Urban pond: A landscape of multiple meanings

Gledhill, DG, James, P and Davies, DH

URBAN POND: A LANDSCAPE OF MULTIPLE MEANINGS

D.G. Gledhill[1], P. James[1] and D. H. Davies[2]

[1]Research Institute for the Built and Human Environment and the School for Environment & Life Sciences, University of Salford, Manchester, M5 4WT
[2]Biosciences Research Institute and the School for Environment & Life Sciences, University of Salford, Manchester, M5 4WT
D.G.Gledhill@pgr.salford.ac.uk

ABSTRACT: Ponds have a range of ecological, social and aesthetic values. However, little work has been done to appraise the values assigned to ponds located in an urban setting. During 2004, 10 ponds were studied in urban areas of Merseyside. Standard ecological techniques were applied to assess diversity of invertebrates, plants and amphibians. A landscape character assessment technique was used to describe the major features of the surrounding landscape and its amenity value and fixed-point photographs collected throughout the year to assess their aesthetic value. Results indicate the complexity of these issues for local communities. Species richness was lower than found in some studies of rural sites but still significant, while the visual features of ponds in the sample-varied considerably. These findings have important implications for urban design and regeneration programmes.

Keywords: Aesthetics, Ecology, Ponds, Urban, Values

1. INTRODUCTION

Urban landscapes demonstrate a variety of values to different user groups, providing not only a series of habitats for many species of plants and animals from sparrow hawks and urban foxes in gardens to Rosebay Willow Herb (*Chamerion augusifolium*) and Birch (*Betula pendula*) on derelict ground and railway embankments (Baines, 1995). Research over the last few years has looked at the potential value of green spaces in towns and cities both to the environment and directly or indirectly to human health and well-being (Lees & Evans, 2000). Green space provides a buffer against pollution and potential alternative habitats to species such as gramivourous birds adversely affected by rural change. There are also social and psychological benefits to living with increased amounts of green as a refuge from concrete, steel and urban bustle (Cave, 1998).

Ponds are a particularly significant feature of urban landscapes in the Northwest of England. This region has one of the richest pond landscapes in Europe. Previous research in the field has focused almost entirely on ponds in the countryside, which are known to have declined by almost 70% over the last two centuries, largely due to changes in agricultural practice and land management strategies (Boothby, 2000). Ponds are important habitats, home to diverse communities of plants and invertebrates (Gledhill, 1999). However this is only part of their story, water has long been a key feature of human landscapes from ancient Babylon to Capability Brown and the duck ponds and lakes of modern towns and cities. The reflective quality of water can enliven otherwise bland vistas and contribute to a sense of place and add to local distinctiveness. Ponds also display a range of amenity values such as waterfowl activity, pond dipping and education. In a survey by the American Environmental Protection Agency, water bodies were, if well maintained, shown to have a positive affect on house prices (USEPA, 1995). While the biological aspects of small water bodies are relatively well documented, little investigation has been made into the human values of ponds in either urban or rural areas.

This particular research programme focuses on the built and human landscape. It is here that the majority of people are concentrated and where human interaction with green or blue space (e.g. parks and gardens (green space) and canals, rivers and ponds (blue space) is all the more important for its social and health related benefits. The aims of the research programme are to investigate the values of ponds in the urban landscape and to determine if these values are complimentary or to identify area of conflict with each other. The research focuses on four main areas ecology, aesthetics, and social and amenity values.

2. METHODOLOGY

As part of the pilot survey for the Urban Ponds Project, 10 ponds in the urban areas of Merseyside were studied during 2004. Ponds were selected on the basis of their availability and access throughout the year.

Standard survey techniques (New, 1998 and Pond Action, 1998) were applied to access the ecological status of sites. This involved 3-minute sweep netting for invertebrates using the Predictive SYstem for Multimetrics (PSYM) to measure the ecological quality of the sites. Sweep net sample were taken throughout the year and from all of the various habitats present within the pond. The PSYM model then compares the number of species of certain types of plants and invertebrates (known as metrics) actually found at the site to those expected based on a set of environmental variables, to determine the degree of degradation from an ecological ideal (Pond Conservation Trust, 2002). These variables are grid reference, altitude, pH, pond base geology, shade, emergent vegetation cover, grazing and area. Each of the six biological metrics produced from the field data (actual data) an Ecological Quality Index (EQI) for each site. Which can be expressed as a percentage of the sites predicted quality. An ideal site would have an EQI of 100% with the EQI decreasing as the quality of the site falls. Invertebrates were identified to specie level where possible or, with some of the more complex groups, to genus level. Location and altitude data were taken from the Ordinance Survey Explorer Map 1:25,000 scale, N^{o} 276.

The nutrient status of the ponds was inferred from the nutrient requirements of the plant species present. The disadvantage to this method is that not all plant species either demonstrate a nutrient preference nor is the nutrient requirements of all species known.

The visual counting and netting of amphibians were used to determine the presence or absence of species. No attempt was made to record the abundance of amphibian species. Large naturally occurring fluctuations in amphibian populations from year to year make the extrapolation of useful population data only reliable if collected over many years (Sewell & Griffiths, 2004). Evidence of breeding (eggs and larvae) was also recorded.

All wetland plants rooted below the winter high water mark were recorded and vegetation structure described by means of the National Vegetation Classification (NVC), which classifies 28 communities of wetland vegetation and an additional 24 aquatic communities (Rodwell, et.al. 1995).

Water samples where collected from a bucket of pond water aggregated from around the pond and 300ml samples frozen for later analysis. This involved recording pH and dissolved oxygen concentration.

A landscape character assessment technique developed by Countryside Commission and Scottish Natural Heritage (Swanwick, 2002) was applied to describe the major features of the surrounding landscape and its amenity value. Landscape features and the surrounding land use within 250m of the pond were recorded along with the degree of visibility, proximity to housing, footpaths and the amount of public access. In addition fixed-point photographic data were collected for each site at regular intervals throughout the year using a digital camera. This data will be used to assess aesthetic value of the ponds on the survey.

3. RESULTS

3.1. Ecological

Thirty-eight species of invertebrates were recorded in the ponds in the sample. Of these the majority were common species and included 8 species of beetles, 4 species of dragonflies and damselflies, aquatic snails and a single record of the mud alderfly. Typical pond species such as water boatmen and water scorpions were recorded frequently in the survey. All are classified as common species, being of widespread national distribution (Boothby 2000).

The median number of invertebrate species found was 6, ranging from one seasonal pond (dry summer) with no aquatic invertebrates at all to the fishing pond at Mill Wood with 19 species. While the median number of plant species per pond was 4 ranging from 0 to 11 species at both Mill Wood and within the local nature reserve at Mull Wood, Croxteth Park.

A total of thirty species of wetland plants were recorded for all the ponds in the sample. Of these the majority were common native species with three species of alien plant species. These were exotic water lilies (*Nymphaea* species), Canadian pondweed (*Elodea canadensis*), Chilean / giant rhubarb (*Gunnera manicata*) and the water fern (*Azolla filiculoides*). The most common marginal species were greater reed mace (*Typha latifolia*), yellow flag iris (*Iris pseudoacorus*), water mint (*Mentha aquatica*) and the rush *Juncus inflexus*. Three uncommon species where identified in the survey rigid hornwort (*Ceratophyllum demersum),* yellow water lily (*Nuphar lutea*) and greater spearwort (*Ranunculus lingua*). These are species with restricted or localised distributions that cannot be considered as common but are not rare enough to warrant an official scarcity classification (Boothby, 2000).

Not all sites fitted easily into the typical communities described by the National Vegetation Classification System (NVC). Common duckweed (*Lemna minor*) occurred in half of all ponds to some degree, although only in one was it the dominant plant species. It was found in both floating mats and scattered amongst other taller pond side vegetation. The A2a *Lemna minor* sub-community was found at two locations characterised by species poor stands (or rafts) of *L.minor*. Significant submerged or partially floating stands of rigid hornwort (A5 *Ceratophyllum demersum* community) where recorded from two out of 10 sites. This plant may have introduced to these sites being frequently sold by aquarists and garden centres as an oxygenator. The only identifiable swamp (marginal) community found was the S12 *Typha latifolia* community, this occurred as both the S12a sub-community of pure stands of *Typha* in deep water and as the S12b sub community of *Typha* dominated stands with an under story often consisting of water mint (*Mentha aquatica*) in shallower water. *Iris pseudoacorus* was dominant at one site and co-dominant forming large mixed stands with *Typha* at two others. Generally botanical diversity was low at all sites. The one notable exception to this observation being the seasonal pond located in school grounds (mostly marsh for much of the year) that exhibited comparatively high diversity for its size, with 5 species in a pond of less than $13m^2$.

Table 1 shows basic water chemistry data collected in mid summer from the ponds in the survey, compared against invertebrate diversity. The latter was calculated using the Shannon Weiner index that calculates the proportion of each species compared to the total number of individuals (the higher the H1 value the greater the diversity of the habitat) (New, 1998).

The highest Shannon Weiner diversity values were found in those ponds with the highest level of dissolved oxygen. The one site that defies this trend is the Statue pond, where despite otherwise adverse biological conditions the water is vigorously oxygenated with fountains.

Water pH ranged from neutral to mildly alkaline throughout the survey 7.7 to 8.3 with a median pH of 8.1.

Table.1 Biological and chemical variables from 10 urban ponds in Merseyside.

Pond Name	N^{o} of plant species	N^{o} of invertebrate species	Shannon-Wiener index (H1)	Mean Oxygen (O_2) saturation (%)	pH
Long pond	6	6	2.49	55	7.9
Statue pond	3	2	0.93	89	7.7
Mull Wood	11	12	3.23	65	8.1
*Park Brow**	4	*N/A*	*N/A*	*N/A*	*N/A*
Golf pond 1	3	9	2.87	54	8.1
Golf pond 2	3	6	2.02	45	8.2
Golf pond 3	5	7	2.57	69	8.1
Golf pond 4	4	3	1.89	51	8.3
Manor Farm	0	2	0.97	19	7.9
Mill Wood	11	19	3.79	75	7.8

**Park Brow was dry at the time of the survey and for the full length of the summer and mush of the autumn. This meant there where no aquatic invertebrates.*

Both invertebrate and plant scores produced in the field fell below those expected by the PSYM model showing varying degrees of degradation from the ecological ideal. The largest differences were for plants. With the actual diversity being only a fifth of that expected for water bodies of the relevant size. The mean EQI (Ecological Quality Index) was 27.89. The range of values was considerable, from 6% to 83%. The two best ponds on the survey stand out very significant from the rest with much higher values. The two highest EQI scores were 72% and 83% for the local nature reserve and the angling pond respectively (see Figure. 1).

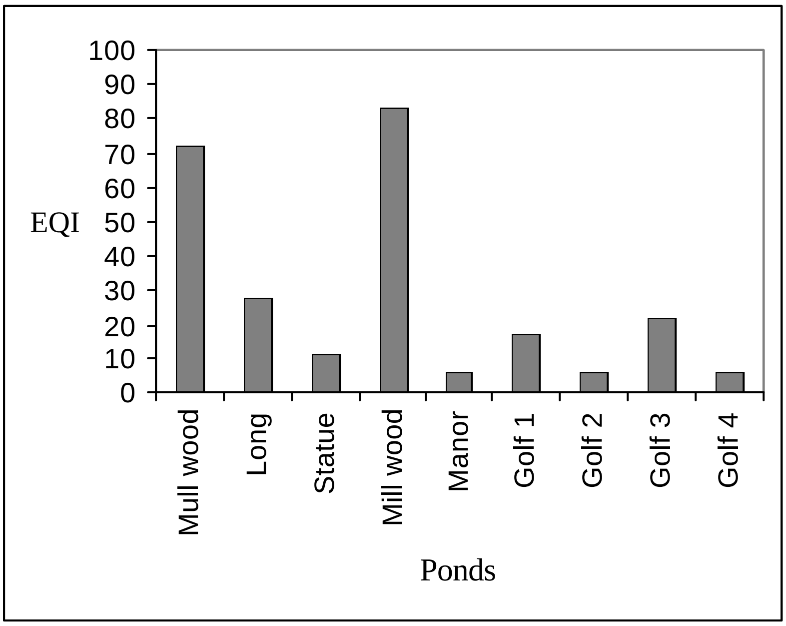
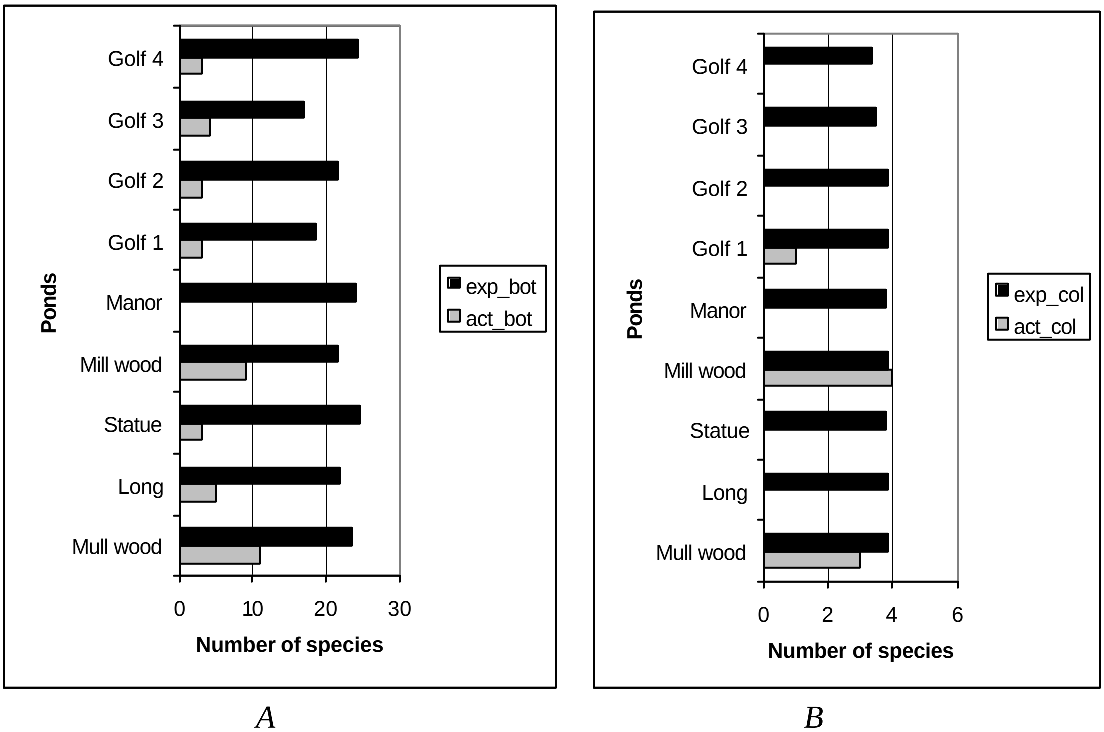


Figure1. Ecological Quality Indices (EQI) produced by the Predictive SYstem for Multi-metrics (PSYM)

It should be noted that even the best ponds fell short of the ideal all be it by a much lesser degree and were still below the expected plant diversity i.e. 11 species recorded in the field compared to a computer prediction of 23.54 for the nature reserve. Beetle and dragonfly diversity (taken as predictors for overall diversity) were higher than expected. Figure 2 shows the expected and actual plant and beetle diversity.



exp_bot – Expected number of plant species / act_bot – Actual number of plant species
exp_col – Expected number beetle species / act_col – Actual number of beetle species

Figure2. Comparison of actual plant (A) and beetle (B) diversities as recorded in the filed with computer predictions produced by the PSYM model.

The alien red eared terrapin (*Trachemys scripta*) was reported to be in one of the ponds at Croxteth Country Park but this could not be independently verified by personal observations. This species is often introduced to waterways when they outgrow their welcome as pets. The scale of the problem they pose to native ecosystems is not yet known.

At least one species of amphibian was found in over half of all the ponds on the survey. These species were smooth newts (*Triturus vulgaris*), common frogs (*Rana temporaria*), common toads (*Bufo bufo*) and a single record of the legally protected great crested newt (*T.cristatus*). This record was one adult female possibly a colonist from a *T.cristatus* breeding pond near by (not included in the survey). Amphibian habitats varied greatly especially for frogs that not only used but also bred in many types of pond including those with dense aquatic vegetation and quantities of rubbish (paper, aluminium drinks cans and supermarket shopping trolleys).

3.2. Visual impact

The ponds contained within the survey represent a very considerable visual diversity. The ponds range from open water with little or no vegetation at one of the newer golf course ponds (Figure 3) to those with marginally more aquatic vegetation (in the more mature of the golf ponds in Figure 4). In others there is so much plant growth as to be almost unrecognisable as a pond (School pond in Figure 5).

Figure 3. A sparsely vegetated golf course pond

Figure 4. A golf course pond with moderate plant growth

Figure 5. A heavily vegetated seasonal pond completely choked with plants.

The primary purposes for the creation of the ponds on the golf course (as stated by the golf club) were to add to the visual impact of the landscape as well as provide water hazards for golfers. The school pond was created to be used for teaching and to add to the school environment, but has seldom been used.

The majority of the sites are either known, or believed to be artificial. While some have been managed or designed to appear natural others were created specifically to appear formal with little or no effort to hide their artificial provenance. Most were created for either practical or aesthetic purposes. The ponds in the formal gardens of Croxteth Hall were created as decretive features in the landscaped Victorian gardens. The degree of formality in their design varies considerably but always the stone lined sheer banks betray their deliberate construction.

Figure 6. A formal pond rectangular in shape with ornamental fountains

The Statue pond in Figure 6 was originally decorated by two large ornamental fountains mounted on stone plinths in the centre of the extremely formal rectangular pond. The statues that once topped these fountains are long gone but the fountains themselves remain and are still operated during the summer. The formal effect of the pond is now rather lost by the excess growth of duckweed (*Lemna minor*) that covers most of the surface.

Figure 7. A natural pond over 200 years old

The fishing pond at Mill Wood however in Figure 7, is much more irregular in shape and planted around the edges to emphasis its natural appearance. Mull Wood Local Nature Reserve on the Croxteth Hall estate was created for education purposes in 1985. It was however designed and is managed to fit comfortably into its locality creating the impression that it were a long-standing feature of the landscape.

From field observations and a review of the literature a theoretical model of the factors affecting the visual impact of ponds was created and will be tested in later stages of the research programme by consultation with local community groups. Photographs taken of sites through the course of the year were used to draw up a list of potential factors that could affect the visual impact of a site these where compared to literature sources concerned with landscape design (Lees and Evans 2003, Turner 1996, Bradshaw et.al. 1986 and Blake 1999) and landscape character assessment (Institute of Environmental Assessment 1995 and Swanwick 2002). A focus group technique will be used in later stages of the research programme to investigate the relative importance of these factors as perceived by local communities and to determine what other factors may influence people's attitudes towards the value of ponds in the urban landscape. The model is presented in Figure 8. Overlapping circles indicate potential connections between factors.

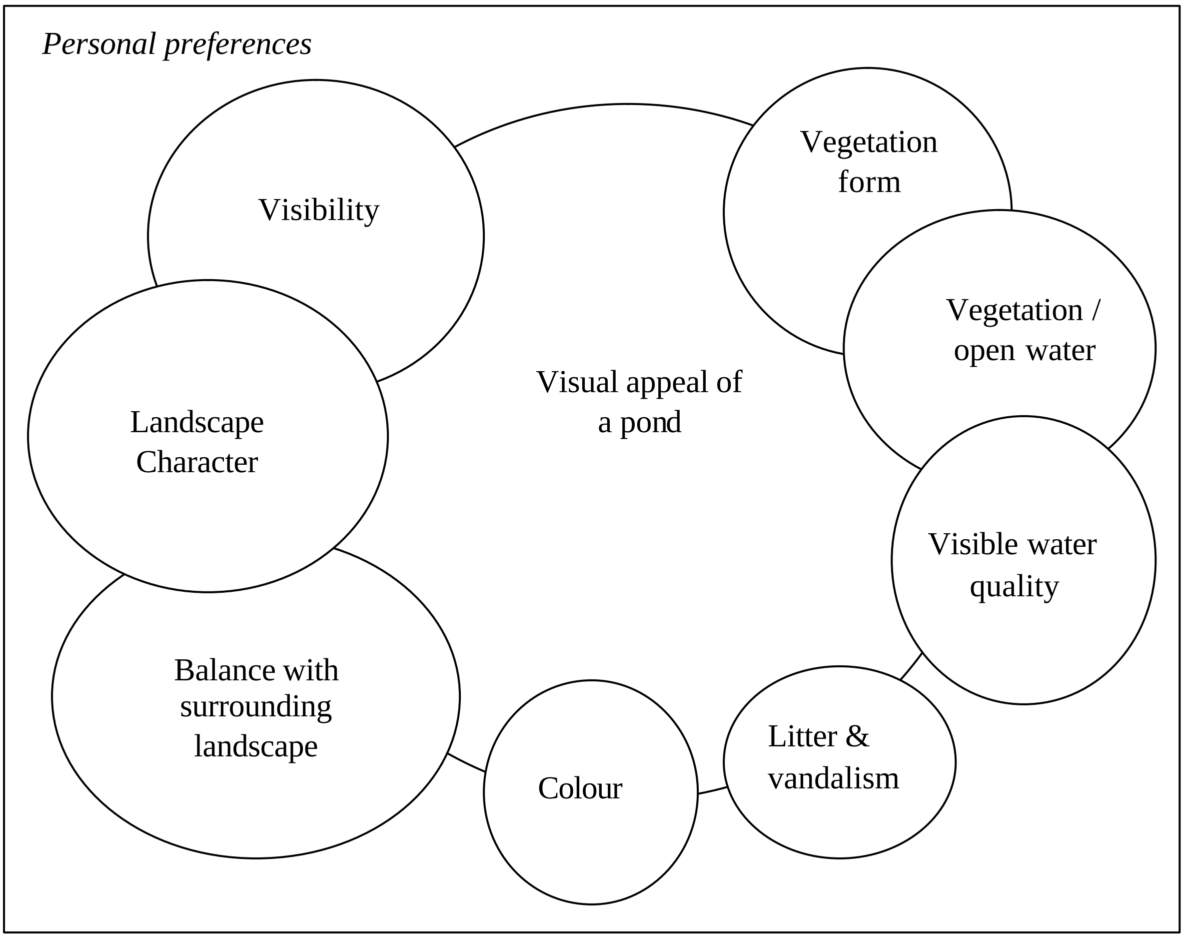


Figure.8 Factors affecting the visual impact of a pond

Balance, in figure 8, refers to the degree to which a pond sits comfortably in its surroundings. Factors such as the variety of plant species and the ratio of emergent plant cover to open water potentially have both ecological and aesthetic consequences. Factors such as littler will detract from the overall appeal of a site, as may cloudy water or algal growth, both factors which can be more cosmetically off putting than they are a serious ecological problem (unless excessive). All of these factors are affected by personal option and preferences.

3.3. Landscape character and amenity values.

The ponds sampled in the survey demonstrate a variety of potential and actually amenity values. All where located in close proximity to housing: in 9 out of 10 cases within 250m. The remaining pond at Mill Wood was within 500m of a very large housing estate, shops and industrial developments. Fifty percent of ponds on the survey were located with areas of urban woodland. Other frequent uses of surrounding land were improved and semi-improved amenity grassland and ornamental gardens. The ponds within the golf course were as previously discussed created for aesthetic reasons and as golfing hazards. Fishing and waterfowl where also recorded as current amenities within the survey as well as wildlife interest for pond dipping. At least one of the ponds on the Croxteth estate shows evidence of past use as swimming and or boating with brick built ramps at regular intervals along the sides of an otherwise ornamental pond. Both of these uses have fallen from favour in recent times due to increased concerns and awareness of health and safety issues.

4. DISCUSSION

Ecologically the ponds on the survey produced mixed results, while the number of aquatic invertebrate species was some way below the expected levels, the botanically diversity fell far below expected with all ponds being better for invertebrate species than plants. The median number of plant species recorded was 4 and fell well below that expected according to the PSYM model (21.96) given the sizes of the water bodies. It can be assumed that while the invertebrate communities colonised of their own accord much more human intervention and management went into the planting of ponds. It would seem that those responsible for the management of such sites need to take heed. In order to improve the ecological quality of the sites as directed by the Water Framework Directive (European Union, 2000) greater thought must be put into the number of species chosen for planting.

The number of invertebrate species was still much lower than those found in many rural ponds but did fall within the ecological predications of the sites. A survey of *c.*1000 farmland ponds conducted by the Pond Life Project in the Northwest of England found an average of 23.75 species of invertebrates. It should be noted that instead of a standardised sampling technique the Pond Life surveys continued to search for invertebrates until "…no new species were recorded" (Boothby, 2000). In a survey of artificially created wildlife ponds in urban Brighton Wong & Young (1997) found a mean number of invertebrate of 4.25 (ranging from 3 to 9) and a maximum Shannon Wiener H1 of 1.84. This compares favourable with the current findings (6) invertebrate species and a H1 value of 2.43 ($\pm$0.88). Brodie and Doberski (1991) concluded that any aquatic communities with Shannon Weiner indices of between 1.5 and 3.0 should be considered species rich. Among the most urban of ponds surveyed by the Ponds Conservation Trust as part of the National Lowland Pond Survey was on Wimbledon Common. This held 17 species of inverts & 14 of wetland plant equal with the best ponds in the current sample.

From the present research it would seem that the ecological status of the ponds surveyed is on the whole quite low, however it should not be discounted as a contribution to urban biodiversity, as at least two ponds surveyed stand out as being of much higher quality.

Despite their differing ecology all of the ponds surveyed can be seen as making a contribution to the aesthetic state of the urban sites, bringing an extra dimension to the landscape. As to whether a pond of good ecological quality can provide the same visual pleasure as one created purely for ornamental reasons there is insufficient data at present to comment. It is worth noting that the only fishing pond on the survey not only has the highest ecological value as well as the added value of offering an amenity to the local community, but also has equal floristic diversity and greater invertebrate diversity than the local nature reserve specifically. While this may or not be an isolated case it does demonstrate that public amenity and wildlife value can co-exist at the same site under certain conditions.

The common amphibian species (common frog, common toad and smooth newt) are adapting well to urban living, occurring in half of all sites on the survey. The great crested newt is known to be present in the survey area but is significantly less abundant than the other species. Given the wide range of conditions that the commoner species has been observed to inhabit it is likely obstacles to dispersal that limit their distribution more than the lack of suitable habitats.

Taken within the wider context these urban green spaces offer opportunities for relaxation and physical activity such as walking or jogging in a more stimulating and pleasant environment than roads and pavements. The ponds located within these spaces form part of the diversity and interest of the landscape, enriching both its value to people and to biodiversity.

It is clear from the ecological data that greater consideration needs to be given to the design and management of urban ponds especially with regard to their planting. The fragmentary nature of the plant communities probably stems from the introduction of species. Usually at lower diversities than is natural for the size of the water body. Modern schools of landscape design may prefer bold statements of few species in large monocultured drifts but this is not necessarily ecologically viable. The overall ecological value could be improved, while at the same time providing a visually much more diverse and pleasing vista.

It is envisaged that further development of the current research will address the social values of ponds and further investigate their visual appeal through a series of local community focus groups and analysis of photographic data. The various strands of the project will be integrated to produce a more holistic assessment of the value of a given pond site. This will take either the form of a numerical scoring system or a more descriptive pond character assessment technique. This will be of use in directing the management of existing sites and in planning the creation of new ones, as well as informing the overall approach to the design of multifunctional urban landscapes and the development of sustainable ecological networks.

5. CONCLUSIONS

The ecological value of urban ponds falls some way below that of their rural counterparts but is still of significance in terms of enhancing urban biodiversity.

Invertebrate diversity was better than plant diversity in the current sample.

Even if the majority of urban ponds were of average ecological importance a small number stand out as highly significant, showing the value for biodiversity that is possible from this particular habitat.

Ponds offer a range of public amenities from pond dipping to fishing to waterfowl.

The visual impact of ponds in the survey varies according to many interrelated factors and further research is needed to determine the exact nature of these factors and the other social values of urban ponds.

The majority of urban ponds on the current survey where planted or managed in a manor that produces unsatisfactorily spartan plant communities of unnatural structure. Better management could increase amenity, aesthetic and ecological values by increasing plant diversity.

Greater consideration of the potential uses of the site by local communities is also needed in planning new sites.

6.REFERENCES

Baines, C. (1995) *Urban areas* Chapter 13, 362-380. In Sutherland, W.J. & Hill, D.A. (1995) *Managing Habitats for Conservation*. Cambridge University Press, Cambridge, England.

Blake, J. (1999) *An introduction to landscape design and construction*. Gower Publishing Ltd, Aldershot, UK.

Boothby, J. (2000) *A landscape worth saving. Final report of the Pond Biodiversity Survey of Northwest England*. Pond Life Project, Liverpool John Moores University. Liverpool, England.

Bradshaw, A.D. Goode, D.A. & Thorpe, E.P. ed. (1986) *Ecology and design in landscape the 24th symposium of the British Ecological Society.* Manchester 1983. Blackwell Scientific, Oxford.

Brodie, I. and Doberski, J. (1991*) Techniques in Ecology and Environmental Science Set B: Aquatic Organisms and Habitats: Data Collection and Analysis*. Daniels Publishing, Cambridge, England.

Cave, S. (1998) *Applying Psychology to the environment*. Hodder & Stoughton. England.

European Union (2000) Establishing a framework for Community action in the field of water policy. Directive 2000/60/EC of the European Parliament and of the Council of 23rd October 2000. *Official Journal of the European Communities,* L327/1 – 327/70.

Gledhill, D, (1999) The Conservation value of ponds in Northwest England: - Species diversity and rarity of invertebrates and macrophytes pp. 89 In Boothby J Ed (1999) Ponds & pond landscapes of Europe. *International conference of the Pond Life Project Vaeshartlet Conference centre*, Maastricht, The Netherlands. 30th Aug – 2nd Sept 1998. Pond *Life* Project. England

Institute of Environmental Assessment (1995) *Guidelines for landscape and visual impact assessment*. E & FN Spon, London.

Lees, S. and Evans, P. (2003) *Biodiversity's contribution to the quality of life.* A research report for English Nature, No 510. Environmental impacts team, English Nature. February 2003. Peterborough, England.

New, T.R. (1998) *Invertebrate Surveys for Conservation*. Oxford University Press, Oxford, England.

Pond Action (1998) *National Lowland Pond Survey 1996*. Pond Action (now the Pond Conservation Trust) Oxford Brookes University, England.

Pond Conservation Trust (2002) *A guide to monitoring the ecological quality of ponds and canals using PSYM*. Pond Conservation Trust, Oxford Brookes University, Oxford, England and the Environment Agency, West Midlands England.

Rodwell, J. (editor), Piggott, C. Radcliffe, D.A. Malloch, A.J.C. Birks, H.J.B. Proctor, M. Shimwell, D. Huntley J.P. Radford E. Wigginton, M.J. and Wilkins, P. (1995) British plant communities*: Volume 4 Aquatic communities, swamps and tall-herb fens.* Cambridge University Press, Cambridge in association with the Joint Nature Conservation Committee.

Sewell, D. and Griffiths, R. (2004) Population dynamics of great crested newts at Metapopulation and landscape levels: a ten-year study. *Paper at Herpetofauna ecology & conservation. Scientific meeting of the British Herpetological society and the Herpetological Conservation Trust. 4th December 2004, Open University, Milton Keynes, England.*

Swanwick, C. (2002) *Landscape Character Assessment Guidance for England and Scotland*. Report for Scottish National Heritage & The Countryside Agency.

Turner, T. (1996) *City as landscape: a post-post modern view of design and planning*. Spon, London. England

United States Environmental Protection Agency (1995) *Economic benefits of runoff controls*. U.S.E.P.A Office of Wetlands, Oceans and Watersheds. USA.

Wong, A.L. and Young, W.A. (1997) An investigation of the ecological and conservation status of wildlife ponds in Sussex. P173 – 178 in Boothby J .Ed (1997) *British Pond Landscapes. Proceedings of the UK conferences of the Pond Life Project*. 7th – 9th September 1997. University College Chester. England.

7. ACKNOWLEDGEMENTS

We would like to thank Claire Menim of the Mersey Forest for providing contacts and pond locations, the many groups and landowners who granted access for survey and also Dr Anita Weatherby at The Ponds Conservation Trust (Oxford Brookes University) for processing data through the PSYM software.