The value of ornamental water bodies in aquatic conservation – a case study of a threatened native fish, crucian carp *Carassius carassius* in an English estate pond

Cefas

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Introduction and objectives

Ornamental 'estate' ponds can be valuable conservation sites, especially for threatened native species such as crucian carp, a species about which very little is known in the UK. The objectives of this study were to evaluate:

- the flora and fauna of Bayfordbury Lake, an ornamental estate pond, during 1994-1995;
- the environmental biology of crucian carp, including temporal trends in body condition over a nine-year period (1992-2000);
- the management options for enhancing and maintaining ornamental ponds as aquatic conservation sites.

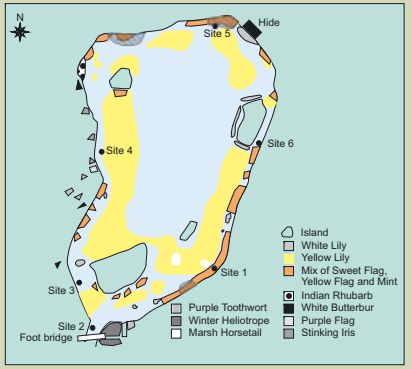

Figure 1. Detailed map of Bayfordbury Lake (Hertfordshire, England), created in 1772 by the Clinton-Baker family, then enhanced in 1840 and 1947. Now 0.8 ha, this eutrophic pond suffered fish kills in 1957-58 (pollution), and Jan. 1992 (anoxia due to ice cover). Vegetation zones are indicated.

Table 2. Mean numbers (per 3 min. kick/sweep net sampling) of aquatic invertebrate taxa observed a six locations in Bayfordbury Lake for winter, spring and summer 1994-1995, in numbers, with total density, number of species and adjusted species richness (species number + total density). Cladocera, Ostracoda and Copepoda were present at all six locations in winter and spring, and at three of six locations during summer.

Group	Genus/Species	Winter	Spring	Summer
Platyhelminthes		0.3		
Oligochaeta	Tubifex	5.5	55.2	20.3
	Stylaria			2.5
	Lumbriculus		16.7	9.8
Hirudinea	*Glossiphonia heteroclita*	0.5	0.5	
	Piscicola geometra			0.3
	Helobdella stagnalis	0.2	1.2	12.3
	Hemiclepsis marginata		0.3	
	Erpobdella octoculata		0.2	
Gastropoda	Planorbiade (Fam.)	0.3	3.0	1.3
	Lymnaeidae (Fam.)	0.5	0.2	1.5
	Acroloxus lacustris	0.5	0.5	0.3
	Hydrobiidae (Fam.)			0.3
Isopoda	*Asellus aquatilis*	3.0	16.5	44.2
Amphipoda	*Gammarus* spp.	13.5	1.0	1.3
	Crangonyx pseudogracilis		1.3	
Aranaea		0.2		
Plecoptera	Nymphs/adults			0.2
Ephemeroptera	*Baetis* sp.	29.7	3.5	
	Cloeon	22.0	8.7	10.2
Odonata	Coenagrionidae (Fam.)	0.3	0.7	
	Lestidae (Fam.)		0.2	
	Aeshnidae (Fam.)	1.3		
Hemiptera	*Notonecta* spp.		0.5	
	Corixa spp.	0.2	0.2	2.3
Megaloptera	*Sialis lutaria*	0.2	0.8	4.7
Trichoptera	Philopotamidae (Fam.)		0.8	0.5
	Limnephilidae (*Limnephilus*)	11.8	5.0	0.8
Coleoptera	*Gyrinus* spp.		0.7	
	Haliplus spp.	0.3		
	Dytiscidae larvae			0.7
	Dytiscus sp.	0.5	0.2	
Diptera	Culcid larvae		0.5	
	Chironomidae larvae	9.0	29.7	7.2
	Chaoborus larvae		0.5	0.7
	Ptychopteridae larvae	1.8		
Total density		99.8	150.3	121.3
Species number		21	28	20
Adjusted species richness		21.0	19.3	16

Table 1. Plant species (* = non-native) in and bordering Bayfordbury Lake in 1994-1995 by ecological category (A = aquatic, T= terrestrial; W = wetland zone), where the number of species of each category is: A = 19; A/W = 1; T = 69; T/W = 8; W = 14; W/A = 11).

Latin name	Category	Latin name	Category
Aegopodium podagraria	T	*Lemna minor*	A
Allaria petiolata	T	*Lemna trisulca*	A
Anthriscus sylvestris	T	*Lotus corniculatus*	T
Arctium minus	T, W	*Luzula sylvatica*	T
Arum maculatum	T	*Lycopus europaeus*	W
*Arum italicum**	T	*Lysimachia nummutaria*	A
Acorus calamus	A	*Lythrum salicaria*	W, A
Agrimonia eupatoria	T	*Medicago lupulina*	T
Alisma plantago-aquatica	A	*Mentha aquatica*	W, A
Allium vineale	T	*Mercurialis perennis*	T
Apium nodiflorum	A	*Myosotis scorpioides*	A, W
Anemone nemorosa	T	*Myriophyllum alterniflolium*	A
Barbarea vulgaris	T	*Myriophyllum verticulatum*	A
Brachypodium sylvaticum	T	*Nasturtiun officinale*	A
Brassica napus	T	*Nuphur lutea*	A
Callitriche obtusangula	A	*Nymphaea alba*	A
Callitriche platycarpa	A	*Petasites fragrans*	T
Caltha palustris	W	*Petasites hybridus*	T
Calystegia sepium	T	*Petasites japonicus**	T
Calystegia sylvatica	T	*Phalaris arundinacea*	T
Capsella bursa-pastoris	T	*Plantago lanceolata*	T
Cardamine pratensis	W	*Plantago major*	T
Carex acutiformis	W, A	*Polygonum amplexicaule*	W
Carex otrubae	W	*Polygonum bistorta*	W
Carex riparia	W, A	*Polygonum persicara*	T
Carex vesicaria	W	*Potamogeton crispus*	A
Centaurea nigra	T	*Potamogeton gramineus*	A
Chenopodium album	T	*Potentilla anglica*	W
Cirsium arvense	T	*Potentilla reptans*	T, W
Cirsium vulgare	T	*Primula veris*	T
Egeria densa	A	*Prunella vulgaris*	T
Elodea canadensis	A	*Ranunculus acris*	T
Epilobium hirsutam	W	*Ranunculus aquatilis*	W, A
Epilobium lanceolatum	T	*Ranunculus ficaria*	T
Epilobium montanum	T	*Ranunculus peltatus*	W
Epilobium parviflorum	T, W	*Ranunculus repens*	T, W
Epilobium tetragonum	T, W	*Rorippa nasturtium-aquaticum*	A
Equisetum fluviatile	W, A	*Rosa canina*	T
Equisetum palustre	W, A	*Rubus caesius*	T
Filipendula ulmaria	W	*Rubus fruticosus*	T
Fritillaria meleagris	T, W	*Rumex crispus*	T
Gallium aparine	T	*Rumex sanguineus*	T
Geranium dissectum	T	*Scrophularia auriculata*	W, A
Geranium pratense	T	*Scutellaria galericulata*	W
Geranium robertianum	T	*Silene dioica*	T
Glechoma hederacea	T	*Solanum dulcamara*	T, W
Glyceria maxima	W, A	*Sonchus arvensis*	T
Heracleum spondylium	T	*Sonchus oleraceus*	T
*Heracleum mantegazzianum**	W	*Stachys sylvatica*	T
Hippuris vulgaris	W, A	*Stellaria media*	T
Hypericum perforatum	T	*Stratioites aloides*	A
Hypericum tetrapterum	T	*Trifolium pratense*	T
Iris foetidissima	W	*Trifolium repens*	T
Iris pseudacorus	W, A	*Taraxacum Sect. vulgaria*	T
*Iris versicolor**	T, W	*Tussilago farfara*	T
Lamiastrum galeobdolon	T	*Urtica dioica*	T
Lamium album	T	*Verbascum spp.*	T
Lamium purpureum	T	*Veronica chamaedrys*	T
Lapsona communis	T	*Vicia cracca*	T
Lathraea clandestia	T	*Vinca minor**	T
Lathyrus pratensis	T	*Viola riviniana*	T

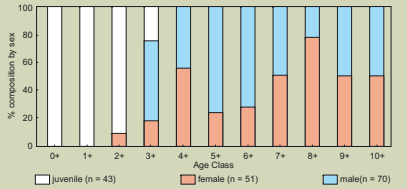

Figure 2. Age-specific proportions of each sex of crucian carp collected in the first week of October 1995. No sexual dimorphism was observed in body morphology.

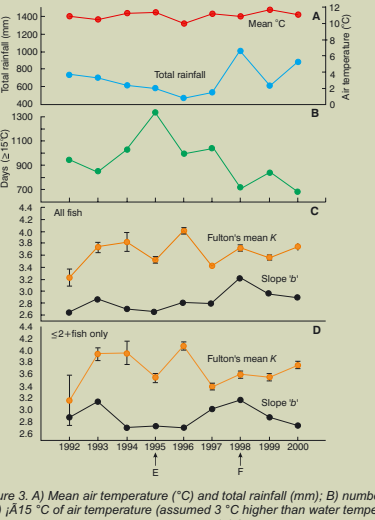

Figure 3. A) Mean air temperature (°C) and total rainfall (mm); B) number of degree-days (°D) ¡Ã15 °C of air temperature (assumed 3 °C higher than water temperature); C) slope regression 'b' and Fulton's condition index (K) for all crucian carp in Bayfordbury Lake between 1992 and 2000; D) same as 'C' but for immature fish (i.e.<3+) only. No correlation between K or b with total rainfall, mean temperature or °Days, except all fish vs. °Days (inverse relationship), suggesting the influence of temperature on body condition may be counterbalanced by environmental influences, e.g. onset of predation by cormorants Phalacrocorax carbo (E) and the use of Siltex® (F) to compact the lake's fine sediments.

*Crucian carp (*Carassius carassius*)*

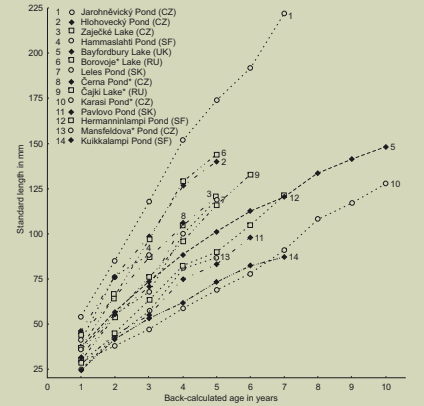

*Figure 4. Standard lengths (in mm) at age (in years) of various crucian carp populations from published sources (summarized in Černý 1971 and Holopainen & Pitkänen 1985). So-called dwarf forms (*Carassius carassius *morpha humilis, Černý 1971), and stunted forms (i.e. Szczerbowski et al. 1997), are indicated with an asterisks in the key. Assuming growth of crucian in Bayfordbury Lake is typical of other English pond populations, conditions in England for the species' growth appear good, though increase in weight is proportionally less than that in length (in Figure 3, isometric growth exists when slope 'b' = 3.0)*

Conservation and management considerations:

- Restore and maintain good water quality through reduction of nutrient inputs
- Control algal blooms by favouring large invertebrates (e.g. use of barley straw, reduce numbers of zooplanktivorous fishes)
- Enhance sediment quality through use of Siltex® or dredging (i.e. in extreme cases)
- Remove, and avoid introduction of, non-native species.

Seminal references

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Holopainen IJ, Pitkanen AK. 1985. Population size and structure of crucian carp (*Carassius carassius* (L.)) in two small natural ponds in Finland. *Annal. Zool. Fenn.* **22**:,397-406.