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POND RESEARCH AND MANAGEMENT

Pond research and management in Europe: "Small is Beautiful"

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The phrase "Small is Beautiful" was first used by the talented scholar Leopold Kohr (1909–1994), but it became more popular thanks to the essays of one of his students, the British economist E. F. Schumacher, and it was coined as a response to the socially established idea that "Big is Powerful". It could be argued that this desire for "bigness" explains why current legal frameworks and the conservation planning and management related to standing waters often overlook ponds, despite their well-known value in terms of biodiversity and socio-economic benefits (Oertli et al., 2004; Céreghino et al., 2008). Of course, this is only one of several possible explanations, but it is important to understand that such long-established ideas can have a lasting effect upon the efficiency of our conservation actions. Beyond this social perspective, the history of science can also provide some explanation as to why ponds have been undervalued for so long.

Some of the first limnological work was undertaken during the late nineteenth–early twentieth century by the Swiss scientist François-Alphonse Forel on the ecology of Lake Geneva (1892, 1895, 1904). From this, one of the firsts treatises of limnology—"*Die Binnengewässer Mitteleuropas*" (Thieneman, 1925)—included a chapter on standing waters that included lakes, ponds, pools and bogs, but most of the chapter focussed upon the larger bodies of water—a trend replicated in the limnology books which followed (e.g. Arévalo, 1929; Naumann, 1932; Ruttner, 1940; Dussart, 1966; Wetzel, 1975; Margalef, 1983). Lakes, therefore, were the "cradle" of limnological studies. During the second half of the twentieth century, the study of limnology broadened to include the ecological processes in rivers and streams, thanks mainly to the H. B. N. Hynes' masterful revision of the subject (Hynes, 1970). Ponds, however, remained overlooked and received significantly less scientific attention than streams, rivers and lakes. This is more

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surprising when several studies have established that (1) on a global scale they cover a greater total area than lakes (Downing et al., 2006); (2) their typical characteristics, such as shallow waters and small size, imply a different ecological functioning (Oertli et al., 2002; Søndergaard et al., 2005); (3) they play a major role in global cycles (Downing, 2010) and (4) they have high aquatic biodiversity (Wood et al., 2003; Williams et al., 2004).

Despite the evidence that ponds per se receive less scientific attention than other water bodies (Oertli et al., 2009), in the scientific literature "ponds" are often included under other terms such as "shallow lakes" (e.g. Scheffer et al., 1993; Moss et al., 2009) or "wetlands" (e.g. Gopal et al., 2000; van der Valk, 2006), as in the USA where the term "wetlands" is often used to describe "ponds" (Batzer & Wissinger, 1996 and references therein; Batzer et al., 1999). These more general definitions may significantly reduce the level of scientific interest and could go some way to explain some of the biases that are regularly observed today in Europe's Water Framework Directive (WFD) (Miracle et al., 2010). Ponds are too small to fit the standard model of site-based protection and they do not fit the standard model of consent-based protection applicable to lakes and running waters under Europe's most powerful piece of water legislation. In this context, three emerging ideas have to be taken into account in pond management decisions: (1) the importance of pond networks in addition to isolated ponds (Gibbs, 2000; Jeffries, 2005); (2) to consider lesser known floral and faunal groups which, nevertheless, contain high biodiversity (i.e. diatoms, meiofauna and insects), and to use surrogate species with caution (i.e. having some idea of their effectiveness for the circumstances in which they will be applied; Favreau et al., 2006; Gascón et al., 2009; Bagella et al., 2011); and (3) differences in the community structure and ecological functioning of water bodies throughout Europe imply, for example, that some limnological paradigms used in the management of cold temperate ponds cannot be generalised to the Mediterranean region (Álvarez-Cobelas et al., 2005; Brucet et al., 2009, 2010).

Ponds, neglected but fascinating habitats

Traditionally relatively few stakeholders were implicated in the management of ponds. Nowadays, the growing importance of a global society means that information is easy to obtain and not restricted to just a few stakeholders. However, describing the relationship between society and ponds is not easy; it requires the work of a multidisciplinary team including not only natural scientists but also social scientists, cultural historians and stakeholders directly involved in the planning process. Although this is an interesting and highly relevant debate, it will not be our principal focus in the present preface. Specifically, we will address first the human attraction and appeal of ponds, and, second, whether or not our genuine fascination and concern over the loss of these vital wetland habitats is adequately projected to an increasingly aware general public. Finally, we will review the various initiatives which have been taken over the past decade to address this issue.

Water bodies have attracted the attention of human beings for a long time. In Aristotle's "*The History of Animals*", he noted several curious observations about ponds and defended the seemingly spontaneous generation of life from mud or sand (referring to "fish", perhaps he had observed fairy shrimps because he was talking about temporary ponds) and rain (talking about eels). Examples of this attraction for ponds can be found in the non-scientific literature, art and popular culture which describe their magnetism. In the first pages of Joseph Kessel's book "*Le Lion*", the narrator feels a spontaneous and irrational desire to go to the pond where many different species of mammals enjoy a peaceful co-existence (Kessel, 1958). Even today, game lodges in East Africa provide tourists with spectacular views of the "water hole" to allow people to see the parade-like sequence of animals (elephants, baboons, waterbucks, warthogs, etc.). Similarly, this powerful attraction is well represented in a popular painting, "*Waterhole Dreaming*" by Lynda Brown Nabanunga from the Djaru Wa tribe (Western Australia). It depicts the desert in a period of drought and in order to survive all of the wildlife and the Aboriginal people of the area have come to the main water hole for water. For the American author Gene Logsdon his book "The Pond Lovers" relates the life histories of people who describe the intense feeling towards water with the words "the attraction to water is in our genes" (Logsdon, 2003). Legends, myths and tales from different human cultures talk about ponds or pond life (e.g. herons and pond fish appear in the tales of the South American Wichí people; hippos and

crocodiles in the tales of the African Ndebele people; and beavers and frogs in the tales of North American Sinkiuse Salish people). In some areas of Europe ponds are veiled in mystery and fairy creatures were believed to live in them (as the Scottish "Urisk" and "Glaistig", the former ugly and peaceful and the latter beautiful and dangerous; or the Catalan "dones d'aigua", female spirits with dragonfly or butterfly wings who live in ponds or streams and sometimes take care of the children and other times kidnap them). However, they are also the scenario of traditional tales ("*The Talking Pond Fish*", a tale explained in several parts of Europe with some regional differences) and of modern tales ("*The Tale of Mr. Jeremy Fisher*" by Beatrix Potter, a story of a fishing frog). Ponds have always been the preserve of people. Their size has made them suitable for many human uses and over the past two millennia they have become part of the daily lives of people around the world. However, if ponds provide such fascination and utility for human beings then why do we neglect them more than other habitats? Maybe, both aspects provide the answer: the human attraction to ponds can stimulate the capture of organisms, and the size of ponds allows people to transform and modify them very easily. If ponds have little or no economic function then it is very easy to fill them in. In the United Kingdom after the Second World War, the intensification of agriculture meant that small wetlands were drained or filled in. Modern machinery meant that a pond which had served as a watering hole for livestock for many centuries could be filled in less than a day—from wetland to dryland in a matter of hours.

Of course, capturing plants and animals and transforming our landscape is part of human nature, but, we would argue, so is the attraction of wildlife itself. Apart from its recently acknowledged economic value, by the start of the twenty-first century the benefits of nature conservation had assumed a new role—providing succour for a healthy society. Involvement in nature conservation—whether actively or passively, is now seen as a remedy for healthy living and living in a pleasant environment enhances our quality of life. In this sense, ponds provide a manageable human scale habitat in which the impact of local action can be seen in a short space of time. In parts of Europe where nature conservation is well-established, such as the United Kingdom, conservation plans are more easily carried out thanks to greater social sensibility (Drake & Pickering, 1997; Hull, 1999). In such countries, the availability of advice and guidance about the natural values of ponds for people of all ages is widely accessible (e.g. Engelhardt, 1964; Ammann, 1983; Jennings, 1985; Deom, 1991; Taylor, 1992; Wood & Dean, 1993; Biggs et al., 1994; Kolvoort & Gates, 2004) and, increasingly, online. Furthermore, this work is supported by a vast library of nature guides covering the natural world in Europe and providing an informed and readily accessible encyclopaedia of information (e.g. Streble & Krauter, 1985; Fitter & Manuel, 1986; Olsen et al., 1999; Grabow, 2000; Greenhalgh & Ovenden, 2007). Within this vast area of knowledge, ponds are widely acknowledged as important habitats for a wide ranges of plant and animal species—however, pond books per se have been inconspicuous until fairly recently. In the United Kingdom, the standard guide to Ponds was, until the mid-1990s, The Observer's Guide to Pond Life by John Clegg which was first published in 1956 (Clegg, 1956). This small pocket guide proudly announced in its preface that:

> There has long been a need, not only among the general public interested in natural history, but also among the ever-increasing number of students taking freshwater biology as an academic subject, for a compact, pictorial guide to the identification of aquatic animals and plants. (Clegg, 1956, p. 5).

Today, the situation is changing and the treatment of ponds is becoming more prevalent with textbooks describing the biodiversity, composition and functions of ponds (e.g. Brönmark & Hansson, 1998; Stoch, 2005) and practical guides to pond management (e.g. Williams et al., 1999; Wissinger, 1999; Lloyd & Alexander, 2002). However, we would strongly argue that more needs to be done to raise the awareness of ponds and the need for their conservation. As part of this process there is an urgent need to transmit recent research findings into a language understandable by all stakeholders—whether they are politicians, farmers, planners, school children, amateur naturalists or the general public at large.

The threats to ponds are well known (Oertli et al., 2005; EPCN, 2007, 2008; Nicolet et al., 2007) and, over the past 20 years, several projects at local, regional and European scales have been undertaken to address the principal issues. These initiatives have

helped to restore, create, or improve pond management techniques and to advise stakeholders about the value of these small water bodies. More recently, the emphasis of these projects has moved towards habitat and species recovery and mitigation measures (e.g. Ruhí et al., 2009, 2012; Antón-Pardo & Armengol, 2010; Gallardo et al., in press; Becerra-Jurado et al., 2011). In northern and central Europe, a number of projects have seen a large number of ponds created to reinforce amphibian populations (e.g. Stumpel & Van Der Voet, 1998; Baker & Halliday, 1999; Briggs, 2001; Rannap et al., 2009)—and this is a very positive new development. Nevertheless, it can be argued that a more rigorous scientific framework for pond creation is still required (Williams et al., 2008).

Another situation that has improved in the last decade is the management and protection of temporary ponds in the Mediterranean region. Several authors have established the value of Mediterranean temporary ponds and the need for urgent action to conserve these high-biodiversity habitats (Giudicelli & Thiéry, 1998; Quézel, 1998; Boix et al., 2001; Bagella et al., 2010) and, although a lot of work has been completed (e.g. LIFE projects in Mediterranean continental France, Corsica, Minorca and València; Grillas et al., 2004; Fraga et al., 2010; Sancho & Lacomba, 2010) it has not been enough. However, in a scenario of global climate change (GCC) some of these threats will continue to grow. Few analyses of the effects of GCC on pond biodiversity or the function of pond food webs have been published (but see Moss et al., 2009; Rosset et al., 2010; Rosset & Oertli, 2011), although for some faunal groups from ponds, such as dragonflies, amphibians or freshwater reptiles, investigations on the effect of GCC do exist (e.g. Blaustein et al., 2001; Hassall et al., 2007; Shoo et al., 2011; Sommer et al., 2011).

Fourth conference of the European Pond Conservation Network (EPCN—Berlin Conference, June 2010)

After the first EPCN meeting in Geneva 2004 ("Conservation and Monitoring of Pond Biodiversity"; Oertli et al., 2004, 2005), three more congresses have taken place: Toulouse 2006 ("Conservation of pond biodiversity in a changing European landscape"; Nicolet et al., 2007; Céreghino et al., 2008), València 2008 ("Pond conservation: from science to practice"; Oertli et al., 2009; Miracle et al., 2010) and, the most recent one in Berlin 2010 ("Eyes of the landscape – the value of ponds in the 21st century"). The last congress was organised by the EPCN and the Leibniz Centre for Agricultural Landscape Research (ZALF), Müncheberg, Germany, with the support of various partners.

During the short time that the EPCN has been in existence, the four meetings have attracted an increasing number of delegates. The figures of attendance of these four meetings illustrate this trend (Table 1). However, two weak points have to be commented upon. First, more than a half of the participants at the fourth EPCN conference came from only three countries (Fig. 1). Although the strength of pond research in different countries goes some way to explain this trend, at the same time it seems that the EPCN needs to make a greater effort to disseminate the value of the network to other regions (such as Eastern Europe). Second, the conference achieved a high scientific level, but it failed to involve many groups of stakeholders. Whilst, as scientists, we applaud our research effort, it is vital that we make a greater effort to influence and inform those people who have a direct impact upon the European pond resource. Whether they are government officials, planners, farmers, politicians or school children, we need to be able to provide them with "user-friendly" information which they can understand and apply.

In total, the Berlin congress included over 60 oral presentations and a similar number of poster presentations dealing with a wide range of topics including:

1. Pond typology, functions, services in landscapes
2. Methods of ecological monitoring and assessment

Table 1 Number of countries, participants and presentations in each EPCN meeting

	Countries represented	Number of participants	Presentations	
			Oral	Poster
Geneva 2004	10	79	23	22
Toulouse 2006	14	60	28	29
Valencia 2008	23	146	38	84
Berlin 2010	22	118	61	64

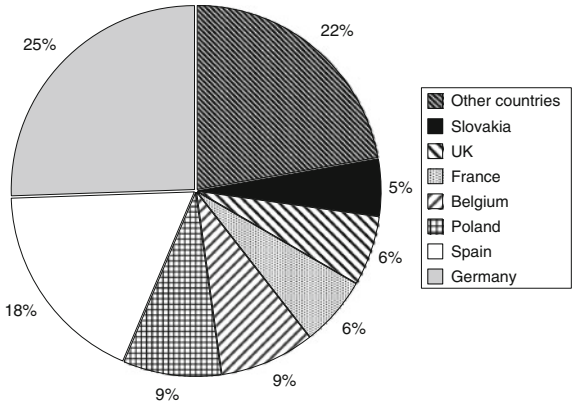

Fig. 1 Number of participants of each country in the last EPCN meeting (Berlin, 2010). Under the category "other countries" we included the countries which were represented by less than five participants. These countries were (ordered by decreasing number of participants): Italy, Switzerland, Norway, Netherlands, Hungary, Czech Republic, Belarus, Sweden, Portugal, Morocco, Malta, Luxembourg, Latvia, Denmark and Austria

3. Pedogenesis and paleolimnology of ponds
4. Hydrology, biogeochemistry, pollution of ponds
5. Habitat functions, biodiversity, bioindication
6. Practical use, conservation, management of ponds
7. Decision aids for policy, legislation, pond users
8. Education on pond functioning, values, wise use

In addition, three workshops were held (W1: ponds as sentinel systems for environmental impacts, W2: state and perspectives of pond research and conservation in Germany, W3: role of fish ponds) and two excursions were also offered, attracting a high level of participation.

This special issue of *Hydrobiologia* contains a selection of 12 contributions presented during the conference. A second selection of manuscripts will be published in a special issue of the journal *Limnologica* under the title: "Eyes of European landscapes – value, traits, conservation and management of ponds".

Special issue content

Like previous selections of manuscripts for the EPCN proceedings, the present proceedings demonstrate the strong relationship between scientific research and "management". It is important to emphasise that scientific research projects do not only produce tools and knowledge requested in management; at the same time, management projects present good opportunities to carry out scientific studies. Thus, some of the selected manuscripts have a clear practical objective (e.g. Teissier et al., this issue), others are basic research studies whose results are needed to improve management strategies (e.g. Jeffries, this issue) and the rest represent basic research performed in the framework of management projects (e.g. Ortells et al., this issue).

As a consequence of the implementation of the Habitats Directive and the Water Framework Directive, an important number of faunal and floral inventories, water body typologies, bioassessment techniques and monitoring programmes have been generated in the last decade in European Community countries. Although ponds have received less attention than other aquatic ecosystems, mainly because their sizes are not covered by the WFD, this situation has led to proposals for management tools and protocols. In turn, these proposals highlight some of what is needed to develop the objectives of both directives: *preserving water quality* and *prioritising conservation actions*. Some of those requirements are to establish a typology of ponds, to identify reference site characteristics, and to improve knowledge of environmental species preferences. Three manuscripts of the present selection treat these aspects. Céréghino et al. (this issue) compared the biological traits of macroinvertebrates in different biogeographical regions on a European spatial scale (the western Mediterranean, Central Europe and Britain are included), whilst Lischeid & Kalettka (this issue), on a more reduced spatial scale (northeast Germany), developed a classification scheme for kettle holes. Reference sites are difficult to identify in Europe due to high human pressure on aquatic environments. For this reason, information from neighbouring areas is important to avoid the degradation of sites and know their value, but also could help to identify characteristics of well-preserved sites and degradation processes. The work of Rhazi et al. (this issue) assessed pool loss in a region of Morocco and identified the main obstacles to the conservation of the plant richness of these pools.

Pond biodiversity loss has been one of the earliest concerns since the creation of the EPCN. Few studies have thoroughly analysed pond biodiversity processes: they have not only overlooked the gain–loss balance in terms of the number of ponds, but also the historical context, i.e. when they were created or destroyed. Jeffries (this issue) performed a

comprehensive analysis of this historical process in a region of the UK and compared the plant biodiversity of several types of ponds created in different historical moments for different social purposes. The previously mentioned manuscript by Rhazi et al. (this issue) also offered a good approach in this sense. Knowledge of community temporal patterns (i.e. *colonisation* and *succession*) provides the ecological framework needed to interpret the processes that took, are taking or will take place in a pond or in a pond network, and that have to be considered to reverse the present day scenario of biodiversity loss. In this sense, Ortells et al. (this issue) analysed the importance of founder effect, natural selection and genetic drift during the *Daphnia magna* colonisation process in newly created ponds in Spain. Moreover, Bosiacka & Pieńkowski (this issue) explored how the characteristics of ponds (i.e. size) or pond networks (i.e. connectivity) determine the macrophyte species richness in ponds located in Poland.

Management improvements such as tool creation, measures of methodological effectiveness, and the evaluation of the results of monitoring programmes or management experiments were also published in this selection. Peretyatko et al. (this issue) developed an efficient cyanobacterial bloom risk assessment tool for ponds in Brussels, whilst Teissier et al. (this issue) and De Backer et al. (this issue) evaluated phytoplankton–nutrient relationships and the probability of fish recolonisation, respectively, after a biomanipulation project carried out in ponds also located in Brussels. In addition, Florencio et al. (this issue) compared the suitability of two sampling techniques to detect species richness and patterns of diel activity.

Finally, two of the manuscripts develop *suitable conservation strategies to protect pond flora and fauna* or provide necessary information to develop them. Šumberová et al. (this issue) analysed historical and recent data on *Tillaea aquatica* L. in the Czech Republic, characterised its habitat, studied the seed bank and seed dispersal, and suggested management measures aimed at promoting the survival of this species. On the other hand, Dolgener et al. (this issue) identified management units for conservation of the *Bombina bombina* (L.) populations in an area of eastern Germany using a genetic approach.

These selected manuscripts are a faithful representation of the high diversity and quality of the presentations of the fourth EPCN meeting, and are a sample of some of the new insights into pond research and management promoted by the EPCN. The fifth EPCN conference, to be held in 2012 in Luxembourg, will be a new step in the enlarging of the network to all European states and to all pond stakeholders.

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