cock Fen Farm, Welney	IDB Drain
U5	TL54299575	Drain parallel to Old Bedford River, SE of Cock Fen Farm, Welney (within copse)	IDB Drain
U6	TL54319644	Drain SE of Reed Fen Farm, Welney	IDB Drain
U7	TL54329652	Jones's Drove, SE of Reed Fen Farm, Welney	Field Drain
U8	TF54930014	Upwell Fen, drain N of Wood House	IDB Drain
U9	TL55419940	Upwell Fen, drain SE of Mill House	IDB Drain
U10	TF55650098	Well Creek, d/s confluence with Popham's Eau, Nordelph	"Main River", Well Creek
U11	TF56430063	Upwell Fen: field drain adjacent Birchfield Road, SE of Nordelph	Field Drain
SF1	TL61239908	Drain S of Twelve Acre Covert, Fordham Fen	IDB Drain
SF2	TL61149901	field drain 1, E of Engine Belt, Fordham Fen	Field Drain
SF3	TL61169885	field drain 2, E of Engine Belt, Fordham Fen	Field Drain
SF4	TL60989883	field drain 3, E of Engine Belt, Fordham Fen	Field Drain
SF5	TL60919945	Catchwater Drain, NE of Engine House, Fordham Fen	Field Drain
SF6	TL60219934	field drain 1, NE of Engine House, Fordham Fen	Field Drain
SF7	TL60199932	field drain 2, NE of Engine House, Fordham Fen	Field Drain
SF8	TL59729957	field drain, SE of Horseshoe Close, Fordham Fen	Field Drain

SF9	TL61329940	Cut-off Channel, S of Border House, Fordham Fen	“Main River”, Cut-off Channel
LD1	TF59140135	Cut Off Channel, d/s Denver Sluice	“Main River”, Cut-off Channel
LD2	TF59220138	ditch 1, W of Middle Drove, Denver	Field Drain
LD3	TF59270133	ditch 2, W of Middle Drove, Denver	Field Drain
LD4	TF59180125	ditch 3, W of Middle Drove, Denver	Field Drain
LD5	TF59130111	ditch 4, W of Middle Drove, Denver	Field Drain
LD6	TL59069864	IDB drain S of Ouse Bridge Cottages, Fordham Fen	IDB Drain
LD7	TL58759843	field drain, SW of Ouse Bridge Cottages, Fordham Fen	Field Drain
LD8	TL56799566	Fourteen Foot Drain, Sedgedrove Farm area, SW of Denver	IDB Drain
LD9	TL56739575	field drain, SW of Sedgedrove Farm, Hilgay Fen	Field Drain
LD10	TL57279644	Church Drain, N. of Sedgedrove Farm, Hilgay Fen	IDB Drain
LD11	TL57249644	field drain 1, N of Sedgedrove Farm, Hilgay Fen	Field Drain
LD12	TL57199641	field drain 2, N of Sedgedrove Farm, Hilgay Fen	Field Drain
LD13	TL57129678	Middle Leading Drain, N of Sedgedrove Farm, Hilgay Fen	IDB Drain
LD14	TL58669700	Church Drain, N. of Pleasant House, Hilgay Fen	IDB Drain
LD15	TL59519827	Ely Ouse river , N of Ten Mile Bank	“Main River”, Ely Ouse (Great Ouse)
LD16	TL60949716	ditch 1 adj Modney Bridge Road, Great West Fen, SW of Downham Market	IDB Drain
LD17	TL60969720	ditch 2 adj Modney Bridge Road, Great West Fen, SW of Downham Market	IDB Drain
LD18	TL58709609	Glover's Drain nr Station House Farm, Hilgay Fen	IDB Drain
LD19	TL59389740	field drain 1 SW of Church Farm, Hilgay Fen	Field Drain
LD20	TL59379732	field drain 2 SW of Church Farm, Hilgay Fen	IDB Drain
LD21	TL58689720	drain 1 N of Peasant House, Hilgay Fen	IDB Drain
LD22	TL58729720	drain 2 N of Peasant House, Hilgay Fen	IDB Drain
LD23	TL46108130	Catchwater Drain, Witcham Hive	IDB Drain
LD24	TL46308137	Witcham Hive, field drain 1, N. of Witcham	Field Drain
LD25	TL45968227	drain 1, Witcham Bridge Drove	IDB Drain
LD26	TL46018234	drain 2, Witcham Bridge Drove	IDB Drain
LD27	TL45918232	drain 3, Witcham Bridge Drove	IDB Drain
LD28	TL46148230	drain 4, Witcham Bridge Drove	IDB Drain

LD29	TL46168246	drain 1, Byall Fen, N of Witcham	IDB Drain
LD30	TL46038243	drain 2, Byall Fen, N of Witcham	IDB Drain
LD31	TL48788290	drain W of Coveney village	IDB Drain
LD32	TL48818293	drain E of Way Head Drove, Coveney	IDB Drain
LD33	TL48388478	drain SE of Willow Farm, Straight Drove, Coveney Byall Fen	IDB Drain
LD34	TL49248359	Grunty Fen Drain, Downham Hythe	IDB Drain
LD35	TL50058545	Main Drain at Common Bridge, Westmoor Common, Pymore	IDB Drain
LD36	TL50758788	ditch at Straight Furlong, NE of Pymore	IDB Drain
LD37	TL51018824	drain SE of Primrose Hill, Pymore	IDB Drain
LD38	TL50998823	Straight Furlong nr Primrose Hill, Pymore	Field Drain
LD39	TL52008820	ditch W of Seventh Drove Farm, Westmoor Fen	IDB Drain
LD40	TL52068814	ditch SW of Seventh Drove Farm, Westmoor Fen	IDB Drain
LD41	TL51388819	Head Fen Drove, Westmoor Fen	Field Drain
LD42	TL50868908	Engine Basin drain u/s Hundred Foot Pumping Station	IDB Drain
LD43	TL51098889	ditch SE of Hundred Foot Pumping Station	IDB Drain
LD44	TL53209017	ditch adj Bates's Drove, NW of Littleport	Field Drain
LD45	TL53379236	ditch at Gold Hill, NW of Littleport	Field Drain
LD46	TL54199085	ditch adj Bell's Drove, NW of Littleport	Field Drain
LD47	TL55859481	Ladyfen Drain at Station Road, SW of Ten Mile Bank	IDB Drain
LD48	TL54919461	Lady Fen 1, WWT Welney	Field Drain
LD49	TL55059449	Lady Fen 2, WWT Welney	Field Drain
LD50	TL55149450	Lady Fen 3, WWT Welney	Field Drain
LD51	TL55229451	Lady Fen 4, WWT Welney	Field Drain
LD52	TL55269439	Lady Fen 5, WWT Welney	Field Drain
LD53	TL55389394	Lady Fen 6, WWT Welney	IDB Drain
LD54	TL55229398	Lady Fen 7, WWT Welney	Field Drain
LD55	TL55149396	Lady Fen 8, WWT Welney	Field Drain
LD56	TL54899407	Lady Fen 9, WWT Welney	Field Drain
LD57	TL54739423	Lady Fen 10, WWT Welney	Field Drain
LD58	TL54619423	Bank Farm 1, WWT Welney	Field Drain
LD59	TL54689411	Bank Farm 2, WWT Welney	Field Drain
LD60	TL54839406	Bank Farm 3, WWT Welney	IDB Drain

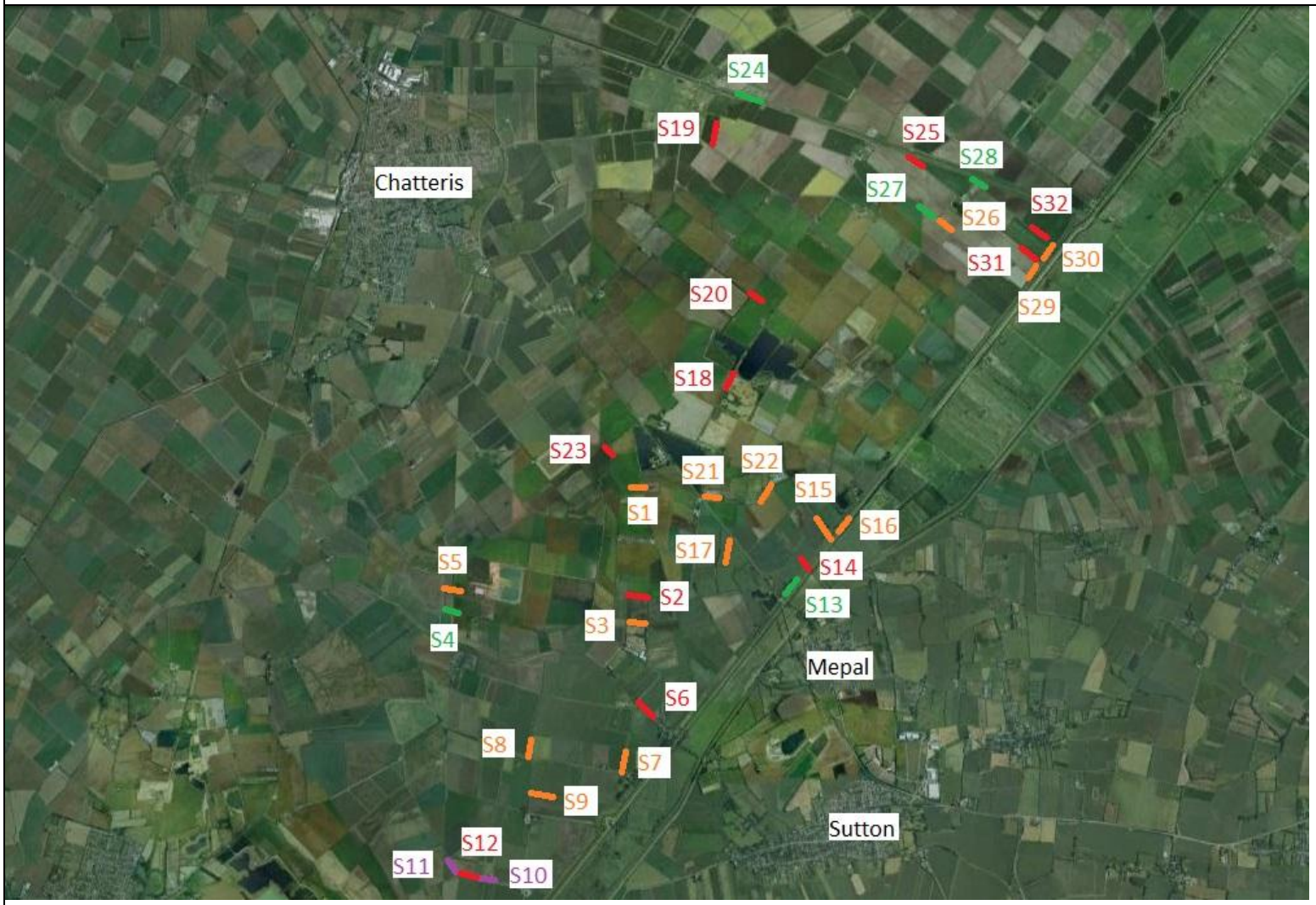
LD61	TL54919397	Bank Farm 4, WWT Welney	Field Drain
LD62	TL54809381	Bank Farm 5, WWT Welney	Field Drain
LD63	TL54989374	Bank Farm 6, WWT Welney	Field Drain
LD64	TL55279372	Ladyfen Drain, SE of Bank Farm	IDB Drain
LD65	TL55009335	drain SE of Bank Cottage (NE of Suspension Bridge)	IDB Drain
LD66	TL54349404	Bank Farm 7, WWT Welney	Field Drain

Appendix 2 Location Maps for sample points and drains of conservation importance

Over & Willingham IDB	Number of drains sampled (15)
	■ surveyed drains that are not of conservation importance Drains of conservation importance (8): ■ plants only (5) ■ plants & aquatic Coleoptera (3) ■ aquatic Coleoptera only (0)
	Grid reference at map centre: TL37007132

Bluntisham IDB	Number of drains sampled (8)
	■ surveyed drains that are not of conservation importance Drains of conservation importance (1): ■plants only (0) ■plants & aquatic Coleoptera (0) ■ aquatic Coleoptera only (1)
	Grid reference at map centre: TL35527219

Haddenham IDB	Number of drains sampled (11)
	■ surveyed drains that are not of conservation importance Drains of conservation importance (6): ■plants only (2) ■plants & aquatic Coleoptera (4) ■ aquatic Coleoptera only (0)
	Grid reference at map centre: TL43237465

Sutton & Mepal IDB	Number of drains sampled (32)
	■ surveyed drains that are not of conservation importance Drains of conservation importance (20): ■plants only (14) ■plants & aquatic Coleoptera (4) ■ aquatic Coleoptera only (2)
	Grid reference at map centre: TL41808339

Manea & Welney IDB	Number of drains sampled (22)
	■ surveyed drains that are not of conservation importance Drains of conservation importance (14): ■plants only (9) ■plants & aquatic Coleoptera (2) ■ aquatic Coleoptera only (3)
	Grid reference at map centre: TL48399063

Upwell IDB	Number of drains sampled (11)
	■ surveyed drains that are not of conservation importance Drains of conservation importance (3): ■plants only (1) ■plants & aquatic Coleoptera (0) ■ aquatic Coleoptera only (2)
	Grid reference at map centre: TL54499798

Stoke Ferry IDB	Number of drains sampled (9)
	■ surveyed drains that are not of conservation importance Drains of conservation importance (4): ■plants only (3) ■plants & aquatic Coleoptera (1) ■ aquatic Coleoptera only (0)
	Grid reference at map centre: TL60489923

Littleport & Downham IDB " Denver and the Ely Ouse area"	Number of drains sampled (6)
	■ surveyed drains that are not of conservation importance Drains of conservation importance (1): ■plants only (0) ■plants & aquatic Coleoptera (1) ■ aquatic Coleoptera only (0)
	Grid reference at map centre: TL59549960

Littleport & Downham IDB " Hilgay Fen and West Fen area"	Number of drains sampled (17)
	■ surveyed drains that are not of conservation importance Drains of conservation importance (1): ■plants only (12) ■plants & aquatic Coleoptera (3) ■ aquatic Coleoptera only (0)
	Grid reference at map centre: TL58439672

Littleport & Downham IDB “ Pymore area”	Number of drains sampled (12)
	■ surveyed drains that are not of conservation importance Drains of conservation importance (7): ■plants only (6) ■plants & aquatic Coleoptera (1) ■ aquatic Coleoptera only (0)
	Grid reference at map centre: TL52998858

Littleport & Downham IDB " Witcham Hive and Byall Fens area"	Number of drains sampled (11)
	■ surveyed drains that are not of conservation importance Drains of conservation importance (1): ■plants only (1) ■plants & aquatic Coleoptera (0) ■ aquatic Coleoptera only (0)
	Grid reference at map centre: TL47158342

Littleport & Downham IDB " WWT Lady Fen/Bank Farm area"	Number of drains sampled (19)
	■ surveyed drains that are not of conservation importance Drains of conservation importance (6): ■plants only (1) ■plants & aquatic Coleoptera (1) ■ aquatic Coleoptera only (4)
	Grid reference at map centre: TL55049430

Appendix 3

Sample point data (general data and plants)

Data for sample points B1-B4 provided as an example of data format (for full data for all sample points refer to electronic copy of Excel sheet: Ouse Washes Landscape Partnership Area Biodiversity project_ditch plant data

Ditch code	B1	B2	B3	B4
Grid reference	TL35637136	TL35627153	TL35567158	TL35197223
Location name	s.e. of Needingworth	e. of Needingworth	e. of Needingworth	e. of Needingworth
Date	25/06/2013	25/06/2013	25/06/2013	25/06/2013
Water width (m)	2.5	3	3	2
Water depth (m)	0.25	0.45	0.8	0.15
Angle of slope (survey side)	60	60	60	45
Angle of slope (far side)	60	60	60	45
Adjacent land use (survey side)	Arable (rape)	Roadside	Rough grassland (and track) adjoining gravel pits)	Rough grassland (and track) adjoining gravel pits)
Adjacent land use (far side)	Agricultural grass ley / hay meadow	Agricultural grass ley / hay meadow	Rough grassland adjoining gravel pits	Rough grassland adjoining gravel pits
Floating mat (%)	0	8	8	5
Emergent vegetation (%)	1	4	24	80
Open water (%)	99	92	68	14
Direct shading (%)	50	15	5	0
Turbidity (1-5) opaque to clear	3	3	4	5
Bed soil type	Organic	Organic	Mineral silt (3cm)	Sand & gravel
pH	7.7	7.8	7.6	7.1
Conductivity (uS/cm)	1040	1030	1010	1180
Successional stage (Early, Mid, Late)	Mid	Mid	Mid	Late
Management regime (Low, Medium, High intensity)	Low	Low	Low	Low
Floating plants				
Cladophora				
Enteromorpha				
Hydrocharis morsus-ranae				
Lemna gibba				1
Lemna minor		4	8	
Lemna minuta				5
Nymphoides peltata				
Riccia fluitans				
Spirodela polyrhiza				
Open Water	99	92	68	14
Emergent vegetation (%)	1	4	24	80
Total	**100**	**100**	**100**	**100**

Appendix 4

Sample point data (ditch Coleoptera)

Data for sample points B1-B4 provided as an example of data format (for full data for all sample points refer to electronic copy of Excel sheet: Ouse Washes Landscape Partnership Area Biodiversity project_ditch Coleoptera data

Ditch Code	Grid reference	Site Name	Date	Species	Notes
U1	TL54359588	Cross Drain (nr pumping house), SE of Cock Fen Farm	04/07/2013	*Haliplus immaculatus*	
U1	TL54359588	Cross Drain (nr pumping house), SE of Cock Fen Farm	04/07/2013	*Haliplus lineatocollis*	
U1	TL54359588	Cross Drain (nr pumping house), SE of Cock Fen Farm	04/07/2013	*Haliplus obliquus*	
U1	TL54359588	Cross Drain (nr pumping house), SE of Cock Fen Farm	04/07/2013	*Haliplus ruficollis*	
U1	TL54359588	Cross Drain (nr pumping house), SE of Cock Fen Farm	04/07/2013	*Noterus clavicornis*	
U1	TL54359588	Cross Drain (nr pumping house), SE of Cock Fen Farm	04/07/2013	*Agabus sturmii*	
U1	TL54359588	Cross Drain (nr pumping house), SE of Cock Fen Farm	04/07/2013	*Hydroporus angustatus*	
U1	TL54359588	Cross Drain (nr pumping house), SE of Cock Fen Farm	04/07/2013	*Hydroporus palustris*	
U1	TL54359588	Cross Drain (nr pumping house), SE of Cock Fen Farm	04/07/2013	*Hygrotus inaequalis*	
U1	TL54359588	Cross Drain (nr pumping house), SE of Cock Fen Farm	04/07/2013	*Hygrotus versicolor*	

Appendix 5

Digital photographs for all sample points

Appendix 6

Summary tables for aquatic Coleoptera

ISIS codes

Broad Assemblage Types (BATs):

W1 = flowing water

W2 = mineral marsh and open water

W3 = permanent wet mire

Specific Assemblage Types (SATs):

W125 = slow-flowing streams

W211 = open water on disturbed mineral sediments

W313 = moss and tussock fen

W314 = reedfen and pools

M312 = brackish-freshwater transition marsh

Bluntisham district			
Species	**GB status**	**ISIS fen specialist codes**	**Other ISIS BATs & SATs**
Agabus bipustulatus	Widespread		
Agabus sturmii	Widespread		
Anacaena bipustulata	Local		W211
Anacaena globulus	Widespread		
Anacaena limbata	Widespread		
Colymbetes fuscus	Widespread		
Cyphon palustris	Widespread		
Donacia simplex	Widespread		
Dryops luridus	Widespread		
Dytiscus dimidiatus	Near Threatened	W314	
Dytiscus marginalis	Widespread		
Enochrus testaceus	Widespread		
Graptodytes pictus	Widespread		
Gyrinus substriatus	Widespread		
Haliplus fluviatilis	Widespread		
Haliplus immaculatus	Widespread		
Haliplus lineatocollis	Widespread		
Haliplus lineolatus	Widespread		
Helophorus aequalis	Widespread		
Helophorus brevipalpis	Widespread		
Helophorus minutus	Widespread		
Hydrobius fuscipes	Widespread		
Hydroglyphus geminus	Local		W211

Hydroporus angustatus	Widespread		
Hydroporus palustris	Widespread		
Hydroporus planus	Widespread		
Hydroporus tessellatus	Widespread		
Hygrotus impressopunctatus	Widespread		
Hygrotus inaequalis	Widespread		
Hygrotus versicolor	Widespread		
Hyphydrus ovatus	Widespread		
Ilybius quadriguttatus	Widespread		
Laccobius bipunctatus	Widespread		
Laccophilus minutus	Widespread		
Limnebius nitidus	Local		W2
Liopterus haemorrhoidalis	Widespread		
Noterus clavicornis	Widespread		
Noterus crassicornis	Nationally Scarce	W314	
Ochthebius minimus	Widespread		
Poophagus sisymbrii	Widespread		
Rhantus suturalis	Local		W211
Haddenham district			
Species	**GB status**	**ISIS fen specialist codes**	**Other ISIS BATs & SATs**
Agabus bipustulatus	Widespread		
Agabus didymus	Widespread		
Agabus sturmii	Widespread		
Anacaena bipustulata	Local		W211
Anacaena globulus	Widespread		
Anacaena limbata	Widespread		
Bagous alismatis	Nationally Scarce		
Berosus luridus	Near Threatened		W211
Cercyon convexiusculus	Local		W2
Cercyon marinus	Widespread		
Chaetarthria seminulum	Nationally Scarce		W3
Cyphon laevipennis	Local		
Donacia dentata	Vulnerable		
Donacia semicuprea	Local		
Dryops luridus	Widespread		
Dryops similaris	Nationally Scarce		W2
Dytiscus marginalis	Widespread		
Enochrus testaceus	Widespread		
Eubrychius velutus	Nationally Scarce		
Graptodytes pictus	Widespread		
Gyrinus marinus	Widespread		
Gyrinus substriatus	Widespread		
Haliplus flavicollis	Widespread		
Haliplus fluviatilis	Widespread		

Haliplus heydeni	Local		W2
Haliplus immaculatus	Widespread		
Haliplus lineatocollis	Widespread		
Haliplus lineolatus	Widespread		
Haliplus ruficollis	Widespread		
Haliplus sibiricus	Widespread		
Helophorus griseus	Local		W2
Helophorus minutus	Widespread		
Hydaticus transversalis	Nationally Scarce	W314	
Hydraena testacea	Local		W2
Hydrobius fuscipes	Widespread		
Hydroporus angustatus	Widespread		
Hydroporus incognitus	Widespread		
Hydroporus palustris	Widespread		
Hydroporus planus	Widespread		
Hydroporus tessellatus	Widespread		
Hygrobia hermanni	Widespread		
Hygrotus impressopunctatus	Widespread		
Hygrotus inaequalis	Widespread		
Hygrotus versicolor	Widespread		
Hyphydrus ovatus	Widespread		
Ilybius quadriguttatus	Widespread		
Laccobius bipunctatus	Widespread		
Laccobius striatulus	Widespread		
Liopterus haemorrhoidalis	Widespread		
Nebrioporus assimilis	Local		
Noterus clavicornis	Widespread		
Noterus crassicornis	Nationally Scarce	W314	
Oulimnius rivularis	Nationally Scarce		W125
Rhantus grapii	Local	W313	
Stenopelmus rufinasus	Local		
Tanysphyrus lemnae	Local		

Littleport & Downham district			
Species	**GB status**	**ISIS fen specialist codes**	**Other ISIS BATs & SATs**
Agabus bipustulatus	Widespread		
Agabus conspersus	Nationally Scarce		M312
Agabus didymus	Widespread		
Agabus nebulosus	Widespread		
Agabus paludosus	Widespread		
Agabus sturmii	Widespread		
Anacaena bipustulata	Local		W211
Anacaena globulus	Widespread		
Anacaena limbata	Widespread		
Berosus affinis	Local		W2
Berosus luridus	Near Threatened		W211
Berosus signaticollis	Local		W2
Cercyon marinus	Widespread		
Cercyon tristis	Local		W2
Colymbetes fuscus	Widespread		
Contacyphon coarctatus	Widespread		
Donacia clavipes	Local		
Donacia semicuprea	Widespread		
Dryops luridus	Widespread		
Dytiscus circumflexus	Local		W211
Dytiscus marginalis	Widespread		
Enochrus melanocephalus	Local		W3
Enochrus quadripunctatus	Nationally Scarce	W313	
Enochrus testaceus	Widespread		
Eubrychius velutus	Nationally Scarce		
Graptodytes granularis	Local	W313	
Graptodytes pictus	Widespread		
Gymnetron villosulum	Nationally Scarce		
Gyrinus marinus	Widespread		
Gyrinus substriatus	Widespread		
Haliplus flavicollis	Widespread		
Haliplus fluviatilis	Widespread		
Haliplus heydeni	Local		W2
Haliplus immaculatus	Widespread		
Haliplus lineatocollis	Widespread		
Haliplus lineolatus	Widespread		
Haliplus ruficollis	Widespread		
Helochares lividus	Local		W211
Helophorus brevipalpis	Widespread		
Helophorus griseus	Local		W2

Helophorus minutus	Widespread		
Hydraena riparia	Widespread		
Hydrobius fuscipes	Widespread		
Hydrochus crenatus	Near Threatened	W313	
Hydroglyphus geminus	Local		W211
Hydroporus angustatus	Widespread		
Hydroporus discretus	Widespread		
Hydroporus memnonius	Widespread		
Hydroporus palustris	Widespread		
Hydroporus planus	Widespread		
Hydroporus pubescens	Widespread		
Hydroporus tessellatus	Widespread		
Hygrotus impressopunctatus	Widespread		
Hygrotus inaequalis	Widespread		
Hygrotus parallelogrammus	Nationally Scarce		M312
Hygrotus versicolor	Widespread		
Hyphydrus ovatus	Widespread		
Ilybius ater	Widespread		
Ilybius chalconatus	Local		W1
Ilybius fuliginosus	Widespread		
Ilybius quadriguttatus	Widespread		
Laccobius bipunctatus	Widespread		
Laccobius colon	Widespread		
Laccobius minutus	Widespread		
Laccobius sinuatus	Local		W2
Laccobius striatulus	Widespread		
Laccophilus minutus	Widespread		
Liopterus haemorrhoidalis	Widespread		
Nebrioporus elegans	Widespread		
Noterus clavicornis	Widespread		
Noterus crassicornis	Nationally Scarce	W314	
Ochthebius minimus	Widespread		
Oulimnius major	Nationally Scarce		W125
Oulimnius rivularis	Nationally Scarce		W125
Peltodytes caesus	Nationally Scarce		W211
Porhydrus lineatus	Widespread		
Rhantus frontalis	Nationally Scarce		W3
Rhantus grapii	Local	W313	
Rhantus suturalis	Local		W211
Scarodytes halensis	Nationally Scarce		W211
Tanysphyrus lemnae	Widespread		

Manea & Welney district			
Species	**GB status**	**ISIS fen specialist codes**	**Other ISIS BATs & SATs**
Agabus bipustulatus	Widespread		
Agabus nebulosus	Widespread		
Agabus sturmii	Widespread		
Agabus undulatus	Near Threatened	W314	
Anacaena bipustulata	Local		W211
Anacaena globulus	Widespread		
Anacaena limbata	Widespread		
Berosus affinis	Local		
Berosus luridus	Near Threatened		W211
Berosus signaticollis	Local		W2
Cercyon convexiusculus	Local		W2
Cercyon marinus	Widespread		
Cercyon tristis	Local		W2
Colymbetes fuscus	Widespread		
Donacia clavipes	Local		
Donacia impressa	Nationally Scarce		
Donacia simplex	Local		
Donacia vulgaris	Local		
Dryops luridus	Widespread		
Dytiscus circumflexus	Local		W211
Dytiscus marginalis	Widespread		
Enochrus quadripunctatus	Nationally Scarce	W313	
Enochrus testaceus	Widespread		
Eubrychius velutus	Nationally Scarce		
Graptodytes pictus	Widespread		
Gymnetron villosulum	Nationally Scarce		
Gyrinus marinus	Widespread		
Gyrinus substriatus	Widespread		
Haliplus flavicollis	Widespread		
Haliplus fluviatilis	Widespread		
Haliplus heydeni	Local		W2
Haliplus immaculatus	Widespread		
Haliplus lineatocollis	Widespread		
Haliplus lineolatus	Widespread		
Haliplus obliquus	Widespread		
Haliplus ruficollis	Widespread		
Helophorus brevipalpis	Widespread		
Helophorus griseus	Local		W2
Helophorus minutus	Widespread		
Hydraena riparia	Widespread		

Hydraena testacea	Local		W2
Hydrobius fuscipes	Widespread		
Hydroporus angustatus	Widespread		
Hydroporus palustris	Widespread		
Hydroporus planus	Widespread		
Hydroporus tessellatus	Widespread		
Hygrotus impressopunctatus	Widespread		
Hygrotus inaequalis	Widespread		
Hyphydrus ovatus	Widespread		
Ilybius ater	Widespread		
Ilybius chalconatus	Local		W1
Ilybius quadriguttatus	Widespread		
Laccobius bipunctatus	Widespread		
Laccobius colon	Widespread		
Laccobius minutus	Widespread		
Laccobius sinuatus	Local		W2
Laccobius striatulus	Widespread		
Laccophilus hyalinus	Widespread		
Liopterus haemorrhoidalis	Widespread		
Noterus clavicornis	Widespread		
Ochthebius dilatatus	Widespread		
Ochthebius minimus	Widespread		
Ouliminus major	Nationally Scarce		W125
Ouliminus rivularis	Nationally Scarce		W125
Plateumaris sericea	Widespread		
Porhydrus lineatus	Widespread		
Rhantus grapii	Local	W313	
Rhantus suturalis	Local		W211
Thryogenes nereis	Local		

Stoke Ferry district			
Species	**GB status**	**ISIS fen specialist codes**	**Other ISIS BATs & SATs**
Agabus bipustulatus	Widespread		
Agabus sturmii	Widespread		
Agabus undulatus	Near Threatened	W314	
Anacaena globulus	Widespread		
Anacaena limbata	Widespread		
Cercyon convexiusculus	Local		W2
Cercyon sternalis	Local		W3
Donacia semicuprea	Widespread		
Donacia simplex	Widespread		
Donacia vulgaris	Widespread		
Dryops ?luridus	Widespread		
Dytiscus marginalis	Widespread		
Graptodytes pictus	Widespread		
Gyrinus substriatus	Widespread		
Haliplus fluviatilis	Widespread		
Haliplus immaculatus	Widespread		
Haliplus lineatocollis	Widespread		
Haliplus ruficollis	Widespread		
Helophorus brevipalpis	Widespread		
Helophorus minutus	Widespread		
Hydrobius fuscipes	Widespread		
Hydroporus discretus	Widespread		
Hydroporus incognitus	Widespread		
Hydroporus memnonius	Widespread		
Hydroporus palustris	Widespread		
Hydroporus planus	Widespread		
Hydroporus tessellatus	Widespread		
Hygrotus inaequalis	Widespread		
Hygrotus versicolor	Widespread		
Hyphydrus ovatus	Widespread		
Ilybius fuliginosus	Widespread		
Laccobius striatulus	Widespread		
Nebrioporus elegans	Widespread		
Noterus clavicornis	Widespread		
Ochthebius minimus	Widespread		
Rhantus exsoletus	Widespread		
Rhantus suturalis	Local		W211

Sutton & Mepal district			
Species	**GB status**	**ISIS fen specialist codes**	**Other ISIS BATs & SATs**
Agabus bipustulatus	Widespread		
Agabus didymus	Widespread		
Agabus nebulosus	Widespread		
Agabus paludosus	Widespread		
Agabus sturmii	Widespread		
Agabus undulatus	Near Threatened	W314	
Anacaena bipustulata	Local		
Anacaena globulus	Widespread		
Anacaena limbata	Widespread		
Bagous alismatis	Nationally Scarce		
Berosus luridus	Near Threatened		W211
Berosus signaticollis	Local		W2
Cercyon convexiusculus	Local		W2
Cercyon marinus	Widespread		
Cercyon tristis	Local		W2
Cercyon ustulatus	Local		W2
Chaetarthria seminulum	Nationally Scarce		W3
Colymbetes fuscus	Widespread		
Cymbiodyta marginellus	Widespread		
Donacia clavipes	Local		
Donacia semicuprea	Local		
Donacia simplex	Widespread		
Donacia versicolorea	Local		
Donacia vulgaris	Local		
Dryops luridus	Widespread		
Dytiscus marginalis	Widespread		
Enochrus testaceus	Widespread		
Graptodytes pictus	Widespread		
Gyrinus marinus	Widespread		
Gyrinus substriatus	Widespread		
Haliplus confinis	Widespread		
Haliplus flavicollis	Widespread		
Haliplus fluviatilis	Widespread		
Haliplus immaculatus	Widespread		
Haliplus lineatocollis	Widespread		
Haliplus lineolatus	Widespread		
Haliplus mucronatus	Nationally Scarce		W2
Haliplus obliquus	Widespread		
Haliplus ruficollis	Widespread		
Helochares lividus	Local		W211

Helophorus aequalis	Widespread		
Helophorus brevipalpis	Widespread		
Helophorus griseus	Local		W2
Helophorus minutus	Widespread		
Hydaticus transversalis	Nationally Scarce	W314	
Hydraena riparia	Widespread		
Hydraena testacea	Local		
Hydrobius fuscipes	Widespread		
Hydrochus crenatus	Near Threatened	W313	
Hydroporus angustatus	Widespread		
Hydroporus incognitus	Widespread		
Hydroporus memnonius	Widespread		
Hydroporus palustris	Widespread		
Hydroporus planus	Widespread		
Hydroporus tessellatus	Widespread		
Hygrobia hermanni	Widespread		
Hygrotus impressopunctatus	Widespread		
Hygrotus inaequalis	Widespread		
Hygrotus versicolor	Widespread		
Hyphydrus ovatus	Widespread		
Ilybius ater	Widespread		
Ilybius quadriguttatus	Widespread		
Laccobius bipunctatus	Widespread		
Laccobius colon	Widespread		
Laccobius striatulus	Widespread		
Laccophilus hyalinus	Widespread		
Laccophilus minutus	Widespread		
Liopterus haemorrhoidalis	Widespread		
Nebrioporus elegans	Widespread		
Noterus clavicornis	Widespread		
Ochthebius minimus	Widespread		
Oulimnius major	Nationally Scarce		W125
Oulimnius rivularis	Nationally Scarce		W125
Oulimnius tuberculatus	Widespread		
Poophagus sisymbrii	Local		
Porhydrus lineatus	Widespread		
Rhantus grapii	Local	W313	
Rhantus suturalis	Local		W211
Thryogenes festucae	Local		

Over & Willingham district			
Species	**GB status**	**ISIS fen specialist codes**	**Other ISIS BATs & SATs**
Agabus bipustulatus	Widespread		
Agabus nebulosus	Widespread		
Agabus sturmii	Widespread		
Agabus undulatus	Near Threatened	W314	
Anacaena bipustulata	Local		
Anacaena globulus	Widespread		
Anacaena limbata	Widespread		
Berosus affinis	Local		W2
Berosus signaticollis	Local		W2
Cercyon convexiusculus	Local		W2
Cercyon marinus	Widespread		
Cercyon tristis	Local		W2
Cercyon ustulatus	Local		W2
Colymbetes fuscus	Widespread		
Donacia semicuprea	Local		
Donacia simplex	Widespread		
Dryops luridus	Widespread		
Dytiscus circumflexus	Local		W211
Dytiscus marginalis	Widespread		
Enochrus melanocephalus	Local		W211
Enochrus quadripunctatus	Nationally Scarce	W313	
Graptodytes pictus	Widespread		
Gymnetron villosulum	Nationally Scarce		
Gyrinus marinus	Widespread		
Gyrinus substriatus	Widespread		
Haliplus flavicollis	Widespread		
Haliplus lineatocollis	Widespread		
Haliplus ruficollis	Widespread		
Helochares lividus	Local		W211
Helophorus brevipalpis	Widespread		
Helophorus griseus	Local		W2
Helophorus minutus	Widespread		
Helophorus obscurus	Widespread		
Hydaticus transversalis	Nationally Scarce	W314	
Hydrobius fuscipes	Widespread		
Hydrochus crenatus	Near Threatened	W313	
Hydroglyphus geminus	Local		W211
Hydroporus angustatus	Widespread		
Hydroporus incognitus	Widespread		
Hydroporus palustris	Widespread		

Hydroporus planus	Widespread		
Hygrobia hermanni	Widespread		
Hygrotus impressopunctatus	Widespread		
Hygrotus inaequalis	Widespread		
Hygrotus versicolor	Widespread		
Hyphydrus ovatus	Widespread		
Ilybius ater	Widespread		
Ilybius fuliginosus	Widespread		
Ilybius quadriguttatus	Widespread		
Laccobius bipunctatus	Widespread		
Laccobius sinuatus	Local		W2
Laccobius striatulus	Widespread		
Laccophilus hyalinus	Widespread		
Laccophilus minutus	Widespread		
Liopterus haemorrhoidalis	Widespread		
Noterus clavicornis	Widespread		
Noterus crassicornis	Nationally Scarce	W314	
Ochthebius bicolon	Local		W1
Ochthebius dilatatus	Widespread		
Ochthebius minimus	Widespread		
Porhydrus lineatus	Widespread		
Rhantus grapii	Local	W313	
Rhantus suturalis	Local		W211
Scirtes hemisphaericus	Local		
Tansyphyrus lemnae	Local		

Upwell district			
Species	**GB status**	**ISIS fen specialist codes**	**Other ISIS BATs & SATs**
Agabus bipustulatus	Widespread		
Agabus didymus	Widespread		
Agabus sturmii	Widespread		
Agabus undulatus	Near Threatened	W314	
Anacaena bipustulata	Local		W211
Anacaena globulus	Widespread		
Anacaena limbata	Widespread		
Anacaena lutescens	Widespread		
Berosus luridus	Near Threatened		W211
Cercyon convexiusculus	Local		W2
Cercyon marinus	Widespread		
Cymbiodyta marginellus	Widespread		
Cyphon laevipennis	Local		
Dytiscus circumflexus	Local		W211
Dytiscus marginalis	Widespread		
Enochrus testaceus	Widespread		
Graptodytes pictus	Widespread		
Gyrinus substriatus	Widespread		
Haliplus flavicollis	Widespread		
Haliplus fluviatilis	Widespread		
Haliplus immaculatus	Widespread		
Haliplus lineatocollis	Widespread		
Haliplus lineolatus	Widespread		
Haliplus obliquus	Widespread		
Haliplus ruficollis	Widespread		
Helochares lividus	Local		W211
Helophorus minutus	Widespread		
Hydraena testacea	Local		W2
Hydrobius fuscipes	Widespread		
Hydroporus angustatus	Widespread		
Hydroporus discretus	Widespread		
Hydroporus palustris	Widespread		
Hydroporus planus	Widespread		
Hydroporus striola	Widespread		
Hydroporus tessellatus	Widespread		
Hygrotus inaequalis	Widespread		
Hygrotus versicolor	Widespread		
Ilybius fuliginosus	Widespread		
Ilybius quadriguttatus	Widespread		

Laccobius bipunctatus	Widespread		
Laccophilus hyalinus	Widespread		
Noterus clavicornis	Widespread		
Ochthebius minimus	Widespread		
Oulimnius indet	-		
Platambus maculatus	Widespread		
Porhydrus lineatus	Widespread		
Tanysphyrus lemnae	Local		

Appendix 7

All survey sites (aquatic Coleoptera),

sorted by Number of Species (NoS)

Where two visits were made, the number of species recorded during the main Survey is given in square brackets. The top ≈10% of sites are highlighted in green.

Code	Site name	No. of species
O15	Long Lane, N of Over (b)	35 [31]
S1	Crooked Drain, S of Mepal Outdoor Centre	28 [22]
H2	North Fen Drain at Dam Bank Bridge, Gall Fen	27 [22]
H8	Adventurer's Head Drain, S of Third Bridge (NW of Aldreth)	28 [16]
O12	Great Ouse floodplain, W of Over: Middle Fen NE boundary (b)	27
U9	Upwell Fen, drain SE of Mill House	15 [11]
M1	Old Mill Drove (nr old pumping stn), N of Welches	24 [12]
LD48	Lady Fen 1, WWT Welney	22
LD47	Ladyfen Drain at Station Road, SW of Ten Mile Bank	21
M5	RSPB Purls Bridge ('Godwit Fields')	21
S9	Sutton West Fen: N of Tubb's Drove	21
LD49	Lady Fen 2, WWT Welney	20
M6	RSPB Purls Bridge ('Godwit Fields')	20
H9	Adventurer's Head Drain nr Clayton's Bridge (NW of Aldreth)	19
LD35	Main Drain at Common Bridge, Westmoor Common, Pymore	19
S3	Blockmoor Fen, NE of Blockmoor Farm	19
U1	Cross Drain (nr pumping house), SE of Cock Fen Farm	18
B6	Great Ouse flood plain (w. bank), e. of Needingworth	17
B7	Bluntisham Fen (eastern drain)	17
LD56	Lady Fen 9, WWT Welney	17
LD57	Lady Fen 10, WWT Welney	17
S18	Block Fen Drove	17
U11	Upwell Fen: field drain adjacent Birchfield Road, SE of Nordelph	17
U6	Drain SE of Reed Fen Farm, Welney	17
LD9	field drain, SW of Sedgedrove Farm, Hilgay Fen	16
O10	Great Ouse floodplain, W of Over: ditch NW of Middle Fen Drove	16
O11	Great Ouse floodplain, W of Over: Middle Fen NE boundary (a)	16
S16	Old Bedford Low Bank: NE of Paradise Cottage	16
U4	Drain parallel to Old Bedford River, SE of Cock Fen Farm, Welney	16
LD34	Grunty Fen Drain, Downham Hythe	15
LD50	Lady Fen 3, WWT Welney	15
LD61	Bank Farm 4, WWT Welney	15
M15	Adjacent Day's Lode Road, N of Manea	15
O6	Great Ouse floodplain, W of Over: ditch adj. river	15

S5	Crooked Drain adjacent Horseley Fen Middle Drove	15
B3	Overcote Lane, opposite White Bridge Farm	14
H1	New Cut, W of Aldreth	14
H10	Little Adventurer's Drain, Adventurer's Fen (NW of Aldreth)	14
LD29	drain 1, Byall Fen, N of Witcham	14
LD36	ditch at Straight Furlong, NE of Pymore	14
M19	Manea Fifties: field drain adjacent Fifty Road	14
S19	Langwood Fen: Langwood Fen Drove	14
S30	Old Bedford Low Bank (b)	14
S8	Sutton West Fen: N of Bedingham's Drove	14
SF5	Catchwater Drain, NE of Engine House, Fordham Fen	14
U3	Drain SE of Mill Bank, Welney (a)	14
U5	Drain parallel to Old Bedford River, SE of Cock Fen Farm, Welney (within copse)	14
LD33	drain SE of Willow Farm, Straight Drove, Coveney Byall Fen	13
LD64	Ladyfen Drain, SE of Bank Farm	13
M7	RSPB Purls Bridge ('Godwit Fields')	13
M8	RSPB Purls Bridge ('Godwit Field's)	13
S12	Sutton Meadlands: Meadlands Main Drove (W of airfield)	13
H3	Field drain by Long Drove, Lower Delphs, SE of Earith	12
LD12	field drain 2, N of Sedgedrove Farm, Hilgay Fen	12
S13	Ouse Washes SSSI Counterdrain, N of Mepal	12
S23	Horseley Fen: W of Mepal Outdoor Centre	12
S26	Langwood Fen: E of Langwood Farm East (a)	12
S29	Old Bedford Low Bank (a)	12
SF1	Drain S of Twelve Acre Covert, Fordham Fen	12
SF4	field drain 3, E of Engine Belt, Fordham Fen	12
B2	Overcote Lane, E of Needingworth	11
B4	Gravel workings, N of White Bridge (w)	11
H11	Gall's Drain nr Second Bridge, Gall Fen, Haddenham	11
LD18	Glover's Drain nr Station House Farm, Hilgay Fen	11
LD3	ditch 2, W of Middle Drove, Denver	11
M12	Manea Fifties: NE of Bond's Farm	11
M4	Bishop's Land, NE of Purls Bridge	11
S10	Sutton Meadlands: Meadlands Main Drove (nr microlight club)	11
S15	Engine Drain, SW of Fortrey's Hall	11
S21	Arthur Rickwood Farm (a)	11
U10	Well Creek, d/s confluence with Popham's Eau, Nordelph	11
M11	Adjacent B1093, SE of Cranmore Lots Farm, Manea	10
M3	Old Mill Drove (field drain B), Byall Fen	10
S14	Drain NE of Toll Farm, N of Mepal	10
LD13	Middle Leading Drain, N of Sedgedrove Farm, Hilgay Fen	9
LD51	Lady Fen 4, WWT Welney	9
LD55	Lady Fen 8, WWT Welney	9

LD6	IDB drain S of Ouse Bridge Cottages, Fordham Fen	9
LD60	Bank Farm 3, WWT Welney	9
LD65	drain SE of Bank Cottage (NE of Suspension Bridge)	9
LD8	Fourteen Foot Drain, Sedgedrove Farm area, SW of Denver	9
M13	South Branch Drain, SE of Bond's Farm, Manea	9
M18	Fodder Fen Common, NE of Bottom Farm (b)	9
M22	Forty Foot Drain, Welches Dam	9
O14	Long Lane, N of Over (a)	9
O4	drain inland of Bedford Corporation Barrier Bank, W of Over	9
S7	Sutton West Fen: New Cross Drove	9
SF9	Cut-off Channel, S of Border House, Fordham Fen	9
H5	Old West River, SE of Earith	8
LD14	Church Drain, N. of Pleasant House, Hilgay Fen	8
LD24	Witcham Hive, field drain 1, N. of Witcham	8
LD5	ditch 4, W of Middle Drove, Denver	8
LD53	Lady Fen 6, WWT Welney	8
LD54	Lady Fen 7, WWT Welney	8
LD58	Bank Farm 1, WWT Welney	8
LD62	Bank Farm 5, WWT Welney	8
LD63	Bank Farm 6, WWT Welney	8
LD66	Bank Farm 7, WWT Welney	8
M17	Fodder Fen Common, NE of Bottom Farm (a)	8
M2	Old Mill Drove (field drain A), Byall Fen	8
O8	Great Ouse floodplain, W of Over: Middle Fen NW boundary (b)	8
S17	Mepal Fen: drain at Black Bridge	8
S2	Blockmoor Fen, N of Blockmoor Farm	8
S28	Langwood Fen: SE of King's Farm (a)	8
H7	W of Dam Bank Drove (b), Lower Delphs	7
LD42	Engine Basin drain u/s Hundred Foot Pumping Station	7
LD52	Lady Fen 5, WWT Welney	7
M14	Ditch adjacent South Branch Drain, Manea	7
O13	Ouse Fen Wash: ditch parallel to river	7
S11	Sutton Meadlands: Meadlands North Drove	7
S22	Arthur Rickwood Farm (b)	7
S25	Byall Fen, ESE of Warth's Hundred Farm	7
SF6	field drain 1, NE of Engine House, Fordham Fen	7
H12	Long Drove, SW of Willow Farm, Adventurer's Head (W of Haddenham)	6
H4	Ditch adjacent Long Drove, Lower Delphs, SE of Earith	6
LD10	Church Drain, N. of Sedgedrove Farm, Hilgay Fen	6
LD19	field drain 1 SW of Church Farm, Hilgay Fen	6
LD2	ditch 1, W of Middle Drove, Denver	6
LD26	drain 2, Witcham Bridge Drove	6
LD45	ditch at Gold Hill, NW of Littleport	6
S24	Forty Foot Drain: N of Langwood Fen	6

U8	Upwell Fen, drain N of Wood House	6
LD11	field drain 1, N of Sedgedrove Farm, Hilgay Fen	5
LD15	Ely Ouse river , N of Ten Mile Bank	5
LD16	ditch 1 adj Modney Bridge Road, Great West Fen, SW of Downham Market	5
LD22	drain 2 N of Peasant House, Hilgay Fen	5
LD25	drain 1, Witcham Bridge Drove	5
LD30	drain 2, Byall Fen, N of Witcham	5
LD37	drain SE of Primrose Hill, Pymore	5
LD4	ditch 3, W of Middle Drove, Denver	5
LD41	Head Fen Drove, Westmoor Fen	5
LD44	ditch adj Bates's Drove, NW of Littleport	5
LD46	ditch adj Bell's Drove, NW of Littleport	5
LD59	Bank Farm 2, WWT Welney	5
LD7	field drain, SW of Ouse Bridge Cottages, Fordham Fen	5
M10	Adjacent B1093, Cranmore Lots Farm, Manea	5
M21	Cow Common, NW of Wisbech Road	5
M9	Purls Bridge Drove, S of Manea	5
O1	Drain W of Riverview Farm, NW of Over	5
O3	Great Ouse floodplain, W of Over: Swavesey Drain	5
O5	Great Ouse floodplain, W of Over: Webb's Hole	5
SF3	field drain 2, E of Engine Belt, Fordham Fen	5
U2	Bank Drain, SE of Cock Fen Farm, Welney	5
U7	Jones's Drove, SE of Reed Fen Farm, Welney	5
B5	Gravel workings, N of White Bridge (e)	4
B8	Queen's Grounds (eastern drain), S of Brownshill Sluice	4
LD17	ditch 2 adj Modney Bridge Road, Great West Fen, SW of Downham Market	4
LD21	drain 1 N of Peasant House, Hilgay Fen	4
LD28	drain 4, Witcham Bridge Drove	4
LD38	Straight Furlong nr Primrose Hill, Pymore	4
LD43	ditch SE of Hundred Foot Pumping Station	4
O7	Great Ouse floodplain, W of Over: Middle Fen NW boundary (a)	4
O9	Great Ouse floodplain, W of Over: Middle Fen W boundary	4
S27	Langwood Fen: E of Langwood Farm East (b)	4
S32	Langwood Fen: SE of King's Farm (b)	4
S4	Long North Fen Drove	4
SF8	field drain, SE of Horseshoe Close, Fordham Fen	4
H6	W of Dam Bank Drove (a), Lower Delphs	3
LD23	Catchwater Drain, Witcham Hive	3
LD27	drain 3, Witcham Bridge Drove	3
LD39	ditch W of Seventh Drove Farm, Westmoor Fen	3
M16	Adjacent Day's Lode Road, N of Watering Hill Farm, Manea	3
O2	Great Ouse floodplain, W of Over: drain N of Webb's Hole	3
S20	Langwood Fen: NE of Langwood Fen Farm	3
S6	Sutton West Fen: E of Primrose Farm	3

SF2	field drain 1, E of Engine Belt, Fordham Fen	3
SF7	field drain 2, NE of Engine House, Fordham Fen	3
LD1	Cut Off Channel, d/s Denver Sluice	2
LD20	field drain 2 SW of Church Farm, Hilgay Fen	2
B1	SE of White Bridge Farm	1
LD31	drain W of Coveney village	1
LD32	drain E of Way Head Drove, Coveney	1
LD40	ditch SW of Seventh Drove Farm, Westmoor Fen	1
S31	Old Bedford Low Bank (field drain)	1
M20	drain crossing B1100 (March Road), Welney	0

Appendix 8

Sites with five or more water beetle species, sorted by Species Quality Index (SQI)

The top ≈10% of sites are highlighted in green.

Code	Site name	No. of species	SQS	SQI
S22	Arthur Rickwood Farm (b)	7	32	4.57
S15	Engine Drain, SW of Fortrey's Hall	11	50	4.54
S10	Sutton Meadlands: Meadlands Main Drove (nr microlight club)	11	49	4.45
S21	Arthur Rickwood Farm (a)	11	47	4.27
LD7	field drain, SW of Ouse Bridge Cottages, Fordham Fen	5	21	4.2
S26	Langwood Fen: E of Langwood Farm East (a)	12	50	4.17
LD11	field drain 1, N of Sedgedrove Farm, Hilgay Fen	5	20	4
LD15	Ely Ouse river , N of Ten Mile Bank	5	19	3.8
S9	Sutton West Fen: N of Tubb's Drove	21	73	3.48
H11	Gall's Drain nr Second Bridge, Gall Fen, Haddenham	11	38	3.45
O14	Long Lane, N of Over (a)	9	31	3.44
H8	Adventurer's Head Drain, S of Third Bridge (NW of Aldreth)	28	95	3.39
LD48	Lady Fen 1, WWT Welney	22	72	3.27
S16	Old Bedford Low Bank: NE of Paradise Cottage	16	51	3.19
U6	Drain SE of Reed Fen Farm, Welney	17	54	3.18
S11	Sutton Meadlands: Meadlands North Drove	7	22	3.14
B7	Bluntisham Fen (eastern drain)	17	53	3.12
LD35	Main Drain at Common Bridge, Westmoor Common, Pymore	19	58	3.10
S8	Sutton West Fen: N of Bedingham's Drove	14	43	3.07
LD55	Lady Fen 8, WWT Welney	9	27	3
M12	Manea Fifties: NE of Bond's Farm	11	33	3
S29	Old Bedford Low Bank (a)	12	35	2.92
S3	Blockmoor Fen, NE of Blockmoor Farm	19	55	2.89
LD57	Lady Fen 10, WWT Welney	17	49	2.88
S5	Crooked Drain adjacent Horseley Fen Middle Drove	15	43	2.87
S17	Mepal Fen: drain at Black Bridge	7	20	2.86
M19	Manea Fifties: field drain adjacent Fifty Road	14	40	2.86
O15	Long Lane, N of Over (b)	35	100	2.86
H2	North Fen Drain at Dam Bank Bridge, Gall Fen	26	73	2.81
S7	Sutton West Fen: New Cross Drove	9	25	2.78
LD54	Lady Fen 7, WWT Welney	8	22	2.75
SF1	Drain S of Twelve Acre Covert, Fordham Fen	12	33	2.75
S30	Old Bedford Low Bank (b)	14	38	2.71
LD36	ditch at Straight Furlong, NE of Pymore	10	27	2.7

U9	Upwell Fen, drain SE of Mill House	15	40	2.67
M1	Old Mill Drove (nr old pumping stn), N of Welches	24	64	2.67
LD18	Glover's Drain nr Station House Farm, Hilgay Fen	11	29	2.64
M3	Old Mill Drove (field drain B), Byall Fen	10	26	2.6
LD12	field drain 2, N of Sedgedrove Farm, Hilgay Fen	12	30	2.5
H9	Adventurer's Head Drain nr Clayton's Bridge (NW of Aldreth)	18	45	2.5
B3	Overcote Lane, opposite White Bridge Farm	15	37	2.47
U5	Drain parallel to Old Bedford River, SE of Cock Fen Farm, Welney (within copse)	14	34	2.43
S1	Crooked Drain, S of Mepal Outdoor Centre	28	68	2.43
H3	Field drain by Long Drove, Lower Delphs, SE of Earith	12	29	2.42
O11	Great Ouse floodplain, W of Over: Middle Fen NE boundary (a)	16	38	2.38
LD47	Ladyfen Drain at Station Road, SW of Ten Mile Bank	21	50	2.38
U10	Well Creek, d/s confluence with Popham's Eau, Nordelph	11	26	2.36
LD42	Engine Basin drain u/s Hundred Foot Pumping Station	7	16	2.29
M5	RSPB Purls Bridge ('Godwit Fields')	21	48	2.29
SF4	field drain 3, E of Engine Belt, Fordham Fen	12	27	2.25
M6	RSPB Purls Bridge ('Godwit Fields')	20	45	2.25
LD56	Lady Fen 9, WWT Welney	17	38	2.24
LD33	drain SE of Willow Farm, Straight Drove, Coveney Byall Fen	13	29	2.23
O10	Great Ouse floodplain, W of Over: ditch NW of Middle Fen Drove	16	35	2.19
LD49	Lady Fen 2, WWT Welney	20	43	2.15
M13	South Branch Drain, SE of Bond's Farm, Manea	9	19	2.11
H10	Little Adventurer's Drain, Adventurer's Fen (NW of Aldreth)	13	27	2.08
M18	Fodder Fen Common, NE of Bottom Farm (b)	9	18	2
M8	RSPB Purls Bridge ('Godwit Field's)	13	25	1.92
M4	Bishop's Land, NE of Purls Bridge	11	21	1.91
M22	Forty Foot Drain, Welches Dam	9	17	1.89
LD61	Bank Farm 4, WWT Welney	15	28	1.87
H7	W of Dam Bank Drove (b), Lower Delphs	7	13	1.86
M14	Ditch adjacent South Branch Drain, Manea	7	13	1.86
O12	Great Ouse floodplain, W of Over: Middle Fen NE boundary (b)	27	49	1.81
O6	Great Ouse floodplain, W of Over: ditch adj. river	15	21	1.8
LD64	Ladyfen Drain, SE of Bank Farm	13	23	1.77
S12	Sutton Meadlands: Meadlands Main Drove (W of airfield)	13	23	1.77
S18	Block Fen Drove	17	30	1.76
LD66	Bank Farm 7, WWT Welney	8	14	1.75
U4	Drain parallel to Old Bedford River, SE of Cock Fen Farm, Welney	19	33	1.74
B4	Gravel workings, N of White Bridge (w)	11	19	1.73
LD50	Lady Fen 3, WWT Welney	15	26	1.73
U1	Cross Drain (nr pumping house), SE of Cock Fen Farm	18	31	1.72
LD52	Lady Fen 5, WWT Welney	7	12	1.71
U3	Drain SE of Mill Bank, Welney (a)	14	24	1.71

O4	drain inland of Bedford Corporation Barrier Bank, W of Over	9	15	1.67
SF9	Cut-off Channel, S of Border House, Fordham Fen	9	15	1.67
LD34	Grunty Fen Drain, Downham Hythe	15	25	1.67
M15	Adjacent Day's Lode Road, N of Manea	15	25	1.67
LD25	drain 1, Witcham Bridge Drove	5	8	1.6
LD41	Head Fen Drove, Westmoor Fen	5	8	1.6
M21	Cow Common, NW of Wisbech Road	5	8	1.6
S13	Ouse Washes SSSI Counterdrain, N of Mepal	12	19	1.58
S23	Horseley Fen: W of Mepal Outdoor Centre	12	19	1.58
LD23	Catchwater Drain, Witcham Hive	7	11	1.57
S25	Byall Fen, ESE of Warth's Hundred Farm	7	11	1.57
LD29	drain 1, Byall Fen, N of Witcham	14	22	1.57
M17	Fodder Fen Common, NE of Bottom Farm (a)	8	12	1.5
LD26	drain 2, Witcham Bridge Drove	6	9	1.5
LD45	ditch at Gold Hill, NW of Littleport	6	9	1.5
S24	Forty Foot Drain: N of Langwood Fen	6	9	1.5
H5	Old West River, SE of Earith	8	12	1.5
LD53	Lady Fen 6, WWT Welney	8	12	1.5
LD62	Bank Farm 5, WWT Welney	8	12	1.5
M2	Old Mill Drove (field drain A), Byall Fen	8	12	1.5
O8	Great Ouse floodplain, W of Over: Middle Fen NW boundary (b)	8	12	1.5
S2	Blockmoor Fen, N of Blockmoor Farm	8	12	1.5
M11	Adjacent B1093, SE of Cranmore Lots Farm, Manea	10	15	1.5
S19	Langwood Fen: Langwood Fen Drove	14	21	1.5
LD9	field drain, SW of Sedgedrove Farm, Hilgay Fen	16	24	1.5
SF6	field drain 1, NE of Engine House, Fordham Fen	7	10	1.43
B6	Great Ouse flood plain (w. bank), e. of Needingworth	17	24	1.41
LD16	ditch 1 adj Modney Bridge Road, Great West Fen, SW of Downham Market	5	7	1.4
LD63	Bank Farm 6, WWT Welney	8	11	1.38
M7	RSPB Purls Bridge ('Godwit Fields')	13	18	1.38
B2	Overcote Lane, E of Needingworth	11	15	1.36
H4	Ditch adjacent Long Drove, Lower Delphs, SE of Earith	6	8	1.33
LD65	drain SE of Bank Cottage (NE of Suspension Bridge)	9	12	1.33
LD5	ditch 4, W of Middle Drove, Denver	8	10	1.25
S28	Langwood Fen: SE of King's Farm (a)	8	10	1.25
H1	New Cut, W of Aldreth	14	17	1.21
SF5	Catchwater Drain, NE of Engine House, Fordham Fen	14	17	1.21
LD22	drain 2 N of Peasant House, Hilgay Fen	5	6	1.2
LD37	drain SE of Primrose Hill, Pymore	5	6	1.2
LD44	ditch adj Bates's Drove, NW of Littleport	5	6	1.2
LD46	ditch adj Bell's Drove, NW of Littleport	5	6	1.2
LD59	Bank Farm 2, WWT Welney	5	6	1.2

LD6	IDB drain S of Ouse Bridge Cottages, Fordham Fen	5	6	1.2
M10	Adjacent B1093, Cranmore Lots Farm, Manea	5	6	1.2
O1	Drain W of Riverview Farm, NW of Over	5	6	1.2
O3	Great Ouse floodplain, W of Over: Swavesey Drain	5	6	1.2
O5	Great Ouse floodplain, W of Over: Webb's Hole	5	6	1.2
U2	Bank Drain, SE of Cock Fen Farm, Welney	5	6	1.2
U7	Jones's Drove, SE of Reed Fen Farm, Welney	5	6	1.2
S14	Drain NE of Toll Farm, N of Mepal	10	12	1.2
LD3	ditch 2, W of Middle Drove, Denver	11	13	1.18
U11	Upwell Fen: field drain adjacent Birchfield Road, SE of Nordelph	17	20	1.18
LD10	Church Drain, N. of Sedgedrove Farm, Hilgay Fen	6	7	1.17
LD19	field drain 1 SW of Church Farm, Hilgay Fen	6	7	1.17
O13	Ouse Fen Wash: ditch parallel to river	7	8	1.14
LD14	Church Drain, N. of Pleasant House, Hilgay Fen	8	9	1.13
LD58	Bank Farm 1, WWT Welney	8	9	1.13
LD51	Lady Fen 4, WWT Welney	9	10	1.11
LD8	Fourteen Foot Drain, Sedgedrove Farm area, SW of Denver	9	10	1.11
LD30	drain 2, Byall Fen, N of Witcham	5	5	1
LD4	ditch 3, W of Middle Drove, Denver	5	5	1
M9	Purls Bridge Drove, S of Manea	5	5	1
SF3	field drain 2, E of Engine Belt, Fordham Fen	5	5	1
H12	Long Drove, SW of Willow Farm, Adventurer's Head (W of Haddenham)	6	6	1
LD2	ditch 1, W of Middle Drove, Denver	6	6	1
U8	Upwell Fen, drain N of Wood House	6	6	1
LD24	Witcham Hive, field drain 1, N. of Witcham	8	8	1
LD13	Middle Leading Drain, N of Sedgedrove Farm, Hilgay Fen	9	9	1
LD60	Bank Farm 3, WWT Welney	9	9	1

Appendix 9

Sites with nine or more water beetle species, sorted by Species Quality Index (SQI)

The top ≈10% of sites are highlighted in green.

Code	Site name	No. of species	SQS	SQI
S15	Engine Drain, SW of Fortrey's Hall	11	50	4.54
S10	Sutton Meadlands: Meadlands Main Drove (nr microlight club)	11	49	4.45
S21	Arthur Rickwood Farm (a)	11	47	4.27
S26	Langwood Fen: E of Langwood Farm East (a)	12	50	4.17
H10	Little Adventurer's Drain, Adventurer's Fen (NW of Aldreth)	13	51	3.92
S9	Sutton West Fen: N of Tubb's Drove	21	73	3.48
H11	Gall's Drain nr Second Bridge, Gall Fen, Haddenham	11	38	3.45
O14	Long Lane, N of Over (a)	9	31	3.44
H8	Adventurer's Head Drain, S of Third Bridge (NW of Aldreth)	28	95	3.39
LD48	Lady Fen 1, WWT Welney	22	72	3.27
S16	Old Bedford Low Bank: NE of Paradise Cottage	16	51	3.19
U6	Drain SE of Reed Fen Farm, Welney	17	54	3.18
B7	Bluntisham Fen (eastern drain)	17	53	3.12
LD35	Main Drain at Common Bridge, Westmoor Common, Pymore	19	58	3.10
S8	Sutton West Fen: N of Bedingham's Drove	14	43	3.07
LD55	Lady Fen 8, WWT Welney	9	27	3.00
M12	Manea Fifties: NE of Bond's Farm	11	33	3.00
S29	Old Bedford Low Bank (a)	12	35	2.92
S3	Blockmoor Fen, NE of Blockmoor Farm	19	55	2.89
LD57	Lady Fen 10, WWT Welney	17	49	2.88
S5	Crooked Drain adjacent Horseley Fen Middle Drove	15	43	2.87
M19	Manea Fifties: field drain adjacent Fifty Road	14	40	2.86
O15	Long Lane, N of Over (b)	35	100	2.86
H2	North Fen Drain at Dam Bank Bridge, Gall Fen	26	73	2.81
S7	Sutton West Fen: New Cross Drove	9	25	2.78
SF1	Drain S of Twelve Acre Covert, Fordham Fen	12	33	2.75
S30	Old Bedford Low Bank (b)	14	38	2.71
LD36	ditch at Straight Furlong, NE of Pymore	10	27	2.7
M1	Old Mill Drove (nr old pumping stn), N of Welches	24	64	2.67
U9	Upwell Fen, drain SE of Mill House	15	40	2.67
LD18	Glover's Drain nr Station House Farm, Hilgay Fen	11	29	2.64
M3	Old Mill Drove (field drain B), Byall Fen	10	26	2.60
H9	Adventurer's Head Drain nr Clayton's Bridge (NW of Aldreth)	18	45	2.5
LD12	field drain 2, N of Sedgedrove Farm, Hilgay Fen	12	30	2.5
B3	Overcote Lane, opposite White Bridge Farm	15	37	2.47
S1	Crooked Drain, S of Mepal Outdoor Centre	28	68	2.43

U5	Drain parallel to Old Bedford River, SE of Cock Fen Farm, Welney (within copse)	14	34	2.43
H3	Field drain by Long Drove, Lower Delphs, SE of Earith	12	29	2.42
LD47	Ladyfen Drain at Station Road, SW of Ten Mile Bank	21	50	2.38
O11	Great Ouse floodplain, W of Over: Middle Fen NE boundary (a)	16	38	2.38
U10	Well Creek, d/s confluence with Popham's Eau, Nordelph	11	26	2.36
M5	RSPB Purls Bridge ('Godwit Fields')	21	48	2.29
M6	RSPB Purls Bridge ('Godwit Fields')	20	45	2.25
SF4	field drain 3, E of Engine Belt, Fordham Fen	12	27	2.25
LD56	Lady Fen 9, WWT Welney	17	38	2.24
LD33	drain SE of Willow Farm, Straight Drove, Coveney Byall Fen	13	29	2.23
O10	Great Ouse floodplain, W of Over: ditch NW of Middle Fen Drove	16	35	2.19
LD49	Lady Fen 2, WWT Welney	20	43	2.15
M13	South Branch Drain, SE of Bond's Farm, Manea	9	19	2.11
M18	Fodder Fen Common, NE of Bottom Farm (b)	9	18	2.00
M8	RSPB Purls Bridge ('Godwit Field's)	13	25	1.92
M4	Bishop's Land, NE of Purls Bridge	11	21	1.91
M22	Forty Foot Drain, Welches Dam	9	17	1.89
LD61	Bank Farm 4, WWT Welney	15	28	1.87
O12	Great Ouse floodplain, W of Over: Middle Fen NE boundary (b)	27	49	1.81
O6	Great Ouse floodplain, W of Over: ditch adj. river	15	21	1.80
LD64	Ladyfen Drain, SE of Bank Farm	13	23	1.77
S12	Sutton Meadlands: Meadlands Main Drove (W of airfield)	13	23	1.77
S18	Block Fen Drove	17	30	1.76
U4	Drain parallel to Old Bedford River, SE of Cock Fen Farm, Welney	19	33	1.74
B4	Gravel workings, N of White Bridge (w)	11	19	1.73
LD50	Lady Fen 3, WWT Welney	15	26	1.73
U1	Cross Drain (nr pumping house), SE of Cock Fen Farm	18	31	1.72
U3	Drain SE of Mill Bank, Welney (a)	14	24	1.71
LD34	Grunty Fen Drain, Downham Hythe	15	25	1.67
M15	Adjacent Day's Lode Road, N of Manea	15	25	1.67
O4	drain inland of Bedford Corporation Barrier Bank, W of Over	9	15	1.67
SF9	Cut-off Channel, S of Border House, Fordham Fen	9	15	1.67
S13	Ouse Washes SSSI Counterdrain, N of Mepal	12	19	1.58
S23	Horseley Fen: W of Mepal Outdoor Centre	12	19	1.58
LD29	drain 1, Byall Fen, N of Witcham	14	22	1.57
LD9	field drain, SW of Sedgedrove Farm, Hilgay Fen	16	24	1.5
M11	Adjacent B1093, SE of Cranmore Lots Farm, Manea	10	15	1.50
S19	Langwood Fen: Langwood Fen Drove	14	21	1.50
B6	Great Ouse flood plain (w. bank), e. of Needingworth	17	24	1.41
M7	RSPB Purls Bridge ('Godwit Fields')	13	18	1.38
B2	Overcote Lane, E of Needingworth	11	15	1.36
LD65	drain SE of Bank Cottage (NE of Suspension Bridge)	9	12	1.33
H1	New Cut, W of Aldreth	14	17	1.21

SF5	Catchwater Drain, NE of Engine House, Fordham Fen	14	17	1.21
S14	Drain NE of Toll Farm, N of Mepal	10	12	1.20
LD3	ditch 2, W of Middle Drove, Denver	11	13	1.18
U11	Upwell Fen: field drain adjacent Birchfield Road, SE of Nordelph	17	20	1.18
LD51	Lady Fen 4, WWT Welney	9	10	1.11
LD8	Fourteen Foot Drain, Sedgedrove Farm area, SW of Denver	9	10	1.11
LD13	Middle Leading Drain, N of Sedgedrove Farm, Hilgay Fen	9	9	1.00
LD60	Bank Farm 3, WWT Welney	9	9	1.00

Appendix 10

All sites (aquatic Coleoptera), ranked by Species Quality Score (SQS)

The top ≈10% of sites are highlighted in green.

Code	Site name	No. of species	SQS
O15	Long Lane, N of Over (b)	35	100
H8	Adventurer's Head Drain, S of Third Bridge (NW of Aldreth)	28	95
H2	North Fen Drain at Dam Bank Bridge, Gall Fen	27	73
S9	Sutton West Fen: N of Tubb's Drove	21	73
LD48	Lady Fen 1, WWT Welney	22	72
S1	Crooked Drain, S of Mepal Outdoor Centre	28	68
M1	Old Mill Drove (nr old pumping stn), N of Welches	24	64
LD35	Main Drain at Common Bridge, Westmoor Common, Pymore	19	57
S3	Blockmoor Fen, NE of Blockmoor Farm	19	55
U6	Drain SE of Reed Fen Farm, Welney	17	54
B7	Bluntisham Fen (eastern drain)	17	53
H10	Little Adventurer's Drain, Adventurer's Fen (NW of Aldreth)	14	51
S16	Old Bedford Low Bank: NE of Paradise Cottage	16	51
LD47	Ladyfen Drain at Station Road, SW of Ten Mile Bank	21	50
S15	Engine Drain, SW of Fortrey's Hall	11	50
S26	Langwood Fen: E of Langwood Farm East (a)	12	50
LD57	Lady Fen 10, WWT Welney	17	49
O12	Great Ouse floodplain, W of Over: Middle Fen NE boundary (b)	27	49
S10	Sutton Meadlands: Meadlands Main Drove (nr microlight club)	11	49
M5	RSPB Purls Bridge ('Godwit Fields')	21	48
S21	Arthur Rickwood Farm (a)	11	47
H9	Adventurer's Head Drain nr Clayton's Bridge (NW of Aldreth)	19	45
M6	RSPB Purls Bridge ('Godwit Fields')	20	45
LD49	Lady Fen 2, WWT Welney	20	43
S5	Crooked Drain adjacent Horseley Fen Middle Drove	15	43
S8	Sutton West Fen: N of Bedingham's Drove	14	43
M19	Manea Fifties: field drain adjacent Fifty Road	14	40
U9	Upwell Fen, drain SE of Mill House	15	40
H11	Gall's Drain nr Second Bridge, Gall Fen, Haddenham	11	38
LD56	Lady Fen 9, WWT Welney	17	38
O11	Great Ouse floodplain, W of Over: Middle Fen NE boundary (a)	16	38
S30	Old Bedford Low Bank (b)	14	38
B3	Overcote Lane, opposite White Bridge Farm	14	37
O10	Great Ouse floodplain, W of Over: ditch NW of Middle Fen Drove	16	35

S29	Old Bedford Low Bank (a)	12	35
U5	Drain parallel to Old Bedford River, SE of Cock Fen Farm, Welney	14	34
M12	Manea Fifties: NE of Bond's Farm	11	33
SF1	Drain S of Twelve Acre Covert, Fordham Fen	12	33
U4	Drain parallel to Old Bedford River, SE of Cock Fen Farm, Welney	16	33
S22	Arthur Rickwood Farm (b)	7	32
O14	Long Lane, N of Over (a)	9	31
U1	Cross Drain (nr pumping house), SE of Cock Fen Farm	18	31
LD12	field drain 2, N of Sedgedrove Farm, Hilgay Fen	12	30
S18	Block Fen Drove	17	30
H3	Field drain by Long Drove, Lower Delphs, SE of Earith	12	29
LD18	Glover's Drain nr Station House Farm, Hilgay Fen	11	29
LD33	drain SE of Willow Farm, Straight Drove, Coveney Byall Fen	13	29
LD61	Bank Farm 4, WWT Welney	15	28
LD36	ditch at Straight Furlong, NE of Pymore	14	27
LD55	Lady Fen 8, WWT Welney	9	27
SF4	field drain 3, E of Engine Belt, Fordham Fen	12	27
LD50	Lady Fen 3, WWT Welney	15	26
M3	Old Mill Drove (field drain B), Byall Fen	10	26
U10	Well Creek, d/s confluence with Popham's Eau, Nordelph	11	26
LD34	Grunty Fen Drain, Downham Hythe	15	25
M15	Adjacent Day's Lode Road, N of Manea	15	25
M8	RSPB Purls Bridge ('Godwit Field's)	13	25
S7	Sutton West Fen: New Cross Drove	9	25
B6	Great Ouse flood plain (w. bank), e. of Needingworth	17	24
LD9	field drain, SW of Sedgedrove Farm, Hilgay Fen	16	24
U3	Drain SE of Mill Bank, Welney (a)	14	24
LD64	Ladyfen Drain, SE of Bank Farm	13	23
S12	Sutton Meadlands: Meadlands Main Drove (W of airfield)	13	23
LD29	drain 1, Byall Fen, N of Witcham	14	22
LD54	Lady Fen 7, WWT Welney	8	22
S11	Sutton Meadlands: Meadlands North Drove	7	22
LD7	field drain, SW of Ouse Bridge Cottages, Fordham Fen	5	21
M4	Bishop's Land, NE of Purls Bridge	11	21
O6	Great Ouse floodplain, W of Over: ditch adj. river	15	21
S19	Langwood Fen: Langwood Fen Drove	14	21
LD11	field drain 1, N of Sedgedrove Farm, Hilgay Fen	5	20
S17	Mepal Fen: drain at Black Bridge	7	20
U11	Upwell Fen: field drain adjacent Birchfield Road, SE of Nordelph	17	20
B4	Gravel workings, N of White Bridge (w)	11	19
LD15	Ely Ouse river , N of Ten Mile Bank	5	19

M13	South Branch Drain, SE of Bond's Farm, Manea	9	19
S13	Ouse Washes SSSI Counterdrain, N of Mepal	12	19
S23	Horseley Fen: W of Mepal Outdoor Centre	12	19
S27	Langwood Fen: E of Langwood Farm East (b)	4	19
M18	Fodder Fen Common, NE of Bottom Farm (b)	9	18
M7	RSPB Purls Bridge ('Godwit Fields')	13	18
H1	New Cut, W of Aldreth	14	17
LD20	field drain 2 SW of Church Farm, Hilgay Fen	2	17
M22	Forty Foot Drain, Welches Dam	9	17
SF5	Catchwater Drain, NE of Engine House, Fordham Fen	14	17
LD42	Engine Basin drain u/s Hundred Foot Pumping Station	7	16
B2	Overcote Lane, E of Needingworth	11	15
M11	Adjacent B1093, SE of Cranmore Lots Farm, Manea	10	15
O4	drain inland of Bedford Corporation Barrier Bank, W of Over	9	15
SF9	Cut-off Channel, S of Border House, Fordham Fen	9	15
LD66	Bank Farm 7, WWT Welney	8	14
H7	W of Dam Bank Drove (b), Lower Delphs	7	13
LD3	ditch 2, W of Middle Drove, Denver	11	13
M14	Ditch adjacent South Branch Drain, Manea	7	13
M17	Fodder Fen Common, NE of Bottom Farm (a)	8	12
H5	Old West River, SE of Earith	8	12
LD52	Lady Fen 5, WWT Welney	7	12
LD53	Lady Fen 6, WWT Welney	8	12
LD62	Bank Farm 5, WWT Welney	8	12
LD65	drain SE of Bank Cottage (NE of Suspension Bridge)	9	12
M2	Old Mill Drove (field drain A), Byall Fen	8	12
O8	Great Ouse floodplain, W of Over: Middle Fen NW boundary (b)	8	12
S14	Drain NE of Toll Farm, N of Mepal	10	12
S2	Blockmoor Fen, N of Blockmoor Farm	8	12
LD23	Catchwater Drain, Witcham Hive	7	11
LD63	Bank Farm 6, WWT Welney	8	11
S25	Byall Fen, ESE of Warth's Hundred Farm	7	11
LD28	drain 4, Witcham Bridge Drove	4	10
LD5	ditch 4, W of Middle Drove, Denver	8	10
LD51	Lady Fen 4, WWT Welney	9	10
LD8	Fourteen Foot Drain, Sedgedrove Farm area, SW of Denver	9	10
O7	Great Ouse floodplain, W of Over: Middle Fen NW boundary (a)	4	10
S28	Langwood Fen: SE of King's Farm (a)	8	10
SF6	field drain 1, NE of Engine House, Fordham Fen	7	10
SF8	field drain, SE of Horseshoe Close, Fordham Fen	4	10
LD13	Middle Leading Drain, N of Sedgedrove Farm, Hilgay Fen	9	9
LD14	Church Drain, N. of Pleasant House, Hilgay Fen	8	9

LD26	drain 2, Witcham Bridge Drove	6	9
LD45	ditch at Gold Hill, NW of Littleport	6	9
LD58	Bank Farm 1, WWT Welney	8	9
LD60	Bank Farm 3, WWT Welney	9	9
S24	Forty Foot Drain: N of Langwood Fen	6	9
H4	Ditch adjacent Long Drove, Lower Delphs, SE of Earith	6	8
LD21	drain 1 N of Peasant House, Hilgay Fen	4	8
LD24	Witcham Hive, field drain 1, N. of Witcham	8	8
LD25	drain 1, Witcham Bridge Drove	5	8
LD41	Head Fen Drove, Westmoor Fen	5	8
M21	Cow Common, NW of Wisbech Road	5	8
O13	Ouse Fen Wash: ditch parallel to river	7	8
LD10	Church Drain, N. of Sedgedrove Farm, Hilgay Fen	6	7
LD16	ditch 1 adj Modney Bridge Road, Great West Fen, SW of Downham Market	5	7
LD19	field drain 1 SW of Church Farm, Hilgay Fen	6	7
H12	Long Drove, SW of Willow Farm, Adventurer's Head (W of Haddenham)	6	6
LD2	ditch 1, W of Middle Drove, Denver	6	6
LD22	drain 2 N of Peasant House, Hilgay Fen	5	6
LD37	drain SE of Primrose Hill, Pymore	5	6
LD44	ditch adj Bates's Drove, NW of Littleport	5	6
LD46	ditch adj Bell's Drove, NW of Littleport	5	6
LD59	Bank Farm 2, WWT Welney	5	6
LD6	IDB drain S of Ouse Bridge Cottages, Fordham Fen	5	6
M10	Adjacent B1093, Cranmore Lots Farm, Manea	5	6
O1	Drain W of Riverview Farm, NW of Over	5	6
O3	Great Ouse floodplain, W of Over: Swavesey Drain	5	6
O5	Great Ouse floodplain, W of Over: Webb's Hole	5	6
U2	Bank Drain, SE of Cock Fen Farm, Welney	5	6
U7	Jones's Drove, SE of Reed Fen Farm, Welney	5	6
U8	Upwell Fen, drain N of Wood House	6	6
B8	Queen's Grounds (eastern drain), S of Brownshill Sluice	4	5
LD30	drain 2, Byall Fen, N of Witcham	5	5
LD38	Straight Furlong nr Primrose Hill, Pymore	4	5
LD4	ditch 3, W of Middle Drove, Denver	5	5
M9	Purls Bridge Drove, S of Manea	5	5
O9	Great Ouse floodplain, W of Over: Middle Fen W boundary	4	5
S4	Long North Fen Drove	4	5
SF3	field drain 2, E of Engine Belt, Fordham Fen	5	5
B5	Gravel workings, N of White Bridge (e)	4	4
LD17	ditch 2 adj Modney Bridge Road, Great West Fen, SW of Downham Market	4	4
LD27	drain 3, Witcham Bridge Drove	3	4
LD39	ditch W of Seventh Drove Farm, Westmoor Fen	3	4

LD43	ditch SE of Hundred Foot Pumping Station	4	4
S32	Langwood Fen: SE of King's Farm (b)	4	4
H6	W of Dam Bank Drove (a), Lower Delphs	3	3
M16	Adjacent Day's Lode Road, N of Watering Hill Farm, Manea	3	3
O2	Great Ouse floodplain, W of Over: drain N of Webb's Hole	3	3
S20	Langwood Fen: NE of Langwood Fen Farm	3	3
S6	Sutton West Fen: E of Primrose Farm	3	3
SF2	field drain 1, E of Engine Belt, Fordham Fen	3	3
SF7	field drain 2, NE of Engine House, Fordham Fen	3	3
LD1	Cut Off Channel, d/s Denver Sluice	2	2
B1	SE of White Bridge Farm	1	1
LD31	drain W of Coveney village	1	1
LD32	drain E of Way Head Drove, Coveney	1	1
LD40	ditch SW of Seventh Drove Farm, Westmoor Fen	1	1
S31	Old Bedford Low Bank (field drain)	1	1
M20	drain crossing B1100 (March Road), Welney	0	0