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Loss detection of aquatic habitats in Italian volcanic lakes using historical data

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Abstract
Italian volcanic lakes represent an important hotspot of aquatic plant diversity. By comparing original data collected in 2009/10 with historical data, we detected species extinction and loss of habitats 3140 and 3150 (Habitats Directive 92/43/EEC). The speed of change detected claim for frequent monitoring and rapid management interventions.

Keywords: *Aquatic plants, conservation, freshwater ecosystems, volcanic lakes, habitats directive*

Introduction

Although freshwater ecosystems host a large number of species (Abramoviz 1996) and provide important services and goods (Costanza et al. 1997), they are seriously endangered by overexploitation, pollution and eutrophication (Dudgeon et al. 2006). Thus, several freshwater habitats are included in the Habitats Directive (92/43/EEC). Furthermore, all European countries are expected to assess the ecological status of their inland water bodies according to the European Water Framework Directive (WFD 2000/60/CE). The majority of natural lakes in Central and Southern Italy (Figure 1) are volcanic, an important lake system in Mediterranean region (Blasi & Frondoni 2011, Capotorti et al. 2012). Mediterranean lakes also feature numerous Sites of Community Importance (SCI – 92/43/EEC), owing to the presence of habitats 3140 (hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp.) and 3150 (natural euthrophic lakes with *Magnopotamion* or *Hydrocharition*-type vegetation). Nevertheless, few studies have focused on macrophytes in Mediterranean region (Bolpagni et al. 2012; Manolaki & Papastergiadou 2012), and monitoring program in the Italian volcanic lakes (IVLs) is missing. In this short note, we used historical data as substitute for real monitoring to assess the trend of aquatic habitats' decline.

Materials and methods

To evaluate the conservation status of macrophytes in IVL, we analysed four lakes in 2009–2010 (Lago Grande, Lago Piccolo, Albano and Nemi). In this paper, we focus on 3140 and 3150 habitats using a multi-temporal data-set. Lakes Nemi and Albano may be considered "natural oligotrophic lakes" (Margaritora 1992), like all the other volcanic lakes in the Lazio region. The ecological conditions found in these two lakes have changed considerably over the last century (Marchesoni 1940; Avena & Scoppola 1987; Ellwood et al. 2009). The Monticchio lakes (i.e., Lago Grande and Lago Piccolo), located in the Basilicata region, are instead small meromictic lakes that may be considered "natural eutrophic lakes". They have not been apparently subjected to severe anthropic impact. A general overview of the physical features of IVL is available in Limno database (Tartari et al. 2004). Data on the presence and distribution of macrophytes were collected in 2009 and 2010 during the growing season (July to September) along the depth gradient, using transect-based samplings. The transects were selected using two different methods: Buraschi et al. (2005) in

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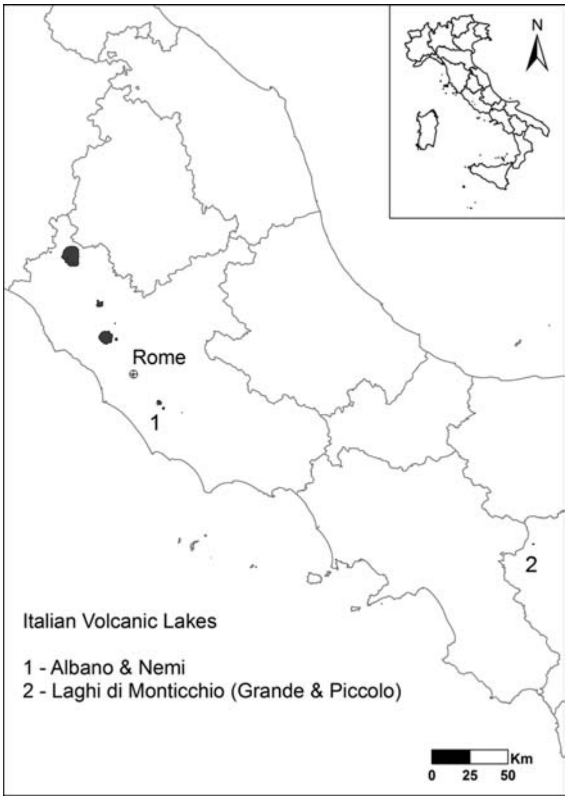

Figure 1. In dark gray the volcanic lake system.

2009; a new sampling method, based on randomly extracted transects, in 2010 (Azzella 2012). Species lists from the recent sampling of the four lakes selected for the purposes of this study were compared with those available in both published and unpublished studies (Table I). We derived data relative to habitat types (Biondi et al. 2009) and vegetation cover from the information and descriptions reported in those studies. By considering the presence and absence of species in each lake, we describe changes that have occurred in species composition and habitats.

Results and discussion

Few botanical references dating from times in which the degree of human impact on Lakes Nemi and Albano was low were found. In 1951, Lake Albano was described as characterized by the coexistence of habitats 3140 and 3150, with extensive meadows of hydrophytes down to a depth of 6 m and of stoneworts to a depth of 10 m (Stella 1951). We detected in 2009/2010 a strong reduction in aquatic vegetation cover and the disappearance of numerous species, including *Potamogeton perfoliatus*, *Potamogeton lucens*, *Nitella gracilis*, *Elodea canadensis* and *Nymphaea alba*. The presence of other species (*Ranunculus tricophyllus*, *Chara aspera*, *Chara vulgaris*, *Potamogeton pusillus*, *Nitella hyalina*) was extremely patchy. Habitat 3140 had already disappeared since the late 80s of the last century (Iberite, unpublished), while 3150 was still recorded in 1987 (Table II). Habitats of "*Magnopotamion*" and "*Chara* meadows" can, however, no longer be considered to be present in Lake Albano.

Some species detected in Lake Nemi in the first half of the 1980s have since disappeared (*Schoenoplectus lacustris*, *P. perfoliatus*, *Cyperus longus*, *Persicaria amphibia*). Other species were instead recorded for the first time (*P. lucens*, *P. nodosus*, *P. crispus*), including a remarkable colonization of stoneworts (*Chara globularis* and *Nitellopsis obtusa*). In 2010, the aquatic plant cover was continuous along the shoreline down to a maximum growth depth. By contrast, in 1981, the vegetation cover in Lake Nemi was discontinuous as it was in Lake Albano in 2010.

Regarding Monticchio Lakes, multi-temporal analysis revealed the loss in the last century (1907–2010) of 67% of species in Lago Grande and 60% in Lago Piccolo. Although both of these lakes should naturally host habitat 3150, in 2010, *P. lucens*, one of the indicator species of this habitat, was present exclusively in Lago Piccolo. Only two hydrophytes were found to be still present in Lago Grande: *N. alba* and *Ceratophyllum demersum*, which are species that also live in highly polluted conditions (Melzer 1999). We may consequently conclude that the presence of habitat 3150 in the two Monticchio lakes has markedly decreased. Species loss and habitat degradation are likely to be due to water pollution caused by an increasing number of tourist activities and the lack of an appropriate sewage treatment system.

Table I. Historical data and references available for the lakes analyzed.

Lake	Reference data	Reference
Albano	1949	Stella (1951)
Albano	1987	Iberite (unpublished)
Nemi	1981	Avena and Scoppola (1987)
Nemi	2002	Mastrantuono and Sforza (2008)
L. Grande and L. Piccolo	1907	Trotter (1908)
L. Grande and L. Piccolo	1999	Venanzoni et al. (2003)

Table II. Past and present records of EU Natura 2000 Habitats based on the analysis of indicative species and description of vegetation.

	Albano			Nemi		Lago Grande			Lago Piccolo		
Habitat	1948	1987	2010	1981	2010	1908	1999	2010	1908	1999	2010
3140	x	–	–	–	x	x	–	–	–	–	–
3150	x	x	–	–	x	x	x	–	x	X	–

Note: x, presence of the habitat; –, absence of the habitat.

Several alien species were detected: *Nelumbo nucifera* stand in Nemi was not visible in the 2005 aerial photographs. We thus hypothesized that the colonization occurred from 2005 onwards, covering an area of ca. 4300 m^2 by 2010, which points to a very high spread rate. *Taxodium distichum* was introduced on the shores of Lago Grande in the 1960s (unpublished data) and is now widespread along most of the shoreline, where it is invading the helophytic communities and is displaying an ability to grow and spread very rapidly.

The detection of new species in Lakes Albano and Nemi may be due to greater sampling accuracy in the 2009/2010 survey as well as to a general improvement in water quality (Mastrantuono & Sforza 2008), following the installation of a sewer system in 1990 in Lake Nemi and in 2009 in Lake Albano. By contrast, the absences recorded in 2009/2010 may be attributed to the local extinction of some species.

The general improvement recorded in Lake Nemi highlights three important points: (1) the loss of species is a partially reversible phenomenon in these lakes, (2) the time required for a partial recovery of the vegetation is rather short and (3) the findings of small patches of *Characeae* meadows demonstrate that habitat 3140 has the potential to occupy the deepest belt of macrophytic vegetation in Lake Nemi, as it did in Lake Albano in 1948. The invasion of *Nelumbo nucifera* and *Taxodium distichum*, as well as of other alien species (see, for example, Iberite et al. 2011), requires urgent management interventions to prevent the loss of native species and habitats (Avena & Scoppola 1987; Celesti-Grapow et al. 2010).

Our results show that IVL may play an important role in European aquatic habitat conservation. Nevertheless, it should be borne in mind that IVLs are subject to numerous changes. Although the available historical data are somewhat patchy and incomplete if compared with more recently collected data, they can help to detect trends in changes (see, for example, Croce et al. 2012). Given the rapid changes that may occur in aquatic ecosystems, including those without historical information, we recommend that detailed, systematic monitoring of IVL be promptly implemented to effectively address conservation priorities and management actions; indeed, we believe that they should be conducted even more frequently than recommended by the European WFD and Habitats Directive.

Notes

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