Contents

Invasive alien species in aquatic environments
Practical information and management insights

Volume 3 | Management insights (cont.)

Plant species

Hydrophytes

Amphibious plants

Riparian plants

* Management reports for these species are also available in volume 2 (2015).

© Alain Dutartre

Large-flowered waterweed

(*Egeria densa*)

Classification	
Order	Alismatales
Family	*Hydrocharidaceae*
Genus	*Egeria*
Species	*E. densa* (Planchon, 1849)

Originated in South America.

Has spread widely due to its use in aquariums.

Description

- Perennial plant, always submerged
- Stalk up to three metres long, thin and fragile, branching, can develop roots at nodes
- Whorled leaves, generally in groups of 4 (but from 2 to 8), 1 to 3 cm long, 0.5 cm wide
- Adventitious roots, thin root system
- White flowers with 3 petals, opening on the water surface at the end of a long stem

Ecology and reproductionn

- Asexual reproduction, i.e. vegetative reproduction through regrowth of stalks from previous year
- Can colonise very different environments (ranging from stagnant to running waters)
- Can occupy the entire water column on favourable sites
- Highly adaptable to nutrient availability
- Can develop on different substrates

Documentation

- Fare A., Dutartre A., Rebillard J.-P. 2001. Les principaux végétaux aquatiques du Sud-Ouest de la France. Agence de l'eau Adour Garonne. 90 pp.
- Hudin S., Vahrameev P. (coord.) 2010. Guide d'identification des plantes exotiques envahissant les milieux aquatiques et les berges du bassin Loire-Bretagne. Fédération des conservatoires d'espaces naturels, 45 pp.
- Muller S. (coord.) 2004. Plantes invasives en France : état des connaissances et propositions d'actions. Muséum national d'Histoire naturelle, Paris, 168 pp.

Author: Emilie Mazaubert, Irstea

Large-flowered waterweed

(Egeria densa)

Managing large-flowered waterweed in the Loiret department

Loiret river board (ASRL)

- The river board was created on 11 November 1858 to manage the upstream section of the Loiret river (from the source to the Chaussée de Saint-Santin), as well as the Montées, Couasnon, Reine-Blanche and Fontaine tributaries.
- ASRL is active primarily in managing and cleaning the hydraulic installations, in maintaining the river, trapping pests and working on the river banks on behalf of local land owners.
- Contact:

- management: Stéphane Thauvin, river warden, contact@asrl.fr
- inventory: Carine Biot, policy officer at the Val Dhuy Loiret SBMP (sub-basin management plan), carine.biot@eptb-loire.fr

Intervention site

- The Loiret River is an outflow of an underground branch of the Loire (80% of total discharge), which means it is a large river (20 metres wide) right from its source. The Loiret is 13 kilometres long and up to 100 metres wide.
- It is crossed by five roads dividing it into reaches comprising 13 mills and 44 hydraulic installations.
- The existence of the hydraulic installations makes for a rather special river where the first ten kilometres are a succession of very wide reaches with very little current.
- The invasive macrophytes are located primarily in these reaches, in the towns of Orléans, Olivet and Saint-Pryvé-Saint-Mesmin, and cover a surface area of 70 hectares.
- The many houses along the river have led to it being named the “Little Venice of the Loiret”.

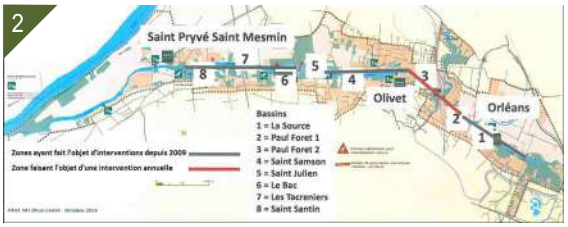
Disturbances and issues involved

- Following the improvement in water quality and its transparency, plants began to reappear in the river starting in 2005.
- Their development accelerated over the following years.
- Large-flowered waterweed was identified in 2008.
- By 2014, it had been observed along nine kilometres of river with significant quantities along seven kilometres.
- In addition to large-flowered waterweed, Nuttall's pondweed and filamentous algae were also observed in large quantities.

1

© SAGE Val Dhuy Loiret

2



© SAGE Val Dhuy Loiret

1. Homes along the first reach of the Loiret River.
2. Map of the intervention areas along the Loiret.

Impacts on the ecosystem

- The plants slow the flow of water.
- Contribution to the development of filamentous algae on the surface.
- Contribution to sediment build-up.
- Formation of dense beds limiting the development of native plant species.
- Disturbances for the movement of fish species.

Impacts on various uses

- Clogging of hydraulic installations.
- Difficulties for boating (crew, canoeing, excursions, travel by local people).
- Major hindrance for fishing.
- High visual impact (deemed unsightly by local residents and walkers).

Interventions

Mechanical uprooting

- In December 2008, ASRL decided to convert one of its barges into a motorised, hydraulic rake (the Ratodo) capable of uprooting and collecting aquatic plants.

■ Since 2009, the purpose of the annual interventions has been to maintain an open channel in the middle of the river to enable the flow of water and boating.

■ The results of the year 2009, when 300 cubic metres of plants were removed, made clear the need to organise the transport of the plants in conjunction with the town of Olivet. The town provided containers and assumed to costs of transporting and composting the plants. The plants and mud from the Loiret were first analysed as a precautionary measure, prior to transporting the material. It was necessary to design and construct in-house a small crane (called the Plukeur) to load the plants in the containers. The procedure consists of the following steps:

- uproot and collect the plants using the Ratodo;
- load the plants onto pontoons (until 2012, since then an oyster-fishing barge has been used);
- transport the plants to a quay;
- use the Plukeur to transfer the plants to a 15 cubic metre container for transportation to a composting unit.

■ Since 2010, this work has been done by two employees for approximately 50 days per year, between March and October:

- in the morning, the plants are collected;
- in the afternoon, the plants are unloaded from the barge and transported to the composting unit.

■ The work is done in the framework of a partnership with the crew club and the fishing association, who express their needs and provide volunteers, and the town of Olivet, that pays for the transport and composting of the plants.

■ A test on a different management technique was conducted in July 2014 when a company using a harvester boat was brought in (the Lyonnaise des eaux company sponsored the harvesting work and the town of Olivet handled the plants).

■ This project lasted two weeks and 270 tonnes of plants were collected. The work involved three employees, a backhoe, three containers and a truck.

■ The harvested area measured 1 200 metres long and 20 metres wide. This work will be repeated for eight years in the framework of the sponsoring programme.

■ Inventory

■ The Val Dhuy Loiret SBMP is a partner in the continuous effort to find information on invasive plants, on how to identify species and on the inventory set up since 2013.

■ The inventory could be established by the entity managing the SBMP, the Loire board, by calling on the services of an intern.

■ Characterisation report in 2013:

- samples were drawn from 45 transects using the contact-point method (4 to 6-metre intervals);
- parameters were measured (temperature, depth, type of substrate, etc.) to assess the relationships between development processes of the plants, but no clear links were revealed;
- a total of 17 species, both alien and native, were identified, including two that are rare in the Centre region *(Zannichellia palustris* and *Potamogeton obtusifolius*);
- the most abundant species were, in decreasing order, filamentous green algae (pervasive), large-flowered waterweed (invasive) and Nuttall's pondweed (invasive).

■ In 2014, the inventory was carried out again, but in a reduced format with only one contact point per transect (the managers did not have enough time to run a complete inventory each year). Following discussions with experts, the protocol for the reduced format will be modified to concentrate on certain transects rather than studying a single contact point on each transect.

3. 4. The motorised, hydraulic rake (Ratodo).
5. Plants loaded onto an oyster-fishing barge.
6. The Plukeur, a small crane used to transfer the plants to the containers.

■ It is still too early to draw any conclusions from the work done, several years of observations are first required.
■ More in-depth scientific assistance will also certainly be needed.
■ A complete inventory will again be conducted in 2015. Subsequently, complete inventories will be conducted every two to five years, as required. In the meantime, partial inventories comprising two profiles per transect will be carried out.

7. Harvester boat.

Results and assessment

■ Results (estimated volumes and location of the harvested plants)

Year	2009	2010	2011	2012	2013	2014
Harvested volumes (m^3)	300	700	1 000	1 000	1 500	1 000
Work periods and zones (see map on page 1)	April: Saint-Santin June to September: Paul-Foret 1 and 2	June: La Source July: Saint-Santin July to September: Paul-Foret 1 and 2	May: Tacreniers June: Le Bac July to October: La Source, Paul-Foret 1 and 2	April: Tacreniers June to October: Paul-Foret 1, 2 and upstream Saint-Samson	July: Le Bac July to October: Paul-Foret 1, 2 and Saint-Samson	February to March: Le Bac June to July: Paul-Foret 1, 2 and Saint-Samson
Basins	**Estimated density of plants from 1 (low density) to 5 (high density)**					
La Source	0	2	4	2	1	1
Paul Foret 1	3	3	4	4	4	3
Paul Foret 2	2	2	4	4	5	5
Saint Samson	0	0	0	2	3	5
Saint Julien	0	0	0	0	2	4
Le Bac	1	4	1	2	4	5
Tacreniers	3	4	3	2	4	2
Saint Santin	3	1	4	2	1	1

■ Costs (in euros)

	2009	2010	2011	2012	2013	2014	TOTAL
Ratodo	10 127	1 766	1 741	2 200	900	8 188	24 923
Plukeur		4 278					4 278
Pontoons			3 185				3 185
Quays		448		591			1 039
Barge + engine				12 535			12 535
Fuel	100	200	700	1 500	1300	1 000	4 800
Additional employees (in summer for uprooting)				3 281	6 053	4 828	14 163
TOTAL	**10 227**	**6 693**	**5 626**	**20 108**	**8 253**	**14 016**	**64 924**

■ The town of Olivet contributed 4 500 euros in addition to the transport of the plants and composting.
■ The Brochet Olivetain (an independent fishing association) contributed 1 840 euros.
■ The cost of the ASRL employees for approximately 60 days of work per year amounted to approximately 20 000 euros in payroll costs, which does not include the temporary personnel hired in the summer, the volunteers or the inventories conducted in 2013 and 2014.
■ With the exception of the contributions by the town of Olivet and the Brochet Olivetain, all costs were borne by ASRL.
■ The plants are transported to a landfill site. Transportation is ensured by municipal employees and the estimated cost of treatment is 17 euros (before VAT) per tonne.

Information on the project

■ ASRL started to inform elected officials and residents of the presence of the plants during its general meeting in 2007. Since that time, the development of the plants has been discussed during each board meeting (4 to 5 per year), at the general meetings of ASRL, the Brochet Olivetain and the Crew club (once each per year), during four meetings of the Val Dhuy Loiret SBMP, during the sustainable-development days organised by the city of Orléans in 2014 and in information bulletins distributed to residents and fishers.
■ For the general public, information has been made available via the media (France 3 television, the *République du Centre* and *Nouvelle République* newspapers), notably in a dozen articles published since 2007.
■ The RBMP internet site may be consulted at:
http://www.sage-val-dhuy-loiret.fr/
■ The Val Dhuy Loiret SBMP has made efforts to communicate via:
- the publication of a guide for residents containing two pages on invasive plants and animals;
- preparation (in progress) of a brochure on the topic;
- three field trips with the members of the local water commission (CLE) and during the national conference on invasive alien species in September 2014;
- publication of reports on the inventories posted on the RBMP internet site;
- participation in the Centre region work group and in the Hydrocharitaceae work group launched by the Pays-de-la-Loire committee for the management of invasive species.

Outlook

■ During the summer of 2014, the theft of the Ratodo motor initiated discussions within the organisation on future management of invasive species. Unfortunately, the Ratodo is no longer capable of effectively handling the situation.
■ For 2015, the objective at ASRL is to double the surface area treated by the harvester boat, i.e. extend it to almost 2 500 metres (with funding from ASRL, the Crew club in Orléans/Olivet and the Brochet Olivetain).
■ The inventory launched in 2013 and 2014 will be pursued to observe the development of the plants and to better understand the important factors in the colonisation.

Authors: Stéphane Thauvin, ASRL, and Carine Biot, Val Dhuy Loiret RBMP. May 2015.

8. 9. Efforts to raise awareness in the field.

For more information

■ Internet sites: http://www.asrl.fr/les-herbes/lesherbes_index.php
http://www.sage-val-dhuy-loiret.fr/
http://www.sage-val-dhuy-loiret.fr/wpcontent/uploads/2013/04/Rapport-destage.pdf
■ Association syndicale de la rivière du Loiret - 336 allée Sainte Croix - 45160 OLIVET
■ SAGE Val Dhuy Loiret - Établissement public Loire - 2 quai du Fort Alleaume - CS 55708 - 45057 ORLEANS CEDEX

2018 edition

Large-flowered waterweed and Curly waterweed

(*Egeria densa* and *Lagarosiphon major*)

Managing large-flowered waterweed and curly waterweed by installing screens on the water bottom

Grands Lacs intermunicipal association

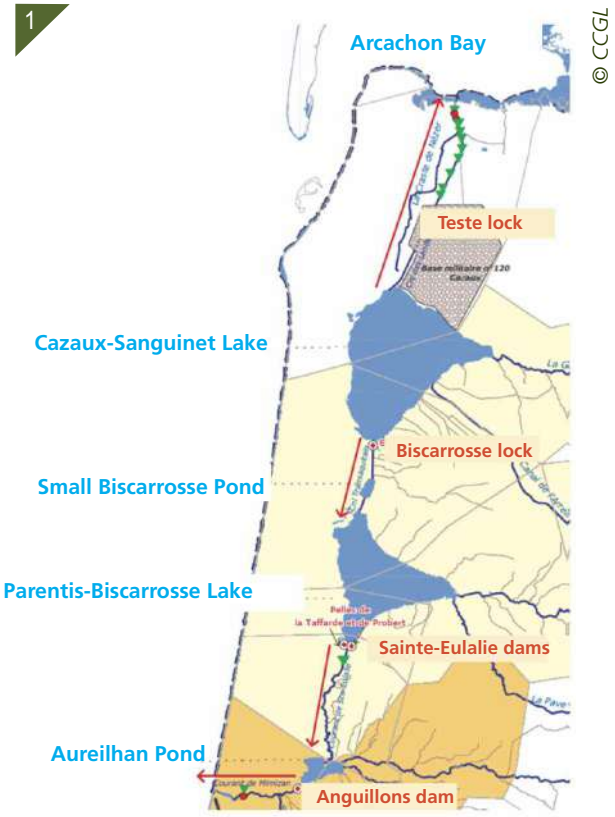
- Since 2003, the public board has managed over 9 000 hectares (90 square kilometres) of freshwater ponds and lakes (out of a total area of 1 500 sq. kilometres).
- The board includes an environmental department whose main missions are the management of the FR7200714 Natura 2000 site (Born and Buch wetlands), management of the hydraulic installations, the water levels in the ponds and lakes, and plant invasive alien species (IAS).
- The Born and Buch SBMP (sub-basin management plan) also contains a number of measures concerning IAS management.
- Contact:

- Laurent Pickhahn, environmental technician:
technicien.rivieres@cdc-grands-lacs.fr
- Chloé Alexandre, SBMP officer:
chloe-alexandre@smbvlb.fr
- Claire Betbeder, Natura 2000 manager:
natura2000@cdc-grands-lacs.fr

Intervention site

- The water bodies in the *Grands Lacs* intermunicipal association include two ponds and two lakes (see Table 1) listed as part of the Born and Buch wetlands Natura 2000 site.

1



1. Functioning and hydraulic management of the water bodies (Born and Buch SBMP).

Table 1. Main characteristics of the water bodies.

	Northern lake (Cazaux-Sanguinet)	Small Biscarrosse Pond	Southern lake (Parentis-Biscarrosse)	Aureilhan Pond
Surface area (hectares)	5 800	92	3 600	340
Maximum depth (metres)	23	2	20	5.6
Average depth (metres)	8.6	0.66	6.7	1.9
Water volume (million cubic metres)	500	0.6	250	6.4
Annual renewal rate	0.23	62.5	1.02	52.5
Uses, activities, issues	Fishing, hunting, boating, swimming, military zone, drinking water	Nature reserve for hunting and fishing	Fishing, hunting, boating	Fishing, hunting, boating

Disturbances and issues involved

■ Curly waterweed, first observed in the area in 1976, was present in the four water bodies.

■ The species would appear to be progressively replaced by large-flowered waterweed that was first observed in 2005 in the Parentis-Biscarrosse Lake and subsequently spread, via the hydraulic network, to the Aureilhan Pond. It has not yet been seen in the Cazaux-Sanguinet Lake.

■ The two species create serious problems for a number of uses and particularly for motor boating in and near the port zones, but also for sailing due to the development of thick beds over surface areas that can reach several hectares. The plants can foul propellers and block the progression of non-motorised craft.

■ The plants, with other amphibious alien species (water primrose and parrot-feather watermilfoil) can also cause decreases in plant biodiversity, notably for swards comprising shoreweeds and lobelias.

Interventions

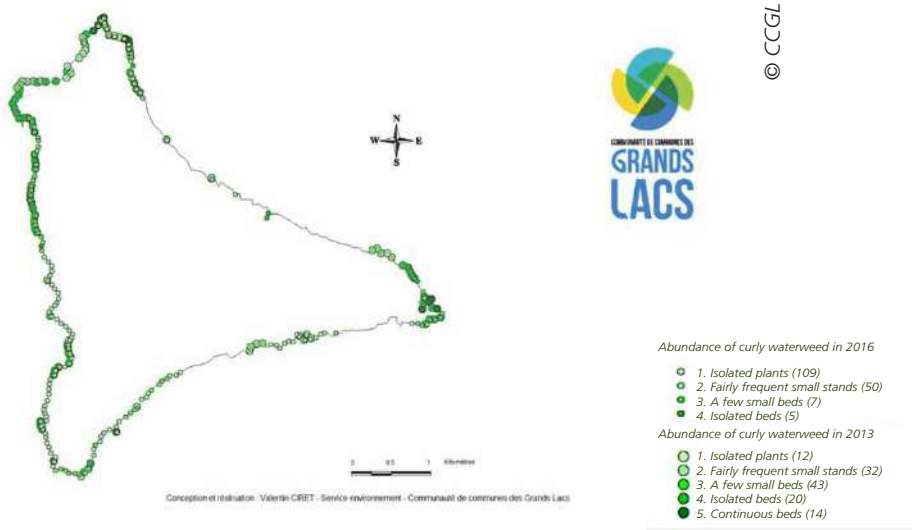
■ The work was carried out to enable the continued use of the water bodies (fishing, boating, etc.) and to preserve the emblematic, native species of plants. It entailed two parts:

■ monitoring of plant dynamics via regular mapping of several invasive plants present in the water bodies, namely curly waterweed (*Lagarosiphon major*), large-flowered waterweed (*Egeria densa*), large-flower water primrose *(Ludwigia grandiflora*) and parrot-feather watermilfoil (*Myriophyllum aquaticum*);

■ experiments in a boating centre using screens laid underwater to block the light and eliminate the problems caused by the submergent plants for boating, and to reduce the risks of fragmenting the plants (propellers) and creating cuttings that could spread the plants throughout the lake.

■ Assessment using maps

■ Since 2009, the environmental department has mapped the spread of the four invasive alien species mentioned above.



Abundance of curly waterweed in Parentis-Biscarrosse Lake from 2013 to 2016.

■ The purpose of this assessment is to identify the important sectors requiring an intervention, the conditions of which depend on the physical situation and the management objectives. The assessment is carried out once every two years and covers a total of 75 kilometres of banks along the water bodies.

■ The method is based on the experimental work done by Irstea (formerly Cemagref) for the Géolandes board (Dutartre *et al.*, 1989). The complete 2016 assessment results may be downloaded at:
http://www.cdc-grands-lacs.fr/Environnement-et-Patrimoine/Lacs-et-especesvegetales-envahissantes/Especes-exotiques-envahissantes-vegetales

■ An example of the assessment results concerning curly waterweed is shown on the previous page.

■ Experiments with screens to block the light

■ Large-flowered waterweed occupied the entire basin of the port in the town of Sainte-Eulalie en Born, creating major problems for motorised boating and for recreational fishing as well.

■ The technique used was similar to that employed recently in Ireland (Lough Corrib, see the management report at http://www.gt-ibma.eu/wp-content/uploads/2016/10/La-garosiphon-major3.pdf), that is the laying of screens underwater to block the light in order to limit photosynthesis and the development of the aquatic vegetation.

■ The main difference lies in the fact that the screens used here were synthetic (polypropylene sheets with fibreglass reinforcing) and will remain definitively on the water bottom, whereas in Ireland, they were made of burlap and should decompose in a few years.

■ A technical and scientific committee was brought together (Irstea, departmental fishing federation and the *Grands Lacs* association) prior to the start of the experiment to set up a monitoring programme, notably by taking samples of plant biomass and analysing the physical-chemical parameters on the site.

■ The operational technique was validated and subsequently refined over time in conjunction with the company doing the job in order to ensure the best possible work conditions.

■ The screens were installed over three consecutive years (2013 to 2015) and cover a total surface area of 9 700 square metres.

■ Information on the experiments is provided in Table 2 below.

■ Before laying the screens, the plants were mowed at a depth of two metres and harvested.

■ The device used the first year (a harvester boat that cut the plants at a depth of two metres) could scrape the bottom and remove a significant part of the root system of the plants, leaving the bottom fairly smooth. The unwieldy operation of the boat near obstacles (docks, banks) led to the decision to use a more versatile, amphibious device called the Mobitrac (see Figure 4) in 2014 and 2015. The latter was also capable of scraping the bottom thanks to a specially made tool similar to cutting bars dragged along the bottom.

■ Any objects found on the bottom were also removed.

■ The screens (Soltis part number Serge Ferrari 86-2053) are micro-perforated to enable the passage of gasses produced in the water column by fermentation in the sediment (http://www.sergeferrari.com/protectionsolaire/gamme-protection-solaire/).

■ A number of selection criteria determined the final choice of the product. During the bidding procedure, tests were run on the resistance to tearing, opacity and above all immersion in water. The latter criterion was decisive given the size of the screens and the technical difficulties of laying them under water.

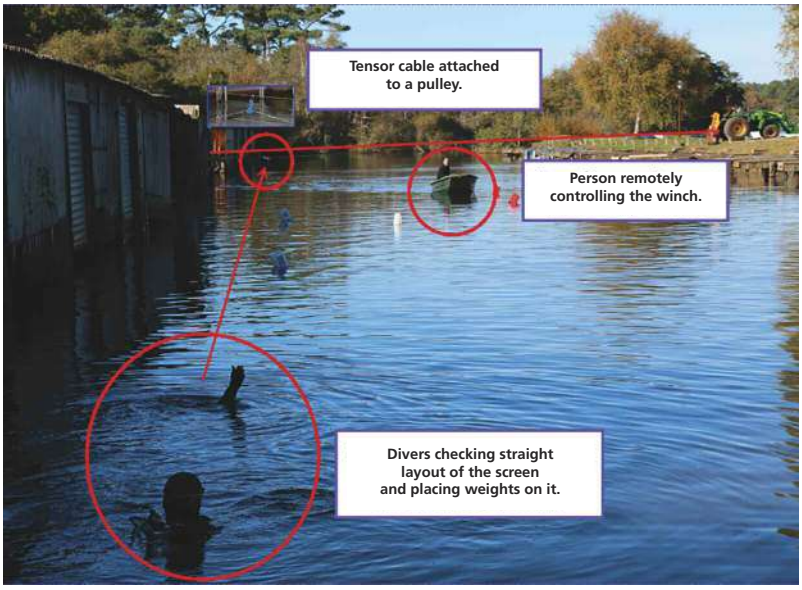
2. The white areas are the basins of the port in the town of Sainte-Eulalie, where the screens were placed.
3. The Mobitrac amphibious device.
4. A screen to block light and photosynthesis.

■ Screens were put together (thermal joining) to create large strips 4 to 5 metres wide and 50 metres long.

■ A company specialised in underwater work positioned the screens, securing them to the sandy bottom using metal connectors and solid concrete blocks.

■ Approximately 90% of the total surface area of the port basins was covered by the screens.

■ The areas under the fishing huts and the docks (floating or on pilings) were not covered for technical reasons (difficulties in unrolling and positioning the screens).



Installation of the screens.

5. Information panel for site users.

Results and costs

■ Results

■ For technical and financial reasons, the areas under the docks and fishing huts along the banks were not covered with the screens. Aquatic plants (exclusively large-flowered waterweed) continue to grow in these areas, thus providing a habitat for fish, a positive factor for the fishing population. However, these areas must be maintained to avoid any risk of the plants spreading (via cuttings) from the beds to the nearby screens.

■ During the months following the installation of the screens, the aquatic plants disappeared from the covered areas (it should be noted that in dense beds, the biomass of large-flowered waterweed can reach 1 to 1.2 kg of dry matter per square metre).

■ Monitoring of the initial phase of work revealed little or no apparent impact on the environment, i.e. the physical-chemical parameters (dissolved oxygen, conductivity, turbidity, pH) were similar in treated and non-treated basins and fish remained present.

■ Annual maintenance on the screens is indispensable. Due to the absence of prior information on the need for maintenance, this work was not scheduled from the start. It consists of using divers to manually uproot:

- cuttings of large-flowered waterweed growing on thin layers of sediment at some points on the screens;
- a small number of plants growing up through the screens following the second year after their installation.

■ Financial aspects

■ The entire cost (148 231 euros) was borne by the intermunicipal association.

Table 2. Intervention activities, dates and costs.

Surface area (sq. metres)	Surface area (sq. metres)	Work done	Period, duration and number of people	Cost not incl. VAT
Bassin des Brochets	3 300	Harvesting	October 2013 3 days	5 000
		Laying screens	November 2013 8 days, 4 people	38 124
		Maintenance	June 2014 3 days, 4 people	6 000
Bassin des Perches	2 500	Harvesting	November 2014 2 days	7 900
		Laying screens	November 2014 4 days, 5 people	28 514
		Maintenance	May 2015 2 days, 4 people	5 250
Bassin des Sandres	3 900	Harvesting	October 2015 4 days	6 937
		Laying screens	October 2015 6 days, 5 people	54 506
		Maintenance	June 2016 3 days, 4 people	7 000
TOTAL	9 700			148 231

Information on the project

■ This work was done in conjunction with the local certified association for fishing and protection of aquatic environments (AAPPMA) and with the support of the port users.

■ An information panel detailing the issues, objectives and work conditions was set up on site to encourage people not to disturb the screens.

■ New port regulations are planned to ensure the sustainability of the work (limited speeds, no anchors, protection of the local environment, etc.).

Outlook

■ Regular monitoring of the three basins using a bathyscope is funded by the intermunicipal association. It was also decided to sign an annual maintenance contract for the indispensable, underwater, manual uprooting of the large-flowered waterweed.

■ Before and after each maintenance operation, the contracting company must film the underwater conditions to determine degree of colonisation by the plants.

Authors: Laurent Pickhan, Grands Lacs intermunicipal association, and Alain Dutartre, independent expert. September 2016.

For more information

■ Internet sites: http://www.cdc-grands-lacs.fr/Environnement-et-Patrimoine/Lacs-et-plantes-invasives ; http://www.sage-born-et-buch.fr/

■ Analysis by the Washington State Ecology department: http://www.ecy.wa.gov/programs/wq/plants/management/aqua023.html

■ Guide d'analyse des projets d'intervention dans les écosystèmes aquatiques, humides et riverains assujettis à l'article 22 de la Loi sur la qualité de l'environnement. Annexe 2 : Méthodes de contrôle des plantes aquatiques et des algues. Ministère du Développement Durable, de l'Environnement et des Parcs, Québec. Updated August 2007.

■ Dutartre, A., Delarche, A., Dulong, J., 1989. Plan de gestion de la végétation aquatique des lacs et des étangs landais. Cemagref, GEREA, Etude N° 38, rapport Géolandes, 121 p.

■ Dutartre,A., Jan, G., 2012. Expérimentation de contrôle des herbiers d'*Egeria densa* dans le port de Sainte-Eulalie-en-Born (Landes) à l'aide d'écrans occultant la lumière. Irstea, rapport, 13 p.

■ Perkins M. A. et col., 1980.The use of fiberglass screens for control of Eurasian watermilfoil. J. Aquat. Plant Manag., 18. 13 – 19.

2018 edition

Large-flowered waterweed

(Egeria densa)

Planting riparian vegetation to limit the spread of large-flowered waterweed in the Jalle de Blanquefort river basin

Bordeaux Métropole

■ As of 1 January 2016, Bordeaux Métropole, the local government for the greater Bordeaux area, took over responsibility for the GEMAPI policy (management of aquatic environments and flood prevention) for the Jalle de Blanquefort river basin from the Jalles, de Lande à Garonne board (SIJALAG). Bordeaux Métropole is now in charge of the jalles[1], the largest natural area within the urban zone. The Métropole uses the studies previously carried out by the SIJALAG and its personnel who joined the Métropole when the board was terminated. It also uses the studies done by *Cistude Nature*, particularly for the management of invasive alien species.

■ Bordeaux Métropole is responsible for regular maintenance operations on the hydrographic network in the Jalle de Blanquefort river basin. The Métropole also manages the current studies on how to improve the status of aquatic ecosystems and mitigate the effects of flooding and droughts.

■ Contact: Fabrice Demarty, GEMAPI technician at Bordeaux Métropole - fdemarty@bordeaux-metropole.fr

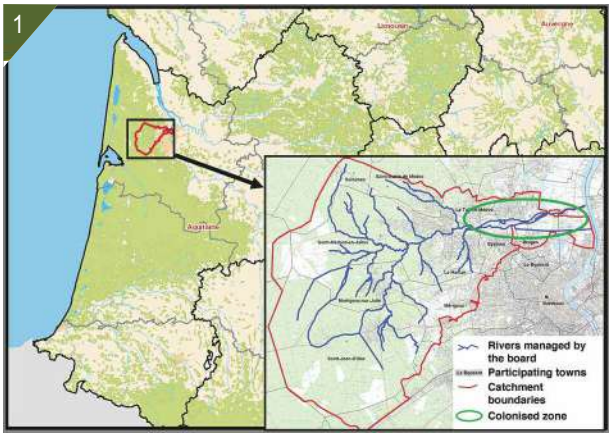
Intervention site

■ The Jalle de Blanquefort river basin covers a total of 13 towns, namely Blanquefort, Bordeaux, Bruges, Eysines, Le Bouscat, Le Haillan, Le Taillan-Médoc, Martignas-sur-Jalle, Mérignac, Saint-Aubin-de-Médoc, Saint-Jean-d'Illac, Saint-Médard-en-Jalles and Salaunes.

■ The work was done in the towns of Blanquefort, Bordeaux, Bruges, Eysines, Le Haillan, Le Taillan-Médoc and Saint-Médard-en-Jalles.

■ The Jalle area includes two Natura 2000 sites, namely the Bruges marshes nature reserve (FR710029) and the Jalle hydrographic network in Saint-Médard and Eysines (FR7200805).

■ The Jalle River itself has been heavily impacted by human activities, e.g. urban development, containment and a series of dams in the downstream section.



© Bordeaux Métropole

1. Map showing the Jalle de Blanquefort river basin.

Disturbances and issues involved

■ *Egeria densa* has been observed on the Jalle since the middle of the 2000s.

■ It forms dense, single-species populations that hinder the flow of water (formation of hydraulic barriers), trap sediment and can provoke variations in water quality.

■ It competes for resources with native plants such as water-starwort [*Callitriche obtusangula*], Eurasian watermilfoil [*Myriophyllum spicatum*], rigid hornwort [*Ceratophyllum demersum*], etc. and can facilitate the development of another invasive plant, creeping water primrose (*Ludwigia peploides*) by providing a base for its growth.

■ The plant is also visually bothersome, particularly in certain reaches where the dense beds reach the water surface.

Interventions

■ In 2011, the SIJALAG launched a study on how to manage *Egeria densa* that at the time was present on 16 kilometres out of the 176 km in the hydrographic network.

■ The main objectives were to:

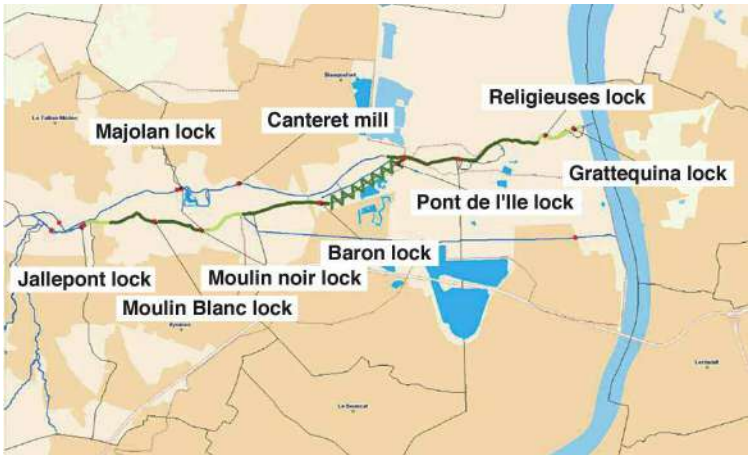
- collect the available knowledge on the colonisation dynamics of the species;
- draw up a status report on the presence of the species in the river basin as well as on its ecological, social and financial impacts and costs;
- propose and experiment with management work.

1. In the Gascon language, the word "jalle" means river or stream.

■ Study results

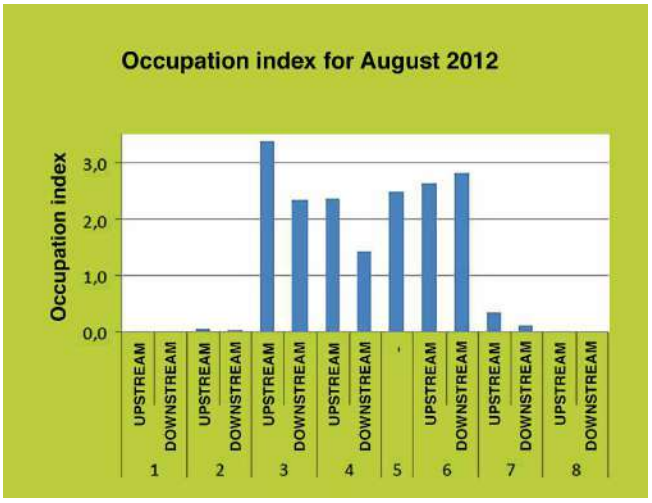
■ The study was carried out over three years (2012 to 2014) and revealed significant variations in the presence and density of the waterweed.

■ Generally speaking, the sites the farthest upstream and those downstream, near the estuary, were the least colonised, whereas the sites in the middle were much more heavily colonised (see the results for 2012 in the figure below).



© F. Demarty

Distribution of waterweed over the different sites. Dark green = high density, light green = light density. The red dots mark locks and mills.



Index for waterweed presence on each site in August 2012 (index = average abundance x number of colonised spots).

■ The analysis also revealed that the presence of the plants would seem to be correlated with a set of other factors, including the flow velocity, bed width and depth, and nutrient richness in the environment (nitrates, oligophosphates). The latter factor would explain why the sites upstream of the wastewater-treatment plants are the least affected.

■ High levels of shade are also correlated with an absence of waterweed.

■ On the basis of these results, further study was put into the potential management techniques.

■ Tests on mechanical uprooting

■ Mechanical uprooting was tested each year in 2011, 2012 and 2013 on two zones in the river, each 400 metres long. The two zones were selected because they had the highest plant densities and the plants constituted a direct, visual disturbance for the patrons of a restaurant along the river.

2. Waterweed clogging a hydraulic installation.
3. The Jalle River colonised by Egeria densa.
4. The machine used to uproot the plants.
5. Uprooting the waterweed.
6. Young trees growing at the SIJALAG nursery.

■ Following this work, the occupation indices for waterweed increased downstream, which probably means that the work caused the dispersal of plant fragments.

■ Given the ineffectiveness of the mechanical uprooting, its cost and impact on the rest of the ecosystem, it was decided not to continue with the technique.

■ Management proposals

■ In light of the relatively low adverse impacts of waterweed on the environment, its colonisation dynamics and the ineffectiveness of the uprooting technique previously tested, it was decided to work on restoring the environment to improve its long-term ecological status. It was hoped that this would limit the colonisation of the species to acceptable levels.

■ The work to restore the equilibrium of the ecosystems was organised along three lines:

- the installation of riparian vegetation to create shade and thus limit the development of the waterweed;
- improvements in the management of water levels by renovating the system of locks and mills to limit the reaches with low flow velocities that facilitated the development of waterweed and to restore ecological continuity (the free circulation of water, fish and sediment);
- a study on how to divert the effluents from the wastewater-treatment plant from the upper section of the river, in order to reduce the quantity of nutrients.

■ To date, only the installation of riparian vegetation has been undertaken.

■ Installation of riparian vegetation

■ Due to the presence of dikes bordering major sections of the river, the riparian vegetation could be planted only along 900 metres of the river.

■ The river is not public property, therefore it was necessary first to receive permission from the owners of the banks. The increase in shade could have caused problems for the vegetable farms with fields along the river, but the project was accepted with any difficulties.

■ The work started in the fall of 2014.

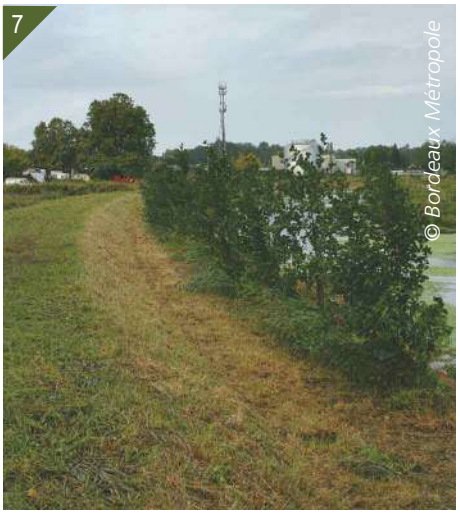
■ A total of 300 trees, approximately 1.5 metres tall, were planted at a distance of two metres from the water, alternating taller and shorter (shrub-type) species.

Latin name	Common name	Number planted
Alnus glutinosa	Alder	150
Fraxinus excelsior	Ash	50
Salix sp.	Willow	25
Corylus avellana	Hazel	25
Sorbus torminalis	Checker tree	25

■ Annual maintenance

■ The waterweed (plants and fragments) is removed from the hydraulic installations each year in the fall.

■ A total of four to five tons of fresh waterweed are removed each year. The plants are spread on the banks of the river (above flood level) to decompose.



7. Trees planted along the Jalle.
8. Work to remove E. densa *from the hydraulic installations.*

Results and assessment

Results

- Restoration of the environment will take place only over the mid to long term, i.e. it will not be possible to draw any conclusions for several years.
- A monitoring programme is not planned for the moment due to a lack of human resources. However, a visual check will be run each year during the maintenance work on the dikes in the summer (July and August).
- As of the spring of 2017, the trees would seem to have taken root along the river. Two and a half years after being planted, the survival rate is 95% and the height of the trees is approximately three metres. Most losses are due to vandalism.

Assessment

- Three technicians spent ten days to plant the riparian vegetation.
- The maintenance work in the fall also requires three persons for approximately ten days of work.

Table listing project costs.

	Year	Cost (€)	Funding
Study of the colonisation dynamics	2012 - 2014	59 000	60% Adour-Garonne Water agency, 40% Bordeaux Métropole
Mechanical uprooting	2011 2012 2013	28 600 30 000 30 000	40% Adour-Garonne Water agency, 35% Bordeaux Métropole, 25% SIJALAG
Fall maintenance	Every year	8 000	60% Adour-Garonne Water agency, 20% Gironde departmental council, 20% Bordeaux Métropole
Riparian vegetation	2014	10 000	60% Adour-Garonne Water agency, 20% Gironde departmental council, 20% Bordeaux Métropole


9

Egeria densa dans la Jalle de Blanquefort

Egeria, qui est elle?

L'*Egeria densa* (appelé Egeria dans le reste du document) est originaire du Brésil et des régions côtières d'Argentine et d'Uruguay. Elle connaît à l'heure actuelle des difficultés dans différentes parties du monde comme : l'Australie, la Nouvelle Zélande, l'Afrique du Sud, l'Amérique latine, et l'Europe et notamment en France. Elle y a été importée et cultivée depuis les années 1920 et s'observe en milieu naturel depuis 1960, sur la jalle milieu des années 2000.

Egeria densa est une hydrocotyle pleurote aquatique submergée qui forme des peuplements mono-spécifiques denses qui restreignent la circulation des eaux, piégeant les sédiments et provoquent des variations de la qualité de l'eau. Elle a également affecté le statut de certaines espèces menacées. Elle a été introduite à travers le monde entier via l'aquariophilie.

Quels impacts réels ? Quels problèmes ?

Cette plante fait partie des espèces exotiques envahissantes qui causent par leurs prolifération des nuisances très importantes vis-à-vis des usages des milieux naturels.

A part les deux espèces de jussie, elles sont en vente libre comme plantes ornementales. Il serait préférable de ne pas les acheter et de les remplacer par des espèces indigènes.

- Le premier des effets négatifs est celui de la gêne visuelle.
- Egeria va aussi occuper des niches écologiques des plantes indigènes qui se développent de mai/as en mois.
- Un autre problème, est le fait que l'Egeria devient un support de développement des algues filamenteuses et d'une autre invasive : la jussie rampante (*Ludwigia peploides*).
- Elle a aussi des incidences hydrauliques : création de bouchons hydrauliques entraînant une perturbation localisée des écoulements, voire une augmentation ponctuelle des niveaux d'eau.

Etude sur la dynamique et la colonisation *d'Egeria densa* dans la Jalle de Blanquefort 2012-2014.

Le but de l'étude a été d'une part d'identifier les facteurs qui influencent le développement de l'Egeria et d'autre part de faire une description plus détaillée de son habitat et de sa distribution en déterminant le comportement de la plante en amont/ aval des ouvrages, entre différents ouvrages, dans la zone ayant subi des arrachages , en présence de la station d'épuration, etc.

Les sites étudiés sont : Moulin du Thil, Echase de Jellgouat, Majolan, Echase du moulin Blanc, Echase du Moulin noir, La forteresse, Moulin du Baron, Echase du pont de l'île, Echase des Religieuses.

L'étude a pu mettre en évidence que transparence, paramètres physiques de l'eau, profondeur, vitesse du courant, ombrage, substrats du fond du lit, apports nutritionnel (nitrates et orthophosphates) et conditions climatiques sont les facteurs aggravants de la prolifération de cette plante.

9. The information sheet on E. densa.

© Bordeaux Métropole

Information on the project

- An information sheet was prepared for the general public.

Outlook

- River compliance in terms of ecological continuity should be achieved by the end of 2019, following a study on the hydromorphology of the hydrological network. Work will also be put into setting up a more rigorous management system for water abstractions by the vegetable farmers because currently, there is no overall management system.
- The project to divert the effluents of the wastewater-treatment plant is also in the planning stage.

Authors: Doriane Blottière, IUCN French committee, and Fabrice Demarty, Bordeaux Métropole. January 2018.

For more information

- Clément, B. 2014. Étude sur la dynamique et la colonisation de la plante invasive *Egeria densa* dans la Jalle de Blanquefort. Résultat des analyses de données concernant *Egeria densa*. Communauté urbaine de Bordeaux et Agence de l'eau Adour-Garonne. 18 pp.
- De Weedt, J. 2012. Étude sur la dynamique et la colonisation de la plante invasive *Egeria densa* dans la Jalle de Blanquefort. SIJALAG. 95 pp.

2018 edition

© Emilie Mazaubert

Water fern

(Azolla filiculoïdes)

Classification	
Order	Salviniales
Family	*Azollaceae*
Genus	*Azolla*
Species	*A. filiculoïdes* (Lam., 1783)

Originated in South America. Introduced in Europe in the 1800s for aquariums and botanic gardens, from which it escaped. The plant was first observed in France in 1880, in the Deux-Sèvres department.

Description

- A small fern, approximately 1-2 cm in diameter, that floats freely on the water surface
- Small, scaled fronds, hydrophobic in the upper section:

- green, tinted red toward the end of the summer
- alternating, tightly nested together
- the fronds spread horizontally over the water surface in step with the growth of the plant

- A short, branching rhizome

Ecology and reproduction

- Habitats consist of calm and stagnating waters, ranging from mesotrophic to eutrophic, including lakes, lentic rivers and streams, canals, ponds, pools, ditches
- Vegetative multiplication (fragmentation)
- Sexual reproduction in the spring in the form of spores capable of resisting drying, this type of reproduction would appear to be very infrequent in France
- The plant cannot resist freezing temperatures
- The species is elusive and unforeseeable in its behaviour, capable of proliferating one year and disappearing the next, which does not facilitate management
- The species has a symbiotic relationship with a cyanobacteria capable of fixing atmospheric nitrogen

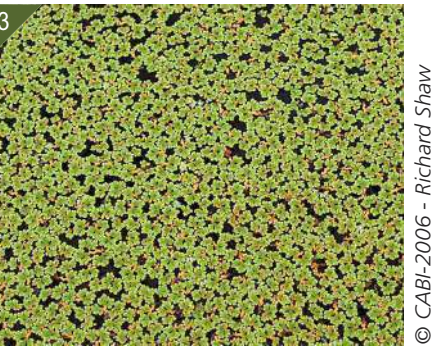
Documentation

- Hudin S. et Vahrameev P. (coord.,). 2010. Guide d'identification des plantes exotiques envahissant les milieux aquatiques et les berges du bassin Loire-Bretagne. Fédération des conservatoires d'espaces naturels, 45 pp.
- Haury J. et Clergeau P. 2014. Espèces invasives en Bretagne. Plantes et vertébrés continentaux. Les cahiers naturalistes de Bretagne, numéro 9. Biotope éditions, 144 pp.
- CABI. 2014. Invasive Species Compendium: *Azolla filiculoides* (Water Fern). http://www.cabi.org/isc/datasheet/8119
- GIS Macrophytes des eaux continentales. 1997. Biologie et écologie des espèces végétales proliférant en France. Synthèse bibliographique. Les études de l'agence de l'eau numéro 68. 202 pp.

Author: Emmanuelle Sarat, IUCN French committee

1 © CABI - 2006 - Richard Shaw

2 © CABI-2006 - Richard Shaw



3 © CABI-2006 - Richard Shaw

4 © CABI-2003 - Richard Shaw

Water fern

(Azolla filiculoïdes)

Experiments on biological control of water fern in the U.K., Belgium and the Netherlandss

Centre for Agricultural Bioscience International (CABI)

- CABI is an international, non-profit organisation active in agricultural and environmental R&D work.
- The organisation provides science advice in the fields of agriculture and the environment in view of improving food security worldwide and environmental protection via R&D projects addressing:

- efforts against crop pests and diseases;
- the development of management methods for invasive alien species (IAS);
- enhanced access to scientific knowledge concerning agriculture and the environment.

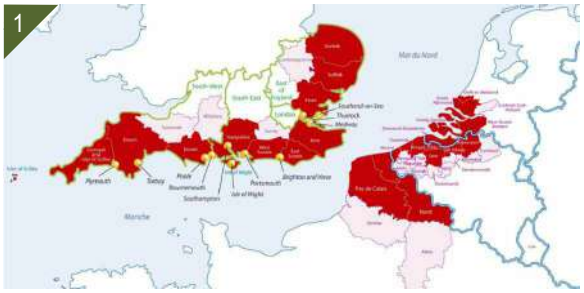
- The organisation groups 48 countries with sites in 21 countries and its headquarters in the U.K. (Egham).
- Contact: Corin Pratt - c.pratt@cabi.org
Richard Shaw - r.shaw@cabi.org

RINSE project

- The European RINSE project (Reducing the impacts of non-native species in Europe) attempts to determine the best management strategies for IASs in the Two seas region (along the English Channel and the southern section of the North Sea).
- The objective of the project is to develop cross-border instruments to improve ranking and targeting of IASs in order to ensure that resources are effectively directed toward the most worrisome species and sites. Particular attention is paid to species in aquatic environments. New management methods are experimented in the field to develop the best practices and issue recommendations to managers.
- The three-year project was launched in 2011 and is funded by the EU in the framework of the Interreg IVA Two seas programme. A total of nine partners from France, the U.K., Belgium and the Netherlands are involved.
- The annual budget is 2.5 million euros.

Intervention site

- The experiments on biologically controlling water fern were carried out in different coastal regions of the U.K., Belgium and the Netherlands.



© RINSE

© Google maps

1. RINSE intervention sites.
2. Study sites in the project on biological control of water fern.

United Kingdom	Cornwall, Hampshire, West Sussex, Surrey
Belgium	Assebroek, Kuurne, Kampveld, Wingene (multiple sites), Gistel, Geel
Netherlands	Rotterdam
France	No study sites.

Disturbances and issues involved

- The plants develop thick mats that completely cover stagnant environments, provoking:

- a reduction in the light and oxygen available for other organisms;
- blocking of filters and pumps, which can result in flooding;
- risks of drowning for livestock because the mats can look like solid land;
- detrimental effects for recreational activities (fishing and boating).

Testing a biological-control method

■ Manual harvesting of water fern is possible, but complex in that the site is often recolonised by fragments left on site. Repeated harvesting operations have rarely succeeded in eradicating the plants over the long term and are very expensive.

■ Herbicides are prohibited in aquatic environments in France and therefore cannot be used to control water fern.

■ Biological control of water fern using a weevil, *Stenopelmus rufinasus*, was studied in 1990 in South Africa with positive results. The tests and monitoring revealed that *Stenopelmus rufinasus* is a specialised predator of water fern. The insect was released in number in South Africa in 1997.

■ In Europe, *Stenopelmus rufinasus* was accidentally introduced in 1901 in conjunction with water fern. The insect species established itself in Europe in spite of the harsh winters in the North that slow its reproduction and dispersal (winter diapause).

■ *Stenopelmus rufinasus* thus represents a potential means of biological control for water fern, particularly for major proliferations of water fern over large surface areas on sites where the insect is not already present.

■ The objective of the experiments was to:

- assess the impact of the *Stenopelmus rufinasus* weevils (bred specifically for the purpose or collected and transported from the natural environment) on sites colonised by water fern;
- determine whether the insect constitutes an effective means of biological control in managing water fern.

Interventions

■ During the first step, efforts were made in each of the regions in question to find proliferations of water fern.

■ A total of 15 sites were selected for the project, ranging from very small water bodies (1 square metre) to ponds covering several hectares.

■ Each site was then described in detail. The surface area colonised by water fern was estimated.

■ Once each site had been fully characterised, a search was made for the *Stenopelmus rufinasus* weevil.

■ On sites where the *Stenopelmus rufinasus* weevil was naturally present, the impact of the insect on water fern was monitored.

■ Specimens of *Stenopelmus rufinasus* were collected in each area and raised under confined conditions in specially equipped laboratories in the U.K. and the Netherlands.

■ The insects were then released, following authorisation, on the sites where water fern had been observed in the U.K., Belgium and the Netherlands. In France, the insect was not introduced because the administrative procedures were still under way.

■ In Belgium, adult insects were collected on one site and directly released on another, i.e. they were not bred in a lab.

■ Modifications in the colonisation of water fern were monitored on the sites over a number of weeks, notably using photographs taken from a fixed site.

3. Manual removal of Azolla filiculoides *in the U.K. (Sussex).*
4. 5. An adult Stenopelmus rufinasus *weevil on water fern.*

Results and assessment

Results of the on-site experiments

- The tests were conducted on approximately 15 water bodies of different types.
- The test results are summarised below.

Country	Site	Type of site	Colonised surface area (square metres)	Date weevil introduced	Introduction method	Number of insects released	Results	Observation time
United Kingdom	Cornwall	Pool	6	July 2012	Breeding, then introduction	50	Elimination	10 weeks
United Kingdom	Hampshire	Pool	240	August 2012	Breeding, then introduction	3 000	Good control	6 weeks
United Kingdom	West Sussex	Pool	200	July 2013	Breeding, then introduction	1 000	Elimination	10 weeks
United Kingdom	Surrey	Pool	20 000	Species naturally present in July 2012	Naturally present		Elimination	15 weeks
Belgium	Assebroek	Pool	200	Species naturally present in April 2013	Naturally present		Elimination	10 weeks
Belgium	Kuurne	Pool	1 200	Species naturally present in July 2013	Naturally present		Excellent control	18 weeks
Belgium	Kampveld	Pool	360	Species naturally present in September 2013	Naturally present		Elimination	8 weeks
Belgium	Wingene	Ditch	50	Species naturally present in June 2014	Naturally present		Elimination (site flooded)	12 weeks
Belgium	Wingene	Pool	500	Species naturally present in June 2014	Naturally present		Virtually eliminated	Ongoing
Belgium	Wingene	Pool	15	Species naturally present in June 2014	Naturally present		Ongoing	Ongoing
Belgium	Wingene	Ditch	30	June 2014	Insects transported	300	Elimination (site flooded)	12 weeks
Belgium	Gistel	Pool and ditch	10 000	Species naturally present in June 2014	Naturally present		Ongoing	Ongoing
Belgium	Geel	Pool	1 000	Species naturally present in June 2014	Naturally present		Elimination	15 weeks
Netherlands	Greenhouse in Rotterdam	Basin	1	Since 2012	On-site breeding		Elimination	Not available
Netherlands	Rotterdam	Canal	500	September 2013	Breeding, then introduction	300	Project interrupted (water fern removed)	6 weeks

Assessment

- Biological control of water fern was effective on the study sites for a moderate cost and no observed negative effects on the environment.
- The main difficulties encountered during the project concerned regulations:

- it was not easy to find the cognizant authorities in each country for the introduction of a species that was already present in the country;
- the protocols required for the experiments had to be drafted.

- Time was also required to find the necessary experts and to set up a network for the project.
- A further difficulty lay in finding enough sites where water fern was present and where the insects could be introduced, particularly in the Netherlands and in France. This was due to variable seasonal weather and the short-lived nature of water fern meaning the species could not always be found on a site from one year to the next.
- The existence of regularly updated databases in Belgium and the U.K. made it much easier and faster to find sites, compared to France and the Netherlands.
- In addition to abiotic factors (harsh winters), the natural presence of *Stenopelmus rufinasus* on certain sites provoked the elimination of water fern even before the experiments could begin.

Outlook

- Additional experiments could be carried out in the exposed regions, particularly in France and the Netherlands where only a few or no sites could be monitored.
- The experiments could also be conducted on a larger area than that for the RINCE programme.
- Breeding and introduction techniques for *Stenopelmus rufinasus* could be improved and consolidated in view of continuous production of the species to improve management of sudden proliferations of water fern, as is the case in the U.K. (England and Wales).
- A genetic study on *Stenopelmus rufinasus* populations would be useful to define the relationships between the insects in the original area and those where the insects are released. If all European populations of the insects are genetically identical, it may be possible to transfer insects between countries rather than breeding them for introductions.

Information on the project

- Information was provided to the various stakeholders, e.g. public authorities, the managers of natural areas and the general public.
- Information was delivered via publications, an internet site, conferences, meetings, posters and various presentations.

Remarks

- In France, water fern has colonised a very small number of small water bodies and networks of stagnant ditches. In general, the colonisation lasts for only a few weeks. The species rarely reproduces sexually in France, however its vegetative multiplication is very dynamic.

6. 7. A pool in England colonised by water fern before (a) and after (b) the introduction of Stenopelmus rufinasus.
8. 9. A pond in Belgium colonised by water fern before (a) and after (b) the introduction of Stenopelmus rufinasus.

■ The development of the plant is highly unforeseeable. It may undergo significant proliferation one year, completely disappear the next and then reappear a few years later on the same site or nearby.

■ Given the knowledge currently available on the species, it is not possible to determine the causes of this erratic behaviour in continental France. Possible causes include climatic conditions, physical-chemical conditions in the colonised biotopes resulting the the rapid growth and decline of populations, and control by *Stenopelmus rufinasus*. In any case, the insect would appear to be fairly widespread in continental France and could well play a role in the short-lived nature of certain proliferations.

■ For the above reasons, water fern is managed from time to time on certain spots, e.g. collected using dip nets or gathered using wooden logs and removed manually.

Authors: Corin Pratt, CABI, and Emmanuelle Sarat, IUCN French committee. September 2016.

© Emilie Mazaubert

10. An example of posters presented during conferences on the biological control of water fern.

For more information

■ RINSE internet site: www.rinse-europe.eu
■ Internet site on controlling water fern: www.azollacontrol.com
■ CABI internet site: www.cabi.org
■ Bedel L. 1901. Description et mœurs d'un nouveau genre de Curculionidés en France. Bulletin de la société entomologique de France, 6 : 358-359.
■ Hill M.P. and Cilliers C.J. 1999. *Azolla filiculoides* Lamarck (*Pteridophyta : Azollaceae*), its status in South Africa and control. Hydrobiologia, 415: 203-206.
■ Janes R. 1998a. Growth and survival of *Azolla filiculoides* in Britain. I. Vegetative reproduction. New phytologits, 138 : 367-375.
■ Janes R. 1998b. Growth and survival of *Azolla filiculoides* in Britain. II. Sexual reproduction. New phytologits, 138 : 377-384.
■ Fried G. 2012. Guide des plantes invasives. Belin, 272 pp.

2018 edition

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.

■ Contact : Yohan Petit, policy officer for invasive alien species - yohan.petit@oec.fr

Intervention sites

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

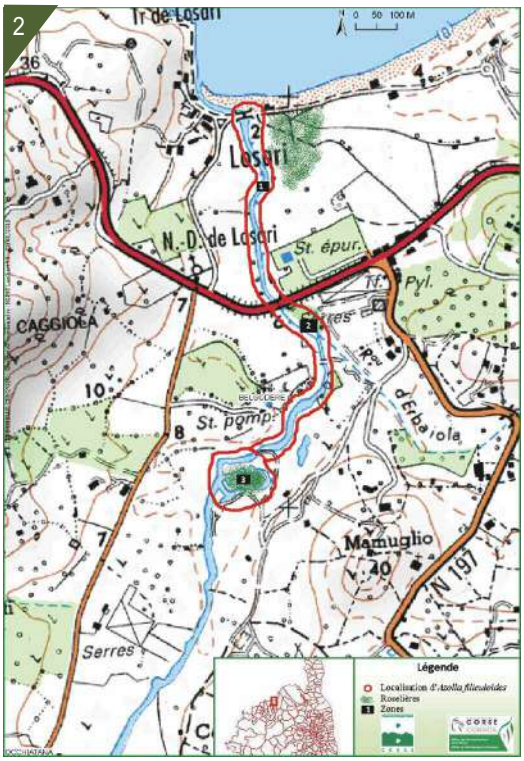
■ It was detected in the towns of Lumiu, Corbara and Belgodère.

■ 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.

1

© N. Suberbielle/CBNC

2



© N. Suberbielle/CBNC

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.

3. Colonisation of the Réginu River by Azolla filiculoides.
4. Initial condition of the pool in Lumiu.

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.

■ 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.

7. The pool in Lumiu following the work.

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

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.

Authors: Doriane Blottière, IUCN French committee, Yohan Petit and Nicolas Suberbielle, CBNC-OEC. January 2018


8
OFFICE DE L'ENVIRONNEMENT DE LA CORSE
CONSERVATOIRE BOTANIQUE NATIONAL DE CORSE
Une plante envahissante :
INVASIVE
L'azolla fausse-fougère
Azolla filiculoides Lam.
L'azolla fausse-fougère (*Azolla filiculoides* Lam.) est une plante originaire d'Amérique du Sud. Elle a été introduite en Europe au début du 19ème siècle dans des aquariums ou des jardins botaniques d'où elle s'est échappée. Elle a aujourd'hui colonisé une grande partie du continent européen[1], incluant la France évidemment.
Description
L'azolla fausse-fougère est une plante vivace, aquatique, flottant librement à la surface des eaux douces et stagnantes. Sa tige fine, fortement ramifiée, présente des racines adventives[2] à intervalles réguliers. Des tiges secondaires, avec les mêmes caractéristiques que la tige principale, peuvent se développer à l'aisselle des feuilles bilobées. Ces feuilles sont en forme d'écailles et n'excèdent pas le demi-millimètre de longueur. Elles sont bordées par une large bande membraneuse et se superposent en couvrant la tige de façon alterne.
Le lobe supérieur de la feuille est verdâtre ou brunâtre à l'automne. Le lobe inférieur, translucide, présente une structure scarieuse[3].
[1] Royaume-Uni, Irlande, Danemark, Belgique, Allemagne, République Tchèque, Slovaquie, Pologne, Espagne, Portugal...
[2] Racines qui apparaissent le long d'une tige, spécialement dans les entre-nœuds.
[3] Se dit d'un organe membraneux, sec, mince et plus ou moins translucide, comme une écaille.

© CBNC

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.

2018 edition

© Alain Dutartre

Curly waterweed

(Lagarosiphon major)

Classification	
Order	Alismatales
Family	*Hydrocharitaceae*
Genus	*Lagarosiphon*
Species	*L. major* ((Ridley) Moss, 1928)

Originated in South Africa.
Introduced for use in aquariums. Observed for the first time in France in the Paris region, before and after World War II. Established primarily along the Atlantic coast, more sparsely in other regions.

Description

- Perennial plant, always submerged
- Thin stalks, numerous branches, easily breakable, up to 5 metres long
- Alternating leaves, long and narrow:
  - developing in spirals except near the top, not whorled, indented leaves
  - length 1 to 3 cm, width 2 mm
  - curving back and down
- Single-sex flowers (only female plants would seem to have established outside the original range and have been observed in France):
  - white flowers blooming on the water surface at the end of a very thin stem 5 centimetres long
  - 3 petals reddish white in colour
  - single flowers, 5 mm in diameter, difficult to observe
- Dense root system that can penetrate deep into muddy sediment (up to 1 metre deep)

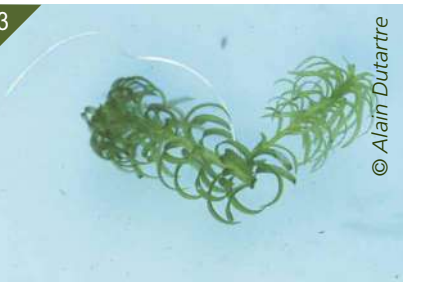
Ecology and reproduction

- Common habitats are stagnant or lentic waters flowing over muddy or sandy beds, rich in organic matter and nutrients (ditches, canals, pools, ponds, lakes, side channels and river banks)
- Reproduction only via vegetative multiplication, by fragments or cuttings

Documentation

- Hudin S., Vahrameev P. (coord.) 2010. Guide d'identification des plantes exotiques envahissant les milieux aquatiques et les berges du bassin Loire-Bretagne. Fédération des conservatoires d'espaces naturels, 45 pp.
- Fried G. 2012. Guide des plantes invasives. Belin, Paris, 272 pp.
- Muller S. (coord). 2004. Plantes invasives en France : état des connaissances et propositions d'actions. Muséum national d'Histoire naturelle, Paris, 168 pp.

Author: Emmanuelle Sarat, IUCN French committee



Curly waterweed

(Lagarosiphon major)

Managing curly waterweed in the valley of the Vergnote River (Lot-et-Garonne department)

Centre for environmental initiatives (CPIE) for the Pays de Serres-Vallée du Lot area

■ The centre is a non-profit environmental-protection organisation founded in 1983 and active in the Lot-et-Garonne department.

■ Its main missions include:

- management of natural environments (studies, inventories, monitoring, upkeep, conservation);
- educational work on the environment and sustainable development (nature walks, conferences, film-debates, citizen-science programmes);
- support for projects (planting hedgerows, environmental issues) and management of a “Biodiversity info” system.

■ Contact: Pauline Lefort, Biodiversity policy officer - contact@cpie47.fr

Intervention site

■ The Vergnote is located in the town of Masquières, in the eastern section of the Lot-et-Garonne department, and has been listed as a ZNIEFF (high-value ecological zone) since 1989.

■ It is also part of the Boudouyssou and Lascrozes Natura 2000 zone.

■ The area, approximately 50 hectares in size, has been listed as a sensitive natural area since 2014. It has outstanding environment diversity and wonderful landscapes. The bottom of the valley is a succession of wet meadows, idle land and EU-listed wet woodlands called “Tufa marshes” and “Petrifying springs with tufa formation” (N2000 code 7220). Amphibians, insects, mammals, reptiles, birds and plants living together compose an emblematic habitat. Remarkable orchids grow on the dry swards covering the calcareous slopes, e.g. *Cephalanthera rubra, Neotinea ustulata, Ophrys simia* and *Gymnadenia conopsea.*

■ The pond colonised by curly waterweed lies in the lower section of the Vergnote, which originates higher up in the valley and runs a total of 1.2 kilometres. The small size of the river does not mean that it does not flow year round. The source waters, derived from the karstic substrate of the surrounding calcareous plateaus, contain high levels of carbonates. Calcium carbonate formations (tufa) may be observed along the entire length of the river.

1. 2. Map showing the site.
3. 4. Curly waterweed prior to the work.

Disturbances and issues involved

- Curly waterweed was found in 2013 in one of the ponds in the valley, approximately 3 000 square metres in size, that was originally dug for recreational purposes (fishing).
- The plant rapidly colonised the pond.
- In 2014, it covered approximately 25% of the surface area and one year later had spread to virtually the entire pond (90%). It competed with other aquatic plants, reduced the quantity of light in the water and created difficulties for fish to move through its dense beds.

Interventions

- In 2013, at a time when the curly waterweed occupied only a small part of the pond, it was decided to eliminate the plant by manually uprooting it.
- The objective was to enable other plant species to recover a level of abundance comparable to the situation prior to the arrival of the curly waterweed.
- A monitoring committee was set up to select the management techniques best suited to the context and to supervise the work.
- It included both technical (Vallée du Lot board, fishing federations, ONCFS, Onema, etc.) and financial partners (Adour-Garonne water agency, Nouvelle Aquitaine region, Lot-et-Garonne department).

Manual uprooting

- In the fall of 2014, over a dozen volunteers gathered for a day of work in manually uprooting the plants once the pond had been partially drained.
- The site was regularly monitored following this initial work. The uprooting was not sufficient to halt the progression of the plant, which continued to colonise the pond in 2015.
- The dispersal of plant fragments may have contributed to the strong spread of the species in spite of the work done. Uprooting could not be carried out on the entire pond because the water in the middle of the pond was still too deep. However, the accessible plants were completely removed, including their roots.

Draining of the pond

- Given the results of the initial efforts, a total draining of the pond was deemed the most effective solution to eliminate the curly waterweed.
- Following discussions with the monitoring committee for the site and obtaining authorisation from the departmental territorial agency, two systems were used to drain the pond in February 2016 (syphoning and a motor pump on a tractor), a time of year outside the reproductive period for amphibians. The two systems were temporarily effective, but the pond continued to fill with rainwater and groundwater.
- A rescue fishing campaign was undertaken at the same time to transfer the fish to a nearby pond. A dozen volunteers from the Fumel APPMA were on hand in the beginning of March 2016 to assist the two CPIE employees. Care was taken not to transfer any curly waterweed to the other pond (the fish were washed by hand and the cleaning water was filtered).
- At the end of March, the dike was opened with an excavator to let the water flow out (the pond had filled since February with rainwater and groundwater). At each step in the work, care was taken to avoid any dispersal of curly waterweed to the ponds downstream using filters and screens that were cleaned once per week.

5. 6. Volunteers manually uprooting the plants.

■ During the summer of 2016, the pond dried partially and most of the curly waterweed died, but the incoming groundwater maintained the humidity in a few small spots where the species survived. In these areas, the very thick mud made it impossible to uproot any further plants.

■ The plants dried and then decomposed on site. Consequently, it was decided not to transport the plants to a composting unit as originally planned. The volume of curly waterweed remaining in the pond was not calculated.

■ The plan for the remainder of the project is to leave the pond drained for at least one full year in view of eliminating the curly waterweed. Discussions with the various partners will determine whether to refill the pond or to let it evolve naturally to a wetland, which would probably be better from an ecological standpoint. Better in the sense that the curly waterweed would probably be able to persist in the areas watered by the groundwater, but would find itself in competition with the native helophytes that would likely return. Consequently, the curly waterweed would probably not proliferate.

Results and costs

■ Results

■ Manual uprooting in 2014. A precise evaluation of the extracted biomass was not done (the beds occupied approximately one-third of the pond surface to a depth of about one metre).

■ Capture and transfer of the fish populations. A total of 557 fish were transferred (six species: Crucian/Prussian carp, goldfish, roach, rudd, carp, stone loach).

■ In November 2016, following the virtually total draining of the pond, most of the curly waterweed decomposed. However, there remains a large “puddle” (30 to 50 square metres) where the species subsists in five centimetres of water.

■ Human and financial aspects

■ 2014

- Pumping prior to the uprooting work: 2 000 € (1 day);
- Manual uprooting: 1 200 € (3 days x 350 € + 150 € of hand tools).

■ 2015

- Discussions with partners, preparation of request for authorisation from the departmental territorial agency (assessment of site, impact on Natura 2000 site): 2 800 € (8 days x 350 €)

■ 2016

- Pumping: 2 830 € (5 days x 350 = 1 750 € + pump rental = 1 080 €);
- Excavator to open the dike and digging the ditch (shovel and pickaxe): 2 950 € (8 days x 350 € = 2800 € + excavator rental = 150 €);
- Capture and transfer of fish populations: 700 € (2 days x 350 €).

■ Total approximately 13 500 € over three years.

■ Funding in the framework of the management programme for the natural site by the regional council (Aquitaine Nature contract), the departmental council (SNA funding) and the Adour-Garonne water agency.

7

8

Lot-et-Garonne : invasion d'une plante exotique

S'ABONNER À PARTIR DE 1€ 1 COMMENTAIRE

Pauline Lefort et Arnoul Mateo au bord du lac presque vide, envahi de cette plante d'aquarium.

ARTICLE ABONNÉS **Le lac du Vallon de la Vergnote, classé Espace naturel sensible, a dû être vidé afin de tenter d'éradiquer une plante venue d'ailleurs.**

Et si un ou deux inoffensifs poissons rouges étaient les responsables ? Ou plutôt leurs anciens propriétaires qui auraient eu la mauvaise idée, sans forcément en mesurer les conséquences, de se débarrasser d'eux en vidant le contenu de leur bocal dans les eaux translucides du lac du Vallon de la Vergnote, à Masquières.

Râteau en main et waders aux pieds, les membres du Centre permanent d'initiatives pour l'environnement (CPIE 47) se gardent de l'affirmer. Même si tout l'indique. L'association, en 2010, a signé une convention de gestion avec la municipalité, propriétaire du site et de huit hectares alentours, classés Espace naturel sensible.

Depuis quelques jours, Pauline Lefort et Arnoul Mateo sont entrés dans une nouvelle phase de lutte contre l'élodée crépue. Objectif : son éradication. Cette plante

7. The pond and waterweed in November 2016.
8. Press article published in the Sud-Ouest newspaper in March 2016.

Table listing costs since 2014

	2014	2015	2016
Pumping operation prior to uprooting	2 000		
Manual uprooting	1 200		
Coordination		2 800	
Draining of the pond			2 830
Opening of the dike			2 950
Capture and transfer of fish			700
TOTAL (€)	4200	2 800	6 480
Days of work	4	8	15

9. Fact sheet on curly waterweed.

Information on the project

- The work in November 2014 was done by volunteers. Information bulletins were published to call for volunteers and inform on the work, articles appeared in the press.
- A short report was drafted on curly waterweed and the work done in 2016.
- In March 2016, a two-page article on the rescue fishing campaign was published in the Sud-Ouest newspaper.
http://www.sudouest.fr/2016/03/12/maree-verte-et-p-oissons-rouges-2298823-3757.php

Outlook

- The curly-waterweed colony and the draining of the pond are monitored.
- If the decision is taken not to fill the pond, the wetland will be monitored.

Authors: Pauline Lefort (CPIE Pays de Serres-Vallée du Lot), Emmanuelle Sarat (IUCN French committee), Alain Dutartre (independent expert). January 2017.

More information

- Information sheet on curly waterweed (2016): www.biodiversite47.fr

2018 edition

PAYS DE SERRES-VALLÉE DU LOT

Curly Waterweed

(Lagarosiphon major)

Managing curly waterweed in the Salagou reservoir (Hérault department)

Hérault departmental council

- The department owns the Salagou dam, the reservoir (750 hectares) and its banks (1 000 ha). It is consequently responsible for maintaining and managing the water body.
- In 2014, the department set up a five-year plan to monitor and limit the spread of invasive alien plants in the Salagou and Olivettes reservoirs.
- It provides technical assistance and funding for work to limit curly waterweed in the Salagou reservoir.
- Contact: Corinne Roumagnac, policy officer for water, risks and littoral zones - croumagnac@herault.fr

Grand Site Salagou-Cirque de Mourèze (SMGS) board

- The board was founded in 2005. Members include the Hérault department and the Clermontais, the Lodévois et Larzac and the Grand Orb intermunicipal boards.
- Its mission is to manage the entire Grand Site Salagou-Cirque de Mourèze, which covers a total of almost 10 000 hectares.
- In its work to preserve landscapes, the board coordinates management projects for invasive alien species (water primrose, curly waterweed, etc.).
- Contact: Victoria Dubus, Natura 2000 policy officer - victoria.dubus@lesalagou.fr

Intervention site

- The purpose of the Salagou reservoir, created following the construction of the dam on the Salagou River in the 1960s, was to provide water for irrigation and regulate the flow of the Hérault River. The reservoir covers 750 hectares in the towns of Clermont l'Hérault, Liausson, Octon, Salasc, Celles and Le Puech.
- The humid environment stands in stark contrast to the surrounding dry landscape of ruffes1. The mouth of the Salagou River and the banks of the lake are listed under the Landscapes law (1930) and as Natura 2000 (special protection zone for birds) and ZNIEFF (natural zone with high ecological value) sites.
- The reservoir is now the site of numerous recreational activities.
- The presence of curly waterweed in the reservoir was first observed by the Porquerolles National botanical conservatory in 2009. Then in 2011, the department ran an underwater inspection that revealed that the species existed virtually everywhere along the perimeter of the reservoir and was spreading rapidly. The plants grow in the water from the banks to a depth of five metres and are visible at the water surface from the spring to the fall (during the winter, the stems lie on the bottom).

Key
Mechanical harvesting
Manual uprooting

1. Sites where work on curly waterweed was done in the Salagou reservoir in 2014.
2, 3. Beds of curly waterweed in the Salagou reservoir.

1. A local term for the red earth made up of clay sediment and iron oxides.

Disturbances and issues involved

■ The thick mat formed by curly waterweed prevents the development of other submergent plants and encourages sedimentation by blocking sediment particles among the plants and due to the deposit of plant fragments on the bottom.

■ The plants also hinder recreational activities on and around the reservoir (boating, swimming).

■ On the other hand, the dense beds of curly waterweed would seem to benefit certain species, notably as a spawning ground for fish (carp, pike, etc.) and for nesting by birds (coots, grebes, etc.). Before the arrival of curly waterweed, very few submergent beds of plants existed in the reservoir.

■ On the basis of this information, the department set up a five-year plan (2014-2018) to monitor and limit the spread of the species, in order to better understand its proliferation and to determine how to optimise the role of each stakeholder involved in its management.

Interventions

■ Given the size of the colonised area and the high growth rates of the plant, curly waterweed could not be eradicated. The intervention had to be adapted to the available human resources and to the technical limitations weighing on the local governments. Priorities were set, i.e. the management work focussed on the sites receiving large numbers of tourists.

■ Each year, a company was hired by the town of Clermont l'Hérault and by the Lodévois et Larzac intermunicipal board to harvest the plants over respective surface areas of 10 000 (Clermont beach) and 5 000 (Vailhés bay) square metres.

■ At the request of the tourism companies and the towns, volunteer work sites for manual uprooting of the plants have been organised since 2014 on beaches receiving moderate numbers of people.

■ These work sites are organised by the SMGS board.

■ Mechanical harvesting

■ This technique was used for the Clermont beach from 2013 to 2017 and in the Vailhés bay from 2013 to 2016.
■ The company used a harvester boat that collects the plants immediately after they have been cut. The maximum cutting depth was three metres.
■ A net was installed around the work zone to avoid the dispersal of plant fragments.
■ Each year, the surface area harvested depended on the local conditions, the water level and the development of the plant beds.
■ The company also handled the plant waste produced by the work. Following temporary storage to dry the plants, the waste was sent to the composting unit of the nearest civic amenity site.

■ Volunteer work sites

■ Different techniques were used, depending on the configuration of each site and the available means:
- purely manual uprooting, from the bank or in the water, to a depth accessible on foot;
- uprooting using a rake, from the bank or in the water;
- manual uprooting from a boat (skiff, canoe), by hand or by making circular movements in the plant bed with a rake;

4. Harvester boat.
5. A test on dragging the plants using a cable.
6, 7, 8. Manual uprooting by volunteers.

- mechanised uprooting by running a chain or cable around a part of the bed and pulling the plants out with a four-wheel drive vehicle or a tractor.

■ The harvested areas were geolocated (GPS coordinates) in order to monitor over several years the changes in the plant colonies.

During the initial work, nets supplied by the departmental council were installed around the harvested zones in order to avoid the dispersal of plant fragments by water currents and the wind. However, due to the size of the harvested areas and the depth of the reservoir, the nets were not suited to the work conditions and ineffective. They have not been reused to date.

■ The plant waste produced by the work was composted on site, on dry surfaces and at a distance of at least five metres from the reservoir.

■ Tests on mechanical uprooting

■ In 2017, the Lodévois et Larzac intermunicipal board experimented with a second technique in view of improving the effectiveness of the work and reducing the cost.

■ When the Vailhés beach was originally created, a layer of coarse gravel was put down in the water, which later enabled the curly waterweed to take root. The project was therefore to scrape the layer of gravel in order to remove the curly waterweed and its root system.

■ The work was done from the bank by an excavator equipped with a special scraper blade. The collected plants were placed in a dumper. The plants were initially deposited near the reservoir to dry and were then sent to a nearby field, owned by the town of Lodève, for composting.

9. The excavator in action.
10. Curly waterweed deposited to dry.

Results and costs

■ Results

■ The work enabled the pursuit of recreational activities by removing the plants from the bathing zone and facilitating the passage of recreational craft from the bank to the open water.

■ Following several years of work, the colonisation of the reservoir by curly waterweed would not seem to have slowed. It is, however, very difficult to monitor changes in the plant beds and to assess the effectiveness of the various work methods because the density and growth rates of the beds depends on a large number of parameters, i.e. sunlight, annual changes in high and low water levels, the water level during the growth period, water temperature, etc.

■ The technique used to manage the curly waterweed in the Vailhés bay using an excavator could be significantly improved. The yield in terms of plants is low when the density of curly waterweed is low and the work is limited to the depth of water accessible to “terrestrial” equipment.

■ The technique involving setting cables from a boat is more effective and makes it possible to remove the alevins caught up in the mass of plants and to put them back into the water. For the next campaign, the plan is to uproot the curly waterweed using a winch set up on the banks. Unfortunately, this technique does not remove the entire root system with the plant.

■ After four years of manual uprooting, it would appear that the density and vigour of the plant bed on one site harvested each year, the Mas de Riri, has declined. It should be noted, however, that this observation must be weighted against the changing weather conditions and is not confirmed by similar observations on other sites.

Costs

- The mechanised harvesting work by the company takes two days on each site, i.e. four days total each year. In 2017, the experiment with the excavator working from the bank occupied company personnel a further day.
- The volunteer work involved between ten and thirty people on each work site.

Results of the work from 2013 to 2017.

	Town of Clermont l'Hérault				Lodévois et Larzac intermunicipal board			
Year	Dates	Surface area (sq. metres)	Volume (cubic metres)	Cost in euros, not incl. VAT	Dates	Surface area (sq. metres)	Volume (cubic metres)	Cost in euros, not incl. VAT
2013	First week of July	No data			No data			
2014	Last week of June	13 000	30 after drying for one week	6 600	Last week of June	5 000	No data	5 200
2015	Last week of June	10 000	16 after drying for one week	10 000	24 and 26 June	3 800	No data	6 000
2016	No data				No data			
2017	No data				14 and 16 June	6 000	150	4 776 € incl. VAT

Results of the volunteer work sites (coloured zones = no work)

		2014	2015	2016	2017
Boating centre (Octon)	Date	12 June	20 June	29 June	1er July
	Number of volunteers	22	20	11	10
	Surface area (sq. metres)	335	230	805	1 011
	Volume extracted (cubic metres)	12	6	No data	No data
Mas de Riri (Celles)	Date	5 July		25 June	24 June
	Number of volunteers	34		25	30
	Surface area (sq. metres)	1 025		790	2 615
	Volume extracted (cubic metres)	20		160	No data
Open-air recreational site (Clermont l'Hérault)	Date			11 and 12 March	April
	Number of volunteers			20	15
	Surface area (sq. metres)			1 000	1 000
	Volume extracted (cubic metres)			80	No data
Celles	Date	13 July			
	Number of volunteers	13			
	Surface area (sq. metres)	230			
	Volume extracted (cubic metres)	3			
Vailhés hamlet	Date	19 July			
	Number of volunteers	17			
	Surface area (sq. metres)	360			
	Volume extracted (cubic metres)	7			

Information on the project

- A brochure to raise awareness concerning alien plants was prepared and distributed in the Hérault department.

Outlook

■ The work to limit curly waterweed will continue in order to enable the pursuit of recreational activities in the Salagou reservoir. The coordination of the work between the various stakeholders could be improved.

■ One option would be to experiment with covering the curly waterweed in a test zone using screens made of a natural fabric (a geotextile made of burlap). This technique was tested in Ireland (http://www.onema.fr/sites/default/files/Grand_Lagarosiphon_R2.pdf) and in the Landes department in France (http://www.gt-ibma.eu/wp-content/uploads/2017/01/6-Egerie-lac-21-09-16.pdf) where it produced good results, however, the very different climate conditions in the Mediterranean environment must also be taken into account. The issues of project management and funding must also be clarified.

■ Efforts must also be pursued to improve the monitoring system, given the difficulties in interpreting the data due to the fluctuating environmental parameters from one year to the next.

■ It would be worthwhile to run a general inventory, similar to that in 2012, in order to assess the situation for the entire reservoir in terms of curly waterweed and other plant species (whether invasive or not) and to determine the impact of the work done.

Authors: Corinne Roumagnac, Hérault departmental council, Doriane Blottière, IUCN French committee, Victoria Dubus, SMGS. January 2018.

11. Informational brochure distributed by the Hérault department.

For more information

■ Internet site of the Grand Site Salagou-Cirque de Mourèze (SMGS) board: http://www.grandsitesalagoumoureze.fr/Presence-d-un-herbier-aquatique.html

■ Plantes exotiques, halte à la colonisation des plans d'eau. Plaquette du Conseil départemental de l'Hérault. 2 pp.

Grand Site Salagou - Cirque de Mourèze

2018 edition

© Nicolas Pipet

New Zealand pigmyweed

(*Crassula helmsii*)

Classification	
Order	Saxifragales
Family	*Crassulaceae*
Genus	*Crassula*
Species	*C. helmsii* (Kirk) Cockayne 1907)

Originated in the southern Pacific, Australia and New Zealand. Introduced for use in aquariums.

Descriptif

- Stalks range from 10 to 130 cm in length and each node can produce roots.
- Leaves have no stem, are straight and curve upward, length 4 to 20 mm, width 0.7 to 1.6 mm
- The small, solitary flowers have 4 white or pink petals:
  - that develop in the axil of the leaves
  - exclusively on the emergent part of the plant
- The number of branches increases when the water level drops

Ecology and reproduction

- The species can develop on different types of wetlands:
  - marshes, ponds, lakes, etc., at depths of up to 3 metres
  - on land saturated with water
- The species can accept widely varying water qualities, e.g. warm and cold water, fresh water and salt water, high or low pH
- High dispersal capabilities via:
  - any stalk fragment containing a node
  - turions (the small buds growing at the top of stalks in the fall)

Documentation

- Saint-Maxent T. 2002. Les espèces animales et végétales susceptibles de proliférer dans les milieux aquatiques et subaquatiques : rapport de stage de DESS Gestion des ressources naturelles renouvelables. p.80-83. European plant protection organisation. 2007. *Crassula helmsii*. EPPO Bulletin. Vol. 37 (2) - 2 pp.
- Bretagne observatory for biodiversity and the natural heritage. 2011. New Zealand pigmyweed (*Crassula helmsii*). On-line descriptive data: http://www.observatoire-biodiversite-bretagne.fr/especes-invasives/Flore-continentale/Invasives-averees/La-Crassule-de-Helm-Crassula-helmsii

Author: Emilie Mazaubert, Irstea

New Zealand pigmyweed

(*Crassula helmsii*)

Managing New Zealand pigmyweed in the pools of Cap Griz-Nez (Pas-de-Calais department)

EDEN 62

- Eden 62 (Public natural areas in the Pas-de-Calais department) was originally founded as a non-profit in 1993, but then became a management board in 1996.
- Its mission is to manage the sensitive natural areas owned by the Seaside and Lake Conservation Trust, the department and a number of towns.
- Eden 62 is financed primarily by the Pas-de-Calais department and serves as the technical arm for the management of the sensitive natural areas, i.e. approximately 5 500 hectares in the department, with a workforce of 130 employees.
- The main objectives of the board are to:

- conserve and improve the heritage value of sites;
- welcome the public while respecting the fragility of sites;
- raise public awareness concerning the ecological value of the sensitive natural areas and the need to preserve them.

- Contact: Xavier Douard, policy officer for the *Site des Caps* park - xavier.douard@eden62.fr

Intervention site

- The Cap Gris-Nez site is exceptional on both the national and European levels in terms of the landscapes and its ecology.
- The Cap Gris-Nez sensitive natural area spans a surface of 106 hectares and is located in the town of Audinghen. It comprises plots of land owned by the Seaside and Lake Conservation Trust.
- It is also located within the borders of the Natura 2000 site FR3100478 (NPC005).
- The point of Cap Gris-Nez was named a *Grand Site de France* in 2011, with Cap Blanc-Nez. Work was done in the framework of a national *Grand Site* project to enable the passage of approximately one million visitors each year.
- Jutting out into the English Channel, the cape is renown throughout Europe as a site for observing migrating birds.

1

Source: Eden 62

2

Source: Seaside and Lake Conservation Trust

Borders of Trust work sites as of 31 December 2012

Town limits

Land acquired by the Trust as of 31 December 2012, but not assigned for management

Land acquired by the Trust as of 31 December 2012 and assigned to Eden 62 for management

Land acquired by the Trust as of 31 December 2012, but leased to farmers and assigned to Eden 62 for monitoring

1. Map showing the position of the site.
2. Land cover on the cape with the pools colonised by New Zealand pigmyweed circled in red.

■ The cliffs, made of sandstone and marls, date from the Jurassic period and tower 50 metres over the sea. Swards of short, salt-tolerant grass may be observed on the top of the cliffs.

■ During WWII, the site was subjected to periodic bombing and the result is a very particular landscape. The "bomb-hole meadows" are flooded in the winter and the water often remains until the summer.

■ Today, the bomb holes are pools conducive to amphibians, such as the northern crested newt, listed in Annex 2 of the Habitats directive.

■ Approximately 30 pools created by bombs exist in the Cap Gris-Nez sensitive natural area.

■ The pools are not filled with water year round, their status depends on rainfall.

■ The New Zealand pigmyweed was discovered on the Cap Gris-Nez site in 2013, during an inventory by the National botanical conservatory in Bailleul.

■ The plant was observed in five pools, located near each other and toward the northern edge of the bomb-hole meadows.

■ Plant diversity is very high in the northern section of the meadows, which benefits from up-flowing water. The slopes of the bomb holes are fairly steep and are populated by dwarf thistle (*Cirsium acaule*) and yellow oatgrass (*Trisetum flavescens*), both EU-listed.

■ The pools themselves contain a small number of aquatic grass beds (aquatic *Ranunculus* spp.) and floating plants, e.g. floating sweet-grass (*Glyceria fluitans*) and common spike-rush (*Eleocharis palustris*), and, on the level just above, hygrophilic sections with wire rush (*Juncus inflexus*).

3. Meadows with bomb holes on Cap Gris-Nez.
4. Pool colonised by New Zealand pigmyweed.

Disturbances and issues involved

■ Colonisation of the pools (old bomb holes) by New Zealand pigmyweed totally stifled the existing aquatic plants and provokes the filling in of the pools.

■ No free water surfaces remained visible, which impacted the reproduction of amphibians, notably the northern crested newt.

■ Grazing by sheep risked accelerating the spread of the N.Z. pigmyweed to the pools not already colonised.

Interventions

■ Objective of the interventions

■ Given the relatively strong presence of the N.Z. pigmyweed on the site and the risks of dissemination by birds and sheep, it was decided to limit the expansion of the species on the site and avoid its dissemination to the Côte d'Opale coast.

■ A number of management recommendations were made by the Bailleul National botanical conservatory following a visit to the site in September 2014 by Eden 62 and the conservatory. The recommendations included manual uprooting and the laying of tarps.

■ These techniques were not implemented due to a number of technical difficulties. The strong wind on the site made it impossible to lay tarps and the accumulation of rain water in the centre of the tarps was also a problem. Manual uprooting was not deemed possible given the large quantities of N.Z. pigmyweed to be removed.

Dredging the pools

- To avoid impacting the local amphibian populations, the work was done during the winter.
- The five pools colonised by N.Z. pigmyweed were dredged in December 2014.
- The project lasted five days and was done by the Colas company in the framework of the work for the National *Grand Site* of the two capes.
- The project owner was the Pas-de-Calais department and the project manager was Eden 62.
- The work was done with a tracked excavator, a tractor with a trailer and a second tractor with a tank trailer.
- The water in the bomb holes had to be pumped in part prior to dredging, using the tank trailer.
- The pumping system was equipped with a filter to avoid picking up fragments of N.Z. pigmyweed.
- Following dredging, the few fragments of N.Z. pigmyweed still present on the water surface were collected using a dip net.
- To drain the water from the dredged material, it was stored for one week along a rural road, in a former municipal dump.
- Waterproof tarps were first laid on the storage site to avoid the dispersal of the N.Z. pigmyweed.
- The material was subsequently transported to a special storage centre.

Results and assessment

Results

- A total of 600 cubic metres of soil and plants were removed.
- The surface area freed by the work represented approximately 1 000 square metres.
- In 2015, N.Z. pigmyweed was again observed in the five pools that had been dredged, i.e. 20 to 30% of the surface areas dredged in December 2014 were again colonised in July 2015 along the edges of the pools, essentially in the water.
- But no other pools were colonised in the meantime.
- The amphibians continue to use the pools during the reproductive periods.
- Following the dredging, the pools regained their original appearance, i.e. that of craters caused by bombs.

Financial aspects

- The work was funded in the framework of the *Grand Site* project by the Pas-de-Calais department.
- The total cost amounted to 30 000 euros (before VAT) for the 1 000 square metres (600 cubic metres) dredged.
- The project involved five people for five days.

5. Filling in of a pool caused by New Zealand pigmyweed.
6. Dredging one of the bomb holes.
7. Temporary storage of the dredged material on a tarp.
8. A pool after the work on 3 May 2012.

Outlook

- Manual uprooting of N.Z. pigmyweed will be undertaken in 2016 in the five pools dredged in 2014. This work will be possible thanks to the previous dredging and the return of the pools to their initial appearance.
- The uprooted plants will be placed in garbage bags for subsequent incineration.
- Manual uprooting will be repeated as necessary.

Authors: Xavier Douard, Eden 62, and Emmanuelle Sarat, IUCN France. February 2016.

9. 10. Pools again colonised by New Zealand pigmyweed in January 2016.

For more information

- Eden 62 internet site: http://www.eden62.org/
- Eden 62. Bilan d'activité 2014. Espaces naturels sensibles du site des deux Caps. 82 pp.
- Conservatoire botanique national de Bailleul. 2014. Étude de la Flore et des végétations, cartographie des éléments d'intérêt patrimonial et propositions de gestion conservatoire des prairies pâturées entre le Cran des Sillers et le Cran Barbier, Cap Gris-Nez (Pas de Calais). Département du Pas de Calais et Eden 62. 76 pp.
- Douard X., Mougey T., Pilon V., Derout D., Geneau D. et Deruelle E. 2011. Document d'objectifs site Natura 2000 NPC 005, Falaises du cran aux oeufs et du Cap Gris-nez, dune du châtelet, marais de Tardinghen, dunes de Wissant, juillet 2001 – septembre 2005. Parties A et B. 225 pp.

2018 edition

New Zealand pigmyweed

(*Crassula helmsii*)

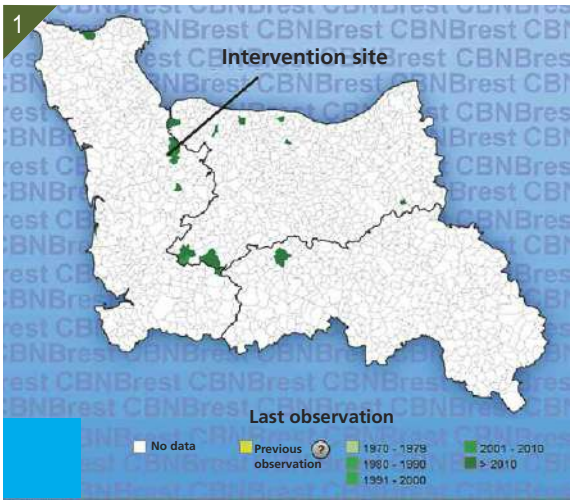
Managing New Zealand pigmyweed in an old side channel of the Vire River (Manche department)

Basse-Normandie nature conservatory

- The conservatory is a certified environmental-protection non-profit and a member of the Federation of conservatories for natural areas. Its headquarters is in the town of Hérouville-Saint-Clair (Calvados department).
- The conservatory implements 4 major principles (learn, protect, manage, enhance) in its work to preserve the natural heritage of the Normandie region. For 20 years, the conservatory has provided its knowledge and experience in the management of natural environments to public and private owners in order to protect the fauna and flora of the outstanding natural habitats in the region. As part of the federation, it collaborates with all the local associations in the region.
- Its work covers the entire region and focusses on 4 main types of environment, i.e. limestone hills, wet meadows and marshes, former quarries and bat caves. The conservatory manages a total of 985 hectares spread over 108 sites. It also manages two regional programmes concerning ponds and invasive alien species.
- Contact: France Mercier - f.mercier@cen-bn.fr

Vire and Saint-Lois river board

- Composite board resulting from the merger of the Saint-Lois development board, the Val de Vire board and the Pays Saint-Lois promotional association.
- The main objective is to monitor and update the local development plan (SCOT) and to encourage the balanced and sustainable economic, social, cultural development of the area.
- Within that framework, a further mission is to maintain the public river domain of the Vire River and the Vire-Taute canal, e.g. manage the vegetation, ensure the correct flow of water and eliminate obstacles to the flow, etc.
- The board also acts as the technical and administrative secretariat of the SBMP (sub-basin management plan).
- Contact: Sylvain Leredde, manager of the public river domain - s.leredde@svsl.fr



Source: E. Calluna, CBN Brest, April 2016.

© CEN-BN

1. Map showing the distribution of New Zealand pigmyweed in the Basse-Normandie region and the intervention site.
2. Map showing the area colonised by New Zealand pigmyweed in an old side channel of the Vire River.

The *Marais du Cotentin et du Bessin* regional nature park

- Members of the park include 150 towns in the Manche and Calvados departments and the two departmental councils.
- The park covers a total of 146 650 hectares and includes a wetland of 30 000 hectares.
- Its missions include, among other aspects, efforts to reconcile the preservation of landscapes and the natural heritage with the development of economic activities. It is in charge of implementing management policies on sites in the Natura 2000 network.
- Contact: Nicolas Fillol - nfillol@parc-cotentin-bessin.fr

Intervention site

■ New Zealand pigmyweed (NZP) was discovered in July 2013 in an old side channel of the Vire River, in the town of Cavigny (Manche department). It is thought to have arrived three years earlier.

■ The entire side channel was colonised by NZP, representing a surface area of approximately 1 700 square metres. In the middle of the side channel, the plants formed a dense mat that thinned out toward the edges due to the shadows formed by the nearby bushes. The plants were nonetheless present under the willows, but in lesser densities.

■ The side channel is no longer connected to the Vire River which flows at a distance of approximately ten metres, however during highwater periods, water does overflow from the river into the channel.

■ At the former meeting point with the river, a mound of sediment formed on which willows and new patches of NZP developed.

■ There was a risk of the plants colonising further areas downstream along the river, which could threaten the Taute marshes, an EU-listed habitat.

■ The site is part of the *Marais du Cotentin et du Bessin* regional nature park. It is located in the *Baie des Veys* and *Basses Vallées du Cotentin* Natura 2000 sites and in Type 1 and 2 ZNIEFF (high-value ecological zones) sites (*Basse Vallée de la Vire* and *Marais du Cotentin et du Bessin*).

■ It is also located in the *Carrières et fours à chaux de Cavigny* sensitive natural area.

■ Finally, it is listed as an internationally-recognised wetland by the Ramsar convention.

3. The side channel colonised by New Zealand pigmyweed.
4. The Gast pond (Manche department) colonised by New Zealand pigmyweed.
5. A pond located near the coast, in Tourlaville (Manche department), and colonised by New Zealand pigmyweed.

Disturbances and issues involved

■ Impacts on biodiversity

■ The plants form dense mats that limit the development of other aquatic plants and eventually result in monospecific stands that reduce biodiversity.

■ The beds of plants modify the oxygen cycle and the pH level that negatively impact animal populations (fish, amphibians and invertebrates).

■ They also affect amphibian reproduction by delaying the hatching of eggs.

■ Impacts on site use and on the economy

■ Proliferation of NZP can block the flow of water in canals and ditches, thus creating flood risks.

■ The mats of vegetation reduce the recreational value of ponds and lakes, and can cause small children and animals to slip and fall.

■ Issues in the Basse-Normandie region

■ New Zealand pigmyweed has been observed in the three departments comprising the region, namely the Manche, Calvados and Orne departments. It was first sighted in the Gast pond (Manche department) in 1996.

■ Since then, dozens of colonised sites have been discovered, primarily along the Vire River, but also in a number of isolated ponds in the region. It is still sold in garden shops.

■ The plant has now been listed as a proven invasive species in the Basse-Normandie region and designated as a priority in the strategy against invasive species that threaten biodiversity.

Interventions

■ Discussions with other stakeholders and partners

■ Following the discovery of NZP on the site in 2013 (after taking a sample and confirming the species identity), the local stakeholders met on site in August 2013 to assess the degree of colonisation and to discuss the necessary management work given the situation.

■ The Manche departmental council, the Cotentin centre for environmental initiatives (CPIE), the *Marais du Cotentin et du Bessin* regional nature park, the Vire and Saint-Lois river board and the Basse-Normandie nature conservatory decided collectively on the management plan for NZP.

■ Preliminary investigations

■ After observing the degree of colonisation on the specific site and noting the issues involved, an initial investigation on the presence of the species was carried out.

■ A team of four people spent two days in a boat, at the end of the summer of 2013, inspecting 25 kilometres of banks along the Vire River from the side channel in Cavigny down to the town of Veys.

■ Seven stands of NZP were discovered with surface areas ranging from 0.2 to 1.5 square metres.

■ Objective of the interventions

■ In the fall of 2013, the main stakeholders decided to launch the management work in order to minimise the risks of NZP dispersal downstream, via the Vire River.

■ Given that the site was no longer used for fishing, the idea of completely filling in the side channel was raised. After studying the available literature on the topic, this management technique was judged to be the most effective, given the context.

■ The management work

■ Technical specifications were drawn up, defining the technical conditions for the work.

■ In advance of the work, the *Marais Cotentin et du Bessin* regional nature park went through the formalities in compliance with the Water law.

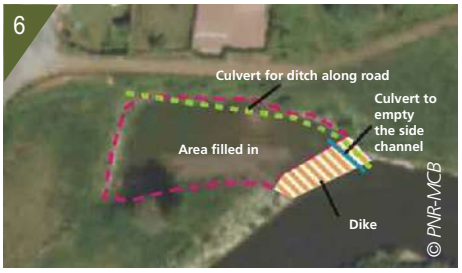
■ The work was managed on site on a daily basis by the Vire and Saint-Lois river board.

■ The first step was to create a dike on the existing mound to cut the side channel off from the Vire.

■ A culvert was installed at the foot of the dike to regulate the water level. The culvert was equipped with an anti-return flap on the Vire side and with a filter (3 millimetre grid) on the channel side to avoid any dispersal of NZP fragments.

■ The entire surface area (1 700 square metres) of the side channel was filled in with on-site deposits and material excavated during work on the sewer system in the town of Meauffe.

■ Prior to the filling work, the water level of the Vire was lowered to facilitate the reinforcement of the dike.



6. Diagram showing the work on the site.
7. a) Creating the dike and b) installing the culvert.
8. The work to fill in the side channel.

■ The work began on 21 July 2014 and lasted four days.

Day 1:

- creation of the dike with the culvert;
- start of the filling process, beginning from the downstream end of the side channel.

Day 2:

- filling both the upstream and downstream ends of the side channel with material stored on a neighbouring lot (belonging to the Manche departmental council).

Day 3:

- transport of the material from the Meauffe lime kilns to the site;
- spreading of the material using shovels and a tractor.

Day 4:

- end of the earthwork with some additional material;
- grading to obtain a constant, gentle slope toward the river.

■ Regular monitoring of the side channel

■ The site has since been monitored for the equivalent of one man-day per year. The purpose is to check the stability of the landfill over the mid to long term and to look for any new NZP stands around the site.

9. The side channel at the end of the work.
10. Manual scraping of colonised areas.

Results and costs

■ Results

■ The consolidation of the dike and the filling of the side channel required 4 000 cubic metres of material. The entire area formerly colonised by NZP was covered with 1.2 metres of soil.

■ The excellent weather during the project made for fast and easy work in moving and arranging the soil, and limited the dispersal of NZP fragments.

■ No NZP regrowth has been observed since the work. Ruderal species are now growing on the site.

■ However, a few, remaining stands of NZP persist along the Vire, further downstream. These stands have been manually removed (scraping of the surface) each year since 2013 by people using spades and travelling by boat. The plants are stored in dry areas.

■ In 2015, large stands of NZP were discovered 30 kilometres upstream of the side channel that was filled in.

■ Financial aspects

■ The total cost of the project for the side channel was 26 832 euros including VAT for the four days of work.

■ The cost was covered by the Seine-Normandie water agency (40%), the regional council (40%) and by the Vire and Saint-Lois river board (20%).

■ The total amount of time spent in 2014 on project management, monitoring, inspections along the river and writing reports represented approximately 16 man-days.

Outlook

- The side channel is monitored annually and the banks of the Vire River are inspected increasingly closely each year.
- The discovery in 2015 of new stands of New Zealand pigmyweed over 30 kilometres upstream of the side channel means that the management programme must be revised because it would now appear that a large part of the Vire basin is colonised.

Information on the project

- A number of technical reports on the management work were drafted by the Basse-Normandie nature conservatory.
- Public meetings were held to inform local stakeholders (fishers, local residents, local governments and managers of natural areas) on the project.
- Articles were published in the local press and in the bulletin of the Vire SBMP.
- Thanks to this particular case, elected officials and local residents were informed on the problems with invasive species.

Author: Emmanuelle Sarat, IUCN France, and France Mercier, Basse-Normandie nature conservatory. September 2016.

For more information

- Basse-Normandie nature conservatory: www.cen-bn.fr
- France Mercier, coordinator of the Basse-Normandie regional action programme against invasive species: f.mercier@cen-bn.fr - 02.31.53.01.05.
- Mercier F. 2013. Diagnostic et préconisations de la gestion de la Crassule de Helms le long de la Vire. Conservatoires d'espaces naturels de Basse-Normandie. 16 pp.
- Mercier F. 2014. Bilan des actions menées le long de la Vire sur la Crassule de Helms en 2014. Conservatoires d'espaces naturels de Basse-Normandie. 10 pp.
- Mercier F. 2015. Bilan du projet « Brigade espèces invasives 2015 ». Chantier et prospection Crassule de Helms – Vallée de la Vire. Conservatoires d'espaces naturels de Basse-Normandie. 5 pp.

2018 edition

New Zealand pigmyweed

(*Crassula helmsii*)

Experiment in managing New Zealand pigmyweed using a thermal weed-control technique

Brière regional nature park

■ The park, initiated by the Ecology ministry in 1970, is managed by a board with members from the 20 towns in the park, from the two "gateway towns" (Nantes and Pornichet), the Loire-Atlantique department, the Pays de la Loire region, the Grande Brière Mottière commission (CSGBM) and the board for the Brivet river basin (SBVB).

■ Its main missions include:

- protecting the natural heritage, notably through suitable management of the natural environment and landscapes (marshes, wet meadows, reed beds, canals, etc.);
- contributing to territorial planning;
- contributing to economic, social and cultural development and to the quality of life;
- welcoming, educating and informing the public;
- carrying out experiments or outstanding projects in the fields mentioned above and contributing to research programmes.

■ Contact: Jean-Patrice Damien, scientific officer - jp.damien@parc-naturel-briere.fr

Intervention site

■ The Brière regional nature park covers a total of 55 000 hectares, of which approximately one-third are wetlands listed as a Ramsar site (18 250 hectares).

■ In conjunction with the Donges marshes, the Brière park is also listed as Natura 2000 and ZNIEFF sites. The park is home to numerous emblematic species (Eurasian bittern, black terns, bluethroats, European otters, etc.) and remarkable flora, notably in the amphibious grasslands and the oligotrophic meadows.

■ In the middle of the park, the Grande Brière Mottière marshes (a joint property) cover 7 000 hectares.

■ New Zealand pigmyweed was first observed in the Pays de la Loire region in 2010 and 2011, including three stands in towns belonging to the Brière regional nature park (Guérande, Donges and Saint-Lyphard). The species was identified for the first time in the Grande Brière Mottière and Brivet marshes in May 2015.

1

© PNR Brière

Key

- Park limits
- Road
- Hydrographic network of the marshes
- Grande Brière Mottière marshes
- Forests and semi-natural environments
- Urbanised areas
- Marsh
- Salt marsh

1. The Brière regional nature park and the different sectors.

■ Given the invasive nature of New Zealand pigmyweed, its potential for establishing itself in the marshes and the potential impacts its proliferation could have on local ecosystems and biodiversity, the park immediately initiated a study on how to manage the species.

Disturbances and issues involved

■ To date, there is little pigmyweed in the park, but given its potential for proliferation, it could spread to the banks and wet areas around the canals and invade the wet meadows, causing significant impacts on biodiversity (competition with native plants, fatal anoxic conditions for fish, etc.) and on local activities (agriculture, boating, fishing, hunting, etc.).

Interventions

■ Testing a mulching method in 2015

■ Following an agreement with the site manager, a mulching test was carried out along the Rozé Canal in the first stand of pigmyweed identified in the Brière marshes. A thick layer (50 to 70 cm) of reeds, drawn from a nearby reed bed, was placed over the plants and secured by metal fencing material anchored using wooden stakes (chestnut wood). The test was halted seven days later because the installation fell victim to arson.

■ Discussions with the partners

■ A technical meeting was held on 20 April 2016 with participants from the regional nature park, the CSGBM commission, the regional environmental directorate, the regional federation against pests (FREDON 44) and the Pays de la Loire nature conservatory.

■ The potential problems caused by the plant were discussed and it was decided to intensify the efforts to locate and monitor stands.

■ In addition, given the very rare positive feedback on management work for pigmyweed and in order to acquire meaningful experience in its management, it was also decided to launch pilot projects to pre-empt its probable spread and limit the dynamics of its colonisation process.

■ A number of methods were discussed, but not selected:

- manual uprooting, deemed ineffective (see the test results in the Pierre-Constant reserve in 2015) and highly time consuming;
- tarping, expensive and difficult to implement, with excessive risks of damage by animals (grazing) and by humans, given the intentional destruction of the mulching test in 2015;
- use of plant-protection products, due to their environmental impact, regulatory restrictions and the need to better assess their effectiveness.

■ Thermal weed control was the only technique selected for testing in that it is relatively easy to implement (technically and administratively) and it was thought to be relatively effective.

■ Inventory

■ The inventory of pigmyweed stands was carried out in the framework of the overall inventory of invasive alien aquatic plants run by the regional nature park from 4 August to 8 September 2016.

■ That part of the year was selected because the plants had developed sufficiently to facilitate their identification in the meadows and particularly in the mud flats no longer covered with water. The inventory was joined with that for water primrose which had spread over a total of 742 kilometres of canals and ditches, and 5 300 hectares of meadows and water bodies.

■ A total of 153 stands of pigmyweed were found, i.e. eight times more than in 2015, ranging from dense beds covering several hundreds of square metres to single, isolated plants, representing a surface area of 40 300 square metres.

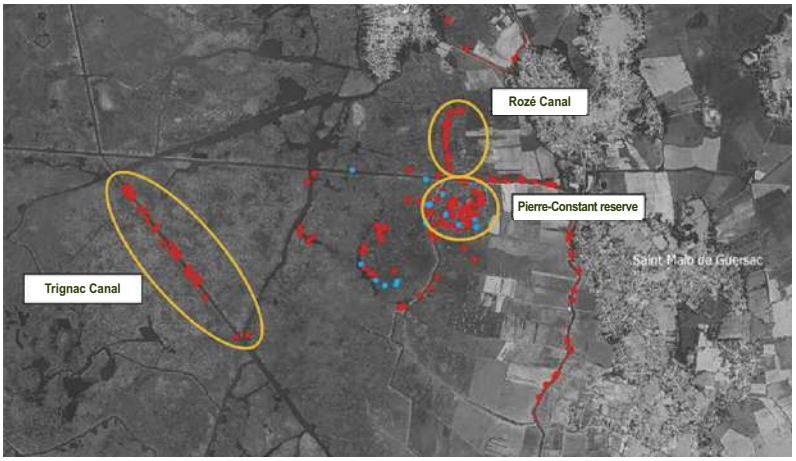
2. New Zealand pigmyweed in a meadow near a water body.
3. Pigmyweed on a mud flat.
4. Installing the mulch.
5. The arsoned mulch installation.

Thermal weed control

The technique was first employed in early August 2016. The objective was to teach the technique to the personnel and to test the equipment along the Rozé Canal.

Subsequent work was done by FDGDON personnel. They were accompanied by at least one person from the park board or from the CSGBM commission during the work which took place on:

- 29 and 30 September 2016 and during the morning of 3 October in the Pierre-Constant reserve;
- 17 and 18 October 2016 along the Trignac Canal.



Positions of pigmyweed stands in the work sector. Stands discovered in 2015 are marked in blue, those discovered in 2016 in red.

The time of year was selected because it facilitated access to the sites (lower water levels, emergent land, drying mud flats) and the visibility of the plants.

The danger of fires at that time of year meant that particular care had to be taken during the work, i.e. suitable weather conditions (little or no wind) were required.

Standard equipment for thermal weeding was used, i.e. a nozzle connected to a 13-kg tank of liquid propane gas via a flexible hose several metres long.

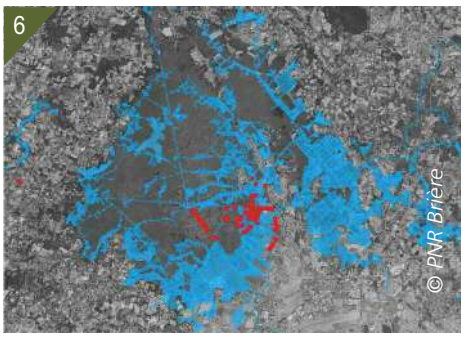
The equipment and the workers were transported to the sites either by boat or by 4-wheel quad.

The work was done either on foot or by transporting the equipment with the quad. The flame must be applied to each plant for about five seconds.

The plants were first marked with paint to facilitate their identification by each two-man team. Some plants were marked with a stake and photographed for subsequent monitoring.

In the Pierre-Constant reserve, 56 stands were identified (consisting mainly of dispersed beds covering a total of 11 410 square metres, though one bed covered 120 m²) and 53 stands were treated. No work was done on the three stands along the western edge of the reserve due to large potential sources of propagules in the immediate vicinity and their position in a reed bed, which would have complicated the work. Stakes were planted near 35 plants for monitoring purposes.

Along the Trignac Canal, 27 stands were identified, representing a total surface area of 8 800 square metres (4 220 m² of dispersed beds, 3 440 m² of fragmented beds and 1 140 m² of continuous beds). One bed on the northern side of the canal was not treated due to a problem with the gas supply (the number of remaining beds did not justify a return trip to the site).



6. Map showing the inventoried areas (in blue) and the stands of New Zealand pigmyweed (in red) in 2016.
7. Identifying the plants prior to the work.
8. 9. 10. Thermal weed control

Results and costs

■ Results

■ Three weeks after the work, initial observations were made on the marked plants:

- in the Pierre-Constant reserve, no completely dead plants were observed. All the marked plants still had at least one living branch or section. In the area with a continuous bed, the upper parts of the plants were dead (dry), but the lower parts close to the ground were still green. A few of the unmarked plants were dead. New plants were also observed;
- along the Trignac Canal, no monitoring was carried out in 2016 due to the difficulty of accessing the site and insufficient resources. The effectiveness of the work will be assessed in 2017.

■ Financial aspects

Costs and time spent on the work (payroll expenses calculated as 225 € per man-day).

	Cost (€)	Man-days
Preliminary test		
Equipment	127.75	-
Personnel costs	900	4
Inventory of pigmyweed		
Personnel costs	3 150	14
Work in P-C reserve and along Trignac Canal		
Equipment	36.60	-
Personnel costs	1 462.50	6.5
Work by FDGDON	3 510	-
Total	9 186.85	24.5

11. Living parts of treated plants.
12. Dead upper parts of plants, but lower parts still alive and green.
13. Dead plants that had poorly developed prior to the work.

Outlook

■ The test revealed a number of difficulties in organising the work during the most favourable periods. On the basis of the initial results, thermal technique would appear to be fairly ineffective. It is difficult to work on 100% of the plants in an area because they are difficult to locate when highly dispersed. This fact hinders any selective management of the plants (e.g. manual uprooting) targeting the initial establishment of the species. Their growth is spread over time, meaning that a single passage is not sufficient to eliminate all the potential shoots.

■ Further evaluation of the results will be carried out in 2017 with at least two passages planned in the treated zones. New Zealand pigmyweed is one of the species targeted by the annual inventory of invasive alien aquatic plants that will be carried out again in 2017.

Authors: Doriane Blottière, IUCN French committee, and Jean-Patrice Damien, Brière regional nature park. June 2017.

For more information

■ PNR Brière. 2016. Essai de contrôle de la Crassule de Helms par désherbage thermique 2016. Note technique d'intervention. Parc naturel régional de Brière. 14 pp.

2018 edition

New Zealand pigmyweed

(*Crassula helmsii*)

Elimination of New Zealand pigmyweed in a wetland in the Seine-et-Marne department

Seine-et-Marne departmental council

■ Since 1991, the Seine-et-Marne department has run a policy to protect sensitive natural areas. In 2017, the department owned over 1 700 hectares of natural areas, of which two-thirds were open to the public (22 sites spread throughout the department). These areas are managed directly by the department.

■ Contact: Christian Desmier, management office for sensitive natural areas - christian.desmier@departement77.fr

© IGN

1. Map showing the site.

Intervention site

■ The site was located at a place called Vallée du Bois Guyon in the town of La Genevraye. It consisted of a low, swampy area that at times was a large pool, colonised essentially by common reeds (*Phragmites australis*). The site was at one time the property of a quarry owner.

■ The New Zealand pigmyweed was discovered in 2007 by a botanist from the Vallée du Loing and Fontainebleau naturalist group (ANVL).

■ The pigmyweed was distributed over an area of approximately 200 square metres and had formed a dense mat over approximately one-half of the area. The site was half covered with water.

Disturbances and issues involved

■ Pigmyweed can spread rapidly and block the flow of water in ditches and canals. It can also hinder the development of native plant species and disturb the ecological balance of the local environment.

■ The site was close to the Épisy marshes, a Natura 2000 site (Basse vallée du Loing) placed on the green list of IUCN protected areas and consequently there was a risk of the plant spreading.

Intervention

■ Meetings were held with the National botanical conservatory for the Paris region (CBNBP) to organise a quick and effective intervention.

■ The objective was to eliminate the pigmyweed before it could disperse.

■ On-site work

■ In the spring of 2007, a programme to manually uproot the plants was launched. The pigmyweed was removed manually as carefully as possible, using rakes, and placed in 100-litre garbage bags.

■ To avoid the dispersal of the plants to the other sections of the pool, a tarp was set up vertically to partition the work site.

■ The closed garbage bags were then stored on a concrete platform in the sun.

■ The following fall, the bags were checked to make sure that the plants were dead and the contents were disposed of similar to any other green waste.

■ In uprooting the *Crassula helmsii*, some reeds were also removed because it was difficult to separate the two. The stems of the reeds were gathered in a pile in the area most heavily colonised by the pigmyweed and burned.

■ Monitoring

■ Following the work, the site was visited each month by two persons during the summer.

■ Some further uprooting and collection were necessary, using a mason's trowel to scrape the surface and completely remove the few plants that had regrown. During the first two visits, one to two garbage bags were filled, then on the following visits, only a few plants were noted and removed.

■ From the middle of the summer onward, no further regrowth was observed.

■ The monthly monitoring visits continued until the fall, then three more visits were made in 2008 (April, June and August).

Results and assessment

Results

- During the initial uprooting work, a total of one cubic metre was collected, including pigmyweed, dirt and reed rhizomes that were difficult to disentangle.
- Following the summer of 2007, no regrowth was observed during the monitoring visits.
- In 2017, the site was again revisited and no pigmyweed was observed. However, the site had been modified. The low, wet area had been dug out and there was an island in the large pool.

Financial aspects

- The initial work occupied five people (two departmental technicians, two CBNBP technicians and one Onema technician) for one day.
- The monitoring work may be estimated to have taken a total of ten hours, not including the transport time.
- The project was paid for by each participating entity, in the form of work hours by the technicians.

Information on the project

- The work was done on private property and no information was made public.

Outlook

- The pigmyweed was eradicated and no further work is planned for the site.

Remark

- This management report does not contain all the information generally found in the reports drafted jointly since 2014 with a large number of managers in the framework of the IBMA work group.
- That is due in part to the fact that the operation took place ten years ago and was a success. The participants from the departmental council and the CBNBP did not require external assistance and, given that at that time the exchange network for IAS management was not yet functional, a report on the work was not immediately drafted, which would certainly have produced more information and additional photos.
- That being said, this report was deemed useful for those confronted with New Zealand pigmyweed, which explains why it is presented here.

Authors: Doriane Blottière, IUCN French committee, and Christian Desmier, Seine-et-Marne departmental council. January 2018.

2. The Épisy marshes.
3. Pigmyweed seedlings in a wet area.
4, 5. The site in 2017.

2018 edition

Water primrose

(*Ludwigia* spp.)

Classification	
Order	Myrtales
Family	*Onagraceae*
Genus	*Ludwigia*
Species	*L. peploides* ((Kunth) P.H.Raven, 1963) *L. grandiflora* ((Michx.) Greuter et Burdet, 1987)

Originated in South America. Accidentally introduced in Languedoc around 1830. Later used as an ornamental plant in outdoor basins.

Descriptif

- Amphibious plant, rooted
- Rigid stalk with nodes, easily breakable
- Yellow flowers, separate petals (*L. peploides*) or overlapping petals (*L. grandiflora*)
- Brace roots and aeriferous roots
- Fruit in the form of capsules

Ecology and reproduction

- High adaptation (long stalks along the surface, branches) and colonisation capabilities (complete occupation of the available space, growth above the water level)
- Very resistant plant (strong root system)
- Production of large quantities of biomass, layer of plant litter on some sites
- Sexual reproduction is possible
- Wide range of favourable biotopes:

- shallow wetlands
- edges of ponds and lakes
- channels, ditches, side channels
- rivers with low discharges during the summer
- wet meadows

Documentation

- Lambert E. 2009. Plantes exotiques envahissantes - Synthèse bibliographique. CEREA/UCO/Angers-GIS « Macrophytes des eaux continentales » - Comité des Pays de la Loire/Gestion des plantes exotiques envahissantes – 2è ed. complétée, 110 pp.
- Hudin S., Vahrameev P. (coord.) 2010. Guide d'identification des plantes exotiques envahissant les milieux aquatiques et les berges du bassin Loire-Bretagne. Fédération des conservatoires d'espaces naturels, 45 pp.

Author: Emilie Mazaubert, Irstea

1. Creeping water primrose (Ludwigia peploides).
2. Large-flower water primrose (Ludwigia grandiflora).
3. The pond colonised by water primrose in the Var department.
4. Root system.
5. Sprouting water primrose.

Water primrose

***(Ludwigia* spp.)**

Managing water primrose in the Gardons basin
Management report on four years of work

Board for balanced management of the Gardons basin (SMAGE des Gardons)

■ The SMAGE is a public river-basin territorial agency (EPTB) created in 1995 that represents 127 towns in the Gardons river basin (2 000 square kilometres on the right bank of the Rhône River) and the departmental council of the Gard department.

■ It is the project manager for the SBMP (sub-basin management plan) and for the Gardons river contract. It has set up consistent, basin-wide policies for:

- flood prevention;
- management of water resources (quantity and quality);
- preservation and restoration of aquatic environments.

■ Since 2009, management of invasive plant species has become an important part of the policy for natural environments. A multi-year management programme was established in 2012.

■ Contact: Jean-Philippe Reygrobellet - smage.jpr@les-gardons.com

Intervention site

■ The Gardon Rivers flow through the heart of the Languedoc-Roussillon region. The rivers originate in the Cévennes mountains, in the Lozère department. They flow through the Gard department and into the Rhône River. The Gardons basin comprises many remarkable aquatic environments (Cévennes national park, Galeizon biosphere reserve, Natura 2000 sites, the Gardon gorges) that are home to an array of emblematic species such as the otter, the European beaver, Bonelli's eagle, shad, eels, bug orchids and summer lady's-tresses.

■ A large number of invasive species have been observed in the rivers of the basin (water primrose, parrot-feather watermilfoil, water cabbage, alien knotweeds, summer lilac, amorpha, etc.). Given the size of the area (2 000 kilometres of river including 500 km of large rivers), a multi-year (2012-2017) management plan was set up in 2011. It is funded by the Rhône-Méditerranée-Corse water agency, the departmental board and the Gard departmental council.

© Smage des Gardons

© Smage des Gardons

1. Presence of water primrose in the Gardons basin in 2015.
2. Sites where work on water primrose was done in 2012.

Disturbances and issues involved

■ The species forms dense, single-species stands that completely cover up to several thousand square metres of water bodies and banks. It competes with and locally eliminates certain other species.

■ Beds of plants modify the daily oxygen cycle to the detriment of animal species.

■ Large quantities of biomass are produced, contributing to sedimentation and filling of channels.

■ Detrimental effects on recreational activities (boating, fishing, swimming, etc.).

Interventions

Inventories

- An overall assessment was run in 2010 on 1 200 kilometres of river to pinpoint the areas needing work.
- In 2012, a more in-depth examination of 70 km of river made it possible to launch the first calls for tenders.
- Inventories were subsequently carried out in 2013 and 2014 by the companies in charge of the work. The results are used to determine the effectiveness of the work done the previous year and to prepare future work.
- All work sites were identified (GPS) and incorporated in a geographic-information system (GIS).

Manual uprooting

- Virtually every section of river colonised by water primrose was treated manually, i.e. 69 km in 2012, then 49 km in 2013 and 2014 (20 km treated in 2012 were subsequently excluded the following years).
- The difficulties in accessing the bankfull channel (active tract) of the Gardon and the relatively small surface areas involved in these sectors justified manual uprooting, which made it possible to limit the negative effects of the work on the ecosystem.
- The river reaches to be treated were very long and could not be handled by a single firm, which explains why the work was divided into sectors.
- Depending on the quantities of water primrose and the period of the year, the work teams (one per sector) consisted of four to ten people on foot, assisted by one or two motorboats, and equipped with nets and sacks.
- A quad and trailer were used as needed, in sectors that trucks could not access, to remove the waste.
- The use of amphibious equipment made it possible to uproot large beds of plants in water during the initial stage of the work.
- Up to four companies at a time were engaged in the work:

- in 2012, at the start of the multi-year management plan, it was difficult to find companies with the necessary experience in uprooting water primrose in rivers;
- the first year served to adapt the procedures and technical specifications to the various constraints (difficulties in accessing the sites and removing the waste, managing the floating craft in running waters, the many side channels that were difficult to detect, major variations in water levels, etc.) and to locate the companies with the necessary capabilities.

- In 2012, the eight work sectors covered a total distance of almost 50 kilometres along the Gardon between Vézénobres and Remoulins, and over 20 km of tributaries to the lower Gardon near the town of Comp.
- In 2013, the tributaries to the lower Gardon were withdrawn from the project because the low colonisation levels did not require comprehensive management. They were subsequently monitored and uprooted on a less regular basis. The project continued in seven sectors spanning a total distance of almost 50 km of river between Ners and Remoulins (along the Gardon River and a gravel pit, see Figure 2).
- Manual uprooting was pursued along these 50 km over the three-year period (2012-2014).
- Each year, the work lasted approximately five months from June to October. The initial plan was for a single uprooting period, but in 2013, the technical specifications were modified to include two passages through each area, one in June-July and the second in August-September. The second was deemed

3. An area colonised by water primrose.
4. 5. Manual uprooting.

indispensable to effectively treat the water primrose.

■ In order to anticipate the quantity of work, the technical specifications were adapted to take into account the significant fluctuations in the growth rates of water primrose:

- the colonised surface areas were estimated and included in the call for tenders, thus enabling the companies to prepare a preliminary quote and calculate the unit prices;
- prior to beginning the work, a company was required to examine its entire sector in order to precisely calculate (GPS) the colonised surface areas and submit the results;
- the sectors were then checked by the managing entity;
- a coefficient was applied to the surface areas to take into account the future growth of the plants and the results were compared to the estimates prior to producing the final quotes.

■ This procedure had a number of advantages, namely it provided an "updated" idea of the surface areas to be treated and it put the companies in a position to foresee the full extent of the work (quantity, access to sites, etc.). The resulting map also served as an inventory for the year that could be used to assess the effectiveness of the past uprooting work, information required for the work reports.

■ Mechanical uprooting

■ The former Ners gravel pit (3 hectares in size, of which 80% was colonised by water primrose), was linked to the Gardon and constituted the starting point of the dissemination to the entire Gardonnenque area. The large amounts of water primrose biomass made effective manual work technically and financially unfeasible.

■ In spite of its being located at the upstream limit of the colonised area, the gravel pit was left as is, however its link to the Gardon was cut by installing stone banking and soil in June 2013 to stop the release of cuttings and seeds from the gravel pit. Unfortunately, this barrier was almost completely washed away by the floods in 2015.

■ At the outlet of the gravel pit, the Gardon was heavily colonised. Over a 500-metre reach, the surface areas were so large (6 000 square metres in 2010, 10 000 sq. metres in 2012) that manual uprooting, though attempted in 2010, was abandoned and the decision was made to opt for mechanical uprooting.

■ The minimal water depth (less than 40 cm in some places), site inaccessibility and the large volumes of plants made it necessary to undertake many technical adaptations and two years of work were required instead of the planned one year.

■ The first phase of mechanical uprooting was carried out in 2012. The equipment included a harvester boat, an amphibious excavator and a crane mounted on a boat with very little draft. The harvested plants were transported on a barge to the opposite bank.

■ During this first phase, significant amounts of seeds freed from the sediment began to germinate. The seeds settled and germinated on the treated sites and on further sites hundreds of metres downstream, at the foot of the river banks and in the accumulated debris. This reduced the effectiveness of the work and study was put into developing other harvesting techniques.

■ The company doing the work suggested testing a technique involving hydraulic dredging and filtering of the sediment. This experimental technique was used during the second (summer of 2013) and third (February-March 2014) uprooting campaigns:

- the boat with the crane was equipped with a suction head and a shredder;

7. 8. Mechanical uprooting with the harvester boat and the raft used to remove the harvested plants (Figure 7), and the boat with the crane and the raft (Figure 8).
9. Seeds freed from the sediment.
10. Nets were installed to avoid dispersal of fragments of water primrose during mechanical uprooting.

- a pump connected to the pipe pulled up the sediment and sent it to the opposite bank where long tubes of geotextile fabric filtered out the stalks, rhizomes and sediment containing the water primrose seeds.

This technique produced positive results concerning the seeds (trapped by the filters), however the low productivity level (only 50 square metres per day for sediment depths of 20 to 40 cm) resulted in excessively high costs that meant the technique could not be continued. In addition, it was effective only in areas under water (at depths of over 20 cm) and therefore could not be used at the foot of the river banks.

■ The elimination of water primrose from the areas under water and the difficulties in mechanically uprooting the edges of colonised areas led to the halt of the mechanised techniques in 2014.

■ The work was done manually on the site in 2015.

■ Given the complexities of mechanical uprooting, the technique is not presented in greater detail in this document.

■ Waste management

■ During the work in 2012, different management techniques for the waste were studied:

- burning in an incinerator for household waste was too expensive (80 euros per metric ton);
- use as a substrate for replanting of landfills at the end of their use was seen as contravening regulations by the State services;
- composting was not possible in the absence of a reliable composting unit;
- spreading in agricultural fields was considered risky due to the danger of the seeds being carried in runoff water during heavy rains.

■ In light of the above conclusions, it was decided to transport the waste in covered trucks to a single storage area outside of floodable zones, i.e. a dry and regularly monitored spot. The land was provided free of cost by a farmer.

■ To avoid any dissemination of water primrose to nearby rivers (200 metres), bunds were created around the storage area to trap any water running off of the mounds.

■ To avoid germination outside the storage area, the SMAGE carries out annual monitoring of both the mounds of plants and the bunds. The nearby rivers were included in the list of monitored areas in order to achieve early detection of invasive plants in the river basin (see below).

■ At some point, when the germination rates have fallen to a low level, the plants will be spread in ploughed fields lying outside floodable zones. The seeds in the sediment are regularly cultivated by the SMAGE in the framework of a simplified procedure and the germination rate is still between 80 and 90% after three years of storage.

■ Monitoring, detection and rapid uprooting

■ The multi-year management plan includes monitoring and early detection work in rivers upstream of and near the zones already colonised. When water primrose is found in these areas, it is immediately uprooted.

■ In 2012, the work was done by SMAGE employees. However, due to a lack of time, only the downstream section of the Gardon d'Anduze and the Capelle Pond were inspected.

■ In 2013, consulting firms were assigned the mission of travelling along the rivers on foot to detect and map not only water primrose, but also the other species concerned by the multi-year management plan (parrot-feather watermilfoil, waterweeds, large-flowered waterweed, water cabbage, Japanese knotweed, desert false indigo and Japanese hop).

■ Each year since 2013, 60 kilometres of river have been inspected.
■ This work limits the risks of seeing the areas colonised by water primrose grow, while also ensuring the early detection of the other targeted species.

Map showing the river sections monitored annually.

■ The results are highly positive. In 2014, a new stand of water cabbage (*Pistia stratiotes*) was discovered in the town of Moussac, 60 km upstream of the known sectors, and in 2015, a square metre of water primrose was discovered along the river running through the town of Alès, 15 km upstream of the known sectors. The plants were immediately uprooted and no new regrowth has been observed.
■ On occasion, however, the plants are not discovered immediately. In 2014, a single large-flowered waterweed was found purely by chance along the Gardonnenque. In 2015, searches finally found the bed responsible for the dissemination downstream. It was approximately 1 000 square metres in size and in water 2 metres deep, in the town of Ners in an area that had not been previously inspected. Given the surface areas involved, it was decided to simply confine the plants to their present location.

■ Revised management strategy in 2015 (manual and mechanical uprooting)

■ All the work done in the framework of the management plan is assessed annually to determine whether the objectives are met and to modify the plan as needed. Concerning the management of water primrose, it became clear as early as 2010 that it would be impossible to completely eliminate the plants.
■ The objectives built into the management plan included a rapid and significant drop in the funds required for long-term management. The confirmation that the seeds were germinating, a mode of dissemination in addition to the cuttings, and the large surface areas covered by the plants on land meant that the overall objectives could not be met.
■ In spite of the highly positive technical results of the work (water primrose was no longer visible along 50 km of river) and the sums already invested, the failure to meet the economic objectives combined with the drops in available funding and the need to shift budget priorities meant that the project was no longer feasible. Consequently, the widespread uprooting was halted in 2015.
■ The work now addresses early detection, awareness raising, confining the species and locally reducing its economic and ecological impacts. Uprooting

is continued only on the upstream borders of colonisation and on the main tributaries (confinement), in closed wetlands and side channels of the Gardon in order to reduce the ecological impact. The main beaches and urban sections are also treated to limit the impacts on human activities.

■ An annual photographic survey is now carried out on certain characteristic areas to estimate the speed of recolonisation on the treated sites and the utility of work to maintain certain areas of water free from the plants (this work is done less frequently, generally every three to five years).

■ Given that water primrose is present in a large number of private ponds throughout the river basin, it must be assumed that it will spread to areas not currently monitored. By raising awareness, it should be possible to limit the risks of inadvertent dissemination and to increase the number of observers, thus improving detection and the possibilities of rapid intervention.

Results and costs

■ Technical results of manual uprooting

Table 1. Technical results

Note. The edges and the surface areas treated during work on such long distances of course vary from year to year, for example due to the discovery of colonised side channels. In order to enable comparisons from one year to the next, the table below does not include surface areas, often relatively large, added to certain sectors.

Technical results		Manual uprooting in 2012		Manual uprooting in 2013		Manual uprooting in 2014	
No.	Geographic sector	Surface area (sq. m) effectively uprooted	Volume harvested (cubic m) in one work period	Surface area (sq. m) effectively uprooted	Volume harvested (cubic m) in two work periods*	Surface area (sq. m) effectively uprooted**	Volume harvested (cubic m) in two work periods**
1-2012	Upstream of the Ners meander	71	0.1	Halted in 2013		Halted in 2013	
1-2013	2nd Ners gravel pit	340	22.5	250	8,0	Not applicable	2.0
2	Ners to Boucoiran	4 690	63.5	544	13.1	Not applicable	25.0
3	Boucoiran to Moussac	3 273	276	1 296	48.6	Not applicable	40.5
4	Moussac to St-Chaptes	3 796	155.8	1 927	310.0	Not applicable	66.3
5	St-Chaptes to Dions	490	14	108	3.2	Not applicable	7.8
6	Dions to Collias	515	5	0.1	1.3	Not applicable	5.1
7	Collias to Remoulins	1 775	56.6	935***	49.6	3 216.0***	106.4
8	Tributaries to the lower Gardon	680	6.3	Halted in 2013		Halted in 2013	
	TOTAL	15 630	599.7	5 060	433.8	so	253.0

** The system was modified in 2013 to include two or three uprooting periods spread over four months. The volumes harvested in 2013 were therefore slightly greater.*
*** Following the work in 2012 and 2013, the water primrose was no longer present in dense beds, but only in random stands along the river banks. Calculations of surface areas were therefore halted.*
**** The company went bankrupt in 2013 and halted the work. A new call for tenders was launched in 2014, but the delay resulted in a rapid spread of the plants. This mishap demonstrates that in jobs of this size, the progress achieved can be rapidly lost.*

■ Manual uprooting of water primrose in rivers turned out to be very different than in ponds, lakes and canals. The experience acquired by companies in the calmer waters (equipment, unit costs, work times) could not be easily transferred to running waters and this resulted in underestimating the financial costs.

■ The difficulties weighing on the work in rivers (running water, difficult access and removal of waste, regular discoveries of “hidden” side channels, etc.) make these jobs very hard to estimate and to manage by the responsible entity. Significant human resources must be brought into play and the teams must display great rigour and autonomy in their work, which implies a high level of confidence between the company and the managing entity.

■ The very small number of specialised companies and their heavy workloads constituted a major obstacle to projects over such large distances and made it difficult to set coherent “market prices”.

■ The discovery of new colonised areas, the failure of one company, a flood causing a massive dissemination, the renewed suspension and transport of seeds in the sediment, etc., make clear the uncertainty of the results of work done on rivers over large distances and surface areas. In areas with running water, compared to those with calm waters where the work conditions are better controlled, the management must foresee significant overruns in terms of the human resources and the overall funding. In some cases, it may be necessary to abandon certain heavily colonised sectors.

■ The time required by SMAGE personnel to organise and manage the uprooting work was considerable:

- 10 to 20% of an FTE (full-time equivalent) job from February to June (contacting the companies and preparing the contracts);
- 80% FTE from June to October (monitoring the work, amendments to the contracts, etc.);
- 20% FTE in November and December (writing reports, requesting subsidies).

■ Financial results of manual uprooting

Table 2. Financial results of manual uprooting

Note. Similar to the technical results, the prices were adjusted to enable comparisons between sectors from one year to the next. This table does not include surface areas added later to certain sectors.

No.	Sector / area	PRICE PAID (in euros incl. VAT)		
		2012	2013	2014
1-2012	Gardon upstream of the Ners meander	3 573		
1-2013	Gravel pit	6 099	3 137	2 970
2	River section	53 613	41 238	6 979
3	River section	37 269	53 127	19 612
4	River section	55 891	77 266	82 548
5	River section	8 721	7 375	3 984
6	River section	15 393	12 916	3 780
7	River section	28 274	11 565	59 388
8	River section	16 074		
	TOTAL	224 911	206 624	206 624

Table 3. Financial results of manual uprooting

Note. This table presents the amounts actually spent, taking into account major changes due to the discovery of small, heavily colonised ponds (reed beds, dense riparian vegetation) that had to be treated to avoid the risks of seed dissemination during floods.

	PRICE PAID (in euros incl. VAT)		
	2012	2013	2014
TOTAL	224 911	278 800	303 269

Information on the project

- An internet site using maps for early detection was created and made available in 2013 (http://invasives.les-gardons.com).
- The work done was used to illustrate various efforts to raise awareness, including TV reports, radio programmes, local meetings, brochures, posters and signs on the work sites, etc.

Outlook

- The work will be pursued in 2016 and 2017 according to the revised management plan set up in 2015.

Authors: Emmanuelle Sarat, IUCN French committee, Jean-Philippe Reygrobellet, SMAGE, and Alain Dutartre, independent expert. September 2016.

11. Internet mapping site used for early detection.
12. Signs presenting the work on all the sites, intended to raise awareness.

For more information

- SMAGE internet site: http://www.les-gardons.com
- Site on invasive plants: http://invasives.les-gardons.com
- Smage des Gardons. 2011. Plan de gestion des espèces végétales invasives sur le bassin versant des Gardons. 72 pp. *
- Smage des Gardons. 2013. Bilan des actions menées en 2012 et 2013. 27 pp. *
- J-Ph Reygrobellet et A. Dutartre. 2013. Acte conférence ZNA à Toulouse. Plan de gestion des plantes aquatiques exotiques envahissantes à l'échelle du bassin versant. Mise en œuvre sur les Gardons (Gard-Lozère). 10 pp.*

** Available on request.*

2018 edition

Water primrose

(*Ludwigia* spp.)

Managing water-primrose colonisation of a canal in the Grande Brière Mottière marshes

Brière regional nature park

■ The park, initiated by the Ecology ministry in 1970, is managed by a board with members from the 20 towns in the park, from the two "gateway towns" (Nantes and Pornichet), the Loire-Atlantique department, the Pays de la Loire region, the Grande Brière Mottière commission (CSGBM) and the board for the Brivet river basin (SBVB).

■ Its main missions include:

- protecting the natural heritage, notably through suitable management of the natural environment and landscapes (marshes, wet meadows, reed beds, canals, etc.);
- contributing to territorial planning;
- contributing to economic, social and cultural development and to the quality of life;
- welcoming, educating and informing the public;
- carrying out experiments or outstanding projects in the fields mentioned above and contributing to research programmes.

■ Contact : Jean-Patrice Damien, scientific officer - jp.damien@parc-naturel-briere.fr

Grande Brière Mottière commission (CSGBM)

■ The commission is responsible for maintaining the Grande Brière hydraulic network and for managing the local biodiversity and human activities in the marshes.

■ It is also in charge of the project for water primrose.

■ Contact: csgbm@orange.fr

Intervention site

■ The Brière regional nature park covers a total of 55 000 hectares, of which approximately one-third are wetlands listed as a Ramsar site (18 250 hectares). In conjunction with the Donges marshes, the Brière park is also listed as Natura 2000 and ZNIEFF sites. The park is home to numerous emblematic species (Eurasian bittern, black terns, bluethroats, European otters, etc.) and remarkable flora, notably in the amphibious grasslands and the oligotrophic meadows.

© PNR Brière

1. The Brière regional nature park and the different sectors.

■ In the middle of the park, the Grande Brière Mottière marshes (a joint property) cover 7 000 hectares.

■ Two species of water primrose may be found in the marshes, namely *Ludwigia grandiflora*, first identified in 1994, and *Ludwigia peploides*, first observed in 2016. In spite of the work (manual uprooting) done over a number of years, the plants are gaining ground in the park.

Disturbances and issues involved

■ Colonisation by water primrose leads to major changes in ecosystems with significant consequences for biodiversity (fauna and flora), and on the ways that the marshes are used, for example:

- loss of native species;
- loss of productivity and constraints for the extensive farming system in the marshes;

- difficulties for traditional uses of the marshes, including fishing, hunting, boating;
- accelerated filling in of aquatic environments in the marshes, with potential consequences in terms of flood risks for nearby developed areas;
- degraded living conditions and a poor image of the park, with negative impacts on tourism.

Interventions

■ The work programme was set up in the framework of the “Local agreement to combat the development of water primrose”, signed in November 2014 by the local stakeholders in the Brière regional nature park and the catchments leading into it (Brivet and Mès Rivers, Pont-Mahé Canal) in order to coordinate the work required to limit its spread.

■ To date, the canals in the Grande Brière Mottière marshes are not overly affected by water primrose, however the spread of the species raised the question of mechanically extracting the plants. The intervention was designed to test the suitability of equipment for the local conditions and to determine the costs and effectiveness of this type of work.

■ The work site was a canal 850 metres long, 13 metres wide on average, located to the south of the Grande Brière marshes, adjacent to private properties and with a dirt road along one side.

Intervention site. The lighter green areas in the meadows are the water primrose.

■ The water primrose was present in abundance in and along the canal. Over a distance of 700 metres, it occupied over 90% of the water surface area and over the remaining 150 metres, it covered an area one to two metres wide along each bank. It had also invaded the nearby meadows and water bodies.

■ Uprooting work

■ The work took place from 15 September to 2 October 2015 in order to take advantage of the better (dryer) soil conditions.

■ The plants were uprooted by an excavator equipped with wide treads and a special fork designed to limit the extraction of sediment and water.

■ The work did not address the beds on the top of the banks or the mud at the bottom of the canal. Their removal would have involved additional quantities of soil and sediment, as well as excess costs and regulatory constraints imposed by the Water law.

2. 3. 4. Canal full of water primrose prior to the work.

■ Depending on the density of the extracted plants, they were either loaded directly into a trailer or first piled on a bank and then loaded. In that water primrose is widely present in that section of the marshes (on and along the dirt road), it was not necessary to lay down tarps to protect the soil and avoid the dispersal of fragments during loading of the plants in the trailers. However, fragments around the loading zone were nonetheless collected by hand.

■ To limit the dispersal of fragments in the canal, a screen (synthetic material, similar to a wind screen with a 4-mm mesh, attached to wooden stakes) was positioned at one end of the work site. The other end was blocked by a fording site that was completely dry at the time of the work.

■ Waste management

■ The harvested plants were stored temporarily on the Pierre-Blanche agricultural site. The site was selected because it offered a number of major advantages, namely easy access for heavy machinery, considerable distance to the nearest residential area, low risk of the water primrose taking root on the landfill platform, no public access and a reasonable distance to the work site (between 1 000 and 2 500 metres depending on the extraction site along the canal and the route taken). The site was made available free of cost by the site managers.

■ The plants were deposited in a long mound and surrounded by hay bales to filter the runoff water and avoid any dispersal of fragments. The pile of plants was turned over twice during the six-week storage period to facilitate runoff and to decompact the plants.

■ The green waste was then transported by truck to the Terralys composting unit in Sainte-Marie-de-Redon (35).

Results and costs

■ Results in 2015

■ During the five days of work, 360 tons of drained, fresh biomass were collected (45 trips with the tractors and trailers) and following the storage period, 186 tons were reloaded and transported. It was difficult to reach the opposite bank in places where the canal width exceeded ten metres, i.e. in those cases, it was necessary to travel to the opposite bank with the machines.

■ The work succeeded in rapidly clearing the canal. However, the sediment probably still contained stalk and rhizome fragments, as well as numerous seeds. In addition, the beds along the tops of the banks were not removed and could thus start to recolonise the canal.

■ Results in 2016

■ Starting in June, water primrose was again present along the entire canal, primarily along the banks in a strip 1 metre to 1.5 metres wide.

■ The middle of the canal was not heavily colonised, but primrose rosettes were visible in spots.

■ In July, the beds had become more dense and taller. They remained on the banks and did not colonise the entire width of the canal. The plants in the middle of the canal remained small in number, but were clearly developing.

■ In order to limit the renewed establishment of the plants, manual uprooting took place over six days in July and August. A total of 75 tons of drained, fresh biomass were collected and transported to the composting unit.

5. The fork used to uproot the plants.
6. Temporary storage of the water primrose, surrounded by hay.
7. Removal of the water primrose.
8. Barrier across the canal to filter fragments.

Assessment

■ In 2015, three people were occupied for five days with the mechanical uprooting (one excavator operator and two tractor drivers).

■ In 2016, manual uprooting occupied ten people over six days. It should be noted that the access conditions to the work site were excellent and resulted in lower costs.

Table listing project costs.

2015	Cost (€)
Mechanical uprooting and transport to temporary storage	8 399.20
Transport to the composting unit	2 505.60
Composting	7 710.30
Work to restore the temporary storage site	297.10
Project management and monitoring	1 750.00
2016	**Cost (€)**
Manual uprooting*	6 600.00
Transport and composting*	410.00
TOTAL	27 672.20

** Estimated cost because part of an overall project.*

■ This test served to establish an initial financial estimate of the costs of mechanical uprooting of water primrose and an estimate of the quantities that must be removed.

■ It confirmed once again the need to combine both mechanical and manual techniques on sites heavily colonised by water primrose.

It is now acknowledged that many invasive alien plants cannot be eliminated from most of the open sites where they are established and that the objective of management projects is now simply to maintain their presence at a low level. Mechanised techniques can rapidly remove large quantities of biomass, but the results are short lived because the remaining fragments and seed banks enable the plants to pursue their colonisation the year following the work. Regular manual interventions to remove the fragments and the yearly crop of young primrose plants are however a means to maintain the colonisation at a low level with no significant environmental impacts

■ The temporary storage is very useful because it reduces the weight of the transported biomass and the composting costs. After six weeks of storage, the weight of the mechanically uprooted plants had been divided by two. After eight weeks, the weight of the manually uprooted plants had been divided by ten.

Information on the project

■ No particular information was published on the project, except for the reports to the local managers and notably those involved in the “Local agreement”.

Outlook

■ On the basis of the observed regrowth of the water-primrose beds, it was estimated that the situation would have returned to that prior to the mechanical intervention within two to four years if the manual work had not been undertaken.

■ To avoid a return to the intense development of the plants, manual work is now programmed annually. The amount of manual work required is expected drop progressively.

■ Earlier manual uprooting over two periods (May and July) is the preferred solution in that it limits the weight of the collected plants and produces more effective results.

■ Given the costs of mechanical interventions and the regular manual work required to reduce over the long term the quantity of water primrose in a heavily colonised area, it is clear that the best solution is to avoid situations where large areas become colonised. Regular manual work in areas with low densities of water primrose can reduce the risks of having to deal later with heavily colonised areas.

Authors: Doriane Blottière, IUCN French committee, and Jean-Patrice Damien, Brière regional nature park. June 2017.

For more information

■ Damien JP. 2015. Contrôle des plantes aquatiques invasives en Grande Brière Mottière par récolte mécanique. Action du Pacte local de lutte contre le développement de la jussie. Compte rendu d'intervention. PNR de Brière. 11 pp.

■ Local agreement to combat the development of water primrose: http://www.gt-ibma.eu/strategies-ou-en-sont-les-institutions/strategies-infranationales/pnr-briere/

2018 edition

Water primrose

***(Ludwigia* spp.)**

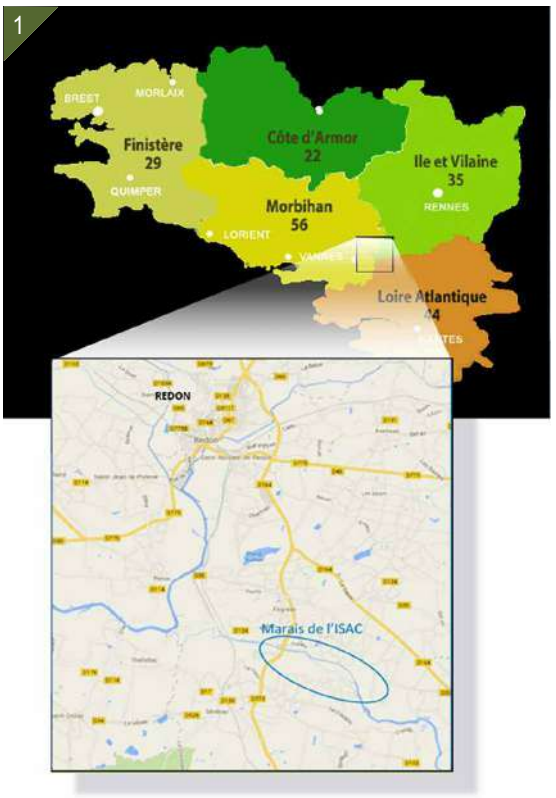
Experiment on restoring wet meadows colonised by water primrose in the Isac marshes (Loire-Atlantique department)

Development agency for the Vilaine River basin (IAV)

■ The agency is a public entity founded in 1970 by the Ille-et-Vilaine, Morbihan and Loire-Atlantique departments.
■ This interdepartmental organisation was awarded the status of a public river-basin territorial agency in 2007 (EPTB Vilaine). It is active in the hydrographic basin of the Vilaine River which covers over 10 000 square kilometres and comprises approximately 12 600 kilometres of watercourses.
■ The main objectives of the agency are to prevent floods, manage the production of drinking water with the Arzal dam and implement the policy of the Vilaine SBMP (targeting water quality and quantity). The agency also manages the Marais de Vilaine Natura 2000 site.
■ The work presented here was carried out in the framework of the European Interreg IVa cross-Channel WOW "WOrking Wetlands" programme.
■ Contact: Benjamin Bottner, scientific officer for biodiversity
benjamin.bottner@eptb-vilaine.fr

Intervention site

■ The site covers approximately 600 hectares and is located in the Isac marshes in the Loire-Atlantique department (44), approximately 12 kilometres to the SE of the town of Redon, between the villages of Fégréac, Sévérac and Guenrouet, and within the Marais de Vilaine Natura 2000 site (10 000 hectares).
■ The soil is loamy (former marine mud flats) with a high clay content. Pockets of peat may also be found. The average elevation lies between 1.9 and 2.1 metres A.S.L.
■ A network of ditches evacuates the water to the Isac River. The water level is managed by a system of gates at the meeting point with the Vilaine River. In the winter (December to February), the water level is maintained at 2.4 metres A.S.L., whereas in the summer, water is pumped to maintain the level at 1.8 metres A.S.L. to facilitate the farm work (primarily late hay making).



© EPTB-Vilaine

1. The Isac marshes in western France.

Disturbances and issues involved

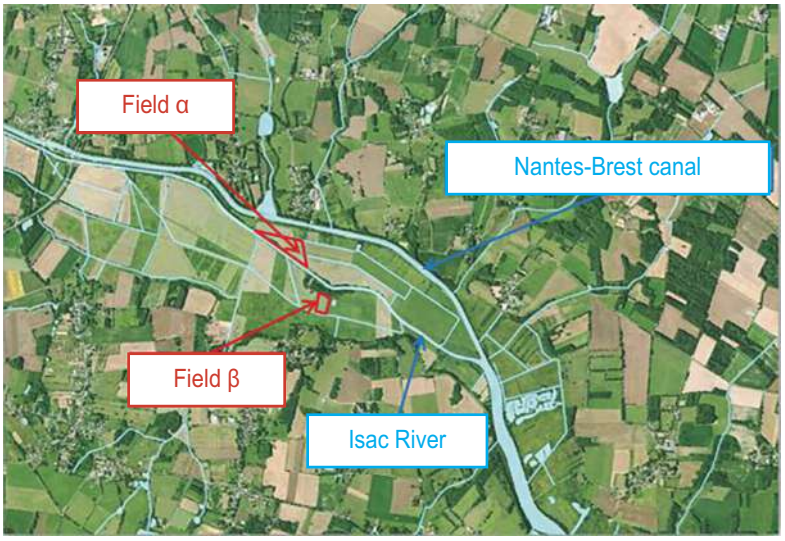
■ Large-flower water primrose (*Ludwigia grandiflora subsp. hexapetala)* observed in the hydraulic network also extensively colonised meadows, to the detriment of the native flora.
■ Its expansion negatively impacts floristic diversity and farming activities. For farmers, there are three major consequences, namely the drop in forage value, the requirement that they withdraw the colonised areas from those receiving CAP subsidies and their exclusion from the benefits of agri-environment-climate measures.
■ In addition, the presence of the invasive species creates difficulties in managing water levels for pike. To encourage the growth of native species rather than water primrose, water levels are lowered early in the spring, a period during which juvenile pike need stable water levels.

Interventions

■ The objective was to test different soil-management techniques using very common farming equipment to remove water primrose while restoring native species.

■ The experiments took place in two fields (see the map below), namely field α in 2013 and field β in 2014, in order to avoid any bias in the results from one year to the next. The particular area was selected because colonisation by water primrose was fairly homogeneous throughout that area and the farmer agreed to use his fields for the experiment.

■ In 2013 and 2014, two control zones were created, one without any work (no mowing or tillage) and the second with only mowing (no tillage).



Map showing the location of the experimental plots.
© EPTB-Vilaine

■ Interventions in 2013

■ Several types of tillage in conjunction with sowing of native plants were tested in order to restore the grass cover.

■ The work was done on strips of land approximately 25 metres long and 3 metres wide (the width of the tillage tools).

■ Two different types of experiment were carried out on field α:

- stripping of approximately 10 cm of topsoil with the aerial parts of the plants and the roots with any substrate, followed by different types of tillage (meadow harrow (MH) or vibrocultivator (VIB)) and sowing;
- mowing followed by tillage (vibrocultivator) and sowing of different plants.

■ Two different types of plants were sown, reed canary grass (*Phalaris arundinacea* (PA)) and tall fescue (*Festuca arundinacea* (FA)), and marsh hay with a high content of great manna grass (*Glyceria maxima* (GM)) was spread. These species were selected because they were deemed suitable for the wetlands in question.

■ The vibrocultivator turns over and mixes the soil to a depth of 15 to 20 cm. It loosens, dries and mixes the soil, thus reactivating the grain bank and resulting in better germination. The meadow harrow treats only the very superficial layer of soil, to a depth of approximately 5 cm.

■ The vibrocultivator was used only once and always lengthwise.

2. The experimental zone prior to the work.
3. The zone after removal of the topsoil.
4. The vibrocultivator in action.
5. 6. The zone just after the work.

■ The work took place during the first two weeks of July and represented a total of approximately 50 hours of work (not including preparation, plus preliminary and subsequent monitoring).

Table 1. Tested operations in 2013.

Code	Operation 1	Operation 2	Operation 3
STRIP	STRIPPING	X	X
STRIP	STRIPPING	X	X
STRIP-MH	STRIPPING	MEADOW HARROW	X
STRIP-MH-PA	STRIPPING	MEADOW HARROW	SOW PA
STRIP-MH-FA	STRIPPING	MEADOW HARROW	SOW FA
STRIP-MH-GM	STRIPPING	MEADOW HARROW	GM
STRIP-VIB-GM	STRIPPING	VIBROCULTIVATOR	GM
STRIP-VIB-FA	STRIPPING	VIBROCULTIVATOR	SOW FA
STRIP-VIB-PA	STRIPPING	VIBROCULTIVATOR	SOW PA
STRIP-VIB	STRIPPING	VIBROCULTIVATOR	X
VIB	MOWING	VIBROCULTIVATOR	X
VIB-GM	MOWING	VIBROCULTIVATOR	GM
VIB-PA	MOWING	VIBROCULTIVATOR	SOW PA
VIB-FA	MOWING	VIBROCULTIVATOR	SOW FA
MOW CONTROL	MOWING	X	X
CONTROL	X	X	X

■ Interventions in 2014

■ The work was done on experimental plots measuring 4x4 metres with tillage tools 3 metres wide.

■ The vibrocultivator appeared to have produced good results in 2013 and was tested again in 2014 under different conditions.

■ A soil aerator, called an actisol, was also available and was tested. It uses blades to aerate the superficial horizon and to stimulate the biological activity of the soil. The blades may be tilted more or less to increase or decrease their penetration in the soil.

■ In 2013, the vibrocultivator was used strictly lengthwise in the fields, but in 2014 it was also used cross-wise because that seemed to have more impact on the water primrose.

■ The difference between a single passage during the summer and five passages, once per week over five weeks, was also tested.

■ The work started on 22 July, somewhat later than in 2013 due to the weather conditions. Approximately 20 hours were spent on preparation (organisation, installing posts) and 25 hours on the actual work (mowing, tillage, etc.).

7. Monitoring the results in October 2013.
8. The actisol soil aerator.
9. Renewed growth of water primrose in May 2014 in the area treated in 2013.
10. Renewed growth of water primrose in July 2015 in the area treated in 2014.

Table 2. Tested operations in 2014.

Code	Operation 1	Tool	Operation 2	Operation 3 (number of passages)
VIB-1pass-Length	MOWING	VIBROCULTIVATOR	Passage lengthwise	1
VIB-1pass-Cross	MOWING	VIBROCULTIVATOR	Criss-crossing	1
VIB-5pass-Length	MOWING	VIBROCULTIVATOR	Passage lengthwise	5
VIB-5pass-Cross	MOWING	VIBROCULTIVATOR	Criss-crossing	5
ACTI-1pass-0deg	MOWING	ACTISOL	Min. blade angle	1
ACTI-1pass-Xdeg	MOWING	ACTISOL	Max. blade angle	1
ACTI-5pass-0deg	MOWING	ACTISOL	Min. blade angle	5
ACTI-5pass-Xdeg	MOWING	ACTISOL	Max. blade angle	5
MOW CONTROL	MOWING	X	X	X
CONTROL	X	X	X	X

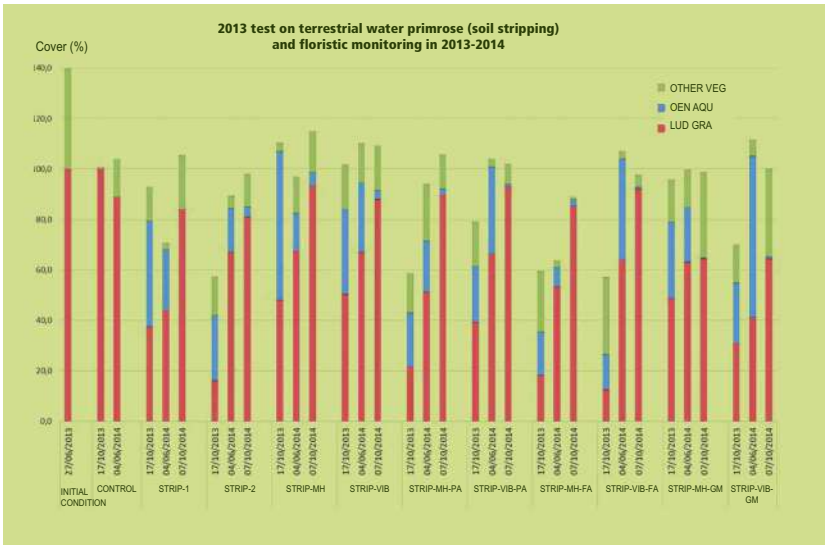
Results and costs

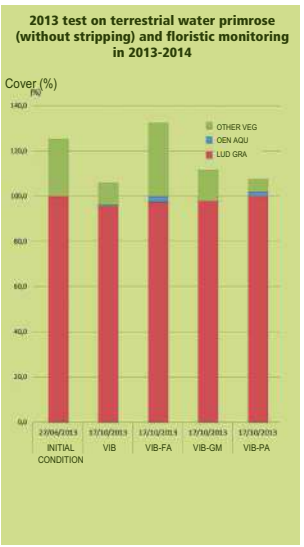
Results for 2013

The results of the experiments in 2013 were not satisfactory. Under virtually all conditions and even though some positive results were observed at the end of the growing season with a notable drop in the cover of water primrose, the species grew back strongly (cover rate > 80%) in 2014.

The only operations to produce a lower cover rate by water primrose (approximately 60%) were STRIP-MH-GM and STRIP-VIB-GM. This was because the corresponding plots were covered with hay and colonised (cover rate almost 30%) by floating sweet-grass (*Glyceria fluitans*). This species developed due to the more humid conditions created by the stripping of the topsoil, which created depressions in the field.

The stripping also had an effect on the development of fineleaf waterdropwort (*Œnanthe aquatica*) at the end of the growing season and the start of the next. The seed bank of this species would seem to have been stimulated and the more favourable hydric conditions enabled its development.



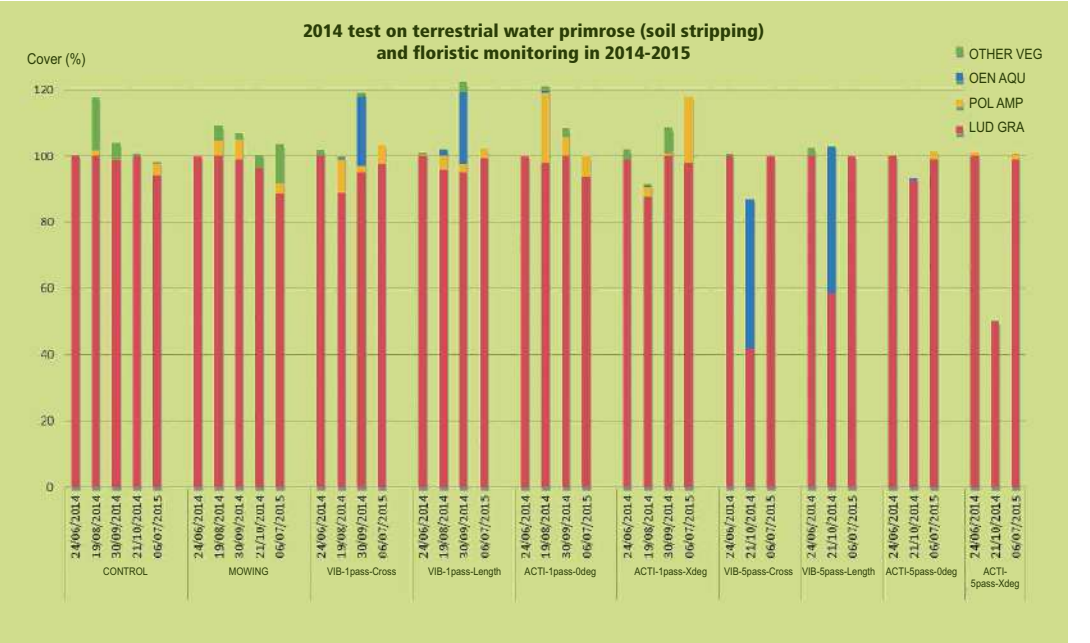


Results of the experiments in 2013.

■ Results for 2014

■ The results of the experiments in 2014 demonstrated the ineffectiveness of the various operations given that water primrose again covered over 90% of the treated areas just one year after the work.

■ The development of fineleaf waterdropwort (shown in blue in the graph) was again noted, as well as that of water knotweed (*Persicaria amphibia*) (in yellow) in the areas with only one passage of the tools.



Results of the experiments in 2014.

■ Financial aspects

Table listing the expenses incurred for the experiments (in euros, including VAT).

	2013	2014	2015*	TOTAL
Equipment and seeds	913.07	187.20	-	1 100.27
Work	1 582.46	1 749.00	-	3 331.46
Scientific monitoring	7 355.40	7 380.00	-	14 735.40
Personnel costs	1 433.60	1 183.60	215.20	2 832.40
TOTAL	11 284.53	10 499.80	215.20	21 999.53

** Drafting of the report.*

■ The costs were covered by the following organisations:

- 50% by the European INTERREG fund;
- 30% by the Loire-Bretagne Water agency;
- 20% by the Development agency for the Vilaine River basin.

Information on the project

■ These experiments were carried out in the framework of the Interreg IVa cross-Channel WOW programme and were presented in the reports filed for the programme. In that the results were not positive, no further publications were made.

Outlook

■ The lack of results in the experiments on techniques to restore the marsh land meant there was no point in pursuing the experiments. Management of terrestrial water primrose in the Isac marshes is now done strictly by adapting the water levels. Regrowth of the native vegetation in the spring is encouraged by lowering the water level earlier in the season than would be the case if there were no water primrose.

Author: Benjamin Bottner, EPTB Vilaine. June 2017.

For more information

■ Internet site presenting the European Interreg IVa cross-Channel WOW "WOrking Wetlands" programme.
http://www.eptbvilaine.fr/site/index.php/projet-wow

Water primrose

(*Ludwigia* spp.)

Testing a method to eradicate water primrose from two ponds in Acigné (Ille-et-Vilaine department)

Ecological-engineering professional federation (UPGE)

- The federation was founded in 2008 to bring together firms active in or linked to the field of ecological engineering.
- Its mission is to structure the ecological-engineering sector and to develop the market, notably by stimulating innovation and encouraging contacts between the various participants.
- The test was carried out in the framework of the compensatory measures for the high-speed train line to the Bretagne and Pays-de-la-Loire regions, constructed by Eiffage Rail Express.
- Contact: Thomas Redoulez - t.redoulez@genie-ecologique.fr

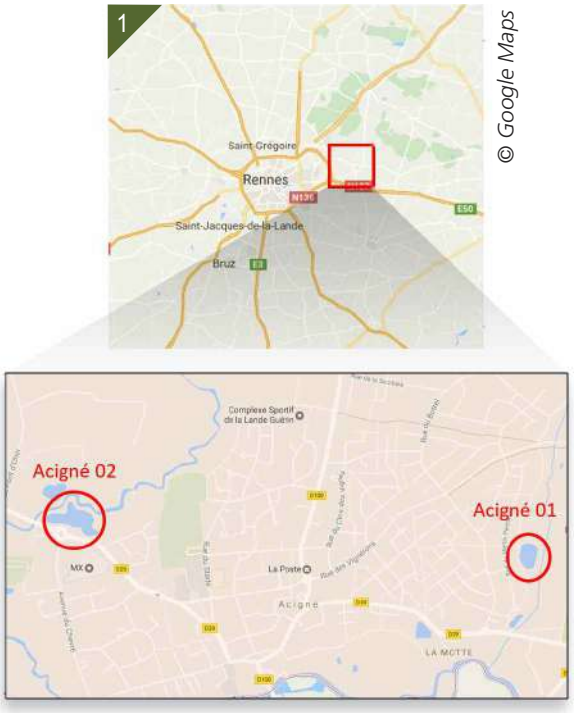
Dervenn Compensation écologique

- This firm is a subsidiary of the Dervenn company (ecological-engineering consulting, research and work), founded in 2002.
- The firm participates in projects to define the technical conditions for and implement compensatory measures, e.g. the creation of wetlands or the restoration of rivers.
- Contact: Vincent Guillemot, Head of the research department - v.guillemot@dervenn.com

Intervention site

- The work was done on two ponds colonised by large-flower water primrose (*Ludwigia grandiflora*), located in the town of Acigné, to the east of Rennes:

- a buffer pond (Acigné 01), 6 000 square metres, supplied by alluvial groundwater and by a ditch from the north draining runoff water from a housing development site. A regulation system sends excess water to the Joval Stream, located approximately 25 metres to the south-east of the pond. The Joval Stream drains a 2.6 square kilometre catchment and flows into the Vilaine River approximately 400 metres downstream of the pond;
- a pond for recreational purposes (Acigné 02), 12 500 m², intended primarily for walkers, supplied by alluvial



1. Maps showing the two ponds in the town of Acigné.
2. Aerial view of the buffer pond (Acigné 01).
3. Aerial view of the second pond (Acigné 02).

groundwater from the Chevré River, located just to the north, and by the river itself via a flap weir used to fill the pond.

■ The town of Acigné proposed these two ponds as compensatory work sites for the high-speed train line to the Bretagne and Pays-de-la-Loire regions, constructed by Eiffage Rail Express.

Disturbances and issues involved

■ The two ponds were heavily colonised by water primrose (70% in Acigné 01 and 90% for Acigné 02), a situation that limited the development of the fauna and flora on the sites.

■ Water primrose is not a major problem for human activities, even though the two ponds, particularly Acigné 02, are often used as recreational areas in the town.

Intervention

■ Meetings

■ The objective of the project was to eradicate the water primrose on the two sites.

■ An organisational meeting was held in March 2016 by the Centre to coordinate the experimentation and implementation of ecological engineering (CCEAGE) to decide on the work methods. All concerned stakeholders were present, including Eiffage Rail Express, the Eiffage sustainable-development department, the town of Acigné, the Development agency for the Vilaine River basin, Agrocampus Ouest, DDTM 35, the city of Rennes, companies (Dervenn, Ouest Aménagement, CARDIN TP) and Louis Diard, botanist, editor of *Flore d'Ille-et-Vilaine*.

■ Work procedure

■ The work was done in May and June 2016.

■ The plan foresaw six steps on each site, namely mechanical uprooting, emptying of the pond, surface removal, burial of the uprooted water primrose, filling in and planting of the site.

■ Removal (scraping the surface to remove the plants with their roots) of the accessible water primrose was done using excavators from the banks.

■ The uprooted plants were stored temporarily on the banks.

■ The ponds were then emptied in two steps:

- simple draining;
- pumping with an in-series filtering system comprising a straw filter + geotextile fabric and a ditch with a grid + geotextile fabric.

■ A bulldozer was use to dig out 30 centimetres of biomass and mud from the centre of each pond.

■ Ditches 1.5 metres deep were dug in the middle and along the ponds. The extracted plants, sediment and soil were buried in the ditches and covered with the soil removed while digging the ditches.

■ Pond Acigné 01 was partially filled with 80 cm of mineral soil and 20 cm of top soil. The banks were reworked and a channel dug to lead the water to the overflow system. The pond refilled naturally and very rapidly with 40 cm of water due to the alluvial groundwater flowing in from the bottom of the pond.

4, 5. Acigné 02 pond, prior to the work.
6. Mechanical uprooting in Acigné 02.
7. Filtering system during pumping of Acigné 02.
8, 9. Removing the surface soil in Acigné 02.

■ Pond Acigné 02 was filled in without raising the initial topographic level in order to maintain the site as a wetland, but not a pond. The fill consisted of 50 to 70 cm of mineral soil, followed by 20 cm of top soil.

■ Reed beds were planted around the two ponds and meadow grasses were also sown around pond Acigné 02. Near pond Acigné 02, the plan was to preserve the reed bed to the south-east and to remove manually the water primrose growing there, but the colonisation turned out to be too extensive and the reed bed was finally removed.

■ During the work on pond Acigné 02, a severe storm occurred when 80% of the surface area had been cleared of the water primrose. The storm dispersed plant fragments and roots that were still in the areas just cleared. Some of the fragments subsequently developed into the terrestrial form of the plants. These sprouts were systematically removed manually using hand tools (garden forks).

10. Reed bed in pond Acigné 02 (after the work).
11. Pond Acigné 02 after replanting.

Results and costs

■ Results

Table presenting project results.

	Surface area treated (square metres)	Extracted biomass (cubic metres)
Acigné 01	6 000	50
Acigné 02	12 500	150

■ Monitoring in May 2017 revealed that in pond 01, no regrowth of water primrose was found. In pond 02, a dozen sprouts were observed.

■ They were uprooted manually.

■ Costs

■ The project was funded 100% by Eiffage Rail Express in the framework of the compensatory measures. Equipment and materials represented 80% of the costs, payroll costs represented the other 20%.

■ Cost of the work:

- Acigné 01: 48 000 euros not including VAT.
- Acigné 02: 77 500 euros not including VAT.

■ The job was done by three people working full time for one month.

■ Details on the planting and monitoring costs were not available.

Information on the project

■ Before the work, a sign was set up on each site, explaining the context and the work, with instructive drawings. A second sign was installed following the work. These efforts served to provide residents with information and avoid negative reactions to the work.

■ Articles appeared in the local press.

■ Information was made available on the internet site and in the UPGE bulletin.

Outlook

- To avoid recolonisation by a patch of water primrose upstream, it is advised to work on the catchment of the Chevré River as a whole.
- The town had planned to create pools in conjunction with the natural refilling via the alluvial groundwater, however it is necessary to postpone these developments to ensure that buried fragments of water primrose are not brought to the surface. The town has agreed to wait several years and to launch the work progressively in order to avoid any regrowth of the water primrose.
- The sites will be monitored by Dervenn for two years with a visit every 15 days during the first year to manually uproot any plants and then once per month during the second year. After the second year, the town will monitor the sites, following training of the technical personnel by Dervenn.
- A citizen-science project, organised by the town in an effort to raise awareness on the part of local residents, is also planned in order to detect as early as possible any regrowth.

Authors: Vincent Guillemot, Dervenn, Thomas Redoulez, UPGE, and Doriane Blottière, IUCN French committee. January 2018.

12

12. Informational sign on the Acigné 02 site.

For more information

- Water-primrose work group - UPGE. www.genie-ecologique.fr/cceage-groupede-travail-sur-la-jussie
- Efforts against water primrose - UPGE. www.genie-ecologique.fr/le-cceage-luttecontre-la-jussie
- Techniques against water primrose – Environnement magazine. www.environnement-magazine.fr/article/48089-les-grands-moyens-contre-lajussie

2018 edition

© A. Hussner

Broadleaf watermilfoil

(Myriophyllum heterophyllum)

Classification	
Order	*Haloragidales*
Family	*Haloragaceae*
Genus	*Myriophyllum*
Species	*M. heterophyllum* (Michaux, 1803)

Originated in the South-East of the United States, introduced in Europe in the 1940s for ornamental pools and aquariums. The plant was first observed in the natural environment in France in the Adour River toward the end of the 1990s.

Description

- Stem light green in colour, often tinted dark red, with rhizomes and branches along its entire length, measuring over one metre in some cases, occasionally above the water level
- Submerged leaves, whorled in groups of four or five, deeply indented, with leaflets having generally fewer than 15 segments, 2 to 5 cm long, making them look feathery
- Emergent leaves, full, thick, pointed, whorled in groups of four to six, up to 3 cm long
- Inflorescences on the stems above water, single-sex flowers whorled in groups of four. Male flowers on the upper part of the stem, comprising four stamens and four free petals up to a few millimetres long. Female flowers on the lower part of the stem, comprising four stigmates, bright pink, curved and covered with down
- Round fruit, dark brown, approximately 1 mm long, with four joined sections. On maturing, the fruit separates into four achenes, with bulging sides and two fine lines of bumps on the dorsal side
- Confusion with other watermilfoil species is possible

Ecology and reproduction

- Amphibious plant, grows on fine sediment in stagnant or slowly-moving water (canals, lakes, ponds, ditches, former channels of rivers, etc.)
- Prefers nutrient-rich water and high luminosity. pH tolerant, but prefers acid waters. Can survive winters under ice
- Primarily vegetative multiplication in Europe, via fragmented stems and rhizomes
- Flowering from June to August, rare in France

Documentation

- Anderson, L. 2015. Pest risk analysis for *Myriophyllum heterophyllum*. European and mediterranean plant protection organization. 31 pp.
- Lebreton, A. 2013. *Myriophyllum heterophyllum* Michaux [*Haloragaceae*] en Haute-Vienne (Limousin, France), et situation de cette plante invasive en France et en Europe. EPPO Bulletin, 43(1), 180–192.
- Global Invasive Species Database (2017) Species profile: *Myriophyllum heterophyllum*. [On line]. Document available at: http://www.iucngisd.org/gisd/speciesname/Myriophyllum+heterophyllum

Author: Doriane Blottière, IUCN French committee.

1

© K. Lauber

2

© V. Levy - CBNB

3

© P. Champion

Broadleaf watermilfoil

(Myriophyllum heterophyllum)

Managing broadleaf watermilfoil on the Somme River and its canals

Somme departmental council

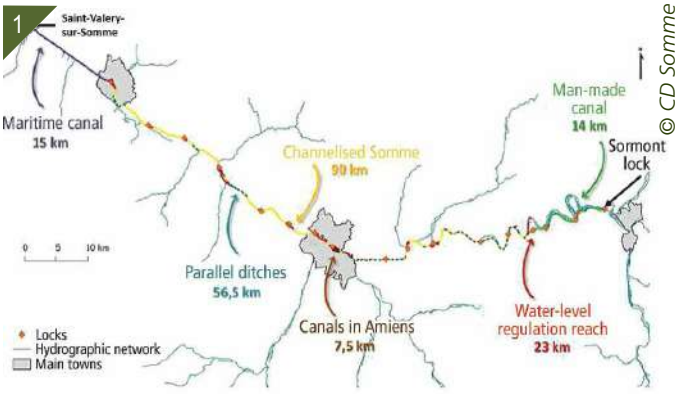
- The departmental council has been the owner and manager of the Somme River public domain since 2006. It is consequently responsible for the maintenance of canals and the management of structures and facilities (locks, dams) on the river and canals.
- In this overall framework, it also manages the invasive alien species, both animal and plant, that are detected.
- Contact: François Bury - f.bury@somme.fr

Intervention site

- The work was done on the public river domain of the Somme department. This area comprises the Somme canal, the channelised section of the Somme, plus several natural river reaches and parallel ditches. This river domain covers 720 hectares in 58 towns and includes a total of 120 km of navigable waterways.
- Since 2011, the Somme and its canals have been the site of particularly strong development of broadleaf watermilfoil (*Myriophyllum heterophyllum*).
- The management work took place on the Somme canal from just upstream of Lock no. 7 (Sormont) to a point downstream of Lock no. 25 in Saint-Valery-sur-Somme.

Disturbances and issues involved

- Broadleaf watermilfoil, due to its density and the formation of the thick mat on the water surface, is a major hindrance for fishing, water sports and boating.
- In that it blocks the growth of native submergent plants, the species represents a considerable threat for biodiversity and the ecological balance. It can reduce the reproductive success of fish by limiting access to spawning grounds.
- Finally, large quantities of broadleaf watermilfoil can alter the chemical parameters of the water by increasing the pH and reducing the quantity of dissolved oxygen.



© CD Somme

© CD Somme

© CD Somme

1. Map of the section of the Somme River public domain where the interventions took place.
2, 3. Zones colonised by broadleaf watermilfoil.

Interventions

■ Mowing (2011 to 2014)

■ From 2011 to 2014, mowing operations (cutting the stalks at a depth of approximately one metre) were regularly carried out in the spring and summer. They took place in the Breilloire reach (see the map on the next page), the first area where strong development of broadleaf watermilfoil was observed.

■ This work temporarily cleared the waterways, but did not produce a long-term solution to the development of the species due to the dispersal of plant fragments that subsequently resulted in rapid recolonisation.

■ Harrowing (2014 to 2016)

■ Experiments using a harrow were carried out in the Breilloire reach in 2014 and 2015 in view of improving the effectiveness of the management work.

■ Harrowing consists of scraping the river bed in order to uproot the plant, using a harrow mounted on an excavator. The work was done from the bank using a 22-ton excavator equipped with a 15-metre boom.

■ This technique has the advantage of removing the root system of the plant and avoiding the risk of trapping alevins when pulling the plants onto the bank, however the great weight of the machine may damage the banks, dikes and trails.

■ In 2014, 145 tons of plants were harvested from 600 square metres of river. In 2015, 710 tons of plants were harvested from 5.7 hectares.

■ The work was repeated in 2016 on the seven sites most affected by the broadleaf watermilfoil, representing a total of 14 hectares. In order to avoid damaging the dikes and the vegetation along the water courses, the excavator equipped with the harrow was installed on a barge that was positioned by a pusher-boat.

■ The plants were placed on a second barge and then stored temporarily near the point where they were harvested.

■ As a precautionary measure, nets were placed downstream of the work zone to collect any watermilfoil fragments and avoid the dissemination of the plants.

■ Meeting of the technical committee

■ Given the troublesome development of the plant, a technical committee was set up and met several times in 2015 and 2016.

■ The committee members included representatives from the following organisations:

- Somme Federation for fishing and the protection of aquatic environments;
- Picardie Conservatory for natural areas (CSNP);
- Bailleul National botanical conservatory (CBNB);
- Regional environmental directorate (DREAL), French biodiversity agency (AFB), Departmental territorial and maritime directorate and the Somme Public river-basin territorial agency (AMEVA);
- Artois-Picardie Water agency;
- Departmental council (Environmental directorate and River and maritime agency (AFM));
- Hauts-de-France Regional council.

■ Following an assessment of the work done in 2016, it was decided to continue

4. Harrowing from the bank.
5. Harrowing from a barge.
6. Nets in the canal to avoid dispersal.

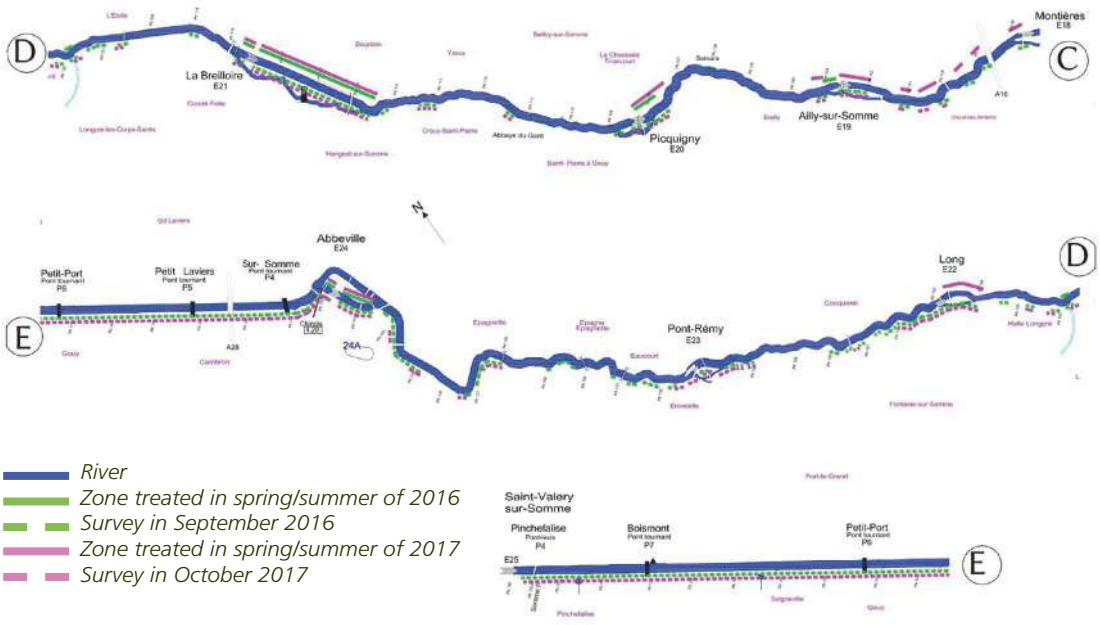
with mechanised harrowing in 2017 and to complete the work with manual uprooting on the berms of the canals in order to reduce any renewed colonisation and clear the waterways for a longer period.

- The committee was of the opinion that all the sites should be treated at some point.
- An application for this project was submitted in compliance with the applicable Water law regulations.

Inventories

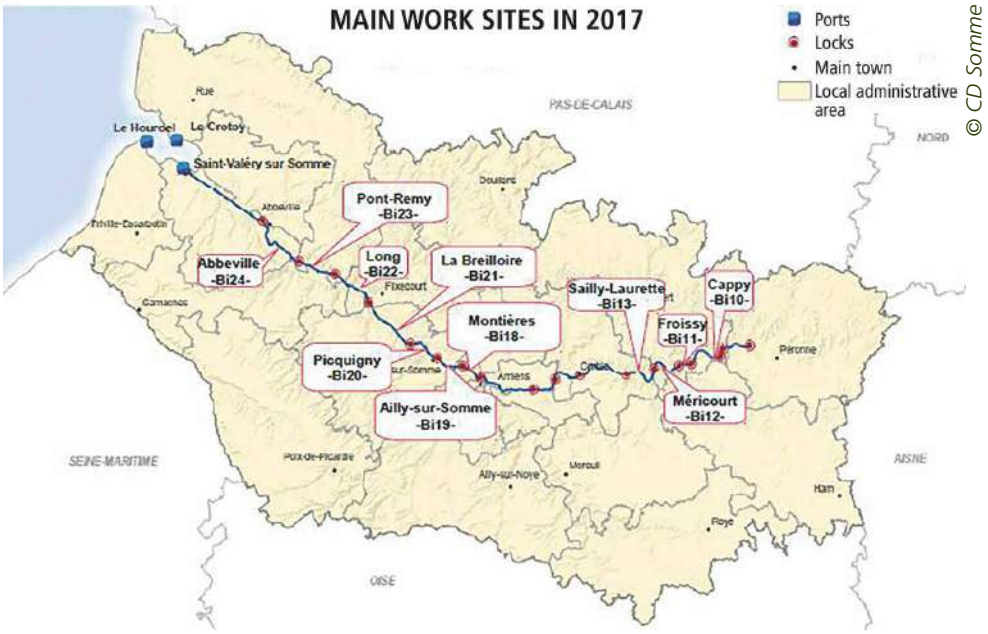
- In September and October 2016, the CBNB ran a scientific assessment to determine the distribution of broadleaf watermilfoil over the entire sector.
- Given that it was not always easy to distinguish the species from the native whorl-leaf watermilfoil (*Myriophyllum verticillatum*) using the available morphological criteria, a genetic analysis was undertaken by the Centre for molecular ecology at the University of Rennes.
- Out of a total of 98 samples, 13 corresponded to whorl-leaf watermilfoil and the rest to broadleaf watermilfoil. The two species were identified in the upstream section of the river, but only broadleaf watermilfoil was found in the downstream section. It was particularly prevalent in the immediate vicinity (upstream and downstream) of locks, where it formed large beds.
- In March 2017, prior to the start of the work, the sector was surveyed with the assistance of the CBNB to map the presence of whorl-leaf watermilfoil and ensure that it was not affected by the work, given that the species is protected.
- Nine priority sites were identified for mechanical uprooting in 2017 and eleven sites for manual uprooting.

7. Drawing a sample of watermilfoil.
8. Manual uprooting of broadleaf watermilfoil.



© CD Somme

Example of maps showing the sites of broadleaf watermilfoil in downstream sections of the Somme River.



Main work sites in 2017.

■ Harrowing and manual uprooting in 2017

■ The mechanical uprooting took place from the beginning of April to mid July and manual uprooting on the berms from the beginning of April to the end of September. Navigation was prohibited during the work.

■ The system for mechanical uprooting was the same as in 2016, i.e. the harrow was mounted on an excavator that worked from a barge. Particular care was taken in the channelised section to ensure that the excavator did not dig into the canal bottom and impact its watertightness. After harrowing, the plants were transported on a barge to a temporary site, before being sent to the storage sites.

■ During the manual work, the plants were carefully uprooted with their roots by hand or using suitable tools (hoe, spade, rake, etc.). The work progressed from upstream to downstream.

■ Nets were set downstream of the work site and any floating fragments were collected using dip nets during the uprooting work to avoid their dispersal.

■ Storage and composting

■ The harvested plants were transported to nearby storage sites where, following draining, drying and decomposition, they will be mixed with soil and used for landscaping. The planned mixture is 20% of decomposed plants and 80% soil, on the basis of a study by the SATEGE research unit (Somme department) that confirmed the percentages.

■ The remaining volume of plants will be transferred to a composting unit in the department.

■ Additional measures

■ Further measures included the installation of an anti-return flap on the interconnections with the canal and nets to prevent the dispersal of the invasive alien species downstream, as well as lowering the water level in the interconnecting water bodies.

Results and costs

Results

- Since the start of the interventions, a total of 860 000 square metres were cleared.
- However, the watermilfoil has returned to all the cleared areas, with variable recolonisation rates (see the table below).

Monitoring data on the harrowing work in 2016 and 2017 in the most heavily infested reaches.

Reach	Surface areas colonised by broadleaf watermilfoil (square metres)				Comments
	Work in spring/ summer of 2016	Survey in October 2016	Work in spring/ summer of 2017	Survey in October 2017	
Abbeville	22 400	21 400	21 500	2 500	10 to 15% of area cleared in 2017 later recolonised
La Breilloire	39 500	57 300	60 600	6 500	10 to 15% of area cleared in 2017 later recolonised
Montières	37 400	2 900	43 000	8 800	20% of area cleared in 2017 later recolonised
Froissy	19 600	6 300	37 000	34 920	95% of area cleared in 2017 later recolonised
Cappy	11 000	25 000	71 900	118 150	100% of area cleared in 2017 later recolonised

Costs

Year	Method	Surface area cleared (sq. metres)	Quantity harvested (metric tons)	Cost (€)
2011	Mowing	40 000	60	No data
2012	Mowing	105 000	195	
2013	Mowing	135 000	265	
2014	Mowing	50 000	85	
	Harrowing	600	145	
2015	Harrowing	57 120	710	78 825
2016	Harrowing	139 574	No data	211 975
	Genetic study	-	-	7 302
2017	Harrowing	312 000	No data	408 000
	Manual uprooting	20 000	No data	124 800
	Scientific monitoring	-	-	10 000
TOTAL	-	**859 294**	No data	**840 902 (2015-2017)**

- The work was done by private companies. The cost of harrowing was estimated at 1.30 euros per square metre and that of manual uprooting at 5.20 euros per square metre (before VAT in both cases).
- The work in 2016 was funded by the Artois-Picardie Water agency (80%) and by the Departmental council (20%).
- The work in 2017 was funded by the Departmental council (20%), the Artois-Picardie Water agency (47%) and by the European ERDF fund (33%).
- The genetic study in 2016 cost 7 302 euros and the scientific monitoring programme in 2017 cost 10 000 euros.

Information on the project

■ Signs were installed on the work sites to inform the public and raise awareness.
■ Articles appeared in the local press (Courrier Picard) and a sequence was shown on the regional television station France 3 Hauts-de-France, etc.

Outlook

■ A study is now under way on planting riparian vegetation along the banks, where possible, in order to create shaded zones and limit the development of the watermilfoil.
■ In that the problem exists well beyond the geographic limits of the department, coordinated efforts are required by all stakeholder in the river basin to ensure effective management of the broadleaf watermilfoil.
■ For 2018, the estimated surface area to be cleared is 363 000 square metres. Plans are now being made for the future work.

Author: Doriane Blottière, IUCN French committee. January 2018.

For more information

■ Canal de la Somme et Somme canalisée : Opération de traitement du Myriophylle hétérophylle par les techniques de l'arrachage mécanique et de l'arrachage manuel. Programme 2017. Dossier de déclaration Loi sur l'eau. Direction générale adjointe Equipement du Département, Direction de l'entretien des Infrastructures, Agence Fluviale Maritime. 125 pp.
■ Caractérisation génétique des populations de myriophylles dans le canal de la Somme. Conservatoire botanique national de Bailleul, Conseil départemental de la Somme. 34 pp.
■ Travaux d'arrachage mécanique et manuel de Myriophylle sur le domaine fluvial départemental, mémoire technique. Département de la Somme, Curages Dragages et Systèmes SAS. 69 pp.
■ Lévy, V. 2017. Premier bilan des actions menées par le Conservatoire botanique national de Bailleul dans le cadre de l'assistance scientifique à la lutte contre le Myriophylle hétérophylle engagée par l'Agence départementale fluviale et maritime de la Somme. Conservatoire botanique national de Bailleul. 8 pp.

2018 edition

© Emilie Mazaubert

Groundsel bush

(Baccharis halimifolia)

Classification	
Order	Astérales
Family	*Asteraceae*
Genus	*Baccharis*
Species	*B. halimifolia* (Linnaeus, 1753)

Originated in North America. Introduced as an ornamental plant in France in 1653. It was mentioned for the first time in the natural environment of the Bretagne region in 1915.

Descriptif

- Vertical trunk with many branches, up to 16 centimetres in diameter
- Smooth, vertical stalks, many branches
- Alternating leaves, deciduous but lasting until late in the fall:
- length 2 to 6 cm, width 1 to 4 cm
- wide, indented leaves near the base of stalks, single, narrow leaves with smooth edges near the flowers
- Flower heads (capitula) comprising 1 to 5 white flowers:
- wide (3 mm) male flowers
- narrower female flowers
- Fruit (on female plants) are achenes with a coma (filament-like hairs), 8 to 12 mm long
- Highly developed root system

Ecology and reproduction

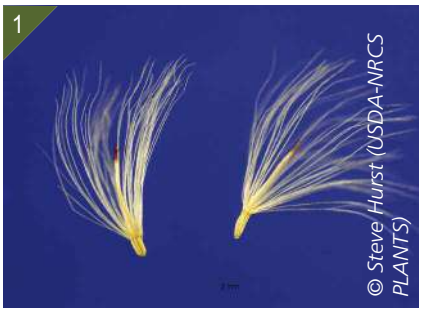
- The species can develop on different types of wetlands along coasts:
- wet meadows, marshes and dunes, reed beds
- roadsides, canals, idle land, hedges
- It can resist dry conditions, cold weather and salt
- Sexual reproduction by the female plant that can produce up to a million seeds that are easily dispersed over long distances by the wind

Documentation

- Hudin S., Vahrameev P. (coord.) 2010. Guide d'identification des plantes exotiques envahissant les milieux aquatiques et les berges du bassin Loire-Bretagne. Fédération des conservatoires d'espaces naturels, 45 pp.
- Fried G. 2012. Guide des plantes invasives. Belin, Paris, 272 pp.

Author: Emmanuelle Sarat, IUCN French committee

1



© Steve Hurst (USDA-NRCS PLANTS)

2

© Jean-Jacques Milan

3

© Marie-Catherine Chaumet

4

© Emilie Mazaubert

Groundsel bush

(*Baccharis halimifolia*)

Controlling groundsel bushes on the Ria d'Etel Natura 2000 site (Morbihan department)

Ria d'Etel management boardl

■ The Ria d'Etel management board (SMRE), founded in 2007, addresses problems dealing with water quality and natural environments in the 18 towns located in the basin of the Ria d'Etel (Etel River).

■ The objectives of SMRE are to:

- preserve water quality in the river basin;
- manage and protect aquatic environments (Aquatic-environment territorial contract);
- develop the potential for commercial fishing;
- promote activities in the littoral zones via a plan for the integrated management of coastal areas (GIZC);
- manage the natural environments, including the Ria d'Etel Natura 2000 site, two sensitive natural areas (SNA) in the department and a site owned by the Seaside and Lake Conservation Trust.

■ Contact: Charlotte Izard, policy officer for biodiversity and Natura 2000 - charlotte.izard@ria-etel.com

Intervention site

■ SMRE is the local operator for the Ria d'Etel Natura 2000 site (FR5300028, Morbihan department). The site covers a total of 4 259 hectares in ten towns along the Ria d'Etel.

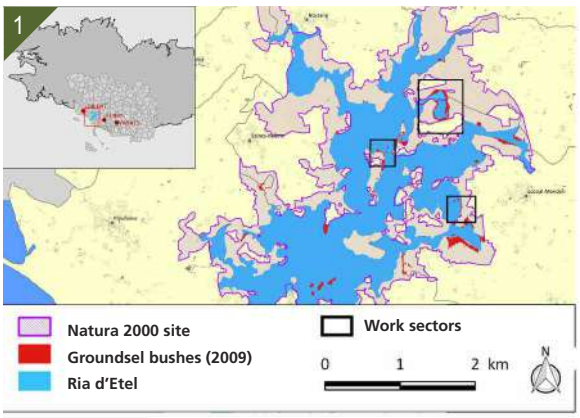
■ The Ria d'Etel is an inlet that penetrates 15 kilometres inland.

■ The area is a true patchwork of natural environments created by the diversity and nesting of marine, littoral and terrestrial habitats.

■ The site was designated by the Habitats directive as an important area in terms of restoration and management issues for the main EU-listed habitats identified, namely heathlands, salt meadows, wet meadows and marine environments. It is also home to an array of remarkable animal species whose habitats must be preserved, including the European otter, bats (Barbastelle, greater mouse-eared bat, Bechstein's bat), butterflies (marsh fritillary), etc.

Disturbances and issues involved

■ The document listing objectives for the Ria d'Etel Natura 2000 site, approved in 2012, mentions management of invasive alien species, including groundsel bushes, as one of the priority conservation issues for the EU-listed habitats. Groundsel bushes are present in all of the towns comprising the site with highly variable colonised surface areas ranging from a few plants to large and dense thickets.



© SMRE

1. Study site and main work sectors

■ *Baccharis halimifolia* colonises the EU-listed salt meadows, disturbing their ecosystem functions and contributing to the closing in and the uniform appearance of landscapes.

■ The salt meadows are home to a very special fauna and flora. They play important roles for birds and fish (rest, feeding and spawning areas, etc.) and are a vital link in the production of organic matter. They are biotopes with an exceptionally high level of primary production (20 to 40 tonnes of organic matter per hectare per year, compared to 10 to 13 tonnes for a maize field). Most of the produced matter is decomposed on site by bacteria and small invertebrates, on which a number of species depend.

■ These environments are also used directly or indirectly for a wide range of activities, including hunting, hiking, mariculture (primary production), picking shellfish, angling (the site is a growth area for juveniles), etc.

Interventions

■ Objective of the interventions

■ Major sections of the Atlantic and Mediterranean coasts in continental France are already colonised by groundsel bushes. The point here was not to eradicate the species along the Ria d'Etel, but rather to limit its development and avoid colonisation of any new sections of salt meadows.

One of the most heavily infested towns is Locoal-Mendon. Since 2010, in a partnership with the town, SMRE has tested various management methods, including work by volunteer groups.

Discussions with other stakeholders and partners

A large number of stakeholders were involved, including elected officials, hunters, hiking groups, schools (agricultural high school), environmental-protection groups, Agenda21 group, etc.

Description of the techniques tested

	Grazing by sheep
Method	Extensive grazing of salt meadows (that may be fenced). Two grazing periods, spring and end-of-summer/fall, over three years. Passage of a rotary cutter each year by the land owner prior to the spring grazing period. Use of rustic sheep.
Prerequisites	A contract was signed for a period of three years with the Association for the management of natural areas by grazing (GEPEN), that provided the sheep to graze the groundsel bushes. A three-year contract was also signed with the owner of the private property to be grazed. According to the contract, SMRE was obliged to provide the necessary material for the sheep (the fence). The owner of the land undertook to pass the rotary cutter once each year, to provide free access to the land and not to destroy the natural environments.
Equipment	Fences for the sheep (Ursus® wire fencing and chestnut-wood stakes).
Animals	Two to four sheep (the area to be grazed is approximately 6 000 square metres).
Grazing periods and duration	2010 to 2012: - 30 days of grazing in the spring of 2010, - 36 days in the fall of 2010, - 56 days of grazing in the spring of 2011, - 35 days in the fall of 2011. In 2012, it was decided to increase the grazing pressure with a single grazing period from April to the end of the fall. At the end of that time, the owner kept the sheep and the area has been continuously grazed since.
Monitoring	The area was photographed before and after each grazing period. N.B. Monitoring prior to grazing did not always take place prior to the passage of the rotary cutter.

	Work by volunteer groups
Method	Thickets of adult groundsel bushes (approximately two metres tall) were uprooted by a specialised company using a mini-excavator. The bushes were burned on site, in a predetermined area, following a special authorisation by the prefecture of the Morbihan department. Currently, no use for the bushes has been found (a study on grinding the bushes has not produced any solutions).
Prerequisites	Metal plates must be placed on the ground to protect the salt meadow from the tracks of the excavator. In that the salt meadows are listed in the land register, the prior consent of the land owner is required (signed contracts).
Equipment	A mini-excavator on rubber tracks and equipped with a bucket. The smallest bushes around the thickets were uprooted by hand.
Work periods and duration	The excavator was used over two periods (one person on the excavator and two others for manual uprooting), the first spanned three days in June 2010 and the second five days in June 2011.
Monitoring	Photographic monitoring before and after the work.

2. Salt meadows colonised by groundsel bushes.
3. Volunteers during uprooting work.
4. 5. Grazing by sheep.
6. Mechanical uprooting.

	Work by volunteer groups
Method	■ Manual uprooting of groundsel bushes ranging from a few centimetres to over two metres tall. ■ Since 2010, in the town of Locoal-Mendon: - there have been, on average, two half-day work sessions each year between December and April involving local volunteers, - at least one work session lasting a full day, each year, with students in a "Nature management and protection" course, - a work session with personnel from the technical department. ■ A number of one-off projects involving volunteers have been organised in other towns in the Natura 2000 zone (Belz, Plouhinec, Nostang, Sainte-Hélène), notably in a partnership with groups that manage hiking trails. ■ In 2015, it became necessary to relaunch the programme given the growing lack of interest on the part of the group of volunteers. A partnership now exists with the Al Terre Breizh association, a regional group specialised in organising projects for ecovolunteers lasting several days. The intent is to ensure the future of the project in a long-term sustainable-development programme . ■ To make the work more agreeable, the town offers volunteers a welcome party.
Prerequisites	■ For the half-day sessions, the town is in charge of organising the work and participants must sign in at the start of the work in order to be covered in the event of an accident.
Equipment	■ During the initial work sessions in 2010, no special equipment was used. The participants brought their own equipment, including gloves, pickaxes and spades. ■ Subsequently, the town and the technical personnel provided tools (pickaxes, branch cutters, etc.) and a dump truck to transport the waste to an incineration unit. ■ Starting in 2012, the town of Locmariaquer lent a tripod with telescopic legs and a chain hoist (one tonne lifting capacity). ■ Then in 2013, the Ria d'Etel intermunicipal association purchased the same equipment (tripod and hoist) and made it available to the management board. ■ In 2015, a special tool was invented by Daniel Lasne (town of Séné), the "baccharache" (groundsel ripper), a heavy-duty garden fork with a special leverage function. Six "baccharaches" were made available to volunteers during an ecovolunteer work session. ■ During the same session, an "animal power" firm (Tout en traction: http://touten-traction.jimdo.com/) demonstrated an uprooting technique using horses.
Work periods and duration	■ In the town of Locoal-Mendon: - one to two half-day sessions each year since 2010, - two days with students in 2014, - two consecutive days in 2015. ■ Other towns: - a project in the town of Belz lasting two and a half days with 20 participants, - a project in the town of Plouhinec with the members of a group that manages hiking trails (a day and a half with 20 participants), - monitoring in the field by the group managing hiking trails in the town of Nostang. Members detect and work (uproot or cut) on groundsel bushes during their weekly sessions, - a session on recognising groundsel bushes and operating the tripod and chain hoist was organised with the group managing hiking trails in the town of Sainte-Hélène (a day and a half with five participants).
Monitoring	■ Photographic monitoring. ■ Since 2014, the number of uprooted bushes has been counted during each session. This technique was proposed by the students in the "Nature management and protection" course at the Kerplouz high school (Morbihan department) in the framework of a study project. In a specific area, divided into 10 m x 10 m squares, each bush was counted. During a later session, the number of bushes counted in each square prior to uprooting was compared with the number after uprooting in order to validate the counting method. Consequently, only the uprooted plants need to be counted. This method requires that a person be designated as the "counter" (who can operate over the entire work site) and that all the participants be informed of the need to carry the uprooted bushes to a collection point where they are counted.

7. Metal plates used to protect the salt meadow when machines are used to mechanically uproot the bushes.
8. 9. Uprooting by volunteers.
10. A tripod with telescopic legs, equipped with a chain hoist.

Results and assessment

■ Results and assessment of grazing by sheep

■ The results were not satisfactory due to the insufficient grazing pressure exerted over periods that were too short. Permanent grazing produced better results. At the end of the project, the land owner purchased the two sheep from the association and kept them on the land (a donkey joined them in 2012). There are no longer any groundsel bushes on that land.

■ The mechanical cutting (mulching machine) by the land owner was very important. It held the colonisation at a low level and provided the sheep with new shoots (greater palatability) instead of the branches from the previous year.

■ Cost (before VAT):

- supply and installation of the fence using chestnut stakes every 2.5 metres and Ursus® wire fencing, 1.2 metres tall, 9.8 euros per linear metre, for a total cost of 4 454 euros including VAT;
- participation in managing the sheep, 450 euros (250 euros the first year and 100 euros the following two years;
- use of a rotary cutter by a farmer (approximately two hours), covered by the land owner;
- total 4 904 euros (the fence was by far the greatest expense).

■ Human resources:

- one policy officer to set up the project (find a favourable site, discuss with the land owner, set up the contracts, etc.), five days;
- project monitoring (photographic monitoring, arrival and departure of the sheep, communication, discussions with the land owner, etc.), two days per year;
- keeping an eye on the sheep and providing water was handled by the land owner.

■ Funding was made available through compensatory measures (preservation of biodiversity) by the Ria d'Etel intermunicipal association.

■ On the whole, grazing would not appear to be a particularly suitable technique for managing groundsel bushes along the Ria d'Etel:

- the proportion of fenced salt meadows is too low compared to the total surface area of salt meadows along the Ria d'Etel;
- it is difficult to find a large enough number of sheep (no sheep farms are located near by and not all types of sheep are suitable);
- grazing on salt meadows is not compatible with shellfish production in the near vicinity due to health considerations (risks of bacteriological contamination);
- the salt meadows are damaged if the grazing pressure is too high (excessive stocking rate or excessive durations). For example, salt bushes (*Atriplex* spp.) are sensitive to trampling;
- however, the technique may be useful in impounded marsh zones (see the Séné nature reserve).

■ Results and assessment of mechanical uprooting

■ The uprooted bushes were not counted following the work. The company was asked to remove all the bushes in three thickets (approximately 250 bushes).

■ Cost (before VAT):

- mechanical uprooting, 500 euros per day (this included the mini-excavator and the driver);
- manual uprooting, 200 euros per day for two people;
- a lump sum for burning of 600 euros;
- total 8 492 euros.

■ The human resources were provided by the company and included mechanical uprooting over eight days (three in 2010 and five in 2011) by one person and manual uprooting over six days (one day in 2010 and five in 2011) by two people.

11. Manual uprooting using the "baccharache" tool.
12. Demonstration of uprooting of groundsel bushes using a horse.
13. Regrowth of a groundsel bush that was grazed by sheep.
14. Manual removal of small groundsel bushes.

■ Funding was made available through compensatory measures (preservation of biodiversity) by the Ria d'Etel intermunicipal association.

■ Mechanical uprooting is effective and fast, but:

- this technique creates an area of bare ground that is very favourable for sprouting of new groundsel bushes, which means that work to remove the young plants must be conducted within the following two years. The removal of the sprouts is very fastidious work;
- the roots of the bushes are easily broken by the machine, leading to a high risk of new sprouts at a later time.

■ Results and assessment of uprooting by volunteers

■ Breakdown of the participation:

- 101 participations (four half days) by 53 volunteers (some participated in two or three sessions);
- 60% of the participants were from the town of Locoal-Mendon and approximately 15% from nearby towns;
- 118 students (three work projects with one day in 2012, two in 2014 and one in 2016);
- eight employees from the technical department;
- 15 ecovolunteers from the surrounding area, but also from the Finistère department, the town of Angers, the Paris region, etc.;
- 20 participants for one day via a partnership with a social reintegration association.

■ Results of uprooting:

- two priority sectors were determined on the basis of three criteria, namely 1) the colonisation by groundsel bushes was deemed controllable, 2) the presence of a plant species on the regional red list of vascular plants in Brittany, the *Troscart de Barrelier* (*Triglochin barrelieri*), and 3) landscapes characteristic of the Ria d'Etel;
- prior to 2014, the bushes were not counted. The quantity of uprooted bushes in cubic metres (based on the number of times the dump truck was filled) was very roughly estimated at 50 cubic metres over six half-days;
- starting in 2014, the number of uprooted bushes was counted. This turned out to be highly motivating for the volunteers and a source of valuable information for elected officials and citizens;
- 12 February 2014, 65 students and 2 688 bushes uprooted;
- 26 March 2014, 40 students and 2 655 bushes uprooted;
- 12 and 13 September 2015, 15 ecovolunteers and 3 organisers, 3 101 bushes uprooted.

■ Cost (before VAT):

- the costs of the small volunteer sessions were limited to those of the policy officer for one day in preparing the work (communication, coordination, etc.) and a half-day of presence on the site;
- the ecovolunteer project cost 6 000 euros, including food, logistics, fund raising and locating the volunteers.

■ Human resources included a policy officer (manager) and two session organisers (from the Al terre Breizh association).

■ Funding:

- organisational tasks were provided in the framework of the Natura 2000 programme (quantities depended on the year, 3-5 days in 2015 including the two days for the ecovolunteer project);
- for the ecovolunteer project, the town contributed 1 000 euros, the volunteers 40 euros each (including 10 euros of membership fees), and the *Nature et Découverte* foundation and the Nicolas-Hulot foundation contributed 3 000 euros.

15. Groundsel bushes sprouting after uprooting.
16. 17. Uprooting of groundsel bushes using the telescopic tripod and chain hoist.
18. Removal of the waste to an incineration unit using a dump truck.

■ The partnership with the Al Terre Breizh association was positive in that it:
- provided greater security in terms of liabilities (the association took out special insurance for the participants in the work sessions);
- facilitated the recruiting of volunteers through its connections in numerous non-profit networks;
- made the project a true event with a public meeting a few days before the start of the work, intense communication before and during the work with a press conference, etc.

19. Manual uprooting by volunteers.

Information on the project

■ Articles were published in the press.
■ Articles were published in municipal bulletins.
■ A public meeting was held (with articles in the press).
■ Videos were produced (one amateur and one for the local television station Tébésud):
- http://ria-etel.n2000.fr/actualites/video-retour-sur-le-chantier-de-benevoles
- http://www.tebesud.bzh/?mode=numEmission&idFicheMere=74824&id=88928

Outlook

■ The ecovolunteer project stimulated the local stakeholders:
- groups that manage hiking trails proposed to devote one or two half-days each year to managing groundsel bushes;
- new partners have shown interest in setting up work sessions. A project is now under way with an association that assists welfare recipients.
■ In 2016, the partnership between the associations, town and board will be renewed and expanded to include other towns in order to organise a session lasting several days.

Author: Charlotte Izard, Ria d'Etel management board. July 2016.

For more information

■ Internet site of the Ria d'Etel Natura 2000 site: http://ria-etel.n2000.fr/

2018 edition

Groundsel bush

(Baccharis halimifolia)

Managing groundsel bushes in the Grande Brière Mottière marshes

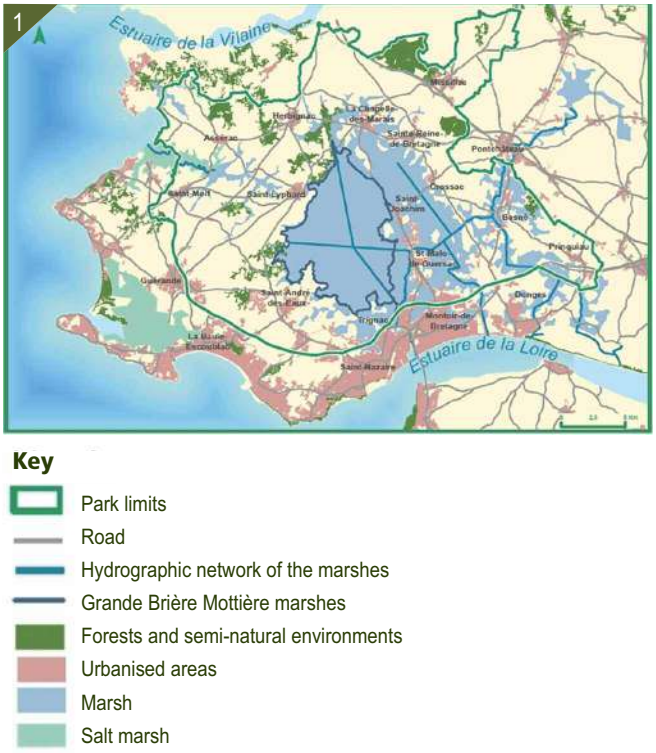
Brière regional nature park

■ The park, initiated by the Ecology ministry in 1970, is managed by a board with members from the 20 towns in the park, from the two "gateway towns" (Nantes and Pornichet), the Loire-Atlantique department, the Pays de la Loire region, the Grande Brière Mottière commission (CSGBM) and the board for the Brivet river basin (SBVB).

■ Its main missions include:

- protecting the natural heritage, notably through suitable management of the natural environment and landscapes (marshes, wet meadows, reed beds, canals, etc.);
- contributing to territorial planning;
- contributing to economic, social and cultural development and to the quality of life;
- welcoming, educating and informing the public;
- carrying out experiments or outstanding projects in the fields mentioned above and contributing to research programmes.

■ Contact: Jean-Patrice Damien, scientific officer - jp.damien@parc-naturel-briere.fr



© PNR Brière

1. The Brière regional nature park and the different sectors.

Intervention site

■ The Brière regional nature park covers a total of 55 000 hectares, of which approximately one-third are wetlands listed as a Ramsar site (18 250 hectares).

■ In conjunction with the Donges marshes, the Brière park is also listed as Natura 2000 and ZNIEFF sites. The park is home to numerous emblematic species (Eurasian bittern, black terns, bluethroats, European otters, etc.) and remarkable flora, notably in the amphibious grasslands and the oligotrophic meadows.

■ In the middle of the park, the Grande Brière Mottière marshes (a joint property) cover 7 000 hectares.

■ The groundsel bushes were introduced in 1915 as ornamental plants on the Guérande peninsula and then spread widely throughout the Guérande salt marshes (the female plants can produce up to one million seeds that are easily dispersed by the wind).

■ In the Grande Brière Mottière marshes, a small number of groundsel bushes were observed prior to 2000, but the number grew considerably starting in 2005 (124 bushes inventoried in 2005, over one thousand in 2006 and 2007).

■ The sites are located on mounds, e.g. areas where work had been done (soil from cleared areas, landfill, etc.), but rarely on farmed, natural elevations.

■ In most places, the bushes are isolated and dispersed, however, in some spots (probably the first sites colonised) the plants form groups of 5 to 36 bushes.

■ The CSGBM commission, with the support of the park board, decided in 2007 to take action against the development and to destroy the existing bushes, on the basis of the precautionary principle given the highly invasive nature of the species and its potential negative impacts on biodiversity.

Disturbances and issues involved

■ The ecological impacts concern the closing in of the environment with the loss of native plant species and degradation of nesting sites for Charadriiform birds (pied avocet [*Recurvirostra avocetta*], black-tailed godwit [*Limosa limosa*], northern lapwing [*Vanellus vanellus*]).

■ The impacts on land use and activities concern more uniform landscapes, a drop in aesthetic value (in a tourist area) and limited access to certain sites.

Interventions

■ Since 2007, the CSGBM commission and the regional nature park have worked together to combat the invasive alien species. The CSGBM funds and executes the work to eliminate the plants, the regional nature park sets up the work programme, monitors the plants and the work, participates in the work and supplies boats. The Loire-Atlantique departmental federation of pest-control groups (FDGDON) was commissioned in 2007 to kill the stumps, the only year in which this technique was used.

■ Groundsel bushes are one of the species targeted by the list of invasive alien aquatic plants revised each year since 1999 by the regional nature park.

■ The purpose of the work is to significantly reduce its presence in the Grande Brière Mottière marshes and if possible to eliminate it.

■ Two different processes were used, depending on the size of the bushes:

- young plants (10 cm to 1.5 metres in height) were manually uprooted with the removal of the entire plant, taking care to avoid breaking roots in order to avoid regrowth, including the soil surrounding the roots;
- bushes over 1.5 metres in height were cut off at the foot and the stump was killed by applying ammonium sulphamate (Attilex) in the fall, when the sap was flowing down (this product is now prohibited in the EU).

■ The uprooted bushes were initially left on site to avoid dispersing the seeds and were then incinerated during the winter. During the first few years, incineration took place on site because of the large volumes and the need to avoid dispersal. Subsequently, the groundsel bushes were stored along the edges of the wetlands and then sent to a civic amenity site.

■ In 2007, the work took place over three periods, in February, during the summer (May to June) and in the fall (end of October and beginning of November). That was a test year used to acquire the technical know-how and to determine the feasibility and effectiveness of the method.

■ The following years, the work was done over a single period, generally in parallel with the work on water primrose in order to take advantage of the joint resources in terms of logistics, funding and human resources. The work is easier at the end of summer and beginning of fall when the bushes are still green and easy to identify.

2. Groundsel bushes along the Brière canal.
3. Groundsel seeds on the ground.
4. 5. 6. Manual uprooting of young plants.

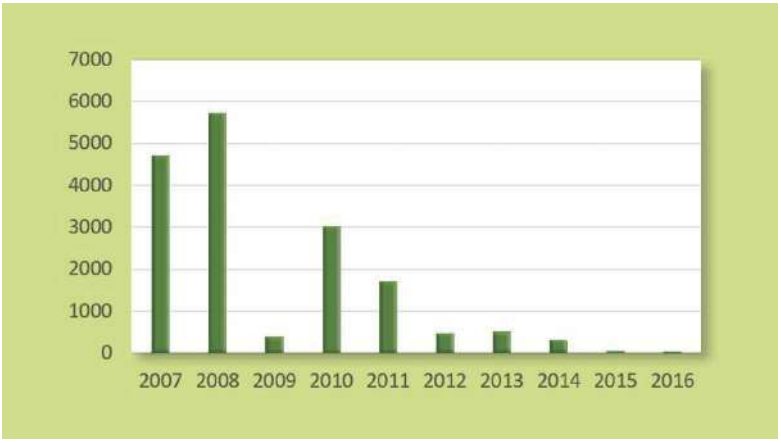
Results and costs

Results

In 2007, 4 372 bushes were uprooted and 324 stumps were killed, for a total of 4 696 eliminated bushes (99.7% of the inventoried plants). That year represented a major effort using the two elimination techniques.

Since 2008, given that no older bushes existed, groundsel bushes have been removed exclusively by hand.

There has been a clear reduction in groundsel numbers over the years, confirming the undeniable effectiveness of the work in the Brière regional nature park.



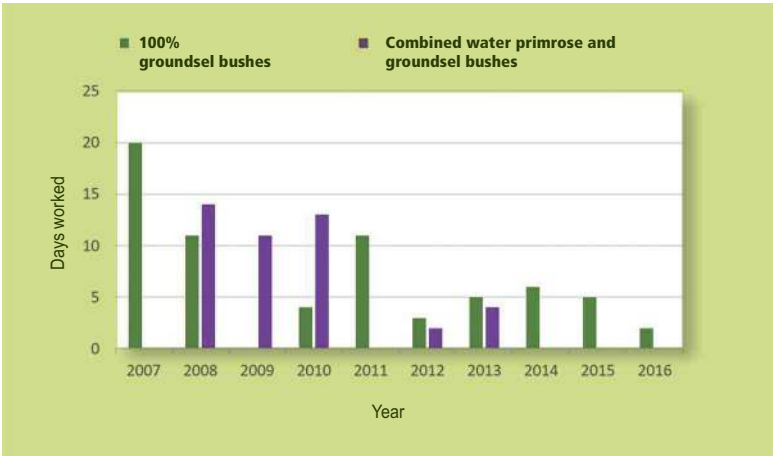
Number of groundsel bushes eliminated each year since 2007.

Assessment

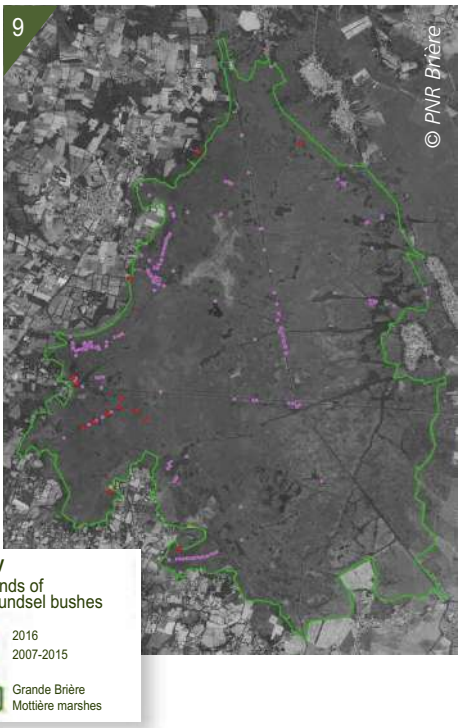
Given that part of the work on groundsel bushes was carried out in conjunction with the work on water primrose, it is difficult to precisely determine the amount of time spent on each species. However, over the past four years, most of the work on groundsel bushes took place during days addressing that species alone.

Over that period, the plant has become much less common, but the time required to find it and to travel to the sites has resulted in relative stability in the costs, in spite of the reduced numbers of plants eliminated.

Funding is provided by the Loire-Atlantique departmental council, the Loire-Bretagne Water agency and by the CSGBM commission itself.



Days worked on managing groundsel bushes and water primrose.



7. Killing a freshly cut stump.
8. Stumps one year after being cut and killed.
9. Map of Baccharis hamifolia *stands in the Grande Brière Mottière marshes, (2007/2008 in purple, 2016 in red).*

Work done on groundsel bushes from 2007 to 2016.

Year	Bushes eliminated	Personnel involved	Days worked	Work periods	Estimated cost (€)
2007	4 696	3 to 8	20	February + May/June + October/November	6 130
2008	5 731	2 to 9	25	August to November	6 000
2009	395	4	11	September/October	1 000
2010	3 027	4 to 9	17	May to October	3 700
2011	1 728	2	11	August and October	2 400
2012	469	3 to 12	5	July to September	1 500
2013	524	2 to 12	9	June to August + December	2 200
2014	310	3	6	September	2 000
2015	50	3	5	October	1 600
2016	28	2	2	October	450
TOTAL	16 958		111		26 980

Information on the project

■ Little information was produced concerning the work on groundsel bushes because the work on water primrose was considered more important. However, the work on groundsel bushes was regularly mentioned in the various documents sent to the local management entities.

■ The work was the topic of a presentation to the regional symposium on invasive plants in the Pays de la Loire region in May 2011, titled « Le baccharis du littoral aux marais de Brière, le point sur douze années de lutte » (Della Valle and Damien, 2011).

Outlook

■ Systematic inspection visits are carried out on the formerly colonised sites and the surrounding areas, and the annual work to uproot the plants continues.

Authors: Doriane Blottière, IUCN French committee, and Jean-Patrice Damien, Brière regional nature park.
June 2017

For more information

■ Della Valle P. et Damien JP. 2011. Le Baccharis du littoral aux marais de Brière, le point sur douze années de lutte. Parc naturel régional de Brière. Presentation to the regional symposium on invasive plants in the Pays de la Loire region in May 2011. 22 pp.

■ http://www.pays-de-la-loire.developpementdurable.gouv.fr/IMG/pdf/Gestion_du_Baccharis-Della_Valle_et_Damien.pdf

■ Internet pages of the Brière regional nature park on invasive alien species: http://www.parc-naturel-briere.com/le-sespeces-invasives-en-briere.html

2018 edition

Groundsel bush

(Baccharis halimifolia)

Experiment in managing groundsel bushes using sheep in the Rostu marshes

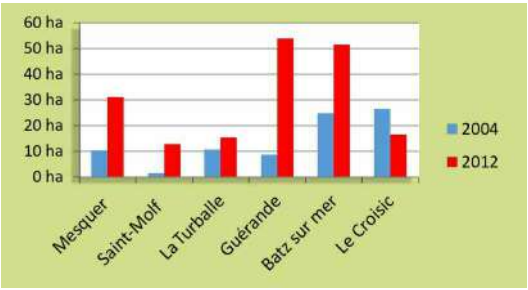
(Mesquer, Loire-Atlantique department)

The Collectif Anti-baccharis (CAB)

- This anti-groundsel non-profit federates environmental-protection associations on the Atlantic coast in their efforts against the development of groundsel bushes.
- The objective is to prepare and undertake all work to reduce the surface areas colonised by the plant (management of work sites, awareness raising, etc.).
- The “Amis des sites de Mesquer” association, a member of CAB, decided to experiment with grazing animals as a management technique.
- Contact: Patrice Pervez, president of CAB and of the “Amis des sites de Mesquer” - patrice.pervez@free.fr

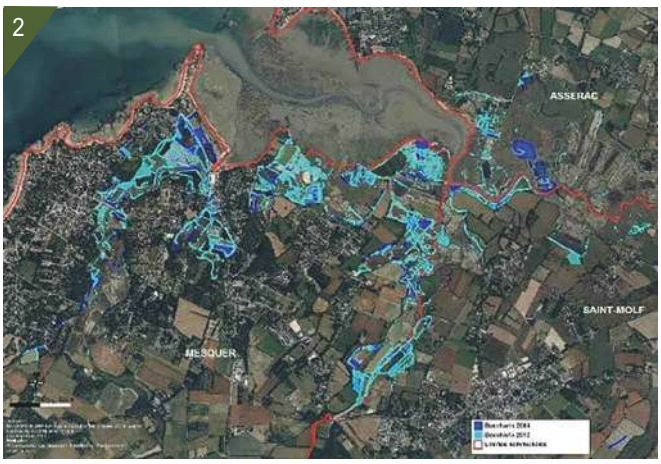
Intervention site

- The experiment was run in the town of Mesquer (Loire-Atlantique department), on the Rostu Marshes Natura 2000 site (FR1100315), that belongs to the Seaside and Lake Conservation Trust, and in the salt ponds operated by the Duchesse salt company. The vegetation of these sites is typical of salt marshes and numerous species of birds live there (little egrets, terns, avocets, stilts, etc.).
- The sites are managed by the Cap Atlantique intermunicipal board in view of maintaining the traditional activities (salt production, oysters), preserving sensitive habitats, encouraging the presence of birds and opening the site to the public.
- Groundsel bushes were first introduced as ornamental plants in 1915 and have developed rapidly over the past few years on the Guérande peninsula. In the town of Mesquer, surface areas colonised by the plant increased from ten hectares in 2004 to over 30 ha in 2008.



Surface areas colonised by groundsel bushes on the Guérande peninsula (source: Cap Atlantique).

© Collectif Anti-baccharis



© Collectif Anti-baccharis

1. Grazing sites (red dots).
2. Spread of groundsel bushes. Presence in 2004 = dark blue, presence in 2008 = light blue.

Disturbances and issues involved

- The species has a major impact on the ecosystem. The embankments of the marshes have been invaded by groundsel bushes several metres high, forming hedgerows, blocking air and light, hindering the development of herbaceous plants and locally reducing biodiversity.

The hedgerows are a significant problem for salt production. By blocking the wind, an essential factor in the production process, they reduce evaporation in the salt ponds and thus hinder production. Extensive maintenance work is required each year to cut and remove the new growth.

Interventions

History

Each year, the local governments organised work projects to cut the plants in an effort to limit their spread. Unfortunately, the techniques used (brush cutters and shears) were ineffective because the plants grew back the next year and continued to spread.

In 2015, two non-profits, the Hiboux du Mès (salt producers) and the Amis des sites de Mesquer, in conjunction with the manager of the Cap Atlantic Natura 2000 sites and the town of Mesquer, decided to run a trial using sheep to curb the growth of the groundsel bushes.

They convinced a former sheep farmer to restart his business and to let the sheep graze on the marsh embankments that the group put at his disposal.

Some 30 Vendean ewe lambs were set out to pasture on 21 hectares in the Rostu marshes. The farmer was pleased to note the high palatability of the groundsel bushes and satisfactory growth rates for the lambs. Plant toxicity was not an issue.

The positive results of the first year led to a prolongation of the operation in 2016. An agreement was signed with the farmer, whereby he noted the size of each lot, the number of animals grazing the lot and the dates of their arrival and departure.

Monitoring the groundsel-bush population

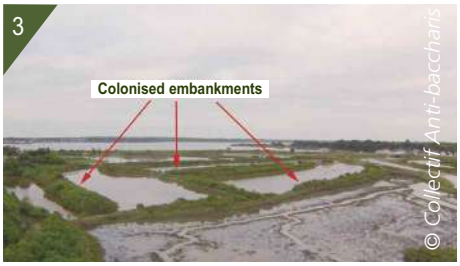
Plant-counting zones for population monitoring were set up in conjunction with Cap Atlantique and their GPS coordinates were noted. The monitoring campaign covered a non-grazed zone near the Pigneux salt pond, where groundsel bushes had been cut in 2014, and the grazed zones near the Kervarin marsh and the Duchesse salt pond.

The plants were counted on circular plots, 10 square metres in size, around a spike of steel rebar with a golf ball on top to assist in finding it. A nylon cord, 1.78 metres in length with a loop at each end, was used to determine the circle perimeter.

While turning around the stake, the plants were counted along the cord, differentiating between the sizes of plants (sprouts, < 50 cm, > 50 cm). A second observer noted the data called out by the observer counting the plants.

The initial counting campaigns were carried out during the summer of 2015.

Twelve counting plots were established, but in October 2016, only seven still existed due to earthwork on the embankments and the removal of the stakes.



3. Marsh colonised by groundsel bushes.
4. Sheep grazing in the marshes.
5. Counting groundsel bushes.

Results and costs

Results

In 2016, 113 sheep grazed a total of 21.20 hectares. The year-round stocking rate was 0.8 livestock units per hectare, i.e. 5.33 sheep per hectare.

Surface areas of the grazed lots.

Grazed lots	Surface area (hectares)
La Saline Neuve	3.50
La Saline Creuse	3.30
Gougny et Grand Bernard	2.72
Le Marais rond	1.20
Le Goile	2.40
Notre Dame - Rostu	1.20
Kervarin Bréhérin	1.00
La Chouette	1.70
La Saline Rouge	1.70
La Duchesse	1.50
La Deudessé	1.30

6. Grazed plants without leaves.
7. The sheep also eat the plants on the sides of the embankments.

In the areas grazed in 2015, no plants larger than 50 centimetres were observed. Not all the plants had disappeared, but they were weak and had lost their leaves, which limited their flowering and capacity to disperse.

In the Kervarin marsh

The initial population was very small, consisting of young sprouts. After one year of grazing, all the plants had disappeared.

Around the Duchesse salt pond

After two years of grazing, the young sprouts and the plants larger than 50 cm has disappeared. They represented 72% of the groundsel bushes counted at the start of the intervention.

Around the Pigneux salt pond

This zone, where the groundsel bushes were cut in 2014, was not grazed. In 2015 and 2016, the bushes grew rapidly, however the smallest plants disappeared.

Table of the monitoring results in 2015 and 2016.

	Kervarin marsh		Duchesse salt pond		Pigneux salt pond (groundsel bushes cut in 2014, not grazed)	
Dates of counts	02 Sept. 2015	27 Oct. 2016	24 July 2015	27 Oct. 2016	02 Sept. 2015	27 Oct. 2016
Young sprouts	3	0	56	0	20	0
Plants < 50 cm	0	0	32	26	13	0
Plants > 50 cm	1	0	6	0	10	4
Average number per square metre	0.4	0	9.4	2.6	4.3	0.4

Costs

- The farmer assumed the high costs of the fencing. As payment for the work, he received a lump sum of 5 000 euros from the intermunicipal board, the town of Mesquer and the non-profit Amis des sites de Mesquer.
- In 2017, further fencing for extended grazing zones was required and funding requests were made to the Pays-de-la-Loire region (8 000 €), the town of Mesquer (500 €) and the non-profit Amis des sites de Mesquer (1 500 €). The requests were granted.

Information on the project

- A presentation on this project was made to the participating local governments and to the association of salt producers.
- A visit to the sites was organised for the general public during the summer of 2016. Two visits for at total of approximately 30 people were also organised in 2017 in conjunction with the Loire-Océan Centre for environmental initiatives (CPIE).
- The experimental results were also presented on the internet site of the non-profit group.

Outlook

- The initial results of the experiment are highly positive and demonstrated that grazing of groundsel bushes by sheep is an effective alternative to manual cutting of the plants.
- Several years of grazing are required to significantly reduce the presence in colonised areas with large plants. However, in areas where only young sprouts are present, a single grazing season is sufficient to completely eradicate the plants.
- Grazing by sheep has been continued in the marshes.
- In that the farmer is not registered in a subsidised agricultural activity and given the considerable expenses incurred for the fencing, CAB decided to study the profitability of the project. A technical and economic study will be carried out in 2017 and 2018 in conjunction with the Loire-Atlantique Chamber of agriculture.

Authors: Patrice Pervez, president of CAB, and Doriane Blottière, IUCN French committee. January 2018.

For more information

- CAB internet site:
www.collectif-anti-baccharis.org

2018 edition

T. Foch ONF

Common bamboo

(*Bambusa vulgaris*)

Classification	
Order	*Poales*
Family	*Poaceae*
Genus	*Bambusa*
Species	*Bambusa vulgaris* (Schrad. Ex J.C.Wendl., 1810)

Originated in southern Asia. Widely introduced in the 1800s and grown for an array of uses, including construction materials, land management (erosion), furniture, textiles, ornaments and human consumption. The plant is now present in most tropical areas of the planet.

Description

- A perennial, ligneous cane (grass), producing rhizomes, capable of reaching a height of 20 metres, in colours ranging from green to yellowish-brown, with vertical streaks
- The stalk (stem or cane) is woody and hollow, 5 to 35 cm in diameter, with nodes every 20 to 45 cm. Stalks have dark hairs when young, but become smooth and glossy with age
- Above-ground roots form in rings on the basal nodes, with rhizomes that spread horizontally in the soil
- On the upper internodes, branches form with a stipule and leaves
- Leaves are smooth, alternating, lanceolate and deciduous, 6 to 30 cm long, 1 to 4 cm wide, green to yellow in colour, with urticating hairs at the base
- The inflorescence comprises rows of seeds up to 3 cm long, no production of fruit

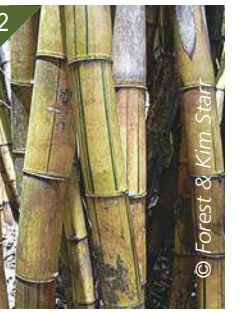
Ecology and reproduction

- The plant can adapt to many types of soil, but prefers wetlands (river banks and around lakes). It can survive short flooding, but is vulnerable to cold weather
- The plant has a life cycle of 20 to 40 years
- Asexual reproduction, via the rhizomes. Stalk cuttings can also throw roots and produce new stands
- Flowering takes place simultaneously among the stalks in a stand, one time after several years of growth, then the plant dies

Documentation

- Foch T. & Van Laere G. 2016. Méthode pour réguler et éradiquer le bambou (*Bambusa vulgaris*). Fiche Technique. ONF & Parc National de la Guadeloupe, 11 pp.
- Invasive Species Compendium. *Bambusa vulgaris* (common bamboo). Document available at http://www.cabi.org/isc/datasheet/8398.
- Coudair K. 2005. Recherche des methodes de contrôle et de valorisation du bambou dans la zone centrale du parc national de Guadeloupe. Rapport de stage. 56 pp.

Author: Doriane Blottière, IUCN French committee



Common bamboo

(*Bambusa vulgaris*)

Experimental work site for bamboo management in the central zone of the Guadeloupe national park

Guadeloupe national park

■ The Guadeloupe national park is a public organisation operating under the supervision of the Ecology ministry. The park is the seventh French national park and the first in a tropical environment. It was created by interministerial decree on 20 February 1989 to protect the central and southern sections of the mountainous region on the island of Basse-Terre.

■ The central zone of the park covers a total of 219 square kilometres (km^2) and the peripheral zone covers another 819 km^2, in 16 towns. The park also includes an adjacent marine area spanning 1 308 km^2, which is essentially the maritime equivalent of the peripheral zone, where the park can launch projects with maritime stakeholders (fishers, pleasure boaters, etc.).

■ Contact: Hervé Magnin - Patrimonial department - herve.magnin@guadeloupe-parcnational.fr

French national forestry agency (ONF)

■ The French national forestry agency (ONF) is a public organisation in charge of managing public forests. It is supervised by the Agriculture and Ecology ministries.

■ In the Guadeloupe archipelago, ONF manages 378 km^2 of public forests, including forests belonging jointly to the French State and the department, other forests belonging exclusively to the department, State forests and sites belonging to the Seaside and Lake Conservation Trust, spread from the volcanic highlands of Basse-Terre to the sheer cliffs of Grande-Terre and the southern islands. In all these areas, the main objectives are to preserve the environment and welcome the public.

■ Contact: Marc Gayot, Biodiversity department - marc.gayot@onf.fr

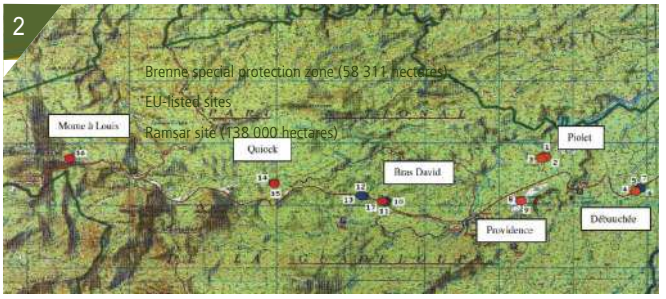
Intervention site

■ The bamboo management site was located along the Traversée Road (D 23), which as its name suggests, crosses the island of Basse-Terre via the wooded, mountainous section.

■ Six sites along a 5-kilometre stretch were selected for their high impact on the landscape, their relative accessibility and the diversity of the sites (bamboo stands at the top of a slope, at the bottom of a slope, along a river, etc.). The objective was to experiment with techniques to eliminate the bamboo in the different situations.

1

2



1. Map of the Guadeloupe national park. Source: Guadeloupe national park.
2. Map showing the sites.

Disturbances and issues involved

■ Common bamboo (*Bambusa vulgaris*) was planted along the Traversée Road while the road was being constructed in 1960 and in a number of mountainous areas on Basse-Terre to stabilise the terrain and enhance the landscape.

■ Bamboo roots tend, however, to grow horizontally and the weight of the plants in fact destabilised the waterlogged terrain. The stalks growing up over the road slow its drying, clutter the road with debris and reduce visibility, thus increasing the risk of accident. The result is high maintenance costs along the road.

Interventions

■ Objective of the interventions

■ The objective was to test a method of permanently eliminating the bamboo that is compatible with the constraints of a national park, i.e. no herbicides and no burning. The purpose of eliminating the bamboo was to enable recolonisation of the sites by native species.

■ The experiment served as a test run to determine the average costs of management work depending on the different work conditions. The data was required to estimate the cost of larger projects and their feasibility in the central zone of the park.

■ The test was proposed by the Guadeloupe national park in response to a call for projects by the Ecology ministry as part of the national biodiversity strategy for 2011-2020 called the "Efforts against land and marine invasive alien species in the overseas territories" policy. In managing the project, the park requested the assistance of two other organisations:

- the French national forestry agency (ONF) which was charged with effectively running the work sites;
- the Guadeloupe departmental roads service which managed automobile traffic on the road during work in the immediate vicinity.

■ Preliminary mapping

■ The sectors colonised by the bamboo were precisely mapped. Between 100 and 120 stands of bamboo with an average of 80 stalks each were found along a 15-kilometre section of the Traversée Road. Among that number, 17 stands representing the various situations (slopes, accessibility, proximity to the road, along a river, etc.) were selected.

■ A degree of operational difficulty (low, medium, high) was assigned to each stand. The degree of difficulty was estimated on the basis of the slope (steep enough in some cases to require harnesses and ropes) and the accessibility (stalk transport by hand), given that it was prohibited to create tracks or roads.

■ The priority sectors for work were then defined on the basis of two criteria:

- the visual impact on the dense rainforest, notably in the highly visited tourist areas;
- risks for the safety of the population, notably in areas along the road.

■ Ten stands were selected for the experiment. The stands were first inspected to check for the presence of epiphyte orchids (specimens of the *Epidendrum* genus) that would have been impacted by the management work.

■ The work took place over a period of four weeks, from 28 May to 21 June 2013. ONF and the park were on hand each day to monitor the work. The work consisted of two steps:

- cutting the stalks with a chainsaw and removal of the branches. Depending on the local conditions, the stalks were carried out by the men, stored on site for later use or ground on site if they could not be used;
- tarping the stumps that had been cut off at ground level. The tarps covered each stand plus a border area 1.5 metres around the stand.

■ Equipment used included:

- a chainsaw to cut the stalks and remove the branches, plus the necessary personal protective equipment;
- machetes to clear the area for debranching;
- a grinder to reduce all the branches and the stalks not carried out;

3. A stand of bamboo before being cut.
4. Cutting the stalks.
5. Removing the branches using a chainsaw.
6. Grinding the branches along the road.

- opaque, waterproof, non-woven tarps, weighing at least 140 grams per square metre;
- metal stakes and nylon cord to secure the tarps;
- a tipping trailer to store and transport the removed plant material.

■ Removal and treatment of the cut plants

■ It was decided to make the best possible use of the cut plants given that bamboo is a valuable resource for many uses (construction, crafts, agriculture). Depending on the situation at each site, the stalks were either stored on site or carried out by the workers. Storage systems were constructed on the sites where the distance to the road made removal difficult. The stalks were stored above ground level to avoid any sprouting of roots and renewed growth of the cut stalks.
■ The stalks carried out and the ground material were provided free of cost to companies, non-profits and private citizens. The transfer was organised near the work site when secure access was available, thus avoiding transport.

■ Monitoring the tarps

■ The tarps were inspected once per month during the first four months following the work, then once per quarter over a period of one year. The purpose of the monitoring was to detect any regrowth of the bamboo through the tarp or along the edges. Any observed shoots were cut during the visits.
■ Monitoring revealed that woven tarps eventually let new shoots through and are not suitable for this purpose. Certain other types of tarps are UV-sensitive and wear very quickly in a tropical climate. They cannot withstand the pressure exerted by the plants.

Results and costs

■ Results

■ The ten selected stands were handled by two companies that responded to the call for tenders. Cutting, removal of the branches and tarping were carried out on all stalks on the sites. A total of 977 stalks were processed during 400 hours of work.
■ In February 2015, two shoots were noted in a stand on the Piolet site (stand 3) and the Morne à Louis site (stand 16). Shoots were also discovered on the Piolet storage site. They were removed using a machete. No other stands produced shoots and the tarps were removed in 2015.

7. A waterproof tarp secured to the ground using metal stakes and nylon cord.
8. Raised storage system.
9. Green stalks available for reuse.

Site		Morne à Louis	Piolet			Quiock	Débauchée		Providence	Bras David		TOTAL
Stand number		16	1	2	3	14	4	5	9	11	17	
Number of stalks processed		150	80	150	120	120	70	100	70	40	77	977
Man-hours per task	Cutting	8	4	6	6	16	10	8	6	4	4	72
	Branch removal	8	4	6	6	24	10	10	12.5	5	5	90.5
	Transport		10	6	12							28
	Grinding	2	1	2	2		15	15	5	10	15	67
	Stump preparation	6	3	3	3	8	8	10	3	8	8	60
	Tarping	2	2	2	2	7.5	7.5	5	5	7.5	10	50.5
	Building storage systems		2	4	4	22.5						32.5
Total man-hours		26	26	29	35	78	50.5	48	31.5	34.5	42	400.5

Table 1. Summary of tasks and man-hours.

By 2016, the stands had been completely eradicated. However, the Morne à Louis stand is still tarped because the first tarp used was of very poor quality and had to be replaced during the year.

Assessment of bamboo use

The total number of equivalent 8-metre stalks was calculated based on the lengths actually cut and the number of cubic metres of ground material (one cubic metre = five stalks). The total amount of material given away represented the equivalent of 1 100 stalks measuring eight metres each. The transfers to the private entities were organised by the Guadeloupe national park (46 transfer documents signed).

Virtually all the cut vegetation was transferred with the exception of a small number of stalks and branches that were left stored on the sites of Piolet and Quiock, due to the transportation difficulties. The vegetation was transferred to gardening companies and to farmers (mulch), to the CIRAD (for experiments on mulching in pineapple plantations), to craftsmen (furniture) and to a boat builder (booms for traditional sailboats).

Human and financial aspects

Excluding the cost of the work by the park personnel, the total budget for the project amounted to 52 703.70 euros, of which 40 000 euros were provided by the Ecology ministry and 12 703.70 euros by the Guadeloupe national park from its own budget.

	Company A	Company B
Total cost	9 821 €	30 081 €
Number of stands processed	4	6
Cost per stand	2 455 €	5 014 €
Total number of stalks cut	500	477
Cost per stalk	20 €	63 €
Number of man-hours	116	284.5

Table of intervention costs (2013).

10. A stand after the work.
11. Stalks stocked along the road.

Information on the project

A press campaign (press release and a report on Guadeloupe 1 radio) was launched by the Guadeloupe national park to inform the population on the project and to alert companies, non-profits and private citizens concerning the availability of the bamboo stalks on the sites at no cost.

A 25-minute film, titled “Bamboo, a friend we can do without”, was directed by Patrick Sardi (Lot’Bô Films).

Outlook

■ Given the high cost of this type of project, the park and ONF intend to set up projects under their management, but executed by the companies and private citizens interested in obtaining the plant products. The pilot sites for the project will be selected along the Traversée Road and the road to the Carbet waterfall. The Guadeloupe departmental council, in charge of road maintenance, would like to permanently eliminate the bamboo stands along the two roads.

■ In 2016 along the Traversée Road, the department financed the work on eight stands in the central zone of the park that were deemed highly troublesome. The Guadeloupe national park funded the purchase and the installation of the tarps for the eight stands.

Authors: Emmanuelle Sarat, IUCN French committee, Thibaut Foch, ONF, Marc Gayot, ONF, Guy Van Laere, Guadeloupe national park. February 2017.

For more information

■ Internet site of the Guadeloupe national park: http://www.guadeloupe-parcnational.fr/

■ Internet site of ONF Guadeloupe: http://www.onf.fr/guadeloupe/@@index.html

2018 edition

© H. Zell

Giant cane

(Arundo donax)

Classification	
Order	*Poales*
Family	*Poaceae*
Genus	*Arundo*
Species	*Arundo donax* (L. 1753)

Originated in Asia. Introduced probably during the Roman period. Grown for numerous uses, notably for musical instruments (clarinets, saxophones, oboes, etc.), reed pens, reed fencing, baskets, landscaping (windbreaks), bio-energy.

Description

- A perennial, ligneous cane (grass), producing rhizomes, can reach a height of 5 to 6 metres and has a life span of over 10 years
- Erect plant with many leaves, growing in dense stands
- Hollow, woody stalk, 2-3 cm in diameter, regular distances between leaf nodes, appearance similar to bamboo
- Fibrous taproots, rhizomes near the soil surface
- Alternating leaves, parallel but on opposite sides, deciduous but long lasting, blue-green in colour, ribbon-like and flat with rough edges 2-8 cm in width, very short ligules with long hairs
- Flowers arranged in erect panicles, oblong-thyrse shaped, pinkish-white in colour, on the upper section of the stalk, 30 to 70 cm long
- Fruit arranged in ears of two to five flowers, often three, approximately 12 mm long

Ecology and reproduction

- The plant flowers from September to October
- For optimal growth, the plant requires direct light and high temperatures
- Preferred habitats include wetlands, reed beds, riparian zones, ditches, roadsides, idle land, sandy soil along coasts. This very rustic plant can grow in poor soil and disturbed areas
- Exclusively asexual multiplication via the stalk and the rhizomes. High percentage of new sprouts from cuttings and rhizome fragments

Documentation

- Fried G., 2012. Guide des plantes invasives. Belin, Paris, 272 pp.
- N.Mauric. *Arundo donax* - Canne de Provence, 2000.
Available on-line at: http://nature.jardin.free.fr/vivace/mc_arundo_donax.htm
- Concept.Cours.d'EAU. *Arundo donax*, 2013.
Available on-line at:
http://cceau.fr/invasions_biologiques/plantes_invasives/arundo_donax/
- INPN. *Arundo donax*, L., 1753.
Available on-line at:
https://inpn.mnhn.fr/espece/cd_nom/84173

Authors: Laurence Teyssier, Compagnie nationale du Rhône, Guillaume Fried, ANSES

Giant cane

(Arundo donax)

Experiment on a mechanical technique to rapidly eliminate giant cane

Board for the Hérault River basin (SMBFH)

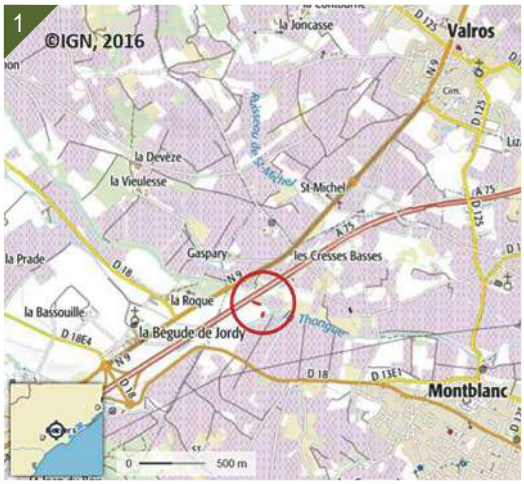
- The board was created in 2009 and awarded the status of a public river-basin territorial agency (EPTB) in 2011.
- It is the managing entity for the SBMP (sub-basin management plan) and acts as the driving force in coordinating the work and studies to provide complete and balanced management of water and aquatic environments in the basin of the Hérault River, a basin spanning 2 500 square kilometres and 166 towns in the Gard and Hérault departments.
- Contact: Antony Meunier – antony.meunier@smbfh.fr

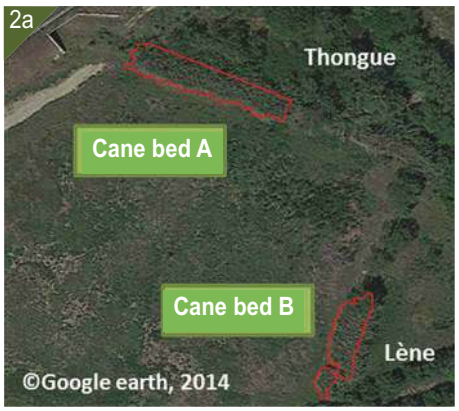
Concept.Cours.d'EAU (C.C.EAU)

- C.C.EAU is an environmental consulting firm specialised in riparian vegetation and invasive plants, with its head-quarters in the Savoie department.
- Concerning invasive species, the firm focusses on:
- formulating management strategies;
- developing assessment methods based on an evaluation of the invasion stages;
- R&D in management techniques;
- managing work sites to remove invasive plant species;
- information and training.
- Contact: Louise Barthod – contact@cceau.fr

Intervention site

- This experiment was made possible by the Pays de Thongue intermunicipal association, the project owner.
- The Thongue and the Lène are two rivers with typical Mediterranean hydrological regimes. They flow into the Hérault River just a few kilometres upstream of the point where the latter flows into the Mediterranean Sea. They have undergone considerable development work and the banks along almost half of their total length are covered with giant cane.
- The site of the experiment comprises two large cane beds[1] that have existed for about 12 years at the confluence of the two rivers along formerly farmed fields that were abandoned following the construction of the A75 motorway, in the town of Montblanc (Hérault department):
- cane bed A, 500 square metres (50 m long and 10 m wide). The bed is located along the ditch draining flows from the discharge installation for the floodplain under the motorway;





1. Map showing the site.
2a. 2b. Aerial photos of the site before (2014) and after (2016) the work.

- cane bed B, 230 square metres (30 m long and 10 m wide). The bed is located on a mound positioned perpendicularly to the flow in the floodplain.

1. In this document, the term "cane bed" designates a stand of giant cane.

Disturbances and issues involved

■ Giant cane creates large, very dense clumps of plants along river banks that have a significant ecological impact on riparian vegetation. The density of the woody stalks (several dozen per square metre) and their height (6 to 7 metres) mean that they can compete with the local vegetation. In addition, the accumulation of non-decomposed plant litter on the ground hinders the sprouting of other species.

■ The woody stalks uprooted during floods can contribute to worsening flood conditions and disturb flows by forming vast obstacles of plant matter in rivers. Cane beds must therefore be preventively cleared to avoid these risks, which results in high maintenance costs for local governments. Their presence also complicates and increases the costs of ecomorphological-restoration work in rivers (grading the banks to form slight slopes, recreating meanders in formerly rectified riverbeds, restoration of riparian vegetation, etc.).

3. Arundo donax.

Interventions

■ The objective of the project was to test an easy mechanical technique to eliminate the cane beds. The technique is a spin-off of the "grinding-tarping" process that has proven effective for Asian knotweeds, another invasive plant producing rhizomes (see the management report at http://www.onema.fr/sites/default/files/EN/EV/publication/EEE/vol2/Reynoutria-spp2.pdf). Given that the rhizomes of giant cane lie closer to the surface than those of knotweed, the tested technique did not include excavation work.

■ The technique consists of grinding the infested soil in order to break up the rhizomes and destroy their root system, then covering the treated soil with a sheet of black plastic to prevent the sprouting of the rhizome fragments.

■ This technique was tested under different conditions (watering the soil to accelerate decay and scraping the soil to different depths to enable greater penetration of the grinder). The "grinding-tarping" process alone was sufficient to produce satisfactory results, which explains why the other test conditions (with essentially the same results) are not discussed here.

Experimental system

■ A total of 17 plots, each approximately two square metres in size, were subjected to different treatments in order to determine the effects of grinding and tarping times on rhizome destruction.

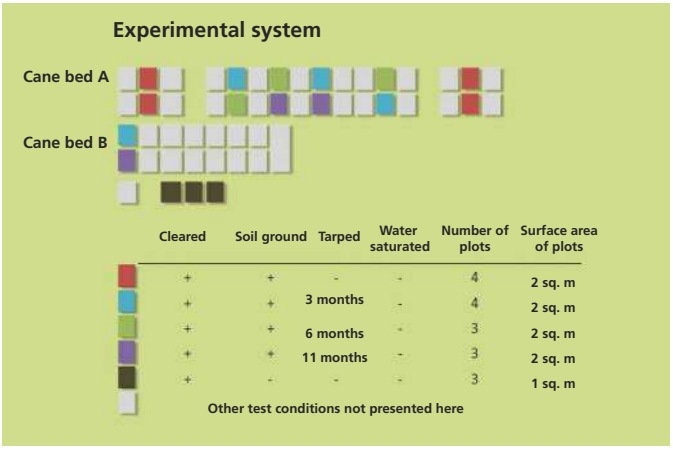


Diagram of the experimental system.

■ Soil grinding

■ The project took place from 13 to 17 April 2015.

■ In order to grind the soil to the greatest possible depth, the plots were first cleared and all plant litter and debris were removed. The waste was deposited in the colonised area that was not treated, next to the plots.

■ The soil was ground three times by a stone grinder at a very low speed (100 metres per hour for the first passage and 200 m/h for the next two).

■ Tarping

■ The plots were covered with two layers of black, plastic tarp (200 microns) held in place by sand bags.

Different tarping durations (3, 6 and 11 months) were tested.

■ Monitoring and assessment

■ Three pedological trenches were dug to determine the depth and position of rhizomes and the overall depth of the plant's root system.

■ The depth of grinder penetration was measured.

■ Following grinding, 20 of the fragmented rhizomes were removed and grown in flower pots for 50 days.

■ The site was visited four times, in July and October 2016 and March and September 2016, in order to:

- count the number of plants starting to grow again in each plot;
- measure the height of the stalks in view of determining the amount of aerial biomass produced using the equation proposed by Spencer et al., 2006;
- dig into a number of plots (over a surface area of approximately one square metre and to a depth of 30 cm) to look at the rhizomes. This work, made necessary because some stalks were eaten, provided information on the mortality rates of rhizomes in the plots where no regrowth was visible.

Results and assessment

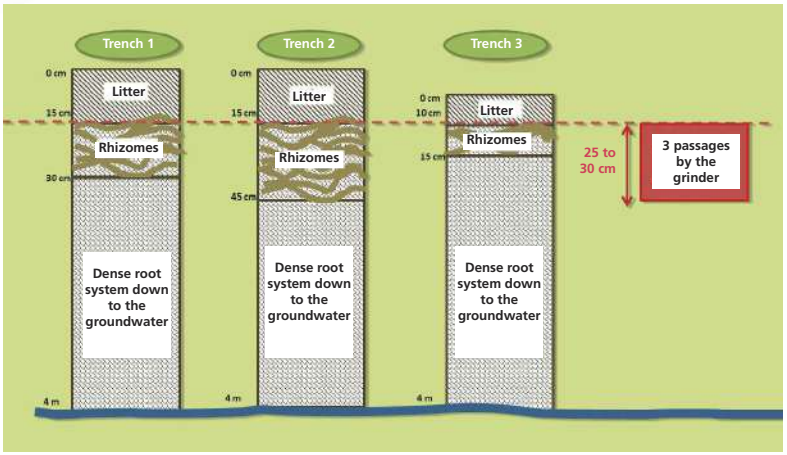
■ Grinder effectiveness in reaching the rhizomes

■ The three pedological trenches revealed:

- an undulating layer of thick, caespitose rhizomes located at depths of up to 30 cm below the plant litter;
- a fine and very dense root system descending to the saturated zone located approximately four metres below the ground level of the site.

■ Following removal of the plant litter, the soil was ground three times to a depth of between 25 and 30 cm. In each case presented here involving grinding, it succeeded in fragmenting the rhizome layer.

4. Fragmented rhizomes following the first passage of the grinder. Average length = 6.3 cm (SD = 2 cm, N = 150).
5. Clearing the plots using a flail-cutter set up on an excavator.
6. Removal of plant waste after clearing.
7. Soil grinding using a stone grinder mounted on a tractor.
8. Tarped, experimental plots.



© C.C.EAU

Grinder penetration and rhizome depths.

■ Effects of clearing alone

■ Clearing alone did not reduce the numbers of giant cane. In the plots that were simply cleared, no reduction in the number of stalks was noted after a single growing season following the work.

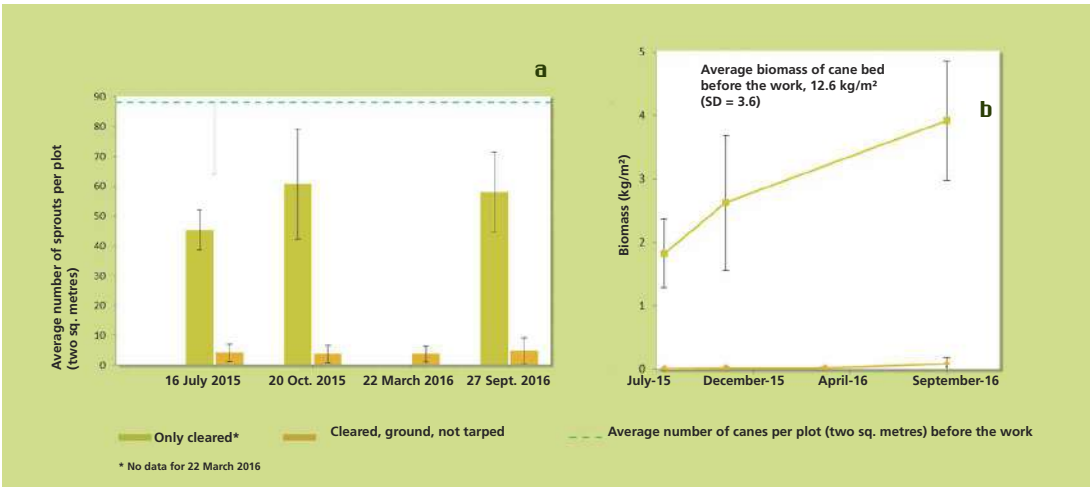
■ However, the aerial biomass produced after two growing seasons was divided by a factor of three compared to the cane bed prior to the work. The stalks had not yet reached their maximum height.

■ Effects of grinding alone

■ Grinding alone resulted in high mortality levels in the rhizomes. The number of sprouts in the ground plots was ten times lower than on the plots that were simply cleared and the biomass produced was also much lower. These results were confirmed by tests attempting to grow the rhizomes. Out of 20 ground rhizomes, only six had produced sprouts after 50 days.

■ However, grinding alone is not sufficient to eliminate giant cane. According to our results, in a cane bed equivalent in size to bed A (500 square metres), grinding alone will result in approximately 1 000 sprouts the following year.

© C.C.EAU



Effects of clearing and grinding alone on the numbers of sprouts and on biomass.

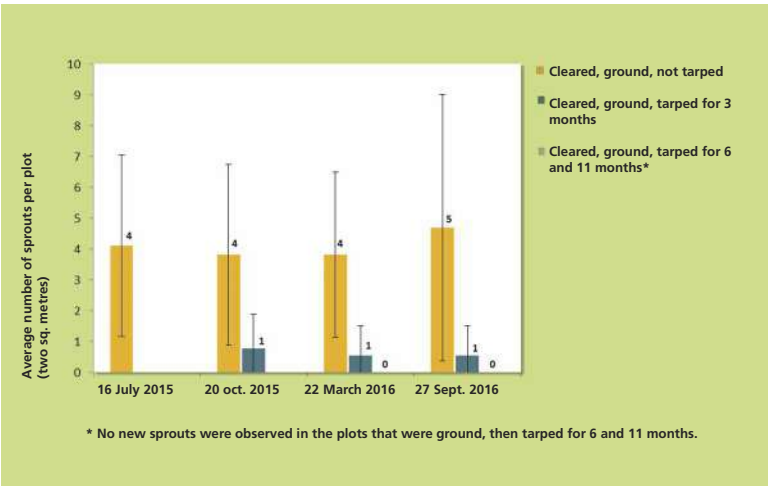
■ Effects of tarping alone

■ The plant was still alive after tarping of non-ground plots for 11 months.

■ Effects of grinding and tarping

■ Placing tarps over the ground soil significantly reduces the number of new sprouts:

- after three months of being tarped, only a single sprout was observed on average in the plots (two sq. metres each). However, three months are insufficient given that, according to our results, the number of sprouts would still be approximately 250 in a cane bed of 500 square metres;
- no new sprouts were observed in the plots (two sq. metres) that were tarped for 6 and 11 months. Consequently, superficial grinding of the soil at the start of the growing season followed by tarping for at least six months resulted in a 100% mortality rate among the rhizomes.



© C.C.EAU

Effects of tarping durations on the numbers of sprouts.

■ An investigation of the three plots ground and tarped for six months confirmed the 100% mortality rate among the rhizomes. This is a reliable result in that an average of 307 dead rhizomes were counted per square metre of soil (SD = 126) and no live rhizomes were observed.

Treatment	Plot	Number of sprouts	Estimated density of rhizomes per sq. metre	Length of rhizomes (cm)	
				Average	Standard deviation
Cleared, ground	1	0	440	4	1
and tarped 6 months	2	0	190	5	1
	3	0	290	4	1

9. After 11 months of tarping, the rhizomes were still alive in a plot that had not been ground.
10. Dead rhizomes collected in the experimental plots after six months of tarping.

Assessment

■ The experiment demonstrated conclusively that it is possible to rapidly eliminate cane beds using an easily implemented technique. Success depends above all on the depth of penetration of the grinder in the soil. For this reason, it is essential to:

- first clear the cane bed and remove all plant litter;
- grind the soil at least three times;
- run at very slow speeds to avoid clogging the grinder;
- check that the soil is ground to a depth that includes the rhizome layer, which can be more or less difficult depending on the type of soil.

■ The period during which the experiment was carried out probably played a major role in its success in that the six months of tarping took place during the growing season with high temperatures during the summer. According to observations on the site, it would appear that the rhizomes first started to rot, then dried. If similar work is carried out during other periods of the year, it may be necessary to tarp the soil for a longer period.

Total cost of the experiment.

Phases	Cost (ex VAT)	Duration
Preparation Bibliographical survey Find a site and a willing land owner Initial visit to the site Drafting of the experimental protocol Description of the type and quantity of work to be done	3 200 €	3 years
Work Clear the cane beds and remove the plant litter Dig the pedological trenches with the excavator Set up the plots (excavator) Grind the soil (stone grinder) and other work Tarping	12 000 €	5 days
Monitoring the work Continuous monitoring in order to improve the technique Attempt to grow the rhizomes	6 400 €	5 days
Monitoring the results Removal of the tarps and monitoring of the plots over two growing seasons (calculation of sprout numbers, measurement of stalk heights, digging up of rhizomes, etc.) Collection of rhizomes and attempts to grow them to determine the rotting process and its impacts Analysis of the results and drafting of a technical report	4 500 €	11 months
Total cost of project	26 100 € Cost ex VAT 31 320 € Cost incl. VAT	

■ Estimation of technical costs

■ Depending on the constraints weighing on a given site, unit costs under real worksite conditions (non-experimental conditions) may vary from 15 € per square metre to 75 €/m^2 (ex VAT, not including management costs) for cane beds ranging from 5 000 to 500 square metres respectively. The highest costs correspond to any additional expenses due to difficult access, the need for earth-working to arrange embankments and river banks, or the need for simple bio-engineering work. The prices per square metre mentioned above do not include work to replant river banks or the removal of plant waste from the site.

Information on the project

■ The project was discussed during a visit to the site by river technicians from the region.

■ Information on the project is available on the internet site of the Pays de Thongue intermunicipal association: http://www.cc-pays-de-thongue.fr/Experimentation-sur-la-Canne-de.html

Outlook

■ On the basis of the results obtained, the proposed technique consists of:
- in the spring, clearing the cane bed, removing the plant litter, making three runs with the stone grinder at low speed and checking the grinding depth, then installing a black, plastic tarp and weighing it down with sand bags;
- monitoring the tarp or setting up a fence (to avoid damage to the tarp by large animals);
- removing the tarp after six months.

■ The experiment demonstrated that 11 months of tarping alone are not enough to destroy the plants. Grinding of the soil is required, however longer tarping times could possibly do the job.

■ The risk of sprouting by stalk fragments cut and removed from the cane bed prior to grinding the soil was not investigated in this study. Given that this risk is theoretically very low during the proposed work period, storage of the plant waste on site should be possible on the condition that checks on sprouts be run and that the waste be removed if sprouts do occur. Another possibility would be to chop the cleared stalks and to lay the chopped waste on the soil prior to tarping. This process will require specific study because it was not investigated during the experiment. Finally, if it is deemed necessary to remove the stalks from the site, the different waste-management techniques must be studied on a case-by-case basis.

■ The proposed technique offers a number of possibilities for the rapid restoration of riparian vegetation in the Mediterranean region, e.g. work on the cane beds in the spring, removal of the tarps in the fall and immediate replanting of the banks.

■ However, a number of practical aspects concerning the actual implementation must still be worked out. They have to do essentially with the depth achieved by the stone grinders and adaptations required depending on the type of soil in order to make sure that the rhizome layer is reached.

■ Monitoring of the work under real-life, worksite conditions is still required to validate the technique and to more precisely determine the costs of the potential conditions encountered on river banks and elsewhere.

Authors: Louise Barthod, Mireille Boyer, C.C.EAU. January 2017.

Pour en savoir plus

■ Internet site of Concept.Cours.d'EAU: www.cceau.fr

■ Internet site of the Board for the Hérault River basin (SMBFH): www.fleuve-herault.fr

■ Spencer, D. F., Liow, P. S., Chan, W. K., Ksander, G. G., and Getsinger, K. D. 2006. Estimating Arundo donax shoot biomass. Aquatic Botany, 84(3), 272-276.

2018 edition

© Mark A. Garland

Japanese hop

(*Humulus japonicus*)

Classification	
Order	Rosales
Family	*Cannabaceae*
Genus	*Humulus*
Species	*H. japonicus* (Sieblod & Zucc., 1846)

Originated in temperate zones of Eastern Asia. Introduced in France in the Jardin des Plantes botanical garden in Paris in 1880. First observed in the natural environment of the Gard department in 2004.

Description

- An annual plant that sprouts in the spring and forms a long creeper 2.5 to 6 metres long
- A single plant can create large “sheets” of single-species vegetation covering up to 50 square metres of ground
- The hexagonal stalk has numerous branches
- Hard, clinging hairs
- Opposing leaves (7 to 10 cm long), with a long stem (longer than the blade):
  - light green in colour
  - palmatilobed (5 to 7, but up to 9 lobes)
  - the veins on the underside have hard hairs
- Male and female inflorescence on different plants (dioecious species):
  - the female inflorescence consists of hanging ovoid cones
  - the male inflorescence is a branched panicle, pale greenish yellow in colour
- Achenes are dark brown with black streaks, 2 to 3 mm long in cones comprising numerous bracts having a texture similar to paper and covered glandular hairs
- The root system is slightly pivoting and has numerous secondary roots

Ecology and reproduction

- Habitats include river banks (above the water level) and idle land
- The plants tend toward rather moist soil with a high nitrogen content, but are indifferent to the pH level
- Exclusively sexual reproduction with pollination by the wind and insects
- The pollen has very high allergenic potential, comparable to that of common ragweed in Korea

Documentation

- Fried G. 2012. Guide des plantes invasives. Belin, Paris, 272 pp.
- Smage des Gardons. Plantes invasives des Gardons. Fiche espèce sur le Houblon japonais. http://invasives.les-gardons.com/wikini/wakka.php?wiki=HumulusJaponicus

Authors : Emmanuelle Sarat, IUCN French committee, and Guillaume Fried, Anses

1, 2 © J.-Ph. Reygrobellet, SMAGE des Gardons

© Mark A. Garland

Japanese hop

(*Humulus japonicus*)

Experiments in managing Japanese hop in the Gardons basin

Board for balanced management of the Gardons basin (SMAGE des Gardons)

■ The SMAGE is a public river-basin territorial agency (EPTB) created in 1995 that represents 122 towns in the Gardons river basin (2 000 square kilometres on the right bank of the Rhône River) and the departmental council of the Gard department.

■ It is the project manager for the SBMP (sub-basin management plan) and for the Gardons river contract. It has set up consistent, basin-wide policies for:

- flood prevention;
- management of water resources;
- preservation and restoration of aquatic environments.

■ Since 2009, management of invasive plant species has become an important part of the policy for natural environments.

■ A multi-year management programme was established in 2012.

■ Contact: Jean-Philippe Reygrobellet - smage.jpr@lesgardons.com

Agency for food, environmental and occupational health & safety (ANSES)

■ ANSES is a public agency placed under the supervision of the Health, Agriculture, Ecology, Work and Consumption ministries.

■ The lab for plant health is active in monitoring, alerting and conducting collective science-advice projects in order to assess the risks caused by pests for the health of crops and forests.

■ It also does work to determine the risks raised by new plants that are introduced and may become invasive.

■ Contact: Guillaume Fried - guillaume.fried@anses.fr

Intervention site

■ The Gardon River flows through the heart of the Languedoc-Roussillon region. The river and its tributaries originate in the Cévennes mountains, in the Lozère department. They flow through the Gard department and into the Rhône River.

© Smage des Gardons

1. Sites where Japanese hop has been observed in the areas managed by the SMAGE.
http://invasives.les-gardons.com

■ The Gardons basin comprises many remarkable aquatic environments (Cévennes national park, Galeizon biosphere reserve, Natura 2000 sites, the Gardon gorges) that are home to an array of emblematic species such as the otter, the European beaver, Bonelli's eagle, shad, eels, bug orchids and summer lady's-tresses.

■ In 2004, 500 square metres of Japanese Hop were discovered by the National botanical conservatory (Mediterranean region) along the banks of the Gardon River, in the town of Saint-Anastasie (Gard department). The plants were the only known instance of the species in the natural environment in continental France.

■ The European and Mediterranean Plant-Protection Organisation (EPPO) placed the species on its alert list in 2007 and, following a rapid assessment by the ranking protocol, Japanese hop was listed as an invasive species in 2012.

■ A large number of invasive species have been observed in the rivers of the basin (water primrose, parrot-feather watermilfoil, water cabbage, alien knotweeds, summer lilac, amorpha, etc.). Given the size of the area (2 000 kilometres of river including 500 km of large rivers), a multi-year (2012-2017) management plan was set up in 2011. It is funded by the Water agency, the departmental board, the Gard departmental council and the EU (in 2012).

Disturbances and issues involved

■ Impacts on the ecosystem

■ The species forms dense, single-species stands that completely cover up to several hundred square metres of ground. It competes with and locally eliminates certain other species.

■ Impacts on health

■ The pollen has very high allergenic potential, comparable to that of common ragweed.

■ Economic impacts

■ Given that Japanese hop is sensitive to hydric stress, the risks of competition with crops in the Mediterranean environment were deemed very low. This assessment must be reviewed in more humid environments.

Summary of the studies carried out by ANSES

■ The multi-year management plan for invasive plant species in the Gardons includes a project to improve knowledge on Japanese hop in order to better understand its biology, impacts and the management possibilities. It was in the framework of this project that ANSES was commissioned to do two studies.

■ Study on the ecological plasticity of Japanese hop (2012-2013)

■ The objectives were to:
- identify the ecological position of Japanese hop with respect to other plants;
- quantify the impacts of hydric stress on the species;
- analyse its allergenic potential as well as the viability, production and dispersal of seeds.

■ Results:
- in the Mediterranean region, Japanese hop has a narrow ecological niche limited to bare river banks and to low areas that remain flooded until the beginning of spring. It has greater difficulty in places where plants are numerous (grassy beds of creeping bentgrass) and in areas where the riparian vegetation reduces the available light;
- moderate tolerance to hydric stress. Through morphological changes (reduction in size), the plant is not eliminated from the environment, but loses in competitiveness;
- the seeds have a very high germination rate (95% after one week of stratification (4°C) and one week in moist sand);
- the number of seeds released annually by a plant is thought to be greater than 1 000 and their longevity estimated at up to three years. Long-distance dispersal is due to flooding in the fall, short-distance dispersal to animals (parts of the inflorescence containing seeds attach to fur).

■ Study on the opportunistic nature of Japanese hop (2013-2014)

■ The objective was to compare the activity of Japanese hop with a native species of creeper present on the same sites (*Gallium aparine*).

■ Results:

- both species respond positively to an increase in available water (size and biomass), but only the hop takes advantage of a greater nitrogen input (more biomass). In relatively infertile areas, the two species produce similar quantities of biomass, which may indicate that Japanese hop is not capable of excluding certain native plants that are better suited to the local conditions. On the other hand, Japanese hop is far more productive in resource-rich environments such as river banks (height of the plant, biomass, leaf traits);
- the competitive impact of Japanese hop is high due to the fact that it rapidly covers the ground and hinders germination of many other annual plants on river banks. The drop in plant diversity reaches 55% during the growing season (May) and 100% by the end of the season (September).

2. Herbaceous area colonised by Japanese hop.
3. A patch of nettles colonised by Japanese hop, being uprooted.
4. A mat of creeping plants colonised by Japanese hop.

Interventions

■ Inventories

■ Inventories were conducted from 2012 to 2014. In order to optimise costs and the informative value of the research, the Japanese hop was included in a list of other invasive species covered by the management plan:

- the three Asian knotweed taxa, namely Japanese knotweed (*Reynoutria japonica*), giant knotweed *(Reynoutria sachalinensis*), Bohemian knotweed (*Reynoutria X bohemica*);
- summer lilac (*Buddleja davidii*);
- desert false indigo (*Amorpha fructicosa*);
- parrot-feather watermilfoil (*Myriophylum aquaticum)*;
- water primrose (*Ludwigia* spp.).

■ Almost 150 kilometres of river were inventoried.

■ Again in order to reduce costs and given the low tolerance of Japanese hop to shade, only the river bed, bare gravel bars and the first ten metres of riparian zones were studied by the firms doing the work. The studies took place primarily during the summer in order to give the plants time to develop, thus facilitating their detection.

■ All sites where the plants were found were identified with GPS data.

© Smage des Gardons

Map of the intervention sites.

■ Tests on different management methods

Tests on management methods were conducted in two sectors (see the previous page):

- sector 1. The entire upstream invasion front was uprooted over a distance of two kilometres (Vézéobre-Ners), where the plant had colonised small surface areas, in order to study its recolonisation potential following uprooting, in an area where no seeds arrived from upstream;
- sector 2. Heavily colonised areas, located in the downstream section of the river basin, are uprooted using a number of different techniques. The point here was to determine the time required for each technique.

Three techniques were tested on three different environments (low herbaceous plants, an area colonised by giant cane (*Arundo donax*), a reed bed and mat of creeping plants).

6. A shredder blade and the results in the field.
7. A cutter blade and the results in the field.

■ Manual uprooting

Type of environment	Low herbaceous plants	Nettles	Giant cane	Reed beds
■ Method employed	■ Manual uprooting. ■ Clear the foot of the bank to create a collection zone, then push the plants down from the top of the bank. ■ Sort the roots to preserve the native species. ■ Remove only the main Japanese hop roots.	■ Manual uprooting. ■ Cut the roots of Japanese hop (the plants are easily identifiable among the nettles). ■ Deposit the plants in a clearly identified area, free of Japanese hop.	■ Manual uprooting. ■ Cut the roots of Japanese hop (the plants are easily identifiable among the nettles). vDeposit the plants in a clearly identified area, free of Japanese hop.	■ Manual uprooting. ■ The Japanese hop plants were identified at ground level (the reeds made identification difficult). ■ Care was required in removing the hop (the reeds break easily).

■ Mechanical cutting:

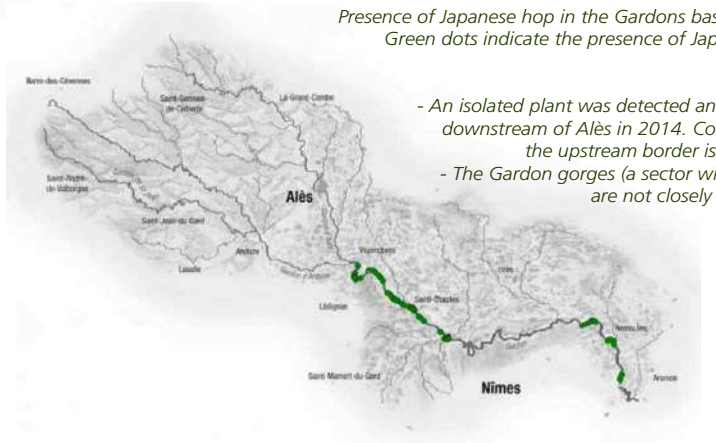
- mechanical cutting was done in an area where the Japanese hop had colonised a mat of creeping plants;
- one part of the site (200 square metres) was cleared using a brush cutter equipped with a shredder blade;
- the second part (250 square metres) was cleared using a brush cutter equipped with a coppice-cutter blade at approximately 15 centimetres above ground level.

Results and assessment

■ Results

■ Inventory data:

- the results confirmed the significant expansion of Japanese hop since 2004;
- the plant is widely present along 80 kilometres of the main river (the Gardon River);
- the plant is expanding naturally in the downstream section of the basin and is probably already present along the Rhône downstream of the confluence with the Gardon.



Presence of Japanese hop in the Gardons basin in 2013. Green dots indicate the presence of Japanese hop.

Notes.
- An isolated plant was detected and uprooted downstream of Alès in 2014. Consequently, the upstream border is not stable.
- The Gardon gorges (a sector with no data) are not closely monitored.

Répartition du Houblon du Japon sur le bassin versant des Gardons en 2013.

8. Result of manual uprooting on a bank (herbaceous area).
9. Result of shredding immediately after the work.

■ Results of the tests on management methods

The type of vegetation growing in conjunction with Japanese hop would not seem to have an impact on the time spent in managing the hop, with the exception of environments colonised by giant cane where manual uprooting is necessary (due to the hardness of the stalks) and environments with reed beds or typha (fragile plants).

■ The effectiveness of manual uprooting could not be assessed due to the strong floods in the fall of 2014 that significantly modified the area.

■ Mechanical techniques

The areas cut mechanically were analysed with ANSES in October 2014:

- in the area treated with a shredder blade, the number of new sprouts was negligible and there were no flowers;
- in the area treated with the cutter blade, the hop plants were still present everywhere (though the density was lower than in non-treated areas) and seeds were observed. This technique did not reduce the risks of pollen being released or of seeds being dispersed.

As a result, simple cutting is not a suitable management technique.

■ Financial aspects

■ The costs of the three management techniques for Japanese hop tested in 2014 were calculated.

■ On the basis of the calculations, an average cost of 6 euros per square metre was set to estimate the cost of future work over the entire colonised area in the Gardons basin. This cost takes into account the different techniques employed (mechanical techniques are not possible in certain sensitive natural environments or in those difficult to access) and the inevitable drops in productivity when dealing with repetitive operations over almost 80 kilometres of river.

Management technique	Sq. metre / person / hour	Hourly cost (not incl. VAT)*	Cost per sq. metre (not incl. VAT)
Manual uprooting 33 hours x 3 people = 340 sq. metres	3.4	35.7	10.4
Cutting (with cutter blade) 1.6 hours x 3 people = 250 sq. metres	55.6	35.7	0.6
Cutting (with shredder blade) 1.5 hours x 3 people = 150 sq. metres	33.3	35.7	1.1

** The hourly cost was estimated on the basis of a 250 euro work day (not including VAT).*

■ It is necessary to add the time required to travel the river and find the Japanese hop. It was estimated that a team of two could examine three kilometres per day, for a cost of 167 euros per kilometre of river.

■ The calculations included the management work on 80 colonised kilometres of the Gardon River, between Ners and Comps, and an in-depth search for Japanese hop on the tributaries over a period of two years.

■ It should be noted that Japanese hop is an annual species and isolated sites are therefore found. Due to increases in competition or modifications in the environment, the work on these sites is not necessarily repeated from one year to the next. Work is shifted to sites where seeds have sprouted. For this reason, the isolated sites receiving work vary from one year to the next, whereas on larger sites (several hundred square metres), the work is much more regular.

Surface areas (m^2) inventoried in 2012 and 2013	Surface areas (m^2) estimated in 2015	Cost of work year N* (euros before VAT)	Cost of work year N+1 (euros before VAT)	Management costs (euros before VAT)	Miscellaneous (euros before VAT)**	2-year budget (euros before VAT)	VAT	2-year budget (euros incl. VAT)
19 949	29 924	191 378	57 413	57 413	44 017	484 187	96 837	**581 024**

** The hourly cost was estimated on the basis of a 250 euro work day (not including VAT).*
*** Miscellaneous includes legal announcements, coordination, work safety, monitoring and communication.*

Information on the project

■ Information was provided to neighbouring river boards via a note and a species fact sheet.

■ All technical and financial partners in the management plan received information on the study conducted over two years and on the decision not to manage Japanese hop unless a collective decision is taken.

■ A report on the studies and management experiments was sent to the various organisations in a position to decide on launching a major management project against this emergent invasive species.

■ A special internet page is available on the SMAGE site: http://invasives.les-gardons.com/wikini/wakka.php?wiki=HumulusJaponicus

Outlook

■ It was decided to halt the work on the species given its range exceeding the SMAGE territory and the management costs exceeding the available budget.

■ The management work on the species may be resumed if there is a decision to launch a regional or national effort involving all the concerned managers.

■ The studies on the plant's ecology (soil analyses, analysis of the grain bank this year) and on its impact (the second year on the same sites to observe any variability) will be finished and published by ANSES.

Authors: Emmanuelle Sarat, IUCN French committee, Guillaume Fried, ANSES, and Jean-Philippe Reygrobellet, SMAGE des Gardons. May 2015.

For more information

■ The SMAGE internet page on the species may be consulted at: http://invasives.les-gardons.com/wikini/wakka.php?wiki=HumulusJaponicus

■ Pinston A. 2013. Etude de la plasticité écologique d'une plante invasive, *Humulus japonicus.* Mémoire de stage de master 1, Université de Bourgogne, 35 pp.

■ Mahaut L. 2014. Le Houblon du Japon (*Humulus japonicus*), une espèce locomotrice ou une simple passagère du train des changements ? Mémoire de stage de master 2, Université de Montpellier 2, 44 pp.

■ Smage des Gardons / Entreprises DEHAPIOT- DIAZ. 2014. Test de 3 méthodes de traitement d'*Humulus japonicus* : arrachage manuel, fauchage, broyage. 11 pp.

■ Smage des Gardons. 2014. Bilan de deux années d'études sur le Houblon japonais (*Humulus japonicus*). Appel à décision sur l'opportunité d'une gestion. 9 pp.

2018 edition

© M.Bravenboer

Yellow skunk cabbage

(*Lysichiton americanus*)

Classification	
Order	Alismatales
Family	*Araceae*
Genus	*Lysichiton*
Species	*L. americanus* (Hultén & H. St John, 1931)

Originated in the Northwest of North America, from Alaska to California. Introduced in Europe in the early 1900s for ornamental purposes.

Description

- Herbaceous plant that can reach a height of one metre when adult
- Wide, basal leaves, bright green, with thick veins, that grow after flowering
- Tuberous rhizome
- Spike inflorescence, called a spadix, 10 to 15 cm long, growing on a large, yellow bract, called a spathe, typical of the Arum genus. The spadices produce a musky odour to attract insects
- The fruit is in the form of green berries

Ecology and reproduction

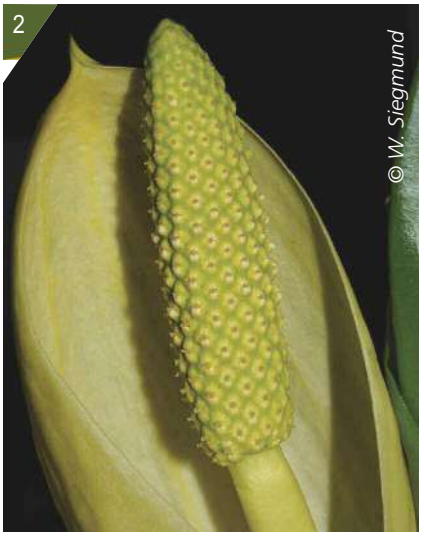
- A perennial plant, slow growing, that can live up to 80 years
- Wetlands (peat bogs, swamps), riparian zones. Found generally in soil with a neutral to acid pH
- Flowers at the end of winter, seeds become mature during the summer. The stem of the spadix then sags and bends over to release the seeds at the foot of the plant
- The seeds can survive in the soil for up to nine years

Documentation

- Lebreton A. 2007. Présence du Lysichite jaune ou Faux arum, *Lysichiton americanus* Hultén & St John (*Araceae*), en France. Symbioses, nouvelle série, n° 20 : 60– 64.
- Lebreton A, Gibernau M. 2015. Lysichite jaune : *Lysichiton americanus* Hultén & St John, 1931. Espèces exotiques envahissantes des milieux aquatiques et associés en France métropolitaine: recueil de fiches d'identification. Onema: pp. 25-26. http://www.gt-ibma.eu/wpcontent/uploads/2015/04/Lysichiton-americanus_-Lysichite-jaune.pdf
- IBMA work group. 2016. *Lysichiton americanus*. Database on biological invasions in aquatic environments. National work group on biological invasions in aquatic environments. IUCN France and the French biodiversity agency. http://www.gt-ibma.eu/espece/lysichitonamericanus/
- Invasive Species Compendium. 2017. Species profile: *Lysichiton americanus*. [On line]. Document available at: http://www.cabi.org/isc/datasheet/31580

Author: Doriane Blottière, IUCN French committee.

1 © P. Grabbanelli



2 © W. Siegmund

3 © K. Stuber

Yellow skunk cabbage

(*Lysichiton americanus*)

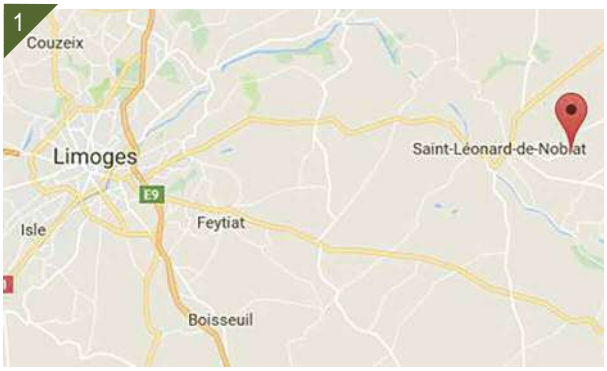
Managing yellow skunk cabbage in Saint-Léonard-de-Noblat (Haute-Vienne department)

Pays Monts et Barrages Centre for territorial development

■ The Pays Monts et Barrages Centre is a grouping of three local governments in the Haute-Vienne department, namely the Noblat, Portes-de-Vassivière and Briance-Combade intermunicipal boards.

■ In the framework of its policy to preserve and develop its environmental resources and enhance the attractiveness of the territory, the centre has launched efforts to set up a management strategy for invasive alien species.

■ Contact: Cécilia Malraison, policy officer
environnement@monts-et-barrages-en-limousin.fr



© Google Maps

1. Map showing the position of the site.

Intervention site

■ Yellow skunk cabbage has been listed as a species of Union concern by the EU, however it is currently present in only two places in France, namely the Haute-Vienne and the Vosges departments.

■ In the Haute-Vienne, four plants were discovered in 2005 by Alexis Lebreton (National agency for hunting and wildlife, ONCFS) in a stand of willow trees on the banks of a pond connected to the hydraulic network.

■ The plants are located in the town of Saint-Léonard-de-Noblat, at a place called the Ancien Moulin du Repaire, at the bottom end of a pond and on the Nouhaud Stream (part of the Loire River basin).

■ Since the discovery, the site has been monitored annually. In April 2017, approximately one hundred adult plants were counted. A large number of young plants were also present, but not counted.

Disturbances and issues involved

■ The species has a high invasive potential and can form dense populations covering large areas. As such, it is detrimental for native plant species. It can also modify the animal communities, notably the insects.

Interventions

■ Since the discovery in 2005, no plants have been uprooted, however work was done each year from 2008 to 2010 to destroy the spadices (the seeds) in order to limit the plant's development.

■ The objective of the work in 2017 was to eradicate the plant from the site.

■ Meetings had first been held with the various stakeholders and partners, in particular the National botanical conservatory in the Massif Central and the ONCFS. During the monitoring visit in April 2017, two adult plants were uprooted in a test to determine the best method.

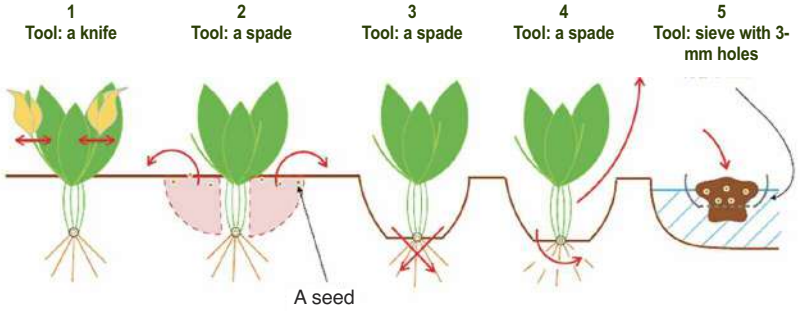
■ Subsequently, two half-day sessions of work were carried out, one in the beginning of May and the other in the beginning of July.

■ Entire plants, with the rhizomes, were uprooted manually using spades and knives (see the figure below). The inflorescences of the adult plants not uprooted in May were cut to avoid their flowering until they were uprooted in July.

■ The resulting green waste was deposited near the work site to avoid any risk of dispersing the plants during the transport. It was placed in the hole left by an uprooted tree a few metres from the site and blocked with a bund. The hole was a very dry spot where the plants had no chance of regrowing and will rot. The rhizome of each plant was split in two to weaken it further and make sure it did not sprout.

■ During the work in May, the soil was sifted to sort out any seeds that might have fallen to the ground, but no seeds were found.

Uprooting method for Lysichiton americanus.



A. Lebreton and J. Charon, April 2017

Step 1. *As a precautionary measure, cut the inflorescences before uprooting the plant.*
Step 2. *With a spade, dig around the base of the plant to remove the soil until the rhizome is visible.*
Step 3. *With the spade, cut the roots under the rhizome.*
Step 4. *Slide the spade under the rhizome and use it as a lever to extract the entire plant. The plants should be deposited nearby, in a dry place, where they will rot.*
Step 5. (test) : *In the river, sieve the first 5 centimetres of soil (from Step 2) from around the plant to remove a maximum number of seeds before filling in the holes. The purpose of this step is to deplete the grain bank more quickly.*

Results and costs

■ Results

■ A total of 102 yellow skunk cabbage plants were uprooted in 2017, including 75 during the work in May (representing approximately 0.6 cubic metres of green waste) and 27 during the work in July.

■ Five juvenile plants were not uprooted due to the lack of time, plus one adult plant that was difficult to reach (located under a pile of branches). They will be uprooted in 2018, during the monitoring visit.

© J. Charon

Distribution of Lysichiton americanus *following the work in July.*

- Hydrographic network
- Plants uprooted in July
- Juvenile plants remaining
- Adult plant remaining
- Deposition zone


2 © J. Charon/ PETR Pays Monts et Barrages


3 © J. Charon/ PETR Pays Monts et Barrages


4 © J. Charon/ PETR Pays Monts et Barrages


5 © J. Charon/ PETR Pays Monts et Barrages


6 © J. Charon/ PETR Pays Monts et Barrages

2. One part of the yellow skunk cabbage plants on the work site.
3. An adult plant.
4, 5, 6. Uprooting the plants.

Assessment

- Only the sieve (11 euros) was purchased for the project, all the other equipment was already available.
- Five people were involved, including two technicians from the Pays Monts et Barrage Centre, an intern (funded by the LEADER programme) and two volunteers.

Information on the project

- Information on the project was published in the bulletin of the National botanical conservatory (Massif Central) and on the internet site of the Pays Monts et Barrage Centre.
- An article for a scientific journal is currently being drafted.

Outlook

- The site will be monitored once per year in the spring for ten years in the framework of a partnership between the Pays Monts et Barrage Centre and the ONCFS. Any regrowth from rhizome fragments or the seed bank will be uprooted for as long as necessary during the monitoring visits.

Authors: Jennifer Charon, Pays Monts et Barrages Centre, and Doriane Blottière, IUCN French committee. January 2018.

7. Deposit site for the yellow skunk cabbage.

For more information

- Klingenstein F, Alberternst B. 2010. NOBANIS – Invasive Alien Species Fact Sheet – *Lysichiton americanus*. Online Database of the European Network on Invasive Alien Species - NOBANIS www.nobanis.org.
- Lebreton A. 2007. Présence du Lysichite jaune ou Faux arum, *Lysichiton americanus* Hultén & St John (*Araceae*), en France. Symbioses, nouvelle série, n° 20 : 60– 64
- Lebreton A, Gibernau M. 2015. Lysichite jaune : *Lysichiton americanus* Hultén & St John, 1931. Espèces exotiques envahissantes des milieux aquatiques et associés en France métropolitaine: recueil de fiches d'identification. Onema : pp. 25-26.
- Organisation Européenne et Méditerranéenne pour la Protection des Plantes. 2006. *Lysichiton americanus*. Data sheets on quarantine pests. Bulletin OEPP/EPPO Bulletin 36, 7–9.

2018 edition

© Guillaume Koch

Asian knotweed

(*Reynoutria* spp.)

Classification	
Order	Polygonale
Family	*Polygonaceae*
Genus	*Reynoutria* (Houtt, 1777)

Originated in Eastern Asia (southern and maritime regions) and in Northern Japan (Sakhalin Island). Introduced in the 1800s for ornamentation, forage, honey making and soil stabilisation.

Description

- Dioecious species that flowers in the fall
- Perennial, herbaceous plants, very large (up to 4 metres high), forming bushes
- Aerial stalks are strong, hollow, green in colour or spotted dark red depending on the species
- Leaves with smooth edges, alternating, with a stipule around nodes along the stalk and, depending on the species:
  - an oval to triangular or even cordate shape
  - a cut-off, straight or rounded base
  - smooth veins or with hairs
- Numerous small flowers that can be white, greenish or reddish, in clusters
- Strong rhizomes, up to 15 to 20 metres long and 2 to 7 metres deep
- Adventitious roots, sprouting from the rhizomes

Ecology and reproduction

- Preferred habitats include sunny to somewhat shady environments, humid atmosphere, drained or slightly moist soil:
  - alluvial environments impacted by human activities, near rivers
  - dryer environments, e.g. idle land, roadsides
- Asexual reproduction, primarily via rhizome fragments and stalk cuttings at nodes
- The two species and their hybrid are generally sterile in Europe

Documentation

- Hudin S., Vahrameev P. (coord.) 2010. Guide d'identification des plantes exotiques envahissant les milieux aquatiques et les berges du bassin Loire-Bretagne. Fédération des conservatoires d'espaces naturels, 45 pp.
- FCBN. Fact sheets on Japanese knotweed and giant knotweed, 4 pp. http://www.centrederessourcesloirenature.com/mediatheque/especes_inva/fiches_FCBN/Fiche%20-%20Reynoutria-japonica-sr.pdf; http://www.centrederessourcesloirenature.com/mediatheque/especes_inva/fiches_FCBN/Fiche%20-Reynoutria-sachalinensis_sr.pdf
- Artois-Picardie water agency, 2002. Fact sheets on animal and plant species likely to proliferate in the Artois-Picardie basin. Artois-Picardie water agency, 38 pp.
- United Kingdom Environmental Agency. 2006. Managing Japanese knotweed on development sites: the knotweed code of practice. United Kingdom Environmental Agency, Bristol. 72 pp.

Author: Emilie Mazaubert, Irstea

*1. Japanese knotweed (*Reynoutria japonica*).*
*2. Giant knotweed (*Reynoutria sachalinensis*).*
*3. Bohemian knotweed (*Reynoutria x bohemica*), a hybrid of the two other species.*
4. River banks colonised by knotweed.

Asian knotweed

(*Reynoutria* sp.)

Managing Japanese knotweed at the confluence of the Luye and Durance Rivers

Development board for the Durance River basin (SMAVD)

■ The SMAVD, a public river-basin territorial agency created in 1976, now groups 78 towns along the Durance River, the Vaucluse, Bouches-du-Rhône, Alpes-de-Haute-Provence and Hautes-Alpes departmental councils, and the regional council. The SMAVD was made responsible for managing the public fluvial domain along the Durance in 1982 and the board is active essentially in the fields of flood management, improved safety, sediment transport, the preservation and management of the natural heritage and management of the various uses of the domain.

■ The work to preserve and manage the natural heritage consists of maintaining and enhancing the riparian vegetation, creating wetlands, protecting remarkable natural areas, scientific monitoring of natural areas and creating fish passes (alone or in conjunction with EDF, the national electricity company), etc. Since 2006, the SMAVD has managed the Durance Natura 2000 site.

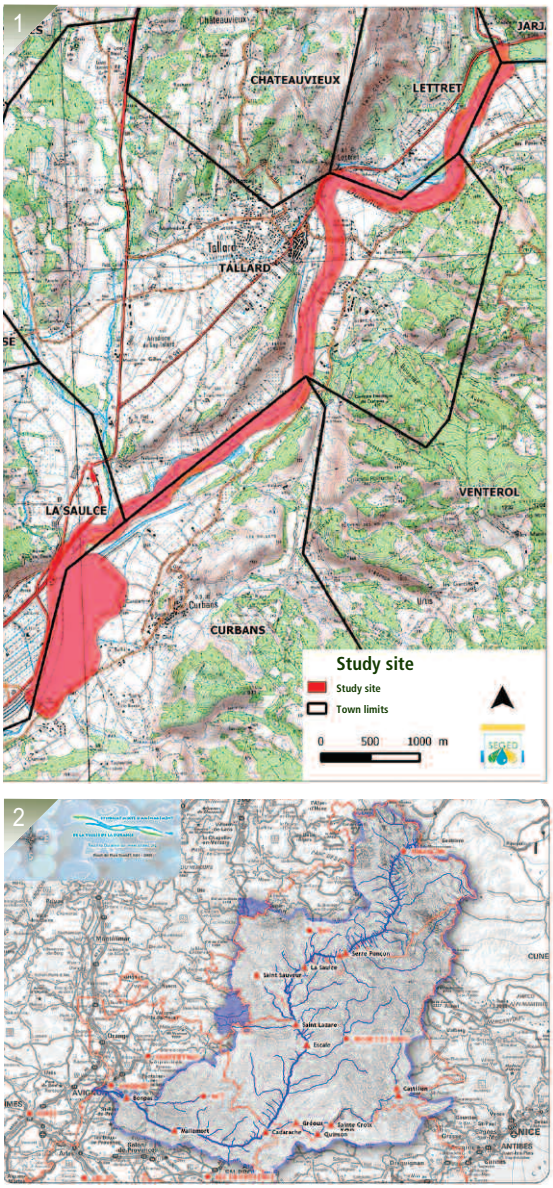
■ Contact: Laure Moreau - laure.moreau@smavd.org

Intervention site

■ The Durance originates at the Montgenèvre mountain pass and flows into the Rhône 305 kilometres downstream. The river basin covers a surface area of approximately 14 280 square kilometres (about half of the entire Provence-Alpes-Côte-d'Azur region) and at least part of six departments in the region, plus a small section of the Drôme department.

■ Since 2004, the Durance, at the point where it is joined by the Luye River, has been heavily colonised by Japanese knotweed that was introduced in the area around the town of Gap. Floods along the Luye spread the knotweed to the confluence with the Durance. The hydrological regime of the Durance slowed the colonisation process of the knotweed, but the higher regime and the releases of large amounts of water since 2008 caused bank erosion in certain sectors that had been colonised by knotweed. As a result, the species was disseminated over a distance of approximately five kilometres downstream of the confluence with the Luye.

■ The intervention zone is located in the towns of Curbans and Venterol in the Alpes-de-Haute-Provence department and in the towns of Saulce, Tallard, Lettret and Jarjayes in the Hautes-Alpes department. EU-listed habitats exist within the intervention zone, including stands of grey alder and white willows. These habitats are home to a large number of EU-listed species, e.g. the black kite and the Eurasian beaver. A large number of invasive alien species (IASs) have also been observed, e.g. giant goldenrod, Kashmir balsam, box elder, Virginia creeper, pale galingale, ailanthus and summer lilac.



© SMAVD

© SMAVD

1.2. Intervention sites.

Disturbances and issues involved

■ Impact on native plants and on habitats

■ In some places, other species can be eliminated by Japanese knotweed through competition and a reduction of sunlight. Large stands of knotweed reduce the diversity of habitats. The plant can snuff out the regeneration of other riparian vegetation. The habitat and its functions for other species are degraded.

■ Impact on the landscape and on human activities

■ The plants produce a more uniform landscape and make access to and circulation on river banks more difficult.

Interventions

■ Management campaign in 2011

■ An initial management campaign against knotweed was carried out in 2011. Following a map-based assessment by EDF in 2010, the priority efforts to eradicate the plants were launched in the stands most heavily eroded by the floods and along the flow channels enabling the dispersal of the plants in the riparian vegetation. In April 2011, mechanical extraction techniques were employed, followed by grinding and tarping of the soil. Barriers were installed to block access to the riparian vegetation. A total of 2 075 cubic metres of material were removed and treated.

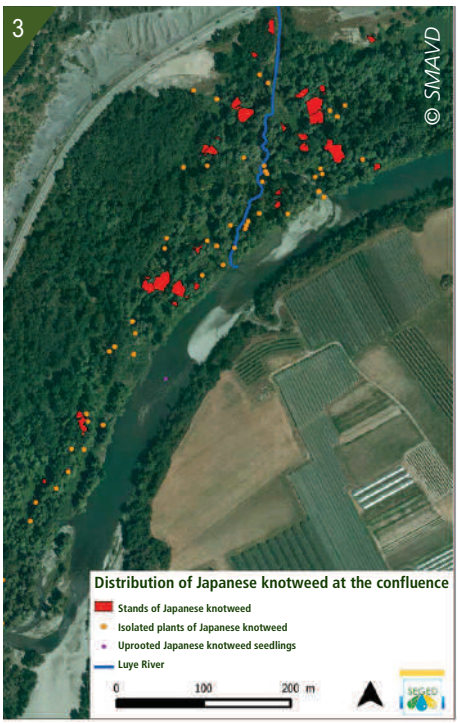
■ In 2012, seedlings were manually uprooted along side channels containing water in the sector from the confluence to the Saulce dam. In 2013, the hydrological conditions during the spring did not allow for a second manual campaign. In 2014, a few knotweed plants were observed outside the tarped areas and along the access trails in spite of the precautions taken by the companies involved.

■ Survey in 2014

■ The survey was carried out by two ecologists over a total of nine days during the months of April, May and June 2014. The technique consisted of walking along the foot of each bank and on the sand bars in the middle of the river, throughout the entire study area. Knotweed points (individual plants) and stands were located using a GPS device. Recorded information included the diameter and average height of the stalks, as well as the type of colonised environment. Stakes were placed around knotweed stands to locate them again more easily. A total of 28 stands as well as 59 points were staked out.

■ Along the Luye, numerous stands of knotweed upstream of the surveyed area represented a risk of contamination and caused a high concentration of Japanese knotweed at the point of confluence between the Luye and the Durance. Knotweed densities dropped with the distance downstream from the confluence. The observed plants furthest downstream were located six kilometres from the confluence.

■ In comparison with the surveys run in 2011, the overall number of points had decreased, notably on the right bank of the Luye, but new points had appeared along the upstream section of the river. Renewed growth was observed in several areas, notably the downstream section of the Durance where a point not observed in 2011 was also noted.



3. Distribution of Japanese knotweed on the study site in 2014.
4. Japanese knotweed in the riparian vegetation.

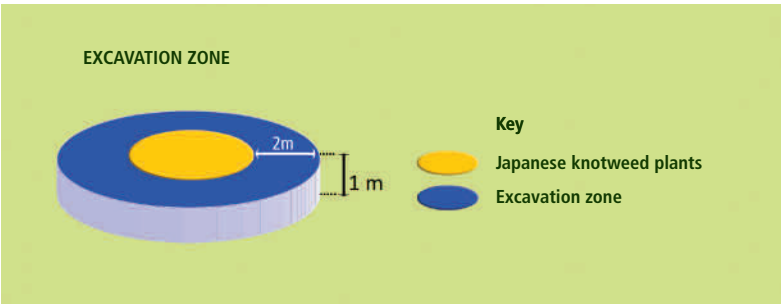
■ Mechanical removal, manual removal and felling of trees

■ The results of the first eradication campaign were encouraging and it was decided to launch a second phase of work in the area following the survey in 2014. Several technical approaches were studied:

- mechanical removal (excavation) of the plants;
- mechanical combined with manual removal;
- mechanical combined with manual removal and targeted felling of trees in the removal zone;
- targeted removal of the plants;
- no intervention.

■ After comparing the various techniques, mechanical and manual removal with targeted felling of trees in the removal zone was selected. Mechanical removal consists of digging up the soil in a circle running two metres beyond the last stalks and to a depth of one metre.

Diagram showing the extent of mechanical removal.



■ Prior to starting the work, cleaning areas for the machines had to be established to avoid any risk of disseminating IASs (invasive alien species). The type of machine used depends on the available access, e.g. a tracked excavator, a tractor with a trailer, a front-end loader, a dumper, etc.

■ The presence of knotweed in the immediate vicinity of trees in the riparian vegetation hindered mechanical removal and made it necessary to cut the trees on certain sites, however the numbers cut were limited to a strict minimum in order to avoid creating clearings (sunlight). Selective cutting was done within one metre around the outermost stalks of the stand mixed in with the trees. Trees along ditches and at distances greater than one metre around the outermost stalks of the stand were kept wherever possible. In the work areas, the plants were removed as carefully as possible mechanically and manually to uproot a maximum amount of rhizomes without damaging the trees, using shovels, pickaxes and a mechanised wheelbarrow to load and move the waste.

■ This technique diminished the impacts on the riparian vegetation by limiting both the number of trees cut and the risks of colonisation by other IASs through excessive opening of the environment due to the cutting of trees and the creation of tracks. Prior to cutting trees, an ecologist checked them for cavities conducive to bats and artificial nesting spots were created. The overall figures for the project were the following:

- mechanical removal was used for 28 stands and 39 plants;
- manual removal was used for 20 plants;
- the total volume of soil removed was previously estimated at 3 363 cubic metres.

5. Rhizomes waiting to be ground up.
6. Storage area.

Number of Japanese knotweed plants/stands in the study area and estimated volume of soil removed.

	Mechanical removal						Manual removal					
	Left bank of the Luye			Right bank of the Luye			Left bank of the Luye			Right bank of the Luye		
	Number	Surface area (m^2)	Volume removed (m^3)	Number	Surface area (m^2)	Volume removed (m^3)	Number	Surface area (m^2)	Volume removed (m^3)	Number	Surface area (m^2)	Volume removed (m^3)
Stands												
Isolated plants		125.6	125.6		364.24	364.24		125.6	125.6		364.24	364.24
Total		1 430.6	1 430.6		1 913.24	1 913.24		1 430.6	1 430.6		1 913.24	1 913.24

■ Waste management and treatment of the contaminated soil

■ The soil was treated using the “grinding-tarping” technique. The soil was ground using a stone grinder to fragment the rhizomes and damage the fine roots:

- the dried soil was spread in a layer ten centimetres thick;
- it was ground in one direction, then a second time in the perpendicular direction and finally stored in piles 1.2 metres high;
- the machines were systematically cleaned before leaving the site.

■ The soil was then covered for several months with opaque tarps that were not waterproof in order to block photosynthesis, but enable the rhizomes to rot:

- a double layer of tarp was placed over the soil;
- the edges of the tarps were extended a full metre in all directions;
- various materials were placed on the tarps to keep them in place;
- a fence was put up to keep large animals from damaging the tarps.

■ Two storage areas, 3 047 and 3 900 square metres in size, were created, the first on the left bank and the second on the right bank of the Luye. At the end of the work, a control group of rhizomes was laid out on each storage site to monitor the rotting process. Each group comprised five rhizomes with two nodes and five with one node, buried ten centimetres under the ground and tarped soil.

■ Planting willows

■ In addition to the work described above, willow cuttings were planted in order to:

- restore the native plant communities (white willows);
- create a cover for the bared surfaces to limit the risks of them being colonised by invasive species;
- compete with the knotweed in the worked areas, particularly where any residual rhizomes remained.

■ The cuttings must be planted in the spring or fall, before freezing temperatures, in densities of four to five cuttings per square metre. Purple willow, almond willow, bitter willow and white willow are the recommended species for cuttings.

■ Work schedule

■ July-August 2015

Preparation of the work sites, installation of the storage areas, clearing of access trails, cutting of trees and checks on hollow trees.

■ September 2015

Mechanical and manual removal of the plants, grinding of the soil, grinding of tree trunks.

■ October 2015

Placing the tarps on the soil, securing the sites, removal of the site installations and execution of the inspection plan.

■ April 2016

First passage over the worked areas (manual uprooting of seedlings) and planting of the willow cuttings, inspection of the storage areas.

■ October 2016

Second passage over the worked areas.

■ April 2017

Third passage and checks on the growth of the willows.

Results and costs

■ Technical results of the work

■ A total of 39 stands and 59 isolated plants were treated over a surface area of almost 4 000 square metres (three additional stands were discovered and treated during the work). The volume of removed material was close to 4 000 cubic metres. One hundred trees were cut. The work techniques adopted made it possible to avoid cutting 210 trees on the work sites.

■ It was finally decided not to plant willow cuttings on certain sites because some excavated areas were of more ecological value as a string of ponds. A number of large excavated areas were partially planted with willow cuttings to create shade for those areas. The access tracks were restored and replanted. The fence was checked and all cables were tightened. The tarps were checked to ensure that they were still correctly positioned.

■ In April 2016, a check was run on the excavated areas, on the soil contaminated by the knotweed, on the tracks and on the other sectors affected by the work:

- on the left and right banks of the Luye, a few rhizomes were collected in the bottom of the excavated areas. A larger number of sprouts were found among the vegetation developing on the vertical banks of the excavated areas. They continued well beyond the two metres around the knotweed stands marked with stakes. The plants and rhizomes were completely uprooted. On the tracks, five rhizome fragments were collected;
- all 12 isolated points along the Durance were inspected. A few rhizome fragments were collected and burned.

■ Two stages of vegetation development were observed. First, a number of very young plants sprouting from small fragments of rhizome rootlets, and secondly, a more advanced stage of plants with stalks 20 to 40 cm high, sprouting from rhizomes cut during the excavation work. Given the differences between the two stages, prolonged monitoring of the sites was considered necessary. All the sites were inspected again in June 2016. A volume of plants equivalent to 15 bags containing 80 litres each (1.2 cubic metres) was removed, primarily from the sides of the excavated holes and from the root system of the trees.

■ Financial aspects

■ The work was carried out in the framework of the Val de Durance river contract. The total cost was 138 000 euros including VAT.

■ Source of funding: Rhône-Méditerranée-Corse water agency (30%), Provence-Alpes-Côte-d'Azur region (30%), SMAVD internal funding (40%).

7. Storage area.
8 and 10. Excavated ponds
9. Recreated ponds.
11 et 12.Knotweed shoots sprouting from rhizomes in the soil. June 2016.

Budget. More detailed information on costs on request.

Work	Total cost ex. VAT (euros)
Preparatory work	21 796
Earthwork and grinding	54 137
Tarping, seeding and planting	19 451
Management and treatment of any waste discovered during the work	3 305
Monitoring and passage for uprooting	3 920
Inspections	2 450
Fence and storage area	9 470
TOTAL	114 799

Outlook

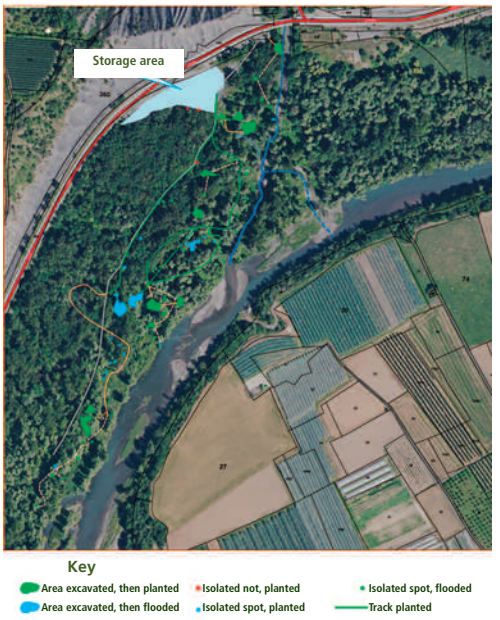
■ Following a new assessment, the new sprouts will be treated in 2017. The storage areas will be restored to their original condition in 2018.

Information on the project

■ Articles in the local press covered the two eradication campaigns. Local elected officials visited the site in February 2016.

Authors: Emmanuelle Sarat (IUCN French committee), Laure Moreau and François Boca (SMAVD). February 2017.

13 **Inspection plan for the planted zones and tracks Right bank of the Luye**



13. Inspection plan for the planted zones on the right bank of the Luye.

For more information

■ SMAVD internet site: http://www.smavd.org/

■ SMAVD. 2015. Éradication de la Renouée du Japon à la confluence Luye/Durance. Rapport de fin de chantier 2015. 7 pp.

■ SEGED-SMAVD. 2015. Éradication de la Renouée du Japon à la confluence Luye/Durance : dossier de projet. 89 pp

2018 edition

Asian knotweed

(*Reynoutria* spp.)

Experiments to manage Japanese knotweed in the Saint-Pierre-et-Miquelon archipelago

Saint-Pierre-et-Miquelon departmental territorial and maritime directorate (DTAM 975)

■ The management programme for Asian knotweed was financed by DTAM, a part of the Ecology ministry. The Saint-Pierre-et-Miquelon DTAM is an interministerial agency of the French State under the authority of the Prefect. The main objective is to protect the natural heritage and living conditions in the Saint-Pierre-et-Miquelon archipelago.

■ The main missions include:

- improving knowledge on invasive alien species (IAS) and natural environments, protecting and conserving species and ecosystems;
- preventing the spread of IASs in Saint-Pierre-et-Miquelon;
- informing the public on the work undertaken.

■ Contact: Frank Urtizberea – DTAM 975, Agriculture, food, water and biodiversity department (SAAEB) - frank.urtizberea@equipement-agriculture.gouv.fr

Intervention site

■ Saint-Pierre-et-Miquelon is a group of seven islands (Saint-Pierre, Miquelon, Langlade, Colombier, Île aux Marins, Île Pigeon, Île Vainqueur) covering a total surface area of 242 square kilometres and located less than 20 kilometres from the southern coast of Newfoundland. The archipelago comprises significant biodiversity and the only boreal forest in France, but also a large number of marshes, peat bogs, grasslands, heathlands and fir forests. The soil is generally poor in nutrients, acid and worn down by both glacial erosion and the climate.

■ The importation of fodder, wood, ornamental plants and the great dependence on neighbouring Canada has resulted in the introduction of many plant species. A total of 136 vascular plants have been introduced, representing 30% of the flora on the islands. The boreal environment is highly sensitive to these disturbances. However, the climate and the environmental quality of the islands constitute an obstacle for plant invasions and only some 20 grass species risk becoming truly invasive. That being said, climate change may lessen that obstacle.

1. Map showing the location of knotweed on Saint-Pierre.

Disturbances and issues involved

■ Seven species of knotweed have been observed on Saint-Pierre-et-Miquelon, namely Japanese knotweed (*Reynoutria japonica*), Himalayan knotweed (*Polygonum polystachum*), common knotgrass (*Polygonum aviculare*), pale persicaria (*Polygonum lapathifolium*), spotted knotweed (*Polygonum persicaria*), arrowleaf tearthumb (*Polygonum sagittatum*) and wild buckwheat (*Polygonum convolvulus*).

■ Japanese knotweed was introduced in 1940 to the archipelago and has progressively colonised numerous areas. Observations have revealed that the areas colonised are gaining in size, notably due to environmental disturbances caused by human activities in areas surrounding towns and in natural areas. The humid nature of the soil and the virtual lack of shade also facilitate the spread of the species.

■ Its colonisation of the islands has also caused a drop in the local plant and animal diversity. The slow decomposition of the litter produced by the plant forms a thick layer of organic matter that hinders the germination of native species.

Interventions

■ Objective of the interventions

■ The purpose of the work was to propose, experiment and implement management methods for Asian knotweed in view of eliminating the species (*R. japonica)*. The work also included efforts to raise awareness, inform and prevent the establishment and spread of new plant IASs in the archipelago.

■ Participation of other stakeholders and partners

■ Also involved in the work were a local environmental-protection group (SPM Frag'îles) and a local company that provided the necessary machines and equipment.

■ Mapping and monitoring

■ As the first step, all public land colonised by knotweed (Japanese and Himalayan) on the islands of Saint-Pierre, Miquelon-Langlade and Île aux Marins was precisely mapped. A team of four people equipped with a GPS, a tape measure and a pH meter travelled the islands during the summer period (23 June to 1 July 2010). The position and size of the knotweed stands was recorded, as was the soil pH data. A total of 497 knotweed stands, covering 25 231 square metres, were found (Table 1).

Sites	Number of stands	Surface area (m²)
Saint-Pierre	435	22 315
Miquelon	28	575
Langlade	5	428
Île aux Marins	29	1 918
TOTAL	497	25 231

Table 1. Number of stands detected and their total surface area.

■ The pH values recorded for each stand ranged from 4.5 to 7, with an average of 6.4, indicating that knotweed plants prefer slightly acidic soil. The growth rate of Japanese knotweed was observed on a plot over a period of 47 days.

■ Identification of priority zones

■ Work priority levels were defined for each of the mapped stands on the basis of two criteria:

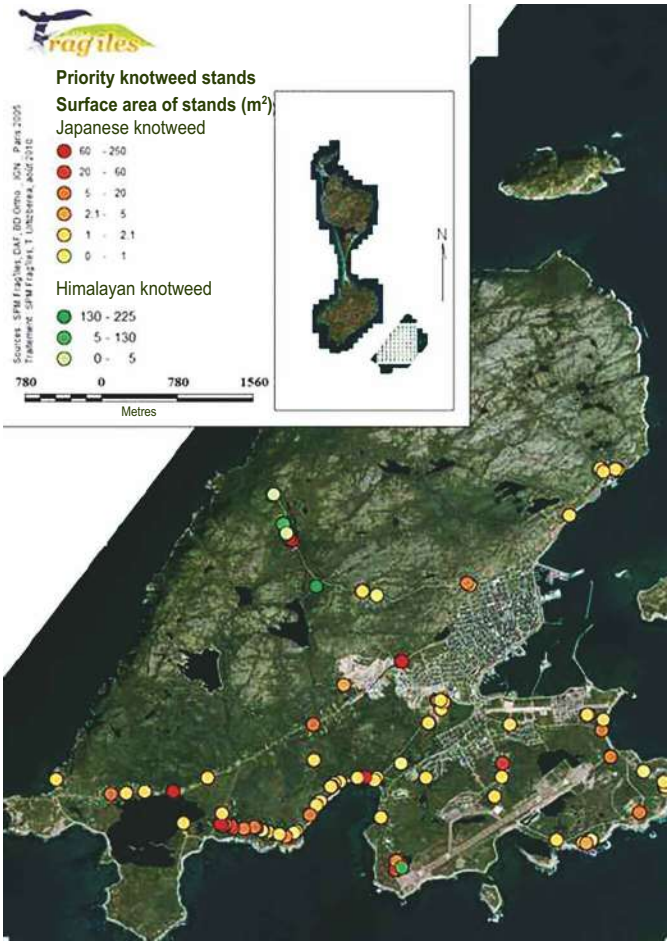
- the proximity of the stand to the natural environment, e.g. near a pond, a stream, along a forest, etc.;
- the size of the stand (management of small stands is less costly and more effective).

■ Out of the 497 stands of knotweed mapped, 151 with a total surface area of almost 3 800 square metres were ranked as priority stands (Table 2). Given the very small number of stands on Miquelon and Langlade, all of them were designated as priority stands.

2. 3. 4. Typical Saint-Pierre-et-Miquelon landscapes.
5. A stand of knotweed.

Sites	Number of priority stands	Surface area (m²)
Saint-Pierre	117	2 787
Miquelon	28	575
Langlade	5	428
Île aux Marins	1	1
TOTAL	151	3 786

Table 2. Stands designated as priorities for work.



Example of a map showing the priority stands of knotweed on Saint-Pierre.

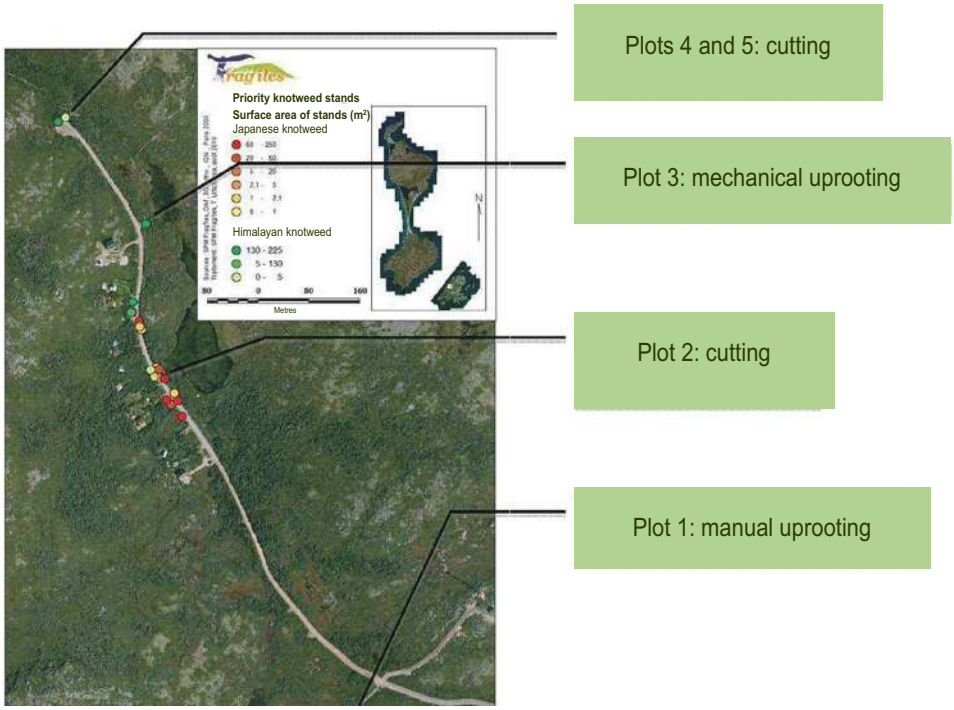
6. 7. Collecting data in the field.
8. Manual cutting of knotweed.

■ Description of the interventions

■ After analysing and comparing the various methods experimented in France, Switzerland and the U.K., it was decided to test three techniques (cutting, manual uprooting and mechanical uprooting) on the Japanese knotweed. On Saint-Pierre, the techniques were tested on five plots. On Miquelon, only manual uprooting was tested.

■ *Manual-uprooting technique:*

- manual cutting of the knotweed, gathering of the plants, raking and gathering any plant debris, storage in the large bags;



Experiments carried out on Saint-Pierre.

- uprooting and collection of the rhizomes, storage on a tarp, then in the large bags. The waste was transported by a specialised company (Impermembrane) to a recycling depot;
- restoration of the area in the fall by planting native species (alder and fir);
- the equipment used included 2 rakes, 1 shovel, 2 pickaxes, 1 metal rod, large collection bags and personal protective equipment;
- human resources: 4 workers.

■ *Mechanical-uprooting technique:*
- manual cutting, raking and removal of debris (similar to manual uprooting);
- removal of a layer of top soil using a small excavator (scraping to a depth of 40 cm), sieving the soil (grid 5 x 5 cm) to recover any remaining rhizomes;
- sections around the plot difficult to access were handled manually;
- removal of the waste for processing by a specialised company;
- restoration of the area in the fall by planting native species;
- the equipment used included 1 small excavator, 2 rakes, 2 shovels, a large screen as a sieve, 2 pickaxes, 2 wheelbarrows, large collection bags and personal protective equipment;
- human resources: 4 workers and 1 excavator operator.

■ Special precautions were taken to avoid dispersal of the knotweed during the work, e.g. storage and burning of the waste, limited movements of machines and equipment, rigorous cleaning of machines and equipment before leaving the site.

■ A decision-aid document was drafted to assist in selecting the work method for each stand of knotweed (see below).

■ Monitoring the plots

■ Annual monitoring of the plots was carried out for at least two years. Any new shoots were uprooted during the monitoring visits. The volume of waste removed from the plots was not calculated.

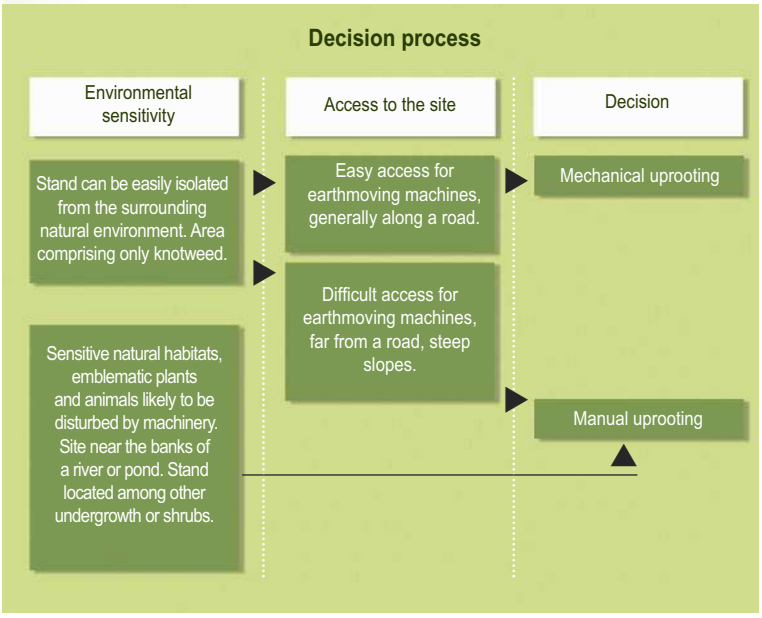


Diagram showing the decision process for work techniques depending on the environmental sensitivity of the site and access.

Results and costs

■ Results

The experiments demonstrated the effectiveness of the techniques, but did not succeed in totally eradicating the knotweed. The density fell considerably on the treated sites, with just a few shoots remaining. It may be hoped that after four or five years of work, the level of knotweed presence will have dropped to the point that the work will no longer consist of major interventions, but of simple maintenance.

■ Human and financial aspects

Item	Cost in euros
Salary of the project manager (two months)	6 000
Salaries of the workers (4 people x 1.5 months)	12 000
40 large bags (sealable) for the plant waste	1 000
Rental of a truck and container to transport the waste to the recycling depot	500
GPS (5-metre accuracy)	400
Instrument to measure soil hygrometry and pH	300
Tools and gloves for manual uprooting	1 000
Supplies (computers, mapping, report, etc.)	300
Travel around the islands during mapping and monitoring	500
Total	22 000

Table of intervention costs (2010).

9. Storage in large bags for collection.
10. Uprooting, collection and storage of rhizomes.
11. Removal of the waste.
12. Scraping the surface with the small excavator.
13. Sieving the soil.

Information on the project

- Informational document for the general public.
- Signs on the work sites presenting knotweed, its impact and the techniques employed.

Outlook

- Due to insufficient funding, the management experiments were interrupted after the first year.

Authors: Emmanuelle Sarat, IUCN France, and Frank Urtizberea, DTAM 975 SAAEB. February 2017.

14

15

14. 15. Examples of informational documents.

For more information

- Claireaux M., Hacala A., Quedinet P., Urtizberea T. et Lemallier E., 2010. Lutte contre les espèces exotiques envahissantes végétales sur l'archipel de Saint-Pierre-et-Miquelon. SPM Frag'îles. 41 pp + annexes.
- Soubeyran Y., 2008. Espèces exotiques envahissantes dans les collectivités françaises d'outre-mer. État des lieux et recommandations. Collection Planète Nature. Comité français de l'UICN, Paris, France.

2018 edition

© G. Mittelhauser

Smooth cordgrass

(Spartina alterniflora)

Classification	
Order	Poales
Family	*Poaceae*
Genus	*Spartina*
Species	*S. alterniflora* (Loiseleur, 1807)

Originated in the United States and Canada. Introduced into France in the 1800s, probably via maritime transport and ballast water.

Description

- A perennial grass, smooth surfaces
- Upright leaves, grey-green in colour, flat or canaliculate, from 20 to 55 cm long and 5 cm wide
- The stalk is 60 cm to 1.2 metres tall and up to 2 cm wide at the base
- The panicle is 10 to 40 cm long, with numerous branches closely spaced
- The seeds are elongated, between 0.5 and 1 cm long
- The rhizomes spread horizontally and produce stolons

Ecology and reproduction

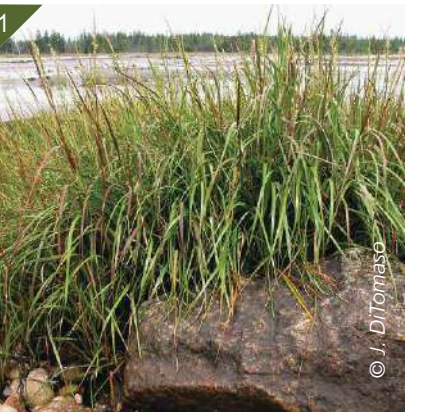
- The plants can develop in different types of littoral wetlands (intertidal zones), e.g. salt meadows, mud flats (slikkes), lagoons
- They can accept high salt concentrations and daily submersions
- They can take root on different substrates, e.g. sand, silt, gravel
- They disperse via seeds produced by sexual reproduction
- Clumps of plants propagate via the stolons

Documentation

- Hudin S., Vahrameev P. *et al.*, 2010. Guide d'identification des plantes exotiques envahissant les milieux aquatiques et les berges du bassin Loire-Bretagne. Fédération des conservatoires d'espaces naturels, 45 pp.
- Télabotanica. 2016. E-flora fact sheet for *Spartina alterniflora*.

http://www.tela-botanica.org/bdtfx-nn-65440-synthese

Author: Emmanuelle Sarat, IUCN French committee



Smooth cordgrass

(Spartina alterniflora)

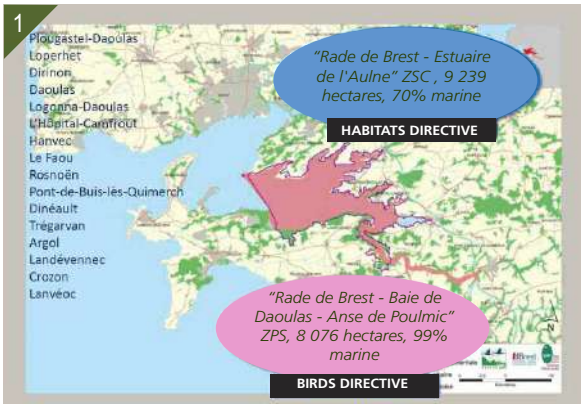
Managing smooth cordgrass in Brest bay (Finistère department)

Armorique regional nature park

■ The park, founded in 1969, covers an area of 130 000 hectares and 44 towns in the Finistère department, ranging from the islands in the Iroise Sea to the area east of the Monts d'Arrée hills.

■ Its missions include protecting and enhancing the natural and cultural heritage through suitable management of the natural environments and the landscapes, contributing to territorial development, to economic, social and cultural development and living conditions, ensuring the welcome, education and information of the public, conducting experimental and/or exemplary projects in the above fields and contributing to research programmes.

■ Contact: Agathe Larzillière - agathe.larzilliere@pnrarmorique.fr



© PNR Armorique.

1. The intervention sites (ZSC = special conservation zone, ZPS = special protection zone).

Intervention site

■ Management work is conducted in the "Rade de Brest - Estuaire de l'Aulne" and "Rade de Brest - Baie de Daoulas - Anse de Poulmic" Natura 2000 site operated by the park.

■ The work is done in five towns, namely Plougastel-Daoulas, Daoulas, Logonna-Daoulas, Hanvec and Rosnoën.

■ The hydrographic network on the site is dense and flows into the southern basin of Brest bay, which explains the presence of many small rivers comprising mud flats and salt meadows in the Aulne estuary.

Disturbances and issues involved

■ The EU-listed salt meadows on the site are threatened by the smooth cordgrass (*Spartina alterniflora*).

■ The species originated in the United States and Canada, and was introduced into France in the 1800s, probably via maritime transport and ballast water.

■ The rhizome-producing grass colonises environments and has a negative impact on many native plants in the salt meadows.

■ In soft mud, the plants can propagate up to one metre per year. A single cordgrass plant can, over a few decades, create a vast, single-species meadow covering several hectares.

■ A consequence of colonisation is the disappearance of salt-meadow plants typical to the Brest bay, e.g. sea purslane (*Halimione portulacoides*), *Salicornia* spp., sea aster (*Aster tripolium L.*), as well as lax-flowered sea-lavender (*Limonium humile*), a plant protected on the national level and whose sole presence in France is in Brest bay.

■ Large stands of smooth cordgrass accelerate the filling in and sedimentation of the small rivers and channels, and they cover mud flats. The probable consequence is a change in the benthic fauna, negatively affecting the fish and waders that feed in those areas (a study is now under way).

■ The colonisation of mud flats by smooth cordgrass is a major problem for mussel and shellfish farmers and for professional and recreational anglers.

■ The filling in of ports and channels by single-species stands of smooth cordgrass also creates problems for boating activities.

Interventions

■ The purpose of the work is to limit the proliferation of smooth cordgrass in particularly important sectors (protected species, sites for the reproduction, feeding and rest of birds) that are not yet heavily colonised, i.e. where the work is still technically feasible.

Discussions with other stakeholders and partners

■ A work group was established in 2010 to discuss site selection and work methods with researchers (European university institute for marine science), local managers of natural areas (Brest Métropole), the managing entities of the "Rade de Brest" SBMP, the National botanical conservatory in Brest, local groups (hunters in the maritime public domain) and environmental-protection groups (Bretagne Vivante), local governments, State services (Departmental territorial and maritime agency and the Maritime and littoral agency) and social reintegration associations.

Description of the interventions

■ A precise map of the sectors colonised by smooth cordgrass was drafted using photo-interpretation and contour GPS techniques.
■ The priority sectors for work were then defined on the basis of various criteria:
- type of substrate;
- emblematic sites, e.g. biologically diverse salt meadows, the presence of lax-flowered sea-lavender (*Limonium humile*);
- the importance for birds (reproduction and nesting sites, etc.);
- the degree of colonisation and the residual surface of the salt meadows;
- site accessibility.

A number of management methods were tested in parallel on the sites:
- mowing;
- uprooting;
- scraping the surface;
- digging containment trenches;
- tarping.

■ Equipment used:
- sickle;
- brush cutter;
- spade;
- garden fork;
- excavator;
- agricultural tarp;
- hand shovel.

■ Scraping the surface is used in areas where the ground is harder or contains gravel, but only for surface areas of less than five square metres.
■ Containment trenches are a technique used for larger areas where the ground is harder or contains gravel, i.e. for colonised surface areas of less than 100 square metres.
■ Tarping is reserved for colonised surface areas of less than ten square metres.

■ Examples of interventions on three sites

■ Work site at Bendy, in the town of Logonna-Daoulas. The work consisted of digging trenches, removing plants using garden forks and laying tarps.
■ Work site in Troaon. The work consisted of digging trenches and laying tarps.
■ Work site in Daoulas with the creation of a multi-test zone. The tests consisted of tarping for two, three and four years and tests on germination. The purpose of the experiments is to check whether a fragment of rhizome is sufficient or an entire rhizome is required to produce a new plant in a favourable environment (bare mud flat). The results may confirm the importance of avoiding any dissemination of rhizomes. Seeds were voluntarily planted *in situ* to check whether the plants reproduce sexually (the hybrid is thought to be sterile according the the National botanical conservatory in Brest).

2

3

4

*2. Lax-flowered sea lavender (*Limonium humile*).*
3. Area colonised by smooth cordgrass.
4. Cordgrass removal by scraping the surface, done by the Finistère group of hunters in the maritime public domain, in a partnership with Brest Métropole, the European university institute for marine science, the Armorique regional nature park and Bretagne Vivante.

■ Scientific monitoring

■ Several monitoring sites for smooth cordgrass were established in 2011 by the LEMAR lab (European university institute for marine science). Phytosociological surveys are also carried out at specific spots or along transects.

■ The resulting chronological data are used to precisely analyse the expansion process and speed of smooth cordgrass within the vegetation in salt meadows. This monitoring provides valuable information that usefully complements mapping.

■ Unfortunately, due to a lack of funding, the monitoring had to be suspended except on the “Ria du Faou” site.

■ Waste management

■ The smooth cordgrass removed by scraping the surface of small plots less than five square metres in size was transported to a farm or to an area in the immediate proximity of the work site, taking care to ensure that it was placed well above the high-water mark (embankments) to avoid any risk of later dissemination.

■ The clumps of soil produced by digging the containment trenches outside of colonised areas were left on site because they did not contain any smooth cordgrass.

Results and costs

■ The experiments conducted since 2011 by the Armorique regional nature park and its partners were an occasion to test various techniques. A certain number were dropped (inefficient, physically difficult or overly expensive) given the poor results obtained:

- uprooting, mowing;
- removal stalk by stalk, except when mixed with stands of lax-flowered sea lavender *(Limonium humile*), for example;
- scraping the surface of soft mud;
- trampling.

■ Other techniques proved more effective and may be used on other sites:

- scraping and removal stalk by stalk on substrates containing gravel;
- mechanical means (if access by land is easy, however it would be useful to test access by sea);
- tarping for a long period (five years);
- isolating small stands of smooth cordgrass by digging shallow trenches around them;
- repeated mowing prior to flowering.

■ Results

■ No regrowth was observed in the scraped zones, on the condition that the rhizomes were completely removed.

■ According to an experiment conducted by the National botanical conservatory between 2005 and 2010, tarps must remain in place for five years before the rhizomes are completely destroyed. Tests are now under way on shorter durations.

■ *In situ* tests of rhizome germination are also being conducted.

5. 6. 7. 8. Digging a ditch.

Results on three sites

	Bendy	Troan	Daoulas
Technique	Trenches, removing plants using garden forks and laying tarps	Trenches and laying tarps	Multi-test zone for tarping and germination tests (in progress)
Work days	2 days in 2012 2 days in 2013 1 day in 2014 1 day in 2015	2 days in 2014	1 day in 2015
Treated surface area	1.5 hectare	112 sq. metres	16 sq. metres
Number of people	2011: 4 people 2013: 10 people 2014: 8 people 2015: 10 people	10 people	10 people
Results	No regrowth in sectors treated with garden forks on substrates containing gravel. Regrowth and progression in sectors of soft mud. The smooth cordgrass did not cross trenches (except where trenches became filled in, hence the need to rework the trenches every two years).	The tarped plants were rapidly destroyed. In the spot where the tarp was accidentally removed, the plants regrew. The clips on the tarp held well, but the ends of the tarp exposed to strong currents were torn. The smooth cordgrass did not cross trenches.	Tarp well set in spite of an outlet with a high outflow. No germination has been observed for the time being.

9. 10. Laying tarps.

Human and financial aspects

- Scraping a colonised surface less than five square metres in size can be done by one person in a half-day.
- Digging a metre of ditch takes one person five to ten minutes.
- To date, the work on sites has been done by volunteers.
- In 2015, an intervention was organised by a non-profit that specialises in “eco-volunteer” projects. * The cost was 1 000 euros for the two-day project.
- The cost of the tools purchased in 2011 (shovels, pick-axes, forks, tarps, hand shovels, duckboards, pails, funded by Brest Métropole) was approximately 1 000 euros (the excavator is not included in this total).
- The participation of a park employee was not calculated, but may be estimated at 5 000 euros since 2011.
- The tarps cost 0.25 to 0.50 euros per square metre.
- The excavator was lent free of cost by the hunting group.

■ Intervention costs in euros (2011-2015)

	2011	2012	2013	2014	2015	TOTAL
Number of work projects	2	3	1	2	2	10
Cost of work	0 (volunteers)	0 (volunteers)	0 (volunteers)	0 (volunteers)	1 000 (eco-volunteer project)	1 000
Cost of tools/equipment (tarp)	1 000 (in 2011)	0	0	0	30 (tarp)	1 030
Management costs	1 400	1 400	600	1 200	800	5 400
People involved (total per year)	40	30	12	18	18	118
Work days	5	5	1	4	2	17

Information on the project

■ Since 2010, each work project has been the topic of at least one press article. Public opinion is, on the whole, highly positive concerning the work. The articles have raised awareness concerning the problem.

■ A public meeting on smooth cordgrass was held in the town of Faou in 2015. The results were positive with 20 people attending and new volunteers signing up for work projects in their town. New projects are planned in the framework of the "Citizen days" organised by the town.

■ A report on the work was broadcast by France 3 Iroise television in 2011.

Outlook

■ A "2016 action plan" is being set up in a partnership with the Agency for protected marine zones. Extensive work is planned in several towns, namely Loperhet, Hanvec, Le Faou, Argol and Pont-de-Buis les Quimerc'h. Firms specialised in this type of work and volunteers will take part.

■ The search for funding will be pursued to continue the work on the sites and avoid regrowth, and to open new sites in the priority zones.

■ A study is planned on the impact of smooth cordgrass on benthic fauna, migratory fish and birds hibernating in the area, in a partnership with local research organisations (European university institute for marine science).

■ A second partnership is now under way with the institute to test the resistance of smooth cordgrass to flooding under laboratory conditions. Further tests will be conducted *in situ*.

Author: Agathe Larzillière, Armorique regional nature park. January 2016.

For more information

■ Internet site of the Armorique regional nature park: http://www.pnrarmorique.fr/Agir/Preserver-labio-diversite/Lutte-contre-les-especesinvasives/La-spartine-americaine *Spartina-alterniflora*

■ Querne J. 2011, Invasion de *Spartina alterniflora* dans les marais de la rade de Brest. Comportement invasif et impact sur le cycle biogéochimique du silicium. 217 pp.

■ Toupet J. 2010, Quelles solutions de gestion pour l'espèce invasive, *Spartina alterniflora*, en rade de Brest ? État des connaissances, synthèse bibliographique et perspectives de travail, rapport de stage de Master 1, Institut universitaire européen de la mer. 84 pp.

■ Le Noac'h J. 2011, Mise en place d'une gestion expérimentale d'une plante invasive en rade de Brest, *Spartina alterniflora*, rapport de stage de master 1, Parc naturel régional d'Armorique et Institut universitaire européen de la mer. 63 pp.

■ Hourdé M. 2014, Mise en place d'un plan opérationnel de lutte contre l'invasion de l'espèce invasive *Spartina alterniflora* dans les sites Natura 2000 « Rade de Brest », Parc naturel régional d'Armorique. 47 pp.

■ Larzillière A. 2014. Document d'objectifs Natura 2000 – Rade de Brest-Estuaire de l'Aulne et Rade de Brest-Baie de Daoulas-Anse du Poulmic, tome 3 : Actions et opérations. Parc naturel régional d'Armorique, Brest métropole océane, Dreal Bretagne, 385 pp.

2018 edition

© R.H. Mohlenbrock

Lizard's tail

(*Saururus cernuus*)

Classification	
Order	*Piperales*
Family	*Saururaceae*
Genus	*Saururus*
Species	*S. cernuus* (Linné, 1753)

Originated in the eastern section of North America. May become troublesome in its natural range. Introduced in Europe as an ornamental plant and has become naturalised in some cases.

Description

- Perennial, herbaceous plant, ranging from 30 to 120 centimetres in height, with a highly characteristic zig-zagging stalk
- The rhizome can reach up to 5 metres in length
- Single, oblong, alternating leaves, heart-shaped at their base, from 10 to 12 cm long and 4 to 5 cm wide
- Spike inflorescence, in clusters, between 15 and 20 cm long
- Hermaphroditic flowers, 5 mm wide, with 6 free-standing stamens, 4 stigmates and 4 carpels almost free-standing two by two, on a whitish, petal-like sepal
- Flowers and leaves produce a pepper scent
- Fruit consists of 4 follicles, almost indehiscent, generally with a single seed

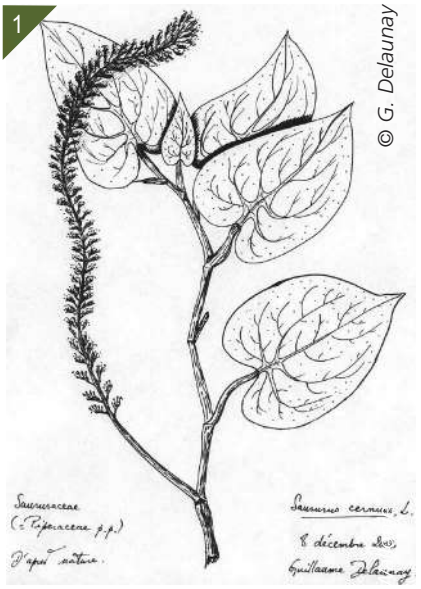
Ecology and reproduction

- Prefers marshes, river banks, the bottom of shallow streams, swampy, wet forests
- Vegetative characteristics, fragile and soft in streams. Erect stalks and strong branches on river banks
- Flowers during the summer (June to September). The species is self-incompatible, but produces numerous seeds through cross-pollination
- Vegetative multiplication by producing sprouts along its rhizomes and through the development of adventitious roots on submergent stalks

Documentation

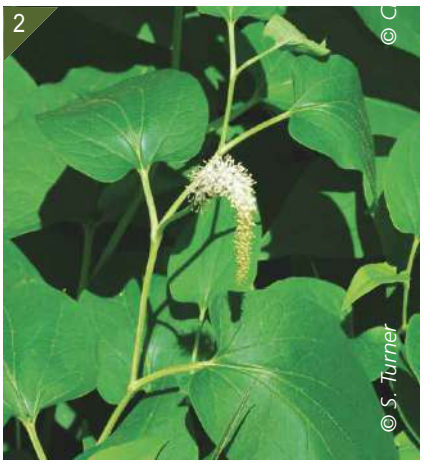
- Delaunay, G. 2005. Contribution à l'étude de la flore du Maine-et-Loire. Un exemple de gestion d'une xénophyte à caractère envahissant : cas de la Lézardelle penchée (*Saururus cernuus* L. Sauracées). Symbioses. 13: 29-31.
- Manual of the Alien Plants of Belgium. 2017. *Saururus cernuus*. [On line]. Document available at: http://alienplantsbelgium.be/content/saururus-cernuus
- GT IBMA. 2017. *Saururus cernuus*. Base d'information sur les invasions biologiques en milieux aquatiques. Groupe de travail national Invasions biologiques en milieux aquatiques. UICN France et Agence française pour la biodiversité. [On line]. Document available at: http://www.gt-ibma.eu/espece/saururus-cernuus/

1



© G. Delaunay

2



© S. Turner

3

© S. Turner

Riparian plants

Author: Doriane Blottière, IUCN French committee.

Lizard's tail

(*Saururus cernuus*)

Managing lizard's tail along the Loire River (Maine-et-Loire department)

Loire-Anjou-Touraine regional nature park

- The regional nature park, created in 1996, federates 117 towns in two departments (Indre-et-Loire and Maine-et-Loire) engaged in a major project to protect their patrimony and ensure best use of local resources.
- The missions assumed by the park focus on the protection and management of the natural and cultural patrimony, territorial planning, economic and social development, welcoming, educating and informing the public, and finally experimental projects and research.
- Contact: Guillaume Delaunay, manager for natural patrimony - g.delaunay@parc-loire-anjou-touraine.fr

Intervention site

- The site is located in the bed of the Loire River, in the Souzay side channel in the town of Souzay-Champigny.
- It is part of the "Vallée de la Loire des Ponts de Cé à Montsoreau" Natura 2000 site that is home to a number of EU-listed habitats and species.
- The lizard's tail was discovered by accident on 16 September 2002 during a field trip on the dewatered sand bars. Two other invasive alien species, with which the lizard's tail may compete, were also discovered on the same site, namely water finger grass (*Paspalum distichum*) and large-flower water primrose (*Ludwigia grandiflora*).
- In November 2003, the lizard's tail had formed a single-species colony covering approximately 70 square metres. The area around the colony was systematically inspected to check if there were other colonies in the vicinity, but none were found.

Disturbances and issues involved

- This perennial, helophyte species, capable of strong growth in favourable environments, can compete with native plant species and contribute to the degradation of EU-listed habitats.
- Along water bodies, the plants can develop strong branches and stalks up to 1.5 metres high.
- They can resist freezing temperatures and winter flooding.

© PNR Loire Anjou Touraine

© PNR Loire Anjou Touraine

1. Map showing the Loire-Anjou-Touraine regional nature park.
2. Map showing the intervention site (red star) on the Loire River.

They multiply vegetatively via long rhizomes with many branches.

- The plants are still very rare in France, but their invasive potential has been demonstrated in wetlands in parts of the world where it is alien (e.g. New Zealand).
- To date, no studies have been carried out on its possible impacts on the local biodiversity and on human uses of the river.

Interventions

■ Given the invasive potential of lizard's tail, it was decided to eliminate the plants in the framework of the Natura 2000 management programme for the site.

■ The work was done on 13 November 2003 because at that time of year, the site was dewatered and heavy equipment could easily access the zone.

■ The area to be cleared plus a three-metre border zone around the plant colony was marked with stakes and paint.

■ A bulldozer equipped with a bucket scooped up the plants and sediment to a depth of 1.5 to 2 metres. This depth was deemed sufficient because no root fragments were observed below a depth of one metre.

■ Additional manual uprooting was done as needed. The sediment and water flowing up from the deepest parts of the excavation were cleaned with a rake and the residual plant fragments were collected by hand.

■ The plant waste and sediment were stored in a dry quarry, on a well-drained site far from any wetland, in a high area of the town. The storage site was visited one year later to check that the plants had not started to grow again.

3. Aerial view of the intervention site (red marker).

Results and costs

■ Results

■ A total volume of 60 cubic metres of plants and sediment was extracted.

■ In May 2004, the spring following the work, no new sprouts of lizard's tail were visible on the excavation site and no living plants were observed among the waste deposited in the quarry.

■ Since then, annual visits have been made each September to look for any new growth. A few isolated plants were observed in 2005, 2009, 2013 and 2014. Each time, the observed plants were uprooted manually.

■ Costs

■ The work was made possible thanks to exceptional funding made available by the French State (funding via the Maritime navigation service in the Departmental territorial directorate). The funds were made rapidly available given the urgency of the situation. The effective cost of the operation was not calculated.

■ The mechanised intervention in 2003 represented one day of work and the additional manual work occupied a park employee for a few hours.

■ The annual visit to the site takes approximately 90 minutes for two park employees. This monitoring work is included in that for the Natura 2000 site with funding from the EU (ERDF) and the French State (Natura 2000 budget). The estimated cost for the regional nature park is 112 euros per year.

Information on the project

■ As early as 2003, this intervention was the topic of publications in specialised, naturalist journals (Symbioses, Bulletin of the Anjou scientific studies society) and in symposia.

■ A report on the 15 years of monitoring will be published as a scientific article in 2019.

Outlook

- The last plants were observed in 2014 when three stalks were noted and destroyed.
- It should be noted that the plant reappeared several times after several consecutive years of absence following the intervention. Caution is therefore advised before declaring the plant definitively eradicated from the site and the annual monitoring will be continued as a precautionary measure.
- In France, the species is not regulated and may be purchased in garden shops. Vigilance is therefore required to detect its presence in the natural environment throughout the country.

Authors: Doriane Blottière, IUCN French committee, and Guillaume Delaunay, Loire-Anjou-Touraine regional nature park. January 2018.

N.B. Unfortunately, the photos of the work in 2003 could not be found by the managers to illustrate this report.

For more information

- Delaunay G. 2003. Contribution à l'étude de la flore du Maine-et-Loire: une nouvelle espèce pour la dition: la Lézardelle penchée, *Saururus cernuus* L. Sp. Pl. 341 (1753). *Saururaceae*. Bulletin trimestriel de la société d'études scientifiques d'Anjou. 118 : 29-38.
- Delaunay G. 2004. Contribution à l'étude de la flore du Maine-et-Loire : quelques observations récentes dans la dition et ses proches environs. Le Monde des Plantes 483 : 29-31.
- Delaunay G. 2005. Contribution à l'étude de la flore du Maine-et-Loire. Un exemple de gestion d'une xénophyte à caractère envahissant : cas de la Lézardelle penchée (*Saururus cernuus L. Saururacées*). Symbioses 13 : 29 - 31. http://www.gtibma.eu/wpcontent/uploads/2017/05/Saururus_cernuus_gestion_maine-et-loire.pdf

2018 edition


Procambarus