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MANAGEMENT of Natura 2000 habitats

* Mediterranean temporary ponds

3170

Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora

EUROPEAN COMMISSION

environment

The European Commission (DG ENV B2) commissioned the Management of Natura 2000 habitats. 3170 *Mediterranean temporary ponds

This document was completed in March 2008 by Ernesto Ruiz, ATECMA

Comments, data or general information were generously provided by:

Miquel Campos, Ayuntamiento de Banyolas, Spain
Patrick Grillas, Tour du Valat, France
Joaquín Fernández, Junta de Extremadura, Spain
Antonio Camacho, Universidad de Valencia
Ana Guimaraes, ATECMA, Portugal

Coordination: Concha Olmeda, ATECMA & Daniela Zaghi, Comunità Ambiente

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Tesorero pond (Badajoz, Spain). Photo: J.L. Pérez-Bote.

31. Standing water

EUNIS Classification:
C1.6 - Temporary lakes, ponds and pools.
C3.4 - Species-poor beds of low-growing water-fringing or amphibious vegetation

* Priority habitat

Summary

Mediterranean temporary ponds are very shallow ponds (a few centimetres deep), isolated from permanent water bodies, which undergo a periodic cycle of flooding and drought, and have a characteristic flora and fauna adapted to this alternation. This habitat is mainly distributed in southern EU countries especially in dry and sub-arid areas. They occur in substrate depressions that may have been created by various geomorphological processes. Some of these ponds may be of artificial origin, e.g. in abandoned quarries. Mediterranean temporary ponds show great variability depending on their geology, geomorphology, depth and source of water (ground or run-off).

The specific plant species present in temporary ponds depend to a large extent on the type of substrate beneath the pond, the depth of water and the duration of flooding. In general they are all conditioned by a short life cycle and are able to produce seeds in the short favourable season. Temporary ponds also host rare and threatened animal species, including some crustaceans such as *Triops* sp., which appear in ponds only when predation from fish or crabs is not present.

The present trend in Mediterranean temporary ponds is clearly regressive. The main problem for this habitat comes from its ephemeral nature and small size. Its limited visibility leads to a lack of recognition of its values and functions which causes them to be readily destroyed or transformed. Additionally, trends in the Mediterranean region due to climate change will probably alter the hydrological regimes of freshwater inland water bodies.

Usual threats come from an inadequate management of the basin due to human activities such as agriculture, tree planting, abandonment of traditional land use and an incompatible use of the temporary ponds, such as excessive grazing, over harvesting of vegetation or over extraction of water. Habitat management is mainly aimed at correcting the negative effects of these activities and at restoring the ecological functions of the ponds.

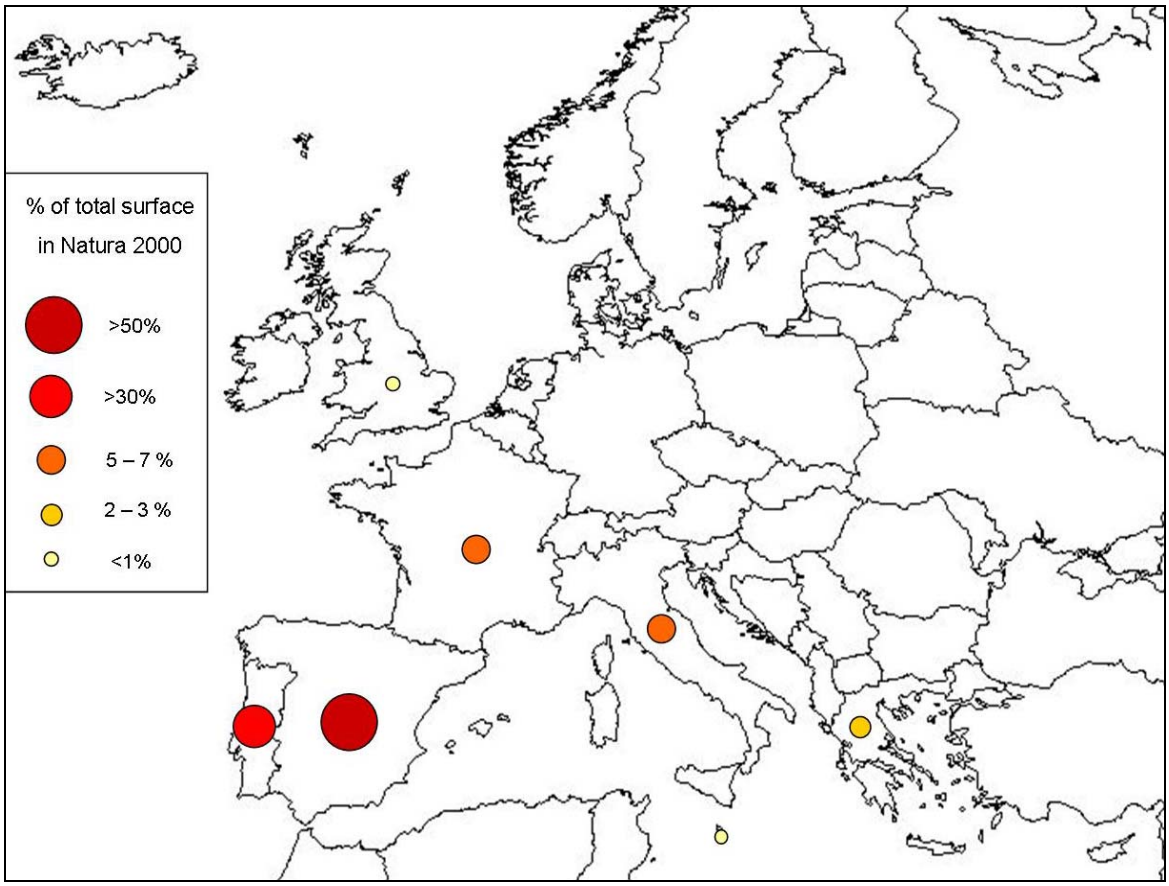
Conservation management of this habitat is usually related to adequate grazing management, control of agricultural activities in the surrounding catchment area and control of invasive alien species. Restoration activities are often necessary when the habitat is subject to severe degradation. However, temporary ponds show a high degree of variability and their management must be adapted to the specific conditions of each. Detailed site specific analysis of each pond should be carried out to determine the precise management measures required.

1. Description of habitat and related species

Mediterranean temporary ponds are small, shallow water bodies which undergo a periodic cycle of flooding and drought. This alternation promotes a very characteristic and particular fauna and flora. The flora is mainly composed of Mediterranean species that are conditioned by a short life cycle and must produce seeds before the dry season, which favours the annual plants. Mediterranean temporary ponds have a unique value due to their particular communities of plants, especially aquatic ferns (*Isoetes*). Small crustaceans that have a very short life cycle are a typical component of the fauna, with some species living exclusively in these ponds.

Distribution

Within the European Union, this habitat is mainly distributed in southern countries especially in dry and sub-arid areas, although one site containing this habitat type has also been identified in south-western United Kingdom.



Percentage distribution of the total surface of Mediterranean temporary ponds in Natura 2000

Mediterranean temporary ponds in Natura 2000 sites

The following data have been extracted from the Natura 2000 Network database, elaborated by the European Commission with data updated on December 2006. The surface was estimated on the basis of the habitat cover indicated for each protected site and should be considered only as indicative of the habitat surface included in Natura 2000.

Biogeographical region	Nº of sites	Estimated surface in Natura 2000 (ha)	% of total surface in Natura 2000
Mediterranean	268	61,894	96.81
Atlantic	12	1,042	1.63
Alpine	1	589	0.92
Continental	11	214	0.34
Macaronesic	4	193	0.31
Countries	**Nº of sites**	**Estimated surface in Natura 2000 (ha)**	**% of total surface in Natura 2000**
Spain	120	33,546	52.47
Portugal	28	21,199	33.16
France	46	3,879	6.07
Italy	66	3,830	5.99
Greece	28	1,467	2.29
United Kingdom	1	10	0.02
Malta	7	1	0.01
TOTAL	**296**	**63,932**	**100**

Main habitat features, ecology and variability

Temporary ponds are distributed all around the world, but are more frequent in dry, semi-arid and arid zones. According to the Ramsar Convention (2002), temporary ponds are small, shallow water bodies (less than 10 ha), isolated from permanent water sources, which undergo a periodic cycle of flooding and drought.

The Interpretation Manual of European Union Habitats (EC 2007) defines Mediterranean temporary ponds as "very shallow temporary ponds (a few centimetres deep) which exist only in winter or in late spring, with a flora mainly composed of Mediterranean therophytic and geophytic species belonging to the alliances *Isoetion, Nanocyperion flavescentis, Preslion cervinae, Agrostion salmanticae, Heleochloion* and *Lythrion tribracteati."*

They occur in substrate depressions. These depressions may have been created by various geomorphological processes such as subsidence or erosion by wind on dry plains, and dissolution of limestone in karstic areas. Alternatively, they might be of artificial origin, e.g. in abandoned quarries or watering holes for cattle or sheep (Ramsar 2002).

Water originates from a variety of sources: rainfall, runoff from the surrounding catchment area (usually an endorheic basin) and/or from groundwater. Temporary ponds that depend on groundwater are typically those of karstic origin or in sandy substrates. Those that depend strictly on rainfall and runoff are usually on impermeable substrates, such as rock or clay.

The hydrological dynamics of a pond depends upon the equilibrium between incoming and outgoing water. Water is lost both directly through the evaporation and indirectly through plant transpiration (both together are known as evapo-transpiration). Water may also be lost through leakage when the pond is on a permeable substrate, such as sand or karst (Grillas *et al*. 2004).

In order for these habitats to function correctly they must undergo a periodic cycle of flooding and drought. This alternation promotes the proliferation of their characteristic and particular fauna and flora.

It is also important that this type of habitat is isolated from permanent water bodies. If the two are connected the temporary ponds will be rapidly colonized during the flooding season by fauna and flora from the permanent water bodies. This may alter the biological composition of the site and cause the loss of most of the temporary pond's own characteristic species due to competition and predation (Ramsar 2002). The connexion with permanent water bodies often results in the introduction of fishes that predate intensively on crustaceans and larvae of amphibians. The introduction of fishes strongly modifies the composition of the invertebrate community, originally formed by species that usually do not experience predation by fishes.

The specific plant species present in temporary ponds depend to a large extent on the type of substrate beneath the pond, the depth of water and the duration of flooding. In general they are all conditioned by a short life cycle and are able to produce seeds in the short favourable season. This condition favours annual plants both in the wet and dry period.

Species that may be found in these habitats include aquatic species as *Nitella opaca* and *Callitriche brutia*, many amphibious species, as *Mentha cervina*, *Isoetes boryana, I. delilei, I. duriei, I. heldreichii, I. histrix, I. malinverniana, I. velata*, *Ranunculus dichotomiflorus, R. lateriflorus*, *Illecebrum verticillatum*, *Cyperus flavescens, C. fuscus, C. michelianus* and *Damasonium alisma,* and some terrestrial species, as *Serapias lingua, S. neglecta, S. vomeracea*, *Agrostis pourretii* and *Centaurium spicatum*. Other species that may be found in these habitats are *Chaetopogon fasciculatus, Cicendia filiformis, Crypsis aculeata, C. alopecuroides, C. schoenoides, Elatine macropoda, Eryngium corniculatum, E. galioides, Exaculum pusillum, Fimbristylis bisumbellata, Glinus lotoides, Gnaphalium uliginosum, Juncus buffonius, J. capitatus, J. pygmaeus, J. tenageia, Lythrum castellanum, *L. flexuosum, L. tribracteatum, Marsilea batardae, M. strigosa* (EC 2007). Different associations of these plants can be found forming ring belts within the pond and in the shores. Many annual species from the surrounding habitats may temporarily colonise these ponds.

Aquatic vegetation and an important part of the invertebrate fauna depend on seeds, spores, eggs and cyst banks to survive during the dry period. The type of fauna associated with these ponds depends on the size of the pond, the soil and the time span of flooding. In the most extreme version of temporary ponds, as in the case of ponds carved out of rock, or cupola ponds, the fauna is poor but very characteristic. It is mainly composed of crustaceans such as branchiopods, ostracods and copepods (Marrone *et al*. 2006, Frisch and Green 2007,) that have a very short life cycle and are usually monocyclic. They lay their eggs or cysts in the sediments at the start of the dry period. These then hatch once the water returns. Opportunistic insects also use the ponds for reproduction or feeding (mainly Odonata, Diptera and some Coleoptera) during the wet period but emigrate to other water bodies when the drought arrives. The maintenance of the sediments as a stock of seeds and resting stages ensuring future populations is essential for the maintenance of the biodiversity of temporary ponds.

Compared to permanent ponds in the same area, temporary ponds host a smaller number of invertebrate species. A study on macro invertebrate diversity in Italy showed that the main environmental factors influencing the number of species in ponds are the length of the flooding period as well as its depth, surface area, dissolved oxygen concentration and macrophyte species richness. Temporary ponds contain a smaller number of taxa than permanent ponds, but both support similar numbers of rare and threatened species. (della Bella *et al*. 2005). Some crustaceans such as *Triops* sp. appear in ponds only when predation from fish or crabs is not present (Pérez-Bote *et al.* 2004).

Figure 1. Triops cancriformis mauritanicus. Photo: J.L. Pérez-Bote

Variability. Different types identified

Mediterranean temporary ponds show great variability depending on their geology, geomorphology, depth and source of water (ground or run-off). Their vegetation may also vary depending on depth, water chemistry and duration of flooding.

Grillas *et al*. 2004 (2004) provide a very complete classification based on the origin and on the type of substrate. Other authors (Bartolomé *et al.* 2005, Gaudillat & Haury 2002) do not make a distinction between natural or artificial ponds, basing their classification instead on the vegetation type conditioned by the substrate and the optimum hydrological period (spring, summer or autumn).

The most characteristic type of Mediterranean temporary ponds are related to topographic depressions located on impermeable substrates of clay and marl or in places where the water table intersects with the ground in rainy period. They can be found on plains in arid and semiarid zones, in endorheic basins and in valley bottoms with similar characteristics (arid climate and endorheic catchments).

Rocky ponds or cupola ponds ('cocons' in catalan) are small ponds that have been carved into hard rock or rock slabs by water erosion. Water comes exclusively from rainfall and the dry period is extreme. The soil layer is very thin and the vegetation is scarce.

Temporary ponds can also occur in poljes and dolines (sinkholes) that are characteristic of karstic sites. Water comes from rainfall and groundwater and occupies temporarily the central lower part of the doline. These ponds tend to have a rich fauna and flora.

Ponds related to river dynamics (but not connected to the river stream) are usually in depressions of less than 1 metre. They get their water from rainfall and, in some cases, from variations in the groundwater table, but not from the river floods. Occasionally these ponds may be affected by river flooding and as a result their biological composition may experience changes, but if those episodes are not very frequent, the dry period allows restoring their original biological composition.

Artificial temporary ponds have also different origins. They may be created for cattle watering, as water reservoirs, or to extract soil or other material. For instance, temporary ponds are found in abandoned quarries of the Reserve Narturelle de Roque-Haute in southern France (Grillas *et al*. 2004). In some cases, the pond has its origins in an old human infrastructure, such as a stonewall or an old pathway.

The type of substrate often determines water turbidity, which in turn influences the development of biological communities. Ponds located on rocky or sandy substrate usually have low mineral turbidity, whereas those overlying materials composed by smaller particle size, such as clay or marl are more suitable to sediment suspension and consequently may present more turbid waters.

Species that depend on the habitat

Mediterranean temporary ponds have a unique value due to their particular communities of plants, especially aquatic ferns (*Isoetes*) and because they harbour a high proportion of endangered species. Plant diversity may be very high in some cases. In Menorca 345 plant species where identified in several temporary wetlands, 102 species usually grow in the flooding area of which 74 are present during the flooding period and 35 in the dry period. (LIFE05/NAT/ES/000058).

A lot of invertebrates rely on temporary ponds for reproduction (e.g. beetles, diptera, dragonflies). Some spend their entire life cycle in these ponds as in the case of branchiopods. Several species of this type of crustaceans are only found in this type of ponds because of the lack of predatory fish. Branchiopods found in these habitats (Alonso 1996) may include *Notostraca* (tadpole shrimps), *Cladocera* (water fleas), *Anostraca* (fairy shrimps) and *Conchostraca* (clam shrimps).

Several amphibians use the ponds as breeding sites. Because they are usually isolated from permanent water bodies, they are free of egg predators such as fish (Meegan 2006). Amphibian species that use temporary ponds, and are therefore accustomed to unpredictable habitats in the Mediterranean region, have a plastic reproductive strategy which allows populations to adjust their breeding period according to episodes of rainfall. Species that use temporary or ephemeral ponds, like *Bufo calamita* or *Pelodytes.*

punctatus, are explosive breeders whose reproductive effort is associated with rain during spring-like seasons (Richter-Boix *et al.* 2006, Grillas & Roché 1997).

Management required for invertebrates and amphibians is just keeping the pond free of fish or invasive crabs, and maintaining the hydrological dynamics of the wetland.

Birds, usually those of a larger size, also profit from temporary ponds. Migratory waterfowl also use the ponds as wintering and stepping stone sites (Grillas & Roché 1997). Storks find food in those pools in winter time and early spring.

Related habitats

Mediterranean temporary ponds are often associated, or in contact, with pasture land, which, in the Mediterranean region, usually corresponds to the following habitats: 1510* Mediterranean salt steppes (*Limonietalia*), 2240 *Brachypodietalia* dune grasslands with annuals, 6220* Pseudo-steppe with grasses and annuals of the *Thero-Brachypodietea*, 6410 *Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*), and 6420 herb grasslands of the *Molinio-Holoschoenion*.

Mediterranean temporary ponds are related to some permanent wetland habitats. According to the Interpretation Manual of European Union Habitats (EC 2007), they are considered a particular sub-type (temporary and very shallow waters) of the habitat 3120 which is characterised by dwarf amphibious vegetation of oligotrophic waters with few minerals, mostly on sandy soils of the Mediterranean region and some irradiations in the thermo-Atlantic sector, which belongs to the *Isoeto-Nano-Juncetea*. They are also related to the habitat 3130 - oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and/or *Isoeto-Nanojuncetea*. In general these three habitat types have similar management requirements in relation to scrub encroachment, eutrophication, pollution, drainage and an over-exploitation of the aquifer.

Ecological services and benefits of the habitat

Depending on the site geology, Mediterranean temporary ponds may participate in the aquifer recharge. This is the case for wetlands located in karstic areas or in permeable substrates where the occurrence of the temporary wetland is related to the height of the water table.

These ponds are crucial in providing water to wildlife in very dry environments and traditionally have been used for livestock watering. Some ponds that are currently classified as Mediterranean temporary ponds were created for this purpose in the past. However, their use by livestock may have a negative impact on the habitat and cause its degradation, as explained below.

Finally, despite their ephemeral nature and small size, temporary ponds have a great importance for biodiversity maintenance in particular as regards some rare invertebrate species (Williams 1997).

Trends

The present trend in Mediterranean temporary ponds is clearly regressive. The main problem for this habitat comes from its ephemeral nature and small size. Its limited visibility leads to a lack of recognition of its values and functions which causes them to be readily destroyed or transformed.

Although temporary ponds have recently been recognized as a wetland type of international importance by the Ramsar Convention (Ramsar 2002), political recognition of these ponds as an important part of the water environment remains insignificant throughout Europe. This is perhaps the single most important reason for the continued loss and impairment of ponds.

An inventory was recently done in Greece which shows that a significant percentage of the Mediterranean temporary ponds in the country are at risk mainly due to human activities, such as agricultural pollution, expansion of cropland and over-exploitation of water resources. It concluded that

immediate restoration and conservation actions should be taken in order to prevent further ecological degradation (Dimitriou *et al*. 2006).

Additionally, actual trends in the Mediterranean region due to climate change will probably alter the hydrological regimes of freshwater inland water bodies (see "Climate change effects").

Threats

Threats affecting this habitat depend on specific site conditions. Usual threats come from an inadequate management of the basin due to human activities such as agriculture, tree planting, abandonment of traditional land use and an incompatible use of the temporary ponds, such as excessive grazing, over harvesting of vegetation or over extraction of water.

Alteration to the hydrological functioning

Alterations in hydrological functioning may affect Mediterranean temporary ponds in different ways, they may be dredged, drained, silted or desiccated. Desiccation may also result from an over-exploitation of the aquifer or a deviation of the water within the catchment area away from the temporary pond.

Silting. Silting of ponds is part of the natural evolution of all wetlands but it can be accelerated by several factors, the main one being related to strong modifications in the catchment basin due to destruction of the vegetation cover around the pond and increasing erosion. Agriculture around the site may lead to silting as well.

Over-exploitation of aquifers. Construction of wells around the pond and tree planting (especially *Eucalyptus)* may cause a depletion of the aquifer which can in turn negatively impact on the hydrology of the site. A reduction in groundwater quantity/availability may lead to desiccation of ponds that are mainly fed by groundwater and cause the eventual loss of the habitat. Although the seed bank and invertebrate cysts may resist long periods of desiccation (sometimes they can last for years), a prolonged drought may lead to a significant loss of diversity and, in extreme cases, to a complete loss of a functional habitat.

Draining. Many wetlands are drained to increase the area that can be used as arable land or because they are considered a source of pests. This is usually done by digging channels to remove the water from the site.

Dredging. Some temporary ponds, used for watering cattle for instance, are dredged and transformed into permanent wetlands. This may cause the invasion of less specialized and more competitive plant and animal species which may threaten the key biodiversity values of temporary pools through an increase in predation and competition.

Modifications to the basin. The following modifications may negatively impact on the ponds: the loss of vegetation which leads to increased siltation, the construction of channels to drive the water out of the site or to bring water into the site. In the first case, the site loses the incoming water and, as a result, desiccates. In the second case, an excess of water changes the hydrological dynamic and the whole functioning of the pond, which may cause it to be transformed into a permanent pond.

Pollution

Pollution affecting temporary ponds comes mainly from the use of pesticides or fertilizers. This type of diffuse pollution is especially difficult to overcome, since part of it can reach the pond not only from the surface, but also from groundwater inflows. Pollution affects crustacean communities and tadpoles of amphibians which are very sensitive to chemical changes in the water and to pesticides and herbicides in particular.

Fertilizers may cause the eutrophication of the pond. Some Mediterranean temporary ponds are oligotrophic and the increase in nutrients tends to modify the plant communities towards more

mesotrophic or eutrophic vegetation. This is more important for deep pools that are flooded over long periods where algae proliferation can be detrimental to the vegetation. However, alternation of flood and dry conditions enhance the de-nitrification of the pools.

Some invertebrate species, as the dragonflies, are very sensitive to pesticides during their aquatic (larval) stage.

Overgrazing

Excessive grazing may lead to the eutrophication of the ponds, intense defoliation of the natural vegetation, direct destruction of plants through trampling, a lower capacity for plants to produce seed (if pastured during the flowering period), the loss of soil structure and changes in the composition of the flora and fauna. An excess of nutrients in the water leads to invasion by more competitive plant species.

However, the impact of grazing can vary depending on the type of livestock and the season. The most important damages to vegetation are caused by large animals (cattle, horses) overgrazing in flooded and wet conditions. Grazing during the dry phase by light animals, not entering into the water, is less detrimental as it does not cause physical damage to the soil. Grazing in late spring can be beneficial to the characteristic plant species of this priority habitat as it reduces the cover of perennial (more competitive) species.

Shrub Encroachment

Encroachment is the name given to the process of invasion of the site by plant species (scrub or big size grasses), which cover completely the surface of the site impeding the development of smaller vegetal species. Scrub encroachment has several impacts on the ponds. Leaf litter tends to silt the site. The amount of light coming into the pond diminishes as a result and typical plants disappear. Water temperature falls due to the lack of sunlight which in turn causes invertebrate cysts and amphibian eggs to have problems in hatching. Evapo-transpiration increases which dries up the pond, whilst the increase in green litter causes the site to silt up and leads to eutrophication.

Fire

Fire may partially destroy the seed bank as well as the vegetation of the pond and its surroundings. The destruction of the vegetation leads to erosion which silts up the pond with ashes and soil; the eutrophied pond then becomes a perfect ground for competitors such as helophytes and scrub which produce green litter and prevent the natural vegetation from re-establishing itself. This in turn causes more siltation and eutrophication. In a relative short time period the pond may disappear entirely.

Invasive species

Several alien invasive species may affect both the fauna and flora of Mediterranean temporary ponds. Some of the most common invasive plant species include *Arundo donax, Paspalum sp, Panicum capillare, Freesia alba, Euphorbia prostrata,* etc. Invasive alien flora can partially or completely displace autochthonous flora.

The introduction of fish or invasive crabs may be a problem as they usually predate on eggs of amphibians as well as on aquatic invertebrates that are characteristic of these ponds. If it is occasional, the problem disappears as the pond dries up. Deliberate introduction of fish is a common problem near urban areas. Invasion by the crayfish *Procrambarus clarckii* has been detected in some temporary ponds in Spain (they come from irrigation channels used in rice fields). This leads to the direct predation of the autochthonous crustacean fauna, (Pérez-Bote *et al.* 2004). This crab also has a negative impact on the plant species (Grillas *et al.* 2004). Another problematic species is the Florida turtle (*Trachemys scripta*) which may displace native turtles and predate on amphibians and other fauna.

Inadequate use of the pond

Ponds can be used as a dumping site (sometimes as the first step to urbanisation) due to the lack of recognition of its values by local inhabitants. It may also be transformed into a permanent pond in order that it can be used as watering spot for cattle or to favour waterfowl all the year round.

Off-road vehicles

Off-road vehicles are sometimes a threat because they flatten and change the structure of the soil and alter the hydrological functioning of the pond. They also destroy the vegetation which causes the water to become turbid and this affects the entire plant and animal community. Off-road vehicles may increase erosion in the catchment area and therefore cause the siltation of the ponds.

Urban sprawl

Urban sprawl does not recognise the existence of temporary ponds, except if they are legally protected or if NGOs campaign for their conservation. Hundreds of sites have disappeared in the last fifteen years as a result of the construction of new residential areas, roads and industrial sites.

Climate change effects

The Mediterranean temporary ponds depend on an annual cycle of rainfall and drought. Rising temperatures may lead to prolonged periods of drought and a general lack of rainfall in certain zones. This could significantly affect this habitat. Without sufficient water they will not be able to maintain their ecological functions.

Climate change would probably alter the hydrological regime of freshwater inland water bodies. A study on the effects of climate change on these ecosystems in the Mediterranean region (Álvarez–Cobelas *et al*. 2005) predicted that some nowadays permanent water bodies can change to temporary, whereas the hydrological regime of temporary ponds might be greatly altered by changes in the temporal distribution of rainfall and runoff. Changes in the frequency and intensity of rainfall might modify the flooding/desiccation patterns of Mediterranean temporary ponds. These changes could prolong inundation periods after intense rainfall and shorten these periods after prolonged droughts, or even prevent pond inundation during several years.

On the other hand, it may be that rainfall increases locally and these ponds become permanent. Then they will lose their functions as temporary wetlands and their associated flora and fauna.

2. Conservation management

General recommendations

As stated above, the occurrence of Mediterranean temporary ponds is decreasing in most of their distribution area, essentially due to human activities. Habitat management is mainly aimed at correcting the negative effects of these activities and at restoring the ecological functions of the ponds.

Many of the problems experienced in temporary ponds have the same source, frequently related to agriculture or cattle management, and thus they may benefit from similar conservation measures. However, temporary ponds show a high degree of variability and their management must be adapted to the specific conditions of each. Detailed site specific analysis of each pond should be carried out to determine the precise management measures required

Sometimes the ecology of the site is not well known. Thus, the first step is to inventory the site and diagnose its problems. Once these are known, a management plan should be drawn up for each wetland or group of wetlands.

Some ponds do not require active management. They are usually the most natural ones in the most oligotrophic sites. However, in many other ponds the presence or abundance of the priority habitats results from interaction between natural processes and disturbance by human activities. This balance may be very fragile and can be disrupted by intensification or conversely by extensification of human activities, changes in practices, long-term processes (e.g. sedimentation), etc. In these sites active management can be necessary. In some sites, the economic activities contribute to the long-term conservation of ecological values through maintaining an appropriate rate of disturbance and indirectly preventing changes in land use.

Active management

Clearing and mowing

Temporary ponds heavily invaded by scrub and perennial plant species such as sedges, reeds and grasses should be cleared of such vegetation. In the absence of grazing, it may be necessary to clear the vegetation manually. This can be done by using mechanical scrub cutters with different types of implements depending on the type of vegetation to be removed. Once the vegetation has been cut, the plant waste must be removed. The frequency of these actions may vary depending on the magnitude of the problem and the particular features of the site. They should be complemented with measures aimed at improving the growth of native species that are characteristic of the pond, which would contribute to reduce the need for clearing and mowing.

Grazing management

In many cases, Mediterranean temporary ponds are linked to a traditional use of the land that is usually related to livestock farming. On the whole, extensive livestock farming is not detrimental to the conservation of temporary ponds (ICN 2007). If properly used, it can even be a useful management tool. The management of grazing must consider the balance between the positive impacts on competitive plant species and the negative impacts on target sensitive species. Grazing is especially needed in sites where the productivity is high enough to support the growth of perennial plant species which compete with the species characteristics of the priority habitats (*Bolboschoenus* sp., *Juncus* sp., etc.).

However, livestock can cause problems if there is overgrazing or grazing at the wrong time of the year. For instance, if the livestock grazes in the wetland during the flowering season, it can cause problems for the reproduction of certain species (*Ranunculus spp., Agrostis spp., Orchis spp.*). This may be a critical demographic issue for rare annual plants.

The main concerns to the presence of grazers in Mediterranean temporary ponds are related to direct destruction of plants and animals by trampling in saturated sediment, re-suspension of sediment by tramping in the mud, and grazing on rare plants. Management strategies should aim to reduce the negative impact through selecting grazers that are light (e.g. local wetland breeds of cattle) and/or do not enter into the water (sheep, goats), or allowing grazing at periods where the cover of the target plants species is minimal.

Grazing may also increase the turbidity of the water and cause a loss of the bottom soil structure. Trampling may damage plant roots especially if pigs are used. For the same reasons, big game, especially wild boar, can also have a negative impact on ponds. Their impact can be drastic by ploughing soil on extensive areas. However they are usually of lower concern because (1) they are usually less numerous than livestock, (2) they usually feed on competitive species, and (3) they promote regeneration niches for the short-living species that are characteristics of temporary ponds (Grillas pers. comm.).

Proper management implies an appropriate grazing load and the use of livestock species or breeds that are as close as possible to those that were traditionally used at a given site. Each site should be studied in detail to determine the best grazing load as well as the time of the year when grazing is least detrimental to the maintenance of the habitat.

Given that one of the problems usually caused by livestock is the increase in water turbidity, livestock should be prevented from grazing directly on the water during the flooded period. The contamination produced by excrements of pigs and cows in particular may cause a significant eutrophication of the pond, which increases water turbidity owing to the algae growing.

According to Grillas *et al*. (2004), grazing by sheep and goats, rather than cattle, is the best way to control the invasion of woody species given the way they graze. They are light, do not enter the water and feed more selectively on twigs and branches than cattle. Moreover, cattle contribute more to eutrophication than do sheep and goats. Nevertheless, the "Basses de Menorca" LIFE project (LIFE05/NAT/ES/000058) reached the conclusion that cattle is most appropriate once a site has been cleared of woody species, since the cattle eat the shoots of these kinds of plants and do not allow them to regenerate. In any case, this example confirms the statement that the measures must be closely studied and monitored on a case by case basis, and their impact must be assessed so that the most appropriate systems can be designed for each site.

The problem of the use of temporary ponds as a watering hole for livestock and as an area for pigs to bathe in has been overcome in the wetland of La Albuera, in Extremadura (LIFE 2003/NAT/E/000052) with the construction of artificial watering troughs around the ponds. This avoids a massive influx of livestock into the ponds during the flooded season.

In a project for the conservation of Mediterranean temporary ponds in Crete (LIFE04 NAT/GR/000105) a livestock watering network was planned to avoid the intensive use of ponds by sheep, which leads to accumulation of faeces and eutrophication of the ponds. Environmentally-friendly watering infrastructure will be installed based on the results of a livestock grazing and watering capacity study. This infrastructure comprises low-scale constructions (e.g. soil ditches with wooden bedding to maintain water) which will be regularly filled from a supply system that receives water from rainfall, a nearby stream or canal or a borehole if necessary.

In these two projects (Crete and La Albuera, Spain) the temporary ponds have been fenced to only allow access by livestock when it is most appropriate and to prevent motor vehicles from entering the wetland.

Control of agricultural activities in the surrounding catchment area

The area surrounding a temporary pond may be farmland. Agricultural activities may cause pollution from fertilizers, pesticides and herbicides, as well as increased erosion within the catchment, which leads to the silting of the pond. In order to avoid these problems, the use of fertilizers and plant health products in the surrounding area should be regulated.

The Portuguese authorities have proposed the creation of 50-metre buffer zones around the ponds where the use of fertilizers and dredging and drainage activities are forbidden, as well as tillage in the dry

season. The measure of protecting 50 metres around the wetlands has also been taken in La Albuera, but the final results of the impact of this measure have not been studied yet.

Certain agri-environmental measures promoting the abandonment of agriculture such as reforestation plans in areas surrounding temporary ponds should also be considered with caution.

Digging of wells and tree plantation (especially with species that consume large quantity of water as *Eucalyptus* spp) must also be controlled in order to protect the underlying aquifer.

Control of alien invasive species

The invasion of alien species may originate from different sources. In the case of invasive animal species, such as the introduction of fish or crayfish (*Procrambarus clarki)*, if the invasion is detected at the beginning of the wet season, an attempt can be made to capture all the individuals using the means best suited for each site (nets, traps or manual capture).

However, if the invasion is only seen at the end of the wet season, it is very likely that the native species within the pond have already been affected (especially micro-crustaceans and amphibians). In this case, the recommendation is to let the pond dry up so that the invasive species disappear and to concentrate efforts on finding the origin of the invasion (e.g. irrigation canals nearby) so that appropriate corrective measures can be taken. *Procamabarus clarkii* can survive the dry season by digging deep holes in the sediment (e.g. in Doñana). So, in contrast with fish which are killed by short drought, the dry season might not be sufficient to eradicate this invasive species (Grillas pers. comm.).

In the case of non native turtles (*Thrachemys sp., Pseudemys sp., Graptemys sp.*), the most practical approach is to capture them directly because they can be harmful to amphibians and invertebrates. It is also important to determine the origin of the turtles since they are often released directly by their human owners. In these cases, awareness raising campaigns may help to prevent further releases.

Invasion by plant species requires a different approach. First, a risk assessment should be done to decide about the most efficient strategy. Some species can invade the site very rapidly and in some cases there can be too many individuals of many species. The invasive species should be eradicated manually as soon as possible. Thereafter the site should be monitored every year to check the evolution of these species and to determine whether it is necessary to continue with the eradication work. This may need to be done over several years as the invading plant species often re-appear because seeds can be carried back into the site by the wind, the water or by animals. Thus the more thorough the initial eradication is, the less effort will be required later on.

The method for eradicating invasive plants depends on the species, the density and the surface area. It is relatively easy to control *Paspalum (*e.g. through grazing*)*, for example, but much more complex and expensive to get rid of *Arundo donax*, which is much larger.

If trees are the problem they must be cut and uprooted. This was done in the Basses de Menorca LIFE project which had invading *Gleditsia triacanthos.* Again the situation should be monitored regularly after initial eradication as there may still be seedlings, seeds and sprouts from root buds present which could cause the invasive plant can regenerate.

In some cases, invasive species appear because of changes in the water regime, for instance, through dredging or dam construction which alter the pattern and duration of flooding. In such cases, it may be enough to restore the proper hydrological conditions and eradicate the alien species for the biotic community of the site to recover.

Restoring temporary ponds

Once the factors affecting a degraded pond are known and have been assessed, it is possible to restore the ecological functions, often starting with the hydrological dynamics.

To restore the hydrological dynamics it is necessary to determine if the pond has suffered a process of drainage or siltation. Most often wetlands in cultivated areas have been deliberately drained to increase the surface of arable land (e.g. La Albuera, in Extremadura, Spain). This drainage can be done in two different ways: by building channels to empty the pond basin or by modifying the runoff that feeds the pond so that the water is driven elsewhere. In these cases, hydrological restoration involves closing the drainage channels and restoring the original conditions of the basin.

When the pond has been silted it may be necessary to remove the excess of sediments, restore the original depth of the pond and correct the conditions within the catchment area that led to this siltation. To determine the depth of the pond, different actions can be carried out. The analysis of sediments can allow identifying the depth where the highest density of seeds, spores and eggs of the target species occur and thus the amount of sediment to be removed. This depth should correspond to appropriate water depth and local hydrology unless changes in the catchment area or the edges of the pool have occurred. A viability analysis of these propagules allows evaluating the feasibility of restoring populations using local material or eventually the need of re-introducing populations, or to rely on natural colonization. A hydrological modelling could be used to identify the depth profile needed for restoring suitable hydrological conditions.

In La Albuera (LIFE 2003/NAT/E/000052) to restore the original profile of the pond, an average 10 cm layer of sediments was dredged using laser-guided digging machines which are often used to build rice paddies. A variation in depth was programmed to increase the pond biodiversity. The final result was a pond with a natural shape and several levels for flooding, enhancing the diversity of the niches. Then the upper sediment layer was taken apart and relocated around the pond shores in order to recover part of the seeds, eggs and cysts.

When materials have to be removed from a silted wetland, this should be done with caution. First, part of the sediments should be removed, and the functioning of the wetland should be checked. Once the right depth has been established for the removal of the materials, the rest of the sediments can be taken out. It is important to leave slopes that are gentle enough to allow the different types of vegetation to find an adequate niche during the flooded period and avoid erosion. When a significant bank of seeds, eggs and cysts is not available in the sediments, the sediments can be removed and replaced with others from other similar wetlands nearby. If there is a significant amount of reproduction and propagation material in the sediments and there are no similar wetlands in the area, part of the sediments should be reserved for later replanting.

When the silting has been caused by materials actively brought by humans, these materials must be removed. This is especially important when the pond has been used to dump solid waste, whether construction debris or other kinds of waste (LIFE04NAT/GR/000105).

Other relevant measures

Inventories and monitoring

To manage temporary wetlands, it is necessary to determine the optimum and average period and intensity of flooding, the animal and plant species composition, the use of the pond by vertebrates, particularly amphibians, and the use of the habitat by waterfowl. It is also very important to monitor the water quality to determine the degree of pesticides and fertilizers contamination, particularly in sites located in cultivated areas. Moreover, it is necessary to analyse the intensity of use of the site by livestock and determine the optimum degree of use in order to adjust it to reasonable levels.

Once the basic parameters and the management measures have been established, the impact of the measures should be monitored to check whether their quality and quantity is appropriate (Gaudillat & Haury 2002).

The indicators used to measure the impact of the actions are the composition of the site in terms of animal and plant species and its evolution over time. It is necessary to determine what are the targets and references. The best references (a set of pools) should be found in undisturbed equivalent sites nearby. If possible, the chemical parameters of the water should be monitored to detect pollutants at an early stage. The diversity and abundance of crustaceans and insects are usually the best indicators of water quality. Monitoring of water level is also very important as it is a general proximate factor that controls the distribution and abundance of species.

Land acquisition

The management measures usually undertaken include the purchase of land. However, given that these areas are small and are often located on private land, it seems more practical to reach management agreements with the landowners to guarantee the conservation of the temporary ponds.

This approach was used in the Microreserves project in Valencia LIFE95/E/A22/E/00856/VAL the conservation authorities involved local landowners in the conservation of this priority habitat, usually on a voluntary basis and sometimes even with great motivation. This is because the management of these sites tends to promote traditional uses instead of compromising them.

However, the conservation of Mediterranean temporary ponds usually depends on the adequate management of the activities in the whole catchment area.

Public awareness

In all cases, there is a clear need to carry out education and awareness raising campaigns addressed both to the general public and to institutions linked to nature conservation, land management and agriculture.

It is especially necessary to work with landowners who have temporary ponds on their property and try to obtain their support for the conservation of these habitats. There should also be adequate educational campaigns aimed at landowners to encourage them not to engage in activities that are detrimental for conservation, such as deepening the ponds so that they can be used as watering holes for livestock all year round, using them to dump solid waste or to release animals (exotic fish, etc.).

Special requirements driven by relevant species

Some plants may be negatively affected by cattle grazing, as cattle eat the flowers and then seeds are not produced. When special care has to be taken for certain species, grazing should be only allowed after those plants have ended its reproductive cycle.

As several amphibians as well crustaceous branchiopods depend on this habitat for reproduction, the ponds should be kept free of fish or invasive crabs that usually predate on eggs of amphibians as well as on aquatic invertebrates.

Temporary wetlands are important for migratory birds and waterfowl but also for resident birds that find food, water and shelter in the pond and its surroundings. Actions addressed to enhance bird conservation have been carried out in some Mediterranean temporary ponds.

In the restoration of La Albuera, part of the sediment removed form the artificially silted ponds were use to build several islands for waterfowl nesting. Around the pond, several hectares of arable land were rented in order to control the type of crops planted and their period of plantation. This has led to an increase in the occurrence of nesting birds in the surroundings of the pond.

Cost estimates and potential sources of EU financing

When estimating the costs of managing a temporary pond the surface of the basin needs to be taken into account. These ponds area frequently surrounded by crops or pastureland or both, if the management requires a reduction in such activities, economic compensation to the farmers should be considered. By the same token if special grazing measures are required these could be remunerated.

Clearing and mowing may be needed. The price per hectare depends on the status of vegetation to be cleared. Scrub is slower to be cleared than helophytes. Clearing and mowing should be carried out with particular care and in very selective way, manually by trained workers, in order not to eliminate species that may be of particular interest. Mowing with a mechanical scythe may involve the cost of three or four men per day to clear one hectare but temporary wetlands are usually small sites, which makes this type of management relatively cheap.

Some examples are described below based on the experiences available from LIFE-Nature projects.

Grazing management

Construction of water troughs. In the project aimed at the conservation of temporary ponds in La Albuera (LIFE03/NAT/E/000052), five water troughs were built (surface <1,000 m^2 and depth <1.5 m) at a cost of €3,000 each. Six hydrants were also built, at a cost of €12,020, per hydrant.

Control of agricultural activities in the surrounding catchment area

Renting of cereal and pasture land. This measure was carried out in La Albuera project (LIFE03/NAT/E/000052) to reduce the intensity of land use around the temporary ponds, at a cost of around €420.

Forage cultivation. High productivity crops were introduced in the Albuera lagoons area to avoid overgrazing and provide alternative feeding resources to livestock. 25 ha were cultivated with alfalfa, and leguminous, in two kind of plots (plots up to 2.5 ha and microparcels <0.5 ha), at a cost of € 841/ha.

Restoring temporary ponds

Recovery of natural filling canals. Measures aimed at the restoration of the natural hydrological functioning of La Albuera lagoons (LIFE03NAT/E/000052) included the elimination of artificial drainage, and the restoration of small natural canals that communicate several lagoons. The cost for excavation of 1 Km of canal (<1m depth) was €6,000, including light machinery and workers.

Restoration by excavation. Excavation and sediment removal were carried out for the restoration of Péguiere pond (Var, France), within a projects aimed at the conservation of Mediterranean temporary ponds in France (LIFE99NAT/F/006304). The intervention involved 530 m3 and has a cost of €3,300 (Grillas *et al.* 2004).

Land acquisition

In the LIFE project on Conservation of temporary ponds in France (LIFE99NAT/F/006304) some land acquisition was done in southern France between 2002 and 2004 to assure the conservation of this habitat. The average cost of the purchase was €2,500-4,000/ha (Grillas *et al*. 2004).

Potential sources of EU funds

Management measures for Natura 2000 were defined in the annexes of Communication from the Commission on Financing Natura 2000 (COM 2004-0431 and its working documents).

Concerning potential sources of EU financing, a Guidance Handbook (Torkler 2007) presents the EU funding options for Natura 2000 sites in the period 2007-2013 that are, in principle, available at the national and regional level. Furthermore an IT-tool is available on the EC web site: http://ec.europa.eu/environment/nature/natura2000/financing/index_en.htm.

Among the diversity of sources for EU funding, the following funds might primarily be of interest for the management of Mediterranean temporary ponds.

- The European Fund for Rural Development (EARDF). This program has a potential to cover several management activities that might be relevant, although the measures have to be covered in the National Strategy and related Rural Development plans (RDPs) in order to be eligible on a national basis. Furthermore Leader+ funds have to be studied on a national basis.

- The European Regional Development Fund (ERDF), The Cohesion Fund and Interreg. These funds might be relevant in single cases although activities related to Natura 2000 sites mostly need to be integrated in a broader development context. However, the Interreg approach is more flexible but needs a European objective and partnership. Different geographical levels were defined and all of them have their specific rules, eligibility criteria and objectives.

- The Financial Instrument for the Environment (LIFE+). The 'Nature' component of LIFE+ supports best practice and demonstration projects contributing to the implementation of the Birds and Habitats Directives but only exceptionally outside Natura 2000 sites. The 'Biodiversity' component is for demonstration and innovation projects contributing to the objectives of the Commission Communication 'Halting the loss of biodiversity by 2010 – and beyond'. Both the 'Nature' and 'Biodiversity' components focus on concrete non-recurring management actions (at least 25 % of the budget). Recurring management is not eligible under LIFE+.

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