ARTIFICIAL TANKS FOR AMPHIBIAN CONSERVATION IN MEDITERRANEAN RURAL LANDSCAPES

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ABSTRACT

In NW Italy, the abandonment of traditional farming is causing the loss of small artificial water reservoirs that are often used by amphibians as trophic and breeding habitats. Starting in 2010, a regional conservation project implemented in Val di Vara (Liguria, NW Italy), had the goal of improving the conservation status of the endangered Yellow-bellied toad (*Bombina pachypus*) and other local amphibians. During this project, nine artificial tanks equipped with special concrete ramps were built. These artificial tanks were constructed under the responsibility of Montemarcello-Magra-Vara Regional Park managers, while local landowners committed to their maintenance by signing an agreement. After more than 10 years, all the tanks are still functional and have been used by five amphibian species (*Bombina pachypus*, *Ichthyosaura alpestris*, *Rana dalmatina*, *Salamandra salamandra* and *Triturus carnifex*), as reproductive or shelter habitats. Moreover, five of the tanks are still used for watering livestock or as nature-based attractors and thus were beneficial to local farmers. These long-term positive outcomes of the project highlight that traditional farming systems may effectively protect both Mediterranean cultural landscape and local biodiversity.

KEYWORDS: amphibian ramps, artificial breeding sites conservation, Mediterranean, rural practices, watering tanks, Yellow-bellied toad.

INTRODUCTION

Amphibians breed, forage and shelter in a variety of natural and artificial habitats in different ecosystems (Wells, 2007; Valdez et al., 2021). Concerning aquatic habitats, amphibians use both standing and flowing freshwater bodies, in which many species lay eggs and develop as larvae through to metamorphosis. Amphibians are threatened worldwide by land degradation, pollution, water abstraction, climate change and the introduction of alien species, and are experiencing local population declines and even species extinction (Stuart et al., 2004). In the Mediterranean region, characterized by cool winters and relatively hot and dry summers (Blondel & Aronson, 1999), intensive agriculture, water reclamation and changes in annual precipitations are jeopardising many freshwater habitats used by amphibians (Beja & Alcazar, 2003; Cox et al., 2006; Albero et al., 2021). In fact, the ongoing abandonment of mountain and inland areas by farmers, pastoralists and foresters has reduced the availability of many human-managed habitats, such as small water reservoirs, that were historically built for watering livestock, irrigation and human consumption (e.g., Quintas-Soriano et al., 2022). In temperate ecosystems, many amphibian species are well adapted to, and often benefit from, artificial freshwater habitats, that represent alternative or substitutive habitats of natural slow-flowing streams, ponds or puddles

(e.g., Romano, 2014; Romano et al., 2012; Hartel et al., 2014). In recent years, the role of artificial habitat structures has been recognised as relevant for the conservation of terrestrial, freshwater, and marine biodiversity, in particular in degraded or human-modified ecosystems (Cowan et al., 2021; Watchorn et al., 2022). Of particular interest is the review paper by Watchorn et al. (2022), that extensively analyses the different kinds of artificial habitats that benefit animal populations. The definition of Watchorn et al. (2022), is relatively strict and limits artificial habitats for conservation to "… purposefully designed habitats meant as human-made substitutes for (or supplements to) natural habitat structures…". Therefore, all man-made habitats that may host temporarily or permanently animal individuals or populations, but that were built without a clear conservation goal such as roofs, chimneys, bridges, water channels, watering tanks and many others should not be included in the previous category. Although this seems a stringent definition, it has a logic because only structures conceived and implemented with a specific conservation goal should be considered by wildlife managers and conservationists as effective tools for the protection and maintenance of biodiversity.

In this paper, we describe the long-term outcomes of a project that realized artificial habitats specifically to benefit at the same time amphibian populations and farming practices, such as irrigation, livestock watering and ecotourism. This conservation project was conceived to be socially acceptable even by local policy makers and landscape planners, because it highlighted the importance of the local cultural heritage and traditional practices in maintaining Mediterranean human-shaped landscapes (Agnoletti, 2014). In fact, multifunctional structures are known to provide different services to society and the general public such as cultural heritage values, food security and maintenance of biodiversity and ecological functions (Quintas-Soriano et al., 2022). Thus, the planned multifunctional use of artificial habitats will be fundamental for a broader acceptance of present and future wildlife projects.

MATERIALS AND METHODS

The amphibian conservation project was funded by the Region of Liguria and the Regional Park of Montemarcello-Magra-Vara in 2010 (Arillo et al., 2013). The focal species was the endangered Yellow-bellied toad *Bombina pachypus* (Bonaparte, 1838), a species in the Low Concern IUCN category, but declining in NW Italy and, in particular, in Liguria (Canessa et al., 2013; IUCN, 2022). The Italian populations of *Bombina pachypus*, often considered a subspecies of *Bombina variegata* Linnaeus, 1758, i.e. *Bombina variegata pachypus* (Hofman et al., 2007; Fijarczyk et al., 2011), are usually associated to temporary streams with limited canopy cover but colonize and breed also in irrigation ponds and livestock watering tanks (Canessa et al. 2013: 2019). The regional conservation project was implemented in the Vara Valley, in the province of La Spezia and had three main goals: i) to increase the availability of breeding habitats for amphibians by building artificial water tanks equipped with special amphibian ramps; ii) to build a small open-air breeding facility to obtain *B. pachypus* tadpoles to be reintroduced in newly-built habitats and iii) to disseminate the importance of traditional rural practices in maintaining high values of local biodiversity. Artificial tanks were built under the responsibility of Regional Park conservation managers, only at locations where three conditions were met: i) presence of a source granting permanent or semi-permanent water flow; ii) presence of landowners committing to the

maintenance of the tank by signing an agreement with the Park authority and iii) current or past occurrence of *B. pachypus* in the surrounding area.

Artificial tanks were made in concrete and local stones, to match the traditional rural architecture and featured concreate exit ramps connecting the bottom to the tank edge. These "amphibian ramps" prevent the risk of post-breeding and metamorphosed amphibians being trapped inside the tank when the water level is low (Figure 1). Tanks were also equipped with a draining hose to allow emptying and cleaning the tank and an overflow duct (Figure 1). In addition, one side of the tank was always in connection with the ground to facilitate the entrance of amphibians during the breeding period. The occurrence of amphibians and their reproduction was monitored every year in five of the artificial sites, while surveys were irregular or opportunistic in the four others. Amphibian monitoring was performed by university staff and partially funded by the Mohamed bin-Zayed Species Conservation Fund (152510524) and the JPICH IRIS Project (699523). Research and reintroduction permits were issued by MATTM (DPN-2010-0010807; 36579/T-A31, 17/06/2016).

RESULTS

In the period 2010-2012, nine artificial concrete tanks equipped with amphibian ramps were built in Val di Vara (Figure 2, 3). In 2022, after more than 10 years from their construction, these tanks are still in place, holding water and offering potential breeding habitats for amphibian populations. In one tank, captive-bred tadpoles of the endangered *B. pachypus* raised in the breeding facility, were introduced and initiated a small reproductive population that continues to be viable as of 2022. The first 50 late-stage tadpoles in stages 38/40 (Gosner, 1960), were released in summer 2012, while 25, 40 and 10 more tadpoles introduced in 2013, 2014 and 2015, respectively. Nematomorph toadlets were already observed in 2012, while in 2016 breeding adults and tadpoles were observed in the tank, confirming a successful reproduction. The presence of adults of both sexes was confirmed annually up to 2022.

Two other tanks were naturally colonised by yellow-bellied toads. The Alpine newt (*Ichthyosaura alpestris)*, Fire salamander (*Salamandra salamandra*), Italian crested newt (*Triturus carnifex*) and Agile frog (*Rana dalmatina*) were also able to colonize the tanks and establishing breeding populations (Table 1). However, in a few cases it was not possible to confirm reproduction, because only adult individuals were observed. Notably, five of the nine water tanks are still actively used by landowners, as livestock watering sites and as nature-based eco-tourist attractions. Although all these concrete structures were still intact after more than 10 years, some tanks were observed to lose functionality over time, due to lack of management. In particular, two main problems were observed: the partial clogging of the water supply pipe that required mechanical interventions to restore water flow, and the accumulation of inorganic debris that gradually reduced the volume of water contained inside the concreate structure. However, in 2021 little field work was needed to completely restore the full functionality of these artificial sites, suggesting that these tanks are relatively robust and necessitate only occasional small interventions to maintain their long-term efficiency.

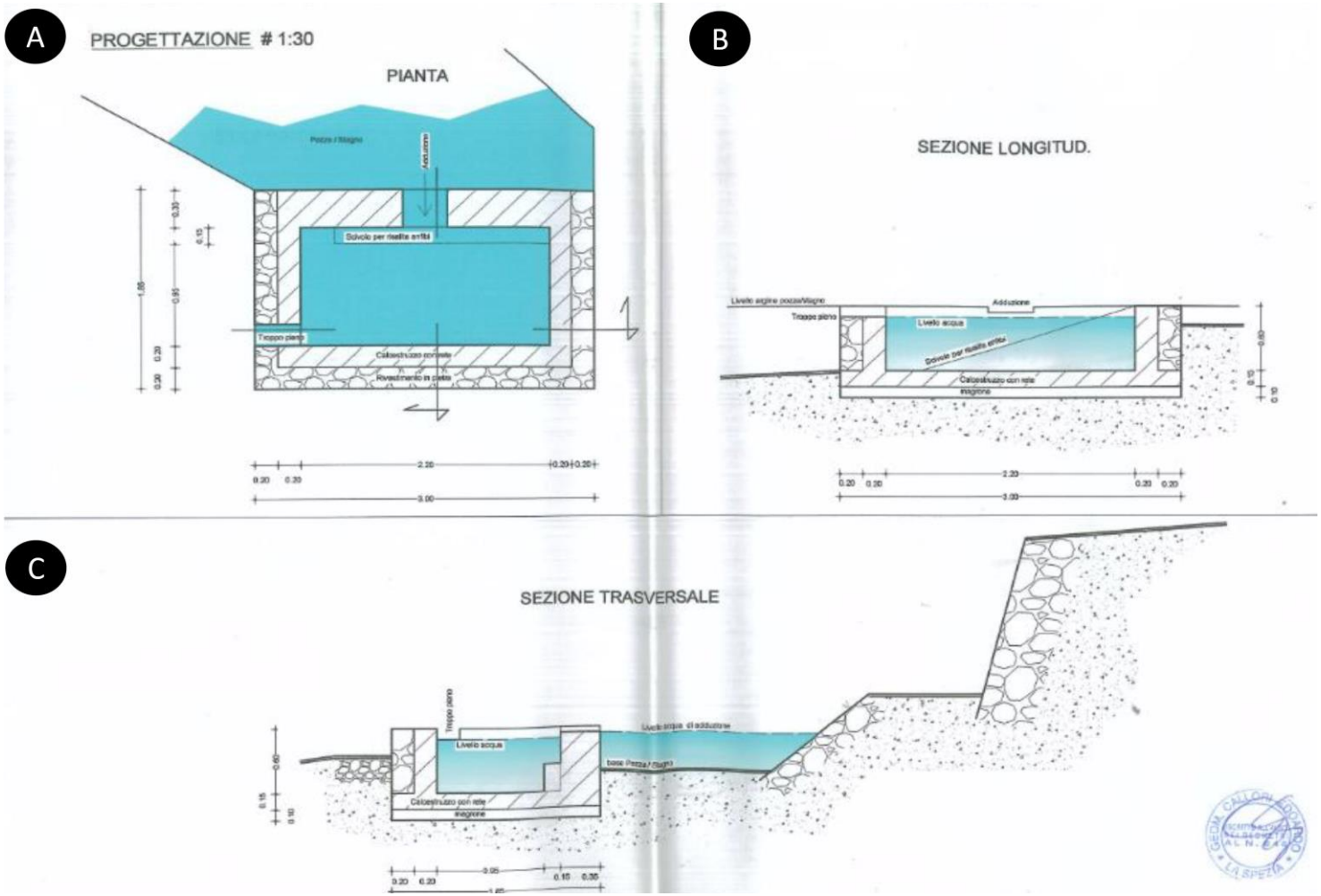

Figure 1. Plan of an artificial water tank equipped with amphibian ramps. A) View from above; B) Longitudinal view; C) Lateral view.

Table 1. Use of the artificial tanks built in the conservation project, by both amphibians (P = presence only; R = reproduction) and landowners or farmers (LW = livestock watering; NE = nature-based ecotourism).

Tank n.	**Yellow-bellied toad (*Bombina pachypus*)**	**Alpine newt (*Ichthyosaura alpestris*)**	**Crested newt (*Triturus carnifex*)**	**Fire salamander (*Salamandra salamandra*)**	**Agile frog (*Rana dalmatina*)**	**Farmers use**
1	Introduced (R)	R				
2	R	R				LW
3	P					
4	R					NE
5		R	R			LW
6				R		
7		R			R	NE
8					P	
9		R				LW

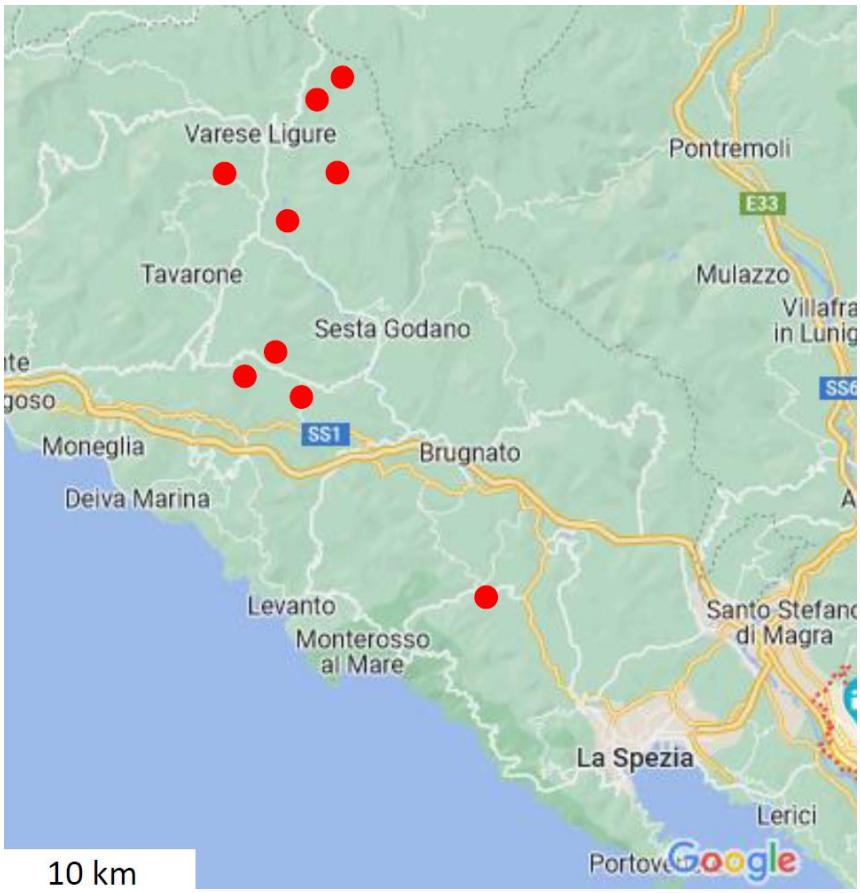

Figure 2. Location of the artificial concrete tanks built for amphibian conservation in Val di Vara, Province of La Spezia, NW Italy (Google Maps, 2022).

DISCUSSION

After more than 10 years, the regional conservation project is still providing positive effects to both local amphibians and farmers. In fact, five amphibian species were able to colonize these artificial habitats and were successful in establishing small viable populations in some of them. Although the Alpine newt, a common non-threatened species, was the species most frequently observed reproducing in the tanks, two species of conservation concern such as the Yellow-bellied toad (*Bombina pachypus*) and the Italian crested newt (*Triturus carnifex*) were also benefitting from these man-made habitats. Given the expected increasing dryness of the Mediterranean basin (e.g., Drobinski et al., 2020), man-made freshwater habitats will represent a fundamental resource for maintaining suitable trophic and breeding sites for amphibian populations and for increasing their connectivity among different natural habitats (Romano et al., 2014; Valdez et al., 2021). Obviously, these artificial structures are also providing benefits to

Figure 3. Artificial concrete tanks for amphibian conservation. A) Tank in construction; B) The amphibian ramp (arrow); C) Tank surrounded by vegetation: D) Tank used for watering livestock.

local landowners and farmers. In fact, building multifunctional water tanks seems a win-win strategy, in which biodiversity conservation and maintenance of rural and cultural values are not in contrast, but are acting with a positive synergic effect. However, it should be reminded that the full functionality of these artificial structures is linked to the maintenance of heir functionality as water reservoirs. In fact, at least one inspection per year should be carried out to verify their conservation status and to provide management.

Recognizing that traditional farming systems may effectively protect both the cultural landscape and the local biodiversity implies that rural traditional practices should be considered when planning conservation strategies in Mediterranean environments (e.g., Agnoletti, 2014; Cevasco et al., 2015). In any case, artificial watering tanks created specifically for amphibian conservation are likely to represent a secondary habitat for wildlife. However, they can still be a powerful conservation tool, allowing interactions among scientific conservation, socio-economic activities and historical cultural values, thus making conservation easier to be socially accepted and more cost-effective to be implemented.

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