

# Guidelines for restoring and managing Mediterranean ponds and canals

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Authors:

Ana Štih Koren, Anja Neduk,  
Katarina Koller Šarić, Dragica Šalamon

Supervised by:

Petra Sisan, WP2 leader



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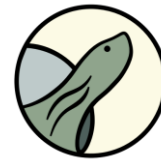
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## Glossary

**Habitat:** A specific type of environment where a particular species of organism naturally occurs or thrives.

**Wetlands:** Areas of land where the water level is close to or at the surface for much of the year, and which provide important ecosystem services such as water purification and flood control.

**Endemic species:** Species that are naturally found only in a particular geographic area or habitat and are not found anywhere else in the world.

**Ponds:** Small bodies of still water, typically shallow and artificially created or naturally occurring, that provide habitats for various aquatic organisms.

**Canals:** Artificial waterways created for irrigation or drainage purposes that can provide habitat for aquatic organisms.

**Ecosystem services:** The benefits that humans derive from ecosystems, including provisioning services (e.g., food, water), regulating services (e.g., climate regulation, flood control), and cultural services (e.g., recreation, aesthetic value).

**Maintenance:** The ongoing management and care of natural or built environments to ensure their continued health and functionality.

**Restoration:** The process of returning an ecosystem to a previous state or condition, typically after it has been damaged or degraded.

**Renovation:** The process of improving or updating an existing ecosystem or built environment to better meet current needs or standards.

**Riparian zone:** A riparian zone is a transitional area between land and a body of water that serves as an important habitat for diverse species and plays significant roles in nutrient cycling, water quality, flood control, and ecological services.

**Amphibian vegetation:** Amphibian vegetation refers to plant species that grow in or around wetlands.

**Natura 2000 areas:** A network of protected areas across the European Union that are designated for the conservation of important habitats and species.

**Natura 2000 species:** Species that are listed under the Natura 2000 network as being of special conservation concern.

**Protected areas:** Designated areas of land or water that are managed for the conservation of natural or cultural resources and provide important ecosystem services.



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**Protected species:** Species that are legally protected from hunting, harvesting, or other forms of exploitation, typically because they are rare, threatened, or endangered.

**Debris:** Debris in the water refers to any type of human-made or natural object that is floating, suspended, or settled in a body of water. Debris in water can come from a variety of sources, including litter, industrial waste, construction materials, and natural sources such as fallen trees and branches.



# 1. Introduction

## 1.1 Wetlands

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Wetlands are areas in which water covers the soil periodically or during the whole year or is near its surface. Along with coral reefs and tropical rainforests, they are the most productive ecosystems in the world. They can be found on all continents except Antarctica. Types of wetlands differ from one another based on soil type, topography, hydrology, climate, chemical composition of water, vegetation, and anthropogenic influence. They are inhabited by all life forms, from microscopic animals and bacteria to vertebrates and from algae to angiosperms. There are various types of wetlands, some of which are marine/coastal wetlands (offshore wetlands, cliffs, and shallow coral reefs), inland wetlands (river mouths, lakes and marshy areas near the lakes, streams, and rivers, flooded woods and meadows, real swamps) and artificially made wetlands like saltworks, irrigation canals, former gravel pits and ponds (Ramsar National Report, 2019).

Wetlands are characterized by their high biodiversity and critical ecosystem services, including water purification, flood control, carbon sequestration, and habitat for a wide range of plant and animal species. However, despite their many benefits, wetlands are also among the most threatened ecosystems on the planet, with many areas facing habitat loss, degradation, and destruction due to human activities such as urbanization, agricultural expansion, and pollution. Effective conservation and management of wetlands is therefore essential to ensure their continued health and functionality, as well as to support the many communities and species that depend on them.

## 1.2 Specificities of Mediterranean wetlands

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Mediterranean wetlands have several unique characteristics that differentiate them from wetland habitats in other climates. They are located in regions with hot, dry summers and mild, wet winters. This means that these wetland habitats may experience seasonal fluctuations in water availability, with periods of drought and low water levels in the summer months. These habitats are often home to endemic and rare species that are adapted to these specific conditions and support a high diversity of plant and animal species (Mediterranean Wetlands: Outlook, 2012).



Mediterranean wetlands have been shaped and managed by humans for thousands of years, and are an integral part of the cultural landscape of the region. Many of these wetland habitats have been used for irrigation, agriculture, and fishing, and continue to be managed for these purposes today. They often face various threats and pressures, including pollution, invasive species, habitat fragmentation, succession, and climate change. These threats can have significant impacts on the biodiversity and ecosystem services provided by these habitats (Mediterranean Wetlands: Outlook, 2012).

### MEDITERRANEAN PONDS AND CANALS

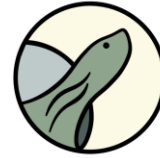
Since almost all Croatian Mediterranean region is built out of permeable limestone, surface waters are scarce so people had to adapt to the rough karst terrain to suit their needs. To survive on such harsh terrain people most often built wells, ponds, and irrigation canals. These ponds served various purposes, like providing a source of drinking water for people and livestock and places for bathing and washing clothes. The water habitats were also indispensable for the survival of domestic animals like sheep, goats, cows, and donkeys. By leaving the traditional way of living, especially reducing the number of sheep, cows, and other livestock, ponds became redundant and seemingly unnecessary. Habitats that were maintained for decades, even centuries, became over years forgotten, abandoned, and sometimes intentionally buried and destroyed. Contrary to the ponds, which are becoming less and less common in the Mediterranean, most irrigational channels are still in the function for agricultural production and continue to be managed for these purposes today.

Over time, ponds and canals become irreplaceable habitats for many animal and plant species in the dry Mediterranean region, and are called an oasis of biodiversity, because sometimes they represent the only “reservoirs” of freshwater.

Due to their high biodiversity and cultural significance, Mediterranean ponds and canals are recognized as important conservation targets. Many of these wetland habitats are protected under national and international conservation frameworks, such as the Natura 2000 network in Europe (Mediterranean Wetlands: Outlook, 2012).

To preserve these hotspots of biodiversity in the Mediterranean region it is crucial to regularly maintain them or to restore the ones who have disappeared.





### 1.3 Is the restoration of wetlands always necessary?

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The need for wetland restoration depends on the specific situation and the condition of the wetland in question.

For example, ponds located in woodland areas, surrounded by valuable old trees, and those with significant bog and fen habitats should be conserved for their intrinsic value and not be disrupted (Norfolks Wildlife Trust, 2023).

Deepening naturally fluctuating ponds may not be the optimal management strategy. While a shallow pond with an average depth of 1m may experience a 0.5m depth loss during a dry summer, this can benefit "beach margin species." However, in nutrient-rich waters, this can double the concentration of remaining nutrients and result in issues like excessive algal growth, which is unsuitable for many desirable aquatic species (Suffolk Wildlife Trust, 2023).

If a wetland is in good condition and provides ecosystem services, restoration may not be necessary. However, in cases where wetlands are degraded or lost, restoration efforts may be needed to preserve their benefits.

### 1.4 General recommendations for maintenance

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As with restoration, before undertaking any maintenance work, it's important to conduct a thorough habitat assessment to identify the existing conditions and any potential issues. This can include mapping the wetland habitat, identifying the plant and animal species that inhabit it, and assessing the water quality and flow. Based on the results of the site assessment, develop a plan that outlines the specific tasks and timelines for the maintenance of the wetland habitat. This can include activities such as vegetation management, erosion control, sediment removal, and water quality monitoring. It may be necessary to hire professionals such as biologists, engineers, or contractors to assist with the maintenance. Seek out experts in wetland management who have experience with Mediterranean habitats to ensure that the work is done properly (Freshwater Habitat Trust, 2011).

Wetlands are often an important cultural and recreational resource for local communities, so it's important to engage with stakeholders and communicate the importance of maintaining a healthy ecosystem. Encourage community involvement and seek out partnerships with local organizations or government agencies to maximize resources and expertise.



One of the benefits of a clean water pond is that, once made, it should need little management. (Freshwater Habitat Trust, 2011).

## IMPORTANCE OF POND AND CANAL MAINTENANCE

Without proper maintenance, habitats can become degraded and may even disappear altogether, and with them all the plant and animal species that inhabit them. Vegetation removal, sediment management, and erosion control can help to prevent the buildup of nutrients and other pollutants that can harm the water quality and harm the native species that inhabit the ecosystem. By controlling invasive species and managing the natural succession of plants, the balance of the ecosystem is maintained and the overgrowth of any one species can be prevented.

In addition to promoting ecosystem health, maintaining favorable conditions of Mediterranean ponds and canals is also essential from a sustainability perspective. These habitats are often located in urban or agricultural areas, which can lead to pollution and runoff from nearby sources. By maintaining the health of the ecosystem and preventing the buildup of pollutants, maintenance activities can help to reduce the environmental impact of these activities and promote sustainable land use practices. Regular maintenance activities can help to create a suitable habitat for threatened or endangered species that inhabit Mediterranean ponds and canals and protect them from further decline.

Maintenance activities can help to ensure that these habitats are accessible and safe for visitors, allowing people to enjoy the beauty and benefits of these natural resources.

## 2. Restoration and maintenance of Mediterranean ponds and canals

### 2.1 Actions taken before restoration and maintenance activities

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#### MAKING A PLAN

An essential question that everyone interested in restoration should ask is "Restore to what?" Ecosystems are constantly changing and dynamic over time and space. A typical long-term



objective for restoration is to have the ecosystem resemble and perform like it did before it was damaged or degraded, even though it is not always feasible to exactly replicate past conditions. Furthermore, a reference ecosystem that is similar and in good or excellent condition can also be used to define a goal. (Douglas).

Once goals have been established, it is important to create short-term objectives and corresponding activities to achieve them. Restoring a pond is very complex, and proper preparation is essential for completing the entire process.

#### OBTAINING PERMISSIONS

Depending on the location and scope of the restoration project, permits, and regulations may be required before the work can begin. It is important to research and comply with all relevant local, state, and federal regulations.

#### **NATURA 2000 considerations**

The Natura 2000 network includes many wetland areas that are important for the conservation of biodiversity. When restoring Mediterranean wetlands, it is essential to take into account the requirements of the Birds Directive and Habitats Directive, as well as other relevant legislation, such as the Water Framework Directive and the Ramsar Convention on Wetlands.

To restore Mediterranean wetlands while considering the Natura 2000 network:

- Identify protected habitats and species in the specific area before restoration work begins.
- Ensure that restoration work does not negatively impact protected habitats or species.
- Monitor the area over time to assess the effectiveness of restoration efforts and adjust management practices as needed.
- Consult with local stakeholders to identify potential issues or conflicts and develop acceptable solutions.
- Plan and coordinate restoration efforts to maximize conservation benefits while considering the complex environmental factors involved.

#### **Presence of protected species**

If the pond for restoration supports a protected species (see Regulation on strictly protected species, NN 144/2013) the competent Ministry before commencing any work should be contacted.



## WHAT IS THE IDEAL PART OF THE YEAR?

The best time to do maintenance activities such as vegetation removal on Mediterranean ponds and canals depends on various factors such as the type of vegetation, the size of the habitat, and the local climate.

In general, the best time to do maintenance activities is during the dormant season, which is typically in late fall or winter. During this time, most plants are not actively growing, which can make removal easier and more effective.

Different types of vegetation may require different timing for maintenance activities. For example, if the vegetation is invasive and spreads quickly, it may be necessary to remove it as soon as it is identified, regardless of the season.

Activities on wetlands during the dormant season are also crucial for animal species because in that period we do not interrupt their mating season, egg laying, water insects emergence, raising hatchlings, incubation of eggs, etc.

Larger habitats may require more time and resources for maintenance activities, so it may be necessary to plan maintenance activities over several seasons or hire professionals to assist.

Also during autumn the ground is dry and pond levels are low so it is easier to remove mud, and clean the pond bottom.

Mediterranean climates can vary greatly depending on the region, so it's important to take into account local weather patterns and any seasonal rainfall when planning maintenance activities. It's generally best to avoid maintenance activities during periods of heavy rain or extreme temperatures.

## ACCESS FOR MACHINERY

To accommodate excavators and dump trucks on a site, it is important to ensure that all access routes, bridges, and gates are capable of handling their size and weight. In some cases, it may be necessary to reinforce these areas and remove any obstacles such as trees, hedgerows, or overgrown vegetation. Additionally, temporary structures such as bridges may need to be erected to access certain areas of the site, especially if there are ditches or other natural barriers present (Freshwater Habitat Trust (2011)).

If there are any sensitive areas on the site, it is crucial to mark them on the plans and physically tape them off on the ground to prevent accidental damage. Given the size and weight of these



machines, even small unintentional movements can cause significant harm to the surrounding environment. Therefore, taking steps to safeguard sensitive areas is of utmost importance during the excavation and transportation process (Freshwater Habitat Trust, 2011).

It is important to ensure that the excavation of the pond and the routes leading to the site do not harm any valuable, threatened, or protected habitats or species.

#### PREVENTION OF THE TRANSFER OF PATHOGENS AND INVASIVE SPECIES

To prevent the introduction of pathogens and invasive species to wetland habitats during pond restoration, it is important to take precautions. All volunteers and contractors should be informed about these issues. Before entering the wetland area, ensure that all equipment, footwear, and clothing are free from mud and debris, and check for any plants or animals that may have attached to them. To eliminate any potential threats, it is recommended to clean and dry all items for at least 48 hours. In situations where complete drying is not possible, disinfection is necessary (National Biodiversity Data Centre, 2023).

## 2.2 Restoration and maintenance activities

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#### TREE AND SHRUB REMOVAL

The size of the pond will determine the number of trees and shrubs that can be retained around its edges. To maximize sun exposure for the pond and promote the growth of emergent plants such as water mint, it is recommended to keep 70% of the pond edges open and sunny. Trees and scrub should be cleared from the south and west sides of the pond, leaving some tree cover to the north and east. This positioning allows the pond to receive the morning sun, which encourages the growth of aquatic plants. It is important to avoid cutting down or removing old trees that hold historical or landscape significance just to open up the pond. Instead, consider pruning only a few lower branches that cast the most shade and be prepared to regularly remove leaves to prevent leaf litter accumulation if the tree is to remain (Suffolk Wildlife Trust, 2023).

#### AQUATIC PLANTS REMOVAL

Aquatic vegetation in and around a pond has numerous benefits. They play a crucial role in maintaining good water quality by reducing erosion and nutrient absorption. They also provide



cover for fish and a substrate for the growth of tiny organisms that are essential food sources for small fishes. Wildlife often uses the shoreline vegetation as hiding places and as feeding areas (Florida Fish and Wildlife Conservation Commission, 2023).

There are three methods available for controlling nuisance plants, mechanical (removal by hand or machine), biological (using triploid grass carp and hyacinth weevil), and chemical (using herbicides). However, mechanical or hand removal is the safest and most preferred method over chemical or biological control. This method involves harvesting the plant material, which not only removes the unwanted nutrients from decomposing plants but also eliminates the buildup of muck on the pond's bottom (Florida Fish and Wildlife Conservation Commission, 2023).

Thinning out excess aquatic vegetation in nutrient-rich farm ponds every autumn can help reduce the progressive build-up of nutrients like nitrates and phosphates. It is recommended to gently take out submerged plants and leave them on the pond edge overnight, allowing small animals to crawl back into the water. This process effectively removes nutrients from the water and prevents the aquatic vegetation from rotting over winter and releasing nutrients back into the water, which can encourage the growth of blanketweed or other forms of algae. Aim to leave 25% of the pond dense with plants and eventually remove the vegetation away from the pond to avoid the nutrients seeping back into the pond when it decomposes. It is important to avoid dumping it on nearby species-rich vegetation (Suffolk Wildlife Trust, 2023).

#### *Excess algae and duckweed*

Algal blooms in ponds can naturally occur and disappear, and in a newly created or restored pond, other plant species can often outcompete the algae. However, if left unaddressed, some algal blooms may worsen over time. Duckweeds (*Lemna* sp.) and algae absorb phosphates as they grow, therefore reducing the level of phosphates in the pond system can help reduce their regrowth, provided that a regular influx of phosphates is not present (Suffolk Wildlife Trust, 2023).

To remove duckweed (*Lemna* sp.), use a sampling net with fine mesh. When blanketweed (algae *Cladophora* spp., *Spirogyra* spp.) is in its growing stages, grab or twist a stick amongst it and drag it to remove large sheathes in one go. Leave the blanketweed overnight on the pond edge to allow animals to return to the pond before removing it from the area. However,



great crested newt larvae (*Triturus carnifex*) are living in the blanketweed, so avoid removing algae from the ponds where the newts are breeding (Suffolk Wildlife Trust, 2023).

*Removal of riparian and amphibian vegetation in the canals*

Amphibian vegetation should not be mowed because it provides important habitat for amphibians, as well as other wildlife, and helps to maintain the ecological balance of wetland ecosystems. It can be allowed only if the water flow is impaired and there is a danger to property and people's health (MINGOR, 2022).

If it's necessary to mow/clear amphibian vegetation in a watercourse, it should be done in a maximum of 2/3 of the watercourse's width, leaving undisturbed substrate and swamp vegetation on both sides, except in cases where it hinders the operation of pumping stations. For canalized watercourses, the cut should be performed in sinusoidal slopes (MINGOR, 2022).

To prevent the leaching of nutrients and pollutants, it is recommended not to mow or clear riparian vegetation in a minimum width of 2 m on all sides. If removal is necessary, the largest possible width should be left with the application of other measures, particularly in agricultural areas (MINGOR, 2022).

In cases where mowing of riparian and amphibious vegetation is required in a specific part of a watercourse, only one side of the banks should be mowed during one vegetation period, leaving the opposite side untouched (MINGOR, 2022).

When carrying out the clearing of shrubs and bushes, it is important to preserve developed bushes as much as possible to stabilize the coast and provide shade for bodies of water.

For the mowed portion of the inundation area, use a rotary or mosaic mowing and/or grubbing technique to ensure that different segments are mowed or grubbed at different times, leaving about 10% of the area undisturbed or unmowed every 100 meters in the form of short strokes or patches of vegetation. During the next mowing period, those patches and strokes should be mowed, and another 10% of the area left undisturbed in the same manner. When clearing brush and trees, preserve them as much as possible.



When performing mowing or clearing works in settlements and tourist or sports-recreational areas, it is permissible to carry out these activities several times a year, but it is important to leave at least 10% of the surface undisturbed during each mowing or clearing period in the form of short strokes or patches of vegetation.

#### *Removal of debris in the canals*

An important consideration for canals is the management of water flow. Canals in wetlands should be designed and maintained to ensure that water flow is controlled and does not cause erosion or damage to the surrounding vegetation. This may involve the use of erosion control measures, such as vegetation cover or stone barriers, to prevent damage to the canal banks.

Another important consideration is the removal of sediment and debris from the canals. While this is important for maintaining water flow, it should be done carefully to avoid damaging any sensitive habitats or disrupting the natural balance of the ecosystem. In some cases, it may be necessary to remove sediment and debris manually or using specialized equipment, rather than relying on heavy machinery that can damage the wetland (MINGOR, 2022).

#### GRAZING

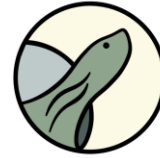
Grazing can be an effective and sustainable way to maintain Mediterranean ponds and canals. Grazing by livestock such as cattle, sheep, or horses can help to control the growth of invasive plant species, maintain open water areas, and promote the growth of desirable vegetation.

Livestock grazing can be especially beneficial in areas where traditional land management practices have been disrupted, leading to the encroachment of invasive plant species. Grazing can help to restore balance to the ecosystem and prevent further damage.

In addition to its ecological benefits, grazing can also provide economic benefits by supporting local farmers and promoting sustainable agriculture practices.

However, grazing must be carefully managed to ensure that it does not have negative impacts on the ecosystem or water quality. Proper fencing and monitoring are important to prevent overgrazing and other forms of damage.





## MUD REMOVAL

If a pond has become silted, it may be necessary to remove the excess sediment, restore the original depth of the pond, and address any issues in the catchment area that caused the siltation (Ruiz, 2008). If the pond mud is black and full of poorly decomposed leaves, it is necessary to remove it to create a hospitable environment for plants. The silt at the bottom of the pond may contain accumulated pollutants or naturally occurring substances that can lower water quality and prevent aquatic vegetation from establishing (Suffolk Wildlife Trust, 2023). To achieve a significant improvement, aim to remove mud from one-third to one-half of the pond area, rather than cleaning the entire pond in one go. It's important to avoid removing underlying clay and altering the natural dimensions of the pond.

Removing materials from a silted wetland must be done with caution. Start by removing a portion of the sediments and assessing the wetland's functionality. After determining the appropriate depth for removing materials, the remaining sediments can be taken out. Gentle slopes should be left to enable various vegetation types to establish themselves during the flooded period and prevent erosion. If there is an insufficient amount of seeds, eggs, and cysts in the sediments, they can be replaced with sediments from similar nearby wetlands. However, if the sediments contain a significant amount of reproduction and propagation material, and there are no comparable wetlands in the area, a portion of the sediments should be reserved for future replanting (Ruiz, 2008).

## DEALING WITH SHORELINES AND DEPTH

Ponds that can be completely emptied contain a biologically diverse zone known as the "drawdown zone". During the summer months, pond water levels typically decrease by at least half a meter, exposing the "drawdown zone" - an area comprising of mud and vegetation that is submerged in winter and spring, but gradually dries out as water levels recede in summer. This constantly changing drawdown zone is a vital part of a pond, providing an exceptional habitat for plants, invertebrates, birds, and small mammals (Freshwater Habitat Trust, 2011).

So when cleaning such ponds, it is important to leave the banks in their natural state without altering their steepness or depth. It is recommended to preserve shallow areas, as they are the most beneficial for wildlife. These shallow areas are often less than 30 cm deep, with many pond animal species residing in areas that are only 1 - 10 cm deep, right up against the bank. If you want to improve a pond for wildlife, focus on these marginal areas. To maintain these



areas, the pond's edge should slope gently at a 3-12° angle. Margins that are 20-30° steep are usually too steep, as a 20° slope would only allow for a narrow 35cm-wide band of critical wildlife-rich area (where water will be less than 10 cm deep) (Freshwater Habitat trust, 2011).

## 3. Disposal of organic material

### 3.1 Spoil disposal

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The disposal of excavated spoil is typically the most time-consuming and costly aspect of a pond construction project. To reduce expenses, it is advisable to consider how the spoil can be utilized on-site, either by spreading it thinly or repurposing it to create beneficial features for wildlife or prevent polluted water from entering the pond (Freshwater Habitat Trust, 2011).

If the spoil is to be spread, it is crucial to ensure that it does not form a rim around the pond, which can impede the flow of clean surface water. A useful way to utilize spoil is to create a lower bank for a pond on a slope. However, this approach is best suited for smaller ponds, as larger ponds may require stronger and safer damming techniques (Freshwater Habitat Trust, 2011).

There are many other ways to utilize spoil, such as creating new habitats, access infrastructure, or landscaped mounds for planting with trees and shrubs. When constructing mounds, it is important to ensure they are in keeping with the scale of the surrounding landscape. Mounds can also serve as a screen for unsightly buildings or busy roads and as a buffer against pesticide drift from adjacent fields (Freshwater Habitat Trust, 2011).

### 3.2 Mud disposal

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The most suitable location for depositing sediment is on a neighboring arable field, where it can be piled up, spread out, and plowed in. The nutrient-rich pond mud can serve as a valuable fertilizer. However, it is crucial to avoid depositing any mud on grassland buffers or areas with a high concentration of wildflowers (Norfolks Wildlife Trust, 2023).



It is recommended to create a grassland buffer zone, ideally at least 10 meters wide, around the pond if one does not already exist. This will serve as a protective barrier for the pond against agricultural fertilizers and sprays (Norfolks Wildlife Trust, 2023).

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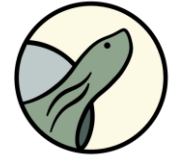
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