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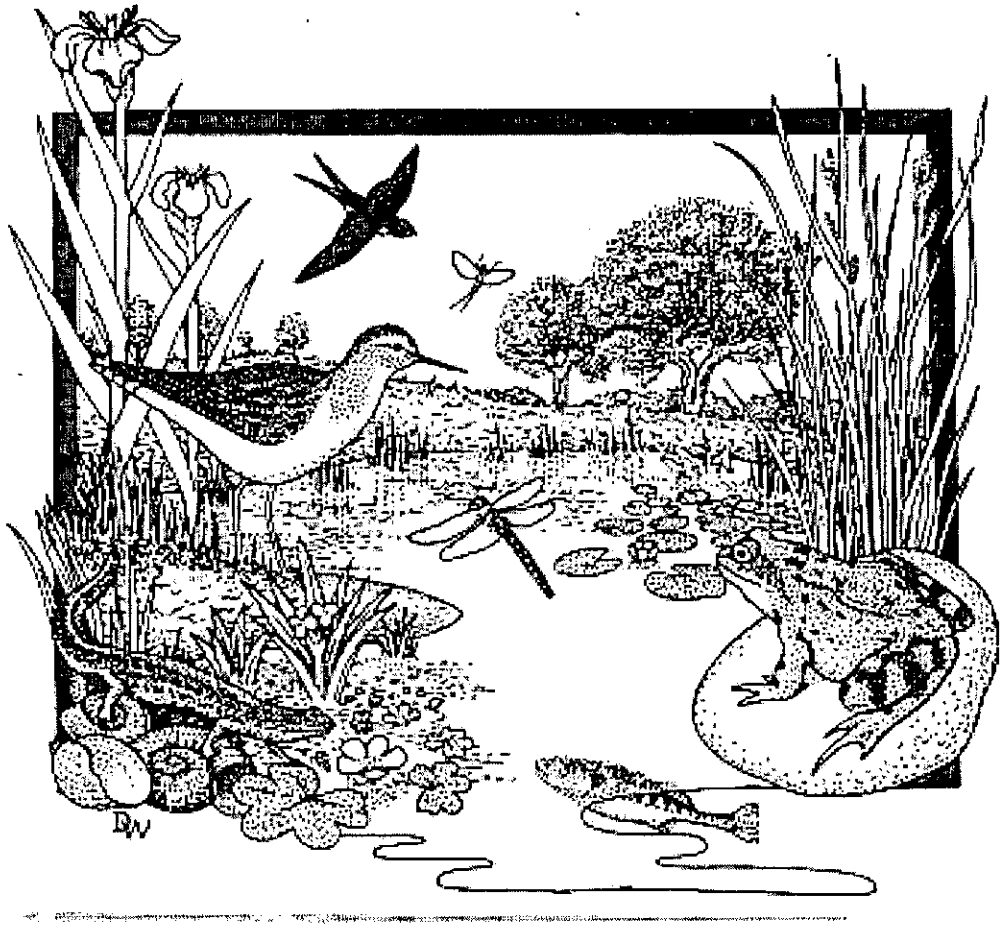
Ecology and management of the Greenmore ponds, Woodcote



November 2000

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Ecology and management of the Greenmore ponds, Woodcote

Summary of findings

The results of an ecological assessment of the Greenmore ponds show that both ponds have a very high conservation value.

The Upper Pond had a good wetland flora and a very rich invertebrate fauna including six Nationally Scarce water beetle species. The Lower Pond's plant community was slightly poorer than might be expected; however, its invertebrate community was again very rich and it supported three Nationally Scarce species. The two ponds had different, but complementary, communities. Upper Pond was particularly rich in water beetle species, whereas Lower Pond supported species of mayfly, caddis fly and water bug that appeared to be completely absent from the Upper Pond.

In terms of site management, the most urgent requirement is to protect Upper Pond's plant community by eradicating the invasive alien plant species New Zealand pigmyweed (*Crassula helmsii*). Rapid action is recommended since the species is becoming extensive and within a year or two it is likely to have spread into deeper water, where it can be exceptionally difficult to eliminate.

A range of other management suggestions are made for both ponds, including a limited amount of tree clearance and vegetation management. However these are not urgent and should, in any case, be carried out over a number of years and combined with regular observation of the effect on the ponds.

CONTENTS

Ecology and management of the Greenmore ponds, Woodcote

1. Aim of the report

This report describes the results of an ecological survey of the Greenmore ponds undertaken by Pond Action for Woodcote Parish Council in September 2000. The report:

(i) describes the results of surveys of the wetland plants, aquatic macroinvertebrate and amphibian communities present in the ponds,

(ii) provides an assessment of the overall ecological quality of the ponds, and

(iii) gives management recommendations that should help to maintain and enhance the ponds' wildlife value.

2. Site location and geology

The two Greenmore ponds (SU643816) lie at the edge of an area of secondary woodland, on Greenmore Hill, south of Woodcote village.

The 1:50,000 geology map for the area suggests that the ponds have been dug into Reading Beds, which are typically a mixture of mottled clay, sand and pebble horizons. However, data from a nearby borehole at Crays Pond (SU637807) suggests that a weathered deposit of unknown age overlies the Reading bed in this area, with the geology from the surface given as: (a) 2.1 m weathered sandy clay with some angular flints (a deposit of unknown age), underlain by (b) 11 m+ Reading Beds: mainly sands with a trace of gravel (Corser 1981).

Whatever its age or origin, the mixed sand and clay geology makes it difficult to identify the ponds' main water sources. If the pond bases are entirely dug into clay, they will be mainly fed by surface water draining in from the surrounds. If, however, one or other of the pond bases cut through sub-surface lenses of sands these water bearing horizons may provide the ponds with a groundwater or spring input. This is quite likely for the deep Lower Pond.

3. Methods

The two ponds were surveyed for plants, invertebrates and amphibians by M. Whitfield and P. Williams on 15th September 2000. The methods used for the assessment were based on standard techniques developed for the National Pond Survey (described in Appendix 1). In brief, invertebrates were surveyed by taking a hand-net sample from each of the pond's main habitats. This sample was sorted in the laboratory to remove invertebrate species for identification. In order to help identify the relative importance of different areas of the pond, each habitat sample was sorted and identified separately. Wetland plants were surveyed by walking and wading the perimeter and open water areas of the waterbodies. Amphibians were searched for around the edge of the ponds and by hand netting in the water.

Information from the sites was compared with data from other UK ponds that have been surveyed using the same methodology. The conservation value of the ponds was assessed on the basis of the richness and rarity of their plant and invertebrate communities. In addition, the computer-based Predictive Method for Multimetrics (PSYM) was used to assess the overall "health" of the pond. Details about the PSYM method are given in Appendix 5.

4. Greenmore Upper Pond

4.1 Physical characteristics of Greenmore Upper Pond

Greenmore Upper Pond is about 0.05 ha in area. Approximately 65% of the pond's margins are shaded by overhanging trees. The heaviest shade occurs along the southern edge where a number of oaks overhang the water's edge, and along the eastern boundary where willows locally grow in the pond. Most of the central areas of the pond are unshaded, and overall only about 35% of the pond is directly overhung by trees.

The pond banks are generally low angled (< 5 degrees). On-site evidence suggests that pond water levels rise and fall by at least 50 cm during the year, giving a broad drawdown (water fluctuation) zone at the edge of the pond up to 7 m in width.

On the date of the survey, the pond had a maximum water depth of 0.8 m and average depths of 0.5 m. Sediment depths varied from 0.1 m – 0.35 m, with an average sediment depth of 0.25 m.

4.2 Wetland plant survey results

Number of wetland plant species

Greenmore Upper Pond had a good wetland plant community, with 19 species recorded (see Appendix 2a). This total is close to the average number of 23 species recorded in ponds in Pond Action's survey of high quality unpolluted ponds assessed for the National Pond Survey (see range of comparable data in Appendix Table 4.1).

Uncommon plant species

No rare or nationally scarce plant species were recorded from the Upper Pond. However, two species, rigid hornwort (*Ceratophyllum demersum*) and ivy-leaved duckweed (*Lemna trisulca*) have a rather restricted distribution in Britain and can be regarded as 'local'[1] plants at national level. In Upper Pond rigid hornwort was present only in low abundance, with just a couple of plants seen in deeper water towards the northern tip of the water soldier (*Stratiotes aloides*) stand.

Additional characteristics of the plant community

The pond was well vegetated, with only the heavily shaded southern edge largely plant free. In other areas of the pond, the plant community was dominated by an outer zone of aquatic grasses and rushes, particularly creeping bent (*Agrostis stolonifera*), floating sweet-grass (*Glyceria fluitans*) and common spike-rush (*Eleocharis palustris*). A range of low-growing wetland herbs including water mint (*Mentha aquatica*), water forget-me-not (*Myosotis scorpioides*) and common marsh-bedstraw (*Galium palustre*) also occurred in this area, as did the highly invasive alien plant New Zealand pigmyweed (*Crassula helmsii*) (see below).

The centre of the pond was dominated by a dense stand of the large-leaved, semi-floating plant water soldier (*Stratiotes aloides*). Two duckweed species, common duckweed (*Lemna minor*) and ivy-leaved duckweed (*Lemna trisulca*), occurred sparsely at the surface between the water soldier plants.

Invasive alien plants and other introduced species

The northern edges of the pond supported extensive stands of the alien wetland plant New Zealand pigmyweed (*Crassula helmsii*)[2]. This is a highly invasive species that can out-compete native plants and lead to considerable loss of wetland biodiversity. In Upper Pond *Crassula* grew over an area of approximately 120 m^2 (6 m x 20 m) along the northern margins of the pond in shallow water 5-30 cm deep (see Figure 1). Within this area, it generally occupied approximately 30-70% of the vegetation sward, growing together with the spike rush and wetland grasses. Fortunately, *Crassula* appeared to be absent from the southern edges of the pond, perhaps because the dense stands of grasses growing in this area have prevented it from gaining a foot-hold.

[1] 'Local' plant species are defined here as species which occur in less than about a quarter of all 10 x 10 km squares in the UK (i.e. less than 700 10 x 10 km squares).

[2] Sometimes also called Australian swamp stonecrop.

Although other plants present at the pond were all native, a number are not typical of woodland ponds in south-central England and had clearly been introduced to the site from gardens or aquarist's stock. This included: water soldier (*Stratiotes aloides*) which in Britain is native only in areas of East Anglia; greater spearwort (*Ranunculus lingua*), which is typically a marsh and fenland plant and a cultivar of white water-lily (*Nymphaea alba.*) which, as a native species, is usually restricted to ponds on flood plains, rivers and other extensive wetlands.

Comparison with previous plant survey data

Comparisons between the plant survey data gathered for the current survey and data collected in 1989 by John Langley (Ecoscan), suggest that the pond has changed relatively little in richness over the past decade: a total of 21 plants were recorded in 1989 and 19 in 2000. There has however been a slight shift in community type, with four 1989 species not recorded in 2000 and three species new to the 2000 survey.

Species recorded for the first time in 2000 were: common marsh-bedstraw (*Galium palustre*), creeping bent (*Agrostis stolonifera*) and bittersweet (*Solanum dulcamara*). The four species apparently lost from the pond since 1898 were spiked water-milfoil *Myriophyllum spicatum*, jointed rush *Juncus articulatus* and two introduced species: fringed water-lily *Nymphiodes peltata* and the alien plant Canadian pondweed *Elodea canadensis*.

Three of the four plants not found at the pond are submerged or floating-leaved aquatic species rather than marginal plants. Their apparent loss may be due to either (a) the encroachment of marginal grasses into the centre of the pond, and/or (b) the dense cover of floating water soldier in more open water areas. It is possible that with a small amount of management, one or more of the "lost" species may reappear from the seed bank in the bottom sediment.

Figure 1. Upper Greenmore pond

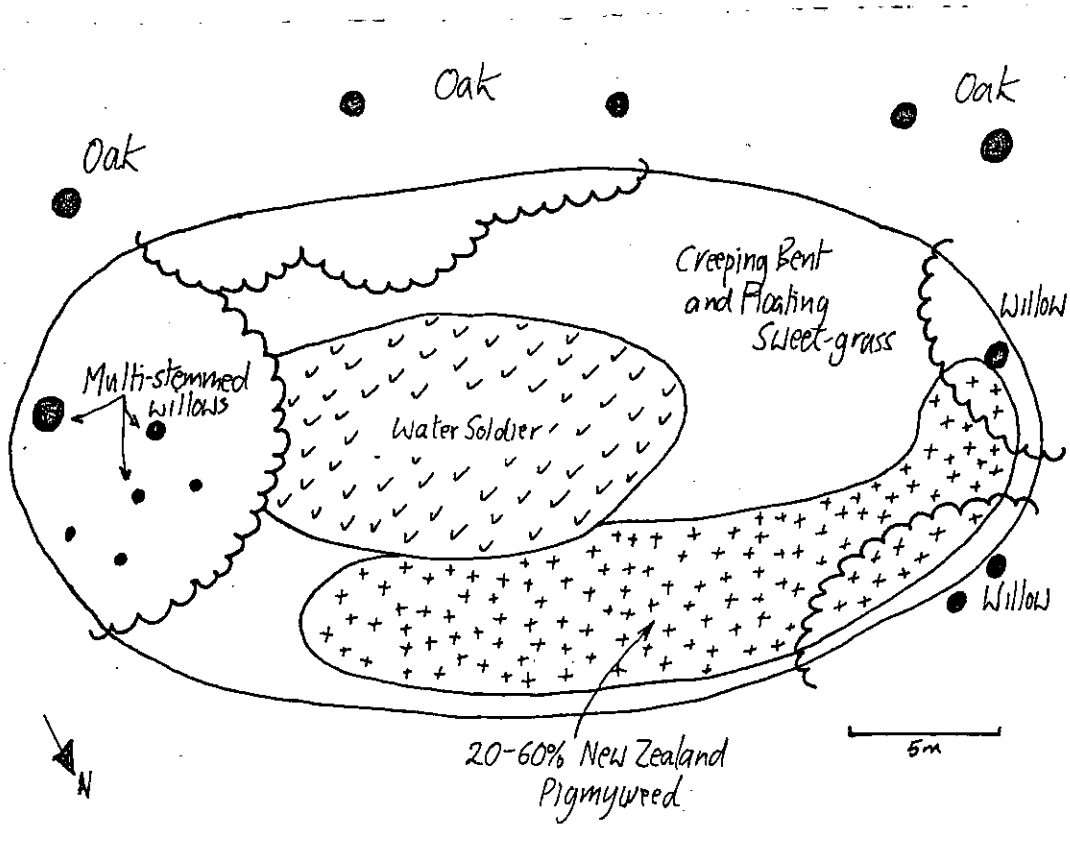


Table1. Number of invertebrate species and uncommon species recorded from Upper Pond

	Habitats sampled:				
	Grassy banks	*New Zealand pigmyweed*	*Shaded banks & other plants*	*Water soldier*	***All***
Number of Species	30	19	28	37	**60**
Number of Nationally Scarce species	5	2	0	1	**6**

Table 2. Nationally Scarce species: the number of individuals found in each aquatic habitat

		Habitats sampled:				
		Grassy banks	*New Zealand pigmyweed*	*Shaded banks & other plants*	*Water soldier*	***All***
Anacaena bipustulata	A scavenger beetle	2	0	0	0	**2**
Cercyon convexiusculus	A scavenger beetle	14	20	0	0	**34**
Cercyon sternalis	A scavenger beetle	6	0	0	0	**6**
Helochares punctatus	A scavenger beetle		1	0	0	**1**
Hydaticus seminiger	A diving beetle	1	0	0	0	**1**
Rhantus grapii	A diving beetle	0	0	0	1	**1**

4.3 Aquatic macroinvertebrate survey results

Number of species recorded

Upper Pond supported a very rich macroinvertebrate community with a total of 60 invertebrate species recorded from the pond (see Appendix 3a). This puts the site within the top 15% of ponds surveyed for the National Pond Survey in terms of species richness. The pond also supported six Nationally Scarce invertebrate species, again an exceptional total. The Nationally Scarce species were all water beetles and included four water scavenger beetles (*Anacaena bipustulata, Cercyon convexiusculus, Cercyon sternalis, Helochares punctatus*) and two diving beetles (*Hydaticus seminiger* and *Rhantus grapii*). Of these species, *Helochares punctatus* is an acid water specialist and its presence reflects the influence of acid sands and gravels at the pond. *Anacaena bipustulata, Cercyon convexiusculus*, *Cercyon sternalis* and *Rhantus grapii* are often associated with fen vegetation or fen leaf litter. *Hydaticus seminiger* is typically seen in densely vegetated wooded or tree-lined ponds. Both *Rhantus grapii* and *Hydaticus seminiger* overwinter on land and fly back to the pond in spring (Nilsson & Holmen, 1995), (see Appendix 3c for additional information).

Habitat information

In total four aquatic habitats were netted for macroinvertebrates. These were the grassy banks, New Zealand pigmyweed (*Crassula helmsii*), shaded banks and water soldier. Table 1 shows the number of invertebrate species and Nationally Scarce species recorded in each of these habitats.

At the time of the survey, the richest habitats were the water soldier and grassy bank areas. The New Zealand pigmyweed was the poorest. In terms of Nationally Scarce species, most of the uncommon invertebrates were found in the grassy banks, although the pigmyweed and water soldier also supported scarce beetles. The number of individuals of each species found in these different habitats is shown in Table 2.

Comparison with previous invertebrate survey data

The methods used to survey invertebrates in the ponds in 1989 and 2000 were not strictly compatible, so the numbers of species and uncommon species recorded in the two surveys cannot be directly compared[3] However, comparison of the species lists from the two dates suggests that the pond community has remained relatively similar with most of the species recorded in 1989 also recorded in 2000. The main differences are the greater number of water bug species found in the 1989 survey, and the higher proportion of water beetles (including uncommon species) recorded in 2000. Both observations may be related to the greater amount of open water that was present in the pond in 1989 and the greater abundance of grassy vegetation present now.

4.4 Amphibians

A total of three newt larvae were netted from the area of grassy bank and New Zealand pigmyweed. The larvae were too small to identify to species, but were either smooth and/or palmate newts (*Trituris vulgaris* and/or *T.helveticus*). It should be noted, however, that September is late in the year for reliable amphibian survey work so that conclusions about trends in the pond's amphibian community should not be drawn from these results.

4.5 Ecological quality assessment

The ecological quality of the pond was assessed to evaluate whether the wildlife community had been damaged by factors such as pollution or poor bank structure. The method used for this assessment is called PSYM (the Predictive System for Multimetrics): this is a predictive method which uses simple environmental variables from the pond (e.g. pond area) and uses these to calculate which plants and animals should be present in the pond if it is in top condition (see Appendix 5).

The results of PSYM analysis of Greenmore Upper Pond are described in Appendix 5. In summary, however, the analysis suggests that the Upper Pond is of good quality, but not quite pristine.

4.6 Conclusions: overall conservation value of the pond

Overall, the pond had a very high conservation value, with a good plant community and a very rich invertebrate community including six Nationally Scarce water beetle species. The grassy bank area was a particularly valuable habitat in that it supported four of the six Nationally Scarce species; however, all parts of the pond contributed to the overall diversity and wildlife value of the site.

[3] In 1989 John Langley sampled the ponds using a relatively subjective "bug hunt" method where each waterbody is netted "until no new species are found", all material collected being processed in the field. The current survey used the National Pond Survey method in which a timed hand-net sample is collected and exhaustively sorted in the laboratory.

5. Greenmore Lower Pond

5.1 Physical characteristics of Greenmore Lower Pond

Greenmore Lower Pond is larger in area than the Upper Pond (c.0.1 ha) and lies approximately 20 m to the south.

The pond is moderately shaded. Approximately 80% of the margins are overhung by trees, with the heaviest shade occurring where oaks overhang the southern and eastern banks. The central areas of the pond are, however, unshaded, so that overall only about 25% of the whole pond is directly overhung by trees.

The pond's upper banks are generally steep and typically comprise a 0.4 m vertical step down to the water's edge, below which the banks drop off moderately steeply (c.10 degrees) into deeper water.

Water depths could only be measured to 1.20 m but it is likely that the pond is much deeper. Sediment depths in excess of 1 m were measured in the southern corner of the pond under the shade of the large oaks. Sediment depths in the centre of the pond could not be measured with accuracy, but were at least 0.5 m deep and probably considerably deeper.

At the time of the survey the water was brown in colour and highly turbid. This coloration is likely to have been, in part, due to tannins from decaying oak and other tree leaves. However the cloudiness was undoubtedly mainly due to fish (particularly cyprinids such as carp) stirring up bottom sediments.

5.2 Wetland plant survey results

Number of wetland plant species

Overall the Lower Pond had a moderately rich plant community, with a total of 14 plant species recorded from the site (see Appendix 2b). This is lower than would be expected for a pond located in a semi-natural area, although still better than most countryside ponds (see Appendix 4 for comparative data). The relative paucity of plant species is likely to be due to a combination of (a) the turbidity of the pond which reduces the potential for submerged aquatic plants, and (b) the bare, disturbed bank edge areas which support few marginal plants. No uncommon plant species were recorded at the pond.

Additional characteristics of the plant community

The richest area of the waterbody for plants was the south-west bank, particularly the shallow areas around the coppiced grey willows where water mint (*Mentha aquatica*), water forget-me-not (*Myosotis scorpioides*), tufted forget-me-not (*Myosotis laxa*) and lesser spearwort (*Ranunculus flammula*) were found. The margins of the northern bank also had small stands of yellow flag (*Iris pseudacorus*) and floating sweet-grass (*Glyceria fluitans*).

A cultivated water-lily (*Nymphaea* species) and fringed water-lily (*Nymphoides peltata*) grew in more open water areas, particularly where the shade was not too great. Most of the rest of the pond, over 90%, was open water.

Introduced species

Several of the pond's plant species are likely to have been introduced to the site, either deliberately or accidentally, from garden centre or aquarist's stock (see Appendix 2b). This includes the alien submerged plant species Nuttall's pondweed (*Elodea nuttallii*) and curly waterweed (*Lagarosiphon major*), as well as fringed water-lily (*Nymphoides peltata*), a species which, although native, is only found naturally in East Anglia and a few floodplain sites in the Thames Valley.

Comparison with previous plant survey data

The number of plants recorded from Lower Pond has increased a little in the 11 years since the last survey, with nine species recorded in 1989 (Langley 1989) and 14 in 2000. Of these, one submerged species, the alien plant Canadian pondweed (*Elodea canadensis*), and one bare ground colonist (celery-leaved buttercup *Ranunculus sceleratus*) were recorded in 1989 but not 2000.

Species new to the pond in 2000 were yellow iris (*Iris pseudacorus*), tufted forget-me-not (*Myosotis laxa*), bittersweet (*Solanum dulcamara*), Nuttall's pondweed (*Elodea nuttallii*), curly waterweed (*Lagaosiphon major*) and ivy-leaved duckweed (*Lemna trisulca*). The latter three species were present in very low abundance, with just a few leaves or stems of each.

5.3 Aquatic macroinvertebrate survey results

Number of invertebrate species recorded

Lower Pond supported a very rich macroinvertebrate community, with a total of 65 species recorded from the pond (see Appendix 3a). This would place the site within the top 15% of ponds surveyed for the National Pond Survey in terms of species richness. The pond also supported three Nationally Scarce water beetle species. These were the scavenger beetles *Anacaena bipustulata* and *Helochares punctatus* and the diving beetle *Rhantus suturalis*. The first two of these species were also recorded at the Upper Pond but *Rhantus suturalis* was only recorded in the Lower Pond. *R. suturalis* is a species which appears to prefer less vegetated habitats than many other water beetles and this may explain its preference for the pond. Brief information about these scarce species is given in Appendix 3c.

Habitat information

Four aquatic habitats were netted for macroinvertebrates. These were the grassy banks, tree roots submerged in the water, small-leaved fringed water-lily *(Nymphoides peltata)* and large-leaved white water-lily (*Nymphaea* species). Of these, the richest habitat by far was the grassy bank area (see Table 3). Note that the open water areas were also netted, but these proved so poor that they were not included as a distinctive habitat in the timed invertebrate sample.

The fact that Lower Pond can support as many species as it does clearly reflects the fact that the pond has at least some shelter where animals can escape from fish predation, particularly areas of marginal grasses, and to a lesser extent submerged root bundles. The importance of these habitats is shown clearly in Table 3. In contrast the large water lilies have a very simple open *underwater* structure which offers little protection from predators.

In terms of Nationally Scarce invertebrates, two of the uncommon beetle species were found in the grassy banks, and one amongst the submerged tree roots. In comparison with the Upper Pond, the abundance of uncommon species was low, with only one individual of each scarce species found (see Table 4). This factor may, again, relate to the relatively high rates of fish predation in the pond.

Table 3. Number of invertebrate species and uncommon species recorded from Lower Pond

	Habitats sampled:				
	Grassy bank	*Small fringed Water-lily*	*Tree roots*	*Large water-lily*	***All***
Number of Species	42	28	33	15	**65**
Number of Nationally Scarce species	2	0	1	0	**3**

Table 4. Nationally Scarce species: the number of individuals found in each aquatic habitat

Species		*Habitats sampled:*				
		Grassy bank	*Fringed Water-lily*	*Tree roots*	*White water-lily*	***All***
Anacaena bipustulata	A scavenger beetle	0	0	1	0	**1**
Helochares punctatus	A scavenger beetle	1	0	0	0	**1**
Rhantus suturalis	A diving beetle	1	0	0	0	**1**

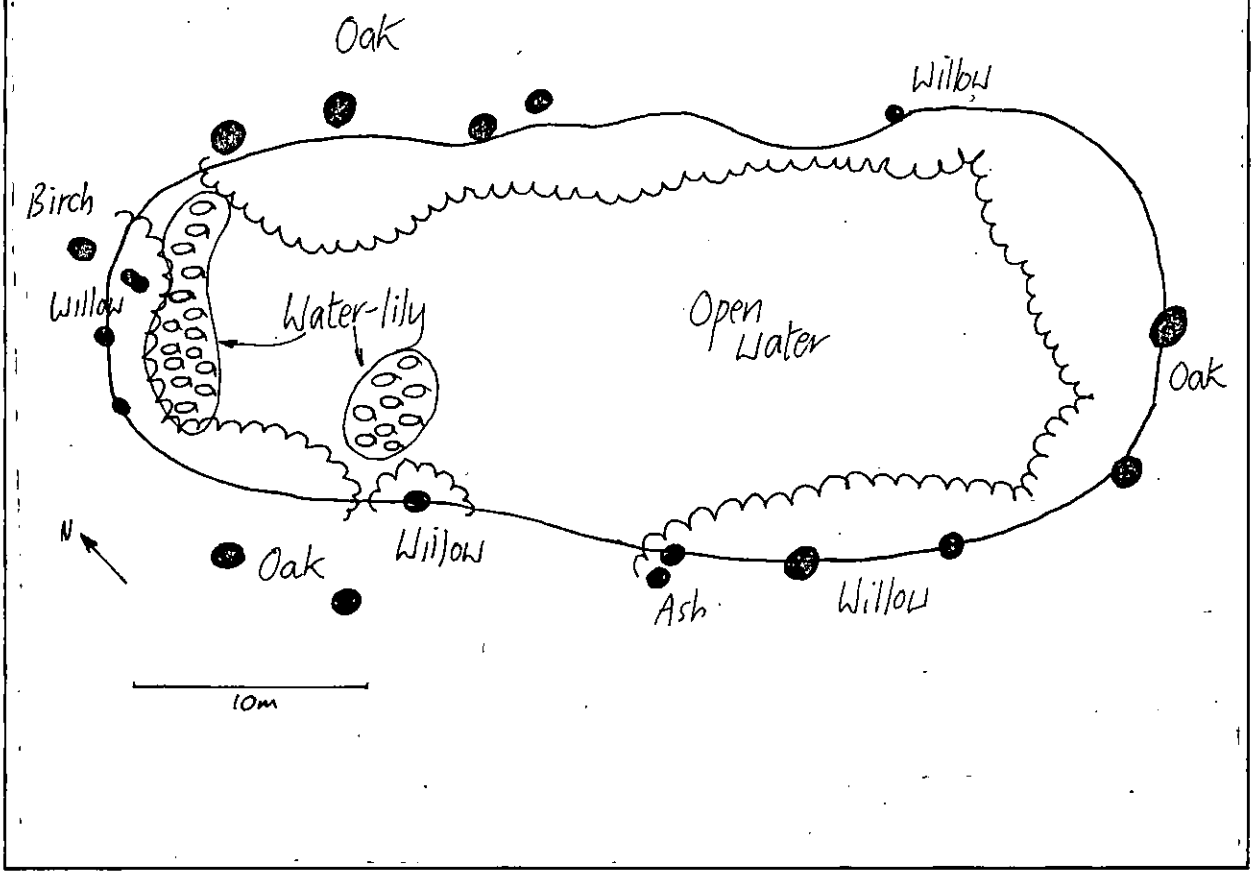
Comparison with previous invertebrate survey data

Comparison of the current invertebrate data with information collected from the pond by John Langley in 1989 (see footnote 3) suggests that the structure of the Lower Pond community has remained similar over the decade, consistently supporting fewer water beetles and a greater number of caddis fly species than the Upper Pond. There is, however, some evidence that the ecological value of the Lower Pond may have improved since the last survey, with more invertebrate species recorded in the current survey than the Upper Pond. The reason for this is not known, but it may, in part, be due to (i) a reduction in the number of fish in the pond, and/or (ii) an improvement in pond habitats, with the pond currently supporting a slightly greater abundance of marginal grasses growing in the water and a more extensive cover of fringed water-lily.

5.4 Amphibians

One newt larva was netted from the grassy bank habitat. As with the Upper Pond, the larva was too small to identify to species but it was either a smooth or palmate newt (*Trituris vulgaris* or *T.helveticus*).

Figure 2. Lower Greenmore pond



5.5 Ecological quality assessment

The results of PSYM analysis of the ecological data from Greenmore Lower Pond are given in Appendix 5. In summary, the PSYM analysis suggests that the pond is slightly degraded. The poorest results were for plant species richness and rarity measures, and suggest that the high water turbidity and regular disturbance to the pond banks are currently reducing the potential of the site to support an high-quality semi-natural wetland plant community.

5.6 Conclusions: overall conservation value of the pond

Overall, the pond had a very high conservation value. Its invertebrate community was particularly species-rich and included three Nationally Scarce species. The plant community was of more limited interest with a moderate conservation value.

6. Comparison of the two ponds

Table 5 summarises the number of species in different invertebrate groups recorded from the two ponds. The results suggest that the ponds have distinctively different community characteristics. Upper Pond has a very rich water beetle community including many Nationally Scarce species, whereas the Lower Pond supports species of caddis fly, water bugs and mayflies that have not been found in the Upper Pond. The aquatic plant communities also differ. Upper Pond has clear water and, therefore, the potential to support submerged or semi-submerged plant species such as curled-leaved pondweed and water soldier. The turbid water in Lower Pond prevents these species from growing in abundance, and so favours surface floating plants, such as water-lily.

The community differences observed are likely to reflect the different depths, habitats and fish stocking levels in the two ponds. The Upper Pond has abundant dense grassy areas which are ideal for water beetles, and relatively little fish predation to reduce their numbers. The Lower Pond is deeper and less overgrown which enables it to support a wider range of water bug, mayfly, and caddis fly species. However the water beetle population of Lower Pond is undoubtedly reduced in both species richness and the number of individuals by both the relative paucity of marginal plants and by the large numbers of fish.

Overall, the results indicate that the two ponds are complementary and that both support valuable wildlife communities.

Table 5. Number of species in different aquatic invertebrate groups in the two ponds

Invertebrate group	Upper Pond	Lower Pond
Flatworms	3	4
Leeches	4	5
Snails, pea mussels and limpets	11	12
Shrimps and slaters	3	3
Mayflies	0	2
Damselflies and dragonflies	4	6
Water bugs	4	8
Water beetles	31	19
Caddis flies	0	4
Alderflies	0	1
Aquatic moth larvae	0	1
Total number of species	**60**	**65**

7. Management recommendations

The management recommendations given below are directed, in particular, towards helping to maintain or enhance the biodiversity value of the two ponds.

7.1 Management of Greenmore Upper Pond

Overview

Greenmore Upper Pond currently has a high ecological quality, which it is well worth trying to maintain and protect. To do this it is recommended that the main focus should be on (i) maintaining the current quality and range of habitats present in the pond, (ii) eradicating *Crassula helmsii* from the site, and (iii) undertaking a small amount of management to increase the diversity of habitats in the pond for amphibians and other wildlife.

(i) Maintaining existing habitats

Particularly valuable habitats in the current pond are:

The marginal grasses

Low growing grasses such as floating sweet-grass (*Glyceria fluitans*) and creeping bent (*Agrostis stolonifera*) currently occupy a large proportion of the Upper Pond. This habitat often looks rather boring and it can be tempting to remove large areas. However, as shown in the current survey, floating grasses are one of the richest pond habitats for invertebrates and amphibians, and they support most of the scarce species recorded in the pond.

This said, the grasses in the Upper Pond are perhaps becoming a little too dense and matted to provide an optimal habitat for most species, and a small amount of plant removal in one or two areas could be beneficial in order to open up the structure a little.

The shallow edges

The pond's broad drawdown zone, which is dry in summer and wet in winter, provides a very valuable habitat for wildlife and it is important that, if dredging or plant removal is undertaken, this area is not deepened in any way. Fortunately, the pond has a firm stony base that is clearly defined so that, in practice, over-deepening should be easy to avoid.

Overhanging willow branches that root into the water

The large grey willow growing in the water at the southern end of the pond now has multiple stems and branches. Many of the low horizontal branches are rooting into the water where the stems touch the surface. These roots provide an excellent habitat for many species, including newt larvae, and most of these water-rooting branches should be retained where possible.

(ii) Removal of Crassula helmsii

New Zealand pigmyweed (*Crassula helmsii*) is a highly competitive plant species that is currently a significant threat to the conservation value of ponds in the UK. The plant quickly colonises bare ground areas. It can also grow together with other plants, but will usually out-compete them over a number of years, forming a dense evergreen mat that native species cannot penetrate. *Crassula* is a very adaptable plant that can grow anywhere from the upper pond bank to deep water. Without control it can, therefore, form monospecific stands over most areas of a pond and lead to considerable loss of plant biodiversity from sites. In addition, if large stands persist, this increases the risk of the plant being spread to other sites. For these reasons it is recommended that an attempt is made to eradicate this species from the pond.

In practice there are relatively few options for *Crassula* control. The two main modes of treatment are: (i) covering the *Crassula* with black plastic to shade it out, and (ii) herbicide application. Neither of these methods is foolproof, however, and repeat treatment should be expected. Fortunately, because *Crassula* remains green in winter, herbicide application is still effective if applied at this time of year. This is an advantage because herbicide application can be made at a time when most native species are dormant and suffer little ill effect. Dredging-out the plant is not recommended because this releases many tiny

fragments that can re-root, and spread the plant to other parts of a site. This can include areas of deeper water where the species can be impossible to control by any means.

The leaflet enclosed ("*Crassula helmsii* - focus on control") provides much useful information, but was produced some five years ago and does not give the most up-to-date advice. In recent trials, Hugh Dawson (Centre for Ecology and Hydrology), who is the main national authority on *Crassula* control, has found that diquat is the most effective herbicide to use to control *Crassula* - not glyphosate which is also mentioned in the booklet, but has proved less effective.

Two diquat applications, sprayed 2 weeks apart, should be 99% effective at removing *Crassula*. The herbicide should be applied to the water over the *Crassula* plants and in a zone 2m out from them, to ensure that underground rhizomes are killed too. The area of application should be disturbed as little as possible during and after treatment. The herbicide would need to be applied by a licensed operator. Diquat is a herbicide which is licensed for use in and near to water; however, the local Environment Agency office would have to be contacted in order that they can give authorisation for herbicide control at the site.

The main alternative to herbicide use is to cover the affected area with black plastic. However, this has already been tried in the past at the Upper Pond, and although it did reduce plant abundance, the species was not eradicated. If black plastic *is* used it needs to be weighed down firmly in the water to prevent light from getting in, and the sheeting from floating. Rolls of black plastic 2m wide are readily, and relatively cheaply, available from builders' merchants.

Recommendation

On balance, it is recommended that *Crassula* is controlled at Upper Pond by Diquat application in winter 2000/2001. It might be possible to use black plastic to cover plants in the shallow parts of the pond. However, the area of *Crassula* is now extensive, and extends into deeper water which can be difficult to cover with sheeting. Given the rapidity with which Crassula can spread once it takes hold, it is strongly advised that control is undertaken in the near future.

Because of the risks of spreading fragments to new areas, including deeper water, it is recommended that herbicide (and/or black plastic) is applied to the pond as it is, without any preliminary attempts to clear the existing vegetation back.

It is important that following the initial action to control *Crassula* at the site, there should be continual vigilance in the next few years to tackle new colonies of the plant which may occur.

It is recommended that there should be no other clearance of pond vegetation, or tree removal until *Crassula* is under control at the site. This is because any areas that are cleared are likely to be particularly attractive to *Crassula*, enabling the species to spread further across the site.

(iii) Additional minor management to increase diversity

The Upper Pond currently appears to be a healthy waterbody with no major pollutant sources. Management of the site is, therefore, not essential and although the pond will continue to fill with sediment and become gradually shallower, it is unlikely to loose its overall conservation value as it matures.

There are, however, a number of reasons why it could be advantageous to actively manage the site over a number of years, in particular (i) to create a better habitat for amphibians, particularly the protected great crested newt, and (ii) to create a more attractive pond for local people.

Improving amphibian habitats

During previous Pond Action visits to the Upper Pond in 1998 all three native newt species (smooth, palmate and great crested) were seen. A visit made by J. Biggs on 20/5/1989, however, only recorded smooth newt, palmate newt and common frog, suggesting that great crested newts may only be present at the site in low abundance. The current survey again only recorded a small number of larvae of smooth and/or palmate newt. The reason relatively few amphibians were recorded in the pond is not clear. Possible explanations are (i) the survey was undertaken late in the year, so that most young have already matured and emerged from the pond, or (ii) the pond is too overgrown to make ideal newt habitat.

For great crested newts the latter reason (poor habitat) is almost certainly true. In most respects Upper Pond would be ideal for great crested newts: the woodland surroundings of the pond provide an excellent terrestrial habitat for all amphibians and the floating and submerged grassy areas of the pond provide good egg-laying sites and a preferred living habitat for great crested newt. The main deficit is likely to be lack of suitable areas for newt courtship. Great crested newts, in particular, prefer ponds which have at least 20% of the waterbody with clear open water free of plants so that male courtship displays can be seen by female newts. Currently the open water areas of the pond are dominated by a dense stand of water soldier, so that very few open water areas exist, except where the pond is shaded.

To improve the habitat for amphibians it is recommended that some water soldier is removed from the central areas of the pond. This traditionally East Anglian species has been artificially introduced to the site and would not naturally occur in the Chilterns. In this respect there is little worry about removing it. However, it does currently provide a very good invertebrate habitat, so removal needs to be undertaken piecemeal over a number of years. As a precaution, therefore, no more than about one quarter of the water soldier should be removed in any one year for the first few years, so that the effects of its removal on other plants, including duckweed, can be monitored. With luck, more appropriate submerged native species, such as rigid hornwort and spiked water milfoil, will grow up from the sediment seed bank to take its place. If so, the amount of water soldier can be gradually reduced at the site. If not, around 50% of the current stand should be maintained.

In addition, as noted above, the amount of open water could be increased a little by removing a small proportion (10%) of the mat of grasses at the edge of the deeper water. This would also allow a better (looser) grass habitat structure develop. In practice, eradication of *Crassula* from the pond may also help to achieve this structure.

Tree removal.

The pond currently has a good balance of shade and overhanging vegetation. However, in the longer term the surrounding trees will inevitably get bigger and begin to overhang the pond more extensively. This will both reduce the light getting to the water and increase the rate of leaf input and sediment build up. It would, therefore, be prudent to consider some tree removal before this becomes a significant issue. Most benefit (to the pond) would be gained by removing young oaks from the southern bank. This is partly because they cast most shade, but also because oak leaves are highly refractory and tannin rich so that they contribute more mass to the sediment. Fallen willow leaves, in contrast, break down more rapidly in water, contributing less to the sediment bulk.

Removal of young willows around the north-west and south-east edges will also help to prevent additional shading around the pond in the long term. However, as noted above, it is important to retain at least 50% of the lower branches growing low over and *in* the water so that the willow root habitat is maintained or enhanced.

The precise effect that tree and shade removal will have on any pond is difficult to pre-judge, so it is recommended that any removal is staggered over a number of years (c. 5-7 years), and that between these times, the effects on the pond vegetation are monitored carefully to ensure that the response is beneficial.

Amenity and aesthetic considerations

In the longer term some sediment and vegetation removal from the pond could be considered in order to keep the site looking more open, particularly if it begins to become covered in duckweed (*Lemna* species) in summer. It is, however, recommended that the option to undertake dredging is left for a number of years, so that the effect of other forms of management (*Crassula* removal, tree felling etc.) can be observed.

Summary of management recommendations for Upper Pond

- Control New Zealand pigmyweed (*Crassula helmsii*) at the site - ***urgent***. Avoid other pond management, particularly vegetation removal, until *Crassula* has been eradicated.
- Once the *Crassula* is under control, remove approximately one quarter of the water soldier from the pond each year for 2-3 years in order to observe the effect on the pond, including (i) how much open water is created between March and May for newt courtship, and (ii) which plants grow up to take its place. Water soldier plants sink to the bottom of the pond in winter so any removal will need to be undertaken at other times of year. Thick gloves are essential for handling these plants to avoid being cut by their exceptionally sharp spines.
- Fell as many shading oaks on the southern bank as is possible given probable community constraints.
- Remove or coppice most vertically growing willow trunks and branches over a number of years, but retain a high proportion of horizontal water-rooting branches along the southern bank.
- Consider removal of some areas of matted grass from the pond, but no more than 10% in any one year. Where possible, aim to remove wedges of vegetation from deep to shallow water and observe the effects for a number of years before continuing. Start with areas close to the main public viewing points for the pond to maximise the visual benefits of the work.
- If the pond begins to become *thickly* covered with duckweed in summer, consider partial sediment dredging, but do not deepen the pond by digging into the gravel substrate.

7.2 Management of Greenmore Lower Pond

Overview

Greenmore Lower Pond currently has a moderate value plant community and a very high value invertebrate community, although the uncommon species were present in very low abundance. The pond is used regularly by fishermen and has a significant fish population. The presence of a high fish biomass clearly impacts upon the pond's plant community. Bottom feeding fish species, such as carp, stir up the sediment creating cloudy water which prevents the growth of native submerged plants. In addition the pressure of fishermen on the bank edges currently reduces the potential for marginal plant stands to develop in the drawdown zone. This said, the pond supports small stands of marginal water plants which are of considerable benefit to the pond's invertebrate community. At the time of the survey the pond had a locally extensive bloom of blue-green algae, covering in total approximately 5% of the surface.

To reduce the impact of fish on the pond, giving clear water and better conditions for wildlife, would require that fish biomass was reduced to more natural levels with (a) a balanced mixed community including piscivores such as perch or pike and (b) reduction in fish biomass levels to a maximum of approximately 0.1 kg biomass per m^2 of pond area. Given the recreational use of the pond, this may be unacceptable, in which case it is probably best to consider the Upper and Lower ponds as complementary, with the Upper Pond largely given over to wildlife conservation and the Lower Pond to fishing. Even if this is the case, however, it would still be worth making some effort to ensure that the existing conservation value of the Lower Pond is maintained by, in particular, encouraging marginal plants and grasses to develop larger stands in places at the pond edge.

Water-lilies

Water-lilies cover approximately 7% of the surface of Lower Pond. One of these water-lily species (fringed water-lily) can sometimes become invasive and may eventually pose a problem to fishermen using the site. It is, therefore, recommended that the cover of this species is monitored so that, if necessary, it can be prevented from becoming rampant.

Blue-green algae

At the time of the survey the pond had blooms of blue-green algae. This was unexpected since blue-green blooms are rather uncommon in ponds in semi-natural areas. Such blooms are usually restricted to ponds that are over-enriched in nutrients, especially phosphate. Usually this is because the waterbody receives nutrient run-off from agricultural areas; however, blooms are also common in ponds with large numbers of ducks or fish, presumably because these animals stir-up bottom sediment and release large quantities of nutrient-rich faeces into the water. It is probable, therefore, that the elevated fish population level in Lower Pond is the main reason for the bloom.

Blue-green algae blooms are only likely to be a problem in the pond during the late summer and autumn when they are typically most abundant. However, at this time, there are possible health issues for domestic animals and possibly fish if the algae switch into a toxic phase during this period. It is likely that maintaining a more natural fish population would help to reduce the algal problem. If not, sediment dredging might be worth considering.

Dredging

The pond undoubtedly contains considerable quantities of silt, although the exact volumes are not known. Because of the natural woodland surroundings the silt will be largely composed of oak leaf litter that is relatively nutrient-poor and inert. Such build up of leaf litter is natural in woodland ponds and is unlikely to have negative impacts on the pond's natural wildlife community (i.e. plants, invertebrates and amphibians). However fish (except perhaps stickleback) would not naturally be found in such isolated woodland ponds, and the build-up of organic leaf matter is unlikely to be optimal for fish, particularly where they are present in large numbers. As a result, fish kills are likely to occur in the pond, especially in hot weather when oxygen levels are naturally low.

If it is considered necessary to artificially maintain Lower Pond as a fishing site, sediment dredging could be considered to remove much of the existing organic silt. Such dredging could, however, be difficult

since it would involve disposal of large amounts of spoil, and probably necessitate draining the pond. In addition, since the pond is located in woodland it would inevitably begin to re-fill with leaf matter so that the benefits of dredging would not be long term. An alternative and possibly more sustainable option to reduce the likelihood of fish kills would be to further reduce fish biomass as discussed above. In addition, cutting back some of the overhanging oaks around the pond would help to at least slow the rate of leaf fall into the water.

Summary of management recommendations for Lower Pond

In practice the future management of the site depends on the amenity priority for the site but *might* include:

- Encouraging one or two more extensive stands of low growing wetland herbs and grasses to grow in the water around the pond edge.
- Monitoring, and if necessary removing, the fringed water-lily to prevent too much encroachment.
- Cutting back oaks to reduce leaf inputs to the pond, although *some* shade should remain to ensure water temperatures do not rise too much and exacerbate fish kills.
- Modifying the fish community to give a more "natural" population with fewer fish in order to reduce the blue-green algae blooms and potential for fish kills.
- Dredging the pond to reduce the existing organic sediment load.

8 References

Corser, C.E. (1981). *Sand and gravel resources of the country between Wallingford and Goring, Oxfordshire.* Mineral Assessment Report 64. Institute of Geological Sciences. HMSO, London.

Environment Agency and Pond Action (2000) A guide to monitoring the ecological quality of ponds and canals using PSYM. Pond Action, Oxford.

Friday, L.E. (1988). A key to the adults of British water beetles (AIDGAP Key). *Field Studies Council Publication* 189.

Foster, G.N. (1985). Atlas of British Water Beetles: Preliminary Edition - Part 4. *Balfour-Browne Club Newsletter* 35.

Foster, G.N. (1987). Atlas of British Water Beetles: Preliminary Edition - Part 5. *Balfour-Browne Club Newsletter* 40.

Nilsson, A.N. and Holmen, M (1995). The aquatic Adephaga (Coleoptera) of Fennoscandia and Denmark. II. Dytiscidae. *Fauna Entomologica Scandinavica.* Volume 32. Leiden Netherlands.

APPENDICES

Appendix 1. Survey methods

The methods used to survey the ponds followed the methods developed for the National Pond Survey, initiated by Pond Action in 1989. National Pond Survey methods have subsequently been used as the basis for many other regional and national surveys including DETR's Lowland pond Survey 1996 (Williams *et al.*, 1998) and Pond Action's national survey of degraded ponds. A full copy of the methodology is given in Pond Action (1998). Modified extracts which describe the field sampling protocol are given below.

Summary of pond survey procedure

The following list gives a broad outline of the information gathered at each pond.

- A description of the main physical features of the pond and its surroundings together with notes about the age, history and management of the pond.
- Water chemistry: a range of chemical determinands are measured. In the present study only data on pH and conductivity were collected as a range of chemical data were already available from the Environment Agency.
- A list of the wetland plant species found within the outer boundary of the pond, together with estimates of the abundance of species or major vegetation stands which occupy more than 5% of the pond.
- A list of the species of macroinvertebrates recorded from the pond with estimates of their abundance.
- Notes on the presence of amphibians and fish.

The methods used for collecting biological data are outlined in more detail below.

Recording wetland plants

The main aim of plant recording is to make a complete list of the *wetland plant species*[4] present within the *outer edge* of the pond[5]. Wetland plants are recorded by walking and wading around the margin and shallow water areas of the pond. In deep water aquatic plants are surveyed using a grapnel thrown from the bank and/or boat.

Sampling aquatic macroinvertebrates

The main aim of invertebrate sampling is to obtain, within the sampling time, as complete a species list as possible for the pond,

The pond is sampled, using a hand net, for a total of three minutes (net in the water time). During this time all of the major habitats in the pond are sampled. Examples of typical habitats are: stands of sedge; gravel- or muddy-bottomed shallows; areas overhung by willows, including water-bound tree-roots; stands of submerged aquatics; flooded marginal grasses and inflow areas. The average pond contains 4-10 habitats. Habitats are identified by an initial walk around the pond examining vegetation stands and other relevant features.

Invertebrate sampling is based on the following protocol:

(i) The three minute sampling time is divided equally between the number of habitats recorded: e.g. with six habitats, each is sampled for 30 seconds. Where a habitat is extensive or covers several widely-separated areas of the pond, the sampling time allotted to that habitat is further divided in order to represent it adequately (e.g. into 6 x 5 second sub-samples).

(ii) Each habitat is netted vigorously to dislodge and collect animals. In stony or sandy ponds the substrates are kicked-up to disturb and capture inhabitants.

[4] The term 'wetland plant species' refers to species defined as wetland plants on the National Pond Survey field recording sheet list. Terrestial plant species are not recorded.

[5] The 'outer edge' of the pond is defined as the 'upper level at which water stands in winter'. In practice this line is usually readily distinguishable from the distribution of wetland plants or as a 'water mark' on surrounding trees or walls.

The three-minute sampling time refers only to 'net-in-the-water' time and does not include time moving between adjacent habitats.

(iii) A one-minute search (total time, not net-in-the-water time) is undertaken for animals that may otherwise be missed in the main 3-minute sample. Areas which might be searched include the water surface (for whirligig beetles and pond skaters), hard substrates (for firmly-attached animals), the silty or sandy bottom sediments (for dragonflies and mayflies) and under stones and logs (for limpets, leeches, flatworms and caddis).

(iv) Amphibians or fish caught whilst sampling are noted on the field recording sheet and returned to the pond.

Sorting and identifying macroinvertebrate samples

The hand-net samples are sorted in the laboratory to remove invertebrates collected in the net. Samples are sorted 'live' and not frozen or preserved prior to sorting. Samples are sorted as soon as possible after collection, usually within three days of collection.

In general the aim of sorting the sample is to remove and identify all individual invertebrates. In samples where one or two species are present in large numbers (e.g. thousands of specimens), specimens of these species are counted in a sub-sample and numbers then extrapolated to the whole sample. All specimens of species which cannot be reliably identified in the sorting tray are removed and preserved in alcohol, with the exception of flatworms which are identified immediately. On average, sorting a pond sample to remove invertebrates takes approximately 6-8 hours. Samples containing a considerable amount of algae or duckweed may take considerably longer.

Species which are not immediately identifiable whilst sorting are identified using biological keys and a microscope with a magnification of at least x30. A list of guides is given in Pond Action (1994). Many species (especially the larval stages of insects) cannot be identified below certain sizes. Appropriate sizes are given in identification keys. After identification, invertebrates are returned to a labelled bottle and archived.

Appendix Table 1.1. Macroinvertebrate taxa included in pond surveys

Taxon	*Identification level*	*Notes*
Tricladida	Species	As adults
Gastropoda	Species	Adult and juvenile stages
Bivalvia	Species	Inc. *Sphaerium* spp., but not *Pisidium* spp.
Crustacea (Malacostraca)	Species	Adult and juvenile stages
Hirudinea	Species	Adult and juvenile stages
Ephemeroptera	Species	As larvae
Odonata	Species	As larvae
Megaloptera and Neuroptera	Species	As larvae
Hemiptera	Species	Mainly adults, but where possible nymphs are also identified
Coleoptera	Species	Mainly adults, but where possible larvae are also identified
Plecoptera	Species	As larvae
Lepidoptera	Species	As larvae
Trichoptera	Species	As larvae
Oligochaeta	Class	Adults and juvenile stages
Diptera	Family	As larvae

Note: watermites, zooplankton and other micro-arthropods are not included in the survey.

Appendix 2a. Wetland plants recorded from Upper Pond

Scientific name[1]	*English name*	*National status (e.g. whether the species is uncommon or non-native)*
Submerged species		
Callitriche stagnalis/platycarpa[2]	Water Starwort species	Common
Ceratophyllum demersum	Rigid Hornwort	Local[1]
Floating species		
Lemna minor	Common Duckweed	Common
Lemna trisulca	Ivy-leaved Duckweed	Local
Nymphaea species	White Water-lily	White water lily is a native species, but this is probably an introduced cultivar
Emergent species		
Agrostis stolonifera	Creeping Bent	Common
Crassula helmsii	New Zealand Pigmyweed	Introduced alien species
Eleocharis palustris	Common Spike-rush	Common
Epilobium hirsutum	Great Willowherb	Common
Galium palustre	Common Marsh-bedstraw	Common
Glyceria fluitans	Floating Sweet-grass	Common
Iris pseudacorus	Yellow Iris	Common
Juncus effusus	Soft Rush	Common
Mentha aquatica	Water Mint	Common
Myosotis scorpioides	Water Forget-me-not	Common
Phalaris arundinacea	Reed Canary-grass	Common native, but probably introduced to site
Ranunculus lingua	Greater Spearwort	Native species but not naturally found in SE England
Ranunculus sceleratus	Celery-leaved Buttercup	Common
Solanum dulcamara	Bittersweet	Common
Number of submerged species	**2**	
Number of floating species	**3**	
Number of emergent species	**14**	
Total number of species	**19**	

Notes

*1 'Local' species are defined here as species which occur in less than about a quarter of all 10 x 10 km squares in the UK (i.e. less than 700 10 x 10 km squares).

*2 No fruits were present to allow identification to species level

Appendix 2b. Wetland plants recorded from Lower Pond

Scientific name[1]	*English name*	*National status (e.g. whether the species is uncommon or non-native)*
Submerged species		
Elodea nuttallii	Nuttall's Pondweed	Introduced alien
Lagarosiphon major	Curly Waterweed	Introduced alien
Floating species		
Lemna trisulca	Ivy-leaved Duckweed	Common
Nymphaea species	White water-lily	Native species, but probably an introduced cultivar
Nymphoides peltata	Fringed Water-lily	Native species but introduced to the site
Emergent species		
Carex species	Sedge species	Introduced
Glyceria fluitans	Floating Sweet-grass	Common
Iris pseudacorus	Yellow Iris	Common
Juncus effusus	Soft Rush	Common
Mentha aquatica	Water Mint	Common
Myosotis scorpioides	Water Forget-me-not	Common
Myosotis laxa	Tufted Forget-me-not	Common
Ranunculus flammula	Lesser Spearwort	Common
Solanum dulcamara	Bittersweet	Common
Number of submerged species	**2**	
Number of floating species	**3**	
Number of emergent species	**9**	
Total number of species	**14**	

Appendix 3a. Macroinvertebrate species recorded from Upper Pond

Species	English Name	National Status	Number of individuals recorded in each habitat:				
			Grassy banks	*New Zealand pigmyweed*	*Shaded banks & other plants*	*Water soldier*	***All***
FLATWORMS							
Polycelis tenuis	A flatworm	Common	258	35	28	80	**401**
Dugesia lugubris	A flatworm	Common				1	**1**
Dendrocoelum lacteum	A flatworm	Common	1		3	1	**5**
SNAILS							
Anisus vortex	Whirlpool Ram's-horn	Common		3		48	**51**
Armiger crista	Nautilus Ram's-horn	Common			1	2	**3**
Gyraulus albus	White Ram's-horn	Common			2	35	**37**
Hippeutis complanatus	Flat Ram's-horn	Common	2			112	**114**
Lymnaea palustris	Marsh Snail	Common	5	17	20	22	**64**
Lymnaea peregra	Wandering Snail	Common	26	3	25	120	**174**
Lymnaea stagnalis	Great pond Snail	Common				2	**2**
Lymnaea truncatula	Dwarf pond Snail	Common		5			**5**
Planorbarius corneus	Great Ram's-horn	Common	17	6	12	300	**335**
Planorbis carinatus	Keeled Ram's-horn	Common				2	**2**
MUSSELS AND PEA MUSSELS							
Musculium lacustre	Lake Orb Mussel	Common	11		1	7	**19**
LEECHES							
Erpobdella octoculata	A leech	Common	13	3	1	50	**67**
Glossiphonia heteroclita	A leech	Local		1			**1**
Helobdella stagnalis	A leech	Common	1		4	8	**13**
Hemiclepsis marginata	A leech	Local				1	**1**
SHRIMPS AND SLATERS							
Asellus aquaticus	A water slater	Common	150		100	260	**510**
Asellus meridianus	A water slater	Common		65			**65**
Crangonyx pseudogracilis	A freshwater shrimp	Common	140	165	100	120	**525**
DRAGONFLIES AND DAMSELFLIES							
Aeshna cyanea	Common Hawker	Common			2	3	**5**
Coenagrion puella/pulchellum	Azure/Variable Damselfly	Common			21	18	**39**
Ischnura elegans	Blue-tailed Damselfly	Common				2	**2**
Pyrrhosoma nymphula	Large Red Damselfly	Common			1	3	**4**
WATER BUGS							
Hesperocorixa sahlbergi	A lesser water boatman	Common				5	**5**
Notonecta glauca	A greater water boatman	Common				1	**1**
Notonecta marmorea	A greater water boatman	Common				1	**1**
Plea leachi	Lesser Backswimmer	Common			1		**1**

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Appendix 3a. Macroinvertebrate species recorded from Upper Pond

Species	English Name	Status	Number of individuals recorded in each habitat:				
			Grassy banks	*New Zealand pigmyweed*	*Shaded banks & other plants*	*Water soldier*	*All*
BEETLES							
Agabus bipustulatus	A diving beetle	Common	2	3	1	3	9
Agabus nebulosus	A diving beetle	Common			1	2	3
Agabus sturmii	A diving beetle	Common	1			2	3
Anacaena bipustulata	A scavenger beetle	Nationally scarce	2				2
Anacaena globulus	A scavenger beetle	Common			16		16
Anacaena limbata	A scavenger beetle	Common	68	120	44	4	236
Anacaena lutescens	A scavenger beetle	Common	16			1	17
Cercyon convexiusculus	A scavenger beetle	Nationally scarce	14	20			34
Cercyon sternalis	A scavenger beetle	Nationally scarce	6				6
Coelostoma orbiculare	A scavenger beetle	Common	1	1	2		4
Colymbetes fuscus	A diving beetle	Common			1		1
Cymbiodyta marginella	A scavenger beetle	Common		1			1
Haliplus flavicollis	A crawling water beetle	Common				1	1
Haliplus lineatocollis	A crawling water beetle	Common			1		1
Haliplus ruficollis	A crawling water beetle	Common				2	2
Helochares punctatus	A scavenger beetle	Nationally scarce		1			1
Helophorus brevipalpis	A scavenger beetle	Common	1		3		4
Hydaticus seminiger	A diving beetle	Nationally scarce	1				1
Hydraena riparia	A scavenger beetle	Common	22				22
Hydrobius fuscipes	A scavenger beetle	Common	6	2	3	7	18
Hydroporus angustatus	A diving beetle	Common	21	33	2	7	63
Hydroporus incognitus	A diving beetle	Common	1				1
Hydroporus palustris	A diving beetle	Common			1		1
Hydroporus planus	A diving beetle	Common	2		2		4
Hydroporus tesselatus	A diving beetle	Common	1				1
Hyphydrus ovatus	A diving beetle	Common	1				1
Ilybius ater	A diving beetle	Common				1	1
Ilybius fuliginosus	A diving beetle	Common	1	20			21
Laccobius biguttatus	A scavenger beetle	Local	1				1
Noterus clavicornis	A diving beetle	Common				1	1
Rhantus grapii	A diving beetle	Nationally scarce				1	1
Number of Species			**30**	**19**	**28**	**37**	**60**
OTHER TAXA							
Pisidium species	Pea mussels		+				+
Velia species	Water crickets			+			+
Ceratapogonidae	Biting midges			+			+
Chironomidae	Non-biting midges		+	+	+	+	+
Oligochaeta	Segmented worms		+	+	+	+	+
Psychodidae	Owl midges		+				+
Tipulidae	Crane flies		+	+	+	+	+

Appendix 3b. Macroinvertebrate species recorded from Lower Pond

Species	English Name	National Status	Number of individuals recorded in each habitat:				
			Grassy Banks	*Fringed water-lily*	*Tree roots*	*White water-lily*	*All*
FLATWORMS							
Polycelis tenuis	A flatworm	Common	13	52	3		**68**
Dugesia lugubris	A flatworm	Common	2				**2**
Dugesia polychroa	A flatworm	Common		6			**6**
Dendrocoelum lacteum	A flatworm	Common	1		1		**2**
SNAILS							
Anisus vortex	Whirlpool Ram's-horn	Common	1				**1**
Gyraulus albus	White Ram's-horn	Common	34	1	1	2	**38**
Hippeutis complanatus	Flat Ram's-horn	Common		55	3	35	**93**
Lymnaea auricularia	Ear pond Snail	Common	2				**2**
Lymnaea palustris	Marsh Snail	Common				2	**2**
Lymnaea peregra	Wandering Snail	Common	45				**45**
Lymnaea stagnalis	Great pond Snail	Common	3	2	1	1	**7**
Planorbarius corneus	Great Ram's-horn	Common	2	3			**5**
Planorbis carinatus	Keeled Ram's-horn	Common	4	6	3		**13**
LIMPETS							
Ferrissia wautieri		Common	3			2	**5**
MUSSELS AND PEA MUSSELS							
Musculium lacustre	Lake Orb Mussel	Common			11		**11**
Sphaerium corneum	Horny Orb Mussel	Common			5		**5**
LEECHES							
Erpobdella octoculata	A leech	Common	202	110	46	52	**410**
Glossiphonia complanata	A leech	Common			1		**1**
Glossiphonia heteroclita	A leech	Local	2				**2**
Helobdella stagnalis	A leech	Common	10	3	7	1	**21**
Hemiclepsis marginata	A leech	Local	4	1	3	1	**9**
SHRIMPS AND SLATERS							
Asellus aquaticus	A water slater	Common		50	50	40	**140**
Asellus meridianus	A water slater	Common	300				**300**
Crangonyx pseudogracilis	A freshwater shrimp	Common	200	50	30	24	**304**
MAYFLIES							
Cloeon dipterum	pond Olive	Common	84	48	24		**156**
Cloeon simile	Lake Olive	Common	12		8		**20**

Appendix 3b. Macroinvertebrate species recorded from Lower Pond

Species	English Name	National Status	Number of individuals recorded in each habitat:				
			Grassy Banks	*Fringed water-lily*	*Tree roots*	*White water-lily*	***All***
DRAGONFLIES AND DAMSELFLIES							
Aeshna cyanea	Common Hawker	Common	8	2	4	4	**18**
Aeshna grandis	Brown Hawker	Common		4			**4**
Coenagrion puella/pulchellum	Azure/Variable Damselfly	Common	176	36	11	5	**228**
Enallagma cyathigerum	Common Blue Damselfly	Common	64				**64**
Ischnura elegans	Blue-tailed Damselfly	Common	11		2		**13**
Pyrrhosoma nymphula	Large Red Damselfly	Common	48	12			**60**
WATER BUGS							
Gerris lacustris	A pond skater	Common	7		1		**8**
Hydrometra stagnorum	Common Water Measurer	Common	2		5		**7**
Ilyocoris cimicoides	A saucer bug	Common		1			**1**
Nepa cinerea	Water Scorpion	Common		3		1	**4**
Notonecta glauca	A greater water boatman	Common		5	4	4	**13**
Notonecta maculata	A greater water boatman	Common			1		**1**
Notonecta marmorea	A greater water boatman	Common	1	1			**2**
Plea leachi	Lesser Backswimmer	Common			1		**1**
BEETLES							
Acilius sulcatus	A diving beetle	Common	1				**1**
Agabus didymus	A diving beetle	Common		1			**1**
Anacaena bipustulata	A scavenger beetle	Nationally scarce			1		**1**
Anacaena limbata	A scavenger beetle	Common	5				**5**
Anacaena lutescens	A scavenger beetle	Common	1				**1**
Colymbetes fuscus	A diving beetle	Common	1				**1**
Haliplus flavicollis	A crawling water beetle	Common	1				**1**
Haliplus fluviatilis	A crawling water beetle	Common			1		**1**
Haliplus ruficollis	A crawling water beetle	Common			2		**2**
Helochares punctatus	A scavenger beetle	Nationally scarce	1				**1**
Helophorus minutus	A scavenger beetle	Common		1			**1**
Hydrobius fuscipes	A scavenger beetle	Common			2		**2**
Hydroporus angustatus	A diving beetle	Common	1				**1**
Hydroporus incognitus	A diving beetle	Common		1			**1**
Hydroporus palustris	A diving beetle	Common	1				**1**
Hydroporus tesselatus	A diving beetle	Common	1				**1**
Laccobius minutus	A scavenger beetle	Common	1				**1**
Nebrioporus depressus	A diving beetle	Common		1			**1**
Rhantus suturalis	A diving beetle	Nationally scarce	1				**1**

Appendix 3b. Macroinvertebrate species recorded from Lower Pond

Species	English Name	National Status	Number of individuals recorded in each habitat:				
			Grassy Banks	*Fringed water-lily*	*Tree roots*	*White water-lily*	***All***
ALDERFLIES							
Sialis lutaria	An alderfly	Common	2				**2**
CADDISFLIES							
Athripsodes aterrimus	A caddis fly	Common	2	8	1		**11**
Glyphotaelius pellucidus	Mottled Sedge	Common	1		1		**2**
Limnephilus flavicornis	A caddis fly	Common	4		2	4	**10**
Triaenodes bicolor	A caddis fly	Common		8	8		**16**
MOTHS							
Elophila nymphaeta	Brown china-mark	Common		5	2		**7**
Number of Species			**42**	**28**	**33**	**15**	**65**
OTHER TAXA							
Chironomidae	Non-biting midges			+	+	+	+
Oligochaetea	Segmented worms				+	+	+

Appendix 3c. Nationally Scarce macroinvertebrate species recorded from the ponds

Definitions

Nationally Scarce Species are species recorded from only 15 - 100 10-km grid squares in mainland Britain.

Nationally Scarce species recorded in Greenmore Upper and Lower ponds

***Anacaena bipustulata* (COLEOPTERA: Hydrophilidae). A water scavenger beetle.**

Frequent in the south of England and the eastern part of the Midlands, with a few sites in the extreme south of Wales; apparently completely absent from the rest of Britain. Occurs in streams, rivers and pits. (Friday, 1988; Foster, 1987.)

***Cercyon convexiusculus* and *Cercyon sternalis* (COLEOPTERA: Hydrophilidae). Water scavenger beetles.**

These two species have a scattered distribution around England and Wales (though both are rather more often found in the east than the west), and *convexiusculus*, the commoner of the two, also has a few records in Scotland. The two species are closely related and very similar in size and appearance, and both are beetles typical of fen plant litter. (Friday, 1988; Foster, 1987.)

***Helochares punctatus* (COLEOPTERA: Hydrophilidae). A water scavenger beetle.**

Although more likely to occur in the south than in other parts of Britain, this species is much more widespread, and ranges further north, than the very similar (also Nationally Scarce) *H. lividus*. The species does not appear to be as scarce as some others with this designation, and may well have been under-recorded in the past since it is by no means always easy to distinguish from *H.lividus* (with which it is, very occasionally, found.) Inhabits wet heathland and lowland bogs. (Friday, 1988; Foster, 1987; Whitfield, pers. obs.)

***Hydaticus seminiger* (COLEOPTERA: Dytiscidae). A diving beetle.**

Since the middle of the 20th century the range of this species appears to have declined: it was once scattered throughout England and Wales, but since 1950 has been recorded almost exclusively in south-east england and the east midlands. Particularly favours shaded pools, and is said by Foster to be 'often associated with *Rhantus grapii* in fen carr (i.e. wet woodland) habitats' – something that obviously holds true for Greenmore Upper Pond. (Friday, 1988; Foster, 1985.)

***Rhantus grapii* (COLEOPTERA: Dytiscidae). A diving beetle.**

Has a scattered distribution in the south of England. Mainly found in fens, richly-vegetated drains in old fen areas, fen carr and shaded ponds. (Foster, 1985.)

***Rhantus suturalis* (COLEOPTERA: Dytiscidae). A diving beetle.**

Mainly found in England, but occasionally in Wales and Scotland. A species typical of silt and detritus pools, described by Foster as a 'strong-flying' and 'warmth-loving' species. (Friday, 1988; Foster, 1985.)

Appendix 4. Assessing pond conservation value: comparison with other sites

The following information gives a range of data about the conservation value of ponds in Britain. This information indicates the *typical* plant and invertebrate species richness of UK ponds based on standard surveys using National Pond Survey methods.

Note that National Pond Survey sites indicate the standard that ponds *should* reach in Britain when they are not exposed to damaging human impacts (e.g. water pollution, intensive land management, over-stocking with fish, artificial feeding of waterfowl). The two wider countryside surveys show the typical state of ponds in the "ordinary countryside" where ponds are often exposed to a variety of factors which reduce their conservation value.

Plant data

Appendix Table 4.5 Number of plant species recorded from UK ponds

		Number of species:		
		Marginal plants	*Aquatic plants*	***Total plants***
National Pond Survey (high quality ponds-mostly located in nature reserves)	*Average*	18	5	**23**
	Range	(1-42)	(0-14)	(1-46)
Wider countryside ponds (DETR Lowland pond Survey)	*Average*	8.0	2	**10**
	Range	(0-30)	(0-10)	(0-35)
Wider countryside ponds (ROPA Survey)	*Average*	11	3	**14**
	Range	(1-32)	(0-11)	(1-38)

Invertebrate data

Appendix Table 4.6 Number of aquatic macroinvertebrate species recorded from other UK ponds

		*Number of invertebrate species**
National Pond Survey (All ponds were high quality i.e. located in semi-natural areas).	*Average*	**32**
	Range	(6-98)
Wider countryside ponds (ROPA Survey)	*Average*	**26**
	Range	(2-64)

*All results are from a single season 3-minute hand-net sample.

Appendix 5. Ecological quality assessment of the ponds using PSYM

5.1 Introduction to the method

PSYM predicts the plants and invertebrates that would be expected to occur in ponds that are little affected by human impacts (e.g. pollution, land drainage, unnatural numbers of fish or ducks). The predictions are made using simple environmental data about a pond (e.g. pond area, geology, pH). Comparing the predicted flora (and/or fauna) with the plants/invertebrates actually present in the pond provides an objective assessment of the extent to which the pond's is reaching its biological potential.

The degree of impairment is described using three plant and three invertebrate biological measures known to be correlated with different types of environmental impact. These are:

Plants:

(i) Submerged and emergent plant species richness

(ii) Number of uncommon plant species

(iii) Trophic Ranking Score

Invertebrates:

(i) Average Score Per Taxon

(ii) Number of dragonfly and alderfly species

(iii) Number of beetle species

A description of the PSYM methodology is available in Environment Agency and Pond Action (2000).

5.2 Results of pond quality assessment from the ponds

The results from the PSYM assessment are summarised in Appendix Tables 5.1 and 5.2. The results from each biological measure are briefly outlined below.

Submerged and emergent plant species richness

In the Upper Pond the number of plant species (17 species[6]) was similar to the number of species which should be expected from the site (21). In the Lower Pond, however, the number of plant species (14) was rather below the expected 21 species. This was probably related to the turbidity of the water and regular disturbance of the banks.

Number of uncommon plant species

The number of uncommon plant species recorded from the Upper Pond (2 species) was slightly below the expected 4 species. The Lower Pond had no uncommon plant species. Again this was probably related to the water turbidity and bank disturbance of the Lower Pond.

Trophic Ranking Score

Trophic Ranking Score is a plant-based measure of pond nutrient levels. It is based on the fact that many plants prefer to grow in water or sediments with a restricted range of nutrient levels. Each plant species is given a score (between 1 and 10) depending on whether it prefers low or high nutrient levels. respectively. The average score of all the plants gives an indication of how enriched a pond is in nutrients.

In the Upper Pond the Trophic Ranking Score was rather higher than would be predicted for the site (9.19 as opposed to the predicted value of 8.65). The Lower Pond was also slightly higher than optimal (8.8). This suggests that the Upper Pond, in particular, may be slightly richer in nutrients than it should be. This might be due to the accumulation of nutrient rich silt developing in the pond.

[6] Note that this measure excludes floating-leaved species such as waterlilies and duckweed, since these do not have a strong negative relationship with pond quality.

Average Score Per Taxon

ASPT (Average Score Per Taxon) is a measure commonly used in river monitoring. It is calculated as follows. Each invertebrate family has a standard score (between 1-10) depending on its tolerance to organic pollution. The average score from invertebrate families found at a site is the ASPT. In ponds, ASPT is related to many types of degradation including heavy metals and nutrient pollution.

The predicted ASPT value for the Upper pond was 4.24 and for the Lower Pond 4.83. The Upper Pond was, in particular, rather lower than the predicted 5.07. The reason for this is not known, but may reflect the lack of open water present in the pond.

Number of Dragonfly and Alderfly species.

It was predicted that pond should support 3 families of dragonflies and alderflies. In fact in both ponds dragonfly numbers were a little below this with only two families observed.

Number of beetle species.

The number of beetle families that the ponds should support was predicted to be 4, and 4 families were observed in both ponds. This measure has a relationship with bank quality as well as water quality, the results therefore suggest that the bank structure was sufficient in both ponds to support a good diversity of beetle families

Overall quality score

The deviation of individual measures from the expected values are scored on a 0-3 scale. These scores are added together to give an indication of the overall value of the site. Adding the values together, the overall score for the plants and invertebrates communities in Upper Pond is 78% of the potential (14 scored out of a maximum of 18 possible). For Lower Pond the score is 72% (13 scored out of a maximum of 18 possible).

Both ponds appear, therefore, to be in a good condition although the scores fairly consistently suggest that the ponds are not quite pristine. In the Lower Pond, in particular, the plant community is rather below its expected value. The Trophic Ranking Score suggests that this is not due to nutrient pollution, so is almost certainly attributable to the pond's turbidity and the frequently disturbed banks.

Appendix Table 5.1. Ecological quality of Greenmore Upper Pond

Measure	Observed in the pond	Predicted values from PSYM	Ratio	Score
Plants				
No. of Submerged and emergent plants	19	21.49	0.88	3
Number of uncommon plant species	2	3.73	0.54	2
Trophic Ranking Score	9.12	8.65	1.05	2
Invertebrates				
Average Score Per Taxon (ASPT)	4.24	5.07	0.84	2
Number of dragonfly and alderfly families	2	3.17	0.63	2
Number of beetle families	4	3.72	1.07	3
Total score				14
Overall similarity of pond to pristine condition				**78%**

Appendix Table 5.2. Ecological quality of Greenmore Lower Pond

Measure	Observed in the pond	Predicted values from PSYM	Ratio	Score
Plants				
No. of Submerged and emergent plants	14	21.49	0.65	2
Number of uncommon plant species	0	3.73	0	0
Trophic Ranking Score	8.8	8.65	1.02	3
Invertebrates				
Average Score Per Taxon (ASPT)	4.83	5.07	0.95	3
Number of dragonfly and alderfly families	2	3.17	0.63	2
Number of beetle families	4	3.72	1.07	3
Total score				13
Overall similarity of pond to pristine condition				**72%**