Ecological Indicators 54 (2015) 1–11

Contents lists available at ScienceDirect

Ecological Indicators

journal homepage: www.elsevier.com/locate/ecolind

Review

Assessing the ecological integrity of endorheic wetlands, with focus on Mediterranean temporary ponds

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ARTICLE INFO

Article history:
Received 2 October 2014
Received in revised form 6 February 2015
Accepted 10 February 2015

Keywords:
Biological indicators
Temporary wetlands
Ecological assessment
WFD

ABSTRACT

EU countries are required to perform an assessment of all freshwater habitats larger than 50 ha by 2015 to meet the requirements set by the Water Framework Directive (2000). To achieve this, an array of indicators and multimetric indices has been developed to monitor European waters. In general, these indicators are developed for large water bodies, while they are still largely lacking for smaller wetlands. This is in contrast with the conservation value, valuable ecosystem services and the often unique biodiversity of these systems, and the fact that like large (>50 ha) wetlands they are also covered by the Ramsar Convention. In (semi) arid regions, such as the Mediterranean basin, small water bodies are often of a temporary nature, are abundant and provide an important source of water for the local people, their livestock and agriculture. The quantity and quality of temporary wetlands are, however, decreasing at an alarming rate worldwide. Although some monitoring techniques were recently proposed, there is still an urgent need for a consistent policy and a user friendly set of monitoring tools for temporary wetlands that can be applied in different regions. In the following review, we present a whole range of indicators used to monitor different types of freshwater habitats, and discuss how some of these methods could be applied to temporary wetlands. Finally, we formulate some recommendations for temporary wetland monitoring and conservation.

Contents

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http://dx.doi.org/10.1016/j.ecolind.2015.02.016
1470-160X/

1. Introduction

Wetlands are one of the most biologically diverse ecosystems on earth (Mitsch and Gosselink, 2007). They usually house a diverse fauna and flora, including many rare and threatened species (Keddy, 2010). Wetlands also perform many important ecosystem services, including water storage, carbon sequestration, flood reduction, sediment trapping and reducing the effects of pesticides and other types of pollution through filtration (Costanza et al., 1997; Joyce, 2012). Although wetlands only cover 6% of the total land surface (Naiman and Décamps, 1997), the value of these areas is estimated to range between 49 billion to 3.4 trillion euros per year, measured as the budget needed if these services were to be replaced (Schuyt and Brander, 2004). According to the Ramsar Convention (Ramsar, 2013), wetlands include marshes, peatland and fens, ditches, lakes, ponds, lagoons, floodplains, estuaries and coastal zones (including coral reefs) not deeper than six meters (at low tide in case of tidal systems). They are characterized by: (i) a water saturated soil, (ii) a different soil composition compared to the surrounding non-wetland areas and (iii) specifically adapted vegetation that tolerates high water levels either permanently or temporarily, depending on the type of wetland (Maltby et al., 2009).

In general, high pressure due to human population growth often results in the disappearance of natural landscape components, such as natural water bodies and riparian zones. Globally, a wetland loss of 50% in the last century is commonly reported (Finlayson and D'cruz, 2005), and different models predict a loss ranging from 11% to 62% by 2080 for coastal wetlands alone (Nicholls, 2004). Together with intensified agriculture, anthropogenic pressure has also led to diffuse pollution and eutrophication in freshwater ecosystems (Arheimer et al., 2005). This loss and degradation of wetlands in general and their ecosystem services is further accelerated by climate change and introductions of invasive species. Despite the urgent need of protection of wetlands, monitoring and conservation are often hampered by sometimes inconsistent and contradictory international agreements and national policies (Turner et al., 2010), which makes their ecological assessment difficult to achieve. Even though the socio-economic value and ecological importance of wetland systems has widely (but only recently) been accepted, particularly in the subtropics, no recovery has yet been observed (Prigent et al., 2012).

The Water Framework Directive (WFD) (Directive 2000/60/EC) commits European Union member states to achieve good qualitative and quantitative status of all (ground and surface) water bodies by 2015 according to a set of standard criteria. In order to assess the current status of European surface waters and monitor any changes after management practices are implemented, a wide array of indicators were developed, not only based on standard chemical parameters, but also on biological characteristics, focusing on macrophytes, fish, phytoplankton and benthic macroinvertebrates (Solimini et al., 2009). Many indicators have been developed for different types of aquatic ecosystems ranging from small streams to large lakes as reviewed in Bird and Day (2010) and Birk et al. (2012). However, the WFD monitoring programs do not incorporate assessment techniques for temporary wetlands. In fact, the WFD currently excludes most temporary systems, since many of them are smaller than the stated size threshold of 50 ha. On the other hand, the Natura 2000 Network and the Ramsar Convention do have a special resolution on temporary wetlands (Ruiz (2008) and Ramsar Resolution VIII.33, respectively) that suggests the need for monitoring programs based on biological indicators to protect and manage temporary wetlands.

In arid and semi-arid regions, temporary waters are often very abundant and are an important water source (Brendonck and Williams, 2000; Williams, 2006; Bouahim et al., 2011). They are usually defined as wetlands that occur in endorheic depressions, characterized by alternating dry and wet phases, where the wet phase is sufficiently long to establish the specific soil conditions and floral and faunal communities of ephemeral ponds (Williams, 2006). They often house diverse plant and animal communities (Williams, 1997; Blaustein and Schwartz, 2001) and contribute tremendously to regional (gamma) biodiversity (Gibbs, 2000; Nicolet et al., 2004; Williams et al., 2004), sometimes even more than large water bodies (Biggs et al., 2014). They offer (temporary) housing to both general (opportunistic) species as well as to unique (temporary pond specific) species that are adapted to living under time stress and extreme environmental conditions (Grillas et al., 2004). Unfortunately, temporary wetlands are often neglected and disappear at an alarming rate, with percentage loss during the last century ranging from 60% to 97% in different parts of the world (Brendonck and Williams, 2000; Nicolet et al., 2004; Rhazi et al., 2012). Due to their small size and shallowness, these habitats are poorly buffered and easily destructed or degraded by human activities, such as urbanization, agriculture and pollution (Rhazi et al., 2012). Additionally, climate change is expected to have a much greater impact on these small water volumes compared to larger lakes (Parmesan, 2006). Therefore, vigilant monitoring and conservation of these systems is crucial. On the other hand, climate change could also increase the number of habitats by transforming currently perennial systems into temporary ones.

Mediterranean temporary ponds are a peculiar type of temporary wetlands, which mainly occur around the Mediterranean basin in southern Europe and North-Africa, but also in other regions experiencing a Mediterranean climate (i.e. mild and rainy winters, hot and dry summers), such as the southwestern coastal region of South Africa, South-West Australia, California and Chile (Grillas et al., 2010). The Mediterranean temporary ponds in southern Europe are included as a EU Priority Habitat under the auspices of the Habitats Directive (Natura code 3170, 92/43/CEE, 21 May 1992). These ponds harbor several rare or threatened species of plants, amphibians and invertebrates listed on international conventions (Habitats Directive, the Bern Convention and the IUCN Red List) (Grillas et al., 2004). The Ramsar Convention is also implemented in the Mediterranean Wetlands Strategy, aimed at "stopping and reversing the loss and degradation of Mediterranean wetlands as a contribution to the conservation of biodiversity and to sustainable development in the region" (Ramsar, 2013). However, lack of political recognition of small waterbodies as an entity and vital part of the water environment remains unacceptably high throughout Europe (Oertli et al., 2005b). Currently, efforts are made to emphasize the need to protect and include small (temporary) waters in the WFD, such as the "workshop on the protection and management of small water bodies" which took place in November 2013 and was organized by the European Environmental Bureau, in co-operation with the European Commission, the Lithuanian Presidency and the Freshwater Habitats Trust (Biggs et al., 2014).