

Conservation and monitoring of pond biodiversity¹: introduction

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PONDS: WHAT? WHY? HOW MUCH?

What is a pond? A small lake, a big pool, a water body in a wetland? Does this specific name 'pond' describe a particular type of water body? The answer is undoubtedly affirmative. As long ago as the beginning of the last century, Forel (1904) noted that ponds are ecologically different from larger water bodies, describing them as lakes where the deep aphotic zone was missing. Since Forel's early comments many other definitions of what constitutes a pond have been proposed, linked to various aspects of their size, depth, type of water supply, use, geographical location, formation, and water quality (see, for example, the review of Jammes (1997)), all to a greater or lesser extent reflecting the fact that ponds are, in various ways, different from lakes. During the early 1990s, the requirement for a practical working definition of what constituted a pond led biologists in the United Kingdom to develop a definition characterizing ponds mainly in terms of easily measured morphological criteria, specifically: 'Waterbodies between 1 m² and 2 ha in area which may be permanent or seasonal, including both man-made and natural waterbodies' (see Biggs *et al.*, 2005). Working in Switzerland, Oertli *et al.* (2000) added a criterion linked more to water-body function, defining a pond as: 'A waterbody with a maximum depth of no more than 8 m, offering water plants the potential to colonise almost the entire area of the pond'.

Why do we have ponds in our landscape? Their origin is very diverse, as they can be created by a wide range of natural processes (e.g. glaciation, land subsidence, river action and tree falls) and human activities (e.g. mineral extraction, water storage). Ponds created by people often have a particularly wide range of

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values to society including water supply (watering livestock, agricultural irrigation, protection against fire, industrial use for cooling or washing), hydrological regulation, nutrient retention, fish production, wildlife protection, recreation, education, religious expression and celebration, and research.

How many ponds do we have in our landscapes? Although we can be certain that ponds are very abundant in most European states, reasonably accurate estimates of numbers are available for only a few. Thus in Switzerland, famous for its beautiful and numerous lakes (365 have a surface area greater than 5 ha), approximately 32 000 smaller water bodies have been enumerated (with a size between 0.01 ha and 5 ha) (Oertli and Lehmann, unpublished data). Similarly, in Great Britain, there are about 400 000 ponds (with a size between 0.0025 ha and 5 ha), representing about 97% of all discrete standing water bodies (Biggs *et al.* 2005), and in Denmark just under 120 000 water bodies between 0.01 ha and 5 ha (Sondergaard *et al.*, 2005). In most cases, numbers are probably lower than 100 years ago (see below).

THREATS AND CONSERVATION PROGRAMMES — WHY STUDY PONDS?

Although they have significant ecological functions and recognized social and economic uses, pond ecosystems are threatened by a number of human activities, of which the most important include increased nutrient loading, contamination, acid rain and invasion of exotic species (Brönmark and Hansson, 2002). To these threats should also be added at a regional scale the drastic diminution of the number of ponds and also the reduction of connectivity between them (isolation and rupture of migration corridors). Disappearance of ponds is the consequence of infilling (both natural and caused by direct habitat destruction), land drainage, decline in many of their traditional uses, and changes of function (e.g. changes in agricultural practices). Enormous numbers of ponds have vanished from the landscape, with the proportion of loss in the European states often higher than 50% and occasionally reaching 90% (Hull, 1997). As is the case for wetlands (Denny, 1994; Ricciardi and Rasmussen, 1999), many pond inhabitants (flora and/or fauna) are now considered to be threatened. At a regional level, ponds can contribute highly to freshwater biodiversity, with recent evidence showing that they often support considerably more species, more unique species and more scarce species than other water-body types (Williams *et al.*, 2004). Moreover, a review of the habitat preferences of a selection of aquatic fauna and flora (Oertli *et al.*, 2000) demonstrated that most species are potential inhabitants of ponds, with a significant proportion of them only ever found in ponds. Mediterranean temporary ponds, which mainly occur in southern Europe, are recognized as being particularly important for their biodiversity, and are included as a Priority Habitat for the EU under the auspices of the Habitats Directive. These ponds harbour several globally rare or threatened species of plants and amphibians listed on international conventions (specifically the Habitats Directive, the Bern Convention, and the IUCN Red List) (Grillas *et al.*, 2004a).

Among the many taxa that depend on ponds, perhaps the best known are the 'flagship groups', particularly the amphibians, dragonflies and aquatic plants, which are particularly emblematic of pond biodiversity; all of these groups include numerous critically endangered species (Beebee, 1992; Semlitsch, 2003; Baillie *et al.*, 2004; Sahlen *et al.*, 2004). Other groups, although less studied, can be expected to demonstrate similar trends on the basis of the evidence so far available (e.g. Crustacea and Coleoptera).

Although temporary ponds have recently been recognized as a wetland type of international importance by the Ramsar Convention (Ramsar Resolution VIII.33), political recognition of ponds as an entity and as an important part of the water environment remains insignificant throughout Europe. This is perhaps the single most important reason for the continued loss and impairment of ponds. Of particular concern is the anticipated loss of, and damage to, the very large numbers of high-quality ponds which still exist in eastern and central European states which have recently joined the EU. While monitoring programmes for fresh waters have been widely implemented in European states, particularly for running waters and lakes, these programmes have largely failed to include ponds. Nevertheless some local initiatives to conduct

programmes for pond conservation have been undertaken during the last 20 years in restricted regions of Europe (e.g. in the UK, Switzerland, France) some of which are still under way (e.g. the UK National Pond Monitoring Network). In addition, there have been a few international projects, typically of three years' duration, involving partnerships of three to five European states, such as occurred during the Pond-Life Project (1994–1997) (Boothby, 1997, 1999) and the Mediterranean temporary ponds Life Project (1999–2004) (Grillas *et al.*, 2004a,b). However, to make significant progress on the conservation of small water bodies at a European level a Europe-wide ponds conservation programme is now needed. An important first step in this process is the need to recognize ponds as a specific water-body type under the Water Framework Directive. There is now an urgent need to undertake action at a European scale for pond conservation, including coordination of research, education and training, pond management and environmental policy.

THE 1st EUROPEAN PONDS WORKSHOP

The diversity, richness and threats to ponds described above provided the background which motivated researchers and managers across Europe involved in pond conservation to meet in the 1st European Ponds Workshop devoted to 'Conservation and Monitoring of Pond Biodiversity' (including those concerned both with fundamental scientific issues and the practical applications needed to protect ponds). Three objectives were given for this first meeting: (i) synthesizing present knowledge on conservation and monitoring of pond biodiversity (scientific basis, methods, assessment and monitoring, case studies), (ii) launching international initiatives on pond conservation and ecology (particularly projects involving different European teams), and (iii) setting up a European network of people and institutions involved in the conservation of ponds. The meeting brought together nearly 100 participants from 11 countries: Belgium, Denmark, France, Germany, Hungary, Ireland, Italy, Moldavia, Poland, Spain, Switzerland and the UK. It was structured in three parts: (i) a plenary session with the presentation of 45 communications (oral or posters), (ii) five working group meetings, and (iii) two field trips on local ponds (alpine ponds and restored alluvial ponds).

This special issue of *Aquatic Conservation* presents a selection of 14 communications; another selection of eight papers is presented in a special issue of *Archives des Sciences* (issue no. 57, 2004).

SPECIAL ISSUE CONTENT

Ponds may support more species than rivers (e.g. invertebrates and plants), and more uncommon species. In terms of regional (gamma) diversity, they often make a greater contribution than any other aquatic habitat (Biggs *et al.*, 2005). However, a crucial issue is to estimate accurately the biodiversity hosted by individual ponds. Oertli *et al.* (2005) detailed standardized sampling methods for the estimation of the species richness of various taxa, including aquatic invertebrates, plants, and amphibians. However, despite the fact that standardized sampling methods are used, bias can be large for some taxa (e.g. amphibians) because detection probabilities may vary among species and between years in an unpredictable way (Schmidt, 2005). Site occupancy models tackle this difficulty, and are a useful tool for monitoring the distribution of animals and plants.

Species and metacommunities show marked spatial and temporal variation, as well as inter-annual turnover (Jeffries, 2005). From local to regional scales, many species are temporally segregated (Cayrou and Céréghino, 2005), while interactions between pond sites through dispersal are evident (Briers and Biggs, 2005). Such observations emphasize the need to consider spatial and temporal issues when developing strategies for pond conservation. Given the importance of ponds in maintaining aquatic biodiversity at the

landscape scale there is a clear need for further research on ponds in the catchment context (Biggs *et al.*, 2005). Specifically, pond networks should certainly be preserved, rather than an attempt be made to target some bodies of water for particular management actions.

Many contributions to this special issue highlight relationships between the species richness of various taxa and environmental variables (e.g. elevation, hydrology, pond area, water chemistry, habitat heterogeneity) with differences between permanent and temporary ponds (Della Bella *et al.*, 2005; Solimini *et al.*, 2005), and between lowland and alpine ponds (Hinden *et al.*, 2005). Ponds, and the biodiversity they host, are highly sensitive to land use and/or human activities in surrounding areas (Carchini *et al.*, 2005). Disturbance such as to nutrient loads (e.g. in farmland or pasture landscapes) may rapidly cause shifts towards eutrophic or turbid conditions (Ruggiero *et al.*, 2005), and affect the species richness of many taxa (Menetrey *et al.*, 2005).

Standard methods for the bio-assessment of ponds, critical to their management, have been proposed by several authors. Contributions under this topic show different approaches. Oertli *et al.* (2005) suggested a reference condition approach, where the ratio of measured species richness to predicted species richness (from environmental variables) allows the allocation of a quality status to each pond. Solimini *et al.* (2005) showed that the overall shape of the biomass size spectrum of benthic macroinvertebrates is similar among Mediterranean pond types, mesohabitats and sampling dates, suggesting a unifying reference for quantitative wetland biomonitoring. Boix *et al.* (2005) built quality indices based on taxon abundance, richness and ecological requirements, and on landscape and wetland vegetation type, respectively. Finally, because of their dimensions, abundance and variety, ponds are good model systems to understand the mechanisms underlying ecological patterns, and for hypothesis testing in fundamental ecology through experimental manipulation (De Meester *et al.*, 2005).

In conclusion, given the encompassing nature of the research needed, the above perspectives will require an integrated approach in which research groups working in different areas and having complementary expertise should be engaged in networking and intensive collaboration.

LAUNCHING THE 'EUROPEAN POND CONSERVATION NETWORK'

The main issue of the working sessions organized in the framework of the 1st European Ponds Workshop was the launching of the 'European Pond Conservation Network' (EPCN), with its mission of 'Promoting awareness, understanding and conservation of ponds in a changing European landscape'. Five objectives for the EPCN were proposed:

- To exchange information on pond ecology and conservation between researchers, managers and practitioners.
- To promote understanding of pond ecology by encouraging the development and coordination of fundamental and applied research.
- To raise the profile of ponds and guide national and supra-national policies for their protection.
- To promote effective practical pond conservation.
- To disseminate information on the importance, attractiveness and conservation of ponds to the people.

A website (www.epcn.org) presents the objectives, the activities and the publications of this network.

This workshop is expected to be the first of a long series: this type of meeting will be periodically repeated. The second workshop will be held in Toulouse on the 23–25 February 2006 with the main topic 'Conservation of Pond Biodiversity in a Changing European Landscape'. It will be co-organized by the University of Toulouse 3, University of Applied Sciences of Western Switzerland, University of Geneva, University of Leuven, Ponds Conservation: The Water Habitats Trust, and the Pôle-Relais Mares et Mouillères de France.

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