Follow-up Ecological Survey of Freshwater Habitats at Bourne Valley Park (Alderney Recreation Ground)

Report prepared for Sarah Austin of the Bourne Stream Partnership

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1. Summary

Assessment of the conservation value of the freshwater habitats in Bourne Valley Park (Alderney) has been carried out three years after the initial survey. Biodiversity is found to have increased both in those environments that were originally surveyed and as a whole through newly created environments. Each of the newly created features – fishing pond and daylighted stream - hold a nationally scarce species of water beetle. The main pond holds a nationally scarce species of weevil. Current management practices have increased biodiversity, but water quality issues remain.

Overall the freshwater habitats offer a mix of moderate and high conservation value.

2. Introduction

An evaluation of the freshwater habitats at Alderney Recreation Ground had been carried out in 2005 prior to a project to enhance the biodiversity and recreation value of the park as a whole (Aquilina, 2005).

This follow up survey was commissioned by Sarah Austin and Stuart Terry of Borough of Poole council to evaluate the changes in the freshwater habitats at Bourne Valley Park at Alderney (formerly known as Alderney Recreation Ground) three years on. The initial surveys were carried out in September 2005 and have been repeated in September 2008 using the same, locations, methods and surveyor. The results are thus directly comparable and can be used to evaluate the ecological benefits of the project and make management recommendations.

3. Scope

The original surveys covered wetland plants and invertebrates using standard techniques. The locations included in the original baseline survey are repeated here with the exception of the wetland area, which has dried out considerably as a result of the construction of the new fishing pond. This new pond is included for the first time as is the daylighted section of the stream which was previously culverted. See aerial photo 1 for locations. The designation of the locations follows that used in the previous report for consistency.

The site descriptions which were detailed in the original report have not been repeated here. However changes to these habitats are described as are the new locations.

The new fishing pond (SZ052938) is a kidney shaped pond of about 1700 m^2. It was dug next to the wetland area that was previously surveyed (2005). There are no overhanging trees or shade and an emergent and submerged flora is beginning to develop. Two fishing platforms have been installed. The banks are rather steep and this has been aggravated by wave wash to create a rather abrupt margin between land and water. It would have been better from the biodiversity point of view to have dug much shallower slopes into the pond which provide better invertebrate habitats than the current steep banks. It is recommended that the creation of a drawdown zone in at least part of the fishing pond is considered for future enhancement work.

The water quality appears to be good with a pH of 6.5 and low nutrient status (conductivity of 164 μS/cm). Water is fed into the pond from the stream via a pipe to maintain water levels, although rainfall over such an area will contribute significantly as well. The pond is in excess of 1.5 meters deep in places and does have a layer of clay and silt on the bottom. This does contribute to the turbidity of the water, especially as dogs stir it up when they swim in the pond.

Photo 1 Fishing pond looking north up Bourne Valley Park

The newly daylighted section of stream appears to be developing well with riffles and pools beginning to appear. It is rather straight but varies in substrate, flow and width along its course. There is a short piped section with an overflow weir which will promote variations in depth depending on flow and act as a balancing feature. Two new bridges allow the stream to be crossed easily by the public. Water quality (pH 6.6 and conductivity 345 µS/cm) in the stream was comparable to that in the higher streams and pond, but it would be expected that the oxygen levels in this section would be high as a result of the flow regime, riffles and weir.

Photo 2 Daylighted stream from one of the bridges

Aerial Photograph of Bourne Valley Park with survey locations. Copyright Google Earth.

4. Methods

The methods used are identical to those used in the original baseline surveys and are standard techniques for evaluating freshwater habitats and cover wetland plants and macroinvertebrates. The surveys were carried out on 12th September 2008.

4.1 Survey methods

The methods used for the wetland plant survey were based on the standard techniques developed for the National Pond Survey (NPS), described in detail in Pond Action (1998). The physical characteristics of the pond were recorded in the field, including factors such as the amount of shade and the pond surface area. Conductivity and pH were measured with field meters. Wetland plants were surveyed by walking and wading the perimeter and open water areas less than 1 m deep noting the species present. The term 'wetland plant species' refers to species defined as wetland plants on the National Pond Survey field recording sheet list. Terrestrial plant species are not recorded.

Aquatic invertebrates were collected using a standardised, timed method, using a hand net from the major habitats in the pond (stands of different wetland plants, distinctive substrates, tree roots etc.). This technique was also used to survey the streams where kick sampling was employed to disturb the streambed with the dislodged invertebrates being washed downstream into the net. The material collected was returned to the laboratory for sorting and identification using a binocular microscope. All major macroinvertebrate groups were recorded to species level, where life-history stage allowed, except for True Flies (Diptera), for which there is little information on species level identification and national distribution, and Worms (Oligochaeta). The invertebrate groups recorded were: Bivalvia (bivalves, excluding *Pisidium* sp.), Coleoptera (water beetles), Crustacea (slaters and shrimps), Ephemeroptera (mayflies), Gastropoda (snails), Hemiptera (water bugs), Hirudinea (leeches), Megaloptera (alderflies), Odonata (dragonflies and damselflies), Plecoptera (stoneflies), Trichoptera (caddisflies) and Tricladida (flatworms).

4.2 Conservation assessment

The conservation value of the pond was assessed on the basis of: (i) the total number of species recorded (species richness), and (ii) the number of uncommon species present (species rarity). A Species Rarity Index (SRI) was calculated to give a measure of average rarity.

A second approach was also adopted using the PSYM analysis, which is based on the families of aquatic invertebrates collected and scored using BMWP (Biological Monitoring Working Party) scores. These are industry standard and have the advantage of being used in the stream assessments as well, although comparison between streams and ponds is not valid. Comparison should only be made between sites with similar characteristics or between the same site over different years. The scores reflect the sensitivity of the families to pollution. The higher the score the cleaner the site.

For wetland plants, comparisons were made with similar data gathered from other UK sites surveyed using the same methodology. The method used for collecting macroinvertebrate data in both the pond and streams was a standardised 3-minute timed sample. The data can therefore be interpreted in the context of other pond surveys for which data is available, but not for the streams as there is no equivalent database.

5. Bourne Valley Park freshwater environments

5.1 Physico-chemical characteristics

Location	**pH**		**Conductivity** (μS/cm)	
	2005	**2008**	**2005**	**2008**
Main pond	7.3	6.5	371	365
North stream	6.9	6.5	266	287
South stream	7.1	6.6	213	359
Daylighted stream		6.6		345
Fishing pond		6.5		164

Table 1 Environmental parameters

The environmental parameters were measured in the field with a Hanna HI98129 Combo pH and EC meter. Comparisons between sites are perfectly valid however comparison between the same site in different years must be guarded as the 2005 survey was carried out after a long dry period and the 2008 survey after a wet summer and in particular, just after a few days prolonged rain. This will have had a flushing effect and will tend to equalise the water chemistry of all the sites. The new fishing pond is perhaps an exception, with rain water contributing to its low conductivity (lack of dissolved minerals and nutrients) more than inflow from the stream.

The major difference between 2005 and 2008 appears to be in the water chemistry of the south stream which has become more acidic and carries more dissolved solutes. This in turn is likely to have affected the main pond. However, these changes are not dramatic and are well within normal ranges.

5.2 Wetland plant results

Location	# plants 2005	# plants 2008
Main pond	18	20
North stream	0	2
South stream	5	5
Daylighted stream		11
Fishing pond		12

Table 2 Wetland plants species richness

The number of plants found in the main pond increased between the two visits by 2 with a total of 20 now being found. This is above average for the wider countryside (Lowland Pond Survey = 10, ROPA survey = 14) and would give the pond a Moderate conservation value.

The number of plants found in the fishing pond at 12 is about average which is remarkable given it is only two years old and not planted up. It was probably an advantage building the pond so close to the old wetland area, which presumably allowed species to spread in quickly eg *Potamogeton polygonifolius* which was present in the wetland.

The number of plant species in the north stream has increased from none to 2, which reflects the more open aspect to the stream as a result of the management of the woodland. The south stream appears not to have changed in total species richness but has changed in the species present. The daylighted stream which is newly created and might be expected to be species poor as a result, is in fact the richest of the three streams. This is because of its open aspect and the colonisation by plants washed downstream from the main pond (eg *Potamogeton crispus*). Some plants will have arrived via natural colonisation such as in bird faeces (especially duck). An example of this last may be Galingale (*Cyperus longus*) which is quite a rare plant if it occurs naturally, but is often planted in garden ponds. It does occur in the pond on the Bourne stream at Alder Road where it is most likely introduced.

5.3 Macroinvertebrate results

Differences between the results of 2005 and 2008 survey years are to be expected even in the absence of any management or habitat creation work. This is because of a number of factors;

- Change occurs naturally over time, whether this is successional change (permanent changes in a specific direction caused by environmental changes) or turnover (‘turnover’ is a natural process whereby species numbers change in the absence of environmental change through a process of random or chance events).

- Surveys are not censuses, they merely capture a representative although incomplete sample of the species present. Therefore two surveys are unlikely to come up with exactly the same results, although consistency is improved through the use of standardized methods. Assessments of the variability inherent in sampling suggest that two samples taken by experienced surveyors from the same place will be greater than 65% similar. Consequently changes in up to 35% may be effectively random.

As a consequence of the foregoing, analysis of the results is important in order to put a context on the raw data and values such as BMWP, ASPT and SRI are used to overcome such variability.

Location	**Species richness 2008**	**Species lost 2005-2008**	**Species gained 2005-2008**	**Species in common 2005-2008**
Main pond	29	15	14 (8*)	15
North stream	18	6	8 (4*)	10
South stream	14	4	4 (2*)	10
Fishing pond	20		(6*)	
Daylighted stream	22		(7*)	
			*species not found elsewhere	

Table 3 Macroinvertebrate species richness 2005 v 2008.

Overall the species richness of the main pond is above average compared with similar environments in the wider countryside (average = 26). The fishing pond is still new and developing both its flora and fauna but is nonetheless approaching the average number of species already. Both ponds would be assigned a Moderate conservation status on the basis of species richness. The presence of a nationally scarce water beetle, *Berosus affinis,* in the fishing pond enhances its conservation value (see SRI later). A nationally scarce weevil *Pelenomus waltoni,* was found in the main pond but this is not included in the standard calculations of species richness or species rarity because it is not a true aquatic species.

The newly daylighted section of stream is clearly successful and has been well designed to complement the other streams, which are different in nature. Each habitat has its unique species and the site as a whole has a good range of habitats available. Overall some 72 species of macroinvertebrate have been found between the two surveys.

Location	BMWP 2005	BMWP 2008	ASPT 2005	ASPT 2008	SRI 2005	SRI 2008
Main pond	100	117	4.55	4.88	1.03	1.03
North stream	71	89	4.18	4.68	1.06	1.06
South stream	69	62	4.06	4.13	1.00	1.00
Fishing pond		75		4.69		1.20
Daylighted stream		97		4.22		1.23

Table 4 Habitat assessments 2005 v 2008.

Supporting the increases in species richness, there is a strong suggestion that the scores used to evaluate the conservation value of the habitats have improved. Whilst BMWP provides a good basis for assessment, it is affected by sample size and so ASPT (Average Score Per Taxa) is calculated to overcome this. Thus, although BMWP appears to have improved for the main pond and the north stream but declined for the south stream, ASPT suggests that all have improved.

There is no past data for the fishing pond or the daylighted stream so they should be compared with the other similar habitats. However caution must be used because both habitats are only two years old and will still be actively being colonized and developed and therefore should not be expected to score as well as established habitats. This having been said, it is clear that the daylighted stream has scored higher than the north and south streams, which would be related to the rather different environmental conditions in the open compared to within the woods where the two smaller streams run.

Species Rarity Index is scored for a site based on the presence of local and nationally scarce (or higher rarity designations –see Table 5 below). All species present are given a numerical value depending on their national rarity status. The values of all the species present are added together (to give a total rarity score). The total rarity score is divided by the number of species present at the site to give the SRI.

The SRI reflects the proportion of rare species in the total assemblage and the scores can usefully be compared against other sites regardless of habitat. Thus the two new habitats are clearly of value in terms of rare or local species as they score highest. Scores over 1.2 give a conservation value assessment of high (as opposed to moderate for scores between 1.01 and 1.19).

Status	Score	Status
Common	1	Species generally regarded as common.
Local	2	Species not falling into any of the categories 'Rare' (i.e. RDB) or 'Scarce', but usually either: (a) confined to certain limited geographical areas within which, however, they may be present in large numbers; (b) widespread in distribution, but present only in small numbers where they occur; or (c) restricted to a specialised habitat of which, however, the species may be a common component.
Nationally scarce	4	Recorded from 16-100 10x10 km grid squares in mainland Britain.
RDB3	8	Red Data Book: Category 3 (rare).
RDB2	16	Red Data Book: Category 2 (vulnerable).
RDB1	32	Red Data Book: Category 1 (endangered).

Table 5. Species rarity terms and scores

The PSYM (Predictive System for Multimetrics) methodology uses environmental parameters to predict the flora and fauna of a similar unimpacted pond and then compares this expected with the observed data to give an index of biotic integrity.

PSYM input parameters	Main pond 2005	Main pond 2008	Fishing pond 2008
Altitude	50	50	50
Easting	4047	4047	4052
Northing	0939	0939	0938
Shade (%)	10	10	0
Inflow(absent=0, present=1)	1	1	1
Grazing (%)	0	0	0
pH	7.3	6.5	6.5
Emergent plant cover (%)	90	99	10
Base clay (1-3)	2	2	2
Base sand, gravel, pebbles(1-3)	2	2	2
Base peat (1-3)	1	1	1
Base rock (1-3)	1	1	1
Area (m^2)	750	750	1700

Table 6 PSYM input environmental parameters

PSYM biological parameters	Observed	Predicted	EQI	IBI (0-3)
Plants				
# submerged + marginal plant sp	19	20.23	0.94	3
# uncommon plant sp	0	3.41	0.00	0
Trophic Ranking Score	8.7	8.07	1.08	2
Invertebrates				
ASPT	4.88	5.11	0.95	3
Odonata + Megaloptera families	3	3.22	0.93	3
Coleoptera families	2	3.85	0.52	2
Index of Biotic Integrity (%)				**72%**

Table 7. PSYM results for main pond

PSYM biological parameters	Observed	Predicted	EQI	IBI (0-3)
Plants				
# submerged + marginal plant sp	11	22.96	0.48	1
# uncommon plant sp	0	3.84	0.00	0
Trophic Ranking Score	8.1	7.86	1.03	3
Invertebrates				
ASPT	4.69	5.40	0.87	3
Odonata + Megaloptera families	3	3.70	0.81	3
Coleoptera families	1	3.76	0.27	1
Index of Biotic Integrity (%)				**61%**

Table 8 PSYM results for Fishing pond

The 2005 results for the main pond are 83% match with expectation (Index of Biotic Integrity), which placed it in the High category for conservation value. The same analysis carried out on the 2008 results gives a 78% match, which is still in the High category. The decline is due to an increase in plant species with a high Trophic Ranking Score. These are used to assess the likely impact of nutrient enrichment upon the pond. In 2005, a decision was made to count *Ranunculus lingua* as a naturally occurring uncommon plant species. This made no difference to the conservation assessment but did increase the percentage match from 78 % to 83 %. As this plant is more usually considered to be introduced as a garden escape (Bowen, 2000), the calculations were repeated to take this into account; the effects being to reduce the 2008 score from 78 to 72 % which places the pond in the Moderate category for conservation value.

The fishing pond had a 61 % match with expectation, but the short length of time since creation will have a dramatic effect on species numbers and this should not be seen as poor at all but rather the interpretation should be that the pond has achieved a Moderate conservation status based on PSYM in only two years.

5.4 Other wildlife

Palmate newt larvae (*Triturus helveticus)* were caught in the fishing pond and the south stream during invertebrate sampling and released again. During the 2005 survey they were caught in the main pond and are likely to be still present there. Other amphibians are likely to be present in the spring but further surveys at this time of year would be required to confirm this.

6. Conservation assessment

Location	Conservation assessment
Main pond	Moderate
North stream	Moderate
South stream	Moderate
Fishing pond	High
Daylighted stream	High

Table 9. Conservation assessment based on macroinvertebrate SRI scores

The biodiversity of Bourne Valley Park has been enhanced through this project primarily through the creation of new habitats (the daylighted stream and the fishing pond). However the benefits of some of the management works are also apparent, especially with regard to the north stream, which has been enhanced by the opening up of some of the canopy in the woodland.

Some of this management effort is less easy to assess positively with regard to the main pond. This has benefitted from vegetation clearance in that the once *Typha* dominated stands are now more open and more species, especially submerged species of plant such as *Potamogeton crispus*, are now either present or more apparent than before. However there is a downside in that the Parrot's feather, *Myriophyllum aquaticum*, which was present in 2005 has spread dramatically and is now dominating some of the opened patches. This plant is extremely difficult to control, and impossible to eradicate, and control is only really feasible through continuous physical removal. Another control method is to lay black plastic sheets over the *Myriophyllum*, which eventually kills it through excluding light. However this technique is unsightly in a pond with public access, may be prone to vandalism, and takes at least a year to achieve and so is not recommended in this case. No further removal of the *Typha* is recommended as it is likely that this will merely allow the Parrot's feather to spread into the spaces created. Care should be taken that it is not allowed to spread to the fishing pond by avoiding working on both ponds at the same time, or if this is necessary then finishing the work on the fishing pond before starting on the main pond (never vice versa).

New macroinvertebrate species are reported in the 2008 survey which include two nationally scarce water beetles *Berosus affinis* and *Laccobius sinuatus* as well as a nationally scarce semi-aquatic weevil, *Pelenomus waltoni.* The range of dragonfly species breeding on the site would appear to have increased as well.

The daylighted stream has been colonised by a range of plant species from existing habitats and the extent of vegetation cover is developing well, however it is as yet still too sparse to provide the cover and food requirements for water voles, which was one of the target species that it was hoped to encourage.

7. Conclusions and recommendations

There are clearly still issues with water quality in spite of improvements in the visual appearance of the south stream which had showed signs of sewage fungus at the upper end in the 2005 survey and now appears clear of this. Pollution incidents are ocassionally reported by the public so there is presumably still a problem with untraced drainage misconnections at properties attached to the culverted section of the south stream from beyond the road crossing at Herbert Avenue.

Habitat management within the woodland has enhanced the biodiversity of the north stream. The major issue with management activities is the unfortunate consequence of opening up the main pond which has resulted in the spread of Parrots feather, *Myriophyllum aquaticum,* an invasive alien plant species. This is difficult to control and eradicate and it is recommended that no further clearance of the Bulrush, *Typha latifolia,* should be carried out. This will suppress the Parrots feather through shading but will not eradicate it.

The newly created daylighted stream section and the fishing pond have been successful in attracting a greater diversity of macroinvertebrate species to the site and are likely to continue to enhance the biodiversity of Bourne Valley Park as they mature and develop. Further enhancement of the fishing pond to make the banks slope more shallowly into the water would benefit invertebrates.

8. Glossary

ASPT	Average Score Per Taxa
BMWP	Biological Monitoring Working Party
BOD	Biological Oxygen Demand
DO	Dissolved Oxygen
EQI	Ecological Quality Index
FBA	Freshwater Biological Association
IBI	Index of Biotic Integrity
IMS	Industrial methylated spirits
PSYM	Predictive System for Multimetrics
SRI	Species Rarity Index

9. References

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10. Appendix 1 Wetland plant species recorded 2005 (1) and 2008 (2)

English name	Latin binomial	National status	Main pond	Main pond	Fishing pond	Daylighted stream	North stream	North stream	South stream	South stream
			2005	2008	2008	2008	2005	2008	2005	2008
Common Water-starwort	*Callitriche stagnalis*	Common	1	2	2	2			1	2
Rigid hornwort	*Ceratophyllum demersum*	Common			2					
Nuttall's waterweed	*Elodea nuttallii*	Common	1	2	2				1	2
Parrot's feather	*Myriophyllum aquaticum*	Common (invasive alien)	1	2						
Curled pondweed	*Potamogeton crispus*	Common		2		2				
		Total # submerged	**3**	**4**	**3**	**1**	**0**	**0**	**2**	**2**
Common duckweed	*Lemna minor*	Common	1							
Water lily	*Nymphea sp.*	Common (introduced)	1							
Bog pondweed	*Potamogeton polygonifolius*	Common		2	2			2	1	
		Total # floating-leaved	**2**	**1**	**1**	**0**	**0**	**1**	**1**	**0**
Water plantain	*Alisma plantago-aquatica*	Common	1	2	2	2				
Fool's watercress	*Apium nodiflorum*	Common		2						2
Pendulous sedge	*Carex pendula*	Common		2	2	2		1		2
Galingale	*Cyperus longus*	Common (introduced)				2				
Great Willowherb	*Epilobium hirsutum*	Common	1	2						
Marsh horsetail	*Equisetum palustre*	Common		2						
Meadowsweet	*Filipendula ulmaria*	Common	1	2						
Floating Sweet-grass	*Glyceria fluitans*	Common	1		2	2				
Yellow Iris	*Iris pseudacorus*	Common	1	2						
Sharp-flowered rush	*Juncus acutiflorus*	Common	1	2	2					
Jointed rush	*Juncus articulatus*	Common			2	2				

English name	Latin binomial	National status	Main pond 2005	Main pond 2008	Fishing pond 2008	Daylighted stream 2008	North stream 2005	North stream 2008	South stream 2005	South stream 2008
Soft rush	*Juncus effusus*	Common	1	2	2	2				
Greater birdsfoot trefoil	*Lotus pedunculatus*	Common	1							
Water forget-me-not	*Myosotis scorpioides*	Common	1	2						
Water pepper	*Persicaria hydropiper*	Common	1	2						2
Common reed	*Phragmites australis*	Common				2				
Lesser spearwort	*Ranunculus flammula*	Common			2				1	
Greater spearwort	*Ranunculus lingua*	Local	1	2						
Round-leaved water crowfoot	*Ranunculus omiophyllus*	Local							1	
Watercress	*Rorippa nasturtium-aquaticum*	Common				2				
Bittersweet	*Solanum dulcamara*	Common		2						
Branched bur-reed	*Sparganium erectum*	Common	1	2						
Bulrush	*Typha latifolia*	Common	1	2	2	2				
Water speedwell	*Veronica anagallis-aquatica*	Local				2				
		Total # emergent	**13**	**15**	**8**	**10**	**0**	**1**	**2**	**3**
		Total	**18**	**20**	**12**	**11**	**0**	**2**	**5**	**5**

11. Appendix 2 Macroinvertebrate species recorded 2005 (1) and 2008 (2)

Group	Species	Common name	Notes	Main pond	Main pond	Fishing pond	South stream	South stream	North stream	North stream	Daylighted stream
				2005	2008		2005	2008	2005	2008	
Flatworms	*Dugesia lugubris/polychroa*	Flatworm				2		2			
	Dugesia polychroa	Flatworm		1							
	Polycelis tenuis	Flatworm				2					
Leeches	*Erpobdella octoculata*	Leech		1	2	2	1			2	2
	Erpobdella testacea	Leech				2					
	Glossiphonia heteroclita	Leech			2		1	2			
	Helobdella stagnalis	Leech							1		2
	Theromyzon tessulatum	Leech			2						
	Haemopis sanguisuga	Horse leech				2					
Crustacea	*Asellus aquaticus*	Water slater		1	2	2	1	2	1	2	2
	Crangonyx pseudogracilis	Freshwater shrimp		1	2	2	1	2	1	2	2
	Gammarus pulex	Freshwater shrimp									
Mollusca	*Bithynia tentaculata*	Common bithynia		1	2						
	Potamopyrgus antipodarum	Jenkins spire snail		1	2		1	2	1	2	2
	Bathyomphalus contortus	Twisted ramshorn									
	Galba (Lymnaea) truncatula	Dwarf pond snail							1		
	Lymnaea palustris	Marsh snail		1							
	Lymnaea peregra	Wandering snail		1	2	2	1	2		2	2
	Lymnaea stagnalis	Great pond snail			2						2
	Gyraulus albus	White ramshorn		1	2	2					2
	Planorbarius corneus	Great ramshorn		1	2	2	1		1		
	Planorbis carinatus	Keeled ramshorn		1							
	Physa acuta type	Bladder snail	alien	1	2	2	1	2	1	2	2
	Musculium lacustre	Lake orb mussel		1							
	Pisidium sp.	Pea mussel		1	2		1	2	1	2	2
Neuroptera	*Nemurella picteti*	Stonefly			2			2	1	2	2
	Nemoura erratica	Stonefly							1		

Group	Species	Common name	Notes	Main pond 2005	Main pond 2008	Fishing pond	South stream 2005	South stream 2008	North stream 2005	North stream 2008	Daylighted stream
Ephemeroptera	*Baetis rhodani*	Large Dark Olive			2	2	1	2		2	2
	Cloeon dipterum	Pond Olive		1					1		
Odonata	*Aeshna cyanea/mixta*	Southern/Migrant Hawker	not separable until final instar		2	2					
	Anax imperator	Emperor dragonfly		1							
	Libellula depressa	Broad-bodied chaser		1							
	Sympetrum striolatum	Common darter			2	2					
	Cordulegaster boltonii	Golden-ringed dragonfly					1	2	1	2	
	Calopteryx virgo	Beautiful demoiselle	local								2
	Coenagrion puella/pulchellum	Azure/Variable damselfly	not separable until final instar		2						
	Ishnura elegans	Blue-tailed damselfly				2					
	Pyrrhosoma nymphula	Large red damselfly		1	2	2	1	2			
Hemiptera	*Velia caprai*	Water cricket							1	2	
	Ilyocoris cimicoides	Saucer bug			2						
	Hydrometra stagnorum	Water measurer		1						2	
	Ranatra linearis	Water stick insect		1							
	Gerris gibbifer	Water skater	local						1	2	2
	Gerris lacustris	Water skater		1		2					2
	Gerris odontogaster	Water skater			2						
	Corixa punctata	Lesser water boatman		1							
	Hesperocorixa linnaei	Lesser water boatman			2						
	Sigara nigrolineata	Lesser water boatman									2
	Notonecta glauca	Water boatman		1	2						
	Notonecta maculata	Water boatman		1							2
	Notonecta obliqua	Water boatman								2	
	Notonecta viridis	Water boatman	local	1	2	2					
Coleoptera	*Gyrinus substriatus*	Whirligig beetle									2
	Haliplus ruficollis	Crawling water beetle			2						
	Agabus bipustulatus	Diving beetle		1							2
	Agabus didymus	Diving beetle						2			

Group	Species	Common name	Notes	Main pond 2005	Main pond 2008	Fishing pond	South stream 2005	South stream 2008	North stream 2005	North stream 2008	Daylighted stream
	Agabus nebulosus	Diving beetle						2			
	Agabus paludosus	Diving beetle								2	
	Hydroporus memnonius	Diving beetle		1							
	Hydroporus pubescens	Diving beetle								2	
	Anacaena globulus	Scavenger beetle		1	2		1		1		
	Anacaena limbata	Scavenger beetle		1	2						
	Anacaena lutescens	Scavenger beetle									2
	Berosus affinis	Scavenger beetle	nationally scarce			2					
	Helochares lividus	Scavenger beetle				2					
	Laccobius bipunctatus	Scavenger beetle		1							
	Laccobius sinuatus	Scavenger beetle	nationally scarce								2
Trichoptera	*Agrypnia varia*	Cased caddis			2						
	Limnephilus marmoratus/flavicornis	Cased caddis	too young to separate to species		2						
	Micropterna lateralis	Cased caddis							1	2	
	Hydropsyche angustipennis	Caseless caddis									2
	Lype reducta	Caseless caddis					1				
	Plectrocnemia conspersa	Caseless caddis								2	
Diptera	Chironomidae	Non-biting midge	larvae	1	2		1	2	1	2	2
	Culicidae	Mosquito	larvae				1		1		
	Dixidae	Meniscus midge	larvae		2				1	2	
	Psychodidae	Moth flies	larvae	1	2			2		2	
	Ptychopteridae	Lesser Crane-flies	larvae					2		2	
	Sciomyzidae	Snail-eating flies	larvae			2		2			
	Simulidae	Blackflies	larvae				1		1	2	2
	Stratiomyidae	Soldierfly	larvae								
	Syrphidae	Hoverfly	larvae	1							
	Tipulidae	Cranefly	larvae	1	2	2				2	2
Others	Hydracarina	Water mite		1							
	Oligochaeta	True worms					1	2	1		2

Group	Species	Common name	Notes	Main pond 2005	Main pond 2008	Fishing pond	South stream 2005	South stream 2008	North stream 2005	North stream 2008	Daylighted stream
Total				35	33	22	18	19	21	24	26
Total sp.				30	29	20	14	14	16	18	22

12. Appendix 3 Macroinvertebrate BMWP scores

BMWP taxa	Main pond	Main pond	Fishing pond	South stream	South stream	North stream	North stream	Daylighted stream
	2005	2008		2005	2008	2005	2008	
Planariidae	5		5		5			
Erpobdellidae	3	3	3	3			3	3
Glossiphonidae		3		3	3	3		3
Hirudinae			3					
Asellidae	3	3	3	3	3	3	3	3
Gammaridae	6	6	6	6	6	6	6	6
Hydrobiidae	3	3		3	3	3	3	3
Lymnaeidae	3	3	3	3	3	3	3	3
Planorbidae	3	3	3	3		3		3
Physidae	3	3	3	3	3	3	3	3
Sphaeridae	3	3		3	3	3	3	3
Nemouridae		7			7	7	7	7
Baetidae	4	4	4	4	4	4	4	4
Aeshnidae	8	8	8					
Libellulidae	8	8	8					
Codulegasteridae				8	8	8	8	
Calopterygidae								8
Coenagriidae	6	6	6	6	6			
Naucoridae		5						
Hydrometridae	5						5	
Nepidae	5							
Gerridae	5	5	5			5	5	5
Corixidae	5	5						5
Notonectidae	5	5	5				5	5
Gyrinidae								5
Haliplidae		5						
Dytiscidae	5				5		5	5
Hydrophilidae	5	5	5	5		5		5
Phryganeidae		10						
Limnephilidae		7				7	7	
Hydropsychidae								5
Psychomyidae				8				
Polycentropodidae							7	
Chironomidae	2	2		2	2	2	2	2
Simulidae				5		5	5	5
Tipulidae	5	5	5				5	5
Oligochaeta				1	1	1		1
BMWP	100	117	75	69	62	71	89	97
# taxa	22	24	16	17	15	17	19	23
ASPT	4.55	4.88	4.69	4.06	4.13	4.18	4.68	4.22