Foxglove Covert Local Nature Reserve: pond survey of the Wetlands

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A report for the People, Ponds and Water Project

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1. Introduction

The Wetlands area at Foxglove Covert Local Nature Reserve has been identified as a Flagship Pond Site by the Freshwater Habitats Trust (formerly Pond Conservation), on account of its importance for Priority Species and the opportunities it affords for volunteer training and involvement.

The Wetlands form part of an extension to the LNR which is located at Catterick Garrison in Richmondshire, North Yorkshire (National Grid Reference SE 158 968). The 1.7 hectare site is situated on the edge of Hipswell Moor in Lower Swaledale, at an elevation of around 205 metres above sea level. It includes a complex of ponds constructed in 2009: these are fed by water abstracted from a spring-fed rivulet to the north, which circulates via a system of pipes and bunds. There are also a number of pre-existing, much older shallow pools of uncertain origin.

This survey was commissioned by the Freshwater Habitats Trust as part of its People, Ponds and Water project, with the aim of providing a baseline assessment of the Wetlands ponds. The survey used PSYM (**P**redictive **Sy**stem for **M**ultimetrics), the nationally-recognised methodology for assessing the ecological quality of still-water habitats developed by the Environment Agency and Pond Conservation (Environment Agency, 2002). Fieldwork was undertaken on 14th, 29th and 30th July 2015 with 22 ponds surveyed (Figure 1).

PSYM uses six 'metrics' (measurements) representing important indicators of ecological quality. The three botanical metrics are based on a walkover survey to record wetland plants. They are:

- diversity of emergent and submerged plant species
- the number of less common species
- Trophic Ranking Score (TRS, an indication of nutrient status based on key plant species)

The three invertebrate metrics are based on a timed sample which involves netting each of the 'meso-habitats' present in a pond (e.g. emergent vegetation, open water, floating vegetation). Although PSYM requires identification of aquatic macro-invertebrates to family level only, during this survey material was identified to species level wherever possible to add value to the data[1].

The invertebrate metrics are:

- Average Score Per Taxon (ASPT, an estimation of biological water quality based on the sensitivity of different invertebrate families to organic enrichment)
- diversity of dragonfly, damselfly and alderfly families

[1] During this survey, bankside sorting of invertebrate samples was used in preference to the laboratory sorting normally used with PSYM.

- diversity of water beetle families

Environmental data are also obtained for each pond (e.g. surface area, altitude, geographical location, water pH, substrate type, degree of shade and amount of emergent vegetation). The data are then fed into a computer model which compares them with a large reference dataset of 'unimpaired' (undegraded) ponds. The model predicts how a high quality pond with similar attributes *should* score for each metric, and compares the predictions with the actual survey results. The scores for each metric are combined to produce an Index of Biotic Integrity (IBI) which provides a holistic assessment of the ecological quality of the pond. This can be categorised as Very Poor, Poor, Medium and Good. Good quality ponds are those which have an Index of over 75% and qualify as Priority Ponds, which are a Habitat of Principal Importance listed under Section 41 of the Natural Environment and Rural Communities Act 2006.

The data for each of the 22 ponds assessed using PSYM are summarised in Appendix 1.

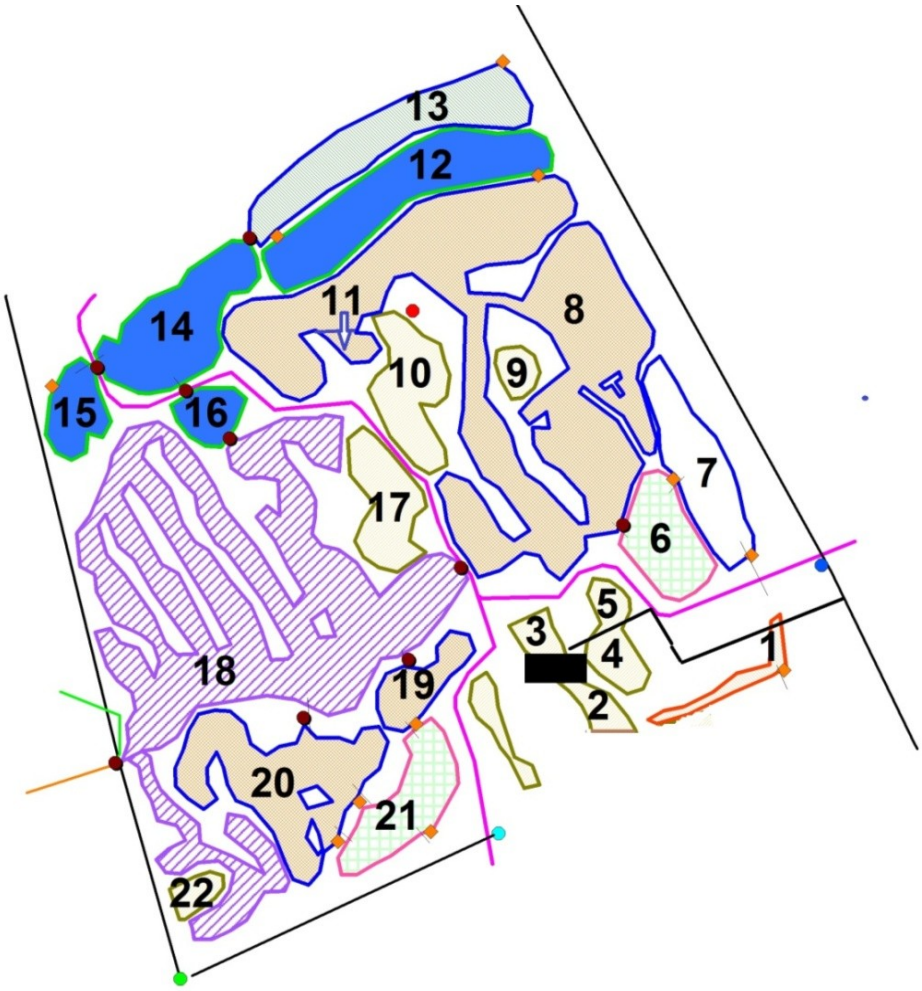


Figure 1: Map showing numbering of the Wetlands ponds

2. The ponds surveyed

Pond 1 (SE 15927 96814)

This is a linear, 'L'-shaped water body at the southern end of the Wetlands which held only a few centimetres of water at the time of the survey. A water sample produced a pH reading of 6.15 with electrical conductivity of 140 µS/cm^{-1}. It supports tall emergent vegetation comprising a mixture of Common Reed *Phragmites australis*, Greater Reedmace *Typha latifolia* and Bottle Sedge *Carex rostrata* with a variety of shorter plants in the understorey. It was the only pond with records of Common Reed, Marsh Marigold *Caltha palustris*, Water Figwort *Scrophularia auriculata*, Square-stalked St John's Wort *Hypericum tetrapterum*, Purple Loosestrife *Lythrum salicaria*, Lesser Water-parsnip *Berula erecta* and Water Forget-me-not *Myosotis scorpioides*. This suggests that conditions are more eutrophic than in the other water bodies on the Wetlands, though this is not obvious from the water chemistry data. A total of 30 wetland plant species were recorded[2]. A modest 19 aquatic invertebrate taxa were recorded, reflecting the almost-dry conditions, but these did include a single Mud Snail.

Pond 1 produced an Index of Biological Integrity of 56%, placing it within the category of **Moderate** ecological quality. It scored well for wetland plant diversity but poorly for representation of uncommon plant species and trophic status (TRS). The pond ranked well diversity of water beetle families and moderately for biological water quality (ASPT) and but yielded no Odonata.

Pond 2 (SE 15896 96807)

This is one of the remnant pools and forms a shallow hollow adjoining the boardwalk leading to the observation hide. A water sample produced a pH reading of 6.71 with electrical conductivity of 110 µS/cm. It is densely-vegetated, predominantly with Sharp-flowered and Soft Rushes (*Juncus acutiflorus* and *J. effusus*). There is around 25% moss cover including Pointed Spear-moss *Calliergonella cuspidata*, Bog Bead-moss *Aulocomnium palustre*, Spiky Bog-moss *Sphagnum squarrosum* and Flat-topped Bog-moss *S. fallax* agg[3]. A total of 20 wetland plants and 13 aquatic invertebrate taxa were recorded; the invertebrate sample included Mud Snail.

As with Pond 1, Pond 2 produced an Index of Biological Integrity of 56%, placing it within the category of **Moderate** ecological quality. It scored well for wetland plant diversity and trophic status but produced no uncommon plant species. Scores for water beetle families and biological water quality (ASPT) were moderate but this pond yielded no Odonata.

[2] For each pond, the number of wetland plants refers to species listed on the PSYM pro-forma; stoneworts and Sphagna have been counted as individual species but other bryophytes have not been counted.

[3] In this report, *Sphagnum fallax* denotes the aggregate of species formerly known as *S. recurvum*. In a 2012 botanical survey, some material was identified as *S. angustifolium*.

Pond 3 (SE 15886 96823)

This shallow, elongate pond is one of the old pools. A water sample produced a pH reading of 6.47 with electrical conductivity of 130 µS/cm. It is located immediately in front of the observation hide and is dominated by Bottle Sedge and Sharp-flowered Rush. Pointed Spear-moss is locally-abundant with smaller amounts of Heart-leaved Spear-moss *Calliergon cordifolium* and Spiky Bog-moss. A total of 25 wetland plants and 29 aquatic invertebrate taxa were recorded. Invertebrates included Mud Snail and a relatively rich water beetle assemblage including the Nationally Scarce small diving beetle *Hydroporus neglectus*.

Pond 3 produced an Index of Biological Integrity of 83%, placing it within the top (**Good**) category of ecological quality. It scored well for wetland plant diversity and trophic status but produced no uncommon plant species. Scores were high for all three invertebrate metrics.

Pond 4 (SE 15899 96814)

Pond 4 is an 'old' pool, situated just to the east of the hide. Most of it is south of the fence and inaccessible to livestock. A water sample produced a pH reading of 5.96 with electrical conductivity of 120 µS/cm.

This pond is almost completely covered with emergent vegetation, mainly Greater Reedmace, Sharp-flowered Rush and Bottle Sedge. A total of 19 wetland plants and 18 aquatic invertebrate taxa were recorded; the latter included Mud Snail.

Pond 4 produced an Index of Biological Integrity of 50%, placing it within the category of **Moderate** ecological quality. It scored well for trophic status and moderately for wetland plant diversity but produced no uncommon plant species. Scores for water beetle families and biological water quality (ASPT) were moderate but this pond yielded no Odonata.

Pond 5 (SE 15901 96825)

This circular remnant pool held ankle-deep water at the time of the survey. It is almost contiguous with Pond 4 but is located north of the fenceline and therefore accessible to livestock. A water sample produced a pH reading of 6.40 with electrical conductivity of 160 µS/cm. Marsh Cinquefoil *Comarum palustre* is abundant in the centre with a fringe of Sharp-flowered Rush and Sphagna around the margin. A total of 25 wetland plants and 16 aquatic invertebrate taxa were recorded; the latter included the Nationally Scarce small diving beetle *Hydroporus neglectus*.

Pond 5 produced an Index of Biological Integrity of 58%, placing it within the category of **Moderate** ecological quality. It scored well for wetland plant diversity and moderately for trophic status but produced no uncommon plant species. It scored well for water beetle families and moderately for biological water quality (ASPT) but yielded no Odonata.

Pond 6 (SE 15915 96829)

This is one of the 'new' ponds and contains a greater proportion of open water than the old pools. Pond 6 also has more sandy material in the substrate than the other water bodies. A water sample produced a pH reading of 7.24 with electrical conductivity of 230 µS/cm.

It supports a fringe of tall emergent vegetation with abundant Broad-leaved Pondweed *Potamogeton natans* in deeper water. Delicate Stonewort *Chara virgata* is locally-abundant on the pond bed. A total of 26 wetland plants and 34 aquatic invertebrate taxa were recorded.

Pond 6 produced an Index of Biological Integrity of 78%, placing it within the top (**Good**) category of ecological quality. It scored well for wetland plant diversity and moderately for trophic status but produced no uncommon plant species. Scores were high for all three invertebrate metrics.

Pond 7 (SE 15929 96836)

This new, rectilinear pond is located near the eastern boundary of the Wetlands. It has a narrow fringe of emergent vegetation, abundant Broad-leaved Pondweed in open water and extensive patches of Delicate Stonewort. A total of 23 wetland plants and 25 aquatic invertebrate taxa were recorded. A water sample produced a pH reading of 7.61 with electrical conductivity of 200 µS/cm.

There was much evidence of Water Vole activity on this pond, including active burrows. A single Great Crested Newt tadpole was netted as well as Smooth/Palmate Newt tadpoles.

Pond 7 produced an Index of Biological Integrity of 89%, placing it within the top (**Good**) category of ecological quality. It scored well for wetland plant diversity and moderately for trophic status and representation of uncommon plant species. Scores were high for all three invertebrate metrics.

Pond 8 (SE 15895 96878)

This large 'new' pond has a highly convoluted outline. A water sample produced a pH reading of 7.05 with electrical conductivity of 260 µS/cm. Vegetation ranges from Greater Reedmace swamp to open water with submerged stonewort beds. A total of 31 wetland plants and 34 aquatic invertebrate taxa were recorded.

A high density of Water Vole feeding stations was noted around the pond banks. Numerous Smooth/Palmate Newt tadpoles were netted during invertebrate sampling.

Pond 8 produced an Index of Biological Integrity of 89%, placing it within the top (**Good**) category of ecological quality. It scored well for wetland plant diversity and trophic status but poorly for uncommon plant species. Scores were high for all three invertebrate metrics.

Pond 9 (SE 15881 96869)

This small, circular remnant pool has been retained within an island encircled by Pond 8. It has a fringe of rush species and a raft of Bog Pondweed *Potamogeton polygonifolius* in the centre. A total of 16 wetland plants and 22 aquatic invertebrate taxa were recorded. The latter included Mud Snail and the Nationally Scarce small diving beetle *Hydroporus neglectus*. A single Water Vole latrine was noted along with small numbers of Smooth/Palmate Newt tadpoles.

A water sample produced a pH reading of 6.10 with electrical conductivity of 80 µS/cm.

Pond 9 produced an Index of Biological Integrity of 67%, placing it within the category of **Moderate** ecological quality. It scored well for trophic status and moderately for wetland plant diversity but no uncommon plant species were recorded. Scores were high for biological water quality and diversity of water beetle families but poor for diversity of Odonata families.

Pond 10 (SE 15861 96858)

This is an 'old' pond near the centre of the Wetlands. The southern part has patchy vegetation with Common Cotton-grass *Eriophorum angustifolium*, Bog Pondweed and *Sphagnum* mosses. The northern lobe is dominated by Bottle Sedge over a ground layer of Pointed Spear-moss. A water sample produced a pH reading of 6.48 with electrical conductivity of 120 µS/cm.

A total of 23 wetland plant species and 21 aquatic macro-invertebrate taxa were recorded, including Mud Snail. (Mud Snail had been recorded from the same pond in 2008).

Pond 10 produced an Index of Biological Integrity of 83%, placing it within the category of **Good** ecological quality. It scored well for wetland plant diversity, moderately for trophic status and poorly for representation of uncommon plant species. Scores were high for all three invertebrate metrics.

Pond 11 (SE 15851 96878)

This small pond is contiguous with Pond 8 but forms a distinct embayment with dense vegetation cover. It may be a remnant of one of the older pools. Sharp-flowered Rush, Bog Pondweed and Pointed Spear-moss are abundant. A total of 22 wetland plant species and 15 aquatic macro-invertebrate taxa were recorded.

A water sample produced a pH reading of 6.40 with electrical conductivity of 300 µS/cm.

Pond 11 produced an Index of Biological Integrity of 78%, placing it within the top (**Good**) category of ecological quality. It scored well for wetland plant diversity and moderately for trophic status but produced no uncommon plant species. Scores were high for all three invertebrate metrics.

Pond 12 (SE 15867 96913)

This rectilinear permanent pond was constructed in 2009. It supports around 20% emergent vegetation cover with stands of Broad-leaved Pondweed in open water. A water sample produced a pH reading of 7.12 with electrical conductivity of 240 µS/cm.

A total of 21 wetland plant species and 33 aquatic macro-invertebrate taxa were recorded. A number of Water Vole feeding stations were evident. Single adult and larval Great Crested Newts were netted during invertebrate sampling and other adults were observed rising to the surface. Smooth/Palmate Newt tadpoles were numerous.

Pond 12 produced an Index of Biological Integrity of 78%, placing it within the top (**Good**) category of ecological quality. It scored well for wetland plant diversity and moderately for trophic status but produced no uncommon plant species. Scores were high for all three invertebrate metrics.

Pond 13 (SE 15845 96910)

Pond 13 is located on the northern edge of the Wetlands and is similar to Pond 12. A water sample produced a pH reading of 7.14 with electrical conductivity of 250 µS/cm. A total of 21 wetland plant species and 23 aquatic macro-invertebrate taxa were recorded. A single Great Crested Newt tadpole and several Smooth/Palmate Newt tadpoles were caught; adult Crested Newts were also observed surfacing.

Pond 13 produced an Index of Biological Integrity of 100% (the highest possible), placing it within the top (**Good**) category of ecological quality. Scores were high for all six metrics.

Pond 14 (SE 15816 96865)

This is a 'new' pond, located to the west of Ponds 12 and 13. It contains extensive emergent vegetation including stands of Common Spike-rush *Eleocharis palustris*, Branched Bur-reed and Greater Reedmace. A small area on the southern edge of the pond supports Alternate

Water-millfoil *Myriophyllum alterniflorum*, Floating Club-rush *Eleogiton fluitans* and, notably, Pillwort *Pilularia globulifera*. A total of 28 wetland plant species and 22 aquatic macro-invertebrate taxa were recorded. Smooth/Palmate Newt tadpoles were caught during invertebrate sampling.

A water sample produced a pH reading of 7.23 with electrical conductivity of 150 µS/cm.

Pond 14 produced an Index of Biological Integrity of 100%, placing it within the top (**Good**) category of ecological quality. Scores were high for all six metrics.

Pond 15 (SE 15797 96864)

This pond is located in the north-west corner of the Wetlands, adjoining Hipswell Moor. It is densely vegetated, mainly with Sharp-flowered Rush and Bog Pondweed. A total of 22 wetland plant species and 15 aquatic macro-invertebrate taxa were recorded; the latter include Mud Snail. Smooth/Palmate Newt tadpoles were caught during invertebrate sampling.

A water sample produced a pH reading of 6.36 with electrical conductivity of 110 µS/cm. Although this is a 'new' pond, it may incorporate a pre-existing pool.

Pond 15 produced an Index of Biological Integrity of 78%, placing it within the top (**Good**) category of ecological quality. It scored well for wetland plant diversity, moderately for trophic ranking and poorly for representation of uncommon plants. All three invertebrate metrics were good.

Pond 16 (SE 15824 96863)

A 'new' pond with very varied vegetation structure including patchy tall and short emergents as well as floating-leaved stands of Broad-leaved and Bog Pondweeds. Pillwort occurs very locally near the northern edge of the pond, growing with Floating Club-rush. A total of 23 wetland plant species and 17 aquatic macro-invertebrate taxa were recorded.

A water sample produced a pH reading of 6.27 with electrical conductivity of 210 µS/cm. A second sample from the Pillwort location gave readings of 6.83 and 160 respectively.

Pond 16 produced an Index of Biological Integrity of 83%, placing it within the top (**Good**) category of ecological quality. It scored well for wetland plant diversity and moderately for trophic ranking but poorly for representation of uncommon plants but poorly for. All three invertebrate metrics were good.

Pond 17 (SE 15855 96852)

This is one of the old pools: as in 2008, it is marked-out by an abundance of Marsh Cinquefoil. There are extensive stands of this floating-mat vegetation comprising Marsh Cinquefoil and Bottle Sedge with carpets of Pointed Spear-moss or, more locally, Heart-

leaved Spear-moss, Kneiff's Hook-moss *Drepanocladus aduncus* or Spiky Bog-moss. Marsh Stitchwort *Stellaria palustris* occurs very locally near the eastern edge of the pond. A total of 24 wetland plant species and 12 aquatic macro-invertebrate taxa were recorded. A few Smooth/Palmate Newt tadpoles were found.

A water sample produced a pH reading of 5.89 with electrical conductivity of 80 µS/cm. A second sample gave readings of 6.47 and 130 respectively[4].

Pond 17 produced an Index of Biological Integrity of 67%, placing it within the category of **Moderate** ecological quality. It scored well for wetland plant diversity and moderately for trophic ranking and representation of uncommon plants. Scores for biological water quality (ASPT) and diversity of water beetle families were moderate but Odonata were poorly represented.

Pond 18 (SE 15848 96814)

This large pond has a very convoluted outline and includes several elongate 'islands' within it. It receives the inflow of spring water which irrigates the newer ponds in the Wetlands. Habitat structure is varied with mosaics of swamp and open water, including submerged stands of Delicate Stonewort and Small Pondweed *Potamogeton berchtoldii*. Intermediate Water-starwort *Callitriche hamulata* is abundant around the inflow. While this pond is probably more calcareous than the others, there are pockets of bog vegetation around the margins including at least four *Sphagnum* species, Bog Bead-moss, Common Haircap *Polytrichum commune*, Bog Pondweed and White Sedge *Carex canescens*. A total of 40 wetland plant species and 36 aquatic macro-invertebrate taxa were recorded. Great Crested and Smooth/Palmate Newt tadpoles were found, and there was frequent evidence of Water Vole activity including several territorial latrines.

A water sample produced a pH reading of 7.45 with electrical conductivity of 340 µS/cm. A second sample gave readings of 7.58 and 330 respectively.

Pond 18 produced an Index of Biological Integrity of 94%, placing it within the top (**Good**) category of ecological quality. Scores were high for all metrics other than Trophic Ranking Score, which was moderate.

Pond 19 (SE 15867 96810)

This is one of the smaller 'new' ponds supporting a mosaic of emergent vegetation with Bottle Sedge, Branched Bur-reed and rushes, and more open water with Broad-leaved, Bog and Small Pondweeds. A total of 17 wetland plant species and 26 aquatic macro-invertebrate taxa were recorded. Water Vole latrines were observed and both Great Crested and Smooth/Palmate Newt tadpoles were caught during invertebrate sampling.

[4] A water sample collected from the same pond in August 2008 gave a pH reading of 5.72 with electrical conductivity of 70 µS/cm.

A water sample produced a pH reading of 7.41 with electrical conductivity of 210 µS/cm.

Pond 19 produced an Index of Biological Integrity of 89%, placing it within the top (**Good**) category of ecological quality. Scores were high for all metrics other than representation of uncommon plants, which was poor.

Pond 20 (SE 15843 96795)

This 'new' pond supports varied habitat: there are extensive stands of Sharp-flowered Rush and Branched Bur-reed but also open areas with Delicate Stonewort, Small Pondweed and Water Purslane *Lythrum portula*. A total of 27 wetland plant species and 22 aquatic macro-invertebrate taxa were recorded. The latter included Mud Snail. Both Great Crested and Smooth/Palmate Newt tadpoles were netted. Numerous Water Vole latrines and feeding stations were present. Water pH was measured at 7.50.

Pond 20 produced an Index of Biological Integrity of 94%, placing it within the category of **Good** ecological quality. Scores were high for all metrics other than trophic ranking, which was moderate.

Pond 21 (SE 15857 96787)

This 'new' pond is situated near the southern boundary of the Wetlands, to the west of the viewing hide. It supports Broad-leaved Pondweed in the centre and mixed emergent vegetation in the margins. A total of 19 wetland plant species was recorded, along with 27 aquatic macro-invertebrate taxa. Water Vole latrines were noted. An adult female Great Crested Newt and several Smooth/Palmate Newt tadpoles were caught.

Pond 21 produced an Index of Biological Integrity of 72%, placing it within the category of **Moderate** ecological quality but close to the threshold for Good quality. It scored well for wetland plant diversity but poorly for trophic ranking and produced no uncommon plants; scores for all three invertebrate metrics were high.

Pond 22 (SE 15820 96768)

This small remnant pool adjoins the south-western boundary of the site. It is dominated by a floating mat of Bottle Sedge. A total of 15 wetland plant species was recorded, along with 18 aquatic invertebrate taxa. A water sample produced a pH reading of 5.97 with electrical conductivity of 120 µS/cm.

Pond 22 produced an Index of Biological Integrity of 50%, placing it within the category of **Moderate** ecological quality. It scored moderately for wetland plant diversity and trophic ranking but produced no uncommon plants. Biological water quality (ASPT) and diversity of water beetle families were moderate but representation of Odonata was poor.

3. Results

3.1 Physico-chemical conditions

Water samples were measured for pH and electrical conductivity (a measure of solute content) using a laboratory standard meter. Readings were obtained for 21 ponds. Mean (average) pH was 6.74 with a range of 5.89 to 7.58. Mean conductivity was 180 µS/cm^{-1}, with a range of 80 to 330.

These readings are only snapshots: water pH in well-vegetated ponds often fluctuates significantly and it can vary from one spot to another within larger ponds due to factors such as inflow of spring water and the acidifying effects of *Sphagnum* carpets. The data shows that the water is moderately acidic to mildly alkaline, but on average slightly below neutral. This is natural for a location on the Yoredale Series geology of the northern Yorkshire Dales, where interbedded sandstones and limestones result in varying conditions over small distances.

Water in the artificially-irrigated ponds is more alkaline than in the original stagnant pools. In the latter (*n* = 10), pH varies from 5.89 to 6.71 with a mean value of 6.30. In the former (*n* = 11), the range is 6.4 to 7.58 with a mean of 7.14. This shows that the irrigating water significantly increases alkalinity and therefore calcium content.

Electrical conductivity is consistently low and within the range expected for ponds with very clean water in North Yorkshire. The data indicates an absence of contaminants such as fertilisers, effluent or road run-off and is probably close to 'natural' water quality. Conductivity is markedly lower in the 'old' ponds, where it ranges from 80 to 160 µS/cm with an average of 120 µS/cm. Although conductivity does not always correlate directly with nutrient status, it is a useful proxy measure and these water bodies can be categorised as oligotrophic (low in plant nutrients).

The new water bodies produced a range of conductivity values between 150 and 330 µS/cm with an average of 240 µS/cm, twice the mean for the 'old' pools. This is a result of the elevated mineral content of the irrigating spring water and values are well below those indicative of any significant pollution. The new ponds can be categorised as having oligotrophic to mesotrophic (moderate fertility) water.

The differences in water chemistry between the new and pre-existing ponds demonstrate the wisdom of retaining 'old' pools in situ and not 'plumbing them in' to the irrigated ponds. As a result, a broad range of conditions can exist within the pond complex and species such as Mud Snail which favour low-nutrient water have been able to persist alongside those preferring more productive and mineral-rich conditions.

3.2 Aquatic invertebrates

A total of 91 aquatic macro-invertebrate taxa were recorded (Appendix 2). These include two species categorised as Nationally Scarce: the Mud Snail and the small diving beetle *Hydroporus neglectus*. The former is also listed as a Species of Principal Importance under Section 41 of the Natural Environment & Rural Communities Act, 2006. Complete invertebrate data have been supplied separately in spreadsheet format.

Only six aquatic invertebrate species which were recorded in the old pools in a 2008 survey were not re-found during the present survey. None of these are of particular significance as ecological indicators.

3.2.1 Molluscs

Eight aquatic mollusc taxa were recorded (*Pisidium* pea-mussels were recorded only to genus). The recent origin of the newer ponds and the seasonal, rather acidic character of the old pools account for the limited range of species. Apart from Mud Snail, all the species are widespread. Jenkins's Spire-snail *Potamopyrgus antipodarum* is a small snail of New Zealand origin which is now very common in both upland and lowland waters.

3.2.2 Odonata (dragonflies)

Six damselfly and dragonfly species were identified as larvae, the most frequent being Large Red Damselfly *Pyrrhosoma nymphula* (15 ponds), Common Darter *Sympetrum striolatum* (12) and Emerald Damselfly *Lestes sponsa* (11). It is possible that additional species would have been identified earlier in the summer. The old, shallow and densely-vegetated pools tended to support few Odonata.

3.2.3 Hemiptera (true bugs)

A modest list of 13 species of water bug is unlikely to be fully representative since pond-skaters (Gerridae) and lesser water-boatmen (Corixidae) are mainly in their immature stages in high summer, making them difficult to identify to species. Sampling in spring or autumn would add others. The lesser water-boatman *Hesperocorixa castanea* and the Moorland Backswimmer *Notonecta obliqua* are closely associated with nutrient-poor waters; conversely, species associated with eutrophic conditions such as *Sigara dorsalis* and *S. lateralis* were conspicuously absent. The Saucer Bug *Ilyocoris cimicoides*, found in Pond 19, is an interesting example of a southern insect which has expanded its range northwards: this unmistakeable bug was first found in Yorkshire in 1997 but now occurs widely in the region.

3.2.4 Coleoptera (beetles)

A remarkable 51 species of water beetle were recorded. Although the Nationally Scarce *Hydroporus neglectus* was the only one with a national conservation status, numerous uncommon or localised beetles are present such as *Agabus affinis*, *A. unguicularis*, *Dytiscus*

semisulcatus, *Hydroporus striola* and *Enochrus ochropterus*. There is a particularly strong suite of beetles associated with shallow, richly-vegetated pools including 12 members of the genus *Hydroporus*.

Few water beetles are associated with specific foodplants but the stonewort-feeding *Haliplus confinis* and *H. obliquus* are plentiful while reed-beetles included *Donacia simplex* (which feeds on bur-reeds) and *D. versicolorea* (on Broad-leaved Pondweed).

3.2.5 Other Orders

Only two common leeches were recorded along with two mayflies, the Common Alderfly *Sialis lutaria*, and aquatic fly larvae or pupae belonging to various midge families (Chironomidae, Dixidae, Chaoboridae) and craneflies (Tipuloidea). Larger crustaceans were represented by the ubiquitous Water Hoglouse *Asellus aquaticus* and the naturalised North American amphipod shrimp *Crangonyx pseudogracilis*. China-mark moth larvae or pupae were present on Broad-leaved Pondweed in several ponds. Caddis-fly larvae or pupae were occasional, all belonging to the genus *Limnephilus*: unfortunately larvae belonged to the most difficult group of species and could not be named with confidence. Other caddis larvae could probably be found earlier in the season.

3.3 Vertebrates

Vertebrates were only recorded incidentally during this survey and no special effort was made to search for Water Voles or amphibians. Evidence of Water Vole activity in the form of burrows, territorial latrines or feeding stations was observed at nine ponds (7, 9, 12, 13, 18, 19, 20 and 21). Some of the larger ponds evidently support sizeable numbers and the population appears to be flourishing.

Adult Common Frogs were noted in two ponds; Frog tadpoles would have left the water by the time of the survey. Smooth/Palmate Newt tadpoles were frequent and noted from 14 ponds (64%). Great Crested Newt tadpoles or adults were recorded from seven ponds (32% of those surveyed. i.e. ponds 7, 12, 13, 18, 19, 20 and 21). This may prove to be a significant population.

3.4 Wetland plants

Sixty-nine wetland plant species were recorded (Appendix 3), including vascular plants, stoneworts and larger semi-aquatic mosses. Bryophytes were not surveyed comprehensively but *Sphagnum* bog-mosses, the associated Bog Bead-moss *Aulocominium palustre* and Common Haircap *Polytrichum commune*, and 'brown' mosses such as *Calliergon*, *Calliergonella* and *Drepanocladus* species were recorded.

The most frequent wetland plants in terms of the number of ponds from which they were recorded were: Lady's Smock *Cardamine pratensis* (all 22 ponds), Sharp-flowered Rush (21

ponds), Lesser Spearwort *Ranunculus flammula* (20), Tufted Forget-me-not *Myosotis laxa* (19), Bog Pondweed, Velvet Bent *Agrostis canina*, Jointed Rush *Juncus articulatus*, Common Marsh Bedstraw *Galium palustre* and Pointed Spear-moss (all in 18 ponds).

Pillwort and Marsh Stitchwort are listed as Species of Principal Importance. Plants categorised as Vulnerable (i.e. undergoing serious declines in distribution) in England include Lesser Spearwort, Marsh Stitchwort and Common Cotton-grass. Species listed as Near Threatened (i.e. moderately but persistently declining) include Star Sedge *Carex echinata*, Marsh Cinquefoil, Tormentil *Potentilla erecta* and Marsh Speedwell *Veronica scutellata*.

A number of additional wetland plants were recorded in 2012 such as Common Stonewort *Chara vulgaris*, Autumnal Water-starwort *Callitriche hermaphroditica*, Blunt-leaved Pondweed *Potamogeton obtusifolius*, Marestail *Hippuris vulgaris* and Blunt-flowered Rush *Juncus subnodulosus*[5]. It is possible that some of these were overlooked during the present survey, though some may not have persisted.

3.5 PSYM assessment

PSYM results have been summarised for each water body in section 2 above. Complete data are provided in Appendix 1. Fourteen of the 22 ponds surveyed (64%) were assessed as being of Good ecological quality using PSYM. Ponds 13 and 14 had Indices of Biotic Integrity of 100%. The remainder were all of Moderate ecological quality, one of these being close to the threshold for Good quality.

This confirms that the Wetlands at Foxglove Covert contains an important cluster of high quality ponds and represents a regionally-important resource. PSYM analysis, if anything, understates the biodiversity value of the ponds for two reasons. Firstly, the method is designed primarily to evaluate permanent or semi-permanent ponds. It does not work as well for seasonal pools, which tend to lack Odonata and have lower ASPT scores than more permanent water bodies: several of the 'old' ponds have seasonal pool characteristics. Secondly, the reference dataset is rather weak for ponds of variable pH in northern England. This has probably resulted in inaccurate predictions for the trophic status (TRS) metric, because the software will compare the survey results with data for very nutrient-poor ponds which would not usually support plants associated with more productive and base-rich conditions. Although this is unlikely to have affected the classification of ecological quality, it does mean that the TRS results should be interpreted with caution. Overall, there is little indication that the ponds are subject to significant anthopogenic (man-made) nutrient enrichment.

[5] M. Hammond, unpublished survey report for North Yorkshire SINC Panel.

3.6 Priority Pond assessment

Priority Ponds were defined using UK Biodiversity Action Plan criteria (Maddock, 2008), and represent the best 20% of UK ponds for wildlife. Priority Ponds continue to be listed as a Habitat of Principal Importance under Section 41 of the Natural Environment and Rural Communities Act, 2006. All public bodies have a statutory obligation to conserve Section 41 species and habitats.

Water bodies qualifying as Priority Ponds are shown in Table 1. Qualifying criteria include PSYM Good quality ponds; ponds supporting exceptional assemblages (30 species or more) of wetland plants; ponds supporting protected species (in this case, Great Crested Newt and Water Vole); and ponds supporting BAP Priority Species (now referred to as Species of Principal Importance, i.e. Pillwort, Marsh Stitchwort and Mud Snail). All of the ponds surveyed with the exception of Ponds 5 and 22 qualify as Priority Ponds on one or more criteria.

Criterion	1	2	3	4	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
PSYM Good quality			✓		✓	✓	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	
Exceptional wetland plant assemblage	✓						✓										✓			
Protected Species: Water Vole						✓	✓	✓			✓	✓					✓	✓	✓	✓
Protected Species: Great Crested Newt						✓					✓	✓					✓	✓	✓	✓
Priority Species: Pillwort													✓		✓					
Priority Species: Marsh Stitchwort																✓				
Priority Species: Mud Snail	✓	✓	✓	✓				✓	✓					✓				✓	✓	

Table 1: Ponds meeting Priority Pond criteria

4. Important species

4.1 Invertebrates

Omphiscola glabra (Lymnaeidae), Mud Snail

GB status: Nationally Scarce; NERC Act Section 41 Species of Principal Importance

Global status: Near Threatened (Prié *et al*, 2011)

A distinctively elongate pond snail, closely associated with pools and pond margins in agriculturally-unimproved habitats, typically on historic Commons. This species has declined massively, though significant populations persist in a few regions such as the New Forest, Cheshire Plain and Humberhead Levels/Vale of York. There are post-1999 records from 47 hectads in Great Britain (Seddon *et al*, 2014). The global population was recently estimated to have declined by 20-25% over 15 years with a 25-49% decline in Great Britain during the period 1985-2010 (Prié *et al*, 2011). It is scarce and declining in most parts of its limited global range (Mud Snail is restricted to Western Europe) and has become extinct in Ireland and Poland.

Its remnant distribution implies that Mud Snail is much more sedentary than most of the Lymnaeidae. It avoids water bodies supporting a rich variety of aquatic molluscs, preferring those which dry out in summer and are poor in nutrients (e.g. Kerney, 1999) though the oft-repeated claim that this is a calcifuge species is misleading.

During this survey, Mud Snail was recorded from ten ponds (1, 2, 3, 4, 9, 10, 15, 19, 20 and 21), i.e. 45% of those surveyed. Five of these were 'old' pools and two others appeared to incorporate older pools within new water bodies. Colonisation of new ponds was most noticeable in the south-west of the site (Ponds 19, 20 and 21). Data from the 2008 survey does indicate that some Mud Snail pools were lost during construction of the new ponds and the population may be smaller than previously.

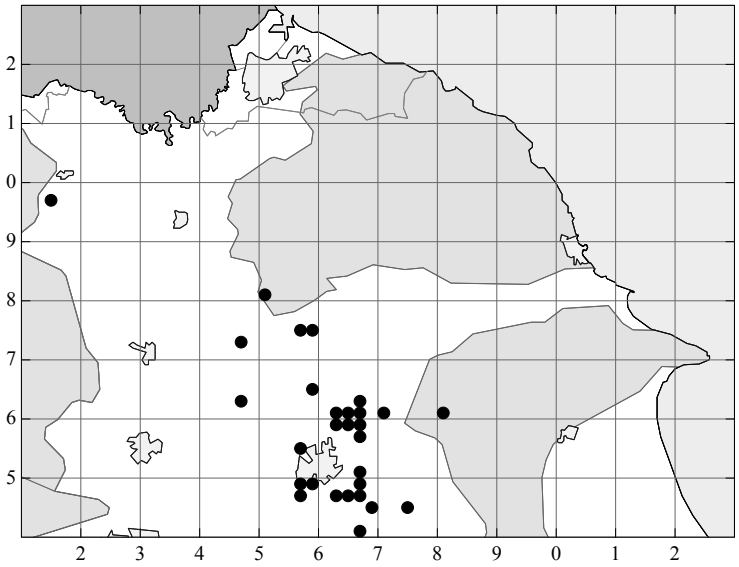
Mud Snail was associated with a water pH range of 5.96 to 7.50 (mean = 6.57) with electrical conductivity of 80 to 210 µS/cm (mean = 128). Mean values were somewhat lower than for all the ponds.

Seven out of ten records were of single specimens collected during the three-minute invertebrate samples. Three individuals were found in Ponds 2 and 9, with five in Pond 3. This suggests that stronger populations are centred on very shallow 'old' pools with dense vegetation and more acidic water.

Hydroporus neglectus (Dytiscidae), a diving beetle

GB status: Nationally Scarce

This tiny diving beetle occurs very locally in mossy or rushy lowland pools, mainly in the east of England. It has a stronghold in the Vale of York, extending north into the Hambleton Hills; Foxglove Covert is an outlier of this distribution and is its most northerly known station in Britain (Foster & Friday, 2011). Five specimens of both sexes of *H. neglectus* were collected in total, from Ponds 3, 5 and 9. This confirms the survival of a resident breeding population first detected in 2008.



Distribution of *Hydroporus neglectus* in northern Yorkshire. Map © R. Merritt. Dots are 2x2 km squares.

4.2 Plants

***Carex echinata*, Star Sedge**

English status: Near Threatened

This small sedge remains frequent in flushes of varying pH status in the uplands but has undergone a protracted decline in the lowlands (Preston *et al*, 2002). It was recorded from the margins of seven ponds.

***Comarum palustre*, Marsh Cinquefoil**

English status: Near Threatened

Mainly occurring in wetlands of moderate or low fertility and forming an important structural component of 'floating mat' vegetation, Marsh Cinquefoil has declined in distribution during the 20th century, especially in southern and eastern England (Preston *et al*, 2002). It is abundant in Ponds 5 and 17 with small amounts in Ponds 8, 14, 16 and 18. This is mostly a species of the older pools.

Above: Marsh Cinquefoil

Below: Pillwort

***Eriophorum angustifolium*, Common Cotton-grass**

English status: Vulnerable

Common Cotton-grass is a classic example of a plant which remains locally-abundant in the uplands of northern and western Britain but has declined seriously in the agricultural lowlands: it underwent a 33% decline in its English distribution during the second half of the 20th century (Stroh *et al*, 2014). This species was found in varying quantities in five ponds on the Wetlands (8, 10, 11, 13 and 18).

***Hydrocotyle vulgaris*, Marsh Pennywort**

English status: Near Threatened

A humble plant of short vegetation in water margins and wet fens which, like many species of less fertile wetlands, is undergoing a long-term decline in distribution in England. Marsh Pennywort was found in Pond 14 only.

***Pilularia globulifera*, Pillwort**

English status: Vulnerable[6]; Species of Principal Importance

Global IUCN status: Near Threatened (Landsdown, 2013)

Pillwort is a delicate perennial fern associated with nutrient-poor water in sites where fluctuating levels and grazing livestock also limit competition from larger plants. It has declined both in Britain and the rest of its limited range in Western Europe range due to the decline of traditional pastoral landscapes, agricultural intensification, nutrient-enrichment and land drainage. The invasive alien Swamp Stonecrop *Crassula helmsii* is also a potential threat. It is categorised as Critically Endangered in Germany, the Czech Republic and Switzerland; Endangered in Norway and Spain; and Vulnerable in Finland and Sweden (Landsdown, 2013).

Pillwort has been lost from nearly half its known sites in Britain (Lockton, 2010). Although there are several recent Yorkshire localities, Pillwort has apparently disappeared from sites where it has been recorded in the past 20 years in Nidderdale, South Yorkshire and on Skipwith Common. It is reported to occur at Good Wood pond at Catterick Garrison, which is likely to have been the source of the Foxglove Covert population.

Pillwort was recorded as follows:

- In Pond 14, it grows in an area of around 2 m^2 at SE 15820 96971, near the southern edge of the pond. It is intermixed with Floating Club-rush but is becoming encroached by Common Spike-rush, Sharp-flowered Rush and Soft Rush.

[6] Pillwort is categorised as Near Threatened in a GB context.

- In Pond 16, quite dense cover of shoots occurs over about 2 m² at SE 15819 96864, near the north-western edge of the pond. A water sample collected in this spot produced a pH reading of 6.83 with electrical conductivity of 160 µS/cm. As in Pond 14, it is intermixed with Floating Club-rush. Encroachment from Greater Reedmace is a potential threat.

***Potentilla erecta*, Tormentil**

English status: Near Threatened

Another common upland species which is restricted to a diminishing number of unimproved grasslands, heaths and fens in the lowlands. Tormentil was recorded in the margins of 15 ponds during this survey.

***Ranunculus flammula*, Lesser Spearwort**

English status: Vulnerable

Although still widespread and locally common, Lesser Spearwort underwent a 32% decline in distribution in England during the latter half of the last century (Stroh *et al*, 2014). It was found in 20 of the 22 ponds surveyed.

***Stellaria palustris*, Marsh Stitchwort**

English status: Vulnerable; Species of Principal Importance

Marsh Stitchwort is a plant of fen and water margin habitats which declined by more than 30% during the late 20th century (Stroh *et al*, 2014). Only six plants could be found during the survey, all in a small area of Pond 17 around SE 15865 56852. Here it was associated with dense vegetation including Pointed Spear-moss, Bottle Sedge, Tufted Forget-me-not, Common Marsh Bedstraw and Bog Pondweed. Water pH was 6.47 with electrical conductivity of 130 µS/cm.

***Veronica scutellata*, Marsh Speedwell**

English status: Near Threatened

A moderately declining species of water-margins on poorer soils. Marsh Speedwell was noted in 15 ponds during the survey.

5. Management advice

- PSYM and Priority Pond assessment show that almost all the Wetlands ponds are of high nature conservation value. Clean water and diverse habitats are key factors. Occasional, small-scale management of some of the 'new' ponds may be necessary to maintain a range of successional stages but it is important to allow others to develop into richly-vegetated fen habitat. Where management is undertaken, due consideration needs to be given to the presence of Protected Species (i.e. Water Vole and Great Crested Newt) and the high botanical quality of grassland on the bunds between and adjoining the ponds.
- The very localised Pillwort populations need careful conservation. Water quality is favourable but this plant is vulnerable to competition from tall emergent vegetation. The relatively stable water levels maintained by the water circulation system may also reduce opportunities for new plants to establish on exposed mud.
- It is always difficult to gauge the 'ideal' level of grazing but grazing pressure was perhaps on the low side at the time of the survey. Given the precarious status of Pillwort nationally, small-scale, carefully targeted management is recommended. This should take the form of manual removal of tall plants within a five metre radius of the Pillwort patches in Ponds 14 and 16, preferably during autumn to early spring. Both the removal of competing vegetation and the trampling should provide a beneficial level of disturbance. Annual monitoring is important, although it is essential to avoid excessive uprooting of this delicate plant.
- Great diligence is needed to prevent colonisation of the Wetlands by Swamp Stonecrop, since this species is already established in several ponds on Catterick Ranges and has occurred in the main area of the LNR. It would be a particular threat to Pillwort. Special care should be taken to avoid movement of machinery, tools or volunteers from infested sites as this highly invasive plant can spread from small vegetative fragments. If this species is detected on the Wetlands, it should be eradicated immediately and additional monitoring put in place in case of any recurrence. Freshwater Habitats Trust can provide advice on control.
- The population of Marsh Stitchwort is very small (around six plants) and this species could easily be lost. It is a plant of richly-vegetated fen habitat, favouring mid-height vegetation, and could be vulnerable to overgrazing. It should be monitored and flowering stems might perhaps be protected with temporary guards (e.g. mesh tubes) if surrounding vegetation is getting heavily grazed. If any volunteers were interested in trying to propagate this plant in order to reinforce the population, this could be worthwhile.
- Mud Snail was recorded from ten ponds, predominantly the old pools. Although numbers of individuals were small, it appears to be surviving well. The old pools should be left disconnected from the water circulation system because introduction of more calcium-rich water could favour generalist species like Wandering Snail

which could out-compete Mud Snail. If opportunities arise to excavate shallow pools on the adjoining part of Hipswell Moor, these could provide additional habitat for Mud Snail.

- The retention of several of the old, pre-existing pools is commendable and there is little evidence of biodiversity loss since the baseline survey in 2008. These pools are less alkaline than the new water bodies, generally support dense emergent vegetation and have fluctuating water levels. They should be left undisturbed apart from maintaining grazing and avoiding any significant increase in scrub cover. Low water levels during dry periods are unlikely to be detrimental to these pools and any temptation to connect them to the circulating water system should be avoided.
- Although habitat structure is excellent, there is a lack of firm substrates which some aquatic invertebrates require. A few submerged or partially-submerged rocks and tree-trunks could be introduced to some of the larger permanent ponds to benefit caddis-flies, flatworms and other species.

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APPENDIX 1: PSYM DATA AND RESULTS

Site details											
Site name	**Pond 1**	**Pond 2**	**Pond 3**	**Pond 4**	**Pond 5**	**Pond 6**	**Pond 7**	**Pond 8**	**Pond 9**	**Pond 10**	**Pond 11**
Survey date	29/7/15	29/7/15	29/7/15	29/7/15	30/7/15	29/7/15	29/7/15	29/7/15	29/7/15	29/7/15	29/7/15
Grid reference	SE 159 968	SE 158 968	SE 158 968	SE 158 968	SE 159 968	SE 159 968	SE 158 968	SE 158 968	SE 158 968	SE 158 968	SE 158 968
Plant metrics											
No. of submerged + marginal plant species (excludes floating leaved)	29	16	23	15	22	23	22	28	14	21	20
Number of uncommon plant species	2	1	1	1	0	1	2	1	1	2	1
Trophic Ranking Score (TRS)	7.41	5.68	5.53	5.53	4.88	6.95	7.72	6.58	5.18	5.15	6.53
Invertebrates metrics											
ASPT	4.44	4.17	4.77	4.5	4.57	5.28	5	4.95	4.82	4.92	5.11
Odonata + Megaloptera (OM) families	0	0	2	0	0	4	3	5	1	3	2
Coleoptera families	3	2	3	2	3	4	4	5	3	3	3
Environmental variables											
Altitude (m)	206	206	206	206	206	206	206	206	206	206	206
Shade (%)	5	10	0	1	0	0	0	0	0	0	0
Inflow (0/1)	0	0	0	0	0	1	1	1	0	0	0
Grazing (%)	5	0	100	20	100	100	100	80	0	100	75
pH	6.15	6.71	6.47	5.96	6.4	7.24	7.61	7.05	6.1	6.48	6.4
Emergent plant cover (%)	75	80	70	90	75	30	25	40	60	70	85
Base clay (1-3)	3	3	3	3	3	3	3	3	3	3	3
Base sand, gravel, cobbles (1-3)	1	1	1	1	1	2	1	1	1	1	1
Base peat (1-3)	1	1	1	1	1	1	1	1	1	1	1
Base rock (1-3)	1	1	1	1	1	1	1	1	1	1	1
Area (m^2)	155	44	60	40	29	265	275	2205	45	181	10

	Pond 1	Pond 2	Pond 3	Pond 4	Pond 5	Pond 6	Pond 7	Pond 8	Pond 9	Pond 10	Pond 11
Results											
Submerged + marginal plant species											
Predicted (SM)	19.0	18.8	19.6	20.1	20.1	18.5	17.9	18.5	20.0	18.9	20.9
Actual (SM)	29	16	23	15	22	23	22	28	14	21	20
EQI (SM)	1.52	0.85	1.17	0.75	1.09	1.24	1.23	1.51	0.70	1.11	0.96
IBI (SM)	3	3	3	2	3	3	3	3	2	3	3
Uncommon plant species											
Predicted (U)	4.2	4.1	4.4	4.5	4.5	4.0	3.6	3.9	4.5	4.2	4.7
Actual (U)	2	1	1	1	0	1	2	1	1	2	1
EQI (U)	0.47	0.24	0.23	0.22	0.00	0.25	0.56	0.26	0.22	0.48	0.21
IBI (U)	1	0	0	0	0	0	2	1	0	1	0
Trophic Ranking Score (TRS)											
Predicted (TRS)	5.69	5.96	5.71	5.63	5.68	5.99	6.86	6.33	5.64	5.75	5.66
Actual (TRS)	7.41	5.68	5.53	5.53	4.88	6.95	7.72	6.58	5.18	5.15	6.53
EQI (TRS)	1.30	0.95	0.97	0.98	0.86	1.16	1.12	1.04	0.92	0.90	1.15
IBI (TRS)	1	3	3	3	2	2	2	3	3	2	2
ASPT											
Predicted (ASPT)	5.26	5.16	5.54	5.46	5.56	5.72	5.50	5.23	5.48	5.49	5.52
Actual (ASPT)	4.44	4.17	4.77	4.50	4.57	5.28	5.00	4.95	4.82	4.92	5.11
EQI (ASPT)	0.85	0.81	0.86	0.82	0.82	0.92	0.91	0.95	0.88	0.90	0.93
IBI (ASPT)	2	2	3	2	2	3	3	3	3	3	3
Odonata + Megaloptera (OM) families											
Predicted (OM)	2.71	2.91	2.56	2.60	2.56	2.50	2.60	2.86	2.60	2.58	2.57
Actual (OM)	0	0	2	0	0	4	3	5	1	3	2
EQI (OM)	0.00	0.00	0.78	0.00	0.00	1.60	1.16	1.75	0.39	1.16	0.78
IBI (OM)	0	0	3	0	0	3	3	3	1	3	3
Coleoptera families											
Predicted (CO)	3.87	3.93	3.55	3.63	3.53	3.38	3.61	3.96	3.59	3.59	3.57
Actual (CO)	3	2	3	2	3	4	4	5	3	3	3
EQI (CO)	0.78	0.51	0.85	0.55	0.85	1.18	1.11	1.26	0.84	0.83	0.84

IBI (CO)	3	2	3	2	3	3	3	3	3	3	3
Sum of Individual Metrics	**10**	**10**	**15**	**9**	**10**	**14**	**16**	**16**	**12**	**15**	**14**
Index of Biotic Integrity (%)	**56%**	**56%**	**83%**	**50%**	**56%**	**78%**	**89%**	**89%**	**67%**	**83%**	**78%**
PSYM quality category (IBI >75%=Good, 51-75%= Moderate, 25-50%=Poor, <25%=V Poor)	**Moderate**	**Moderate**	**Good**	**Moderate**	**Moderate**	**Good**	**Good**	**Good**	**Moderate**	**Good**	**Good**
Is this a Priority Pond? (Good quality category)	**No**	**No**	**Yes**	**No**	**No**	**Yes**	**Yes**	**Yes**	**No**	**Yes**	**Yes**

Site name	Pond 12	Pond 13	Pond 14	Pond 15	Pond 16	Pond 17	Pond 18	Pond 19	Pond 20	Pond 21	Pond 22
Survey date	30/7/15	30/7/15	30/7/15	30/7/15	30/7/15	30/7/15	30/7/15	30/7/15	30/7/15	30/7/15	30/7/15
Grid reference	SE 158 968	SE 158 968	SE 158 968	SE 157 968	SE 158 968	SE 158 968	SE 158 968	SE 158 968	SE 158 968	SE 158 967	SE 158 967
Plant metrics											
No. of submerged + marginal plant species (excludes floating leaved)	18	19	25	20	20	22	35	15	24	17	13
Number of uncommon plant species	1	3	3	2	2	3	5	1	3	0	0
Trophic Ranking Score (TRS)	6.78	6.5	6.54	7.07	6.94	5	6.31	6.06	6.7	7.8	6.58
Invertebrates metrics											
ASPT	5	4.79	5.42	4.91	4.92	4.43	5	5.31	5	4.86	4
Odonata + Megaloptera (OM) families	3	2	4	2	3	1	4	4	3	3	1
Coleoptera families	4	4	3	3	3	2	3	4	4	3	2
Environmental variables											
Altitude (m)	206	206	206	206	206	206	206	206	206	206	206
Shade (%)	0	0	0	0	0	0	0	0	0	0	0
Inflow (0/1)	1	1	1	0	1	0	1	1	1	1	0
Grazing (%)	100	100	100	100	100	100	75	100	80	80	80
pH	7.12	7.14	7.23	6.36	6.27	5.89	7.45	7.41	7.5	7	5.97
Emergent plant cover (%)	20	30	65	70	60	70	50	35	65	20	90
Base clay (1-3)	3	3	3	3	3	3	3	3	3	3	3
Base sand, gravel, cobbles (1-3)	1	1	1	1	1	1	1	1	1	1	1
Base peat (1-3)	1	1	1	1	1	1	1	1	1	1	1
Base rock (1-3)	1	1	1	1	1	1	1	1	1	1	1
Area (m^2)	600	617	260	96	102	185	2600	133	660	232	47

	Pond 12	Pond 13	Pond 14	Pond 15	Pond 16	Pond 17	Pond 18	Pond 19	Pond 20	Pond 21	Pond 22
Results											
Submerged + marginal plant species											
Predicted (SM)	18.4	18.4	18.3	19.3	19.3	19.0	19.7	17.9	18.5	18.5	20.0
Actual (SM)	18	19	25	20	20	22	35	15	24	17	13
EQI (SM)	0.98	1.03	1.37	1.03	1.03	1.16	1.77	0.84	1.30	0.92	0.65
IBI (SM)	3	3	3	3	3	3	3	3	3	3	2
Uncommon plant species											
Predicted (U)	3.9	3.9	3.8	4.3	4.3	4.3	3.9	3.7	4.0	4.0	4.5
Actual (U)	1	3	3	2	2	3	5	1	3	0	0
EQI (U)	0.26	0.77	0.78	0.46	0.46	0.70	1.28	0.27	0.75	0.00	0.00
IBI (U)	1	3	3	1	1	2	3	1	3	0	0
Trophic Ranking Score (TRS)											
Predicted (TRS)	6.27	6.30	6.32	5.70	5.68	5.63	6.93	6.47	6.07	6.07	5.63
Actual (TRS)	6.78	6.50	6.54	7.07	6.94	5.00	6.31	6.06	6.7	7.80	6.58
EQI (TRS)	1.08	1.03	1.04	1.24	1.22	0.89	0.91	0.94	1.10	1.29	1.17
IBI (TRS)	2	3	3	1	2	2	2	3	2	1	2
ASPT											
Predicted (ASPT)	5.53	5.52	5.57	5.54	5.69	5.61	5.18	5.61	5.61	5.61	5.56
Actual (ASPT)	5.00	4.79	5.42	4.91	4.92	4.43	5.00	5.31	5.0	4.86	4.00
EQI (ASPT)	0.90	0.87	0.97	0.89	0.86	0.79	0.97	0.95	0.89	0.87	0.72
IBI (ASPT)	3	3	3	3	3	2	3	3	3	3	2
Odonata + Megaloptera (OM) families											
Predicted (OM)	2.59	2.59	2.55	2.56	2.50	2.53	3.04	2.54	2.55	2.55	2.55
Actual (OM)	3	2	4	2	3	1	4	4	3	3	1
EQI (OM)	1.16	0.77	1.57	0.78	1.20	0.40	1.31	1.58	1.18	1.18	0.39
IBI (OM)	3	3	3	3	3	1	3	3	3	3	1
Coleoptera families											
Predicted (CO)	3.58	3.60	3.53	3.54	3.40	3.47	3.88	3.47	3.48	3.48	3.52
Actual (CO)	4	4	3	3	3	2	3	4	4	3	2
EQI (CO)	1.12	1.11	0.85	0.85	0.88	0.58	0.77	1.15	1.15	0.86	0.57

IBI (CO)	3	3	3	3	3	2	3	3	3	3	2
Sum of Individual Metrics	**15**	**18**	**18**	**14**	**15**	**12**	**17**	**16**	**17**	**13**	**9**
Index of Biotic Integrity (%)	**83%**	**100%**	**100%**	**78%**	**83%**	**67%**	**94%**	**89%**	**94%**	**72%**	**50%**
PSYM quality category (IBI >75%=Good, 51-75%= Moderate, 25-50%=Poor, <25%=V Poor)	**Good**	**Good**	**Good**	**Good**	**Good**	**Moderate**	**Good**	**Good**	**Good**	**Moderate**	**Moderate**
Is this a Priority Pond? (Good quality category)	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**No**	**Yes**	**Yes**	**No**	**No**	**No**

Appendix 2: list of aquatic macro-invertebrates recorded during the survey

Species	English name	Family	Order	GB status
Crangonyx pseudogracilis	an amphipod shrimp	Crangonyctidae	Amphipoda	Naturalised
Musculium lacustre	Capped Orb Mussel	Sphaeriidae	Bivalvia	Common
Pisidium sp.	a pea mussel	Sphaeriidae	Bivalvia	-
Donacia simplex	a reed-beetle	Chrysomelidae	Coleoptera	Local
Donacia versicolorea	a reed-beetle	Chrysomelidae	Coleoptera	Local
Agabus affinis	a diving beetle	Dytiscidae	Coleoptera	Local
Agabus bipustulatus	a diving beetle	Dytiscidae	Coleoptera	Common
Agabus nebulosus	a diving beetle	Dytiscidae	Coleoptera	Common
Agabus paludosus	a diving beetle	Dytiscidae	Coleoptera	Common
Agabus sturmii	a diving beetle	Dytiscidae	Coleoptera	Common
Agabus unguicularus	a diving beetle	Dytiscidae	Coleoptera	Local
Dytiscus marginalis	Great Diving Beetle	Dytiscidae	Coleoptera	Common
Dytiscus semisulcatus	a great diving beetle	Dytiscidae	Coleoptera	Local
Hydroporus angustatus	a diving beetle	Dytiscidae	Coleoptera	Common
Hydroporus erythrocephalus	a diving beetle	Dytiscidae	Coleoptera	Local
Hydroporus gyllenhalii	a diving beetle	Dytiscidae	Coleoptera	Common
Hydroporus incognitus	a diving beetle	Dytiscidae	Coleoptera	Common
Hydroporus memnonius	a diving beetle	Dytiscidae	Coleoptera	Common
Hydroporus neglectus	a diving beetle	Dytiscidae	Coleoptera	Nationally Scarce
Hydroporus nigrita	a diving beetle	Dytiscidae	Coleoptera	Local
Hydroporus palustris	a diving beetle	Dytiscidae	Coleoptera	Common
Hydroporus pubescens	a diving beetle	Dytiscidae	Coleoptera	Common
Hydroporus striola	a diving beetle	Dytiscidae	Coleoptera	Local
Hydroporus tristis	a diving beetle	Dytiscidae	Coleoptera	Local
Hydroporus umbrosus	a diving beetle	Dytiscidae	Coleoptera	Local
Hygrotus impressopunctatus	a diving beetle	Dytiscidae	Coleoptera	Common
Hygrotus inaequalis	a diving beetle	Dytiscidae	Coleoptera	Common
Ilybius ater	a diving beetle	Dytiscidae	Coleoptera	Common
Laccophilus minutus	a diving beetle	Dytiscidae	Coleoptera	Common
Elmis aenea	a riffle beetle	Elmidae	Coleoptera	Common
Gyrinus substriatus	Common Whirligig	Gyrinidae	Coleoptera	Common
Haliplus confinis	an algivorous water beetle	Haliplidae	Coleoptera	Local
Haliplus flavicollis	an algivorous water beetle	Haliplidae	Coleoptera	Local
Haliplus lineatocollis	an algivorous water beetle	Haliplidae	Coleoptera	Common
Haliplus obliquus	an algivorous water beetle	Haliplidae	Coleoptera	Local
Haliplus ruficollis	an algivorous water beetle	Haliplidae	Coleoptera	Common

Species	English name	Family	Order	GB status
Haliplus sibiricus	an algivorous water beetle	Haliplidae	Coleoptera	Common
Helophorus aequalis	a scavenger water beetle	Helophoridae	Coleoptera	Common
Helophorus brevipalpis	a scavenger water beetle	Helophoridae	Coleoptera	Common
Helophorus flavipes	a scavenger water beetle	Helophoridae	Coleoptera	Common
Helophorus grandis	a scavenger water beetle	Helophoridae	Coleoptera	Common
Helophorus minutus	a scavenger water beetle	Helophoridae	Coleoptera	Common
Helophorus obscurus	a scavenger water beetle	Helophoridae	Coleoptera	Common
Anacaena globulus	a scavenger water beetle	Hydrophilidae	Coleoptera	Common
Anacaena lutescens	a scavenger water beetle	Hydrophilidae	Coleoptera	Common
Coelostoma orbiculare	a scavenger water beetle	Hydrophilidae	Coleoptera	Local
Enochrus ochropterus	a scavenger water beetle	Hydrophilidae	Coleoptera	Local
Hydrobius fuscipes	a scavenger water beetle	Hydrophilidae	Coleoptera	Common
Hydrobius subrotundatus	a scavenger water beetle	Hydrophilidae	Coleoptera	Local
Laccobius bipunctatus	a scavenger water beetle	Hydrophilidae	Coleoptera	Common
Noterus clavicornis	a burrowing water beetle	Noteridae	Coleoptera	Common
Contacyphon variabilis	a marsh beetle	Scirtidae	Coleoptera	Local
Scirtes hemisphaericus	a marsh beetle	Scirtidae	Coleoptera	Local
Chaoboridae	phantom midge larvae	Chaoboridae	Diptera	-
Chironomidae	non-biting midge larvae	Chironomidae	Diptera	-
Dixidae	meniscus midge larvae	Dixidae	Diptera	-
Tipulidae	cranefly larvae	Tipulidae	Diptera	-
Cloeon dipterum	Pond Olive	Baetidae	Ephemeroptera	Common
Caenis sp.	a mayfly	Caenidae	Ephemeroptera	-
Potamopyrgus antipodarum	Jenkins's Spire-snail	Hydrobiidae	Gastropoda	Naturalised
Galba truncatula	Dwarf Pond Snail	Lymnaeidae	Gastropoda	Common
Omphiscola glabra	Mud Snail	Lymnaeidae	Gastropoda	Nationally Scarce
Radix balthica	Wandering Snail	Lymnaeidae	Gastropoda	Common
Stagnicola palustris agg.	Marsh Pond Snail	Lymnaeidae	Gastropoda	Common
Gyraulus crista	Nautilus Ramshorn	Planorbidae	Gastropoda	Local
Corixa punctata	a lesser water-boatman	Corixidae	Hemiptera	Common
Hesperocorixa castanea	a lesser water-boatman	Corixidae	Hemiptera	Local
Hesperocorixa linnaei	a lesser water-boatman	Corixidae	Hemiptera	Common
Hesperocorixa sahlbergi	a lesser water-boatman	Corixidae	Hemiptera	Common
Sigara distincta	a lesser water-boatman	Corixidae	Hemiptera	Common
Sigara fossarum	a lesser water-boatman	Corixidae	Hemiptera	Common
Sigara nigrolineata	a lesser water-boatman	Corixidae	Hemiptera	Common
Gerris sp. immature	a pond-skater	Gerridae	Hemiptera	-
Ilyocoris cimicoides	Saucer Bug	Naucoridae	Hemiptera	Local
Nepa cinerea	Water Scorpion	Nepidae	Hemiptera	Common
Notonecta glauca	Common Backswimmer	Notonectidae	Hemiptera	Common

Species	English name	Family	Order	GB status
Notonecta obliqua	Moorland Backswimmer	Notonectidae	Hemiptera	Local
Microvelia reticulata	a water-cricket	Veliidae	Hemiptera	Local
Theromyzon tessulatum	Duck Leech	Glossiphoniidae	Hirudinea	Common
Haemopis sanguisuga	Horse Leech	Haemopidae	Hirudinea	Common
Asellus aquaticus	Water Hoglouse	Asellidae	Isopoda	Common
Elophila nymphaeata?	china-mark moth larvae	Pyralidae	Lepidoptera	-
Sialis lutaria	Common Alderfly	Sialidae	Megaloptera	Common
Aeshna juncea	Common Hawker	Aeshnidae	Odonata	Common
Enallagma cyathigerum	Common Blue Damselfly	Coenagrionidae	Odonata	Common
Ischnura elegans	Blue-tailed Damselfly	Coenagrionidae	Odonata	Common
Pyrrhosoma nymphula	Large Red Damselfly	Coenagrionidae	Odonata	Common
Lestes sponsa	Emerald Damselfly	Lestidae	Odonata	Common
Sympetrum striolatum	Common Darter	Libellulidae	Odonata	Common
Oligochaeta indet	a worm	Oligochaeta	Oligochaeta	-
Limnephilus sp. indet	a caddis fly	Limnephilidae	Trichoptera	-

Appendix 3: wetland plant list

Species	English name	Status in England[7]
Achillea ptarmica	Sneezewort	
Agrostis canina	Velvet Bent	
Agrostis stolonifera	Creeping Bent	
Alisma plantago-aquatica	Common Water-plantain	
Angelica sylvestris	Wild Angelica	
Aulocomnium palustre	Bog Bead-moss	
Berula erecta	Lesser Water-parsnip	
Calliegonella cuspidata	Pointed Spear-moss	
Calliergon cordifolium	Heart-leaved Spear-moss	
Callitriche hamulata	Intermediate Water Starwort	
Caltha palustris	Marsh Marigold	
Cardamine pratensis	Lady's Smock	
Carex canescens	White Sedge	
Carex oedocarpa	Common Yellow Sedge	
Carex echinata	Star Sedge	
Carex nigra	Common Sedge	
Carex panicea	Carnation Sedge	
Carex rostrata	Bottle Sedge	
Chara virgata	Delicate Stonewort	
Cirsium palustre	Marsh Thistle	
Comarum palustre	Marsh Cinquefoil	NT
Dactylorhiza fuchsii	Common Spotted Orchid	
Deschampsia cespitosa	Tufted Hair-grass	
Drepanocladus aduncus	Kneiff's Hook-moss	
Eleocharis palustris	Common Spike-rush	
Eleogiton fluitans	Floating Club-rush	
Epilobium palustre	Marsh Willowherb	
Epilobium parviflorum	Lesser Hairy Willowherb	
Equisetum palustre	Marsh Horsetail	
Eriophorum angustifolium	Common Cotton-grass	VU
Filipendula ulmaria	Meadowsweet	
Galium palustre	Common Marsh Bedstraw	
Glyceria fluitans	Flote-grass	
Hydrocotyle vulgaris	Marsh Pennywort	NT
Hypericum tetrapterum	Square-stalked St John's Wort	
Isolepis setacea	Bristle Club-rush	
Juncus acutiflorus	Sharp-flowered Rush	
Juncus articulatus	Jointed Rush	
Juncus bulbosus	Bulbous Rush	
Juncus conglomeratus	Compact Rush	

[7] Based on the BSBI England Red List (Stroh *et al*, 2014). VU = Vulnerable, NT = Near Threatened

Juncus effusus	Soft Rush	
Juncus inflexus	Hard Rush	
Lemna minor	Common Duckweed	
Lythrum portula	Water Purslane	
Lythrum salicaria	Purple Loosestrife	
Mentha aquatica	Water Mint	
Myosotis laxa	Tufted Forget-me-not	
Myosotis scorpioides	Water Forget-me-not	
Myriophyllum alterniflorum	Alternate Water-millfoil	
Phragmites australis	Common Reed	
Pilularia globulifera	Pillwort	VU
Polytrichum commune	Common Haircap	
Potamogeton berchtoldii	Small Pondweed	
Potamogeton natans	Broad-leaved Pondweed	
Potamogeton polygonifolius	Bog Pondweed	
Potentilla erecta	Tormentil	NT
Ranunculus flammula	Lesser Spearwort	VU
Scrophularia auriculata	Water Figwort	
Sparganium erectum	Branched Bur-reed	
Sphagnum cuspidatum	Feathery Bog-moss	
Sphagnum fallax	Flat-topped Bog-moss	
Sphagnum fimbriatum	Fringed Bog-moss	
Sphagnum squarrosum	Spiky Bog-moss	
Sphagnum subnitens	Lustrous Bog-moss	
Stellaria palustris	Marsh Stitchwort	VU
Stellaria uliginosa	Bog Stitchwort	
Typha latifolia	Greater Reedmcae	
Veronica scutellata	Marsh Speedwell	NT