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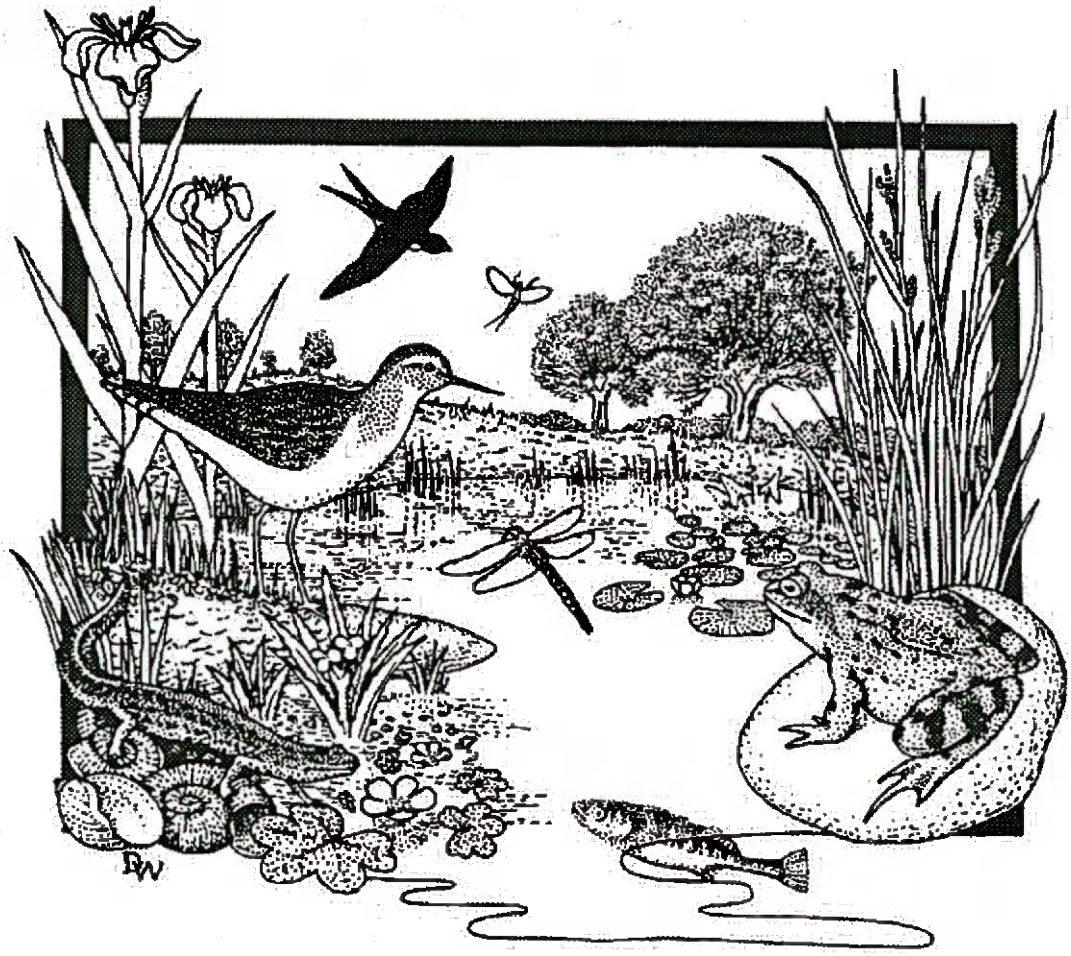
Plant and macroinvertebrate assemblages in the new mesocosms



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New mesocosms: plant and invertebrate assemblages

1. Aim

This short report gives the results of a survey of the aquatic macroinvertebrate and wetland plant assemblages in the six new mesocosms at Zeneca Agrochemicals, Jealott's Hill Research Station, Bracknell, Berkshire.

2. Methods

The mesocosms were surveyed for plants on 30/9/99 and for macroinvertebrates on 30/9/99 - 1/10/99.

Macroinvertebrates were sampled using a small 'D-frame' hand net. Samples were sorted in large white trays on the bankside. Within each mesocosm, the three water depth zones (0.1 m, 0.3 m, 0.5 m) were sampled separately. In total, each mesocosm was sampled and sorted for a period of approximately 2.5 hours. Most invertebrates were returned to their respective mesocosms after sorting; however, a small number (c.15) were preserved in alcohol for microscopic identification.

All invertebrates were enumerated at species level with the exception of (i) *Haliplus ruficolis* group females, which cannot be identified beyond this level, (ii) *Coenagrion puella/pulchellum* which cannot be reliably separated as larvae, (iii) dipteran larvae, which were identified to family level, and (iv) oligochaetes which were identified to Class level. In addition, although it was established that all mesocosms contained both *Coenagrion puella/pulchellum* and *Ishnura elegans*, because of the large numbers present it was not practicable to separate these species since this would have necessitated killing more than was desirable; numbers of these taxa were therefore aggregated and the total count was then divided equally between the two taxa in the final species lists (Appendix 1 and 2).

Macrophytes were recorded in terms of the percentage cover of each species present in the mesocosms. As with the macroinvertebrates, within each mesocosm, plant species were recorded separately for each of the three depth zones.

3. Results

3.1 Species richness

Invertebrates

In total, 45 aquatic macroinvertebrate taxa were recorded from the mesocosms as a whole (See Appendix 1). The average number of taxa recorded per mesocosms was 28. The richest groups across all the mesocosms were beetles (12 species) and bugs (9 species).

Within individual mesocosms, the richest groups were snails and bugs (average of 7 and 6 species per mesocosm respectively). Just under half of all taxa (n=19) were present in all the mesocosms. Shrimps, slaters and snails were generally the most widespread groups. Predatory and herbivorous bugs also occurred widely. The most variable group were the water beetles. Only one beetle species *Haliplus lineatocollis* was present in all mesocosms and most beetle species occurred in only one mesocosm; in addition, many of the beetles were present as single specimens (Appendix 1).

Plants

In total 10 macrophyte species were recorded from the mesocosms. The average number of species recorded per mesocosm was 7.8. The most common species were submerged aquatics (6 species in total). Floating-leaved and emergent plant species were uncommon (2 species in total in both groups).

Table 1. Comparison of the average species richness in the three mesocosm depth zones

	Mesocosm depth zone		
	Shallow (0.1 m)	*Medium (0.3 m)*	*Deep (0.5 m)*
No. invertebrate taxa	29 (22-36)*	19 (15-26)	15 (13-17)
No. submerged and floating-leaved plant spp.	3.7 (2-5)	5 (4-6)	4.8 (4-7)
No. emergent plant spp.	2 (2-2)	1 (1-1)	0 (0-0)

* Average from mesocosms (range in parentheses)

Most plant species were widespread and occurred in all mesocosms, but four taxa, *Myriophyllum spicatum*, *Spirodela polyrhiza*, *Callitriche* sp. and the alien aquatic *Lagarosiphon major*, were restricted to three or fewer mesocosms (see Appendix 2).

3.2 Richness of the different mesocosm depth zones

Invertebrates

In all the mesocosms, the shallow zone (0.1 m) was much the richest area for macroinvertebrate species (average of 29 species per mesocosm in this depth zone). The middle and deeper zones supported only a half to a third, respectively, of the species found in the shallow zone (See Table 1).

Plants

The total number of plant species recorded was relatively constant across the three depth zones. However, not surprisingly, the submerged and floating-leaved component of the plant assemblage was richer in deeper water and emergent plant species were more common in shallow water.

3.3 Comparison of the larger and smaller mesocosms

Similar numbers of plant and invertebrate species were recorded in the larger and smaller mesocosms (Table 2).

Table 2. Comparison of average species richness in the large and small mesocosms

	Large (6 m length)	*Small (3 m length)*
No. invertebrate taxa	31.3 (25-35)*	30.0 (25-36)
No. submerged and floating-leaved plant spp.	6.3 (5-7)	5.3 (4-7)
No. emergent plant spp.	2 (2-2)	2 (2-2)

* Average from mesocosms (range in parentheses)

4. Comparison with countryside ponds

To investigate the similarities between the mesocosms and wider countryside ponds the mesocosms were compared with ponds from Pond Action's National Pond Survey (NPS) database. The latter is a data set of high quality ponds from minimally impaired land uses.

For the comparison, the six mesocosm assemblages were compared with assemblages in NPS ponds located within a 50 mile radius of Jealott's Hill (n=49). Note that the collection and sorting methods are not identical in the two data sets; the results are, however, likely to be broadly comparable.

Invertebrates

Overall, the mesocosms were relatively rich and supported similar numbers of invertebrate species to ponds in the wider countryside (See Table 3). In most groups, the numbers of species were close to the average for the National Pond Survey ponds. The numbers of species of flatworm, snail and dragonfly were slightly above average, but not abnormally so. Similarly, caddisflies were very slightly below the NPS species average.

The biggest difference between the mesocosms and ponds was in the number of water beetle species recorded. Thus, whereas in the NPS ponds the average number of water beetles recorded was 15 species per pond (range 2-45), the number per mesocosm was only 4 species (range 2-6) (and some of these were single individuals: it is possible that these were visitors 'passing through' rather than genuine colonisers). This is an important difference since beetles are a particularly species-rich group in ponds, typically making up between a third and a half of all macroinvertebrate species recorded.

Plants

The number of submerged and floating-leaved plant species in the mesocosms was close to the NPS ponds average. However, the mesocosms supported far fewer emergent plant species, with only two species per waterbody in the mesocosms, compared to an average of 20 species in NPS ponds.

Table 3. Comparison of invertebrate richness in 6 mesocosms and 49 ponds

	Number of species: average and (range)	
	Mesocosms	*Ponds*
Tricladida	1.7 (1-2)	0.5 (0-3)
Mollusca	6 (6-6)	4.5 (0-17)
Hirudinea	0.7 (0-1)	1.5 (0-6)
Crustacea	2 (2-2)	1.5 (0-3)
Ephemeroptera	1 (1-1)	1.0 (0-4)
Plecoptera	0 (0-0)	0.05 (0-1)
Odonata	4.5 (3-5)	3 (0-11)
Hemiptera	6.8 (4-9)	6 (0-14)
Coleoptera	4 (2-6)	15 (2-45)
Megaloptera	0 (0-0)	0.7 (0-1)
Trichoptera	0.7 (0-1)	1.5 (0-7)
Total number of invertebrate species (excluding diptera and oligochaetes etc.)	**27 (23-32)**	**35 (6-65)**

Table 4 Comparison of plant richness in 6 mesocosms and 49 ponds

	Number of species: average and (range)	
	Mesocosms	*Ponds*
No. submerged spp.	4.2 (3-5)	3.9 (0-11)
No. floating-leaved plant spp.	1.6 (4-6)	1.6 (0-5)
No. emergent plant spp.	2 (2-2)	19.8 (5-43)
Total Number of plant spp.	**7.8 (6-9)**	**25.3 (7-57)**

5. Conclusions

Overall, the new mesocosms appear to have developed well and already have a richer fauna than the older deep cylinder mesocosms. In particular, the new design supports greater numbers of species of corixid bugs, dragonflies and water beetles than were typical of the cylinder mesocosms. This suggests that if the new mesocosms were classified with the NPS ponds thier invertebrate communities would be more like those of ponds than the cylinder mesocosms were were shown to be.

In terms of the invertebrates, the main difference between the mesocosms and ponds was that the water beetle assemblage in most mesocosms was still relatively poor. This is likely to be due to a number of factors including:

(i) the characteristics of the introduced stock: the mesocosms were stocked from the existing mesocosms which themselves held relatively impoverished beetle communities,

(ii) the 'newness' of the mesocosms: only one summer season was available for natural colonisation from the areas around,

(iii) the mesocosm design - the new mesocosms:

- were relatively deep for many water beetles, even in the shallow (0.1 m) zone,
- had no drawdown zone,
- had hard surrounds, unsuitable for beetle pupation,
- had a vegetation structure which was not optimal, in that it was lacking the grassy margins which many water beetle species prefer.

Of these three factors, it is likely that mesocosm design probably had the most critical influence on the paucity of water beetles.

In terms of the macrophytes, the aquatic and floating-leaved assemblages were representative of high quality ponds. The emergent plants were, however, relatively species-poor. This is not surprising given that emergents are often physically large plants which occupy an extensive part of most ponds (the drawdown zone where they are most prolific typically occupies about 50% of the area of a pond). It is difficult to create the space needed for a wide variety of these plants to grow in relatively small mesocosms. However, it would be relatively easy to produce some increase in marginal plant species richness through careful planting of the shallow and mid depth zones of the mesocosms.

6. Recommendations

Given the findings from the study a number of recommendations can be made. These aim, particularly, to increase the number of water beetle and marginal plant species to make the mesocosms more representative of natural ponds.

Planting

- Low growing grasses could be planted in the shallow zone of the pond to provide a good water beetle habitat. Suitable species are Creeping bent (*Agrostis stolonifera*) and/or any of the three low growing Sweet-grasses (*Glyceria* spp.).
- The shallow grasses could be intergrown with wetland herbs to increase marginal plant diversity and underwater architectural variety in the shallow zone. Particularly suitable species are Water Mint (*Mentha aquatica*), Articulated Rush (*Juncus articulatus*) and Common Spike-rush (*Eleocharis palustris*). Other possibles are Water Forget-me-not spp (*Myosotis* spp.), Brooklime (*Veronica beccabunga*) and Watercress (*Nasturtium* spp.). In addition, Common Water-plantain (*Alisma plantago-aquatica*), which is already in the mesocosms, is useful plant when young. It's main disadvantage is that as it gets bigger the leaves become aerial, giving less underwater structural diversity for invertebrates.
- Ideally the mid-depth zone of the mesocosms should be used to grow a thicker sward of taller emergent plants. The Branched Burr-reed (*Sparganium erectum*) which is present already is useful, but when fully grown it has robust rigid stems which can be difficult to sample with a net. Reed Sweet-grass (*Glyceria maxima*) could be added too, or used in its place, since this is a rather smaller plant, and often supports rich invertebrate communities.

Mesocosm design

With an average depth of 0.1m, the current 'shallow zone' is relatively deep for many macroinvertebrate species (particularly the water beetles) as well as many bankside emergent plants. In addition, there is no natural drawdown zone - an important feature of almost all lowland ponds.

The ideal solution from a biological viewpoint would be to create a 'pond edge' by introducing sloping banks at the mesocosm edges. This would provide a good marginal habitat for marginal plants, and would inevitably develop as one of the richest areas for invertebrate species.

Appendix 1. Invertebrate data from the new mesocosms

Taxa	Number of invertebrates in each mesocosm 1	2	3	4	5	6
Flatworms						
Dugesia polychroa	22	4	12	3	5	4
Polycelis tenuis	0	2	4	1	0	1
Leeches						
Erpobdella octoculata	0	0	5	1	10	2
Shrimps and slaters						
Asellus aquaticus	130	80	100	105	150	120
Crangonyx pseudogracilis	130	130	110	120	150	130
Snails						
Lymnaea peregra	1	4	7	1	2	3
Lymnaea stagnalis	90	100	120	100	130	90
Planorbarius corneus	8	3	10	13	33	10
Planorbis carinatus	40	74	80	50	105	50
Musculium lacustre	18	6	22	12	9	10
Sphaerium corneum	18	11	23	2	7	14
Mayflies						
Cloeon dipterum	40	90	90	130	45	110
Dragonflies						
Anax imperator	2	8	13	25	7	4
Coenagrion sp.	18	50	35	40	40	40
Ischnura sp.	18	50	35	40	40	40
Pyrrhosoma nymphula	0	3	12	2	13	5
Libellula quadrimaculata	0	1	13	0	0	8
Libellulid (very small)	0	0	0	1	0	0
Bugs						
Callicorixa praeusta	0	6	4	0	0	3
Corixa punctata	1	4	9	2	1	2
Ilyocoris cimicoides	6	2	6	5	1	1
Notonecta glauca	3	1	6	1	5	2
Notonecta maculata	3	1	1	0	0	2
Notonecta marmorea	3	1	1	0	1	2
Sigara dorsalis	0	1	0	0	0	0
Sigara falleni	1	6	11	0	0	4
Sigara nigrolineata	30	50	70	3	17	32
Caddisflies						
Agrypnia varia	0	4	9	2	0	9
Beetles						
Agabus chalconatus	0	0	0	0	0	1
Anacaena lutescens	1	0	0	0	0	0
Haliplus lineatocollis	3	1	3	3	6	5
Haliplus obliquus	1	0	0	0	0	1
Haliplus (ruficollis gp. female)	0	1	0	0	1	0
Helochares punctatus	0	0	1	0	0	0
Hydroporus angustatus	0	1	1	0	0	2
Hydroporus planus	0	1	2	1	0	1
Hydroporus striola	0	0	1	0	0	0

(Continued)

Appendix 1. Invertebrate data from the new mesocosms (Continued)

Taxa	Number of invertebrates in each mesocosm					
	1	**2**	**3**	**4**	**5**	**6**
Beetles (continued)						
Hydroporus tesselatus	0	1	0	0	0	0
Laccophilus hyalinus	0	0	1	0	0	0
Oulimnius tuberculatus	0	0	0	1	0	0
Moths						
Nymphula nymphaeata	0	2	0	1	0	2
Flies						
Chaoboridae	70	120	90	50	30	80
Chironomidae	1	5	6	15	31	2
Muscidae	0	0	0	0	0	1
Oligochaeta	0	1	0	15	10	1
Total number of taxa	**25**	**35**	**34**	**29**	**25**	**36**

Appendix 2. Invertebrate data from the new mesocosms (including depth zones)

Taxa	No. invertebrates in each mesocosm depth zone																	
	1 D	1 M	1 S	2 D	2 M	2 S	3 D	3 M	3 S	4 D	4 M	4 S	5 D	5 M	5 S	6 D	6 M	6 S
Flatworms																		
Dugesia polychroa	6	6	10	0	2	2	4	3	5	3	0	0	0	3	2	1	1	2
Polycelis tenuis	0	0	0	0	0	2	0	1	3	1	0	0	0	0	0	0	0	1
Leeches																		
Erpobdella octoculata	0	0	0	0	0	0	0	3	2	0	0	1	1	3	6	0	0	2
Shrimps and slaters																		
Asellus aquaticus	30	50	50	10	20	50	20	30	50	5	50	50	50	50	50	30	40	50
Crangonyx pseudogracilis	30	50	50	30	50	50	20	40	50	20	50	50	50	50	50	30	50	50
Snails																		
Lymnaea peregra	0	1	0	1	1	2	0	2	5	1	0	0	0	2	0	1	0	2
Lymnaea stagnalis	20	20	50	20	30	50	30	40	50	20	30	50	30	50	50	20	20	50
Planorbarius corneus	0	2	6	0	0	3	0	5	5	1	2	10	3	20	10	0	4	6
Planorbis carinatus	10	10	20	4	20	50	20	30	30	10	20	20	5	50	50	10	10	30
Musculium lacustre	6	6	6	0	5	1	1	6	15	6	5	1	0	3	6	0	4	6
Sphaerium corneum	6	6	6	5	4	2	3	10	10	0	1	1	1	5	1	4	6	4
Mayflies																		
Cloeon dipterum	10	10	20	20	20	50	20	40	30	30	50	50	5	20	20	30	30	50
Dragonflies																		
Anax imperator	0	0	2	1	1	6	3	5	5	5	10	10	1	2	4	0	0	4
Coenagrion sp.	3	5	10	10	15	25	5	10	20	10	15	15	10	15	15	10	5	25
Ischnura sp.	3	5	10	10	15	25	5	10	20	10	15	15	10	15	15	10	5	25
Pyrrhosoma nymphula	0	0	0	0	0	3	2	5	5	0	0	2	1	6	6	1	1	3
Libellula quadrimaculata	0	0	0	1	0	0	4	5	4	0	0	0	0	0	0	1	3	4
Libellulid (very small)	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Bugs																		
Callicorixa praeusta	0	0	0	2	2	2	0	4	0	0	0	0	0	0	0	0	0	3
Corixa punctata	0	1	0	0	2	2	0	3	6	0	0	2	0	0	1	0	0	2
Ilyocoris cimicoides	0	0	6	0	1	1	0	2	4	0	0	5	0	0	1	0	0	1
Notonecta glauca	0	0	3	0	0	1	0	1	5	0	0	1	0	0	5	0	1	1
Notonecta maculata	0	0	3	0	0	1	0	0	1	0	0	0	0	0	0	0	1	1
Notonecta marmorea	0	1	2	0	1	0	0	0	1	0	0	0	0	0	1	0	0	2
Sigara dorsalis	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Sigara falleni	0	0	1	0	1	5	3	3	5	0	0	0	0	0	0	0	0	4
Sigara nigrolineata	10	10	10	0	0	50	0	20	50	2	0	1	1	6	10	6	6	20
Caddisflies																		
Agrypnia varia	0	0	0	0	0	4	3	1	5	0	1	1	0	0	0	1	5	3
Beetles																		
Agabus chalconatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Anacaena lutescens	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Haliplus lineatocollis	0	0	3	0	0	1	0	1	2	0	0	3	1	3	2	0	1	4
Haliplus obliquus	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Haliplus (ruficollis gp. female)	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0
Helochares punctatus	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Hydroporus angustatus	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	2
Hydroporus planus	0	0	0	0	0	1	0	0	2	0	0	1	0	0	0	0	0	1
Hydroporus striola	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0

(Continued)

Appendix 2. Invertebrate data from the new mesocosms (continued)

Taxa	No. invertebrates in each mesocosm depth zone																	
	1 D	1 M	1 S	2 D	2 M	2 S	3 D	3 M	3 S	4 D	4 M	4 S	5 D	5 M	5 S	6 D	6 M	6 S
Beetles (continued)																		
Hydroporus tesselatus	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Laccophilus hyalinus	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Oulimnius tuberculatus	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Moths																		
Nymphula nymphaeata	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	2
Flies																		
Chaoboridae	50	10	10	50	50	20	40	30	20	20	20	10	0	20	10	30	30	20
Chironomidae	1	0	0	0	0	5	5	0	1	0	5	10	20	1	10	0	0	2
Muscidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Oligochaeta	0	0	0	0	0	1	0	0	0	0	5	10	0	0	10	0	0	1
Total	**13**	**16**	**22**	**13**	**19**	**32**	**17**	**26**	**33**	**15**	**15**	**26**	**15**	**19**	**24**	**15**	**19**	**36**

Appendix 3. Plant data from the new mesocosms

	% plant cover in each mesocosm					
	1	**2**	**3**	**4**	**5**	**6**
Submerged species						
Callitriche sp.	0	0.2	0.1	0	0	0
Ceratophyllum demersum	14	5	7	11	6	6
Chara vulgaris	13	7	14	24	6	7
Lagarosiphon major	6	5	5	0	0	6
Myriophyllum spicatum	0	0	0	0	0	1
Potamogeton crispus	28	57	21.5	11	17	6.5
Floating-leaved species						
Potamogeton natans	5	5	5	4	5	6
Spirodela polyrhiza	0	0.2	0.6	0	0.2	0.1
Emergent species						
Alisma plantago-aquatica	8	12	6	7	12	13
Sparganium erectum	5	8	4	9	5	10
Filamentous algae (excluded from totals)	7	34	43	33	43	51
No. of submerged species	4	5	5	3	3	5
No. of floating-leaved species	1	2	2	1	2	2
No. of emergent species	2	2	2	2	2	2
Total number of species	**7**	**9**	**9**	**6**	**7**	**9**

Appendix 4 Plant data from the new mesocosms (including depth zones)

	% plant cover in each mesocosm depth zone																	
	1 D	1 M	1 S	2 D	2 M	2 S	3 D	3 M	3 S	4 D	4 M	4 S	5 D	5 M	5 S	6 D	6 M	6 S
Submerged species																		
Callitriche sp.	0	0	0	0.1	0	0.1	0	0	0.1	0	0	0	0	0	0	0	0	0
Ceratophyllum demersum	10	3	1	2	2	1	3	3	1	5	5	1	4	1	1	3	3	0
Chara vulgaris	0	5	8	1	1	5	3	6	5	1	3	20	0	1	5	1	1	5
Lagarosiphon major	1	5	0	0	5	0	4	1	0	0	0	0	0	0	0	3	3	0
Myriophyllum spicatum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Potamogeton crispus	15	8	5	50	5	2	13	8	0.5	5	5	1	10	5	2	3	3	0.5
Floating-leaved species																		
Potamogeton natans	2	3	0	3	2	0	3	2	0	2	2	0	4	1	0	3	3	0
Spirodela polyrhiza	0	0	0	0	0.1	0.1	0	0.1	0.5	0	0	0	0.1	0	0.1	0.1	0	0
Emergent species																		
Alisma plantago-aquatica	0	0	8	0	0	12	0	0	6	0	0	7	0	0	12	0	0	13
Sparganium erectum	0	2	3	0	6	2	0	2.5	1.5	0	3	6	0	3	2	0	5	5
Filamentous algae	4	2	1	15	18	1	22	20	1	17	15	1	22	20	1	23	27	1
Total number of species (excluding filamentous algae)	**4**	**6**	**5**	**5**	**7**	**7**	**5**	**7**	**7**	**4**	**5**	**5**	**4**	**5**	**6**	**7**	**6**	**4**

Mesocosm depth zones: D=deep, M=medium, S=shallow