



Importance of a traditional irrigation system in amphibian conservation in the Cinque Terre National Park (NW Italy)



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ABSTRACT

In Mediterranean agricultural landscapes the impact of irrigation on biodiversity, and in particular on wildlife, remains controversial. This study investigated the role of traditional irrigation in the conservation of amphibians in the smallest and most densely populated national park in Italy, the Cinque Terre National Park (CTNP). The coastline in this area is so steep that dry stone walls were built to create arable land surfaces, irrigated by water stored in small open tanks. An almost complete census of these tanks and a survey of amphibian populations in natural and artificial habitats were undertaken from 2009 to 2012. A total of 58 water tanks were censused, 12 of them being empty, damaged or abandoned. All the tanks containing water were built in concrete and had small volume capacities (mean = 3.6, range 0.3–12.4 m³) but, overall, hosted all the seven aquatic amphibian species still present in the Park's natural freshwater habitats. Amphibians bred in 66% of the tanks still used for irrigation; large tanks were occupied more often than small tanks and hosted a different, more species-rich amphibian community. These results have management implications and confirm that, in the CTNP, extensive agriculture and biodiversity are compatible, and that maintaining traditional irrigation systems will benefit amphibian populations, especially in the case of drier climate scenarios.

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Introduction

Of the many factors responsible for the global amphibian decline, an emerging phenomenon in recent decades, the most important are habitat alteration, fragmentation and loss of breeding sites (Stuart et al. 2004). Aquatic habitats, which are the reproductive sites for many amphibian species, deserve distinct attention particularly because their reduction in number and quality is alarming both in the New and Old World (Halliday 2005; Stevens et al. 2002; Tiner 1984). Distribution of suitable water bodies becomes especially important when viewed in the framework of amphibian metapopulations, which are divisions of a larger population into relatively isolated sub-populations within a given area (e.g. Marsh & Trenham 2001; Molles 2005). The implications of this conceptual framework are that amphibian populations increase their level of fitness through the exchange of individuals between sub-populations inhabiting different water bodies, while their fitness is

threatened by a reduction in nearby breeding sites (e.g. Kolozsvary & Swihart 1999; Semlitsch & Bodie 1998).

In the Mediterranean, small seasonal aquatic habitats represent the overwhelming majority of freshwater ecosystems (Blondel & Aronson 1999), in which rare taxa of high conservation concern are common (Bologna & La Posta 2004; Griffiths 1997) or even exclusive (e.g. Della Bella et al. 2005), as is the case of Amphibia (Beja & Alcazar 2003; Diaz-Paniagua 1990; Jakob et al. 2003). Indeed, the Mediterranean basin is a biodiversity hotspot, albeit with a long-lasting history of human influence and modification (Mazzoleni et al. 2004; Myers et al. 2000). Therefore, many ecologists believe that the resulting mosaic of traditional pastures, vineyards, olive orchards shrublands and managed woods deserve conservation efforts to maintain both the traditional rural landscape and the current high level of biodiversity (Benton et al. 2003; Dudley 2012; Sokos et al. 2013). The main threats to such Mediterranean semi-natural ecosystems are land reclamation, urbanisation and intensification of agricultural practices. Indeed, all these activities have a major impact upon the traditional landscape, reducing its overall biodiversity (Atauri & de Lucio 2001; Blondel & Aronson 1999; Underwood et al. 2009). For Mediterranean amphibians

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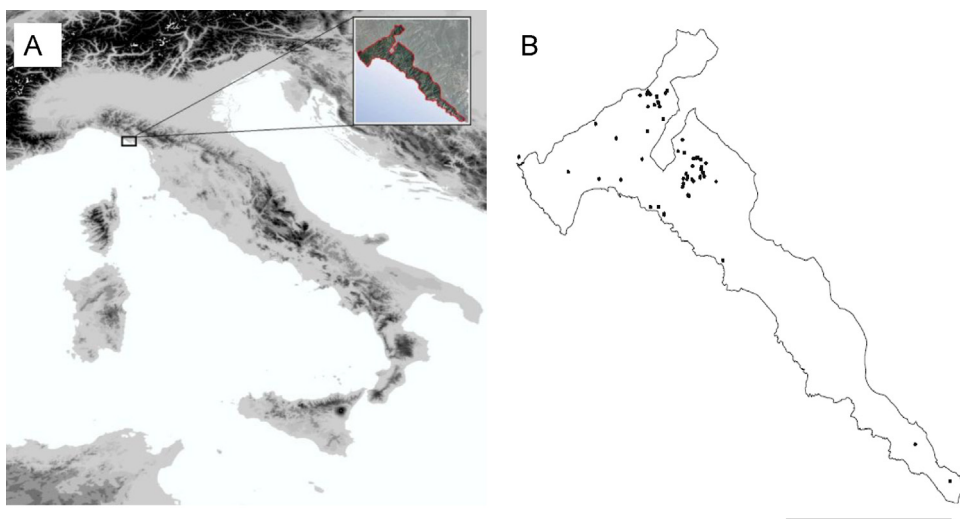


Fig. 1. (A) Map showing Italy and the location of the Cinque Terre National Park (inset); (B) distribution of the water tanks in the Cinque Terre National Park, horizontal bar corresponds to 5 km.

in particular, the major threats are habitat loss, introduction of allochthonous species, water pollution and drainage mainly caused by agricultural intensification (Cox et al. 2006).

The ability of amphibians to colonise artificial aquatic sites successfully has been well documented and is a worldwide phenomenon. It concerns mainly the colonisation of artificial habitats that simulate natural ones, e.g. man-made ponds, smooth shorelines and the presence of aquatic vegetation (Lannoo 2014; Monello & Wright 1999; Petranks et al. 2003; Rannap & Lõhmus 2009). However in the Mediterranean, in recent years it has clearly emerged that even artificial aquatic sites of smaller size (e.g. tanks, drinking-troughs and reservoirs with water surface < 10 m²) and extremely different in shape in comparison to natural sites, represent an important contribution to the potential breeding habitats for amphibians (Romano et al. 2010, 2012; Tripepi et al. 2001). These artificial water bodies may play an important role in maintaining viable populations of amphibians, while the adoption of intensive farming and the abandonment of traditional irrigation practices may cause the local loss of small isolated populations, as was the case in Spain (Casas et al. 2012; Fuentes-Rodríguez et al. 2013) and in NW Italy (Canessa et al. 2013). The impact of irrigation on Mediterranean ecosystems is still controversial. For instance, some studies show that intensive artificial irrigation reduces the distribution of steppe birds (Brotons et al. 2004), while others suggest that irrigation, by increasing local habitat heterogeneity, may be beneficial to some invertebrate taxa such as butterflies (González-Esteban et al. 2011). Therefore, our study aimed to assess the impact of a traditional irrigation system, still in use in the Cinque Terre National Park (CTNP) upon freshwater fauna and especially amphibians, which are considered the most threatened vertebrate group at the global level (Stuart et al. 2004). In this paper, traditional activities are defined as those that have long been in use (i.e. several decades in the focal landscape) and are well established in local agricultural practices (Agnoletti 2013).

Material and methods

Study area

The Cinque Terre National Park (CTNP), established in 1999 to preserve a traditional cultural landscape, occupies an area of over 3844 ha along the coast of Eastern Liguria (NW Italy, Fig. 1A) and

extends from the seacoast up to 812 m a.s.l. The CTNP has a resident population of about 5000 and is at the same time the smallest and most densely populated National Park in Italy (Corrado 2009). Its geomorphology is largely unfavourable for human settlements, as about 70% of the coastline is steep, with a slope > 60 degrees. Therefore, the colonisation of this area was completed only in the Late Middle Ages (i.e. around 1300 AD) when farmers from the inland regions of Liguria established the first permanent settlements along the coastline. The natural landscape was gradually transformed, the steep coastal slopes being dissected with natural dry stone walls that sustained strips of arable land or terraces. These terraces were then cultivated as vineyards, olive groves or small orchards. The resulting landscape is unique, with thousands of km of dry stone walls that sustain a system of cultivated terraces overlooking the sea (see Fig. 1, in Supplementary material). To preserve this outstanding cultural landscape, in 1997 the area was designated as part of a larger UNESCO World Heritage Site comprising Portovenere, Cinque Terre and the Islands of Palmaria, Tino and Tinetto.

In recent decades sustainable tourism has played the main socio-economic role in the life of the community, while traditional agriculture has declined in the most unfavourable parts of the area. Because the interaction between traditional farming and the natural environment maintained high levels of natural biodiversity (Mariotti et al. 2002; Peccenini 2005), the CTNP was also designated by the Italian national authorities as a Natura 2000 Site (IT1345005), established under the so-called European Habitats Directive 92/43/EEC. The main protected natural habitats according to this Directive are the rocky cliffs that host many nesting raptors and endemic plant species, together with the hill tops that are covered by sparse woods of Maritime Pine *Pinus pinaster*, Holm Oak *Quercus ilex* and European Chestnut *Castanea sativa* (Mariotti 2008). The known flora of the CTNP consists of 866 species (Peccenini 2005), confirming the biodiversity value of this relatively small area. Hill-ridges lie parallel to the coast and are only 2–3 km from the shoreline (Fig. 1A). Therefore, due to this geomorphological setting, torrents are very short, while standing water is infrequent and characterised by a pronounced temporary hydroperiod (*sensu* Yavercovski et al. 2004). The climate is sub-Mediterranean with dry summers, while rainfall is concentrated during spring and autumn. The mean annual temperature is 15.3 °C, while annual rainfall is approximately 900 mm (data from the town of Levanto, just outside the Park boundaries; Barberis et al. 1992).

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