



Water fern (*Azolla filiculoides*)

Managing water fern on two sites in northern Corsica

National botanical conservatory in Corsica (CBNC)

■ The National botanical conservatory in Corsica, a department of the Environmental office in Corsica, received in 2008 the necessary authorisations to become the eleventh national botanical conservatory.

■ Its objective is to:

- identify and conserve the wild flora and habitats (natural and semi-natural) on Corsica;
- provide information and technical assistance to the State, public agencies and local governments in implementing national and regional policies in the fields of environmental protection and territorial planning;
- inform and educate the public on preserving plant diversity.

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Intervention sites

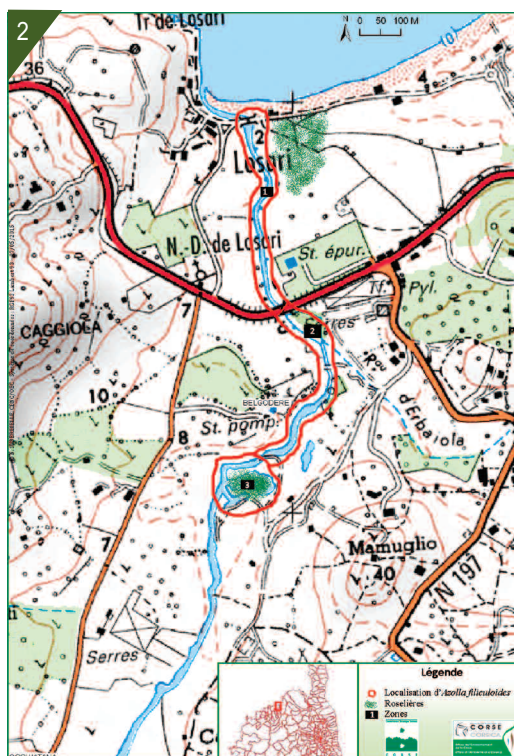
■ On Corsica, the species was observed for the first time in the natural environment in 2014.

■ It was detected in the towns of Lumiu, Corbara and Belgodère.

■ In Belgodère, the Réginu River flows into the Mediterranean at a place called Lozari. The water fern colonised a 2-kilometre section of the river starting from the mouth. In November 2014, the water fern had completely covered the river from the beach to the bridge of the national road. This section of the river belongs to the Seaside and Lake Conservation Trust. The land along the river upstream of the bridge belongs to various land owners. The zone downstream of the bridge includes numerous reed beds that make access to the water difficult in some areas. Upstream of the bridge, a number of pools subsist over the summer, that are thought to be outflows of the water table. There are also stagnant pools that flow together only when the water level is at its highest (winter and spring). They were also colonised by the water fern. The briars, thick bushes and dense riparian vegetation make access to the zone difficult.



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1. Map showing the location of *Azolla filiculoides* in Corsica.

2. Belgodère site with the invaded zone outlined in red.



■ In Lumiu, the water fern was located exclusively on private land, in an ornamental pool 3 metres deep and covering a surface area of approximately 7 square metres, supplied by the water table. The owner mentioned that the species had appeared spontaneously in 2010 and gave his permission for the work to remove the plants. The water fern had created a mat approximately 15 cm thick on the water surface and the few plants that slipped through the overflow system appeared to have died by drying.

■ The CBNC also found the species in a temporary pool in Corbara in 2013. Even though the pool had completely dried in November 2014, the species reappeared each year when the water returned.

Disturbances and issues involved

■ The species multiplies very rapidly due to the fragmentation of the stems. Its biomass can increase quickly and the plants can create a dense and thick mat on the water surface.

■ Impacts on the ecosystem

■ The presence of a thick mat on the water surface considerably reduces both gas exchange with the atmosphere and the luminosity in the water. The drop in the dissolved oxygen threatens the survival of aquatic fauna and the absence of light means that photosynthesis by the other plant species is no longer possible. The decomposition of the water fern can provoke an increase in sedimentation and in the concentration of phosphorous, manganese, iron and nitrogen, thus contributing to eutrophication of the environment.

■ Impacts on various uses

■ Water fern can block the pumps in water abstractions and cause significant reductions in the output of irrigation systems.

■ Its presence can lead to a reduction in fish populations, an adverse consequence for fishing.

■ The release of foul odours and a modification in the colour of the water also create a disturbance, both visual and olfactory, for people along the river.

Interventions

■ Field trips were made in November and December 2014 around the previously observed sites to determine the presence of the species. The trips also served to inform the local stakeholders and to set up a monitoring network. A data sheet for new discoveries was prepared to facilitate transmission of the information to CBNC.

■ The known sites were monitored for a year, starting in November 2014, to observe the development of the water fern and to determine the best time to intervene, given the characteristics of the local environment.

■ The three towns were asked to appoint a policy officer in charge of regular monitoring.

■ The overall objective of the work was to halt the propagation of the water fern and, given the relatively small areas involved and the fact that Corsica is an island, completely eradicate the species over time.

■ During the work, particular attention was paid to avoid fragmenting the plants and their dispersal. Precaution was taken in the water (slow movements) and in filling the burlap bags.



3. Colonisation of the Réginu River by *Azolla filiculoides*.

4. Initial condition of the pool in Lumiu.

■ **Work in Belgodère**

- The work was carried out once per month from May to September 2015, then once every two months as necessary until the end of the year.
- Due to the very low water level in the river, it was not necessary to install the floating barriers that were initially planned to isolate the work zone and block the dispersal of the plants.
- Two teams, each comprising two individuals, successively entered the water, each person holding one end of a net (mosquito netting) spanning the entire width of the river and running 30 cm deep, and gathered the water fern. They advanced until the net was full or very heavy, then turned to the bank. The second team then emptied the net using dip nets and placed the fragments of water fern in burlap bags.
- Where this method was not possible, notably in deep water, dip nets were used to collect the plants from a boat or from the banks.
- These techniques were used for several passages until no fragments remained in the water.
- In the areas where the water fern was present in the pools of water, only the dip nets were used.
- The work was carried out a second time one week later in order to collect any new sprouts.
- The high waters at the end of 2015 and the beginning of 2016 cleared a majority of the remaining plants out to sea.

■ **Work in Limiu**

- The work was done on 27 February 2015.
- The water fern was gathered together using a mosquito net attached to poles, running to a depth of approximately 20 centimetres, then removed using the dip nets and placed in burlap bags.
- At the start of the work, the water fern was so heavy that the telescopic poles for the dip nets could not be used. The nets had to be handled directly by hand.

■ **Work in Corbara**

- No work has been undertaken on this site for the time being, due to the technical difficulties caused by the site characteristics and the vegetation. However, the site is monitored once per year to track the progress of the plants.

■ **Transport, storage and elimination of the waste**

- The waste was stored in burlap bags to avoid the loss of any fragments between the work site and the storage site. A tarp was placed on the bottom of the dumper used for the transport.
- The bags were emptied into a hole measuring 2 x 2 x 1.5 metres, dug on a site far from any contact with water and protected from animals. The plants were covered with 80 centimetres of dirt.
- All the equipment used was rinsed with clean water or salt water. The waders and shoes were brushed clean and rinsed. The mosquito nets, dip nets, burlap bags and tarp were soaked overnight in a container with bleach, then rinsed with salt water.



5. Setting up the mosquito net for the pool in Lumiu.
6. Collecting fragments of water fern with a dip net.

- The water and mud from the cleaned equipment were stored far from a source of water.
- Following the work in Lumiu, part of the equipment (wooden poles, mosquito net) was burned by the municipal technical department to avoid any risk of water-fern fragments being dispersed.

Results and costs

■ Results

- In Lumiu, one 80-litre bag and half a second bag were filled during the work in 2015. The owner of the pool may also have removed some plants that were not removed during the work.
- No information on the quantity of water fern collected in Belgodère was available.
- The project was a success on the two sites and to date, no water fern has been observed in Lumiu or on the Réginu River.

■ Assessments

Summary of the equipment used and the equipment costs.

Equipment	Quantity	Characteristics	Unit price in euros
Mosquito net	1	1 X 30 metres, 25 holes per square centimetre	7 per metre
Wooden poles (for the mosquito net)	6	110 cm long, 40 mm diameter	5
Dip net (type swimming pool)	4	Fine mesh, large volume	20
Burlap bags	30	100 litres	3
Gloves (pairs)	12	Gardening gloves	15
Waders	4		60 (minimum)
Protective tarp	1	5 X 4 m, waterproof	35
Brushes	3	Scrub brush with hard bristles	10
Container for cleaning equipment	2	120-litre waste bin, waterproof	50
TOTAL	-	-	792

Number of people and time spent on each site.

Site	Number of people	Details	Duration of work
Belgodère	6	1 technician from the intermunicipal board, 5 technicians from town personnel	20 hours (minimum)
Lumiu	6	3 technicians from town personnel, 3 technicians from CBNC	1.5 hours



7. The pool in Lumiu following the work.

Information on the project

- Informative document on invasive species and another document specifically on *Azolla filiculoides*, both widely distributed.
- Articles in the town bulletins.

Outlook

- Active monitoring was set up on the Belgodère site and in the nearby natural zone with high ecological value (ZNIEFF) in Ostriconi, in order to detect the growth of water fern. Trips to the sites were made every two months over the summer period (April to October) in 2014 and 2015. This work was halted in the beginning of 2016 because the species had disappeared from the Belgodère site.
- However, the two sites are still examined at least once per year by CBNC to detect any return of the species.
- To identify the point of origin of the colonisation and avoid any use of the plant, a letter with the informative document on water fern was sent by the town of Lumiu to the local residents. The purpose was not to determine the exact cause of the problem, but to facilitate effective detection and preventive measures.

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8. First page of the informative document on water fern.

For more information

- Suberbielle, N. et Petit, Y. 2015. Plan régional de gestion, *Azolla filiculoides* Lam. Conservatoire Botanique National de Corse. 65 pp.
- Suberbielle, N. et Petit, Y. 2015. Compte-rendu d'arrachage, *Azolla filiculoides* Lam. commune de Lumiu. Conservatoire Botanique National de Corse. 8 pp.
- Suberbielle, N. et Petit, Y. 2015. Protocole simplifié de lutte contre *Azolla filiculoides* Lam. sur la commune de Belgodère. Conservatoire Botanique National de Corse. 11 pp.

This management report was drafted in January 2018 by the work group for biological invasions in aquatic environments, set up by the French biodiversity agency and IUCN France, in addition to those already presented in the second volume of the book titled "Invasive alien species in aquatic environments, Practical knowledge and management insights", in the Knowledge for action series published by the French biodiversity agency (<http://www.onema.fr/sites/default/files/ENIEV/cat7a-EEE-vol2.html>).