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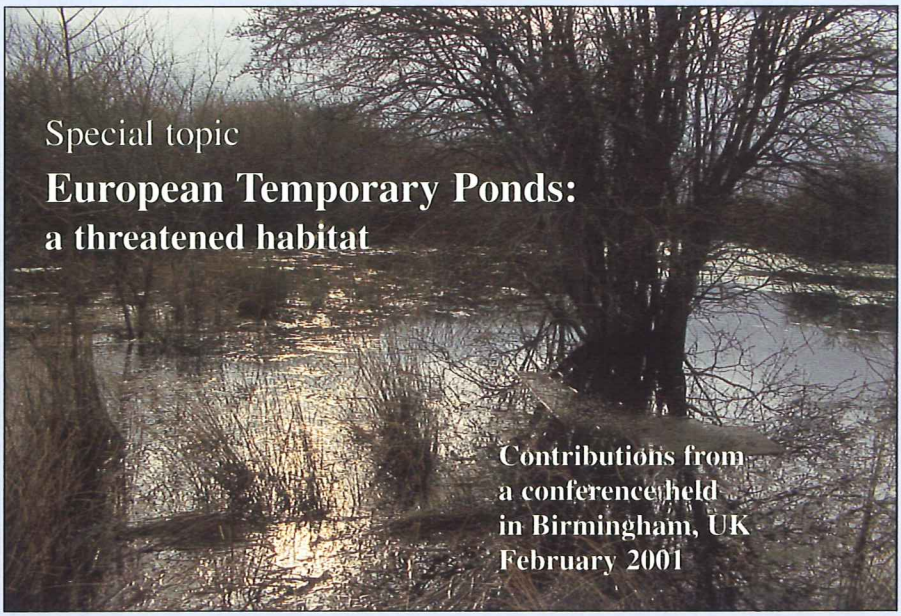

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TEMPORARY PONDS IN THE UK: A CRITICAL BIODIVERSITY RESOURCE FOR FRESHWATER PLANTS AND ANIMALS

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Introduction

The importance of ponds for biodiversity in Britain has been demonstrated by a number of studies (e.g. Bennett 1997; Collinson et al. 1995). However, most of the research and interest has been directed at permanent waterbodies, and temporary ponds have been largely neglected (Williams et al. 2001).

In this article I present some preliminary findings from a project which aims to fill some of the many gaps in our knowledge of temporary ponds in Britain. The project, which currently runs for three years until the end of 2001, aims specifically to investigate the ecology of temporary ponds in England and Wales by describing (i) their wetland plant and macroinvertebrate communities, (ii) their physico-chemical characteristics, and (iii) their value as a biodiversity resource.

To date, observations on plants and macroinvertebrates are available from 70 undegraded temporary ponds located in areas of semi-natural landuse, mainly nature reserves and Sites of Special Scientific Interest. The temporary ponds were selected by stratified random sampling using the ITE land classes (Bunce et al. 1994) and were surveyed using methods compatible with the National Pond Survey (Ponds Conservation Trust, unpublished data) and the Department of the Environment, Transport and the Regions' (DETR's) Lowland Pond Survey 1996 (LPS96, Williams et al. 1998).

Here, I shall focus on the assessment of temporary ponds as a biodiversity resource and briefly consider aspects of species richness, rarity and distinctiveness. Where possible, temporary ponds are compared with other waterbody types, mainly permanent ponds from the National Pond Survey (NPS), to give the results a broader context.

Species richness in temporary ponds

The survey of 70 temporary ponds shows that, for both plants and invertebrates, temporary ponds have fewer species than comparable permanent ponds (Table 1). Three-minute hand-net samples for aquatic macroinvertebrates yielded, on average, 25 species per temporary pond (not including Diptera), compared with 38 species for permanent ponds surveyed

in the NPS. Data for wetland macrophytes show that more species occur in permanent than in temporary ponds, averaging 17 species per temporary pond and 23 in permanent ponds. However, undegraded temporary ponds have on average six more plant species per site than ponds in the wider countryside (mean 11 species, Table 1), which are often degraded by human activities such as intensive agriculture. This comparison suggests that degradation may have a worse effect than drying out on the species richness of ponds.

Table 1. Species richness in temporary and permanent ponds in England and Wales. NPS: National Pond Survey (The Ponds Conservation Trust, unpublished data), LPS96: DETR's Lowland Pond Survey 1996 (Williams et al. 1998).

	Mean	Range
Macroinvertebrates		
Temporary ponds (50 undegraded sites)	25	6-50
Permanent ponds (80 undegraded NPS sites)	38	9-78
Macrophytes		
Temporary ponds (70 undegraded sites)	17	0-37
Permanent ponds (130 undegraded NPS sites)	23	3-56
Permanent ponds (268 LPS96 sites)	11	0-35

Table 2. Rare species found in 70 temporary ponds.

Conservation status	Number (%) of temporary ponds	
	Macrophytes (70 sites)	Macroinvertebrates (50 sites)
Total uncommon	56 (79%)	41 (82%)
Local species	54 (76%)	28 (56%)
Nationally Scarce species	11 (15%)	34 (68%)
Red Data Book species	5 (7%)	13 (26%)

The importance of temporary ponds as a habitat for rare species

About 80% of the temporary ponds surveyed support uncommon plant and/or invertebrate species (Table 2). For invertebrates, Red Data Book species were recorded from more than a quarter of all temporary ponds surveyed.

A comparison of the overall number of rare species found in all temporary ponds with those from other permanent ponds and rivers shows that the overall percentage of uncommon species is similar for undegraded temporary and permanent ponds (Table 3). Out of 231 macroinvertebrate species found in temporary ponds, 17% are nationally scarce and 6% are Red Data Book species. For permanent ponds, 16% nationally scarce and 5% Red Data Book species were recorded among 342 invertebrate species. A comparison between temporary ponds and river sites from the RIVPACS data, which were also collected using a three-minute net sample (Wright et al. 1996), shows that temporary ponds support a higher proportion of rare invertebrate species than river sites (Table 3). In a total of 368 invertebrate species recorded in the river samples, only 11% are nationally scarce and 4% are Red Data Book species.

The macrophyte communities of undegraded temporary and permanent ponds have a similar proportion of nationally scarce and Red Data Book species (Table 3). However, a mixed set of degraded permanent and temporary ponds recorded for the DETR Lowland Pond Survey is far less rich in rare plant species than undegraded temporary ponds, particularly in terms of Red Data Book plants. In fact the only Red Data Book species found in the DETR's Lowland Pond Survey, true fox sedge (*Carex vulpina*), was found in a seasonal pond (Williams et al. 1998). Overall, the implication is that temporary ponds appear to be as good as permanent ponds as a habitat for rare species, even though they have fewer species.

Table 3. Rare species found in temporary and permanent ponds, and permanent rivers. NS: nationally scarce, RDB: Red Data Book, TP: temporary pond, PP: permanent pond. RIVPACS: River Invertebrate Predication and Classification System (Wright et al 1996). NPS/LPS96: see Table 1 for definitions.

	Number (%) spp	
Macroinvertebrates	**NS**	**RDB**
Temporary ponds (50 sites, 231 spp)	39 (17%)	13 (6%)
Permanent ponds (80 NPS sites, 342 spp)	55 (16%)	17 (5%)
Rivers (614 RIVPACS sites, 368 spp)	41 (11%)	13 (4%)
Macrophytes	**NS**	**RDB**
Temporary ponds (70 sites, 180 spp)	7 (4%)	5 (3%)
Permanent ponds (130 NPS sites, 231 spp)	13 (5%)	4 (2%)
TPs/PPs (377 LPS96 sites, 177 spp)	6 (3%)	1 (0.6%)

Even relatively small temporary ponds that appear rather uninteresting often support uncommon species and can hold a suprisingly diverse fauna and flora. For example, I found 34 macroinvertebrate species, including four nationally scarce water beetles (*Agabus labiatus*, *Coelambus paralellogrammus*, *Enochrus affinis* and *Helochares punctatus*) in a small (25 m^2) temporary pond on Skipwith Common in Yorkshire (Fig. 1). An equally small pond in the Lizard Peninsula, Cornwall, supports two Red Data Book water beetles (*Graptodytes flavipes*, *Hydroporus cantabricus*) and a Red Data Book plant (three-lobed water crowfoot *Ranunculus tripartitus*). These species are not apparent during the dry phase and the site would be easily overlooked during a summer survey (Fig. 1). Similarly, a temporary pond in the New Forest, Hampshire, which becomes inconspicuous in the summer, supports two Red Data Book species: a plant (Hampshire-purslane *Ludwigia palustris*) and a macroinvertebrate (the mud snail *Lymnaea glabra*) (Fig. 2).

Comparison of macroinvertebrate communities in temporary and permanent ponds

A preliminary analysis of the invertebrate communities in 50 temporary and 80 NPS permanent ponds from England and Wales was carried out to investigate major differences between temporary and permanent ponds. DECORANA analysis (Hill 1994) did not separate them into distinct groups, which would be expected if they had markedly different communities (Fig. 3a). The main factor correlating with axis 1, which represents a major variation in the dataset, is pH rather than waterbody permanence.

To investigate the data in more detail, the effect of pH was removed to see if a difference between temporary and permanent pond communities became more apparent. DECORANA ordination on acid ponds gave a better separation of temporary and permanent ponds (Fig. 3b); the environmental gradient on axis 1 is now mainly related to water permanence and depth. Further analysis of the data is needed before any firm conclusions can be drawn.

The difference between the invertebrate communities of temporary and permanent ponds also can be illustrated by comparing the average proportion of the main invertebrate groups in both pond types. As Fig. 4 shows, the most striking difference between temporary and permanent ponds is that temporary ponds have a significantly greater number of mobile species ($p < 0.001$, Mann-Whitney U test), particularly water beetle species, with on average about 15% more water beetle species. In contrast, permanent ponds have a significantly higher proportion of species in groups like leeches and water snails ($p < 0.001$). This may be both because many species in these groups

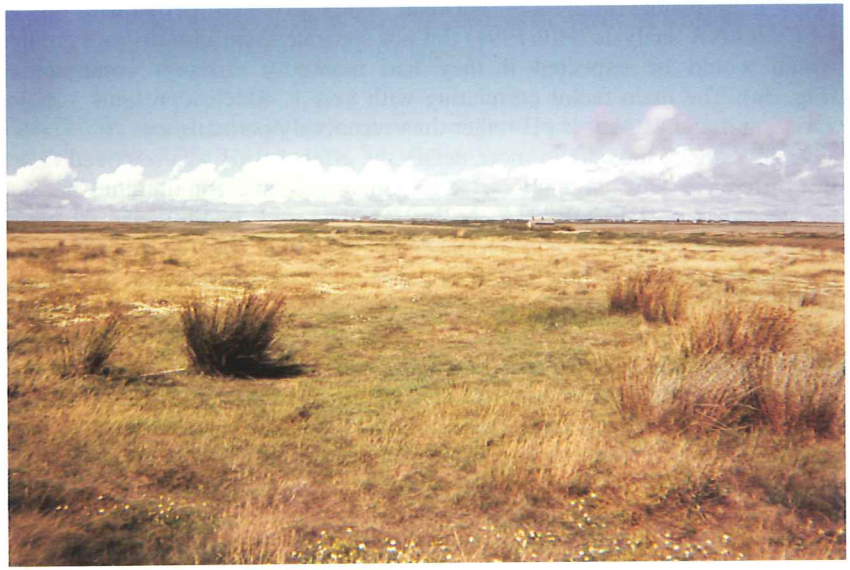
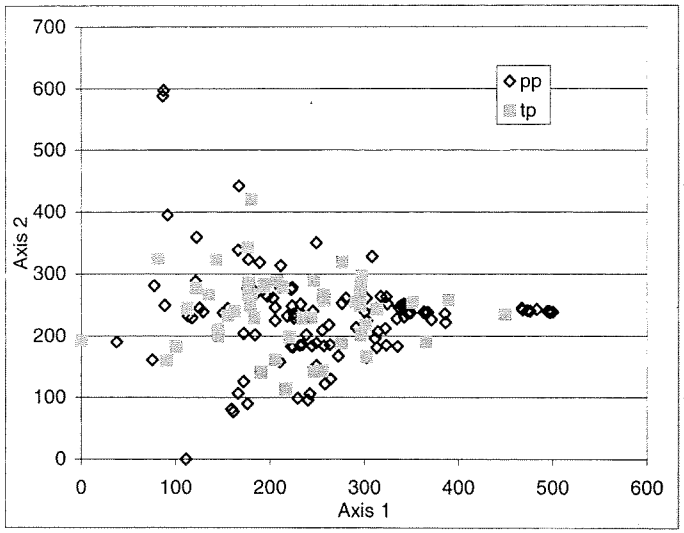


FIG 1. *Above*: A temporary pond in its drying phase, on Skipwith Common, Yorkshire. *Below*: A temporary pond in its dry phase, on The Lizard Peninsula, Cornwall.

FIG 2. A temporary pond in the New Forest (Hampshire), shown here in its wet *(above)* and dry *(below)* phase.



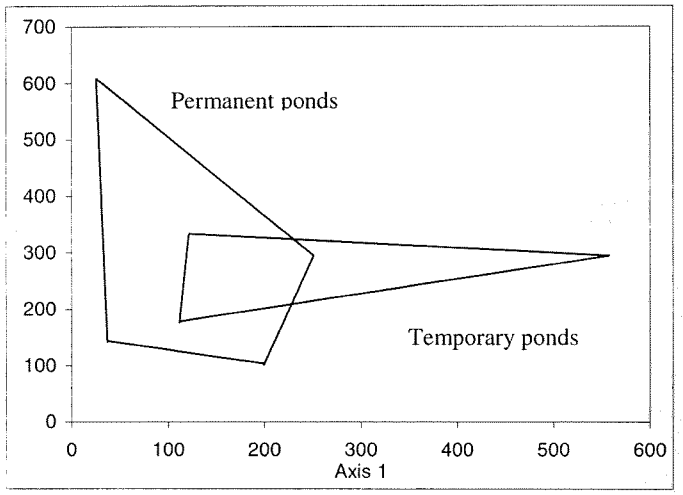


FIG. 3. (a) (*above*): DECORANA ordination of the macroinvertebrate communities of temporary ponds (tp, closed symbols) and permanent ponds (pp – open symbols). (b) (*below*): DECORANA ordination of the macroinvertebrate communities of acid ponds (pH range 2.5 to 7).

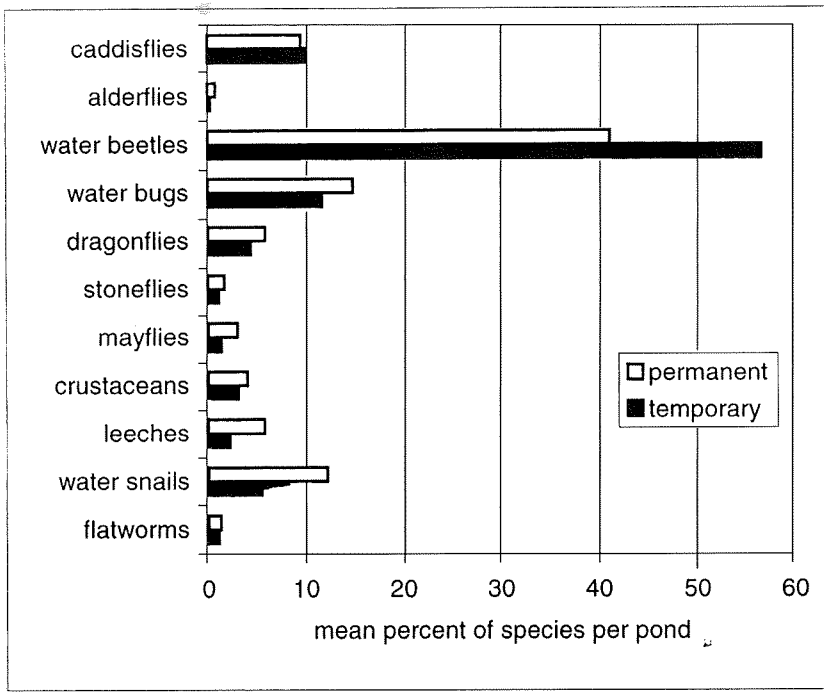


FIG. 4. The main macroinvertebrate groups of temporary and permanent ponds.

cannot tolerate periodic desiccation, and because they have relatively low mobility, and so have a more limited potential for recolonisation after periods of drought. The data showed no difference between temporary and permanent ponds in terms of the number of caddisfly, flatworm and crustacean species recorded.

All of the major groups of invertebrates are represented in temporary ponds. Species that have been found include specialists which prefer temporary habitats, such as the caddisfly *Limnephilus vittatus* and the water beetle *Hydroporus pubescens*, and a range of generalist species which occur in both permanent and temporary ponds. Aquatic snails were less common in temporary than permanent ponds, but there were exceptions: the wandering snail *Lymnaea peregra*, for example, was recorded from more than a third of the temporary ponds. It is often assumed that only specialist dragonfly species can breed successfully in temporary ponds, but nymphs of the common southern hawker *Aeshna juncea* can diapause during the dry period (Corbet

Table 4. Amphibians found in 50 temporary ponds.

	Number (%) of ponds
Great crested newt	2 (4%)
Smooth newt	13 (26%)
Palmate newt	16 (32%)
Evidence of use by frogs and toads	13 (26%)
Total with amphibians present	28 (56%)

1999) and were recorded in more than twice as many temporary than permanent ponds.

Amphibians in temporary ponds

Amphibians were recorded on an *ad hoc* basis in the temporary pond survey, with frog and toad spawn recorded as present or absent, and larval or adult amphibians, identified while netting for invertebrates (Table 4). Despite the limitations of the survey, it is clear that temporary ponds are used widely by amphibians, with slightly more than half (56%) of temporary ponds supporting one or more species. A quarter were used by frogs (*Rana* spp.), toads (*Bufo* spp.) and smooth newts (*Triturus vulgaris*). Palmate newts (*Triturus helveticus*) were found in about a third of the ponds and great crested newts (*Triturus cristatus*) were present in two sites.

Summary and conclusions

The preliminary results of this study clearly show that although temporary ponds generally support fewer wetland plant and invertebrate species per site than are found in permanent ponds, they are an important habitat for rare species and are commonly used by amphibians. Overall, this confirms recent views that temporary ponds are an important biodiversity resource in the UK (Bratton 1990; Collinson et al. 1995; Williams et al. 1999) and suggests that there needs to be more widespread consideration of their protection.

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