

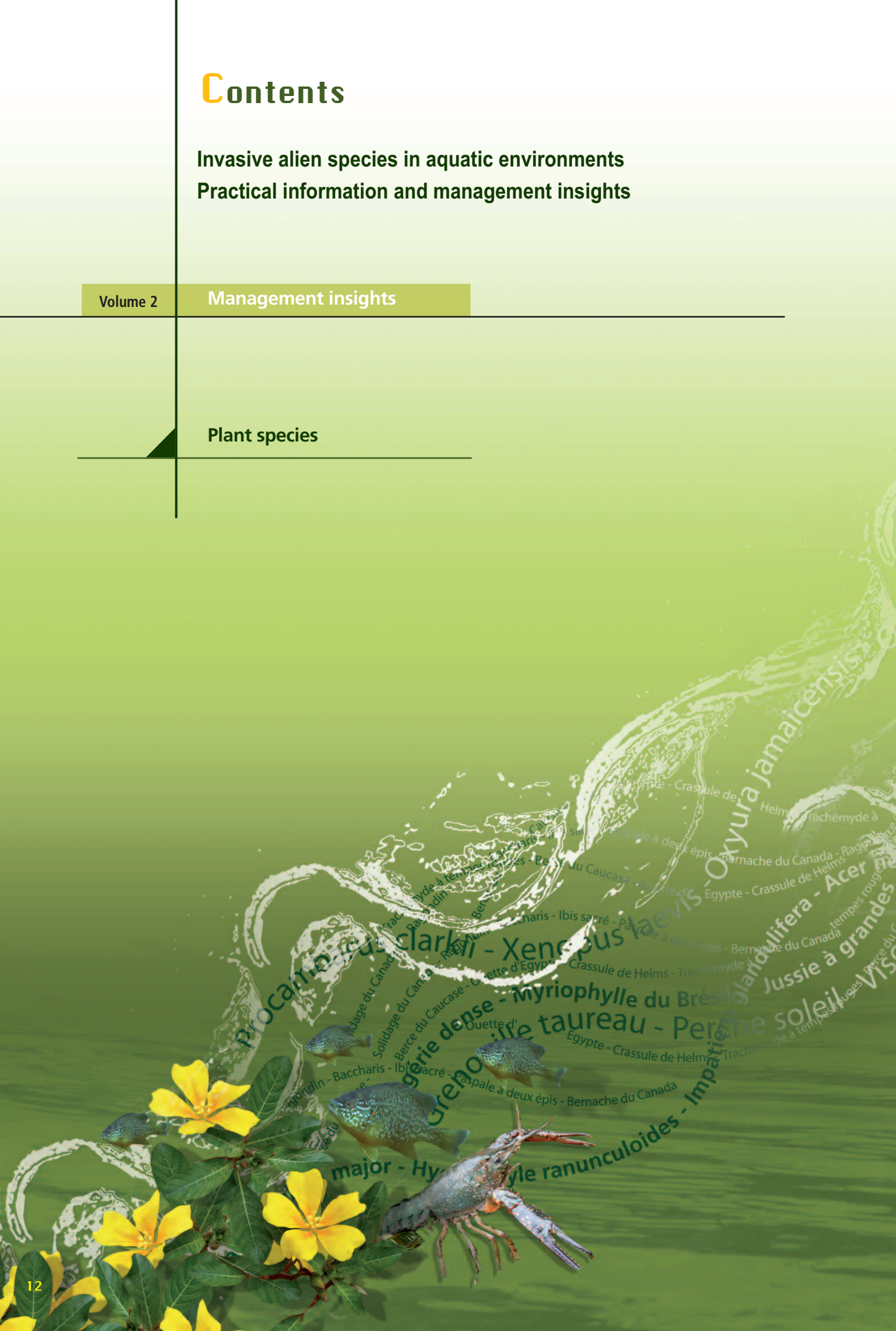
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Large-flowered waterweed

(*Egeria densa*)

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 reproduction

- 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

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- 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

Classification

Order	Alismatales
Family	Hydrochariaceae
Genus	<i>Egeria</i>
Species	<i>E. densa</i> (Planchon, 1849)



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Large-flowered waterweed

(*Egeria densa*)

Managing large-flowered waterweed in the Marans La Rochelle canal

Charente-Maritime departmental council (CG 17)

■ CG 17 is a local government, owner since 2007 of 170 kilometres of rivers in the Public River Domain (DPF) that are no longer considered waterways and are located in the department.

■ Concerning those rivers, the main missions assumed by CG 17 are to manage the hydraulic installations, maintain the riverbed and the banks, monitor and ensure the conservation of the public domain, define and implement restoration and enhancement projects.

■ Two services within the Water division are particularly active in executing those missions:

- the waterways service (SEVE) manages and maintains the DPF, contact: Catherine Labat - catherine.labat@cg17.fr ;
- the river service manages the departmental aquatic-environments policy, including efforts against invasive alien species, contact: Sylvie Fonteny - sylvie.fonteny@cg17.fr.

Intervention site

■ The Marans La Rochelle canal is part of the DPF owned by CG 17. The canal, 22 kilometres long, is located in the northern section of the Charente-Maritime department and links the southern edge of the Marais Poitevin marshes to the city of La Rochelle (it ends in the maritime channel of the city). The average width of the canal is 15 metres and at its start (northern end), the altitude is 2.1 metres above sea level.

■ The canal traverses two types of geological terrain. The northern section is marsh land, whereas in the southern section, the canal was dug through a limestone plain where the surrounding hills can reach an altitude of 30 metres.

■ In hydraulic terms, the canal is made up of two distinct reaches, separated by a third section. It is supplied primarily by runoff from the surrounding basin (38.2 square kilometres) and with water from the underlying aquifer.

■ The canal and its banks are a recreational area and a number of enhancement studies have been carried out since the 1980s.

■ *Egeria densa* was present particularly in the southern reach, a section 16 kilometres long. The work was done in this section.

■ Recently, the increasing presence of *Egeria densa* renewed debate about dredging the canal, an operation required for its upkeep and that would also serve to control the invasive species. Projects to manage the plant were launched while waiting for the decision on whether to dredge the canal.



© CG 17

1. The Marans La Rochelle canal.

Disturbances and issues involved

Initially identified in 2001, *Egeria densa* rapidly spread over the 16 kilometres of the southern section and is now virtually the sole species forming a bed covering the entire canal.

■ Impacts on the ecosystem

- Disappearance of other plant species.
- Contribution to sediment build-up.
- Obstacle to flow.
- Contribution to the development of filamentous algae on the surface.

■ Socio-economic impacts

- Hindrance for boating.
- Unsanitary.
- Negative impact on fishing.

The issues involved in managing *Egeria densa* in the Marans La Rochelle canal are primarily socio-economic in nature. The objective is to meet the needs of users and to develop tourism by enhancing the site and improving the aquatic environment.

Interventions

- The work on managing *Egeria densa* in the Marans La Rochelle canal started in 2001.
- From 2001 to 2004, technical trials were conducted on different management techniques, e.g. mowing-harvesting, mechanical uprooting, chemical treatments. None of these techniques had any real effect on the beds of *Egeria densa* that simply grew back and returned to the initial condition over the three months following the work. In 2004, a stopgate was installed 13 kilometres from the southern outlet to limit the progression of the plant to the north, into the marches and toward the Marais Poitevin marshes.
- Since 2005, a part of the colonised zone (13 kilometres out of the 16 in the southern reach) is mowed and harvested, a technique already used in other water bodies in the DPF.
- This work is done early in the year starting in April to enable various activities, e.g. fishing, local sports events and boating.
- The work is carried out by contractors from April to July each year.
- The harvester boat can mow two-thirds of the canal bed.
- In sections where the public is not present on the banks (narrow sections), the plants are deposited on the banks and not removed. In the other sections, the plants are transported to a composting unit.
- The quantity of plants harvested was evaluated visually (each pile was considered to represent approximately 1 cubic metre).

Results and costs

■ Results

- The results should be evaluated with caution because the quantities of plants harvested were determined strictly on a visual basis and depended on the person making the evaluation. In addition, non-negligible quantities of filamentous algae were also harvested and included in the estimates.

■ Costs

- Mowing of the plants, in spite of the repeated interventions, did not reduce the quantities of *Egeria densa*.
- Improvements were achieved in the visual appearance of the canal and in the main uses of the canal by humans.
- The interventions were expensive in terms of the equipment required and the human and financial resources. The average cost per kilometre and per year over the years 2009 to 2012 was 1 594 euros, which does not include consumables (oil, fuel, etc.).

Table breaking down the costs of interventions from 2009 to 2013 (*average man-day cost = 87.50 €).

Year	Period	Section treated (metres)	Number of piles (= 1 cubic metre)	Days worked	Payroll costs* A	Mower repairs and transport B	Total (A + B)	Average cost per km
2009	April - May	13 500	255	26	4 550 €	11 967.07 €	16 517.07 €	1 223.49 €
2010	April - July	13 500	145	29	5 075 €	6 317.66 €	11 392.66 €	843.90 €
2011	April - July	13 500	282	46	8 050 €	18 124.77 €	26 174.77 €	1 938.87 €
2012	April - June	13 500	150	29	5 075 €	26 897.82 €	31 972.82 €	2 368.36 €
2013	February -March	8 700	207	20	3 500 €	Not available	Not available	Not available



2. Zone colonised by *Egeria densa* and algae.
3. Harvester boat and transport of plants.
4. Piles of cut plants deposited on the banks.

■ Current project to dredge the canal

- Starting in 2005, the continued growth of *Egeria densa* resulted in renewed interest in the project to dredge the canal. Dredging of the entire canal was planned from 2012 to 2014. The work, using hydraulic or dry dredging, involved removing the sediment from the canal bed. The quantity of sediment to be removed was estimated on the basis of bathymetric measurements.
- End of 2012 - mid 2013. Hydraulic dredging of the northern reach (not colonised by *Egeria densa*), linear distance 6 300 metres, 70 000 cubic metres of sediment removed, i.e. only half of the sediment in order to reduce costs and not impact the reed beds. Maintenance of the canal did not require removal of all the sediment.
- Mid 2013 - beginning of 2014. Dry dredging of the southern section of the southern reach, linear distance 8 700 metres, 66 500 cubic metres of sediment removed, representing all the sediment in order to effectively counter the growth of *Egeria densa*.
- End of 2013 - end of 2014. Hydraulic dredging of the northern section of the southern reach, linear distance 6 800 metres, 135 000 cubic metres of sediment removed, representing all the sediment in order to effectively counter the growth of *Egeria densa*. Initially, the plan was to dry dredge the entire southern reach, however geotechnical difficulties (compressible clays) resulted in the decision to use the technique only in the southern section.
- The sediment removed using hydraulic dredging was placed in a draining basin and then spread over agricultural fields. The sediment removed using other means was spread directly in fields.
- Total cost of project: 6 598 000 € before VAT.
- Breakdown of costs. Northern reach: 1 115 000 € before VAT. Southern reach: 5 483 000 € before VAT.
- Funding was provided by the French State, the EU, the Loire-Bretagne water agency and local governments.
- The programme is still under way and no conclusions have been drawn concerning the effectiveness of the work.

● Outlook

- The task now is to monitor the impact and assess the effectiveness of the dredging work on the presence of *Egeria densa* and to observe the reaction of the environment by:
 - during the work, analysing the agronomic value of the drained sediment and any changes in the abundance and regrowth potential of *Egeria densa* on the temporary and final storage sites for the sediment;
 - following the work, monitoring water quality (each quarter), sediment quality (every 5 years) and sedimentation (every 5 years with bathymetric measurements every 20 years);
 - following the work, monitoring plant species (the monitoring protocol must still be adapted to the site).

■ Information on the project

- Participation in the Hydrocharitaceae work group launched by the Pays-de-la-Loire regional environmental directorate.
- The departmental council informed elected officials, local residents and people using the canal by inviting them to visit the dredging sites in March 2013 and publishing articles in the local press.

Author: Sylvie Fonteny, Charente-Maritime departmental council



5. Marans La Rochelle canal colonised by *Egeria densa*.

For more information

Sylvie Fonteny
River unit, Charente-Maritime depart-
mental council
sylvie.fonteny@cg17.fr



Large-flowered waterweed

(*Egeria densa*)

Management and scientific monitoring of large-flowered waterweed in the Vendée River

Board for the Marais Poitevin marshes and the Vendée, Sèvre and Autises basins

- Intermunicipal association (16 towns) created in 1992 in the south-western section of the Vendée department, in the Pays-de-la-Loire region.
- In charge of the 2008-2012 Contract to restore and maintain wetlands (CRE ZH) for the Marais Poitevin marshes in the Vendée department.
- In charge of the *Egeria densa* management programme in the Vendée basin since 2006. This management programme was folded into the CRE ZH contract in 2008 and targets:
 - restoring balanced functioning between the ecosystem compartments;
 - reducing the visible aspects in the town of Fontenay-le-Comte during the summer period;
 - making possible traditional uses of the Vendée River (fishing, boating);
 - avoiding the spread of the plant to other canals in the Vendée basin and to other ecologically important areas downstream (the Marais Poitevin marshes).

Vendée departmental federation for fishing and the protection of aquatic environments

- Main missions assigned by the Vendée departmental council (CG 85):
 - centralise and organise information on the presence of invasive alien aquatic plants (status report) in the Vendée department (85);
 - identify, with CG 85, the priority sites for interventions;
 - coordinate work sites;
 - represent the department in the regional committee for the management of invasive species.
- Managing entity for the *Egeria densa* management programme, responsible for:
 - providing the board with technical assistance in carrying out the management work;
 - monitoring the work sites;
 - assessing the results achieved;

- participating in the scientific monitoring by Agrocampus Ouest since 2010.

■ Contact: Dimitri Bouron, technician
 dimitri.bouron@federation-peche-vendee.fr.

Intervention site

- The intervention site is a reach of the Vendée River located in the town of Fontenay-le-Comte (85). The Vendée River is a tributary to the Sèvre-Niortaise River and flows through the Marais Poitevin marshes.
- In 2012, the work was carried out on a reach 3.5 kilometres long. A weir in the town marked the upstream limit and the Boisse dam the downstream limit of the site.
- Upstream of the intervention site is the Mervent reservoir that is used as a supply of drinking water and as a means to attenuate low-flow levels and manage flooding



1. Section of the Vendée River where the work took place in 2012 (the limits are shown in red).

Disturbances and issues involved

Egeria densa was observed for the first time in isolated groups on the Vendée River in 1997 in the town of Fontenay-le-Comte. In 2005, the plant had colonised almost 10 kilometres of river, covering up to 90% of the surface in places. Its propagation was reinforced by releases of water from the Mervent reservoir, that transported plant fragments and entire plants over long distances.



■ Ecological impacts

- Formation of dense beds limiting the development of native plant species.
- Reduction in the movement of fish species.

■ Impacts on human activities

- Disturbances to boating activities.
- Development of dense beds making fishing impossible.
- Unsightly conditions caused by the dense beds largely covering the surface.

Interventions

■ 2012 is the seventh year of efforts to manage *Egeria densa* on the Vendée River. Mowing and harvesting are used to control the development of the plant. Special technical specifications set the technical requirements for the work. From the start, the intervention site was divided into 14 sections in order to carry out annual monitoring of the most heavily infested parts of the river. Subsequently, the sections served to study the progress of colonisation, calculated on the basis of the volumes removed from each section. Clear, easily identifiable landmarks signalled the beginning and end of each section.

■ Mowing and harvesting work

- The work took place from 2 to 27 July 2012.
- Three boats were used for the work. A mower and a pusher-harvester were present for the first week of work and a harvester was present from beginning to end.
- Nets were installed across the entire width of the river at 3 different places to limit the dispersal of *Egeria densa* fragments.
- The mowed plants were temporarily stored for 1 to 2 days at two different places on the banks to dry.

■ Storage and fate of the harvested plants

- Transportation by truck (without tarps) from the temporary sites to the final site.
- The final site was farm land (no flood risk) in the town of Fontaines, less than 10 km from Fontenay-le-Comte.
- The plants were mixed with fertiliser and spread in fields.

Scientific monitoring

Starting in 2010, Agrocampus Ouest set up scientific monitoring of the project in order to participate in management of *Egeria densa* by tracking plant development and assessing the effectiveness of the management work.

■ A partnership between the fishing federation and Agrocampus Ouest was established, with financial support from the Pays-de-la-Loire regional environmental directorate.

■ Two observation and sampling campaigns were carried out before (beginning of June) and after (end of July) each annual intervention. They consisted of:

- setting up a control sector, where no work took place, upstream of the intervention site;
- estimating the percentage of the water surface covered by the plants by analysing maps of the intervention site and analysing contact points on transects created in 2012;
- estimating the plant biomass using 0.25 square-metre quadrants for samples drawn on foot (along the banks) and, since 2012, 1 m² quadrants for samples drawn by diving in the middle of the riverbed.



2. Beds of *Egeria densa* in the Vendée River, in the town of Fontenay-le-Comte.



3. Pusher-harvester boat.

4. Harvester boat.

5. Net installed across the river.

Results

■ Results of interventions

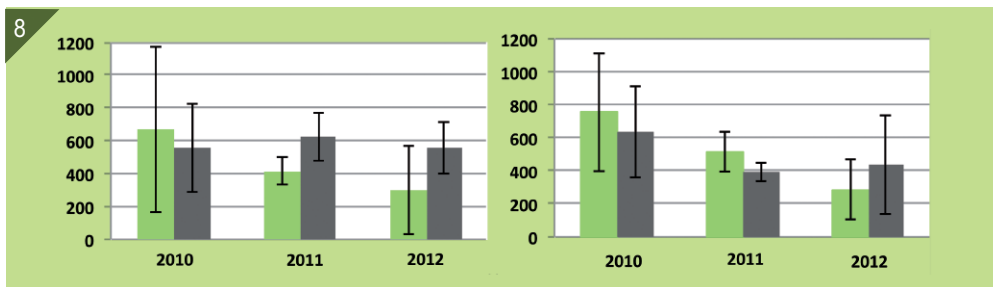
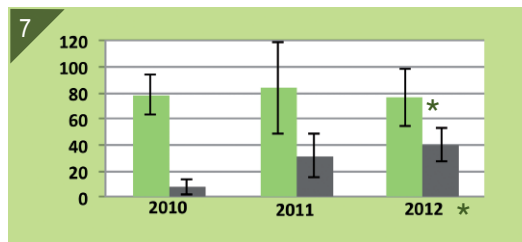
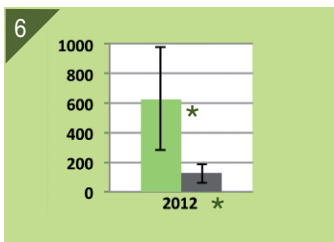
- In 2012, a total of 1 200 cubic metres of *Egeria densa* (fresh plants) were removed over a river section 3.5 km long.

Results since 2010.

Year	2010	2011	2012
Harvested volumes (cubic metres per kilometre)	154	230	343
Total amount billed (euros)	22 620	29 080	Approx. 21 000
	(4 kilometres)	(4 kilometres)	(3.5 kilometres)

■ Results of the scientific monitoring

- No statistically significant differences in terms of biomass with the control sector. No interannual or seasonal variations.
- Significant effect of the work on the biomass of *Egeria densa* in 2012 (samples drawn by diving).
- The results from 2010 to 2012 indicate that the effects of the work done were short lived (just a few months).



- Before work
- After work
- * Statistically significant changes

6. Average biomass of *Egeria densa* in the intervention zone (in grammes of dry matter per square metre).

7. Average cover of *Egeria densa* in the intervention zone (in %).

8. Average biomass of *Egeria densa* in the 0.25 square-metre quadrants (in grammes of dry matter per square metre). Control zone (no intervention) on the left (green) and work zone on the right (brown).



Outlook

- Preparation of a report on the Contract to restore and maintain wetlands (CRE ZH) with the partners and drafting of a new contract with an addition for 2013 to ensure the continuation of the work.
- Monitoring to detect the presence of other invasive alien plants (Japanese knotweed and water primrose) in the Vendée River.
- Continuation of the partnership between the fishing federation and Agrocampus Ouest, and of the scientific monitoring.
- Launch of electrofishing campaigns by the fishing federation to determine the impact of *Egeria densa* on fish populations.

Information on the project

- Information panels were set up on the banks of the river to inform on the work carried out in Fontenay-le-Comte.

Remarks

- An initial intervention was already carried out in 1999. Problems involving coordination between the partners and practical aspects led to a halt in the work until 2006.
- The harvesting boats cannot work on the beds in very shallow water along the banks. As a result, the biomass samples drawn on foot (0.25 square metre quadrants) are not indicative of the effectiveness of the work on *Egeria densa* in those areas.
- In 2012, the reduction in cover by *Egeria densa*, compared to 2011 (prior to the work), and the increase in the volume of the plants mowed and harvested may indicate more effective work in that year.

Author: Sandra Fernandez, Irstea

For more information

- **Internet site of the board:**
www.cc-vendee-sevre-autise.com
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- Work site to mow, harvest and transport *Egeria densa*. Brief summary of the work in 2012.
- Bouron D., F.V.P.P.M.A. 2010. Poster « Organisation et difficultés d'un projet de gestion d'espèces envahissantes : Cas de l'Égérie dense sur la rivière Vendée ».
- Haury J., Bouron D. 2012. Approche scientifique au service des gestionnaires : la saga d'*Egeria densa* dans le Massif armoricain. In Haury J., Matrat R. (Eds), 2012. Plantes invasives, la nécessité de différentes approches. Actes du colloque régional Les plantes invasives en Pays-de-la-Loire, 11-12 mai 2011, Angers, Terra botanica. Æstuarina, collection Paroles des Marais atlantiques : 83-96.
- Moyon F. 2012. Évaluation de la gestion d'*Egeria densa*, plante aquatique invasive sur la rivière Vendée à Fontenay le Comte. Propositions d'actions et recommandations aux gestionnaires - 50 pp. Maître de stage : Haury J.





Curly waterweed

(*Lagarosiphon major*)

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

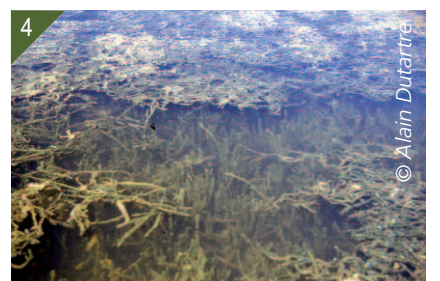
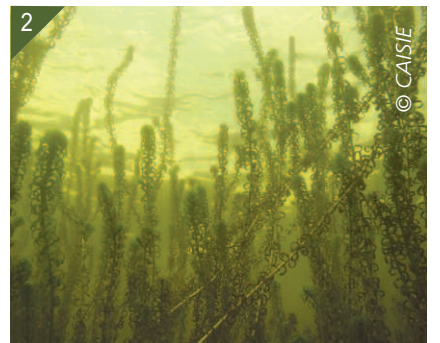
Documentation

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- 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

Classification

Order	Alismatales
Family	Hydrocharitaceae
Genus	<i>Lagarosiphon</i>
Species	<i>L. major</i> ((Ridley) Moss, 1928)





Curly waterweed

(*Lagarosiphon major*)

Managing curly waterweed in the Blanc Pond

Géolandes, the board in charge of saving and managing the ponds and lakes of the Landes department

- The public board for intermunicipal cooperation was created in 1988.
- Members are the Grands-Lacs, Mimizan and Côte-Landes-Nature intermunicipal associations, the towns of Moliets-et-Maâ, Messanges, Azur, Soustons, Seignosse, Tosse, Ondres and Tarnos, and the Landes departmental council.
- The main missions include:
 - balanced management of ponds and lakes to avoid sedimentation (sand and mud), through preventive work (creation and maintenance of decanting basins for sand on the tributaries) and curative work (sediment extraction);
 - design and creation of installations on ponds and lakes (e.g. beaches) for the public, while preserving natural environments;
 - efforts to control the proliferation of aquatic species and to preserve native species;
 - studies on general and specific topics (hydraulic monitoring, water quality, monitoring of aquatic vegetation, bathymetric studies, impact studies, etc.);
 - participation in collaborative management of water resources and wet lands.

Contacts: Lionel Fournier - lionel.fournier@cg40.fr,
Andoni Zuazo - andoni.zuazo@cg40.fr.

Intervention site

- The territory covered by Géolandes includes 15 freshwater ponds and lakes of very different size and depth, representing a total of over 10 000 hectares and including highly diverse plant communities.
- Géolandes manages curly waterweed in the Blanc Pond, located in the towns of Seignosse, Soustons and Tosse in the southern section of the department. The pond covers 183 hectares and has a maximum depth of 2 metres. It lies in the basin of the Courant de Soustons River and is part of a string of ponds (between the Noir and Hardy Ponds).



1. The Blanc Pond.

- The Blanc Pond and its banks are listed as natural sites in a decree by the *Conseil d'État*, under the name *Étangs landais*, representing a total surface area of 830 hectares. The Blanc Pond and its basin are also part of the Natura 2000 site for the wetlands behind the Marensin dune.

Disturbances and issues involved

- Curly waterweed started to colonise Blanc Pond in the middle of the 1980s and spread over a surface area of up to 120 hectares. This submergent plant occupies the entire depth of the water in the form of very dense beds, particularly in the western section of the pond where the muddy sediment contains high levels of organic matter.

■ Ecological impacts

- Regression of native hydrophytes.
- Reduced biodiversity and greater environmental uniformity.
- Accelerated sedimentation and filling of the pond.
- Enhanced transparency due to nutrient consumption resulting in a reduction in phytoplankton.
- Increase in fish production.

■ Impacts on pond use

- Significant obstacle to boating activities (a vacation centre is located on the southern edge of the pond).
- Significant obstacle to fishing and hunting of waterfowl.

Interventions

Following the tests on equipment in the years 1988 and 1989, Géolandes launched annual operations to harvest *Lagarosiphon major* starting in 1990.

■ Annual harvesting

- Harvesting took place in May and June, before the summer season.
- The surface areas harvested annually represented 40 hectares up to 2009 and from 15 to 25 hectares starting in 2010.

The work targeted the areas most important for the various activities.

■ Technical characteristics:

- simultaneous cutting and harvesting by the harvester boat;
- 30 cubic metres of storage capacity on the boat;
- cutting depth as close as possible to the bottom and the base of the plants (approximately 2 metres);
- transfer of the plants to a carrier system comprising multiple containers or to a tractor with a trailer.

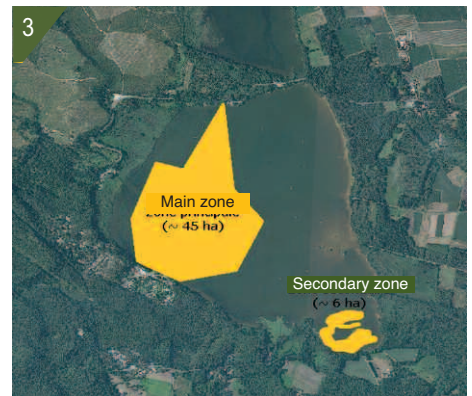
In 2012 and 2013, prior to the work, echo-sounding systems were used by the CARMA research unit from Irstea along transects to detect the most infested sectors in the important areas in order to set up the harvesting plan.

■ Storage and elimination of the plants

- The plants were deposited in dry sections of forest (sandy substrates) for drying or natural composting.
- The selected areas on town property (towns of Seignosse and Soustons) were dry and located near the point where the harvester boat unloaded the plants.

Results and costs

- From 1998 to 2009, the harvested volumes of *Lagarosiphon major* varied significantly and the cost per cubic metre increased gradually.
- Starting in 2010:
 - reduction in the harvested area (-35% to -60% depending on the year);
 - greater flexibility in the procurement procedure (public contracts divided into sections);
 - more precise selection of the harvested areas (echo-sounding along transects in 2012 and 2013).



2. Blanc Pond colonised by *Lagarosiphon major*.
3. Potential harvesting zones.
4. Harvester boat.

- These modifications in policy made it possible to reduce costs while meeting the needs of users.
- Harvesting is the only technique capable of handling large surface areas while limiting the disturbances and damage to the environment. Manual uprooting is possible only for limited surface areas (technical constraints and high costs).
- Concerning plant elimination, drying and natural composting in dry forest areas (sandy substrate) produce good results in eliminating the harvested biomass that consists essentially of water.

Total cost and cost per cubic metre of work to manage *Lagarosiphon major* in the Blanc Pond from 1998 to 2013.



Outlook

- Géolandes commissioned Irstea (CARMA research unit) to assess the impact of harvesting *Lagarosiphon major* in Blanc Pond (2011-2013) and to update its assessment of the management strategy.
- After 20 years of harvesting *Lagarosiphon major*, the other types of macrophytes would appear to be in good physiological condition and there were no notable physical-chemical differences (water and sediment) between the studied areas (colonised - non colonised, harvested - non harvested, etc.).
- On the basis of the above observations, the probable effects of harvesting, that should be better characterised by setting up additional experiments, are the following:
 - annual harvesting limits plant development;
 - harvesting every two years has no effect;
 - a halt in regular harvesting for several years encourages plant development.

■ The study results do not indicate the need for any changes in the management strategy of Géolandes over the short term. It should be noted that the use of the echo-sounding technique prior to harvesting is a very useful contribution when setting up the harvesting plan.

Information on the project

■ Training sessions on aquatic plants were organised by Géolandes in conjunction with Cemagref (now Irstea) in 1991 and 2004 for the personnel of the local governments participating in Géolandes and for the organisations managing natural environments (fishing and hunting federations, environmental-protection groups, etc.).

■ Information was regularly made available to the general public and to the persons involved in management operations for aquatic plants.

■ Information was regularly made available to elected officials during the meetings of the Géolandes board, during the delivery of studies and during visits in the field.

■ Numerous articles on the management of invasive aquatic plants were published in the regional press and in the bulletin of the Landes departmental council.

■ A number of scientific and technical articles were published in conjunction with Cemagref (Irstea) on the management of invasive plants in the ponds of the Landes department.

■ Presentation of management insights acquired by Géolandes concerning invasive plants during various symposia, e.g.:

- the Aquitaine Nature professional meetings (Bordeaux, April 2010);
- the symposium titled Biological invasions in aquatic environments (Paris, 12-14 October 2010);
- the workshop titled Macrophytes! (Talence, 28-30 May 2013).

Authors: Sandra Fernandez, Irstea, and Andoni Zuazo, Landes departmental council

For more information

■ Géolandes board:

<http://www.gt-ibma.eu/strategies-ou-ensont-les-institutions/strategies-infranationales/syndicat-mixte-geolandes/>

■ Fournier L., Zuazo A. 2012. Organisation de la gestion des plantes exotiques envahissantes dans les lacs et étangs littoraux landais. Sciences, Eaux et Territoires, 6 : 42-45.

■ Dutartre A., Oyarzabal J., Fournier L. 2003. Interventions du Syndicat Mixte Géolandes dans la régulation des plantes aquatiques envahissantes des lacs et des étangs du littoral landais. Gestion des espèces exotiques envahissantes en zones humides, Sallertaine, 13 et 14 novembre 2003. Aestuarium, 6 : 79-97.

■ Géolandes, 2004. Document de session de formation plantes aquatiques « Présentation des lacs et des étangs landais, de la dynamique de quelques plantes aquatiques indigènes et exotiques et des modalités de gestion des plantes exotiques envahissantes ».

■ Castagnos E., Dutartre A. 2001. Évolutions récentes des peuplements de plantes aquatiques exotiques dans les lacs et les étangs landais (Landes, France). Cemagref, unité de recherche Qualité des eaux et Géolandes, Étude 66, 227 pp.

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Curly waterweed

(*Lagarosiphon major*)

Managing curly waterweed in Lough Corrib, Ireland

Inland Fisheries Ireland (IFI)

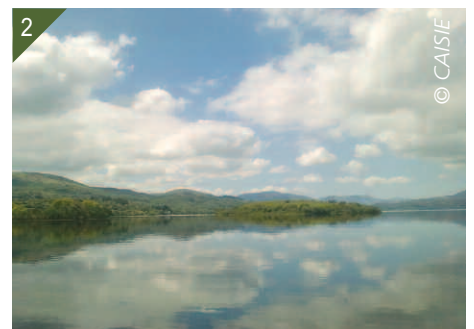
IFI is the public agency in charge of protecting, managing and conserving Irish inland fisheries and ocean fish stocks. The agency was created in 2010 and manages 74 000 kilometres of river and 120 000 hectares of lakes and ponds in Ireland.

Context and issues involved

Lagarosiphon major was introduced in Ireland as a plant intended to oxygenate artificial water bodies. The species was discovered in 2005 in Lough Corrib, the second largest lake in Ireland (17 800 hectares) and a Natura 2000 zone containing important spawning grounds for brown trout (*Salmo trutta*). Since 2005, curly waterweed has colonised 113 sites representing a total surface area of 92 hectares.

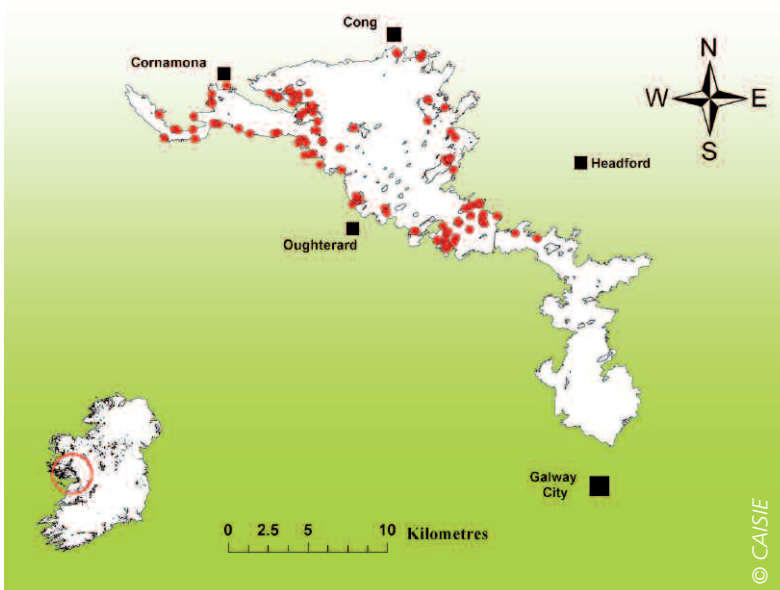
Curly waterweed colonised the sites very rapidly, creating a thick blanket on the water surface that blocked the light and hindered the development and even the continued existence of native macrophytes. This had an effect on the structure of the macroinvertebrate community and on the salmonid population.

Other problems concerning the use of the lake (fishing and boating) were also observed and flooding risks caused by poor water circulation were also mentioned.



1. The study site.
2. Lough Corrib.

Distribution of *L. major* in Lough Corrib in 2007.



Interventions

■ In the framework of a LIFE project addressing invasive alien species in general in Ireland (Control of aquatic species and restoration of natural communities in Ireland - CAISIE Project), a programme to manage and study the impacts of curly waterweed on biodiversity was conducted from 2008 to 2013. The programme consisted of:

- studying the biological cycle of *Lagarosiphon major* in Lough Corrib;
- developing good management practices and new methods to control *Lagarosiphon major*;
- assessing the effectiveness of the control techniques used and the impact of species management on the ecosystem;
- determining the impacts of *Lagarosiphon major* on the native communities of fish, macroinvertebrates and plants;
- testing techniques to ecologically rehabilitate the lake following the management operations.

■ Depending on the current development stage of the species, three main management techniques were employed:

- blocking the light by laying a sheet of biodegradable burlap along the bottom of the lake from the beginning of the summer to the beginning of the fall. The burlap was positioned using boats. The fabric was supplied in rolls 5 metres wide and 900 metres long, with a density of 200 grammes per square metre;
- mechanical cutting using V-shaped bars capable of reaching the roots, during the coldest months (mid-fall to the beginning of April). Nets were installed to avoid dispersal of fragments of curly waterweed and to facilitate mechanical recovery of the plants;
- manual uprooting by divers in areas where plant densities were very low.

Results

■ In 2008, prior to the start of the coordinated management operations, a total of 92 hectares were colonised by *L. major* in Lough Corrib. At the end of the CAISIE programme, 90% of the affected surface areas had been treated and the area requiring management had been reduced to 9 hectares.

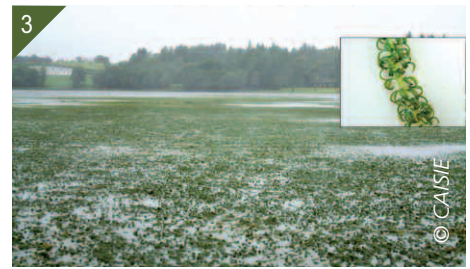
■ Mechanised operations (cutting and harvesting) were carried out on 98 hectares. The harvested plants were dried and composted on site. Manual uprooting was done in very small areas (a total of 0.5 hectare) and made it possible to selectively manage *L. major* in sections where its density was low. Regrowth of native macrophytes occurred, but at slower rates than on the sites where sheets of burlap were used.

■ The latter method was implemented on a total of 5 hectares and had a number of advantages:

- ease of use (the biodegradable fabric rapidly absorbs water and sinks to the bottom, it is not necessary to remove it);
- the curly waterweed covered by the fabric quickly dies;
- native macrophytes regrow through the burlap fabric after approximately 4 months and the original plant community fully recovers after about 2 years.

■ Cost of managing *Lagarosiphon major* in Lough Corrib:

- 400 000 euros from 2005 to 2008;
- 1.5 million euros from 2009 to 2012;



3. 4. Lough Corrib, before (1) and after (2) the management work on curly waterweed.
5. Installing a biodegradable geotextile in Lough Corrib.
6. Cutting and harvesting of plants.
7. Efforts to raise the awareness of school children.

- 300 000 euros in 2013;
- estimated cost of 300 000 euros for management in the coming years;
- i.e. a total of 2.2 million euros for the period from 2005 to 2013.

■ The CAISIE programme (LIFE07 NAT/IRL/000341) as a whole cost 1.5 million euros over 5 years (with European funding covering 45%). A socio-economic study (Kelly *et al.*, 2013) calculated that the damages inflicted on the Irish economy by invasive alien species and the cost of their management represented over 200 million euros per year. The annual impact on aquaculture, fishing and recreational activities was estimated at 4 million euros for a sector (fisheries) that currently employs 10 000 people with sales of over 500 million euros. The CAISIE programme served to develop management and awareness-raising methods designed to reduce those socio-economic impacts.

Outlook

■ The management work will continue to be conducted in Lough Corrib and good-practices guides will be drafted for personnel trained to use the methods tested during the CAISIE programme. Inland Fisheries Ireland will continue to support the current efforts (management, awareness raising and biosecurity measures), by launching research programmes on the management of invasive alien species, including a programme on the biological control of Himalayan balsam.

Information on the project

■ In parallel with the management work, special efforts were made in the framework of the CAISIE programme to raise the awareness of the public and managers through informational documents, a disinfection protocol for fishing equipment, cleaning kits, demonstrations of management techniques, a film, a news bulletin and presentations in schools.

■ The results of the work on curly waterweed in the framework of the CAISIE LIFE programme were presented in detail during an international conference held in April 2013 and titled Freshwater invasives, Networking for strategies.

■ The CAISIE programme also dealt with other invasive alien species in aquatic environments in Ireland. Management projects were set up for Asian clams (*Corbicula fluminea*), Himalayan balsam (*Impatiens glandulifera*), Japanese knotweed (*Fallopia japonica*), giant hogweed (*Heracleum mantegazzianum*) and New Zealand pigmyweed (*Crassula helmsii*).

Authors: Emmanuelle Sarat, IUCN French committee

For more information

- CAISIE programme:
www.caisie.ie
- Inland Fisheries Ireland
<http://www.fisheriesireland.ie/>
- Caffrey J.M., Millane M., Evers S., Moran H. and Butler M. 2010. A novel approach to aquatic weed control and habitat restoration using biodegradable jute matting. *Aquatic Invasions* 5 : 123-129.
- Caffrey J. 2013. Control of Aquatic species and restoration of natural communities in Ireland (CAISIE). Layman's report. 17 pp.
- Caffrey J. 2013. Control of Aquatic species and restoration of natural communities in Ireland (CAISIE). Final report. 69 pp.
- Kelly J., Tosh D., Dale K. and Jackson A. 2013. The economic cost of invasive and non-native species in Ireland and Northern Ireland. Northern Ireland Environment Agency and National Parks and Wildlife Service, Invasive Species Ireland. 95 pp.



Water pennywort

(*Hydrocotyle ranunculoides*)

Originated in North America.

An ornamental aquatic plant often used to oxygenate basins and aquariums.

Description

- Herbaceous, perennial, amphibious plant
- Roots firmly established in the substrate, strong presence of adventitious roots
- Smooth stems, floating or creeping, that root at the nodes (internode distance is 4 to 12 centimetres)
- Floating or emergent leaves, alternating:
 - 2 to 8 cm in diameter, indented edges with 3 to 7 lobes
 - cleaved base
 - long, pulpy stems (up to 35 cm)
- Small, white flowers, hermaphroditic, grouped in umbels of 5 to 10 flowers
- The fruit is a double achene, rounded, flat, brown in colour

Ecology and reproduction

- The preferred habitat is stagnant to lentic waters, generally shallow (ditches, canals, pools, areas near water bodies). The plants tend toward eutrophic waters, rich in organic matter and nutrients.
- Reproduction through vegetative multiplication:
 - fragmentation of stolons (runners), cuttings are possible where there are nodes
 - growth is possible without direct contact with the substrate
- Terrestrial plants are strongly rooted, but less developed than the aquatic plants

Documentation

- Dortel F., Lacroix P., Magnanon S. 2011. Plan de lutte contre l'Hydrocotyle fausse-renoncule (*Hydrocotyle ranunculoides* L.f.) en région Pays de la Loire, 85 pp.
- Fried G. 2012. Guide des plantes invasives. Belin, Paris, 272 pp.
- Fried G., Hussner A., Newman J., Schrader G., Triest L., Van Valkenburg J. 2009. Report of a Pest Risk Analysis for *Hydrocotyle ranunculoides* - O.E.P.P. 28 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.
- FCBN, Fiche espèce *Hydrocotyle ranunculoides* L.f., 4 pp.

http://www.centrederessourcesloirenature.com/mediatheque/especes_inv/a/fiches_FCBN/Fiche%20-%20Hydrocotyle%20ranunculoides_sr.pdf

Author: Emilie Mazaubert, Irstea

Classification

Order	Apiales
Family	Araliaceae
Genus	<i>Hydrocotyle</i>
Species	<i>Hydrocotyle ranunculoides</i> (L. f., 1782)





Water pennywort

(*Hydrocotyle ranunculoides*)

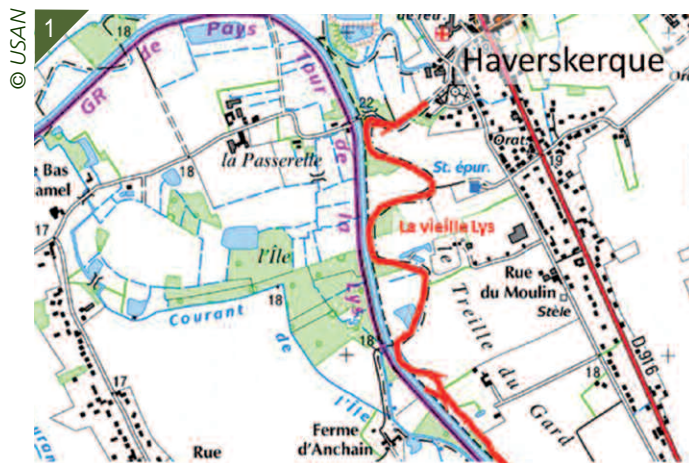
Management of water pennywort by the Union of sanitation boards in the Nord department

Union of sanitation boards in the Nord department

- The union was first recognised as a public agency by prefectural order dated 17 August 1966, then as a public board by prefectural order dated 11 December 2007.
- The union federates 7 intermunicipal agricultural enhancement boards with its headquarters in the town of Radinghem-en-Weppes, in the Nord department.
- The main missions include:
 - work on rivers not belonging to the State in order to reduce flood risks;
 - the establishment of ecological management plans designed to organise comprehensive and rational maintenance work on rivers over five-year periods;
 - administrative and accounting management of other organisations (an ASAD, a certified association for drainage and other land-consolidation organisations, various boards);
 - agricultural drainage work in the framework of an agreement with the ASAD for Northern France;
 - management of the pest-control group for Radinghem-en-Weppes;
 - since 2012, management of invasive plants via the LUPIN (control of invasive plants) project that is part of the INTERREG IV France – Wallonia – Flanders programme. The purpose of the LUPIN project is to develop cross-border management methods for invasive alien plants.
- Contact: Valérie Lorenski - vlorenski@usan.fr.

Intervention site

- Management work on water pennywort (*Hydrocotyle ranunculoides*) was carried out on a 2-kilometre long section of the Vieille Lys River in the town of Haverskerque (59).
- The Vieille Lys is a small river just 6.2 km long. It originates in the town of Aire-sur-la-Lys and flows into the Lys River (channelised) in the town of Saint-Venant.
- The work constituted the initial management operations for invasive species conducted by the Union of sanitation boards in the Nord department (USAN). The interventions were carried out after observing the potential impacts of water pennywort and constituted the starting point for the LUPIN project.



The river section where the work took place is shown in red.

Disturbances and issues involved

- During the summer of 2005, the association *Agir ensemble pour notre environnement* alerted USAN about the presence of *Hydrocotyle ranunculoides* in the Vieille Lys River. Plant identification was confirmed by the botanical conservatory in Bailleul. In 2005, water pennywort had colonised two kilometres of the Vieille Lys River.
- USAN decided to intervene in order to manage the effects caused by water pennywort.
- **Impact on ecosystems**
 - The plants developed to the point of creating dense beds that consumed the available oxygen and deprived the environment of light, thus leading to the death of many native species, notably fish.
- **Impacts on human activities**
 - The plants increased flooding risks in the village of Haverskerque by blocking installations and raising water levels.
 - Fishing became impossible, notably due to the lack of fish in the environment.

Interventions

- In order to control water pennywort on the Vieille Lys River, USAN proposed mechanical uprooting with subsequent monitoring.
- The authorities in charge of water regulations (the National agency for water and aquatic environments and the various water police forces) drafted specifications including precautionary measures to avoid propagation of the plants.

■ Barriers

- Two barriers were installed downstream of the worksite, each comprising two screened sections.

■ Mechanical uprooting

- The work was carried out during one week in February 2006.
- The two tracked excavators used for the work were equipped differently:
 - the first had a simple bucket to dig a ditch to bury the uprooted plants. The ditch was approximately 20 cm deep and 50 to 60 cm wide. It ran along the worksite (2 kilometres), approximately 5 metres distant from the river (outside the buffer zone);
 - the second was equipped with a harvester bucket designed to uproot the beds of water pennywort and to place the plants in the ditch.
- Following the work, USAN technical personnel inspected the site and manually collected any remaining cuttings.

■ Manual uprooting

- During the summer of 2006, following the mechanised work, interventions took place every 3 weeks.
- The team consisted of 3 technical personnel.
- They used a boat to access the foot of the banks (riparian vegetation along the banks was abundant).
- The plants were uprooted manually and placed in garbage bags in the boat.
- The bags were subsequently transported to the waste-disposal centre.

Results and costs

■ Results

- Following mechanical uprooting, the quantity of water pennywort on the surface of the intervention zone had been visibly reduced.
- The remaining surface area requiring manual uprooting was estimated at 1%.

■ Human and financial aspects

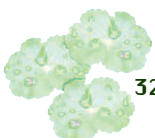
- The project was a success thanks to the constant monitoring of the river section following the work in 2006. The section was inspected every 2 months up to 2009 and then every 4 to 6 months until 2011.
- No new colonisation by water pennywort had been noted as of the last inspection in 2011.
- Burial of the plants produced no problems. No regrowth was noted in the ditches.
- The work was done by in-house personnel, the costs were not calculated.

Outlook

- The site will be monitored to avoid any new colonisation by water pennywort.
- The LUPIN 2012-2014 project is intended to manage invasive species in aquatic environments following the work on water pennywort:



2. Harvester bucket with screen.
3. River section prior to the work.
4. River section after the work.
5. Mechanical uprooting.



- in conjunction with the pest-control group (GDON) for Maritime Flanders and the province of Western Flanders;
- targeting 5 invasive species present in both countries, namely Japanese knotweed, water pennywort, Himalayan balsam, giant hogweed and water primrose.

■ The main objectives are to:

- create a joint management unit for administrative and technical monitoring;
- inventory invasive plants along each side of the border;
- develop a joint management method and launch projects in test zones (identification of the test zones is currently under way).

■ Information on the project:

- information panels on the 5 species were set up in the town;
- a technical booklet was drafted for land owners, presenting the management techniques employed and the monitoring and inspection systems set up for the project;
- articles were published in the press.

Information on the project

- The work was presented in the report on invasive alien species prepared by the Nord-Pas-de-Calais regional observatory for biodiversity in January 2013.

Authors: Sandra Fernandez, Irstea



6. Manual collection of cuttings following the mechanised intervention.

7. Presentation of the LUPIN project.

For more information

- USAN: www.usan.fr
- USAN internet site presenting its activities:
<http://www.usan.fr/nosactions.html>
- Excerpt from the report on invasive alien species prepared by the Nord-Pas-de-Calais regional observatory for biodiversity in January 2013, 3 pp.
- USAN. 2011. Synthèse sur les interventions : « Bilan et évolution de la lutte contre l'Hydrocotyle », 10 pp.
- Press article published in the *Voix du Nord* newspaper on 18 November 2012.





Water pennywort

(*Hydrocotyle ranunculoides*)

Managing water pennywort in the Bourret basin

Côte-Sud river board

■ The river board was created in 2001 as the managing entity for the river contract covering the Bourret and Boudigau basins spanning 22 towns in the southern section on the Landes department.

■ The main missions include:

- restoring and working on the rivers to maintain proper functioning and the quality of aquatic ecosystems, notably by creating structures (groynes, weirs, bank protection systems) suited to the sites;
- conserving and restoring flood expansion zones;
- managing invasive alien species;
- monitoring water quality and contributing to improving data dissemination and efforts to locate the source of pollution;
- contributing to achieving good ecological status by coordinating the current uses in the river basins;
- preserving the ecological heritage of side channels and wet lands linked to the river.

■ Contact: Magali Costa - costa-smrbb@wanadoo.fr.

Intervention site

■ The river board worked on the Cousturet stream, a part of the Bourret basin colonised by water pennywort. The Cousturet is 7 kilometres long and flows through the towns of Tosse, Saubion and Angresse. Water pennywort was also present in 2 ponds near the stream, on the site called Lagrollet in the town of Saubion.

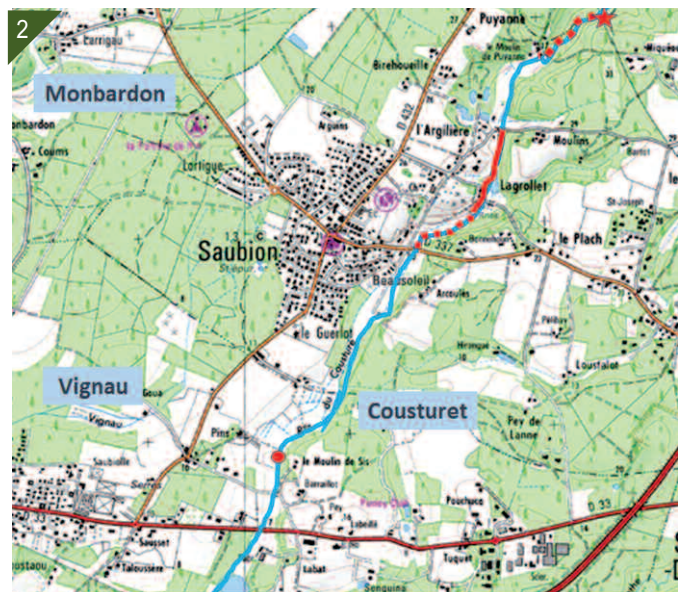
■ The colonised section represented 4 km of river, including:

- 830 metres of which 10% to 20% were colonised;
- 400 metres of which 70% to 90% were colonised.

■ The remaining sections were sparsely colonised.

■ Private properties included parts of the stream along woods and meadows, as well as a pond with a surface area of 5 000 square metres.

■ The area lies in part in a biological reserve created by the law on water and aquatic environments and listed in the 2010-2015 river basin management plan.

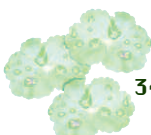


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1. 2. Intervention sites.

Key

- Section colonised 10% to 20%
- Section colonised 70% to 90%
- ★ Origin of the colonisation
- Isolated site (colonised)



Disturbances and issues involved

■ The presence of water pennywort was confirmed on 15 October 2012 by the National botanical conservatory for South-west France following on-site analysis on the Cousturet stream. On 18 October 2012, inspections revealed the origin of the colonisation in 2 private ponds in the town of Tosse.

■ Ecological impacts

- Massive growth of the plant led to slower flows which in turn blocked sediment transport (sedimentation by sand).
- The plants also blocks light which threatened native aquatic species (water-starworts, water mints, etc.).

■ Impacts on human activities

- Sedimentation in a recreational water body, possible impacts on fishing.
- Difficult access to the stream for animals, impact on grazing (reduced visibility of the pond and of the hydrographic network as a whole).
- Fishing became impossible, notably due to the lack of fish in the environment.

Interventions

■ Starting in 2012, the river board initiated manual uprooting of water pennywort in the basin to limit its colonisation.

■ Manual uprooting

- The work was done by a team of 4 agents.
- A single passage along the river was carried out in June 2012, the first year of the work.
- In 2013, manual uprooting was pursued with 5 passages from 5 June to 28 October.
- The tools used included:
 - neoprene gloves because direct contact with water pennywort provoked irritations;
 - waders;
 - buckets to collect the plants;
 - a boat to store the collected plants.

■ Screens

- Screens were installed on outlets to cut off heavily colonised areas and protect the downstream sections:
 - a screen was installed at the origin of the colonisation, on a tributary to the Cousturet upstream of the confluence to cut off the upstream section;
 - a screen was installed on the overflow outlet of the pond at Lagrollet to isolate the second source of contamination.
- Cleaning of the screens is indispensable and was carried out once or twice per week.

■ Waste management

- The harvested plants were deposited in a forest where water primrose had already been stored (town of Soorts Hossegor). No regrowth was noted on the site.



3. Beds of water pennywort.

4. Areas colonised by water pennywort prior to the work.

Results and costs

■ Results

- Along the 4 kilometres of river, 20.55 cubic metres of water pennywort were harvested in 2012 and 6.5 cubic metres in 2013.
- The reduction in the density of beds and surface cover was estimated at 80%.
- In spite of the uprooting and the installation of screens, a new area downstream, the Barthes d'Angresse area, was colonised.
- A cutting of water pennywort was observed at the end of 2012 on the upstream Boudigau, near the floating barrier just downstream of the Orx marshes (this information was transmitted to the Orx nature reserve). No new observations were made in 2013.

■ Situation at the end of the work

- A reduction in surface cover and in the sections colonised by water pennywort was observed.
- The quantities harvested dropped significantly from 5.14 cubic metres per kilometre in 2012 to 1.62 cubic metres per kilometre in 2013.
- The beds of water pennywort were not as dense.
- The advantages of rapid intervention include:
 - smaller quantities of plants to be harvested;
 - selective manual uprooting is easier. Native plants are less affected and can compete with the invasive species;
 - immediate uprooting of the first sprouts limits the development of large, single-species beds;
 - manual uprooting is the best technique because, contrary to mechanical uprooting, there is no need to wait for the plants to develop sufficient volumes. Faster intervention limits the development of new colonies.
- In 2012, the difficult conditions made the work much harder for the personnel. The water was cold and deep (one metre), and the plants were rooted in the bottom of the river bed. Access to the work site was difficult for the vehicle.
- In 2013, the harvested quantities were smaller, interventions were launched early in June and the work zone was accessible through to September.
- Regular cleaning of the screens was an important factor, notably after heavy rains carrying cuttings from the Lagrollet Pond.

■ Human and financial aspects

- The number of man-days required was high, but necessary given the quantities harvested and the need to contain the species and avoid its propagation to the entire hydrographic network.

Cost of management work.

Year	2012	2013	TOTAL
Number of man-days	36	31.5	67.5
Overall cost (€)	6 840	5 985	12 825



5. Cutting of water pennywort.
6. Overflow outlet of the Lagrollet Pond invaded by water pennywort prior to the installation of screens.

Outlook

- Manual uprooting will be pursued along the entire colonised section and in the affected areas. Work will be programmed early in the year, as soon as water levels drop, given that the plant is not affected by cold weather and produces large quantities of biomass very rapidly.
- The screens will remain in place and be regularly cleaned to avoid the spread of cuttings.
- Monitoring of aquatic environments will be pursued to detect new colonies and intervene rapidly in order to limit the development of the plant.
- The storage site for water pennywort will be monitored to detect any new growth.
- Extension of the surface areas colonised by water pennywort will be monitored.
- A study will be conducted on how to manage the species in the private Lagrollet Pond located near the river. The owners will be informed in order to obtain a commitment to manage the plants and a partnership will be proposed.

Information on the project

- Information is provided to elected officials during board meetings and to local residents.
- Feedback from the project is provided to elected officials and to municipal services.
- An internship report was drafted.

Authors: Sandra Fernandez, Irstea, and Emmanuelle Sarat (IUCN French committee).



7. 8. 9. Screens.

For more information

- www.riviere-bourret-boudigau.fr
- SMRBB, 2013. Memo on management work against water pennywort. 3 pp.





Parrot-feather watermilfoil (PFW)

(*Myriophyllum aquaticum*)

Originated in South America. Introduced as an ornamental plant in France in 1880 near Bordeaux to test the potential for naturalisation. Present primarily along the Atlantic coast, sporadically in the North, East and near the Mediterranean.

Description

- Perennial, amphibious plant
- Long, knotty stalks up to 3 to 4 metres long, 5 mm in diameter
- Can extend up to 40 cm above the water level
- Adventitious roots
- Leaves are pinnately-divided:
 - whorled in groups of 4, 5 or 6
 - 8 to 30 segments (feather like)
 - light green colour for submergent leaves, length 2.5 to 3.5 cm
 - dark green colour for emergent leaves, length 3.5 to 4 cm
- Sterile single-sex flowers (only female plants have been observed in France):
 - white, very small (1 mm)
 - on very thin, long, white stems, at the axil of leaves
- Root system firmly established in the substrate

Ecology and reproduction

- The preferred habitat is stagnant or lentic waters, exposed to sunlight, e.g. ditches, ponds, slow rivers and wetlands
- 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. Muséum d'Histoire naturelle, Paris, 168 pp.

Author: Emmanuelle Sarat, IUCN French committee

Classification

Order	Saxifragales
Family	Haloragaceae
Genus	<i>Myriophyllum</i>
Species	<i>M. aquaticum</i> (Verdcourt, 1973)





Parrot-feather watermilfoil

(*Myriophyllum aquaticum*)

Managing parrot-feather watermilfoil and water primrose in the Jaunay and Gué-Gorand marshes

Board for the Vie, Ligneron and Jaunay marshes (SMMVLJ)

■ The public board was created by prefectural order in 1981 and has its headquarters in the town of Givrand (Vendée department).

Board members include the Vendée departmental council, 3 intermunicipal associations and 2 towns.

■ Six associations also have advisory status, namely the Soullans and Rouches marsh association, the Saint-Hilaire-de-Riez and Notre-Dame-de-Riez marsh association, the Vallées dam association, the Basse Vallée de la Vie marsh association, the Jaunay and Gué-Gorand marsh association and the Vie marsh association.

■ The main missions include:

- maintaining and restoring the marshes and rivers in the collective interest;
- providing water management and coordination;
- piloting the SBMP (sub-basin management plan) for the Vie and Jaunay basin;
- managing the marsh section of the Sauzaie dunes and Jaunay marshes Natura 2000 site.

■ Contact:

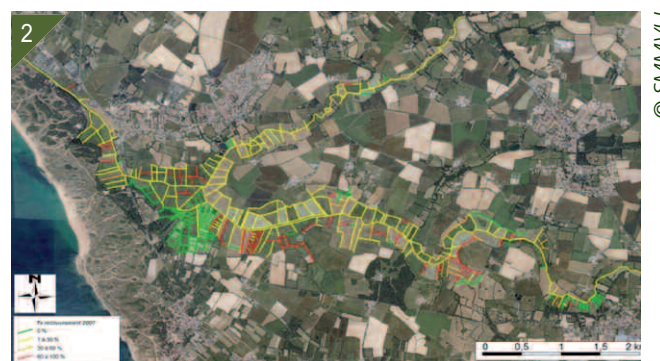
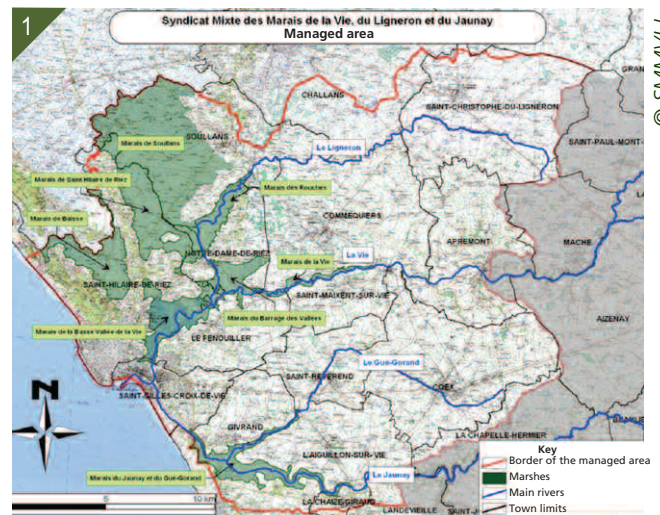
Pierre Travert - p.travert.smmvlj@orange.fr.

Intervention site

■ The board manages an area spanning 310 square kilometres, with 5 500 hectares of marshes and 300 kilometres of rivers and tributaries. Since 1996, SMMVLJ has played an active role in managing invasive alien aquatic plants, primarily in two marshes under its responsibility:

- the Jaunay and Gué-Gorand marsh colonised by *Ludwigia* spp. and parrot-feather watermilfoil (*Myriophyllum aquaticum*) since 1994 over its entire surface area (570 ha);
- the Soullans and Rouches marsh invaded by parrot-feather watermilfoil (PFW) since 2002, in a section spanning 150 metres.

■ PFW is no longer present in the Soullans and Rouches marsh following management work conducted from 2006 to 2010. The marsh is nonetheless monitored yearly to detect any regrowth.



1. Intervention sites.

2. Percentage covered in 2007.

3. Percentage covered in 2012

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■ Since 2011, the work to limit the expansion of invasive alien aquatic plants has taken place exclusively in the Jaunay and Gué-Gorand marsh.

■ Where they meet, the Jaunay and Gué-Gorand Rivers flow into the Jaunay and Gué-Gorand marsh, which covers a total surface area of 570 hectares. The marsh is situated in the towns of Saint-Gilles-Croix-de-Vie, Brétignolles-sur-Mer, Givrand, l'Aiguillon-sur-Vie and Chaize-Giraud.

Disturbances and issues involved

■ *Ludwigia* spp. and PFW were first observed in the Jaunay and Gué-Gorand marshes in 1994. They have now colonised the entire marsh (570 hectares), i.e. a total of 64 kilometres of rivers and ditches. The percentage of covered surface area ranges from 1 to 90%.

■ Colonisation of the marsh by these species has had a number of significant impacts:

- accelerated sedimentation;
- lower water quality;
- reduced biodiversity due to competition for light and space with the native plant species;
- more difficult conditions for recreational activities such as hunting and fishing.

Interventions in 2012

■ Since 2006, SMMVLJ has carried out extensive work (manual and mechanical uprooting) on the rivers and ditches of the marsh.

■ This work is also listed in the document listing objectives (DOCOB) for the Sauzaie dunes and Jaunay marshes Natura 2000 site of which the Jaunay and Gué-Gorand marsh is a part.

Manual uprooting

■ The work was done by SMMVLJ and the ASFODEL social reintegration association.

■ Work periods:

- First period from 11 June to 17 July 2012;
- Second period from 29 August to 12 October 2012.

■ Work procedure:

- manual uprooting of the plants on the banks or from a boat (team of 2 people);
- temporary storage in 100-litre containers in the boat;
- any cuttings were removed using a dip net;
- pitch forks were used to pull up large clumps.

■ Storage and fate of the harvested plants:

- the plants were deposited and spread on land near the ditches;
- they decomposed naturally given the high summer temperatures.

Mechanical uprooting

■ The work was done by a private company and by SMMVLJ (collection of plant fragments following the mechanical uprooting).

■ The work took place from 23 July to 9 August 2012.



4. Canal colonised by PFW.

5. Manual uprooting using a boat.

6. Equipment used for manual uprooting (pitch fork in the centre).

7. Mechanical uprooting.



■ Equipment used:

- excavators to uproot the plants;
- pumps to clear the ditches of water;
- nets to avoid dispersal of stalk fragments;
- dip nets to collect stalk fragments.

■ Disposal of the uprooted plants and the mud:

- the waste was deposited and spread on land near the ditches;
- the mud was later reworked and seeded by farmers.

■ Annual monitoring:

- inspection reports for each sector of the marsh are drafted to monitor changes in the colonised areas;
- colonisation of each ditch is monitored and mapped.

Results and costs

■ Results for 2012

	Manual uprooting	Mechanical uprooting
Linear distance worked	129 km	4 km
Volume removed	58 m ³ (587 bags, 100 litres each)	10 067 m ³
Total time of interventions	~ 865 H	112 H

■ Certain ditches remained highly colonised (over 60% of the surface covered) due to the high initial level of colonisation (100% coverage), the shallow water and trampling by livestock which facilitates propagation of the plants.

■ Comparison between 2011 and 2012:

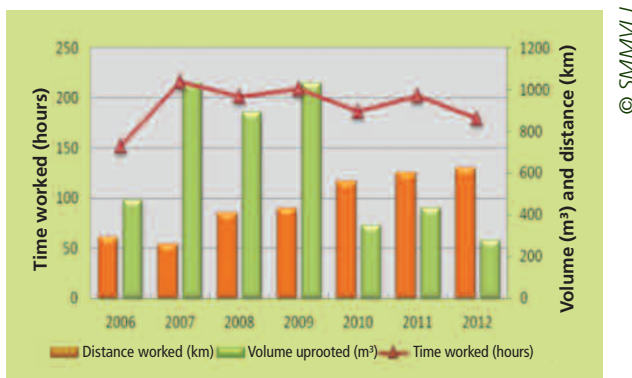
- larger area worked in 2012 than in 2011;
- reduction in the volume harvested by manual uprooting in 2012 (80 cubic metres in 2011);
- unusual weather conditions in 2012. The low temperatures during the summer may have slowed the growth of the aquatic plants and reduced quantities to be harvested.

■ Significant reduction in the quantities of plants harvested manually since 2010.

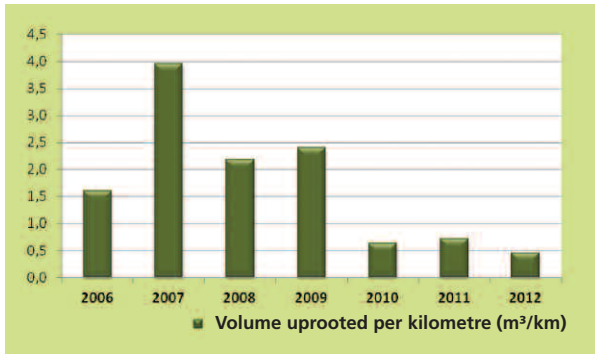
■ The mapping done by the marsh board revealed that the percentage of surface area covered by invasive plants has decreased since 2010.



8. Ditch before manual uprooting.
9. Ditch after manual uprooting.



Results of manual uprooting from 2006 to 2012



© SMMVLJ

Average volume uprooted per kilometre worked from 2006 to 2012.

Human and financial aspects

Cost of work in 2012.

Manual uprooting	ASFODEL association (600 hours)	6 660.00 €
	Marsh board	10 575.15 €
	Subtotal	17 235.15€
Mechanical uprooting	Company	13 419.72 €
Total (incl. VAT)		30 654.87 €

Outlook

- Monitoring will be set up for particularly troublesome areas (trampling by livestock, heavily colonised ditches) in view of launching a new action programme.
- Manual uprooting (three periods) will be pursued in 2014.

Information on the project

- The annual technical report on work was sent to the Vendée federation for fishing and the protection of aquatic environments, the Vendée departmental council and the Loire-Bretagne water agency.
- A number of technical information sheets were drafted.
- Documents available on the SMMVLJ site:
 - a guide on invasive alien terrestrial plants, particularly the main plants found locally (pampa grass, groundsel bushes and Japanese knotweed);
 - the annual report on work carried out by the marsh board.

Authors: Sandra Fernandez, Irstea, and Emmanuelle Sarat (IUCN French committee).

For more information

- SMMVLJ : www.vie-jaunay.com
- Syndicat Mixte des Marais de la Vie, du Ligneron et du Jaunay. 2013. Bilan de la lutte contre les plantes aquatiques exotiques envahissantes - année 2012. 28 pp.



Parrot-feather watermilfoil

(*Myriophyllum aquaticum*)

Managing parrot-feather watermilfoil in the Chicheboville-Bellengreville fens

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.
- Contact: France Mercier - f.mercier@cen-bn.fr.

Intervention site

- The Chicheboville-Bellengreville fens (alkaline wetlands) cover 150 hectares approximately 10 kilometres to the south-east of the city of Caen. The fens are biologically very rich with remarkable terrestrial and aquatic habitats, as well as a large number of rare and protected species.
- The site is protected by a number of statutes, including a type-1 ZNIEFF (natural zone with high ecological value), the Chicheboville-Bellengreville Natura 2000 site n° FR2500094, the Calvados sensitive natural area and conservatory sites (19 hectares are managed by the conservatory, including land owned by the conservatory, private property and all the property owned by the town of Chicheboville).
- The conservatory has been involved in managing the fens since 2000 (land owner since 2000 and Natura 2000 manager since 2004).
- Parrot-feather watermilfoil (PFW) was discovered in the Chicheboville-Bellengreville fens in 2011 by the National botanical conservatory in Brest, on a number of private lots that became town property in 2012. Since then,



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Key

- PFW beds in 2011 (4 000 square metres)
- PFW beds in 2012 (6 600 square metres)
- PFW beds in 2013 (7 000 square metres)
- Small islands
- Isolated plants in 2011
- Isolated plants in 2012
- Isolated plants in 2013

1. Map showing the spread of PFW from 2011 to 2013 in the Chicheboville-Bellengreville fens.

the conservatory has mapped the area and launched management work on the basis of agreements with the various land owners.

Disturbances and issues involved

Impacts on biodiversity

- Menace à court et moyen terme l'habitat d'intérêt communautaire « plans d'eau eutrophes avec végétations enracinées avec ou sans feuilles flottantes », déjà jugé en mauvais état de conservation. Compromet également le maintien de la vie aquatique (herbiers de characées, faune aquatique, etc.) associée à l'étang.

Risk of dispersal via the hydrographic network

- The colonised pond, located in the heart of the fens, is connected to the network of ditches running throughout the fens. Via this network, the plants could easily spread to other pools and ponds, in effect colonising the entire fens.

Interventions

■ 2011

- The species was discovered in the privately owned section.
- Mapping revealed that 4 000 square metres (40% of the pond) were colonised by PFW.
- Filters were installed on all water inlets and outlets to prevent dispersal of the plant.
- Manual uprooting over 2 days was organised with the conservatory team, owners and volunteers.
- 370 square metres of beds were uprooted, stored on site on tarps and then incinerated.

■ 2012

- The town purchased the private land with financial assistance from the Seine-Normandie water agency and the Calvados departmental council
- Mapping revealed that 6 600 square metres (almost 70% of the pond) was colonised by PFW.
- No management work on the plants was undertaken due to the change in ownership.

■ 2013

- Mapping revealed that PFW beds covered 7 000 square metres of the pond.
- Mechanical uprooting was launched.
- Funding was provided by the Water agency, the Calvados departmental council and the regional environmental directorate.
- The work consisted of:
 - clearing the banks to facilitate access by the machines;
 - installing filters on the water inlets and outlets and regularly cleaning them;
 - mechanical uprooting from the banks with a 24-ton excavator;
 - mechanical uprooting from a barge;
 - manual uprooting and finishing work by a team of 4 people with boats and dip nets to collect any floating stalk fragments and isolated plants;
 - digging a ditch on the bank, lined with a geotextile fabric, for storage and drying of the plants;
 - transport off site in a closed container to dry farm land for spreading.

Results and costs

■ Results

- Manual uprooting in 2011:
 - a voluntary manual-uprooting project was conducted to determine the time required for PFW management in the pond. During a total of 96 man-hours (8 people over two days), 370 square metres of beds were uprooted, representing barely 10% of the surface area covered by PFW in the pond;
 - inspections in 2012 revealed that the entire surface area uprooted in 2011 was again covered with PFW. Given the size of the site and the need to deal with the entire site in order to produce effective results, mechanical means were deemed indispensable.



2. The pond colonised by parrot-feather watermilfoil in the spring of 2013.

3. Manual uprooting.

4. Bucket used for mechanical uprooting.

5. Barge with an excavator on board.

6. Various steps during the work on PFW in 2013.



■ Mechanical uprooting in 2013:

- mechanical uprooting produced effective results with very little subsequent regrowth. A special bucket was created for aquatic plant beds by attaching large “claws” to a standard bucket;

- manual finishing work was indispensable to reduce the amount of regrowth the following year. It was also necessary in areas that the excavator could not access (the island in the middle of the pond and the reeds along one edge of the pond).

■ The dry farm land where the PFW was spread was monitored regularly. To date, no regrowth has been observed.

■ In the fall, the conservatory team spent 2 days manually uprooting PFW to limit the regrowth and reduce the quantities to be uprooted in 2014. Only 400 litres of plants were collected.

■ **Human and financial aspects**

■ The work done produced very encouraging results.

■ Mechanical uprooting made it possible to conduct an unusually large management project for Basse-Normandie and to eliminate the largest PFW colony in the region. The conservatory noted with satisfaction the professional work and the care taken to avoid dispersal of the plants. In addition, in spite of the mechanical means employed, beds of native aquatic species could be preserved in the pond. These natural beds have since expanded and can now compete with the PFW on the condition that the management work be continued.

■ It was difficult to obtain the funding for the mechanised work (70 000 euros incl. VAT), which did not include the site monitoring work done by the conservatory.

■ Important aspects include precise technical specifications, daily monitoring of the work site, careful cleaning of the equipment (with a boot bath for smaller objects) and regular monitoring of the fields where the plants were spread.

Outlook

■ Manual uprooting will be conducted regularly to attempt to completely eliminate PFW from the site.

■ Further work is planned for 2014 if the funding can be obtained. Manual uprooting by a social reintegration association is planned for 2 days per month for 6 months. The plants will be stored on a geotextile fabric, then transported to the same dry farm land as in 2013.

Information on the project

■ During the project, an information panel was set up on the land to explain the work and raise awareness concerning invasive species. People using the road and neighbours (hunters) were informed, as was the farmer who received the plants on his land. The funding entities and local elected officials visited the work site.

■ A poster explaining the management work for PFW on the site was prepared and presented at the meeting of conservatories in Bourgogne in November 2013. It was also made available to local officials, the funding entities and project partners.

■ Following the work, articles were published in the local press.



9 Lutter contre le Myriophylle du Brésil sur un site à fort enjeu écologique

1 ha de plan d'eau – 80% envahis par le myriophylle du Brésil en 2013
 Dans les marais de Chicheboville-Bellengreville, au sud-est de Caen, en Basse-Normandie
 Propriétaire : commune de Chicheboville (14)
 Gestionnaire : Conservatoire d'espaces naturels de Basse-Normandie
 Statuts en faveur du patrimoine naturel : ZNIEFF de type I, site Natura 2000 et ENS

2011 - Découverte du myriophylle du Brésil sur la parcelle
 Chantier-bénévoles d'arrachage manuel

2012 - Accompagnement de la commune pour l'acquisition de la parcelle

2013 Chantier d'arrachage mécanique

Département du chantier :
 - Déagrement des berges du plan d'eau pour faciliter l'accès aux berges.
 - Pose de filtres aux entrées et sorties d'eau.
 - Arrachage mécanique des herbiers avec une pelle de 2,47 mètres de long.
 - Arrachage mécanique du reste des herbiers avec la pelle depuis une barge flottante.
 - Finition en arrachage manuel (écouverts, flottantes et pieds isolés).
 - Couverture d'une fosse aux bords pour stockage et nettoyage des herbiers.
 - Exposition hors site avec bonne imperméabilisation pour les parcelles agricoles voisines.

Durée du chantier : 3 semaines
 Coût : 70 000€
 Maître d'ouvrage : Conservatoire d'espaces naturels de Basse-Normandie
 Maître d'œuvre : Environnement & Forêts et REVET

Enseignements :
 - Financement innovateur à mobiliser.
 - Suivi fin du chantier nécessaire.
 - Matériau du matériel minéralisé.
 - Création d'un espace pour le stockage des plants récoltés.
 - Lutte des herbiers en forêt de Basse-Normandie.

Partenaires techniques et financiers

- 7. The plants were stored in a ditch prior to being transported.
- 8. Aerial view of the pond in the fall of 2013, after the work to remove the parrot-feather watermilfoil.
- 9. Poster explaining the management work.

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 - +33 (0)2 31 53 01 05



New Zealand pigmyweed

(*Crassula helmsii*)

Classification

Order	Saxifragales
Family	Crassulaceae
Genus	<i>Crassula</i>
Species	<i>C. helmsii</i> (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 colonisation of a pond by New Zealand pigmyweed

Sèvre-Niortaise basin interdepartmental institution (IIBSN)

- Public agency set up by the Charente Maritime, Deux-Sèvres and Vendée departmental councils in 1987.
- The main missions include:
 - restoring and maintaining the hydraulic networks and installations in the Marais Poitevin marshes in a partnership with the State and the marsh board;
 - managing the Sèvre-Niortaise and Marais Poitevin SBMP and the Vendée SBMP;
 - coordinating the technical group for invasive alien plants in the Sèvre-Niortaise basin.
- Contact: Nicolas Pipet - nicolas.pipet@sevre-niortaise.fr

Autize and Egray intermunicipal board for hydraulics (SIAH)

- The board is active in the Autize basin (the part located in the Deux-Sèvres department) and the Egray basin, two tributaries to the Sèvre-Niortaise River.
- The objective is to establish a sustainable management and maintenance policy for the aquatic environments along the two rivers and their tributaries.
- The board is the managing entity for the Aquatic-environment territorial contract (CTMA) Autize-Egray 2013-2017:
 - an initial study prior to any work was conducted in 2010;
 - the objectives of the CTMA are to restore ecological continuity, particularly along the Autize, to limit clogging of the river beds and to reduce disturbances produced by farms.
- Board headquarters are located in the town of Beugnon (Deux-Sèvres department).
- Contact: Thierry Gambier - siah.autize.egray@gmail.com

Intervention site

- The pond infested with New Zealand pigmyweed (NZZ) is located in the town of Chappelle-Bâton (Deux-Sèvres department), in the upstream section of the Sèvre-Niortaise basin, in the Autize basin managed by the SIAH. IIBSN participated in this project in the framework of the technical group for invasive alien plants by providing technicians from the Sèvre-Niortaise basin.



1. Intervention site

- Approximately 250 square metres (10 x 25 m) of the pond surface were covered by NZZ. The water depth varied from 20 to 60 centimetres with between 20 and 40 cm of sediment.
- The pond belonged to a farmer and was located along a road.
- The pond received water from a fountain, but was not connected to the aboveground hydrographic network. The nearest stream was the Raganier Stream, located 500 metres away.

Disturbances and issues involved

- NZZ was observed for the first time on the site on 3 October 2011. This was also the first observation in the Poitou-Charentes region. The species has high dispersal capabilities, hence the need for rapid action once it has been detected. It is necessary to avoid colonisation of new sites by plant cuttings.

■ Impact on water flow

- The plant can block canals and ditches.

■ Impacts on the ecosystem

- The plant can limit the development of native aquatic plant species.
- NZZ beds modify the daily oxygen cycle to the detriment of animal species and thus to the ecological richness of the environment.

© Géoportail

■ Impacts on pond use

■ The development of a thick mat of plants along the edge of a pond or lake reduces the recreational value and can result in children and animals (pets, livestock) slipping and falling.

Interventions

■ The work was carried out starting in the spring of 2012, from April to August. It was organised jointly by IIBSN and SIAH with the participation of the farmer who owned the site.

The work consisted of two different operations.

■ Mechanical uprooting

■ On 12 April 2012, the farmer uprooted all the beds using a tractor with a front-end loader equipped with a claw.

■ Manual uprooting

■ Following the mechanical uprooting, IIBSN and SIAH worked twice on the site:
- on 4 May 2012, work on 5 beds, including 3 beds observed in 2011 and 2 new beds that appeared after the mechanical uprooting. Plus collection of cuttings.

Two people for 1 hour;

- on 16 August 2012, work on 5 beds plus collection of cuttings. Three people for 1 hour.

■ The workers started manual uprooting from the middle of the pond and worked to the edges in order not to trample the colonised zones and avoid any risk of fragmenting the plants and driving them into the sediment.

■ The plants were collected in 10-litre buckets and then transferred to basins.

■ Transport of the uprooted plants

■ The mechanically uprooted plants were stored on a hill approximately 100 metres from the pond. On the dry, relatively inaccessible hill, it was possible to monitor the changes in the plants following their transfer. The site also served for the plants uprooted manually.

■ Precautions taken during the work

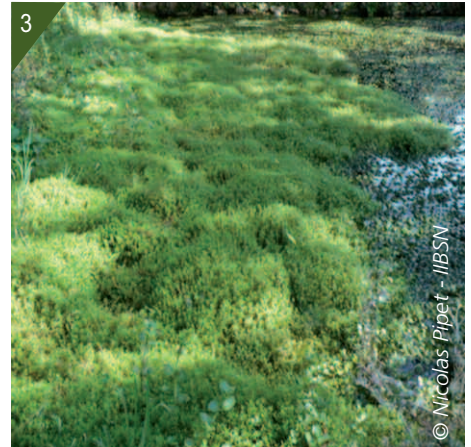
■ Manual work was preferred for very small beds and to collect stalk fragments.

■ Repeated manual interventions were organised for the entire pond.

■ A dry field located far from the wet areas was selected for plant storage to avoid any risk of regrowth and to monitor plant resistance to drying.

■ The people doing the work were trained to identify the species to improve detection of small beds.

■ Prior to the work, the wildlife on the site was observed in order to limit the negative impacts of the work.



2. Intervention site.

3. Beds of NZP.

4. Manual uprooting of NZP.

5. Plants ready for transportation.

6. A pile of harvested plants.

Results and assessment

■ Results of the work done from 2011 to 2013

Surface area colonised (square metres)					Biomass harvested (kilograms)					Time spent (hours)				
Oct. 2011	April 2012	May 2012	Aug. 2012	July 2013	April 2012	May 2012	Aug. 2012	July 2013	Sept. 2013	April 2012	May 2012	Aug. 2012	July 2013	Sept. 2013
44.4	49.5	16.75	16.75	0.8	2 000*	95	50	> 10	> 10	NC	2	3	1	1

*The 4 cubic metres harvested (stored) were a mix of NZP, other plants and sediment.

■ Assessment

- Approximately 95% of the initial biomass was harvested.
- Between 3 October 2011 and 3 May 2012, the mechanised work reduced the surface areas colonised, but produced cuttings.
- The manual work was effective and fairly simple for the beds located in the pond.
- The manual work required a large amount of time.
- Starting in 2013, the work and monitoring was organised by the SIAH technician.
- The storage area was monitored to learn more about the harvested plants.
- Plant regrowth in the pond was monitored and manual uprooting was repeated 3 times per year (May, July and September).
- A precise assessment of the management work was undertaken to check the effectiveness of the work over several years.
- Contact was maintained with the farmer.
- Checks were run to ensure that NZP did not spread to nearby aquatic environments.



7. The pond after the work on 3 May 2012.

Information on the project

- At the end of 2011, an initial observation report for the species in the Poitou-Charentes region was drafted by Irstea and IBSN, subsequently the National botanical conservatory for South-west France issued an alert concerning the species.
- At the end of 2012, a document summarising the work and monitoring carried out in 2011 and 2012 was drafted.
- The results of the work were presented annually to the farmer and to the town of Chapelle-Bâton.
- Annual reports on the work were published.

Remarks

- NZP has been designated an emergent invasive species in France given its limited presence in continental France.
- Experiments on the management techniques for NZP were conducted in another pond in the town of Donges (Loire-Atlantique department) in March and November 2012. A report on the work done was drafted by the Pays-de-la-Loire regional environmental directorate and the National botanical conservatory in Brest.

The report is available on the IBMA site.

Author: Emilie Mazaubert, Irstea

For more information

- IBSN internet site:
<http://www.sevre-niortaise.fr/accueil/des-thematiques-du-bassin-versant/les-plantes-exotiques-envahissantes/>
- For more information on the Sèvre-Niortaise basin, see the report on *Managing colonisation and proliferation of water primrose in the Marais Poitevin marshes* on page 70 in this document.
- Documents presenting the Autize and Egray intermunicipal board for hydraulics (SIAH).
- Fact sheet on New Zealand pigmyweed, National botanical conservatory in Brest:
<http://www.cbnbrest.fr/site/pdf/Crassule.pdf>
- Pipet N., Dutartre A. 2012. Synthèse des actions menées en 2011 et 2012 sur *Crassula helmsii* présente dans une mare des Deux-Sèvres. IBSN, Irstea, note, 19 pp.
- Sauvé A., Rasclé O. 2012. Intervention d'éradication de la Crassule de Helms (*Crassula helmsii*) - mare de Donges Est (44).





New Zealand pigmyweed

(*Crassula helmsii*)

Managing New Zealand pigmyweed in the Netherlands

RINSE project

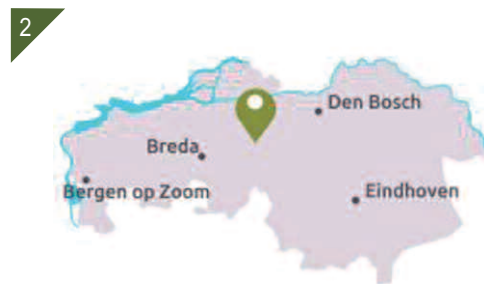
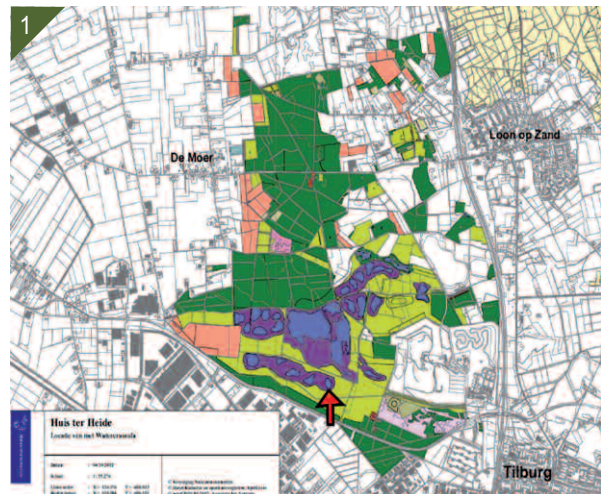
- The European RINSE project (Reducing the impacts of non-native species in Europe) attempts to determine the best management strategies for IASs in the Two seas region (along the English Channel and the southern section of the North Sea).
- The objective of the project is to develop cross-border instruments to improve assessment and targeting of IASs in order to ensure that management work effectively addresses the most worrisome species and sites. The project is concerned in particular with the species that grow in aquatic environments, e.g. New Zealand pigmyweed, water pennywort, Himalayan balsam, topmouth gudgeon, the Egyptian goose, American mink and muskrats. New management methods are experimented in the field to determine 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 total budget for the three years is 2.5 million euros.

Context and issues involved

- New Zealand pigmyweed (NZZ) was observed for the first time in the Netherlands in 1995, in a nature reserve near the town of Breda.
- As long as the plants did not impact drainage systems, very little work was undertaken to manage it.
- Subsequently, the species gradually began to cause problems (competition with native aquatic plants, reductions in wetlands used by birds) during restoration projects for important natural sites such as dunes.
- Its increasing presence in pools and ponds also causes problems for the conservation of amphibians.

Interventions

- In the framework of the RINSE project, an experiment was conducted in the town of Huis ter Heide (Netherlands), where NZZ was spreading in a pond.



1. 2. Study site.

- In June 2012, an initial visit to the site served to characterise the situation prior to any work:
 - NZZ was in the process of dispersing in the emergent riparian zones;
 - the degree of colonisation varied depending on the dry period for the pools and ponds;
 - the plants were massively present on the banks of the largest pond and were probably present below the water surface;
 - all the colonised areas were in contact with the main pond during the wettest part of the year.
- Following the initial visit, the objective of the management work was to limit the spread of NZZ by:
 - prohibiting grazing by animals that can disperse the plants unintentionally;
 - emptying the main pond;
 - removing the top 20 centimetres of soil;



- burying the contaminated soil nearby.

- In parallel, population-monitoring work was launched on the site.
- The work started in July 2012.
- It took several weeks to empty the pond because 50 centimetres of water remained in the middle due to flows from the water table and rainfall.

■ Dry dredging of sediment and soil

- The drained sections of the pond and the dry areas on the site were dry dredged to a depth of 20 centimetres.
- The entire pond and the rest of the site were dredged in August 2012.
- Approximately 3 400 cubic metres of sediment and soil were removed from the dry areas and the pond once the water level had dropped 50 centimetres (1 200 cubic metres of the remaining water were pumped).
- The residual plants in the middle of the pond (section never completely emptied) remain a constant source of propagules.

■ Dyofix

- The use of Dyofix (an anti-algal, triarylmethane dye) was planned. This dye limits luminosity in the aquatic environment, thus hindering photosynthesis and plant growth.
- In October 2012, the application for a waiver to use Dyofix was submitted.
- Voluntary personnel monitored the ponds on the entire study site. NZP was detected on two new sites.
- New management recommendations were implemented:
 - the exposed banks of the pond were covered with opaque sheets of plastic (tarps);
 - monitoring sites were established;
 - newly colonised sites were reported and eliminated or isolated;
 - monitoring was set up for NZP fragments that drift off and colonise neighbouring sites.

■ Tarps

- Plastic tarps (4 metres wide and 1 500 metres long) were installed on the exposed banks of the pond in November 2012.
- In January 2013, the water level rose, covering the tarped areas and resulting in dispersal of the stalk fragments. In response, voluntary personnel collected the fragments on a weekly basis.
- Following official approval, Dyofix was used for the first time in January 2013 when 16 kilogrammes were spread. Subsequently, the dye was used twice again, in March 2013 (14 kg) and in August 2013 (30 kg).

Results and costs

- The results in the emergent areas of the site were very encouraging. No regrowth has been noted to date following the removal of 20 centimetres of topsoil and the installation of the tarps.
- On the other hand, the results in the pond were mixed:
 - there was no significant reduction in NZP after the initial use of the dye, even though the recommended dosage (100 µg.l-1) was exceeded each time;
 - the reduction in the luminosity achieved by the dye was insufficient, except in the deepest part of the pond and for very short periods.



3. 4. The colonised pond, prior to the work.
5. Dredging work.
6. Site following the work.

- Higher concentrations of the dye would be necessary to compensate the luminosity problem, the significant fluctuations in the water level and the colonisation/growth potential of NZP.

- The above difficulties severely limited the potential of this technique in the given context and in similar situations.

- The meagre results are also due to the delayed use of Dyofix:

- the water level rose regularly following emptying of the pond in August 2012 due to inputs from the water table and rainfall;

- this situation enabled the NZP to take root once again between the dredging work and the first use of Dyofix in January 2013 (the maximum water level was reached in December 2012 and January 2013, when the water covered the tarps).

- Below is an assessment of the management costs.

Details on management costs.

Work	Cost in euros
Mechanical dredging	55 000
Plastic tarp (4 m x 1 500 m)	5 500
Fence (750 m)	1 500
Dyofix (60 kg)	1 200
Hours worked in 2012 by Natuurmonumenten (877 hours)	21 000
Hours worked in 2013 by Natuurmonumenten (95 hours)	Not quantified
Hours worked in 2013 by volunteers (482 hours)	Not quantified
Inventories (INBO)	Not quantified
Project monitoring (NVWA)	Not quantified
TOTAL	84 200

Outlook

- Establishment of sites to monitor the effects of the Dyofix.
- Maintain the concentration of Dyofix in the water.
- Remove cuttings, fragments and sand landing on the tarps.
- Monitor newly colonised areas in order to rapidly eliminate the plants.
- Mechanical mowing carried out at the end of 2013.



7. 8. Laying of the plastic tarps.
 9. Creation of the monitoring sites.
 10. NZP fragments following the use of Dyofix.
 11. Spreading Dyofix in the water.

Information on the project

■ Presentations of management work during NZP conferences in the framework of the RINCE project:

- St. Ives, Grande-Bretagne 7 - 8 mars 2013. *The 45th Robson Meeting. The on-going Crassula battle at Huis ter Heide.*

- Brockenhurst, Grande-Bretagne, 20 mars 2013. Conférence : New Zealand pygmyweed : tackling the challenge : « *Crassula helmsii in The Netherlands and Flanders: rules, regulations, management options and environmental impact* » ;

- Norwich, Grande-Bretagne, 17-18 octobre 2013 : Best practice workshop : *Managing invasive aquatic plants : « Physical and mechanical control of Crassula helmsii and Ludwigia peploides : is it a realistic option? ».*

■ A good-practices guide for NZP management is currently being drafted.

http://www.bosschap.nl/cmsAdmin/uploads/praktijkadvies-watercrassula_25-11-2013_002.pdf

Authors: Emmanuelle Sarat, IUCN French committee, and Johan Van Valkenburg, National Reference Centre, National Plant Protection Organisation (Netherlands)

For more information

■ Johan Van Valkenburg, Netherlands Ecology ministry

j.l.c.h.van.valkenburg@minlnv.nl

■ RINCE internet site:

<http://www.rinse-europe.eu/>

■ Natuurmonumenten :

<https://www.natuurmonumenten.nl/watercrassula>

■ Van Valkenburg J., de Hoop E. 2013.

The on-going Crassula battle at Huis ter Heide. In: Newman J.(ed.) The 45th Robson Meeting 7-8 March 2013.

Proceedings, Waterland Management Ltd, CaneEnd, p. 10.

■ Van Valkenburg J. et al.,2013. *Crassula helmsii in The Netherlands and Flanders: rules, regulations, management options and environmental impact. RINSE Conference : New Zealand pygmyweed : tackling the challenge. Brockenhurst, Grande-Bretagne, 20 March 2013.*

■ Van Valkenburg J. 2013. *Physical and mechanical control of Crassula helmsii and Ludwigia peploides : is it a realistic option? RINSE Best practice workshop : Managing invasive aquatic plants. 17-18 October 2013, Norwich, Great Britain.*

■ Denys L., Van Valkenburg J., Packet J., Scheers K., De Hoop E. et T. Adriaens 2014b. *Attempts to control aquatic Crassula helmsii at Huis ter Heide (Tilburg, The Netherlands), with special reference to dye treatment. In: Boets P. et al. (eds)*

Science for the new regulation. Abstract book BENELUX conference on invasive species, Ghent, p. 51.





Water primrose (*Ludwigia* spp.)

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. CERE/UCO/Angers-GIS « Macrophytes des eaux continentales » - Comité des Pays de la Loire/Gestion des plantes exotiques envahissantes – 2^e 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

Classification

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



© Emilie Mazaubert



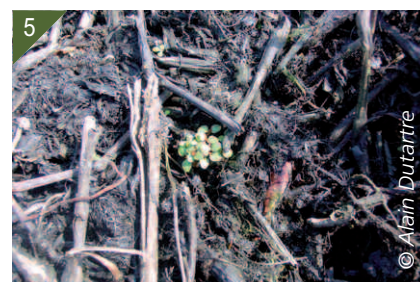
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1. Creeping water primrose (*Ludwigia peploides*).
2. Large-flower water primrose (*Ludwigia grandiflora*).
3. The pond colonised by water primrose in the Var department.
4. Root system.
5. Sprouting water primrose.



Water primrose

(*Ludwigia* spp.)

Experiments in managing water primrose in meadows and amphibious environments of the Barthes de l'Adour area

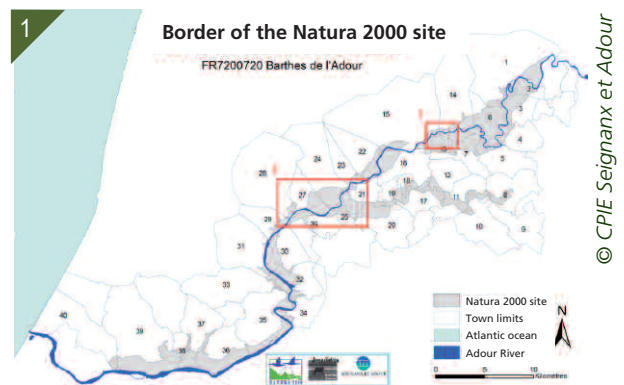
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Seignanx and Adour centre for environmental initiatives (CPIE)

- The non-profit association *Nature et Loisirs* was created in 1990 by the local governments in the Seignanx area and was certified as a CPIE in 1999.
- The centre has set up a management-coordination project for water primrose based on three main activities:
 - experiments in test zones on control methods not employing herbicides, including an assessment of the impacts on vegetation and a visual assessment of recolonisation rates for water primrose and native species following implementation of the methods;
 - assistance in project management for towns owning wetlands (*barthes*) along the Adour River, including the drafting of management objectives for water primrose depending on the needs of the towns, proposing alternative methods not employing herbicides and checking the suitability of those methods, coordinating subcontractors (including planning and monitoring of the work) and drafting an annual report on water-primrose management for the towns;
 - drafting of a precise annual characterisation and monitoring report on water primrose in the municipal wetlands based on aerial photographs.
- Funding is provided by the Landes departmental council, the Adour-Garonne water agency and the State.
- Contact: Frédéric Cazaban - cpieseignanxadour@orange.fr

Intervention site

- In the framework of the management-coordination project for water primrose, the CPIE is active in certain towns located in the Barthes de l'Adour Natura 2000 zone and owning wetlands intended for collective grazing. The zone comprises 520 hectares of floodable meadows spread over seven towns in the Landes department.
- The *barthes* are alluvial plains along the Adour and Luy Rivers that are regularly flooded. The hygrophilic meadows found in this type of environment are now partially invaded by water primrose.
- Since 2010, the CPIE has conducted experiments on management methods for water primrose in the towns of Tercis-les-Bains and Orist. The experiments are carried out



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1. Barthes de l'Adour Natura 2000 site and location of the municipal lands.
(1. Saint-Vincent-de-Paul, 2. Rivières, Mées, Tercis-les-Bains and Orist).

on two types of environment and on three study sites:

- wet meadows in the Barthe de Castetbielh (town of Tercis-les-Bains);
- amphibious environments in riparian zones along the edges of the Barthe de Castetbielh Pond used for hunting and in grassy areas subject to tidal variations in the New Barthe in the town of Orist.

Disturbances and issues involved

- The main problem in the Barthes area is the spread of water primrose from the aquatic environments to the meadow environments. In 2012, the CPIE assessment of water-primrose progression using aerial photographs revealed that 111 hectares of the 520 hectares of municipal wetlands were invaded by water primrose, i.e. 21% of the total surface area.
- **Impacts on ecosystems**
 - A reduction in the number of native species making up the plant communities in the meadows and amphibious areas.
 - Disappearance of protected and/or emblematic species (*Marsilea quadrifolia*, *Luronium natans*, *Damasonium alisma*).
- **Impacts on agricultural use**
 - The quantity and quality of the meadows for livestock grazing is reduced.

Interventions

■ Since 2010, the CPIE has conducted experiments on managing water primrose without herbicides (mowing and thermal weed control) in the towns of Tercis-les-Bains and Orist. From 2010 to 2012, some of the experiments were run on ponds used for hunting. An agreement was signed between the owners of the ponds and the CPIE on 6 April 2011 stipulating the obligations of each party.

■ Experimental organisation on each study site

- Two types of plots, 1 square metre each, were marked out with stakes:
 - E-type (experimental) plots that each received a single type of treatment;
 - T-type (control) plots were not treated and served to observe the natural development of water primrose;
 - the 1.5-metre area around E-type plots was treated like the plots to avoid the border effect.

■ Study protocol

- Start of work:
 - in 2010 and 2011, April for amphibious environments and June for meadows;
 - in 2012, June for amphibious environments and July for meadows (due to flooding of the plots in April).
- Prior to any treatment, the following work was carried out on each plot:
 - a georeferenced aerial photograph was taken to calculate the exact percentage of cover by each plant species using GIS software;
 - a number of parameters were noted in an observation report. For water primrose, the parameters were the average height of stalks, the percentage of stalks and rosettes, water depth, the percentage of surface area covered and the number of flowers. For the other species, the parameters were the name, percentage of surface area covered, number of plants and their average height.
- Treatments and observations were carried out once per month.

■ Types of treatment

- Thermal weed control using a burner.
- Mowing (only on the Barthe de Castetbieilh wet meadow):
 - using a brushcutter on 6 E-type plots;
 - during the period from June to August;
 - the cut water primrose (three 100-litre bags) was stored and dried in a glass-house outside the wetlands (on the CPIE site 34 kilometres from the study site).
- Mowing and thermal weed control (only on the Barthe de Castetbieilh wet meadow):
 - the first test was conducted in 2011;
 - the protocol was the same as for simple mowing, but with thermal weed control.



2. Meadow invaded by *Ludwigia grandiflora*.
3. Tractor equipped with a burner.

Table indicating the work done on the different sites.

Experimental sites	Barthe de Castetbieilh (Tercis-les-Bains)		New Barthe (Orist)
	Amphibious	Meadow	Amphibious
Type of environment	Amphibious	Meadow	Amphibious
Duration of work	4 months	3 months	4 months
Number of E-type plots	5	6	6
Number of T-type plots	5	6	6

Results and assessment

■ Results

- The experiments were conducted to assess the effectiveness of the tested treatments and their effects over the 3-year period.
- Over the years 2010 to 2012, during the growth period for water primrose (March to September), temperatures and solar irradiance were higher than normal and trended higher. Precipitation also increased over the 2010 to 2012 period.
- The observation data were tested statistically (Mann-Whitney test) to compare the results between the T-type plots and the E-type plots for each year of monitoring. The trends in the parameters were also assessed over the three years.
- Thermal weed control.

Summary of results in the amphibious and meadow environments.

Treatment	Results in amphibious environments	Results in meadow environments
Surface area covered by water primrose	<ul style="list-style-type: none"> ■ Cover on E-type plots was lower than on T-type plots, but regrowth was rapid. ■ In Tercis, a significant reduction was noted after the third year. 	<ul style="list-style-type: none"> ■ No significant effect of the treatment was noted during monitoring over 3 years. ■ Residual effect of treatment at the start of 2012, but the effect faded during growth season.
Height of water primrose	<ul style="list-style-type: none"> ■ Significant effect at the end of the monitoring periods in each of the 3 years on the two sites with increasing differences between the E-type and T-type plots. 	<ul style="list-style-type: none"> ■ Significant effect at the end of monitoring in 2010 and 2011. ■ No significant effect in 2012 (results altered by grazing of the T-type plots).
Flowering of water primrose	<ul style="list-style-type: none"> ■ Significant effect at the end of the monitoring periods in each of the 3 years on the two sites, except in Orist in 2012. ■ Persistent effect on flowering that was increasingly delayed and limited from one year to the next. 	<ul style="list-style-type: none"> ■ Significant effect at the end of monitoring in 2010 and 2011.£ ■ No significant effect in 2012 (results altered by grazing of the T-type plots).
Growth dynamics of water primrose	<ul style="list-style-type: none"> ■ In Tercis, the percent of colonisation dropped in 2010 and 2012. ■ In Orist, the treatment was ineffective on plants in aquatic environments (long flooded period). 	<ul style="list-style-type: none"> ■ Significant difference in the growth rate in 2010. ■ No significant effect the following two years.
Surface area covered by other plant species	<ul style="list-style-type: none"> ■ Significant effect in 2011 on the two sites with increased cover by other species. 	<ul style="list-style-type: none"> ■ No significant effect during the 3 years of monitoring.

- Mowing (only in the meadow environments):
 - no significant effect on the surface area covered by water primrose during the 3 years;
 - significant effect on height in 2010 and 2011. No significant effect in 2012 (grazing of the T-type plots);
 - no significant effect of the treatment on flowering;
 - significant effect on growth (height) in 2010 and 2011. No significant effect in 2012;
 - significant effect (increase) on the surface area covered by other species.
- Mowing + thermal control (only in the meadow environments starting in 2011):
 - no significant effect on the surface area covered by water primrose;
 - significant effect on height of water primrose in 2011. No significant effect in 2012 (grazing of the T-type plots);
 - no significant effect on the flowering of water primrose;
 - no significant effect on the surface area covered by other species.

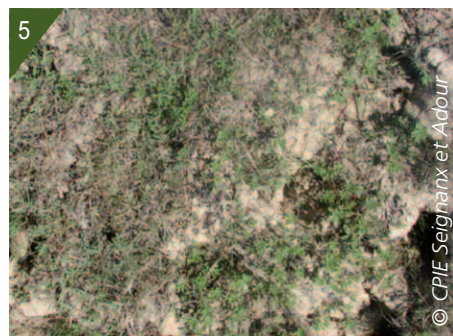
■ Assessment

- The results in the meadows are difficult to interpret, particularly in 2011 and 2012. Following the end of herbicide use, the livestock began to consume the water primrose. This phenomenon spread and increased in 2011 and 2012, to the point of significantly altering the parameters of the T-type plots.
- The thermal control produced very limited results over the 3 years of monitoring. However, the treatment would seem to be more effective in amphibious environments than in the meadows.
- Mowing had a significant effect (increase) on the surface area covered by other species.

● Outlook

- Work during August on the zone being colonised by mowing and ensiling to avoid the creation of water-primrose litter that blocks the development of all other vegetation. This work was undertaken in 2012 and amplified in 2013.
- Thermal control was temporarily interrupted due to the lack of suitable equipment.
- A project to manage water primrose over the entire Barthes area is being developed. This project is the follow-up to a feasibility study conducted in 2011 and 2012 to assess the costs, resources required, advantages and disadvantages of various management methods (thermal weed control, mowing, ensiling, enclosure and reprofiling of the meadows). The study is presented in the following pages, in the report titled *Experiments in managing water primrose in meadows of the Barthes de l'Adour area (part 2)*.

Author: Sandra Fernandez, Irstea



4. Plot prior to thermal weed control (June 2012).

5. Plot after thermal weed control (August 2012).

For more information

- Internet site of the Seignanx and Adour CPIE:
www.cpie-seignanx.com
- Internet site of the Barthes de l'Adour Natura 2000 site:
<http://barthesmidouzemarensin.n2000.fr/>
- Action programme of the Seignanx and Adour CPIE. 2012. Coordination of water-primrose management in the Barthes de l'Adour area, 98 pp.



Water primrose

(*Ludwigia* spp.)

Experiments in managing water primrose in meadows and amphibious environments of the Barthes de l'Adour area

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Seignanx and Adour centre for environmental initiatives (CPIE)

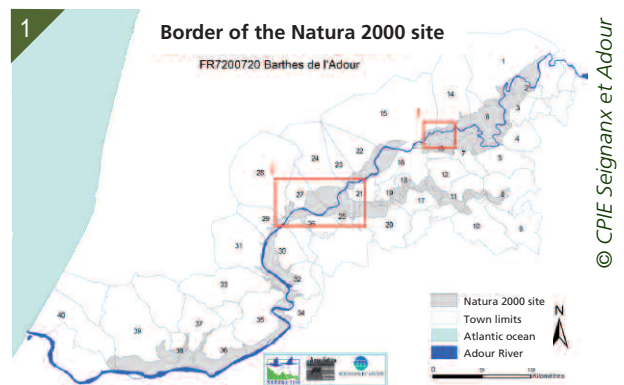
- The non-profit association *Nature et Loisirs* was created in 1990 by the local governments in the Seignanx area and was certified as a CPIE in 1999.
- The centre has set up a management-coordination project for water primrose:
 - assistance in project management for towns owning wetlands (*barthes*);
 - assessment of the management methods used in the municipal *barthes*;
 - management of water-primrose colonisation using transects and aerial inspection;
 - publication of a technical document on best practices for water-primrose management;
 - funding is provided by the Landes departmental council, the Adour-Garonne water agency and the State.
- Contact: Frédéric Cazaban - cpieseignanxadour@orange.fr

Intervention site

- Since 2010, in the framework of the management-coordination project for water primrose, the CPIE has provided assistance for project management to the towns located in the Barthes de l'Adour Natura 2000 zone and owning wetlands intended for collective grazing. * The *barthes* are alluvial plains along the Adour and Luy Rivers that are regularly flooded. In 2011, the CPIE assisted four towns, namely Tercis-les-Bains, Rivière, Saint-Vincent-de-Paul and Orist. In 2012 and 2013, the CPIE was also active in the town of Mées.

Disturbances and issues involved

- The main problem in the Barthes area is the spread of water primrose from the aquatic environments to the meadow environments. In 2012, the CPIE assessment of water-primrose progression using aerial photographs revealed that 111 hectares of the 520 hectares of municipal wetlands were invaded, i.e. 21% of the total surface area.



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1. Barthes de l'Adour Natura 2000 site and location of the municipal lands.
(1. Saint-Vincent-de-Paul, 2. Rivières, Mées, Tercis-les-Bains and Orist).

Impacts on ecosystems

- A reduction in the number of native species making up the plant communities in the meadows and amphibious areas;
- Disappearance of protected and/or emblematic species (*Marsilea quadrifolia*, *Luronium natans*, *Damasonium alisma*).

Impacts on land use

- A reduction in the quantity and quality of the meadows for livestock grazing.

Interventions

History of management work

- In the 1990s, large-flower water primrose (*Ludwigia grandiflora*) first appeared in the canals and ditches of the Barthes area.
- In 1996, the initial management efforts were undertaken, consisting of uprooting and burial of the plants, and use of herbicides.
- From 1996 to 1999, the management work in the canals and ditches was halted because *Ludwigia grandiflora* had regressed significantly. However, it appeared in the lakes used by hunters.
- In 1999, several lakes were treated (plants uprooted).
- In 2002, *Ludwigia grandiflora* was present in all the ponds and lakes, and in most of the amphibious grasslands and floodable meadows used for grazing in the Barthes area.

■ From 2003 to 2009, herbicides were used to control *Ludwigia grandiflora* on the meadows of several towns (Tercis, Rivière, Saint-Vincent-de-Paul, Orist, Saubusse) and in the canals spanning the entire Barthes area:

- 2006, biological control of *Ludwigia grandiflora* was attempted using African buffalo in the town of Tercis. The attempt was halted due to the lack of results;
- 2007, manual uprooting was attempted for the first time in a canal in the town of Tercis;
- 2009, the use of herbicides in aquatic environments was forbidden nationwide.

■ In 2010, use of herbicides was halted in the meadows and canals of the municipal *barthes*. An experimental programme to study alternative methods for *L. grandiflora* and *L. peploides* (see page 55, the report titled *Experiments in managing water primrose in meadows and amphibious environments of the Barthes de l'Adour area (part 1)*) was launched.

■ Management methods

■ Since 2010, the CPIE has tested a number of methods intended to manage *Ludwigia grandiflora* in the towns that requested assistance.

■ Thermal weed control:

- the work was done by a local farmer or by municipal personnel in the towns of Tercis-les-Bains and Saint-Vincent-de-Paul;
- the equipment was provided by a private company.

■ Mowing and removal:

- the work was done by a local farmer using a mower, a rake and a round baler in the town of Tercis-les-Bains;
- the plants were then transported and stored on concrete slabs (in a quarry and on a farm) by local farmers. Some of the plants were used as bedding in a cow barn.

■ Ensiling (chopping) and removal:

- the work was done by a private company using a tracked silage harvester in the towns of Tercis-les-Bains, Rivière and Orist;
- the plants were then transported by local farmers using trailers and stored on a dry, sandy hill or on a concrete slab in a quarry.

■ Combined mowing and thermal control:

- the work was done by a local farmer in the town of Tercis-les-Bains;
- the equipment was provided by a private company.

■ Fencing off (exclosure) of the meadow:

- the work was done in the town of Rivière;
- local farmers and hunters installed the fences around the colonised *barthes*.

■ Reprofilling and exclosure:

- the work was done by a local company specialised in farming work in the town of Rivière;
- the area was ploughed to a depth of 10 to 15 centimetres, then harrowed to break up the clumps of earth.

■ Monitoring protocol for the tests

■ Monitoring of the experimental management methods was set up in 2010 and conducted from 2011 to 2013 in the towns of Rivière and Tercis-les-Bains to assess their impacts on large-flower water primrose.



2.3. Meadow invaded by *Ludwigia grandiflora*.
 4. Burner for thermal weed control.
 5. Ensiling (chopping) the water primrose.
 6. Map showing water primrose in a municipal meadow (dark red = high density, light red = low density).

■ Six transects, 100 to 300 metres long with sampling points, were created in the treated areas in 2013.

- T1: 100 m in a fenced-off and ensiled area;
- T2: 100 m in a grazed, control area;
- T3: 100 m in a fenced-off and reprofiled area;
- T4: 100 m in a fenced-off area;
- T5: 300 m in a mowed area;
- T6: 200 m in an ensiled area;

■ A sampling point was established every 20 or 50 centimetres (500 to 600 points per transect).

■ Analysis of aerial photographs:

- aerial photographs were taken annually in July-August starting in 2011;
- analysis was conducted on both raw and processed photographic data;
- photos were georeferenced and a mosaic was created;
- conclusions were drawn and maps produced.

Results and costs

■ Preliminary results of the monitoring in 2013

■ The results presented here are the initial conclusions of the monitoring on the management trials conducted in 2013. The results of the aerial-photo analysis are not presented here.

Methods	Results
Thermal weed control	<ul style="list-style-type: none"> ■ This method was not employed in 2013 due to the difficulties in finding a functional solution for the tractor. ■ Its effectiveness is equivalent to mowing and ensiling (chopping), but it is more complex to implement.
Mowing and ensiling (T5 and T6)	<ul style="list-style-type: none"> ■ Exceptional flooding occurred in 2013 in the <i>barthes</i>, particularly in Tercis, where the <i>barthe</i> remained totally submerged for over two months until July, leading to: <ul style="list-style-type: none"> - damage to and disappearance of the plant communities in the meadows; - colonisation by <i>Ludwigia grandiflora</i> and other invasive species (<i>Myriop aquaticum</i> and <i>Paspalum distichum</i>). ■ Management results were difficult to analyse given the exceptional weather conditions.
Grazed, control area (T2)	<ul style="list-style-type: none"> ■ Over 44% of bare ground due to grazing. ■ Relatively high frequency of <i>Ludwigia grandiflora</i> (24%) and <i>Polygonum hydropiper</i> (20%). ■ Very few grasses (16%).
Meadow closed to grazing (T4)	<ul style="list-style-type: none"> ■ Relatively high frequency of grasses and reeds, in particular <i>Agrostis stolonifera</i> (46%), <i>Paspalum distichum</i> (33%), <i>Juncus acutiflorus</i> (20%). ■ Concurrent development of water primrose (42%) but at a low relative frequency (22%) compared to that of the other species (the total relative frequency is greater than 100% due to the presence of several species at a given sampling point).
Reprofiling and enclosure (T3)	<ul style="list-style-type: none"> ■ Relatively high frequency of grasses and reeds, in particular <i>Agrostis stolonifera</i> (38%), <i>Paspalum distichum</i> (17%), <i>Juncus acutiflorus</i> (30%). ■ Virtual disappearance of <i>Polygonum hydropiper</i>. ■ Very low relative frequency of water primrose (8%).

■ Costs

■ The total annual cost for water-primrose management in the four towns was 19 055,19 € (before VAT) in 2011 and 9 902,88 € (before VAT) in 2012.

Method	Cost	Advantages	Disadvantages
Thermal control	565 €/ha	<ul style="list-style-type: none"> ■ No waste management. ■ Effective method after a single treatment. ■ Zones can be selected. ■ No observed impact on grasses from one year to the next. ■ Only one person required. 	<ul style="list-style-type: none"> ■ Method not advised during hot weather with wind. ■ Effective only at low speeds (2 km per hour). ■ Effective on relatively flat land. ■ Not suitable for high, dense vegetation (the burners are blocked).
Ensiling (chopping)	580 to 750 €/ha	<ul style="list-style-type: none"> ■ Grass cover is not affected. ■ Immediate removal (no deposit on site). 	<ul style="list-style-type: none"> ■ Method requires 2 or 3 people and equipment. ■ A nearby storage place is required. ■ Effective on relatively flat land. ■ Small surface area treated per hour.
Mowing	230 €/ha	<ul style="list-style-type: none"> ■ Grass cover is not affected. ■ Large surface area treated per hour. ■ Only one person required. 	<ul style="list-style-type: none"> ■ Many operations required for a given area (mowing, drying, baling, removal). ■ A nearby storage place is required. ■ The plants remain on site during the drying, creating a risk of regrowth.
Mowing and thermal control	557 €/ha	<ul style="list-style-type: none"> ■ Can reach the base of the stalks and the creeping root system when there is a significant amount of litter. ■ Only one person required. 	<ul style="list-style-type: none"> ■ Many operations required for a given area from one year to the next. ■ Grass cover is affected. ■ Encourages the creeping type of water primrose.
Ensiling (chopping) and thermal control	573 to 659 €/ha	<ul style="list-style-type: none"> ■ Can reach the base of the stalks and the creeping root system when there is a significant amount of litter. 	<ul style="list-style-type: none"> ■ Two operations for a single treatment. ■ Method requires 2 or 3 people and equipment. ■ Grass cover is affected.
Exclosure	2.50 to 2.70 € per metre distance	<ul style="list-style-type: none"> ■ No impact on the environment. ■ Rapid implementation. ■ Can be implemented over large areas. 	<ul style="list-style-type: none"> ■ Unpopular method for livestock farmers and the public.
Reprofiling	48 €/ha	<ul style="list-style-type: none"> ■ Easy implementation with local farmers. ■ Make available land abandoned by livestock. 	<ul style="list-style-type: none"> ■ Limited to small areas (a few hectares), compatible with ecological issues. ■ Reprofiling area must be fenced off long enough for the grass to grow back.

● Outlook

- Revitalisation of the meadow plant community (enhanced grazing conditions):
 - adaptation of grazing conditions (rest time for the meadow, grazing management, etc.);
 - control over water levels during the spring and summer (restoration of the hydraulic system, maintenance of canals, ditches and hydraulic installations);
 - exclosure and work on the soil in areas being colonised by water primrose (fences put up and soil turned over (Rotavator) in September).
- Direct management of water primrose by mowing or ensiling (chopping), with removal of the plants outside the wetlands to a storage area or for spreading on fields or used as bedding for livestock in a barn.

Author: Frédéric Cazaban, CPIE Seignanx et Adour

For more information

- Internet site of the Seignanx and Adour CPIE:
www.cpie-seignanx.com
- Internet site of the Barthes de l'Adour Natura 2000 site:
<http://barthesmidouzemarensin.n2000.fr/>
- Action programme of the Seignanx and Adour CPIE. 2013. Coordination of water-primrose management in the de l'Adour area, 98 pp.



Water primrose

(*Ludwigia* spp.)

Managing water primrose using mechanical uprooting and sediment dredging

Beuvron basin management board (SEBB)

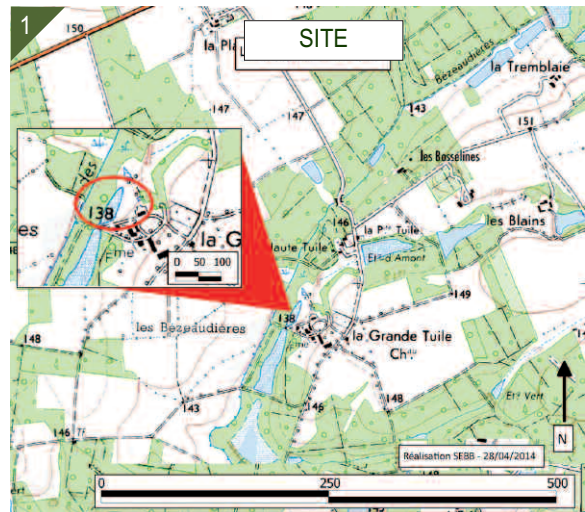
- The SEBB is a local government created in 1996.
- Its main missions are to manage the rivers in the Beuvron basin, including restoration and maintenance of the rivers, and to conduct the necessary studies on management of the rivers and of invasive alien species (both plant and animal).
- Workforce and territory. One policy officer for the basin contract, a river technician, four operators for river maintenance and a part-time secretary make up the SEBB personnel. The board represents 70 towns in the river basin, covering a total of 2 191 square kilometres.
- Contact: Dominique Béguin - beguin.sebb@orange.fr

Fishing federation for the Loir-et-Cher department (FDP 41)

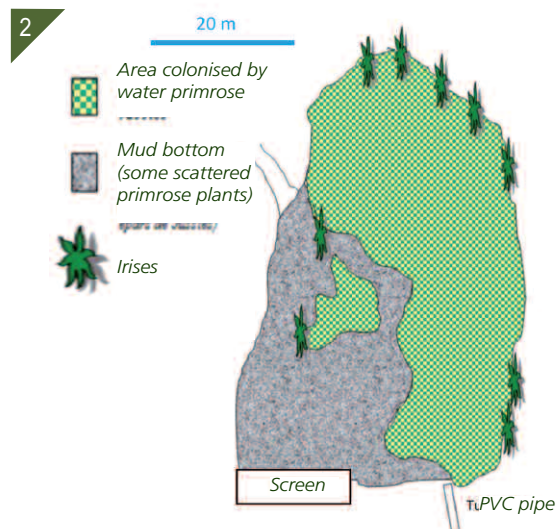
- A non-profit association certified for environmental protection, based in the city of Blois, grouping 40 certified associations for fishing and protection of aquatic environments (AAPPMA) and the certified departmental association of recreational fishermen using nets and traps, representing a total of approximately 11 000 members.
- Its main missions are to coordinate and organise the work of the AAPPMAs, to gain knowledge and protect aquatic environments, to protect fish populations, develop recreational fishing and raise the awareness of members.
- Employees include a secretary-accountant, a policy officer in charge of coordination, an officer in charge of monitoring fish populations, two scientific officers and a maintenance operator.
- Contact: Isabelle Parot - fed.peche41@wanadoo.fr

Site d'intervention

- Sologne is a "territory", covering approximately 5 000 square kilometres spread over three departments (Cher, Loir-et-Cher and Loiret).
- It is divided into two main parts:
 - Grande Sologne, including the ponds (between the Sauldre and Beuvron Rivers), the section near the city of Orléans (between the Beuvron and Cosson Rivers) and the section along the Cher River;
 - the wine-growing section in the western part of the river basin.



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1. Study site. The pond is located upstream of a string of three ponds.

2. Colonisation of the pond by water primrose, prior to the intervention.

- This area is home to a very large number of wetland plant and animal species and is an important ecological site in Europe.
- Large-flower water primrose (*Ludwigia grandiflora*) is present in Sologne in the rivers and in a number of ponds. In the rivers, it is located essentially in the lentic reaches (slow currents). Many ponds have also been colonised to different degrees by the plant.
- The existence of strings of ponds facilitates the spread of the plant from one pond to the next.

Disturbances and issues involved

- A high level of biodiversity exists in Sologne due to the many wetlands that, if colonised by water primrose, could no longer serve for the native plant and animal species that depend on wetland conditions.
- High densities of water primrose tend to “occupy” colonised sites due to the accumulation of organic matter resulting from the production of biomass by the plant. As a result, the volume of non-colonised water is reduced and the environment becomes less diverse because it no longer provides the habitats required by the native species that originally occupied the area. Water primrose is a highly competitive species with respect to the other aquatic species and particularly protected species.

Interventions

- Following an informational meeting in 2004 on issues surrounding water primrose in Sologne and an open-house in 2005, the Pays-de-Grande-Sologne board decided to test mechanical uprooting of water primrose in a local pond.
- The test took place in the town of Souvigny-en-Sologne thanks to a land owner who took interest in the project. Two ponds on the property were colonised by water primrose and it was decided to conduct the test on the smaller pond (1 850 square metres) located upstream of a string of three ponds.
- In 2007, when the project began, water primrose had colonised two-thirds of the total surface.
- The pond was drained before the work was undertaken.

■ Project steps

- Mechanical uprooting and soil stripping, followed by three inspections with manual uprooting:
 - the first inspection immediately following the work;
 - the second two months after the work;
 - the third eleven months after the work.
 - The work started in 2008.
- The site was then monitored annually from 2009 to 2013.

■ Mechanical uprooting and soil stripping (2008)

- The plants were uprooted and removed using a tracked excavator, a tractor and a trailer.
- For the test, it was decided to remove the water primrose, the plant litter and 40 centimetres of sediment (on average) in order to limit regrowth by cuttings and seeds (removal of all roots and seeds).

■ Manual uprooting

- Manual uprooting was included in the project for several reasons:
 - uprooting was undertaken around the emergent native riparian vegetation to help it develop and compete with the water primrose;
 - following the mechanical uprooting, it was required to remove the new shoots that generally appear after a few days. This occurs because the excavator bucket tends to leave many rhizomes in the soil during uprooting. It was therefore essential to include manual uprooting in order to reduce recolonisation by the plants. This work was made easier due to the very small volumes involved.



3. The drained pond.

4. Work to uproot the plants and strip the top layer of sediment.

5. Removal of the plants and sediment.

■ Waste management

- The plants and sediment were transported by tractor and trailer to a meadow. Every effort was made to limit the passage of the excavator in the beds of primrose to avoid dissemination of the plants.
- The waste was spread in a nearby meadow. It was planned not to create mounds, but a layer approximately 10 centimetres thick.
- The waste was spread only in the top section of the meadow in order not to cover typical wetland plants present in the lower section.

Results and assessment

■ Results

- The volume of waste (plants and sediment) removed from the pond amounted to 1 200 cubic metres.
- The entire amount was spread in the nearby meadow. In the end, the waste was spread over a surface area of 3 500 square metres in a layer approximately 30 to 40 centimetres thick.
- Manual uprooting took place in 2008.

Date	Number of people	Time spent (hours per person)	Volume removed (litres)
28 July	3	8	240
9 September	2	3	160
22 September	1	2,5	54
30 September	2	3,5	160

■ Subsequent monitoring (2009, 2010, 2013)

- The owner was trained to identify water primrose so that she could carry out manual uprooting herself.
- * Monitoring of the meadow where the waste was spread:
 - the drying time was longer than planned given the thickness of the spread material;
 - in 2009, the very hot summer resulted in the disappearance of the stands of reeds in the meadow and the appearance of grasses;
 - in 2010, wetland plant species such as reeds and hemp-agrimony (*Eupatorium cannabinum*) reappeared, signalling that the soil on the site still contained a high degree of humidity;
 - in 2013, the plant community in the meadow comprised grasses and shrubs (*Genisteae* (brooms) and blackthorn), similar to the situation before the work. The species observed in 2010 were no longer present.

■ Monitoring of the pond

- 2009. Sporadic, but regular regrowth of water primrose was observed in the pond and along the banks (probably due to plant litter buried during the work).
- 2010. Following the manual uprooting carried out in 2009, the sections of the pond under water were free of water primrose. However, the species was still present at the foot of the banks.



6. 7. The meadow prior to the work (2008) and in 2013.

- 2011. A few plants persisted at the foot of the banks in the sections no longer covered with water, which made them more difficult to uproot.
- In 2010 and 2011, the work to uproot the plants was done by a private firm. The volumes removed and the time spent are not known.
- 2012. A few plants were present on the dewatered bank at the foot of the pond, mixed with marsh seedbox (*Ludwigia palustris*). No regrowth was observed in the pond. A volume of 10 litres was removed by two people in 30 minutes.
- 2013. Three small areas were noted (less than 1 square metre each) and uprooted (40 litres). This work occupied one person for an hour.

■ Financial aspects

- The mechanical uprooting and stripping was funded by the land owner (50%) and by EU LEADER+ funds (50%) managed by the Pays-de-Grande-Sologne board. The overall cost was 5 800 euros including VAT.
- In 2010 and 2011, the land owner brought in a specialised firm for manual uprooting that cost 500 euros each year, i.e. a total of 1 000 euros including VAT.

Year	Volume removed (litres)	Time spent (hours)	Price (in euros incl. VAT)
2008	614	39.5	5 800
2010	Not available	Not available	500
2011	Not available	Not available	500
2012	10	0.5	-
2013	40	1	-
TOTAL	At least 670 litres	At least 41 hours	6 800 € incl. VAT

Outlook

- Site monitoring was conducted for a year in conjunction with the land owner. During that time, she learned to identify water primrose (a similar native plant, marsh seedbox, was also present) and how to uproot the plants. Today, the owner regularly monitors the pond and if necessary calls a firm specialised in this type of work.

Information on the project

- Management of water primrose calls for greater communication and notably of information on how to handle it rapidly following its establishment on a new site.
- With that in mind, a brochure on the best manual uprooting technique for water primrose was recently drafted so that anyone confronted with the start of a colonisation can take effective action. Intended for the general public, the brochure is available in town halls and can be viewed on the SEBB site.

Authors: Emmanuelle Sarat, IUCN French committee, and Dominique Béguin, Beuvron basin management board.



8. The pond just before the work (2008).

9. The pond in 2012.

For more information

- www.bassin-du-beuvron.com
- www.fedepeche41.com
- Béguin D. et Parot I. 2013. Compte-rendu de l'opération test d'arrachage mécanique de jussies, Petit Étang, la Thuile, Sauvigny-en-Sologne, Loir-et-Cher. Syndicat d'entretien du bassin du Beuvron et Fédération de pêche et de protection du milieu aquatique du Loiret-Cher. 20 pp.
- Syndicat d'entretien du bassin du Beuvron et Syndicat intercommunal du Bas Cosson. 2013. La jussie, plante exotique envahissante : méthodologie d'arrachage manuel. 2 pp.





Water primrose

(*Ludwigia* spp.)

Managing water primrose in the Vistre basin

Public river-basin territorial agency for the Vistre basin

- The public entity was founded in 1998 and federates towns and groups of towns.
- On 1 August 2011, it was acknowledged by prefectural order as a public river-basin territorial agency (EPTB) in the area covered by the Vistre, Vistrenque and Costières SBMP:
- The Vistre EPTB provides overall water management, including:
 - maintenance of the river beds and banks, removal of jamming debris and management of landings (multi-annual management plan for river environments);
 - reduction of risks and vulnerability caused by river flooding and rural runoff;
 - participation in protecting water bodies, hydro-morphological restoration work and revitalisation of rivers.
- Contact: Christophe Pezeril - christophe.pezeril@eptb-vistre.fr

Intervention site

- The EPTB manages an area of approximately 790 square kilometres and 185 kilometres of river.
- The Vistre River originates in the town of Bezouze, to the north-east of Nîmes, and flows into the Rhône canal at Sète, to the north of Aigues-Mortes.
- In 2009 and 2010, management of water primrose was conducted primarily on sections of the Vistre, in nearby wetlands and on two tributaries, the Buffalon and the Tavernolle.
- Starting in 2011, in an effort to optimise management operations, the work was more focussed, targeting heavily colonised wetlands and the areas around the work sites of the previous years, in the towns of Bouillargues and Nîmes.

Disturbances and issues involved

- The presence of water primrose in the Vistre basin became troublesome starting in 2007. The plants developed primarily in the Buffalon and in the Vistre from the confluence with the Buffalon to the Bastide site (Nîmes).



1. Territory managed by the Vistre EPTB.

Impacts on ecosystems

- High level of biomass produced, contributing to sedimentation and filling of stagnant biotopes.
- The beds of plants trap silt and suspended matter in the water.
- Hydraulic circulation in rivers is disturbed.
- Competition with native species.

Interventions

- At the request of the Rhône-Méditerranée-Corse water agency, the Vistre EPTB has since 2008 organised uprooting of water primrose in the upper sections of the Vistre basin to avoid colonisation of the downstream sections.

Manual uprooting

- A boat and a winch are used.

Mechanical uprooting

- Mechanical uprooting was used in areas where manual uprooting was not feasible (excessive depth or large surface areas).
- The work was done by a private firm (the Marquis company).
- An excavator with a 10-metre arm and a screening bucket was used.

■ Drying the uprooted plants

- The plants were deposited at the top of the banks.
- They remained spread on the banks for 7 days.
- They degraded naturally on site.

■ Tarping

- Tarps were spread on the banks for 10 to 15 days.
- They were used on non-flooded strips of ground colonised by water primrose, along the wetlands.
- After removing the tarps, the plants could be rapidly uprooted.
- In 2011, tests were conducted with two types of tarps, opaque black and translucent green.

Year	Work periods	Work sectors	Techniques
2008	26 June to 29 July	16 reaches (Vistre, Tavernolle, Buffalon)	Manual and mechanical uprooting
2009	30 June to 7 August	27 reaches (Vistre, Tavernolle, Buffalon)	Manual uprooting
2010	10 August to 6 September, 18 October (mechanical uprooting)	27 reaches (Vistre, Tavernolle, Buffalon)	Manual and mechanical uprooting + tarping
2011	27 June (spreading of tarps) 12 July to 20 September	12 reaches (Vistre, Buffalon)	Manual uprooting + tarping
2012	28 June (spreading of tarps) 14 August to 21 September	12 reaches (Vistre, Buffalon)	Manual uprooting + tarping

Results and assessment

■ Results of uprooting since 2008

- No increase in the area colonised by water primrose along the managed reaches.
- Decrease in the areas covered by water primrose along heavily shaded and rapidly running river reaches.

Year	Linear distance (metres)	Full-time equivalent days	Weight of removed plants (kg wet matter)	
			Manual uprooting	Mechanical uprooting
2008	5 049	71	5 098	2 365
2009	10 788	84	9 082	-
2010	7 846	76	10 100	4 706
2011	1 606	59	3 158	-
2012	1 376	33	3 478	-

■ Results of tarping

- Tarping reduced the volume of stalks to be uprooted.
- Observations after removing the tarps:
 - in November 2011, the plants under the translucent green tarps had started to regrow whereas there was no regrowth under the opaque black tarps;
 - identical observations in 2012.
- Manual uprooting was easier in the tarped areas.
- Tarping is not selective, i.e. it impacts the native species as well as the water primrose.

- In April 2013, natural recolonisation by native plants (Iris, Carex, *Veronica beccabunga*) was observed in the tarped areas.

Outlook

- Continue management work on water primrose in the Vistre basin.
- Monitor colonisation in the tarped areas, after uprooting.
- Encourage colonisation of native species by planting or seeding, in the absence of natural colonisation.
- Continue management work on the riparian vegetation of the banks to increase the shade along rivers.
- Operations started in 2006 include planting, brushcutting, clearing of jamming material in rivers, severe cutting back of willow trees.

Information on the project

- Annual publication of a report titled *The work to uproot water primrose in the upstream sections of the Vistre basin*.
- Partnership with a class from the Rodilhan agricultural school for a half-day of uprooting in 2010, 2011 and 2012.
- Project to publish a brochure and fact sheets on the work done.

Author: Sandra Fernandez, Irstea

For more information

- Annual report titled *The work to uproot water primrose in the upstream sections of the Vistre basin*, from 2008 to 2012, S.M.B.V.V.- E.P.T.B.
- Presentation of the board for the Vistre basin.
- Presentation of the Vistre EPTB.
- Pézeril C., Serre Jouve S., Arce E., Archaimbault V., Chauvin C., Dumont B., Dutarte A., Foulquier A., Morin S., Montuelle B. 2010. Revitalisation écologique du cours du Vistre (Gard) : modalités techniques et évaluation des gains écologiques. Actes des 4èmes Journées Atelier de REVER, 6-7 novembre 2012, Lyon.
- Pézeril C., Dutarte A. 2013. Gestion de la Jussie (*Ludwigia peploides*) dans la rivière du Vistre (Sud-Est de la France). Poster présenté au Colloque Macrophytes, 28-30 mai 2013, Bordeaux.



2. Uprooting water primrose with a school class in 2011.
3. Tarp covering an area colonised by water primrose.
4. Situation after 7 days of being covered by a tarp.
5. Situation after tarping and manual uprooting.
6. Site tarped in 2012 and naturally recolonised by native species in April 2013.



Water primrose

(*Ludwigia spp.*)

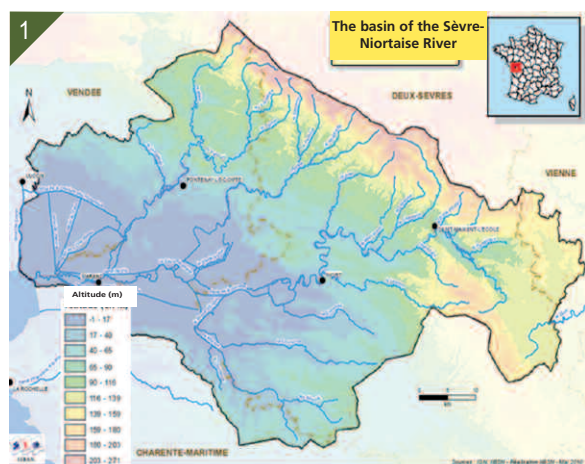
Managing colonisation and proliferation of water primrose in the Marais Poitevin marshes

Sèvre-Niortaise basin interdepartmental institution (IIBSN)

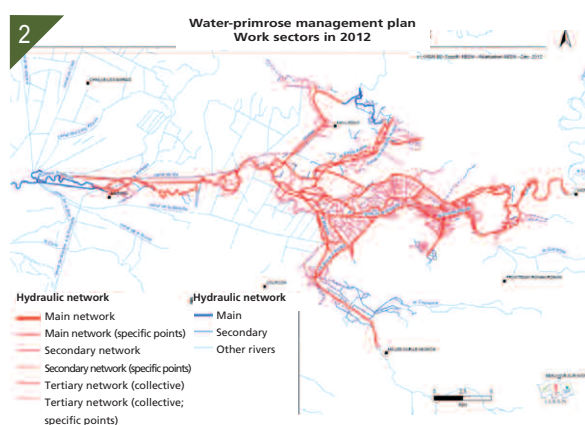
- Public agency set up by the Charente Maritime, Deux-Sèvres and Vendée departmental councils in 1987.
- The main missions include:
 - restoring and maintaining the main channels in the Marais Poitevin marshes in a partnership with the State and the marsh boards;
 - modifying the hydraulic installations in the marshes to enable the passage of fish;
 - conducting studies on water management;
 - managing the Sèvre-Niortaise and Marais Poitevin SBMP and the Vendée SBMP;
 - controlling the proliferation of plants, notably alien plants.
- Contact:
 - Nicolas Pipet - nicolas.pipet@sevre-niortaise.fr:
 - manages the restoration and maintenance work on rivers in the Marais Poitevin marshes;
 - manages the project to “control colonisation and proliferation of water primrose in the Marais Poitevin marshes”;
 - provides information to people in the area (elected officials, the public, etc.), trains managers and technicians from other areas;
 - participates in a number of work groups, committees and observatories on the departmental, regional and national levels, notably IBMA.

Intervention site

- The basin of the Sèvre-Niortaise River lies in four departments (Deux-Sèvres, Charente-Maritime, Vendée and Vienne) and two regions (Poitou-Charentes and Pays-de-la-Loire). The basin is approximately 100 kilometres long from the inland source to the Baie de l’Aiguillon and stretches 50 kilometres from north to south.
- The Sèvre-Niortaise is the main coastal river draining the basin and runs a total of 160 kilometres (not including the network of marshes). Its source lies in the town of Sepvret, at an altitude of 153 metres in the Deux-Sèvres department, and the river flows through the Marais Poitevin marshes before entering the Baie de l’Aiguillon. The main tributaries, from upstream to downstream, on the right bank are the Chambon, Egray, Autize and Vendée, and on the left bank the Lambon and Mignon.



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1. Territory managed by IIBSN.
2. Work sectors in 2012.

- On the basis of discussions with the concerned persons and entities, the hydraulic network of the Marais Poitevin marshes has been defined as follows:
 - the main network forming the structure of the marshes including rivers flowing through at least two departments (flood and low-flow management, boating, tourism, etc.). This network covers 508 hectares and represents a total of 252 kilometres;
 - the secondary network comprising lesser rivers providing collective services locally (draining of land, water storage, tourism, etc.). The total distance covered by this network is 460 kilometres (90 km in the Charente-Maritime department, 200 km in Deux-Sèvres and 170 km in Vendée);
 - the tertiary network consists of upriver networks of which a part serves collective uses (230 km) and the rest private uses.

Disturbances and issues involved

■ Since 1991, the water channels in the wetlands linked to the Sèvre-Niortaise, Mignon and Autizes Rivers have been colonised by two species of water primrose.

■ Impacts on water quality

■ Beds of plants modify the daily oxygen cycle to the detriment of animal species and consequently reduce the ecological richness of the environment.

■ Impacts on the ecosystem

- High level of biomass produced, contributing to sedimentation and filling of channels.
- Problems arise for the movement of water and fish.
- Competition with native species.
- Unpleasant visual effects due to waste trapped by the beds.

■ Impacts on boating

■ The dense beds block the passage of boats and other small craft.

■ Impacts on fishing

■ The development of dense beds makes fishing impossible.

Interventions

■ Experimental work was undertaken by IIBSN and Cemagref (Bordeaux) from 1994 (4 km of banks) to 1998 (140 km) to test the effectiveness of management techniques.

■ Starting in 1999, a management plan was launched, including:

- annual mapping of water primrose in the main network;
- work to remove the plants;
- monitoring of the work (qualitative and quantitative aspects);
- improvements in knowledge (studies on plant biology and ecology, potential uses of the extracted biomass, tests on extraction techniques, etc.);
- information, awareness raising and feedback on projects.

■ The work consisted of two different techniques:

- manual uprooting of beds on controlled sites (two sequences in May and November);
- mechanical uprooting with manual finishing work on heavily colonised sites, where the objective is simple maintenance work (manual uprooting) the following year.

■ Precautions taken during the work:

- use of tarps when transporting the plants;
- nets to prevent dispersal during mechanical uprooting;
- filtering of the water in boats to collect stalk fragments, etc.



3. 4. Rivers colonised by water primrose.

5. Canal colonised by water primrose.

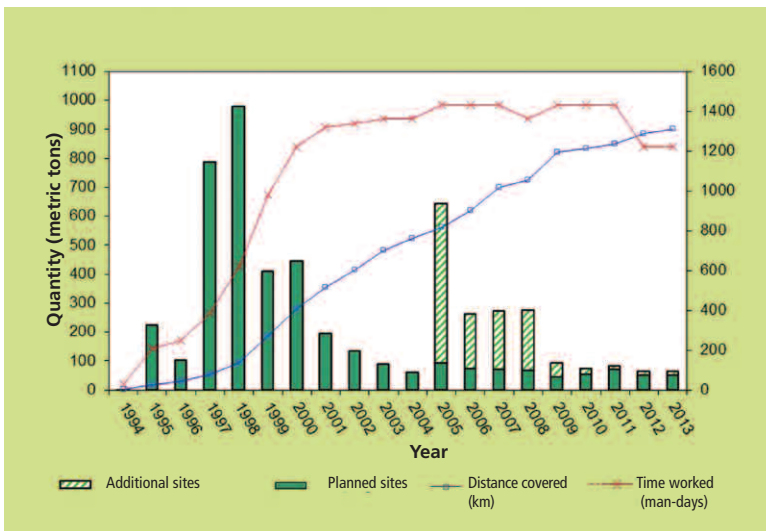
Results and assessment

■ Results in 2013

- The work took place from 27 May to 08 November 2013.
- A total of 1 311 084 metres (1 311 km) of river banks were treated.
- Notable figures concerning the 2013 harvest (all techniques and all networks together):
 - number of beds larger than 10 square metres uprooted = 64 (compared to 20 in 2012 and 114 in 2011);
 - number of beds smaller than 10 square metres uprooted = 9 232 (compared to 9 638 in 2012 and 17 143 in 2011);
 - number of young plants (fragments) collected = 31 733 (compared to 25 092 in 2012 and 43 528 in 2011).
- For this project, IIBSN hired ten technical personnel (term contracts) for the period May to November. The total amount of work carried out by this team represented almost 55 man-months (ten term contracts for 5.5 months). The technical management, monitoring and assessment of the work was provided by the IIBSN technician (Nicolas Pipet).



6. Manual uprooting.
7. Mechanical uprooting.



Water-primrose management work from 1994 to 2013. Distances covered, quantities harvested and time worked.

■ Recycling of the water primrose

- The organic waste was ploughed under for transformation into nutritional elements and humus by biological agents.
- The plants were stored on farm land (waivers had to be requested to transport the water primrose to non-floodable areas, far from aquatic environments).
- They were first sorted to extract any stones, wood, other waste, etc.
- The plants were then spread in fields according to the spreading plans of the farms and local constraints.
- The plants were dried, ground and ploughed under.
- Analysis of the plants and the soil (micropollutants, organic products) was required.
- Monitoring of the land following recycling was also required.

Outlook

- The results since the start of the operation prove the effectiveness of the management techniques with a regular increase in the lengths of river bank treated, a fairly stable number of hours worked and a reduction in the quantities harvested.
- In 2014, the work will be pursued along the banks treated in 2013, comprising manual maintenance (one or more sequences) for most of the banks.
- Work on other sites will depend on the environmental conditions (notably the weather conditions) determining the development of the beds (time of year, proliferation) and access to the sites (water levels). A further aspect is the effectiveness of the uprooting done the previous year.
- In parallel, IIBSN will continue to participate in various committees, groups and observatories, and will respond to requests for information (managers, local governments, etc.).

Information on the project

- The institution participates in work groups dealing with biological invasions:
 - the Biological invasions in aquatic environments work group (IBMA);
 - the Pays-de-la-Loire committee for the management of invasive alien plants;
 - the Poitou-Charentes regional observatory on invasive alien plants in aquatic ecosystems (ORENVA);
 - the Vendée departmental technical group for invasive alien plants;
 - the technical group for invasive alien plants in the Sèvre-Niortaise basin (piloted by IIBSN);
 - the Marais Poitevin observatory for natural heritage (IAS section piloted by IIBSN).
- The institution also participates in a number of events:
 - workshops to inform and raise awareness, conferences;
 - training sessions, meetings with managers;
 - symposia, exhibitions.
- * It reports to funding entities and to elected officials:
 - meetings, written reports, etc.
- Participation à diverses manifestations :
 - journées d'information et de sensibilisation, conférences ;
 - formations, accueil de gestionnaires ;
 - colloques, exposition.
- Restitution aux financeurs et aux élus :
 - réunions, rapports d'activités, etc.

Author: Emilie Mazaubert, Irstea



8. Brochure to raise awareness concerning water primrose.

For more information

- IBSN internet site:
 - <http://www.sevre-niortaise.fr/accueil/des-thematiques-du-bassin-versant/les-plantes-exotiques-envahissantes/>
 - <http://www.sevreniortaise.fr/accueil/les-travaux-dans-lemarais-poitevin/la-vegetation-aquatique/>
 - Pipet N. et Dutartre A. 2011. Proposition d'une méthode de recyclage et de valorisation agronomique des jussies extraites des milieux aquatiques. IIBSN et Cemagref. 3 pp. http://www.sevre-niortaise.fr/wpcontent/uploads/61_173_fiche-valorisation-agronomique-des-jussies_059.pdf





Box elder (*Acer negundo*)

Originated in North America. Introduced in France in the 1800s as an ornamental tree.

Descriptif

- Large tree, height up to 15 to 25 metres
- Opposing leaves, comprising 3 to 7 oval leaflets, irregularly indented
- Dioecious species
- Flowers in hanging clusters, without petals, with long pedicels
- Fruit made up of double samaras at an acute angle
- Cordate root system providing very little stability

Ecology and reproduction

- Sexual reproduction via the samaras
- Can also produce suckers
- Can produce numerous new shoots after being cut
- Alluvial areas are the preferred habitat

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.
- 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

Classification

Order	Sapindales
Family	Aceraceae
Genus	<i>Acer</i>
Species	<i>A. negundo</i> (Linnaeus, 1753)





Box elder

(*Acer negundo*)

Project to eliminate box elder by the Biogeco joint research unit (2008-2011)

Biodiversity, genes and communities joint research unit (BIOGECO)

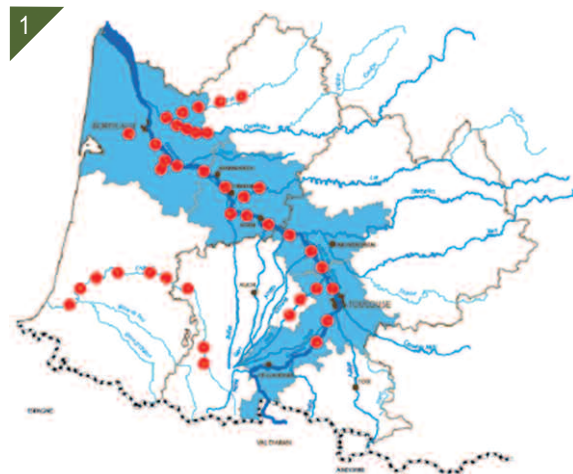
- The joint research unit comprises three teams from the Ecology of forests, prairies and aquatic environments department at INRA and a team from the University of Bordeaux 1.
- The research focusses on analysis of the mechanisms governing the evolution of diversity on different hierarchical levels (communities, species, populations, genes) in order to achieve sustainable management of resources and environments.
- Contact: Annabel Porté - annabel.porte@u-bordeaux1.fr, head of the Functional ecology and genomics team.

Study on the invasion of box elder in the riparian vegetation of South-western France

- Information on the invasion speed and the impacts on biodiversity.
- Identification of the mechanisms involved in the proliferation.
- Study of control methods and dissemination of the information.
- Steps:
 - 2008, review of the literature on the various control methods;
 - 2009, launch of the experiment on control methods (year n);
 - 2010, assessment of the results of the control methods (year n+1);
 - 2011, assessment of the results of the control methods (year n+2);

Intervention site

- 70 sites along 10 rivers in South-western France were inspected.
- The presence/absence of box elder and the degree of colonisation were observed on each site.
- Three study sites were selected in light of their high concentrations of box elder and the large areas covered:
 - the Bruges marshes natural reserve contained a coppice that had started to age with an increase in the number of fairly large-diameter trees, though smaller trees continued to represent a majority of the population;



© BIOGECO



© Google maps

1. Map showing the inspected sites.
2. Study sites.

- the riparian vegetation along the Leyre River in the town of Salles, in the Landes-de-Gascogne regional nature park, included a larger number of small trees and sprouts, i.e. a typical, young coppice;
- the riparian vegetation along the Save River in the town of Marestaing, where mid-sized trees represented a relative majority, indicating a fairly old population probably the result of long-standing occupation of the site by box elder.

Disturbances and issues involved

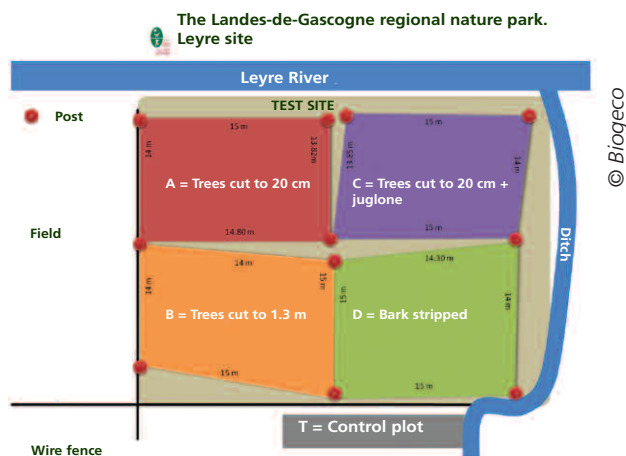
- Box elder can impact alluvial communities in different ways:
 - possible modification of the structure and composition of fauna and flora;
 - superficial root system that does not stabilise river banks.
- The study on the potential methods for box-elder management was launched at the request of the departmental councils of the Aquitaine region following an alert issued by the river technicians of the River and wetland management groups (CATERZH) concerning the development of box elder.

Interventions

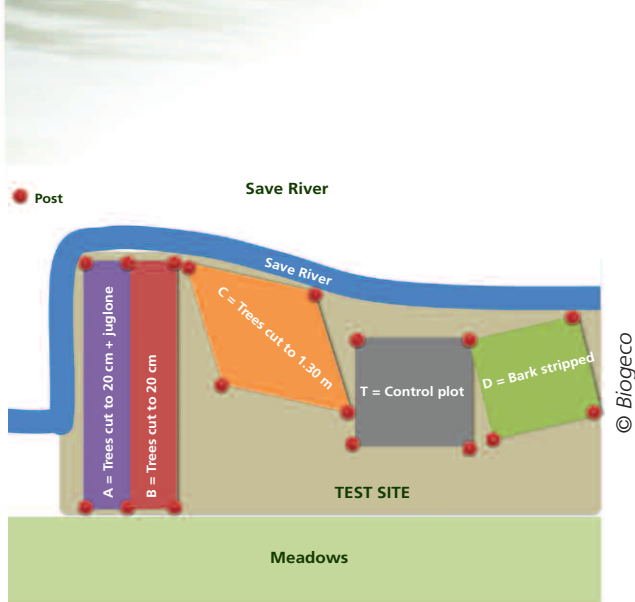
- Selection of different treatments following a review of the literature:
 - treatment C, where all the trees are cut using a chainsaw to a height of 10 to 20 centimetres above ground level. This is the standard treatment used by river technicians and served as the reference for the others;
 - treatment H, where all the trees are cut using a chainsaw to a height of 1.3 metres above ground level;
 - treatment E, where a ring of bark 20 to 30 centimetres wide is stripped off all the trees, down to the xylem, at a height of approximately 1 metre above ground level. The bark is removed using an axe or a chainsaw. Care must be taken to remove all the living tissue between the bark and the hardwood in order to starve the trunk by blocking the transit of sugars coming from the leaves;
 - treatment J, using juglone, an allelopathic substance produced by walnut trees and a known herbicide. All the trees are cut to a height of 10 to 20 centimetres above ground level and notches 2 cm wide are cut into the trunk using a chainsaw or machete to hold the paste made of walnut leaves. The trunks are then covered with cut paste.
- Between March and June 2009, five plots, approximately 200 square metres each, were laid out on each of the three study sites:
 - one plot was reserved as a control plot;
 - the other plots were each subjected to a different treatment.
- Plots were randomly assigned a treatment and any seedlings and waste (trees, bark) were removed from the site. All native species remained untouched.
- The treatments were carried out after the rising of the sap, when the leaves were well developed (in May).



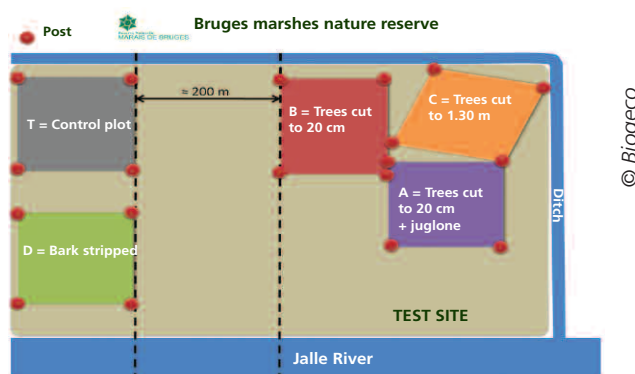
3. Box elder.



Plots on the Leyre site.



Plots on the Marestaing site.



Plots on the Bruges site.

Results and assessment

■ Results

■ Different parameters were used to assess the effectiveness of the different treatments on the plots:

- mortality
- total number of new shoots;
- diameter and length of the five largest new shoots.

■ Mortality:

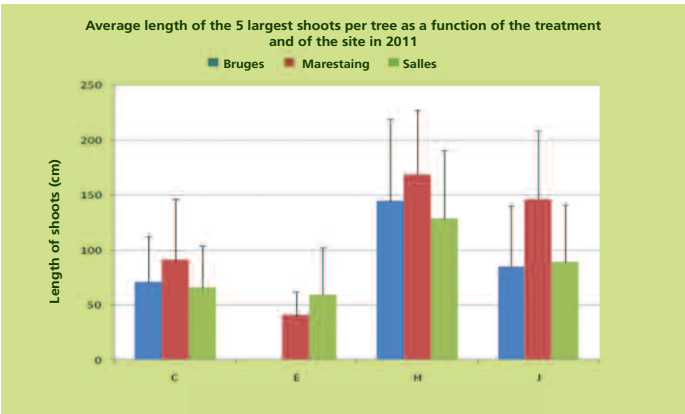
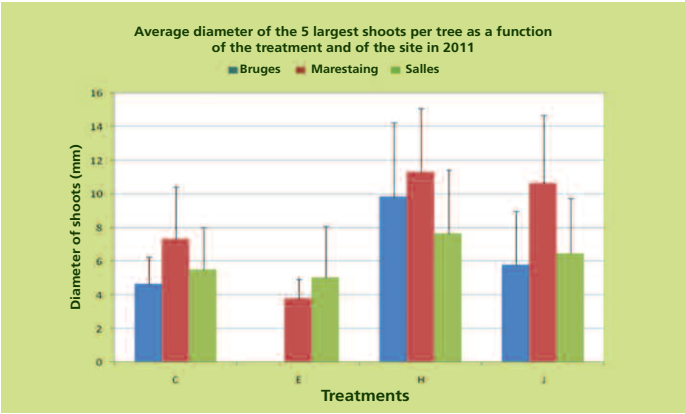
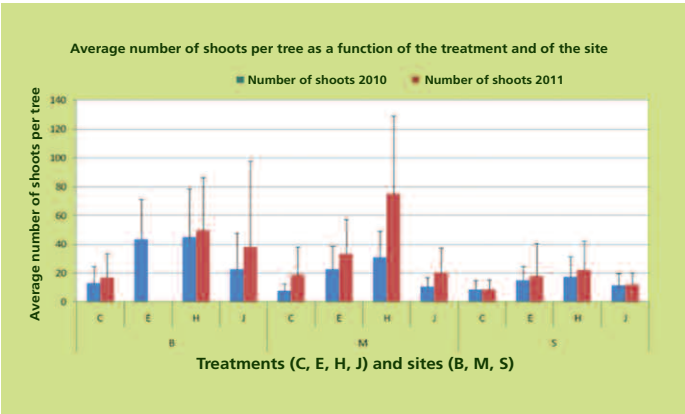
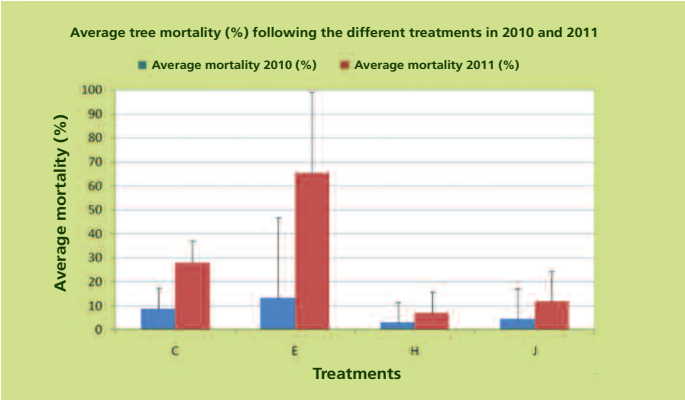
- mortality increased after two years of treatment;
- average mortality rates varied significantly for a given treatment depending on the site due to the influence of abiotic (environmental conditions) and genetic (origin of the trees) parameters;
- stripping of the bark was the most effective in spite of the healing process (exsudat) observed on certain sites that slowed the decline of the trees.

■ New shoots:

- high growth potential, some shoots reaching a high diameter to length ratio;
- the number of shoots per tree increased significantly in 2011;
- the shoots were more vigorous on the trees cut to a height of 1.3 metres;
- the juglone-based treatment (J) was not effective, which may be due to the low concentration (walnut leaves were used and not pure juglone);
- the five largest shoots were smaller in size when the bark was stripped from the trees (treatment E), a treatment that tired the trees.



4. Treatment C.
5. Treatment H.
6. Treatment E.
7. Treatment J.



Results of the different treatments.



Results of the treatments.
 8. Treatment C.
 9. Treatment E.
 10. Treatment H.
 11. Treatment J.

■ Assessment of the study

■ The experiments in the framework of the three-part study programme on the invasion of box elder were launched in 2008.

■ 2008:

- review of the literature on invasive species;
- preparation of the field experiments under controlled conditions.

■ 2009:

- end of the study on colonisation patterns;
- start of the study on invasion mechanisms;
- preparation of the experiments on control methods.

■ 2010 and 2011:

- end of the comparative study on box elder and native species in riparian vegetation (Porté *et al.*, 2011);
- continuation of the study on the invasion mechanisms of box elder;
- assessment of the control methods tested in the field;
- dissemination of study results.

■ Assessment of the experiments on control methods

■ The treatments were undertaken in the spring of 2009.

■ The following years, new shoots were cut and the trees were restriped (if a healing process was observed).

■ On the site level, the most effective method was stripping of the bark down to the xylem for at least two or three consecutive years.

■ Monitoring is required to avoid the return of box elder in the treated areas (due to the seed banks present in the invaded areas).

■ When fully exposed to sunlight, box elder grow more rapidly than native species. To avoid a situation where an undergrowth of box elder comes to dominate a stand, it is necessary to counteract the possible opening up of an environment by removing the box elder and encouraging the native species.

○ Outlook

■ An analysis of the genetic variability of maple populations in France and Europe would be useful.

■ This study could be expanded to include other species of invasive trees in South-western France (*Baccharis halimifolia*, *Prunus serotina*, *Robinia pseudoaccacia*, *Ailanthus altissima*).

■ What is the impact of climate change on invasion dynamics?

■ It would be useful to develop a model to calculate invasion risks in riparian vegetation, based on the bark-stripping method and result monitoring, to improve the techniques used for the method, to determine the costs, to test the support methods (replanting) and avoid the return and dominance of box elder in the treated areas.

Information on the project

■ Field trips are organised in the areas invaded by box elder.

■ Field personnel are trained to monitor populations.

■ Informational meetings are organised and results are disseminated.

■ Scientific articles have been published.

■ The study and its results have been presented at a number of different events.

■ Study results are available on the BIOGECO site.

For more information

■ BIOGECO internet site:

<http://www4.bordeauxaquitaine.inra.fr/biogeco/Personnel/MP/Porte-Annabel/Arbres-invasifs>

■ Moreau A. 2010. Évaluation de l'efficacité de méthodes de lutte contre l'espèce invasive *Acer negundo* L. Master Écologie fonctionnelle comportementale évolutive, Université de Rennes 1, 23 pp.

■ Porté A., Lamarque L., Lortie C., Michalet R. et Delzon S. 2011. *Invasive Acer negundo outperforms native species in non-limiting resource environments due to its higher phenotypic plasticity. BMC Ecology*, 11(1) : 28.



Biodiversité, gènes & communautés



Asian knotweed

(*Reynoutria* spp.)

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

Classification

Order	Polygonale
Family	<i>Polygonaceae</i>
Genus	<i>Reynoutria</i> (Houtt, 1777)



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© Nicolas Poulet



© Alain Dutartre



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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* spp.)

Experiments in mechanical removal of invasive alien knotweed in France, Switzerland and Germany

Concept.Cours.d'EAU SCOP (CCEAU)

■ CCEAU is an environmental consulting firm specialised in riparian vegetation and invasive plants, with its headquarters in the town of Sainte-Hélène-du-Lac (Savoie department).

■ The main missions include:

- assessing the invasion stages of various plants along rivers;
- formulating management strategies for invasive plants;
- managing work sites using mechanical equipment to uproot Japanese knotweed;
- providing training and raising awareness on how to manage invasive plants;
- conducting R&D work on invasive plants.

■ Contact: Mireille Boyer - mireille.boyer@cceau.fr

Centre for Agricultural Bioscience International (CABI)

■ CABI is an international organisation active in agricultural and environmental R&D work.

■ The competence centre based in Delémont (Switzerland) is specialised in biological control of invasive alien species (IAS).

■ Contact: Esther Gerber - e.gerber@cabi.org

Experimental research programme

■ A programme of applied research was set up by CCEAU (initial trials from 2005 to 2009) and then expanded in a partnership with CABI (2010 to 2013).

■ The objective was to run full-scale trials to develop a non-chemical technique to eliminate stands of Japanese knotweed (*Reynoutria* spp.) by destroying the rhizomes.

■ The study was conducted in three steps:

- grinding of the colonised soil and laying of a black, plastic tarp until the Japanese-knotweed rhizomes had completely decomposed;
- formulation of indicators used to check the effectiveness of grinding techniques ensuring the most rapid decomposition possible;
- assessment of the decomposition time under the tarp.
- évaluation de la durée de décomposition sous la bâche.



1. Study sites (2005 to 2012).

2. Map showing the invasion stages of Japanese knotweed around Lake Bourget in France.

- No Japanese knotweed was observed during the inspection.
- Rapid intervention is required before the plants have colonised large areas. * A high priority must be assigned to techniques capable of completely eliminating the plants or isolating the infested areas.
- Complete elimination of the plants in the sector would already appear unfeasible for technical and/or financial reasons, but management techniques could significantly slow the speed of colonisation.
- The sector is already heavily invaded, but it would still be worthwhile to slow the invasion by hindering the establishment of new plants growing from disseminated propagules.
- There is no longer any point in attempting to slow the natural colonisation of the river. However, local management work may be conducted on certain sites to handle specific requests concerning a particular use, hydraulic problems or remarkable sites.

Intervention site

- From 2005 to 2013, the research programme was set up on eleven experimental sites in Eastern France, Switzerland and Germany.
- The trials were made possible thanks to a partnership with local participants where the managers proposed the sites and provided the funding. CCEAU and/or CABI developed the experiments and monitored them.
- The sites were selected to ensure a wide range of conditions (soil types and climate) in order to check whether the plant reacted in the same manner on all sites to the mechanical technique.
- Technical feasibility was tested during actual field trials addressing problems such as access, water levels, flood risks, bank stability, infested waste and the impact of large machines.
- The solutions found for all the above difficulties resulted in the progressive development of a precise method protocol.

Disturbances and issues involved

- Knotweed can cause numerous problems on the banks of continental aquatic ecosystems. All the trials carried out were also designed to meet the specific needs of local stakeholders in terms of management or development work.

■ Ecological impacts

- Reduced biodiversity in terms of both species and habitats.

■ Impacts on river management

- The presence of the plants creates major technical constraints during work and maintenance on rivers.

■ Impacts on crops

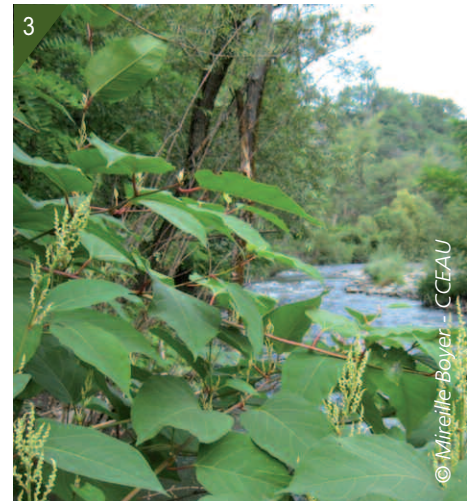
- Reduced yields and/or available land.

■ Impacts on land use

- The plants can significantly hinder certain activities (access to river banks).

Interventions

- The objective of the research programme was to develop a mechanised management technique for Asian knotweed.
- The technique consisted of grinding the colonised soil and then covering it with a black, plastic tarp until the rhizomes fully decompose.
- This technique was initially tested in 2005 and improved in 2007. The initial results were presented in an article published in 2009 by CCEAU.
- During the development work, it was possible to determine the decomposition time of the rhizomes (and consequently the time the tarps had to remain in place) and to devise an indicator used to check the effectiveness of the grinding work



3. *Reynoutria spp.*

4. Grinding the infested soil using a bucket grinder.

5. A black, plastic tarp is placed over the ground soil.



■ Mechanised technique

- The soil colonised by the plants is excavated.
- The soil containing the Japanese-knotweed rhizomes is then ground using different types of equipment depending on the local conditions (bucket grinder, stone crusher, pulvimixer). The soil may be ground on the excavation site or transported to a site specifically for grinding.
- The ground soil is covered with a black, plastic tarp until the rhizomes have completely decomposed.
- Numerous precautions intended to avoid dispersal of the knotweed were included in the method protocol and in the technical specifications for the companies involved. Compliance was checked by the project manager.

■ Monitoring during the work

- To determine the time that the tarp must remain in place, the decomposition rate of the rhizomes was observed according to a number of successive monitoring protocols. The final protocol is presented below, in the section titled *Assessment and practical applications*.

Results and assessment

■ Effectiveness of the grinding process

- To achieve rapid and complete decomposition, grinding of the soil must produce a significant and uniform effect on the knotweed rhizomes, i.e. the rate of damage must exceed 90%.

* Comparison between stone crushers (high rotor speed) and bucket grinders (low rotor speed):

- grinding is more effective with tractor-mounted stone crushers in that the resulting average length of the rhizomes is shorter;
- grinding the soil twice using a stone crusher is enough whereas it must be sent through the bucket grinder several times to achieve a sufficiently uniform result;
- use of additional grinding bars on bucket grinders (for soil with a low clay content) produces shorter rhizome lengths and significantly increases productivity because the soil does not need to be ground as many times.

■ Time the tarp must remain in place

- Decomposition rates on different sites vary depending on the humidity:
 - under wet conditions (water-saturated soil), the time required is between 26 and 34 weeks;
 - under dryer conditions, the time required is between 48 and 70 weeks.



6. Stone crusher.

7. Grinding bars installed on a bucket grinder.

Length of rhizomes after grinding as a function of the equipment used and the number of grindings on sites where 100% plant mortality was achieved. Source: Concept.Cours.d'EAU

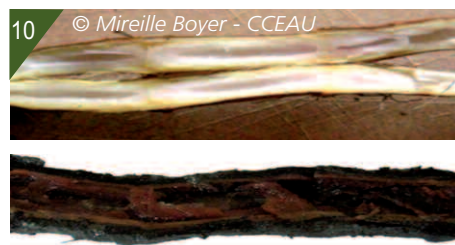
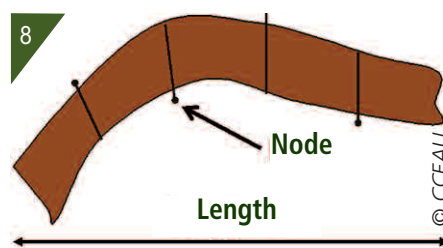
Tool	Number of grindings	Average length of rhizomes (cm)	Standard deviation
Stone crusher	2	7.9	4.4
Bucket grinder	2	6.5	4
Bucket grinder	2	10	3.3
Bucket grinder	5	10.4	5.6
Bucket grinder	3	12.2	4.8
Bucket grinder	5	13.1	7.6
Bucket grinder	2	13.2	6
Bucket grinder	1	14	8.2
Bucket grinder	1	16	8

Length of rhizomes after grinding depending on whether grinding bars are used to improve the process. Source: Concept.Cours.d'EAU

Grinding bars	Number of grindings	Average length of rhizomes (cm)	Standard deviation
No	1	21.4	10
Yes	1	15.2	9
No	2	14.1	7
Yes	2	11.5	7
No	3	13.8	5
Yes	3	10.1	6

Assessment and practical applications

- The “grinding-tarpping” process eliminated the plants completely and relatively rapidly (less than two years). On all the experimental sites assessed to date, the mortality rate was 100% (no regrowth), except in Switzerland where the tarp was removed too soon (after 51 weeks).
- This technique can handle specific situations such as the need to protect a recently colonised hydrographic network or the need to prepare infested soil for later use.
- The experimental results were used to produce an indicator capable of determining the effectiveness of grinding by equipment with low rotor speeds (bucket grinders), thus ensuring rapid and complete decomposition of rhizomes thanks to a sufficient number of passages through the grinder.
- The indicator is based on the average length of the rhizomes after grinding of the soil:
 - five samples of ten rhizomes are measured to the millimetre, not taking into account the natural curves (see Figure 7);
 - grinding is sufficient when the average length of the rhizomes is 14 centimetres, with a maximum standard deviation of 6 cm.
- The tarping period is difficult to predict.
- If the site owner is not in a hurry, it is best to leave the tarp for at least 18 months.
- Otherwise, it is necessary to set up a monitoring system for plant decomposition using control rhizomes to determine whether the tarp can be removed without any risk of regrowth:



8. Diagram of a rhizome.

9. Collecting the control rhizomes.

10. The tissue of control rhizomes (a live rhizome on top, a dead rhizome below).



- bury to a depth of 20 centimetres five burlap bags each containing ten control rhizomes that are fresh and not ground (5 rhizomes with one node and 5 with two nodes). The minimum diameter of the control rhizomes should be 9 to 15 millimetres;
- set up visual markers or use a GPS device to locate the control rhizomes;
- place detectable netting between the tarp and the soil in order to find the buried bags;
- prepare as many sets of five bags as planned tests (12 months later, 14, 16, etc.);
- cut through the tarp and dig up the soil to recover the bags;
- cut the control rhizomes lengthwise;
- determine the decomposition status by observing the colour of the tissue (white = rhizome still alive, brown/purple/black = somewhat decomposed, totally black = rhizome is dead).

Information on the project

- Data and know-how are traded with river technicians during technical meetings:
 - Seine-Normandie water agency (River meetings in Château Renard) in May 2008;
 - AGRIDEA (Maintaining river banks) in September 2009;
 - ARRA (Managing and controlling Japanese knotweed) in June and September 2010;
 - ARLR (Management and control strategies for invasive plants) in June 2011, Aveyron departmental council (Strategy and control methods for Japanese knotweed in rivers) in September 2011;
 - symposium in Dijon (LIFE project for streams) in June 2009;
 - symposium in Saint-Étienne (Japanese knotweed) in October 2012.
- Presentations during training sessions (IFORE, ATEN, Rhône Valloire intermunicipal association, CISALB).
- Drafting of detailed reports on experimental work sites and dissemination to the concerned managers.
- Internet site presenting management techniques for Japanese knotweed: www.cceau.fr

Author: Mireille Boyer, CCEAU

For more information

- Internet site of Concept.Cours.d'EAU SCOP: www.cceau.fr
- Internet site of the Centre for agricultural bioscience international: www.cabi.org
- Internet site of Mireille Boyer: <http://reynoutria.japonica.pagespersoo-range.fr/>





Asian knotweed

(*Reynoutria* spp.)

Managing Japanese knotweed in the Gardons basin

Board for balanced management of the Gardons basin (SMAGE)

■ 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.

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

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.

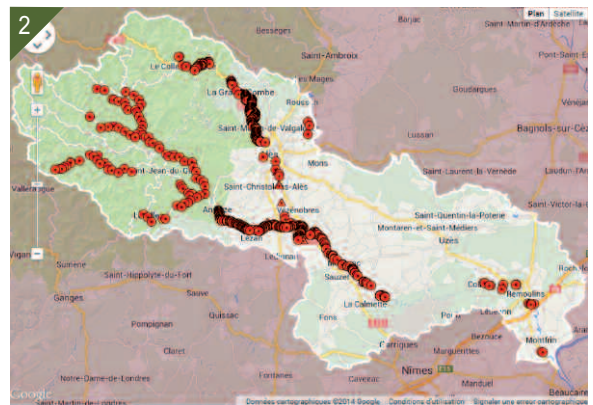
■ The Gardons basin comprises many remarkable aquatic environments (Cévennes national park, Galeizon biosphere reserve, Natura 2000 sites, the Gardon gorges) that are home to an array of emblematic species such as the European beaver and the otter, Bonelli's eagle, shad, eels, bug orchids and summer lady's-tresses.

■ A large number of invasive species have been observed in the rivers of the basin. Given the size of the area (2 000 kilometres of river including 500 km of large rivers), a multi-year management plan was set up in 2011. The plan includes work on water primrose, knotweed, amorpha and summer lilac, as well as research, early-detection efforts and awareness raising.

■ The Gardons basin is heavily impacted by Asian knotweed. The area in the Cévennes mountains down to Vézénobres is widely infested and the situation is considered irreversible in most places. The Gardon d'Alès River is a local exception upstream of Collet-de-Dèze and downstream



© SMAGE des Gardons



© Google maps
© SMAGE des Gardons

1. Map showing the Gardons basin.

2. Map showing the location of Japanese knotweed colonies. Note. The map above shows all the known sites. The surveys were conducted with varying degrees of accuracy and the density of points does not necessarily correspond to the actual degree of colonisation. The map should be interpreted as simply indicating the presence or the absence of knotweed.

of Alès. In the Gardonnenque and lower Gardon areas, the plants are less heavily established and management work is undertaken in those places where it is thought to be effective. The tributaries (outside the Cévennes) are not yet impacted by Japanese knotweed and active monitoring is carried out regularly.



Disturbances and issues involved

■ Impact on bank stability and on flooding

- The presence of the plants destabilises steep banks (shallow root system and withering of the above-ground parts of the plant in the winter).
- It also limits the mobility of gravel bars during flooding.

■ Impact on native plants and on habitats

- In some places, other species can be eliminated through competition and a reduction of sunlight.
- Large stands of knotweed reduce the diversity of habitats.

■ Impact on the landscape and on human activities

- The plants produce a more uniform landscape, are highly unsightly in the winter and make access to and circulation on river banks more difficult.

Interventions

■ A joint approach

■ In 2009, a steering committee for invasive plant species was set up by the water stakeholders in the river basin to identify their mutual needs and define the necessary monitoring and management work to be divided among the managers of natural areas. Since 2011, a number of different management techniques have been implemented and inventories using GPS data have been carried out on the main rivers.

■ The management plan includes more or less ambitious projects for plant species other than the invasive knotweed species, e.g. water primrose, summer lilac, amorpha, giant hogweed. Research is also being done, in conjunction with ANSES (the Agency for food, environmental and occupational health & safety) on an emerging species, Japanese hop (*Humulus japonicus*). Finally, a general monitoring system for the entire river basin is being progressively set up.

■ The work done by the Gardons SMAGE on invasive knotweed is presented below. However, a number of other local managers also organise manual uprooting and awareness raising, e.g. the Galeizon board, the Alès urban area, the Natura 2000 Mialet site, etc.).

■ Manual uprooting

■ Grand'Combien site (since 2009), in the framework of a citizen project to recover a neglected urban sector. Joint management of work to open paths and remove Japanese knotweed along a 3-kilometre section of river banks:

- regular manual uprooting of the knotweed, 3 to 6 interventions between April and October;
- opening and maintenance of a discovery trail along the banks.

■ Cendras sector (since 2009). Monitoring of 18 sites where regrowth was manually uprooted. Approximately 35 square metres were mechanically uprooted in 2013.

■ Collet-de-Dèze site. Uprooting of 1 square metre of isolated knotweed in the upstream section of the river basin in 2012. The site was monitored in 2013.



3. Manual uprooting of knotweed.
4. The uprooted material is sent two or three times through the grinder.
5. Grinder in the bucket.
6. The ground material is deposited in the hole from which the plants were uprooted.
7. It is then covered with a biodegradable fabric.

■ Manual uprooting with mechanical assistance

■ Sainte Croix-Vallée française site. Six mats of knotweed were uprooted manually or with mechanical assistance in 2012, along a kilometre of river in the uppermost colonised area on this tributary. This work was followed by manual uprooting of the regrowth in 2013 and 2014.

■ Manual derooting with mechanical assistance

■ This technique consists of manually removing the rhizomes from a large volume of soil progressively cleared by an excavator. It should be used only for small to mid-sized mats of plants.

■ This work was carried out in 2010 on 46 mats of knotweed representing a total of 204 square metres spread over six kilometres along the downstream Gardon d'Alès River.

■ Grinding-tarpping of the waste and rhizomes

■ This technique was developed and implemented by the Concept Cours d'Eau consulting firm. An initial test phase was conducted on a pilot site in Grand'Combe in 2011-2012, prior to large-scale implementation in 2013.

■ In 2013, work was carried out in two main sectors, namely on the downstream Gardon d'Alès River and the downstream Gardonnenque River. A total of 202 mats representing 886 square metres of stalks were split into four groups along 20 kilometres of river:

- the waste was sent through a crusher-grinder bucket two or three times on site;
- the waste was returned to the hole and covered with a tarp to inhibit regrowth and accelerate rotting of the rhizomes;
- the tarps were then covered with healthy soil from the site to reduce any risk of the waste being exposed during flooding;
- any regrowth from dispersed fragments was uprooted the following year;
- the sites are monitored.

■ Initially, the technique called for plastic tarps to be used to cover the waste. However, given that plastic tarps had to be mechanically removed and that the sectors spanned a large area (20 km) subject to flooding, it was decided to use a thick, biodegradable fabric made of hemp and burlap (1 200 grammes per square metre).

Results and costs

■ Manual uprooting

■ On the Grand'Combien site, five years after the intervention, the results are very positive. The knotweed has retreated along the entire river section and only rare shoots may now be found. The general public is present on the banks much more often and the quantity of waste thrown by local residents from the road has dropped regularly. The work using unemployed people had a positive social impact in that the project was fully supported by the employees of the Cévennes development association (TEDAC) and approved by the local residents.

■ In the Cendras sector, of the 18 mats uprooted, new shoots were present on 12 in April, but on only 7 in October. Concerning the 35 square metres uprooted mechanically in 2012, the results are satisfactory in that very little new growth had to be uprooted in 2013. In the other sectors, the reduction in the quantity of regrowth has continued.



8. 9. The Grand'Combe sector colonised by Japanese knotweed in 2009 and after the work in 2013.



■ Manual uprooting with mechanical assistance

■ Collet-de-Dèze site. Monitoring in 2013 of the treated site confirmed that the work in 2012 resulted in the disappearance of knotweed from the site. Monitoring nonetheless continues.

■ Sainte Croix- Vallée française site. Only one of the sites was insufficiently treated and regrowth in the hole would indicate that the deepest rhizomes were not removed. On the other sites, the results are positive and it may be assumed that knotweed will soon be eliminated from the sector.

■ Manual derooting with mechanical assistance

■ This technique is highly effective in that it definitively eliminated the knotweed colonies from approximately 30 sites. Colonisation of the other sites has fallen back significantly and the regrowth is managed on an annual basis. However, its implementation requires very meticulous work and should be reserved for mats less than a few square metres in size.

■ Grinding-tarpping of the waste and rhizomes

■ Additional mats of knotweed were discovered during the work, unfortunately the original budget was not sufficient to treat all the colonised areas. It was nonetheless possible to remove most of the knotweed present in the selected sectors and to treat all the priority sites (landings and areas affected by flooding).

■ Some problems were encountered with the biodegradable fabric (used to replace the plastic tarp):

- the fabric degraded very rapidly once buried, thus making it easier for rhizome shoots to push through;
- the highly permeable fabric prolonged the life of the rhizomes because it did not block water or air.

■ Consequently, the biodegradable fabric will no longer be used and the monitoring programme in 2014 will provide information on success of the measure. The grinding-tarpping technique using a plastic tarp will be tested on a few strategic sites in 2014.

■ Human and financial aspects

Summary table of the techniques used, the results and the costs.

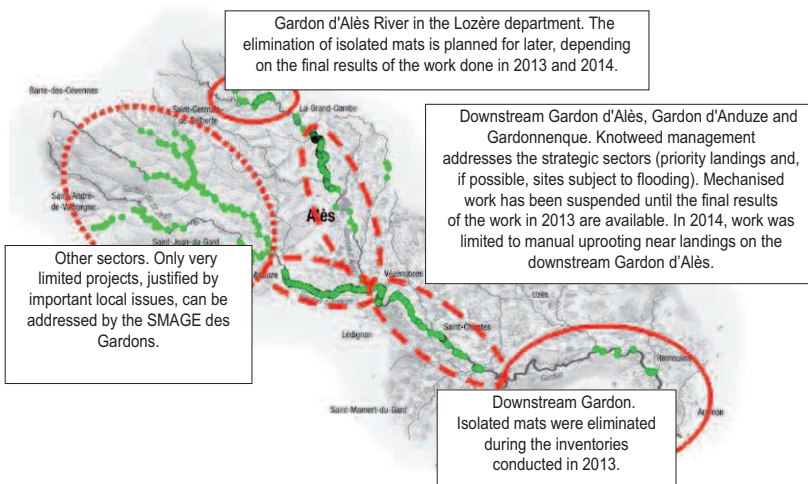
Site	Technique	Linear distance	Surface area *	Cost not incl. VAT (2013)	Duration
Grand'Combien	Manual uprooting	3 km	Widespread colonisation over 50% of linear distance	34 220	29 weeks per year since 2009
Cendras	Manual and mechanical uprooting	2 km	18 mats with scattered regrowth	4 890	1 week per month in 2013
Collet-de-Dèze	Manual uprooting with mechanical assistance	Isolated site		400	1 day in 2012
Croix Vallée-Vallée française	Manual uprooting with mechanical assistance	1 km	6 mats and 40 m ²	10 886	2 weeks in 2012
Downstream Gardon d'Alès	Manual derooting with mechanical assistance	6 km	46 mats and 206 m ²	55 420	6 months in 2010
Downstream Gardon d'Alès and downstream Gardonnenque	Grinding-tarpping	20 km	202 mats and 886 m ²	255 168	4 months for 4 sectors in 2013

* The unit of measure is the surface area covered by dense stalks at ground level. The surface areas effectively treated during interventions are much larger because they extend, on average, 1.5 metres beyond the visible stalks.

Outlook

■ The management plan for Japanese knotweed was regularly adjusted taking into account the work assessments and the inventories carried out in 2012 and 2013. Depending on the degree of colonisation along rivers by the plant, specific strategies have been formulated:

- heavily colonised areas are not included in the management plan given the excessive human and financial resources required and the technical difficulties;
- for areas less severely colonised, the work focusses on the most important sectors (urban areas, priority landings);
- for isolated sites, the work is undertaken immediately.



Map showing the location of Japanese knotweed along the Gardons Rivers in 2013 (prior to the work on the downstream Gardon d'Alès and the Gardonnenque). Green dots indicate the presence of Japanese knotweed.

Map showing the sites for the various techniques employed. © SMAGE des Gardons

Information on the project

■ An internet site with mapping applications for early detection of new species and monitoring of established species was created. It can be used by persons having observed a plant to signal the observation. It also serves for disseminating links, photos and information on invasive species to facilitate their identification and locate their presence in the Gardons basin:

<http://invasives.les-gardons.com>

The site is intended for collective monitoring of the river basin and to improve the effectiveness of management in sectors where colonisation has just begun.

■ Presentation of the management plan during various meetings (symposium on management of non-agricultural areas organised by AFPP in Toulouse, October 2013, work group of managers for protected natural areas in the Languedoc-Roussillon region, ATEN, etc.).

■ During various events (flower shows, plant sales, fishing events, etc.), stands informing on invasive plant species are set up.

■ Efforts to raise awareness are made via local radios, the press, town bulletins, public meetings and signs on work sites.

Authors: Emmanuelle Sarat, IUCN French committee, and Jean-Philippe Reygrobellet, SMAGE des Gardons.

For more information

- www.les-gardons.fr
- <http://invasives.les-gardons.com/>
- SMAGE des Gardons, 2014. Management plan for invasive plant species in the Gardons basin. Report on work in 2012 and 2013. 27 pp.





Asian knotweed

(*Reynoutria* spp.)

Managing Bohemian knotweed in the Garaye River

Operational committee for the Rance River (COEUR Émeraude)

- This association, founded in 1994, is the organisational entity for the future Rance-Côte d'Émeraude regional nature park.
- The main missions include:
 - managing the project to create the park and informing the public on the project;
 - assisting local governments in their projects to protect and develop their natural heritage and to implement sustainable-development policies (inventories, urbanism, Natura 2000, impact studies, walking trails);
 - setting up sustainable management of sediment in the Rance estuary;
 - assisting farmers in their efforts to reconcile agriculture and the environment;
 - preserving and restoring the bocage landscape (in the framework of the Breizh Bocage programme);
 - ensuring the protection of the marine and littoral environments, and of the maritime heritage;
 - contributing to the sustainable development of economic and recreational activities;
 - protecting aquatic environments and water resources.
- Management work on knotweed is conducted in favour of biodiversity in the framework of the policy on knowledge, mapping and control of invasive species. The work presented here is also part of the mission to protect aquatic environments.
- Contact: Xavier Laurent, scientific officer for water, aquatic environments and wetlands
xavier.laurent@coeuremaude.org

Intervention site

- Management work on *Reynoutria x bohémica* was done in the Côtes-d'Armor department, on the left bank of the Garaye River, a tributary to the Rance.
- The Rance springs from the Monts du Mené and flows to the English Channel at its mouth between Dinard and Saint-Malo.
- The work site was located in the town of Taden.



© Google maps

1. The town where the work took place.

Disturbances and issues involved

- On the site in June 2013, *Reynoutria x bohémica* was present along 125 metres of river bank, representing a total surface area of over 2 000 square metres. The knotweed was planted in the 1980 to mask an old dump and a storage area for construction equipment.
- **Impacts on the ecosystem**
 - Competition with native riparian species.
 - Weakening of the river banks.
 - Increased shade on the colonised reach of river.
- **Impacts on human activities**
 - The more difficult access to the banks can make fishing impossible.
 - The intervention was designed to avoid any propagation of *Reynoutria x bohémica* cuttings by the river to the Rance estuary Natura 2000 zone and make possible normal use of the site.

Interventions

■ Starting in 2004, a method combining uprooting and tarping of the knotweed was implemented, followed by the planting of willows. The objective of this method was to help the native riparian species in the competition for space and light. Monitoring was ensured by a COEUR Émeraude policy officer and a team from a social reintegration association based in Dinan.

■ Manual uprooting

- This work was done on the entire colonised area.
- The first year of work was 2004:
 - the work took place from February to March;
 - the “dry” stalks of *Reynoutria x bohemica* from the previous year were uprooted;
 - the rhizomes were removed using pitchforks and garden forks.
- Over the following years, until 2013, the work consisted of:
 - interventions from April to September;
 - 3 or 4 interventions per month;
 - the harvested plants were burnt on site.

■ Manual uprooting and tarping

- The work was done on 900 square metres of colonised river banks. Due to the insufficient level of available funding, this area was treated sector by sector from 2005 to 2013. The treated surface area varied from year to year, depending on the funding. The work consisted of several phases:
 - manual uprooting from April to May of the area to be tarped, plus a 50 cm border;
 - smoothing of the soil using the municipal backhoe (30 minutes);
 - installation of bundled willow wood (fascines) along the banks to stabilise them;
 - installation of the tarp made of a biodegradable geotextile fabric (18-month service life) immediately after the uprooting work in May (before any regrowth). The fabric, made of 70% burlap and 30% hemp, was between 8 and 10 millimetres thick;
 - maintenance of the tarped area. Every two weeks until the planting of the willows, the tarp was walked on and compressed (two times using a lawn roller) to keep it firmly pressed to the ground;
 - planting of willow cuttings (*Salix fragilis* and *S. aurita*) collected on the opposite bank of the river from October to November. Five or six trees, approximately 1 metre high and 1 to 3 cm in diameter, were planted per square metre in holes cut into the tarp.

■ Maintenance following tarping

- This work was done during the months of March to September, from 2006 to 2013 (30 minutes per month) in the areas tarped the previous years.
- New willow cuttings were planted to replace the cuttings that did not grow.
- Any shoots of *Reynoutria x bohemica* growing around or through the tarps were manually uprooted as they appeared.

Results and assessment

■ Results

- As early as 2007, the river bank was recolonised by approximately 20 native species commonly found on river banks.
- The method employed was effective in recreating competitive conditions for native species, but could not completely eradicate the knotweed.



2. 3. The work site at different stages of colonisation and work.
4. The site following manual uprooting.
5. Installation of bundled willow wood (fascines) along the banks.
6. Tarped area.
7. Tarped area with planted willow cuttings.



Assessment

- Significant human resources were required during the 3 years of work.

Type of worker	Time worked in man-days	
	2004	Following years (average)
Social reintegration association	63	25
COEUR policy officer	13	5
Total	76	30

- It is worthwhile to initially weaken *Reynoutria x bohemica* by uprooting the plants as early as possible.
- It is necessary to ensure regular maintenance of the tarped areas over several months to assist the regrowth and sustainability of the native species.
- The control method employed can be reused on other sites with adaptations for the local conditions (economic, social and environmental).
- Given the significant human resources required, the method should probably be limited to high-value sites.

Outlook

- The maintenance work will be halted in 2014 to see whether the restored riparian vegetation can sustain the current equilibrium without any further intervention.
- The same method will be used on dunes, on a site colonised by *Reynoutria x bohemica* in the town of Saint-Lunaire (Côtes-d'Armor department), but by planting elderberry and/or privet to compete with the invasive species.
- An objective is to identify competitive native species suited to different types of environments colonised by *Reynoutria x bohemica* and to various site uses (notably along roadsides due to the importance of visibility).
- A further goal is to federate local stakeholders on the topic, notably by informing the general public and creating a participatory observatory (project under way).

Information on the project

- Ten highschool students participated in manually uprooting *Reynoutria x bohemica*.
- A two-page report was published on the work in the feedback document on projects to manage natural areas titled *Management of invasive species in the Bretagne region*, prepared by the Bretagne Vivante non-profit, a regional association for environmental protection.
- The work was also presented during the national symposium on Asian knotweed held on 23 and 24 October 2012 in the city of Saint-Étienne.
- Internet pages were created on the COEUR Émeraude site presenting IAS management and the work done by the regional nature park and the towns, as well as data and recommendations for plant management intended for the general public.
http://www.coeur.asso.fr/Actions_aquatiques_p4.html (pages en construction).

Remarks

- Bohemian knotweed (*Reynoutria x bohemica*) is a hybrid produced by cross breeding of Japanese knotweed (*Reynoutria japonica*) and giant knotweed (*Reynoutria sachalinensis*).

Author: Sandra Fernandez, Irstea



8. Tarped area during regrowth of native species.
9. Tarped area after regrowth of native species.

For more information

- COEUR Émeraude internet site:
<http://www.coeur.asso.fr/>
- Quemmerais-Amice G. et Magnier M. 2012. La Renouée de Bohême à Taden, p 44 – 45. Dans *La gestion d'espèces invasives en Bretagne*, recueil d'expériences menées sur des espaces naturels. Bretagne Vivante, Brest, 72 pp.
http://www.bretagnevivante.org/images/stories/Reserves/Forum_gestionnaires/recueil%20esp%C3%A8ces%20invasives_2012.pdf





Asian knotweed

(*Reynoutria* spp.)

Experiments in using grazing to manage Japanese knotweed in the Mayenne department

Mayenne departmental council (CG 53)

■ CG 53 manages the departmental network for the management of invasive alien plants in a partnership with the departmental federation for fishing and the protection of aquatic environments.

■ CG 53 is both the owner of the *Moulin à papier* site in the sensitive natural area in the town of Saint-Calais-du-Désert and the manager of the site restoration project:

- the work was part of the management plan for the Saint-Calais sensitive natural area drawn up by the Normandie-Maine regional nature park to “manage invasive species, primarily Japanese knotweed and balsam”;
- the work was carried out in collaboration with Agrocampus Ouest (Rennes).

Contacts: Sandrine Forêt (CG 53) - Sandrine.foret@cg53.fr, Jacques Haury (Agrocampus Ouest) - jacques.haury@agrocampus-ouest.fr

Michel Bozec (Agrocampus Ouest) - michel.bozec@agrocampus-ouest.fr

Intervention site

■ The *Moulin à papier* site is a wetland upstream of the Mayenne River, in the Saint-Calais-du-Désert sensitive natural area. The experiments were conducted on several colonised sites within the former poplar grove:

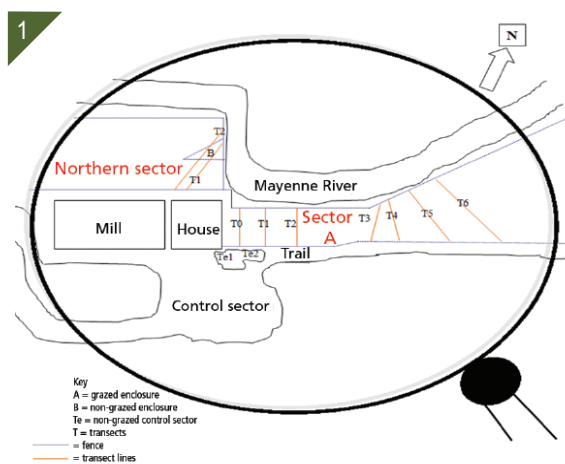
- sector A, a grazed area in an enclosure measuring 11 352 square metres;
- northern sector, that consists of an enclosure (grazed) and an enclosure (not grazed);
- control sector, located to the south of the house, not grazed and divided into two parts. Te.1 is the non-grazed control sector for transects T1 to T6 in sector A and Te.2 is the non-grazed and tarped control sector for transect T0 in sector A.

■ The initial experiments concerning *Reynoutria japonica* on this site (mowing and burning of the plants) took place in 2009.

■ In 2010, mowing followed by tarping was experimented and the first assessments concerning surface areas and biomass quantities were conducted.



© Agrocampus Ouest



© Agrocampus Ouest

1. Study site.
2. Diagram of the Moulin à papier experimental site.

■ At the end of 2010, it was decided to try another management method in 2011, namely using goats to consume the knotweed.

Disturbances and issues involved

■ The presence of *Reynoutria japonica* was observed for the first time on the *Moulin à papier* site between 2005 and 2007, and confirmed in 2008 during the examination done in the framework of the site management plan drafted by the Normandie-Maine regional nature park.



- The former poplar grove was colonised by *Reynoutria japonica* following a logging operation that disseminated the rhizomes of the initial population that was planted by the miller to enhance the landscape. In 2011, three colonies measuring 60, 200 and 1 500 square metres were noted.

- CG 53 set up experiments on how to manage *Reynoutria japonica* and the impacts of its colonisation.

■ Ecological impacts

- Long-term damage to rivers banks due to erosion.
- A reduction in the number of native plant species due to competition with *Reynoutria japonica* for nutrients and light (with a general closing in of the environment).

■ Impacts on land use

- The plants are a hindrance for fishing, hunting, etc.
- Management of *Reynoutria japonica* was set up in the framework of the restoration policy for the wetland.

Interventions

- Since 2009, CG 53 has worked to restore the wetland while limiting the propagation of the knotweed and progressively reducing the stands. The unsatisfactory results produced by the management techniques employed in 2009 and 2010 led to the decision to use goats in 2011. Agrocampus Ouest was selected to monitor the effectiveness of the technique.

■ Grazing as a management method

- On 13 July 2011, the day they were weaned (except for two or three animals already one year old), 13 male, domestic goats (*Capra aegagrus hircus*) were brought to the site:

- reproduction was not an issue;
- the species was suited to underbrush with regrowth of woody plants.

- The animals were present the entire year on the site.
- A local, retired person checked the animals daily for a fee.
- The pen, approximately one hectare in size (10 000 square metres), was set up and maintained by the *Études et Chantiers* social reintegration association.
- A rotary cutter was used to mow or create passages inside the pen from July to September in order to provide the animals with paths and more accessible land.
- The trees in the pen were protected against stripping of the bark by the animals.

■ Scientific monitoring

- Monitoring was conducted in 2011 using quadrants (biomass samples) and a set of transects for plant inventories during three periods, two prior to grazing in June and July and one during grazing at the end of September. The observations and measurements were made in all the sectors, including the two control sectors Te. 1 et Te.2 (R = with *Reynoutria*) that were not grazed.

- Plant inventories:

- the study areas were quadrants (2 m x 2 m) positioned along the transects in areas with *Reynoutria* (R) and in others without (S). Each transect received two quadrants, 1 R and 1 S;
- each quadrant was photographed and geolocated (GPS).



3. Control sector colonised by *Reynoutria japonica*.
4. 5. Domestic goats (*Capra aegagrus hircus*).

Table of the observations and measurements.

Data registered	Variables
Complete list of plants	Taxonomic richness (number)
	Plant frequency
% surface area of each species	% surface area of all plants
Max. height of each species (measured)	Max. height of each species (average)
Measured height of each knotweed stalk [x measurements per quadrant]	Average height of each knotweed stalk [1 value per quadrant]
Height of water during flooding [5 values per quadrant]	Average height of water during flooding [1 value per quadrant]
Total fresh and dry plant biomass (knotweed and other species) in each type of quadrant (R, S)	Average fresh and dry plant biomass (knotweed and other species) in each type of quadrant (R, S)



6. Collecting a biomass sample.

■ Biomass samples:

- the sampled area is a smaller 0.25 square metre quadrant (0.5 m x 0.5 m) in each 4 square metre quadrant;
- the same plant inventories were carried out;
- using a spade but without taking too much soil, samples were taken of the aerial and below-ground parts of all the plants in the quadrant;
- each quadrant was photographed and geolocated (GPS);
- the samples were collected in a black, garbage bag and labelled. For samples from areas with knotweed (R), the knotweed plants were separated from the other plants (two bags);
- the bags were individually weighed (fresh weight) shortly after the samples were taken, then stored flat on the floor of a cool, dark place (a closed garage at Agrocampus Ouest);
- the biomass was dried in the open bags for 7 to 8 months at ambient temperature prior to each bag being individually weighed (dry weight).

■ Additional observations on the site noted the consumption (browsing) of the vegetation and the knotweed, including the presence, abundance and freshness of faeces.

Results and assessment

■ Results

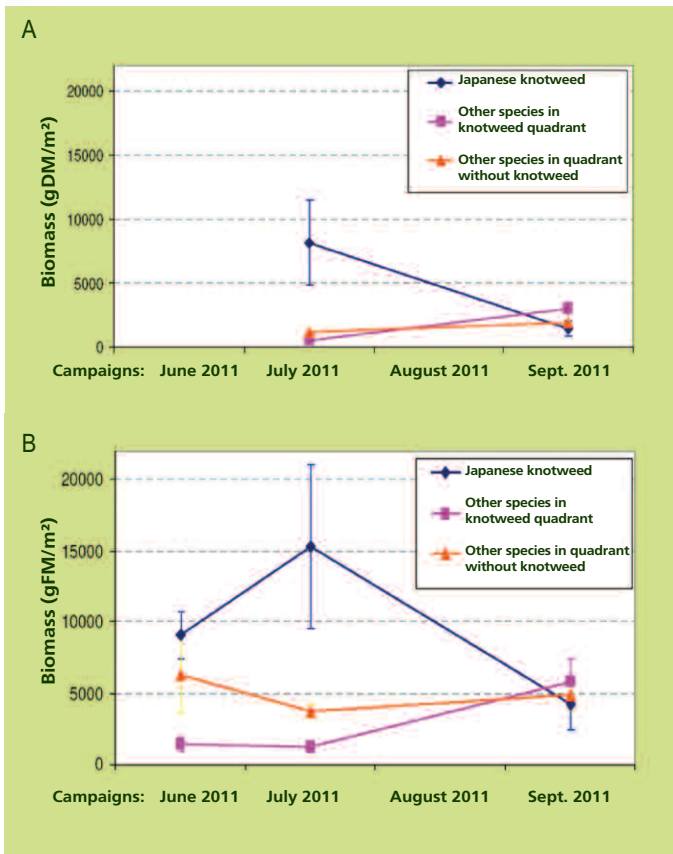
■ The impact of *Reynoutria japonica* on the other species was confirmed prior to grazing:

- there was 3 to 4 times less fresh biomass of the other species in the quadrants with *Reynoutria japonica* than in those without;
- the number of species, their abundance and surface areas were inversely correlated with the abundance of *Reynoutria japonica*.

■ Grazing reduced the knotweed biomass and led to an increase in the biomass of the native species.

■ The number of native species increased from 6 to 8 before grazing to 15 during grazing. This increase was due to the fact that grazing limited the pressure exerted by the Japanese knotweed and enabled the native species to develop.





A. Average dry biomass.
B. Average fresh biomass.

■ Assessment

- Certain animals had difficulty in adapting to the environment. Two had to be removed from the site and two others died due to ectoparasites (their young age made them more susceptible to parasites).
- The animals immediately (the first day) started eating the Japanese knotweed throughout sector A.
- The use of the rotary cutter between the last two campaigns had an impact on the environment that probably modified the interpretation of the results. But did it influence the consumption of knotweed by the goats or contribute to dispersing stalk fragments and rhizomes?
- The costs incurred by this project were not available.

○ Outlook

- Management of *Reynoutria japonica* by grazing will be pursued and monitored.

Information on the project

- The work was presented during the national symposium on Asian knotweed held on 23 and 24 October 2012 in the city of Saint-Étienne.

Author: Sandra Fernandez, Irstea



7. Grazed area at the end of September 2011.
8. Comparison between a control zone (left) and a grazed area (right) in 2012.

For more information

- Haury J., Moreau C., Bozec M., Druel A., Paulet Y., Cabral T. 2012. Expérimentation de gestion raisonnée de la Renouée du Japon (*Reynoutria japonica*) sur le site du « Moulin à papier », à Saint-Calais du Désert (53). Synthèse d'intervention 2011 et rappel des résultats 2010. Agrocampus Ouest site de Rennes, Dreal Pays de la Loire et Conseil général de la Mayenne. 48 pp.
- Bozec M. 2013. Précisions sur le protocole élaboré par AgroCampus Rennes pour le suivi du pâturage des renouées par les chèvres des fossés, CG53, Moulin à Papier, St Calais du désert. 1 pp.



Groundsel bush

(*Baccharis halimifolia*)

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

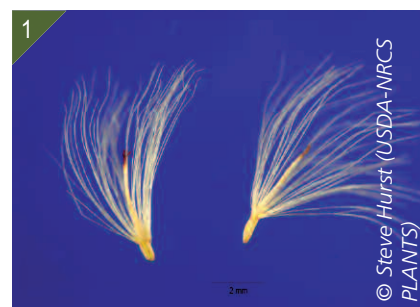
Documentation

- 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

Classification

Order	Astérales
Family	Asteraceae
Genus	<i>Baccharis</i>
Species	<i>B. halimifolia</i> (Linnaeus, 1753)





Groundsel bush

(*Baccharis halimifolia*)

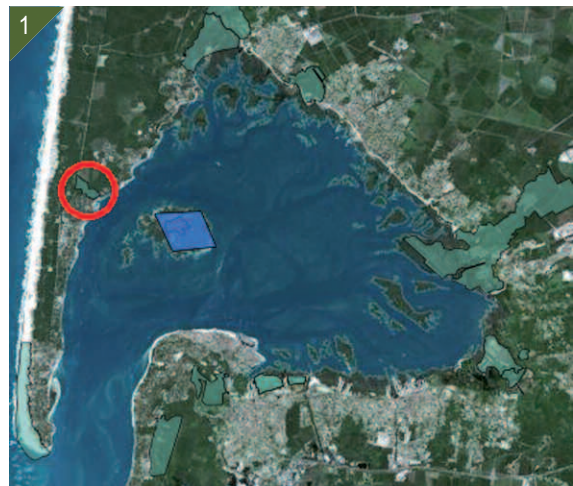
Managing groundsel bushes at the Pirailan reservoirs

Pirailan reservoirs

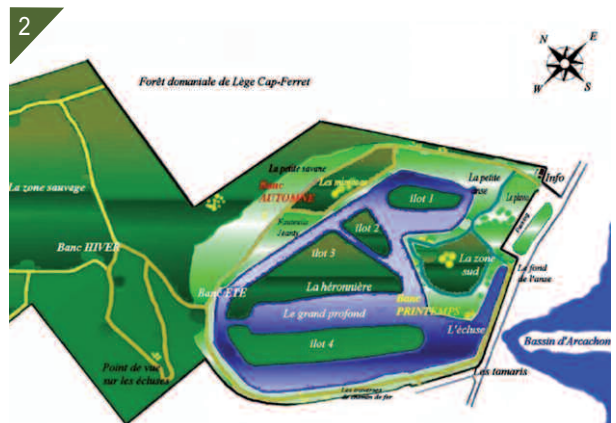
- The reservoirs are a protected, natural site in the town of Lège-Cap Ferret (Gironde department), that have belonged to the Seaside and Lake Conservation Trust since 1997.
- The site is managed and monitored by municipal personnel from Lège-Cap Ferret.
- A management plan, proposed by the environmental research and study group, was launched in January 1999 and one objective is to control groundsel bushes.
- Contact: Marie-Catherine Chaumet (manager of the Pirailan reservoirs)
marie-catherine.chaumet@laposte.net

Intervention site

- The Pirailan reservoirs are located in the town of Lège-Cap Ferret, along the coast of the Arcachon basin. The town manages the site in a partnership with the departmental council.
- The site covers a total of just over 39 hectares and is made up of:
 - a reservoir (6 hectares) with a bed of sand and mud, supplied via a lock. The vegetation on the banks consists of salt-meadow species;
 - four small islands within the reservoir, with cover comprising woody plants and bushes, with dead trees standing or fallen (3 hectares);
 - a stand of pine trees covering most of the site, including a more or less open understorey and more dense sections with thickets and fallen dead trees;
 - small hills rising up to 30 metres above sea level.
- Due to the management work on groundsel bushes, it was decided, in conjunction with the National botanical conservatory for South-west France, to make the Pirailan reservoirs a pilot site for monitoring plant dynamics.



© Réservoirs du Pirailan



1. 2. Site of the Pirailan reservoirs.

Disturbances and issues involved

- The presence of groundsel bushes around the Arcachon basin was mentioned for the first time in 1891. The species has been present on the Pirailan site since the 1960s, primarily around the reservoir and on the islands. It covered a significant percentage of the surface area with individual bushes exceeding heights of 2 metres.
- The plants had a considerable impact on the site:
 - competition with native plant species resulting in the disappearance of emblematic species;
 - greater environmental uniformity;
 - closing of the landscape along the reservoir;
 - a reduction in nesting waterfowl.

Interventions

■ In the framework of a management plan set up in 1997, the site manager has regularly organised interventions to eliminate groundsel bushes.

■ Different techniques have been employed:

- manual uprooting of young plants;
- cutting the plants using a saw, shears, a brushcutter or a chainsaw, depending on the size of the bushes and the density of the cover;
- elimination of new growth and removal of stumps using a hatchet.

■ The work was done:

- on a few areas of the site each year, but primarily on the islands and around the reservoir;
- by one or two persons.

Work schedule and methods used from 1997 to 2012.

Year	Month	Methods
1997	09	Manual uprooting of young plants
1998	05-08	Manual uprooting of young plants and cutting
1999	05-11	Manual uprooting of young plants and brushcutting
2000	12	Brushcutting
2001	06-11	Manual uprooting of young plants, brushcutting of regrowth
2002	01-02, 04-05, 07-09, 12	Manual uprooting of young plants and brushcutting
2003	06-12	Manual uprooting of young plants and brushcutting
2004	03-04, 07-11	Manual uprooting of young plants and brushcutting
2005	01, 07-12	Manual uprooting, cutting and brushcutting
2006	02, 06, 08, 12	Manual uprooting of young plants and brushcutting
2007	01, 07, 09-11	Manual uprooting, cutting and brushcutting
2008	02, 05-12	Manual uprooting, cutting and brushcutting
2009	05-06, 08-10, 12	Manual uprooting and cutting
2010	01, 03-12	Cutting, tailing (removal of peduncle) and removal of stumps
2011	01, 04-10	Tailing and removal of stumps
2012	01, 08-10	Tailing and uprooting of young plants

Results and costs

■ Results

■ The groundsel bushes were virtually eliminated thanks to regular work.

■ The landscape underwent changes:

- development of native herbaceous and shrub species on the banks and in the reservoir;

- in 1999, 94 different plant species were present on the site, in 2012 the number had risen to over 300 including some emblematic species (*Urospermum dalechampii*, *Rhagadiolus rhagadiolides*, *Papaver dubium*, *Ruppia cirrhosa*, *Sarcocornia*).

■ Assessment of management costs (examples)

■ The work is very physical and repetitive, and requires observational capabilities when the groundsel bushes are hidden by the vegetation. The results are however highly visible and constitute an encouragement to continue the management efforts.

■ In 2008, approximately 89 hours of work were devoted to the groundsel bushes and 9 hours to equipment maintenance. The total outlay amounted to 991 euros, including 775 euros for maintenance and 216 euros for fuel).

■ In 2012, 18 hours of work and 191 euros were invested in the management effort.



3. Island no. 4 in July 2007.

4. Island no. 4 in July 2013.

5. Overall view of the Pirailan reservoirs.

Monitoring of the islands following the work. Observations in 2011 and 2012.

Year	Month	Small islands	Observations
2011	January	1	10 sprouting trunks
		2	10 sprouting trunks
		3	35 sprouting trunks
		4	100 sprouting trunks
	October	1	1 sprouting trunk + 5 seedlings
		2	2 sprouting trunks + 1 adult bush + 2 basal shoots + 155 seedlings
		3	12 sprouting trunks + 5 basal shoots + 100 seedlings
		4	73 sprouting trunks + more than 200 seedlings
2012	January	1	0
		2	70 seedlings
		3	8 sprouting trunks + 3 basal shoots + 67 seedlings
		4	10 sprouting trunks + 14 basal shoots + 159 seedlings
	October	1	0
		2	0
		3	3 basal shoots + 1 seedling
		4	1 adult plant + 60 seedlings



6. Aerial view of the Pirailan reservoirs.

Outlook

- Regular work and monitoring to control groundsel bushes will be pursued over the entire site.
- Thanks to the partnership with the National botanical conservatory for South-west France in the framework of the DELTA programme (Plant biodiversity in the Arcachon basin and the Val de Leyre - LEADER project), following the elimination of the groundsel bushes, the Pirailan reservoirs were designated as a pilot site for monitoring plant dynamics. Regular monitoring of two plots was set up for a period of 10 years.
- The objectives of the monitoring programme are to:
 - understand, confirm or develop the hypotheses concerning plant dynamics during and after the work to eliminate groundsel bushes;
 - assess the impact and the effectiveness of the management work on the observed plant dynamics;
 - monitor the development of the groundsel bushes and of the vegetation in general;
 - assist the manager in monitoring the groundsel bushes;
 - monitor an alien species (e.g. *Viburnum tinus*) even outside of the plots;
 - monitor any new species colonising the plots (*Atriplex hastata*, *Suaeda maritima*, *Phragmites australis*, *Pucciniella maritima*, etc.).

Information on the project

- The conservatory has taken on the task of informing and raising awareness among managers and the general public via meetings and brochures.
- During presentations by the site manager, the impact of invasive plants on biodiversity is discussed.
- Meetings among the littoral protection officers are an occasion for discussions between the people managing the species.

Authors: Sandra Fernandez, Irstea and Emmanuelle Sarat (IUCN French committee).

For more information

- www.conservatoire-du-littoral.fr
- www.cbnsa.fr
- DELTA programme (Plant biodiversity in the Arcachon basin and the Val de Leyre)
- Caillon A., Caze G., Pradel C. 2012. Plantes exotiques envahissantes : une menace pour la biodiversité... ensemble agissons ! CBNSA. 20 pp.
- Caillon A., Caze G, 2011. Notice méthodologique : suivi de la dynamique des végétations suite à la gestion des espèces exotiques envahissantes arbustive. CBNSA, 8 pp.





Groundsel bush

(*Baccharis halimifolia*)

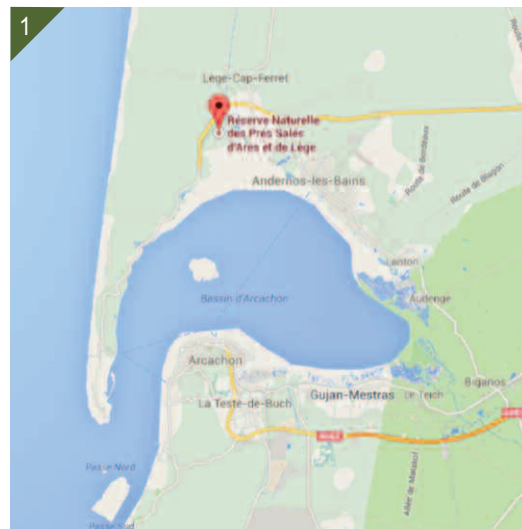
Managing groundsel bushes in the Arès - Lège-Cap-Ferret National salt-meadow nature reserve

Arès - Lège-Cap-Ferret National salt-meadow nature reserve

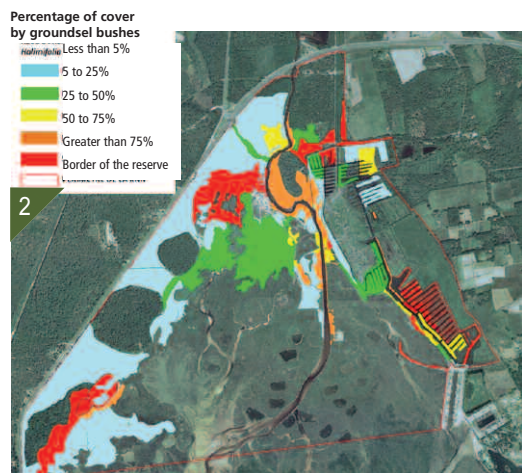
- The area was acknowledged as a national nature reserve by the Ecology ministry in 1983.
- It has been managed by the National agency for hunting and wildlife (ONCFS) since 2007 as part of the ONCFS network of reserves, in collaboration with the French national network of nature reserves.
- The management work was set up in the framework of the Rational management of groundsel bushes (*Baccharis halimifolia*) technical project, part of the 2010-2014 management plan for the nature reserve in order to:
 - counter the significant loss of natural habitats (an estimated 35 hectares in 2007);
 - preserve the plots for protected species (enclosures, etc.);
 - win back potential habitats for emblematic species;
 - preserve EU-listed natural habitats and/or those of value for migratory waterfowl and European pond turtles.
- Contacts: Sylvain Brun, manager and Richard Deneuic, technician and protection officer
 sylvain.brun@oncfs.gouv.fr,
 richard.deneuic@oncfs.gouv.fr

Intervention site

- The Arès-Lège salt-meadow nature reserve covers 380 hectares and is located at the northern end of the Arcachon basin in the towns of Arès and Lège-Cap-Ferret (Gironde department). The presence in the largest salt meadows of the Aquitaine region of rare plant species that are typically found in salt meadows or Mediterranean regions justified the classification of the site as a nature reserve on 7 September 1983.
- Its geographic position at the outlet of the canal from the ponds means it serves as an ecological corridor between the Arcachon basin (150 square kilometres) and the catchment basin comprising the Médoc ponds (1 000 square kilometres), an important area for animals (migratory birds and fish, European otter and European pond turtles). In addition, the reserve contains a patchwork of natural habitats of which some are rare in France.
- From 2007 to 2012, the management work on groundsel bushes, coordinated by ONCFS, targeted 21 sites spread from the diked section (banks and former fish reservoirs) to the tidal section.



© Google maps



© BIOTOPE 2007



© ONCFS

1. Site of the Arès nature reserve.
2. Position and percentage of cover by groundsel bushes in the Arès reserve in 2007 (prior to launching management work).
3. Management of groundsel bushes in the Arès reserve in 2012.



■ The reserve comprises many types of environments including marshes, reed ponds, meadows, contact zones between salt meadows and dunes, low areas among the dunes, banks of water bodies, wetlands in the diked section and salt-cedar hedges.

Disturbances and issues involved

■ The presence of groundsel bushes around the Arcachon basin was mentioned for the first time in 1891 and it was first observed in the reserve in 1975, though older observations signalled its establishment as early as the 1960s. A study conducted on the reserve in 2010 (Dusfour) revealed a major increase in the species since 1985. It was estimated that the plant progressed 11.21 hectares from 1985 to 2007, i.e. an annual increase of 0.34 hectares between 1985 and 2007, and of 1.25 hectares between 2005 and 2007. The colonisation dynamics of groundsel bushes would seem to have accelerated by a factor of four over the 20-year period.

* The colonisation by the species produced observable ecological impacts in the nature reserve, e.g.:

- loss of habitats for emblematic species and/or EU-listed habitats;
- a reduction in plant biodiversity (interspecific competition);
- more uniform landscapes;
- erosion of banks (groundsel bushes stabilise banks less than native species);
- increased accretion under the bushes.

Interventions

■ Since 2007, ONCFS has set up different projects to manage groundsel bushes. Two types of work have been carried out, restoration work where the adult bushes (2 to 4 metres high) are eliminated and maintenance work to clear new growth and shoots. Different techniques were used depending on the sensitivity of the area to be restored (presence of protected plant species, spawning grounds for European pond turtles, natural habitats with fragile topsoil, etc.) and taking into account various practical aspects (access and feasibility of the technique in the area).

■ All the restoration and maintenance work in important conservation areas was done by volunteers (local people and non-profits) in the framework of the anticipatory management project set up by ONCFS, by external suppliers with funding from ONCFS, the Aquitaine regional environmental directorate and the Aquitaine regional council, and by the technical departments of the towns of Arès and Lège-Cap Ferret (clearing using a rotary cutter, waste transport).

■ Manual cutting

- The groundsel bushes are cut manually, using sickles, billhooks, etc., taking care to avoid native species.
- The bushes are temporarily stored in piles near the managed areas.

■ Rotary cutters

- The work is done using a machine mounted on wide tracks and equipped with a blade, a tracked tractor or a forestry shredder
- This technique makes for rapid progress in areas with dense stands of groundsel bushes.
- The shredded organic matter does not need to be transported.

■ Mechanical uprooting

- An excavator is used.



4. An area colonised by groundsel bushes.
5. Manual cutting.
6. Rotary cutter in action.

■ Transport and elimination of the plants

■ This work (shredding and transport to a landfill or burning) was done by the technical departments of the towns of Arès and Lège-Cap-Ferret.

■ Work periods

■ The work was done from mid-August to the end of February, outside of the reproduction periods of animals.

Results and assessment

■ Results

■ By the end of 2012, just over 13 hectares of salt meadows had been restored, including 8.5 ha by manual cutting, 4.5 ha by mechanical shredding and 0.1 ha by mechanical uprooting.

■ This work made it possible to:

- restore the "open fringe effect" along the banks of the reservoirs and wet meadows that encourages the presence of many birds (Anatidae, waders and large waders);
- restore the contact zones between salt meadows and dunes, the habitats of emblematic plant species and EU-listed natural habitats (salt-cedar hedges, sedge land and reed beds).

■ The restored areas are regularly maintained to perpetuate their conservation status.

■ Assessment

■ Participatory management:

- in 2012, 128 people participated (7 different organisations and a worksite open to the general public);
- the work serves to create social ties and bridge generation gaps between participants (young people encountering problems, the unemployed, hunters, managers, the public, etc.).



7. Fish reservoir prior to manual cutting (November 2009).

8. Fish reservoir after manual cutting (November 2009).

Breakdown of man-days supplied by the organisations from 2010 to 2012.

Organisation	2010	2011	2012
Arès municipal hunting association (ACCA)	11	37	11
Lège-Cap-Ferret ACCA	-	17	-
Maritime hunting association for the Arcachon basin	6	6	6
Cap Termer	5	3.5	5
Surf Insertion	24	12	24
Arès tourist office	-	-	-
TOTAL	46	65.5	46

Total cost of restoration and maintenance work of all types (2010 to 2012)

Year	External suppliers (funding by ONCFS, Envir. Dir. and Aquitaine RC)	Municipal departments of Arès and Lège-Cap-Ferret	Volunteers (costed)	Total
2010	8 602.73 €	4 390.00 €	7 958.00 €	20 950.73 €
2011	9 568.00 €	9 222.50 €	13 061.50 €	31 852.00 €
2012	10 671.00 €	16 155.60 €	12 915.60 €	39 748.20 €
Total	28 841.73 €	29 771.10 €	33 935.10 €	92 550.93 €

Advantages and disadvantages of management methods.

Management method	Advantages	Disadvantages
Manual cutting	<p>Minimum disturbances (damage to soil and noise).</p> <p>Work in sectors that are sensitive or difficult to access.</p> <p>Low carbon footprint.</p> <p>Ideal technique for maintenance work (5 to 6 times less time consuming and less tiresome than restoration work).</p> <p>Can be done by anyone.</p> <p>Contributes to social ties and connections.</p>	<p>Long, physical work.</p> <p>Irregular results depending on the worker (volunteers, personnel from the reserve).</p> <p>Involves large amounts of labour.</p> <p>Difficulty in planning and executing work over the long term (depends on the number of volunteers each year).</p>
Mechanical shredding	<p>Rapid work in heavily colonised areas.</p>	<p>Environmental disturbances (soil and fauna).</p> <p>Accessibility for machines.</p> <p>Non-selective technique.</p>
Mechanical uprooting	<p>None</p>	<p>Major disturbances to soil.</p> <p>Expensive (time and money).</p> <p>Wrong technique for the site.</p>

Information on the project

- Information on the management of groundsel bushes is provided to the volunteers when they work on the site and to the general public visiting the nature reserve in welcome stations (ONCFS and partners for environmental education on the site).
- A conference on management of groundsel bushes was organised for the general public, in conjunction with the National botanical conservatory for South-west France, on 6 October 2012.
- Feedback from the management project for groundsel bushes was presented at the Meeting of ONCFS reserves in October 2012 and during the Médoc lakes SBMP meeting devoted to invasive species in February 2013.
- Annual reports are uploaded to the internet site of the national nature reserve.

Author: Sandra Fernandez, Irstea

For more information

- Internet site of the Arès - Lège-Cap-Ferret National salt-meadow nature reserve:
<http://reserve-naturelle-pres-sales.org/>
- Dusfour G. 2010. Caractérisation des dynamiques des espèces végétales envahissantes dans la zone tidale de la Réserve naturelle nationale des prés salés d'Arès-Lège : le cas particulier de *Baccharis halimifolia*. Rapport de Stage Master 1 « Dynamique des écosystèmes aquatiques ».
- Managing groundsel bushes in the Arès - Lège-Cap-Ferret National salt-meadow nature reserve. Report for the year 2010. Arès - Lège-Cap-Ferret National salt-meadow nature reserve and ONCFS, January 2011.
- Presentation on managing and monitoring groundsel bushes (*Baccharis halimifolia*) in the Arès - Lège-Cap-Ferret National salt-meadow nature reserve. Meeting of ONCFS reserves, 16 October 2012.
- Gestion du *Baccharis*. Projet 2012-13. RNN des prés salés d'Arès et de Lège-Cap-Ferret/ONCFS, juillet 2012.



Groundsel bush

(*Baccharis halimifolia*)

Managing groundsel bushes in the Spanish Basque country

LIFE + *Estuarios del País Vasco* project

■ The LIFE + *Estuarios del País Vasco* project (LIFE08NAT/E/000055) (*Restauración de hábitats de interés comunitario en estuarios del País Vasco*) attempted to counter the problems caused by groundsel bushes (*Baccharis halimifolia*) in the main estuaries of the Basque country, by focussing on the most heavily invaded areas.

■ The objectives of the planned activities for the project included:

- conservation and restoration of the EU-listed habitats affected by the progressive advance of invasive alien species and by the detrimental conditions for hydraulic dynamics;
- improvement of environmental conditions for EU-listed species and migratory birds;
- implementation of good practices for environmental restoration, including innovative experiments that can be reproduced in other regions affected by the same problems;
- raising the awareness of experts, managers and the general public concerning the difficulties caused by groundsel bushes in estuaries.

■ The total budget for the project was 1.8 million euros (50% from the EU LIFE-Nature fund and 50% provided by the Environmental department of the Basque government).

■ The project was managed by IHOBE, a public agency overseen by the Environmental department of the Basque government.

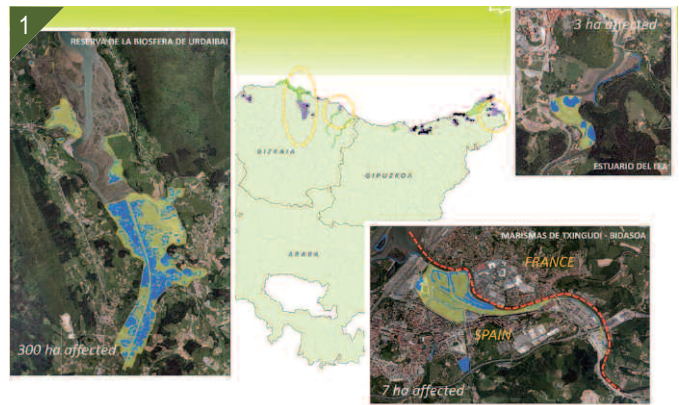
■ Contact: Estela Beteta – estela.beteta@ihobe.net

Context and issues involved

■ Groundsel bushes are considered one of the most troublesome invasive alien species in Spain. In the Basque country, it may be found in each estuary, from Txingudi (Irun) to Barbadun (Muskiz).

■ The most heavily impacted estuary was located in the biosphere reserve of Urdaibai (Bizkaia), where over 300 hectares were colonised. The reserve, a Ramsar site listed by UNESCO as a world natural heritage, comprises an array of habitats (cliffs, swamps, river plains, heathlands) and serves as a winter rest and reproduction site for many species of migratory birds.

© IHOBE



1. Study sites.

■ The colonising groundsel bushes competed with certain native species such as common reed (*Phragmites australis*), sea rush (*Juncus maritimus*) and aquatic warblers (*Acrocephalus paludicola*).

■ The colonisation also raised problems concerning the use of the environment, e.g. damage to banks and infrastructure, reduced access to rivers.

■ In response, an initial programme was set up. It included:

- a status report with maps on the distribution of groundsel bushes in the Urdaibai reserve (2005);
- experiments on how to control the plants using herbicides.

■ The LIFE + *Estuarios del País Vasco* project was prepared and submitted in 2008, then implemented starting in 2010.

Interventions

■ Interventions were conducted on three estuaries confronted with different geographic situations and degrees of invasion:

- the Urdaibai reserve on the estuary of the Oka River, of which 300 hectares were colonised by groundsel bushes;
- the Txingudi area on the estuary of the Bidasoa River, a RAMSAR site with 7 hectares colonised;
- the Lea River (a river basin spanning 82 square kilometres), of which 3 hectares were colonised.

■ The objective of the interventions planned in the framework of the LIFE + project was to prevent the dispersal of seeds and to protect the natural habitats of the estuaries.

■ The management techniques had to be modified during the project to take into account the



- site characteristics, e.g. water levels, tidal effects;
 - accessibility;
 - difficult climatic conditions (wind, rain);
 - appearance of new invasive species on the study sites;
 - presence of groundsel bushes on nearby sites that contributed to the renewed colonisation of the treated sites;
 - very high germination rates for seeds.
- various difficulties encountered in the field:

■ Manual uprooting

- Technique used on young plants, less than 1.5 metres tall.
- Elimination of the entire root system.
- This work was carried out year round.
- Effective technique, but expensive.

■ Cutting targeting the female plants

- Selective cutting to avoid the dispersal of seeds.
- This technique limits the spread of the plants, but does not eliminate them.

■ Herbicide

- Technique used on adult plants and new shoots.
- Active ingredient: glyphosate.
- The herbicide was applied on the trunks using brushes, following cutting.
- This technique is possible only under favourable weather conditions (no wind or rain).
- Requires safety measures (gloves, masks).
- Highly effective and less expensive than manual uprooting.

■ Monitoring of the management work

- On the three study sites, monitoring was set up for 45 plots (3 metres x 3 metres) and 164 transects (10 m x 50 m).
- Monitoring was initiated two months after the work.
- Measured parameters:
 - presence and abundance of native species to measure the degree of habitat restoration;
 - regrowth of groundsel bushes to determine the effectiveness of the work;
 - development of seeds to assess the risk of a new invasion following the work..

Results and costs

■ Results

- A total of 570 000 adult plants were treated on the three sites.
- Over 5 million seedlings were uprooted.

Overall results of the management work (source: IHOBE).

Method	Treated surface area (ha)			TOTAL
	2011	2012	2013	
Herbicide, first treatment	139.69	38.27	14.50	192.46
Herbicide, second treatment	78.08	55.49	138.75	272.32
Manual uprooting	80.31	81.76	72.68	234.75
Selective cutting			79.78	79.78
TOTAL	298.08	175.52	305.71	781.41

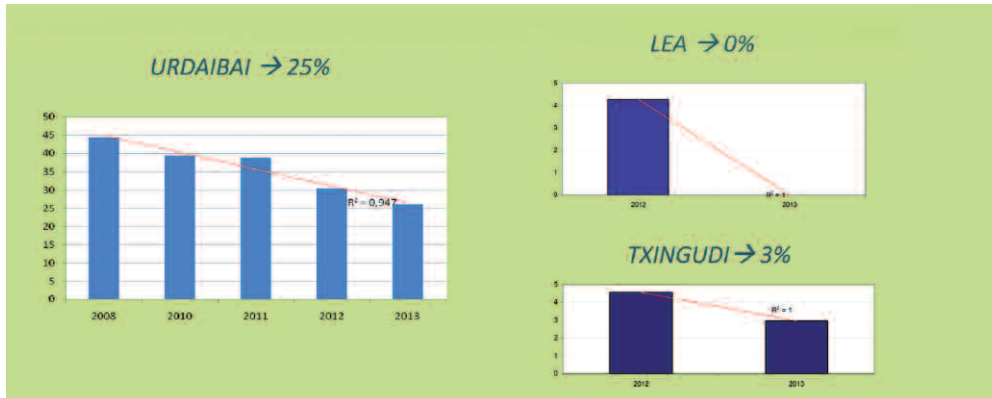


2. Urdaibai biosphere reserve.
3. Manual uprooting.
4. Use of a herbicide.
5. Monitoring regrowth of groundsel plants.

■ Regrowth of groundsel plants

■ A reduction was observed on all three sites, particularly on the least colonised site (the estuary of the Lea River where groundsel plants were totally eliminated from the three-hectare colonised area).

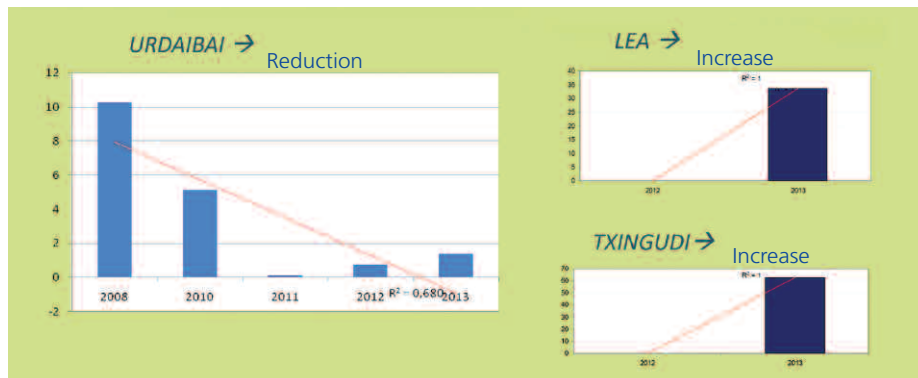
Change in the observed number of groundsel plants starting to grow again.



■ Effects on the density of seedlings

■ A reduction was observed in the Urdubai reserve, but an increase in the estuaries of the Lea and Txingudi Rivers.

Change in the observed number of groundsel seedlings.



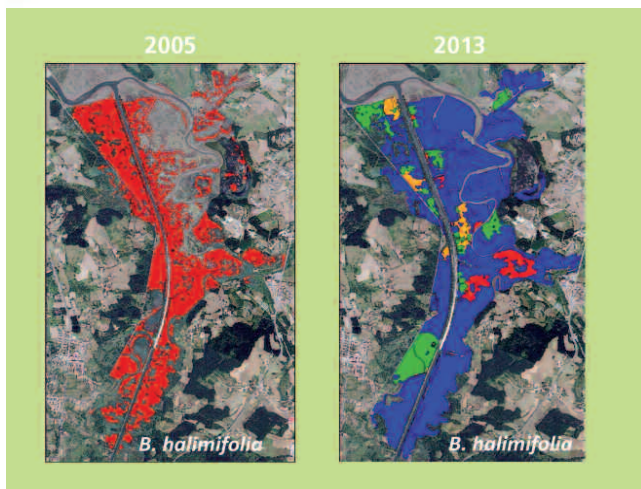
■ Detailed results for the Urdaibai reserve (2012)

- Percentage of new shoots is 26%.
- Estimated germination capacity of the seed bank in the soil: 1 seedling per square metre compared to 10.28 seedlings observed for the status report in 2008.
- In terms of habitat restoration, the native species were more abundant, namely *Atriplex prostrata*, *Phragmites australis* (together 41%), *Juncus maritimus* (18%), *Elymus athericus* (9%).
- Groundsel bushes were still present in 70% of the treated surface areas, with an average abundance of 10% (maximum abundance 50%).
- Between 10 and 35 workers were present on each site.

Assessment of project costs.

Method	Average cost (€ per hectare)
First treatment	2 988
Second treatment	2 277
Uprooting of seedlings	1 081
Manual uprooting	1 789
Selective cutting	486
TOTAL	8 621





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Results of management work in the Urdaibai reserve (groundsel bushes shown in red).

Outlook

■ The methods used to manage groundsel bushes have proven their effectiveness, however the results vary depending on the site:

- on heavily colonised sites, the rate of regrowth is very high. The plants are managed and their extension limited through a combination of techniques (uprooting of plants and seedlings + use of a herbicide);
- on sites where the presence of groundsel bushes is limited to certain spots, the rate of regrowth is low and total eradication is possible.

■ The initial work to eliminate the plants is effective, however the subsequent germination rate of seedlings remains very high.

■ Manual uprooting is the most effective technique.

■ The techniques employed and the work conditions must adapt to the situation on each site.

■ Surveillance and monitoring after the work is indispensable to ensure effective results.

■ Coordination and data exchange are indispensable for the management of invasive species spanning several regions.

■ Finally, further scientific research is required on the species biology, intervention techniques and the response of groundsel plants to the management work.

Information on the project

■ Communication efforts in the framework of the LIFE + programme:

- awareness raising of the general public through signs and informational documents, videos, an internet site, an educational programme, exhibitions;
- drafting of a "good-practices guide" for management (a French version will soon be available);
- presentation of posters during conferences and workshops, e.g. Néobiota 2012 (Turkey), EWRS 2014 (France);
- creation of an international work group for groundsel bushes (two meetings during the management programme).

Author: Emmanuelle Sarat, IUCN French committee



6. 7. New seedlings in a previously treated area.
8. Results of management work in the estuary of the Bidasoa River.

For more information

■ LIFE project + *Estuarios del País Vasco*: www.euskadi.net/life_estuarios

■ Beteta E., 2014. LIFE + project, Estuaries of the Basque country. *Baccharis halimifolia* management on the Atlantic coast. 4th International symposium on weeds and invasive plants. Montpellier, 20 May 2014. 37 pp.

■ Beteta E., 2012. LIFE + project, Estuaries of the Basque country. Control and elimination of *Baccharis halimifolia* L. in Urdaibai. Poster presented at the Seventh international conference on biological invasions, Neobiota 2012, Halting Biological Invasions in Europe. From Data to Decisions. Pontevedra, Spain, 12-14 September 2012.



Garden balsam

(*Impatiens* spp.)

Originated in central Asia and the Himalaya (Kashmir balsam, Himalayan balsam, small balsam). Also in North America (orange balsam). Introduced as ornamental plants in the 1800s and 1900s.

Description

- Annual, herbaceous plants
- Stalks range in length from 30 cm to over 1 metre. Stalks are strong, fluted, hollow and, for *I. glandulifera* and *I. balfouri*, are reddish in colour.
- Single, indented leaves with a stem:
 - opposing or whorled in groups of three for *I. glandulifera*, alternating for *I. capensis* and *I. balfouri*
 - length 2 to 18 cm, width 2 to 7 cm
 - oval, lanceolate blade
- Flowers with a short spur bending down, in clusters of 3 to 14 flowers:
 - purple to white for *I. glandulifera*
 - pink corolla with three lobes and an upper white section for *I. balfouri*
 - pale yellow for *I. parviflora*, orangish for *I. capensis*
- Fruit in the form of thin capsules, 1.5 to 3 cm long, that explode at the slightest touch when ripe
- Small root system, roots break and can be uprooted easily

Ecology and reproduction

- Preferred habitat is a cool environment with nutrient-rich soils:
 - riparian zones, rocky river banks, alluvial forests
 - ditches, moist slopes, near rubble and slopes
- The plants can accept considerable shade
- Sexual reproduction through autochorous dispersal of the seeds
- Vegetative multiplication and dissemination by cuttings of stalks and roots for *I. glandulifera*

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

Classification

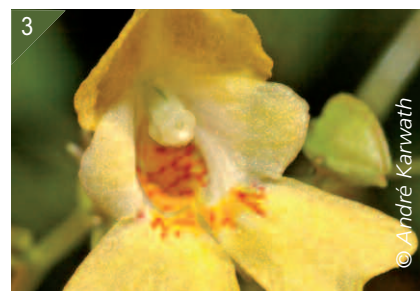
Order	Geraniales
Family	Balsaminaceae
Genus	<i>Impatiens</i> (Linnaeus, 1753)



© Joan Simon



© Cen Centre



© André Karwath



© Fritz Geller-Grimm



© Mnolf



© Marper

1. Kashmir balsam (*Impatiens balfourii*).
2. Himalayan balsam (*Impatiens glandulifera*).
- 3- Small balsam (*Impatiens parviflora*).
4. Orange balsam (*Impatiens capensis*).
5. 6. Leaves and fruit of Himalayan balsam.





Garden balsam

(*Impatiens* spp.)

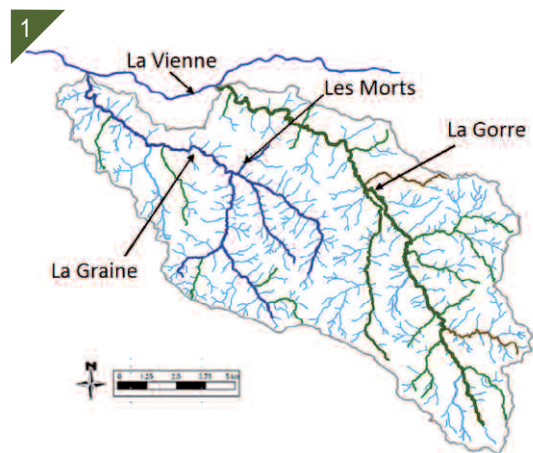
Managing Himalayan balsam in the Graine basin

Vienne Gorre river board (SMVG)

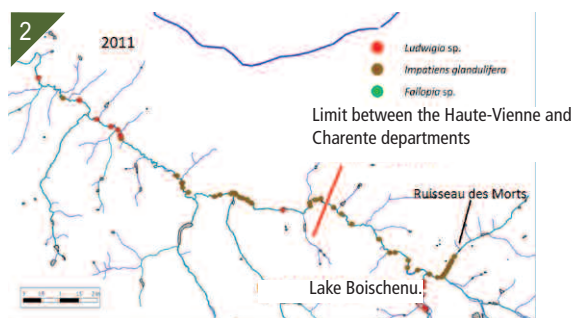
- The public board for inter-municipal cooperation was created in 1965.
- For its work on rivers, the SMVG represents 14 towns, 11 in the Haute-Vienne department and 3 in the Charente department.
- The main projects in the framework of the 2009-2013 contract for river restoration and maintenance (extended to include 2014) aim to:
 - restore the natural flow conditions of rivers;
 - improve the functions provided by riparian vegetation;
 - limit clogging of the riverbed;
 - enable free movement of fish;
 - preserve and encourage suitable management of emblematic environments;
 - develop fishing and water-oriented tourism;
 - drive policy, communicate and raise awareness;
 - limit the proliferation of invasive species by monitoring and managing *Ludwigia* spp. and *Impatiens glandulifera*, managing coypu and muskrats selectively and in a coordinated manner, monitoring the arrival of new invasive species and improving knowledge on emblematic aquatic species.
- Contact: Marie Adalbert - smvg.riviere@orange.fr

Intervention site

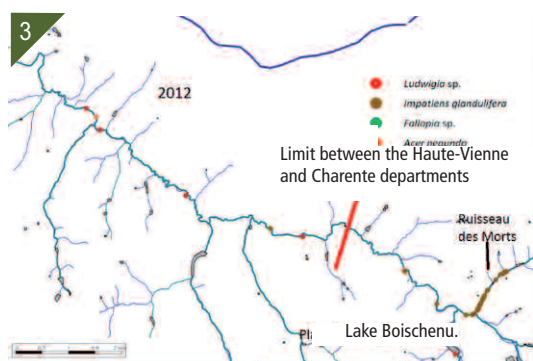
- The area managed by SMVG partially overlaps with that of the Périgord-Limousin regional nature park. The hydrographic network is fairly dense (approximately 500 kilometres of river) and comprises two main rivers, the Gorre and the Graine, two large tributaries and a large number of small streams.
- For *Impatiens glandulifera*, SMVG:
 - worked in 2006 on the Gorre River on a test work site with the Périgord-Limousin regional nature park and the National botanical conservatory for the Massif Central (CBNMC). The maps drawn up in 2007, on the 20-kilometre section of banks along the Gorre from the town of Saint-Laurent-sur-Gorre, the starting point of the colonisation, to the confluence with the Vienne River, indicate a total colonised surface area of approximately 40 hectares. Given the difficulties involved (long distances, windfalls, wooded slopes, etc.), SMVG decided not to do any management work on the Gorre River;



© SMVG



© SMVG



© SMVG

1. Basins of the Graine and Gorre rivers.
2. 3. Location of invasive plants along the Graine River in 2011 and 2012.

- has worked since 2010 on the Graine River and its tributary, the Morts stream (19 kilometres long), following the discovery of *Impatiens glandulifera* in the area.

Disturbances and issues involved

■ *Impatiens glandulifera* was observed for the first time in 2000 in the area managed by SMVG on the banks of the Gorre River. It probably originated in a private garden. On the Graine River, it was first observed in 2010 in high concentrations upstream along a few kilometres of river bank. Downstream, the colonisation consisted of isolated plants observed down to the town of Chabanais, where the river flows into the Vienne River.

■ The development of *Impatiens glandulifera* has had negative ecological impacts on the area managed by SMVG:

- a reduction in local biodiversity due to the shade caused by the dense stands;
- greater instability of river banks due to the very weak root system of the species compared to the native species.

Interventions

■ Since 2011, SMVG has intervened on the banks of the Graine colonised by *Impatiens glandulifera* by supervising the work of a private company (manual uprooting and clearing). The initial work was carried out under pressing conditions in August 2010, following observations of the species along the Graine. That work is not described here.

■ An annual status report on the colonised areas is prepared prior to the interventions, in conjunction with the Poitou-Charentes regional observatory on invasive alien plants in aquatic ecosystems (ORENVA) and CNBMC.

■ Work periods

■ The work is organised in four periods due to the staggered growth of *Impatiens glandulifera*:

- period 1 during the second half of June;
- period 2 during the second half of July;
- period 3 during the second half of August;
- period 4 (optional) during the second half of September.

■ Techniques employed

■ Clearing of densely colonised sectors (only in 2011):

- use of a brushcutter to cut the plants at their base;
- work done in heavily colonised upstream sections of the Graine;
- manual uprooting in 2011 and 2012 in areas with isolated groups of plants.

■ Fate of the uprooted and cut plants

■ The stalks were broken into several pieces.

■ If no seeds, flowers or fruit had developed, the plants were deposited on the banks.

■ If seeds, flowers or fruit had developed, the plants were transported in large bags to a storage site in the town of Rochechouart.

■ The plants were subsequently transported to the incinerator in Limoges in October.

■ The same work was carried out for the other invasive alien plants along the Graine, namely *Ludwigia* spp. and *Acer negundo*.



4. *Impatiens glandulifera*.
5. Clearing with a brushcutter.
6. Uprooted and cut plants deposited on the bank.
7. Bank colonised by *Impatiens glandulifera*.

Results and costs

■ Results in 2011 and 2012

- Significant reduction in the number of uprooted *Impatiens glandulifera* plants (1 020 in 2011, 74 in 2012).
- Reduction in the number of areas colonised by the species.
- Major reduction in the quantities (all species combined) of vegetation removed (1 140 kilogrammes in 2011, 120 kg in 2012). A majority of the weight was due to *Ludwigia* spp.
- Balsam plants represented approximately 1% of the above quantities.
- The implemented technique was highly effective (assessment based on the annual maps), due notably to the vigilance of personnel during inspections along the entire river and during the work.
- Interventions are easier when colonisation is still in the early stages, but greater effort must be put into the inspections.

■ Costs

Costs for the management of invasive alien plants in 2011 and 2012.

Costs	2011	2012
Cost breakdown	Interventions : Haute Vienne : 8 671 € Charente : 12 259 € Removal: 108.88 € Legal notice: 267.68 €	Interventions : Haute Vienne : 4 933.50 € Charente : 7 534.70 € Removal: 12.92 € Legal notice: 337.75 €
Total cost	21 306.56 €	12 848.87 €
Days worked	Haute-Vienne: 14.5 days	Haute-Vienne: 7.5 days
Days worked	Charente: 20.5 days	Charente: 11.5 days
Number of workers	2	2

The legal notices correspond to announcements published in an official bulletin for public works contracts in view of selecting the company to do the work.

Outlook

- Management of *Impatiens glandulifera* and of the other invasive alien plants along the Graine will be pursued in the framework of the contract for river restoration and maintenance (extended to include 2014).
- A new contract will be signed in 2015.

Information on the project

- Transmission of monitoring data and status reports to Orenva and CBNMC (models for data-entry sheets available on the internet site of the Vienne public river-basin territorial agency).
- Articles published on the work in the local press (*Populaire du Centre* newspaper) and in municipal bulletins.
- Information sent to land owners (102 people) on the impacts of the species and on the work to be carried out.
- Organisation of training courses on how to identify and manage invasive plants by the Vienne public river-basin territorial agency for elected officials and employees managing public land and for river technicians.
- An informational brochure on management of invasive plants in the Vienne basin published on the internet site of the Vienne public river-basin territorial agency.



8- *Impatiens glandulifera*.

For more information

- Page on invasive plants on the internet site of the Vienne public river-basin territorial agency:
<http://www.eptb-vienne.fr/-Plantes-invasives-.html>.
- Internet site of Orenva:
<http://www.orenva.org/>.
- Vienne Gorre river board. No date. Report on the management of invasive alien plants. Himalayan balsam. 1 p.
- Vienne Gorre river board 2011. Report on work against invasive alien species. 3 pp.
- Vienne Gorre river board 2012. Report on work against invasive alien species. 3 pp.
- Périgord-Limousin regional nature park. 2006. Test work sites for Himalayan balsam in the Gorre basin. Report. 22 pp.

Etablissement Public
du Bassin de la Vienne

O RENVA





Giant hogweed

(*Heracleum mantegazzianum*)

Originated in the Caucasus and was introduced as an ornamental plant in Northern and Western Europe in the 1800s. It became invasive starting in the 1950s-1960s and is currently found in three-quarters of France (the North and the East).

Description

- Perennial, herbaceous plant that can reach a height of 2 to 5 metres. Strong stalk, 5 to 10 centimetres in diameter, fluted, hollow, purple spots and covered with white hairs
- Compound, alternating leaves:
 - length up to 1 metre, width 50 cm to 1 m
 - sessile leaflets, ending in a fine tip
 - smooth leaves with indented edges
- White flowers in a compound umbel, diameter greater than 50 centimetres, with between 50 and 120 stems
- The fruit is made up of flattened achenes, elliptical in shape, length 8 to 14 mm, width 6 to 8 mm
- Robust taproot with numerous lateral roots

Ecology and reproduction

- The species can develop in different types of shaded environments rich in nitrogen:
 - idle land, embankments, landfill, roadsides and train lines
 - river banks, shaded edges of forests, transition areas between wetlands and forests, and wet meadows
- Plants can accept a range of pH values and soil textures
- Exclusively sexual reproduction, a vegetative phase of 3 to 4 years before the unique flowering and death of the plant
- The fruit of the plant is disseminated by water and transportation of contaminated soil

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. Muséum national d'Histoire naturelle, Paris, 168 pp

Author: Emmanuelle Sarat, IUCN French committee

Classification

Order	Apiales
Family	Apiaceae
Genus	<i>Heracleum</i>
Species	<i>H. mantegazzianum</i> (Sommier et Levier, 1895)





Giant hogweed

(*Heracleum mantegazzianum*)

Managing giant hogweed in the Pays d'Honfleur intermunicipal association

Être & Boulot association

- The association for professional and social insertion was founded on 6 November 2002 and subsequently approved and certified by the Work ministry (DIRECCTE) and the Calvados departmental council.
- The association is active in the territory of the Pays d'Honfleur intermunicipal association (CCPH).
- The main missions of the Environment and littoral team are to:
 - improve living conditions by flowering and improving urban areas;
 - put natural areas to use through tourism and recreational activities;
 - protect the environment and the biodiversity of protected zones (ZNIEFF, Natura 2000, etc.);
 - manage areas colonised by giant hogweed in the CCPH area in a partnership with the National botanical conservatory in Brest and the Basse-Normandie nature conservatory.
- Contact: Pierre Levallois - etre.et.boulot@wanadoo.fr

Intervention site

- In the framework of the management project for giant hogweed, the Être & Boulot association works on colonised sites in the CCPH area.
- In 2012, the association worked on 20 sites spread over the 13 towns of the CCPH. Certain sites were identified by individuals that contacted the association following efforts to inform on the situation by CCPH and the association.

Disturbances and issues involved

- In the Basse-Normandie region, only two areas would seem to be colonised by giant hogweed. The largest is around Honfleur, notably in the city park. The species has also invaded several sectors of the port area.
- An isolated colony in the Grand-Hazé marshes in the Orne department is also known to exist.
- The species provokes a number of known impacts observed on the intervention site.



Key	
Green	Sites known in 2007
Orange	Sites discovered in 2008
Pink	Sites discovered in 2009
Yellow	Sites discovered in 2010
Light Blue	Sites discovered in 2011

1. 2. 3. 4. Intervention sites from 2007 to 2011 in four sectors of CCPH.
 BD Ortho - IGN Paris 2006. Data: Être & Boulot / CFEN.
 Production: Florence Thinzilal, September 2011

Impacts on biodiversity

- The species is highly competitive (rapid growth and large size) with respect to most native species in the areas colonised by giant hogweed.

Impacts on human health

- Giant hogweed provokes strong allergic reactions (dermatosis) following direct contact with the skin. This is due to the presence of furanocoumarin in all parts of the plant, a substance that burns the skin.

© CCPH

Interventions

■ Since 2007, in a partnership with the National botanical conservatory in Brest, the Être & Boulot association has worked to manage giant hogweed. The objective is to reduce the size of the flower heads and to limit flowering by slowing regrowth.

■ To that end, two techniques were used, crown cutting and cutting the flower stem. Both methods were used on all the colonised sites and repeated six times on average on each site, from mid-April to mid-September.

■ Manual and mechanical cutting

■ A billhook was used for manual cutting and a rotary cutter on the back of a tractor for mechanical cutting.

■ This technique is the first used on a site to let the plant regrow.

■ Crown cutting

■ The crown of leaves is cut off from the roots at ground level using a spade, in order to weaken the roots and to slow regrowth.

■ This technique is used for maintenance work

■ Fate of the plant waste

■ The plant matter was initially deposited on site to limit regrowth by blocking light.

■ The flower heads were transported to a ditch and covered with quicklime (once per year).

■ Precautions taken

■ During the work, the personnel wore disposable boilersuits, gloves and a respiratory assistance device.

■ After the work:

- the boilersuits were put in garbage bags and thrown away;
- the other equipment (boots, gloves) were rinsed with water.

Results and assessment

■ Results

■ The results include a reduction in the number of plants and in their height, and a weakening of the roots due to the crown cutting combined with systematic cutting of the plants.

■ Giant hogweed disappeared from two sites (no. 19 and 11) following the work in 2010.

■ Many new sites have been sparsely colonised since 2010.



A. Density of plants per square metre per year on sites discovered in 2010.
B. Density of plants per square metre per year on sites discovered in 2008



5. Giant hogweed (*Heracleum mantegazzianum*).
6. Fully equipped personnel.
7. Plant matter left on site.
8. Mechanical cutting using a rotary cutter.

■ Assessment

■ Since 2009, the preferred method has been crown cutting combined with systematic cutting of the plants (manual and mechanical cutting) given its effectiveness in slowing plant growth.

In the beginning, seven techniques were to be used from 2007 to 2009:

tarping, manual and mechanical cutting, chemical treatments, soil removal and replanting, crown cutting and grazing. Tarping and soil removal with replanting were never implemented. The grazing trial was not pursued on the colonised plot (maize was planted by the farmer).

■ Each year, new sites colonised by giant hogweed were found in the CCPH area and beyond.

■ The difficulties encountered included:

- problems organising the work due to the many stakeholders involved (private land owners) and land use (work under way on some sites);
- the lack of a “technical manger” to provide assistance in the event of problems during the work;
- the large (and increasing) number of man-hours required each year.

Man-hours worked each year.

Year	Time spent (hours)
2008	700
2009	960
2010	1 600
2011	2 400
2012	1 810

■ Outlook

■ Pursue the use of the crown cutting technique and develop new techniques such as planting native species to compete with the giant hogweed.

■ Expand the technical assistance for project management provided by the regional environmental directorate and the Basse-Normandie nature conservatory.

■ Information on the project

■ An informational brochure on giant hogweed (*Heracleum mantegazzianum*) was published by the CCPH.

■ A fact sheet on the species and the work done was distributed by the Être & Boulot association to its members and stakeholders, and to visitors to trade shows and other events in which it participates.

■ Articles on the work carried out were published in the local press (Ouest-France and Pays d’Auge newspapers, the annual bulletin of the CCPH and the bulletin of the Basse-Normandie regional council).

Author: Sandra Fernandez, Irstea



9. Site colonised by giant hogweed (*Heracleum mantegazzianum*) in 2009.

10. The same site in 2011 prior to the annual work.

11. The same site in 2011 after the annual work.

For more information

- Être & Boulot internet site: <http://etre-et-boulot.org/>
- Two slide shows on the work done by the Être & Boulot association, 2010, 2011.
- CCPH. 2012. Raw data on the programme against giant hogweed.





Goldenrod

(*Solidago* spp.)

Originated in North America. Introduced in Europe in the 1600s for ornamentation and honey making.

Description

- Perennial, herbaceous plants producing rhizomes
- Tall stalks, from 50 to 150 centimetres high:
 - green with hairs for *S. canadensis*
 - reddish and smooth for *S. gigantea*
- Alternating leaves, sessile or with a short petiole:
 - length 9 to 10 cm, width 10 to 14 mm
 - pure green and pubescent on the under side for *S. canadensis*
 - blue-green and smooth or ciliated for *S. gigantea*
- The inflorescence is a pyramid-shaped panicle:
 - flower heads (capitula) comprising flowers 4 to 8 millimetres in diameter
 - yellow flowers, with a ligule
- Achenes 0.5 to 2 mm long, with a coma (filament-like hairs) 3 to 4 mm long
- Strong root system producing multiple rhizomes

Ecology and reproduction

- Habitats include:
 - the sides of roads and train tracks
 - idle land, riparian vegetation and shaded edges of forests
 - river banks, marshes and wet meadows
- *S. canadensis* is more tolerant of dry conditions and can colonise a wider range of soil types
- Highly effective reproduction through vegetative multiplication (generation of clones by rhizomes)
- The seeds can be spread 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

Classification

Ordre	Astérales
Famille	Asteraceae
Genre	<i>Solidago</i>
Espèce	<i>S. canadensis</i> (Linnaeus, 1753) <i>S. gigantea</i> (Aiton, 1789)



1. Canadian goldenrod (*Solidago canadensis*).
2. Stalk and leaves of *S. canadensis*.
3. Giant goldenrod (*Solidago gigantea*).



Goldenrod

(*Solidago spp.*)

Experiments in managing Canadian goldenrod in the Chenevières meadows

Centre nature conservatory

■ The non-profit association, founded in 1990 and certified as a nature conservatory by the State and the Centre region, has its headquarters in the city of Orléans.

■ The main missions include:

- conducting studies and compiling naturalist inventories to learn more about environments and species;
- protecting natural environments in line with the environmental policies set up by the State and local governments;
- managing sites according to the management plans approved by the scientific council of the conservatory and implemented with in-house personnel or with partners, including farmers, social insertion groups, specialised firms, volunteers, etc.;
- enhancing the managed sites and welcoming the public by offering nature walks, work projects for volunteers, public meetings and other suitable projects (nature trails, informational signs, etc.

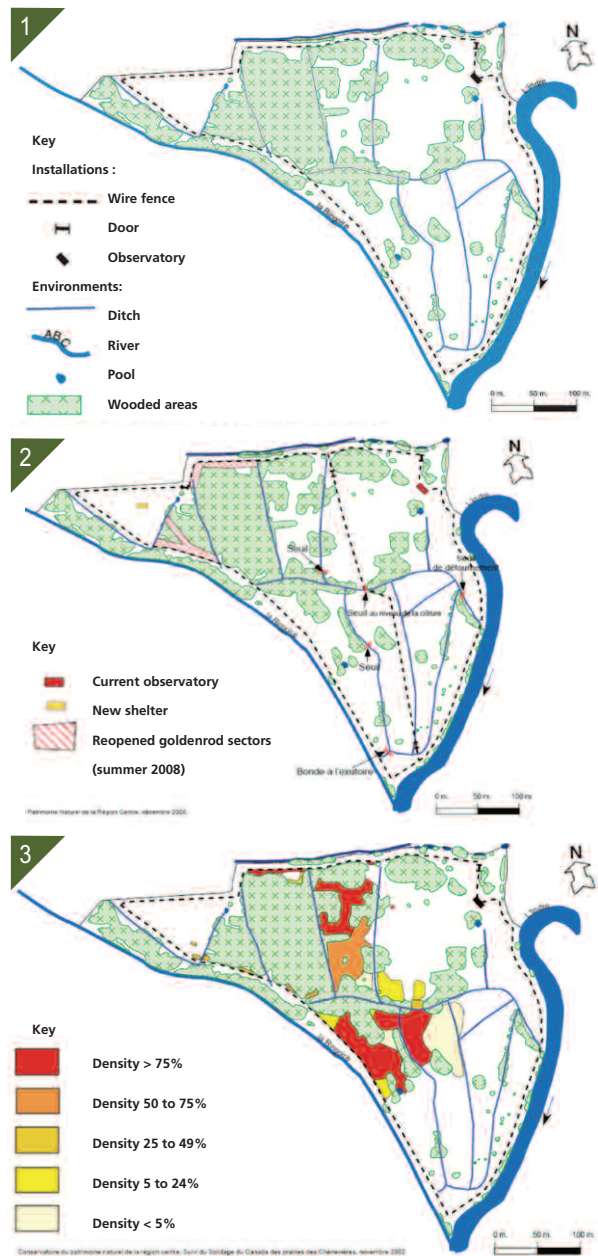
■ Contact: Jean-Baptiste Colombo - antenne18-36@CEN-Centre.org

Intervention site

■ The Centre nature conservatory is an active participant in managing Canadian goldenrod (*Solidago canadensis*) in the Chènevières meadows in the town of Déols (Indre department). Following a management agreement signed with the town, the conservatory now manages the entire site.

■ The Chènevières meadows are influenced by the Indre River and its tributary the Ringoire, which both contribute to flooding the meadows. The impermeable, clay-rich soil retains water on the surface during winter and spring flooding. The Chènevières meadows are a regionally important site and are divided into two parts:

- a fenced wetland (11.3 hectares) that has been grazed since 1993 by Camargue horses. This area comprises a eutrophic marsh (a patchwork of transition areas between wetlands and forests covering 6.5 hectares) spotted with oligo-mesotrophic pools, a stand of willows in swampy terrain (2.6 ha) and calcareous idle land (2.2 ha);
- a peripheral zone open to the public with a walking trail around the fenced area. A series of informational signs present the marsh and its features.



1. Map of the Chènevières meadows.
 2. Positions of the outlet and weirs installed in 2007.
 3. Densities of Canadian goldenrod in the Chènevières meadows in 2002

■ This natural area is part of a network of protected sites including the Montet meadows (50 hectares, also managed by the conservatory) and the Saint-Gildas meadow. It is also part of the Vallée de l'Indre Natura 2000 site.

Disturbances and issues involved

■ unauthorised dump and the strong growth of shrubs. The site was colonised by Canadian goldenrod due to green waste deposited by nearby vegetable gardens. The species was not consumed by the Camargue horses and subsequently developed rapidly to the point of occupying a total of 2 hectares in 2000.

■ *Solidago canadensis* has a very effective means of propagation for rapid and massive colonisation of sites resulting in significant impacts:

- competition with native plant species including a number of emblematic and/or protected species (Carey, reed canary grass, reeds, etc.);
- colonisation of emblematic and/or protected wet natural habitats (sedge wetland, transition areas between wetlands and forests);
- decreased grazing value (low palatability).

■ The conservatory also works to restore the wetlands on the site (swampy meadows and grassy edges) and to preserve the remarkable species (fauna and flora) linked to those habitats.

Interventions

■ Starting in 2003, the conservatory set up an experimental management system for Canadian goldenrod in the framework of the successive management plans (2003 to 2010 and 2010 to 2017) for the Chènevières meadows.

■ The work consists of shredding the plants followed by flooding of the site thanks to the weirs that make it possible to prolong the flooded period.

■ Technical problems rendering access to the site difficult (fragile soil due to heavy rains) made it impossible to use the rotary cutter in 2008 and 2010.

■ Mechanical and manual cutting

■ The work was done in the month of July by the technical department of the town of Déols.

■ The surface areas ranged from 0.98 hectares to 0.35 ha from 2002 to 2012.

■ Mechanical cutting:

- a tractor equipped with a rotary cutter was used in the accessible areas;
- the areas most densely colonised by *Solidago canadensis* were treated;
- the work was done by three technical personnel and a technical assistant.

■ Manual cutting:

- the work was done using brushcutters;
- the areas treated including border and wooded areas, and relatively inaccessible places;
- the work involved 6 to 8 people;
- the cut plants were not removed, but simply decomposed naturally on site in 2 to 3 weeks.

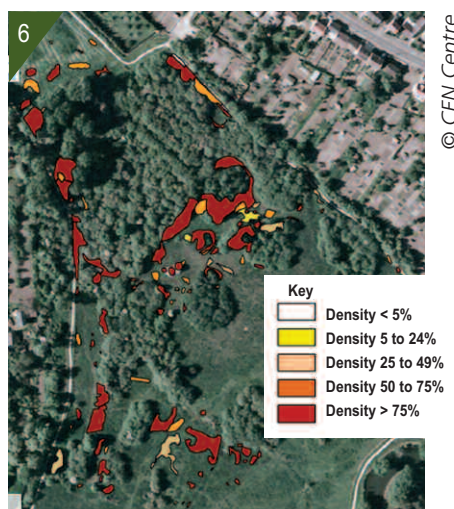
■ Hydraulic restoration of the meadows

■ The work was done in 2007 by a social reintegration association.

■ A manually adjustable drain was installed at the outlet of the ditch system in conjunction with a set of weirs.

■ Annual monitoring of colonisation

■ Since 2002, the conservatory has carried out annual monitoring of Canadian goldenrod on the site. The result was mapping of the species distribution according to five density classes. In parallel, the number of days the site is flooded is estimated using the network to measure discharges established by the regional environmental directorate and an inventory of plants is produced to monitor the appearance of new plant species.



4. Mechanical shredding using a rotary cutter.
5. Mechanical means used to uproot the plants and strip the top layer of soil.

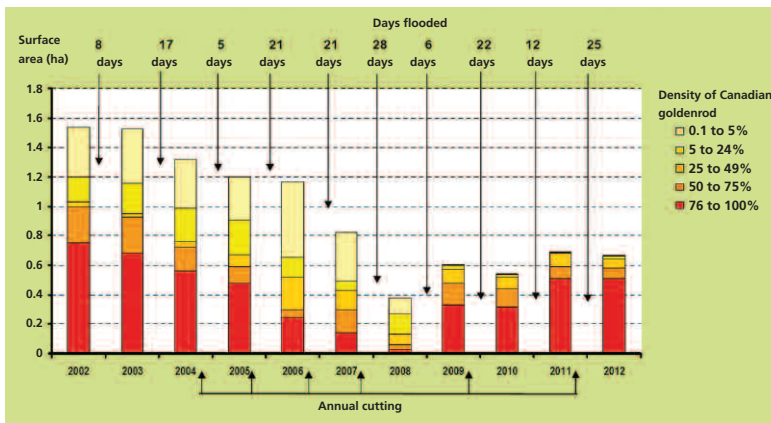
6. Densities of Canadian goldenrod in the Chènevières meadows in 2012.

■ The person conducting the annual monitoring changed in 2009. This change may have somewhat affected the analysis results concerning the spread of Canadian goldenrod, in particular the estimates concerning densities.

Results and assessment

■ Results

- From 2002 to 2012, the colonised surface area was reduced by 55%.
- A number of highly colonised areas (density greater than 76%) persist, in spite of the overall reduction observed from 2002 to 2008. The proportion of these areas rose sharply from 2008 to 2012.
- Colonised surface areas increased markedly the year following a year without any work:
 - an increase of 60% from 2008 to 2009;
 - an increase of 28% from 2010 to 2011.



Surface areas colonised by Canadian goldenrod in the Chênevières meadows from 2002 to 2012. Source: Centre nature conservatory.

Outlook

- Pursue the management work until Canadian goldenrod has been completely eliminated from the site (the 2013 monitoring programme is now being finished).
- Since 2012, management work on Canadian goldenrod has been carried out on another conservatory site, the “Floodable meadows along the Loire River” site in the town of Herry (Cher department), in the framework of a Natura 2000 contract and using the same techniques.

Information on the project

- Documents available on the conservatory site:
 - a page on Canadian goldenrod (*Solidago canadensis*) with a description of the species and the management techniques;
 - an annual report on the activities of the conservatory.
- Informational signs on sensitive natural areas and on the Chênevières meadows are set up at the entry to the site and on the foot path.
- A feedback report on the management work was published in the Management guide for peat bogs and fens in the alluvial valleys of Northern France (Crassous and Karas, 2007).

For more information

- Centre nature conservatory internet site:
<http://www.cen-centre.org/groupe-plantes-invasives/>
<http://www.CEN-Centre.org/groupe-plantes-invasives/>
- Crassous C., Karas F. 2007. Guide de gestion des tourbières et marais alcalins des vallées alluviales de France septentrionale. Fédération des conservatoires d’Espaces Naturels, Pôle-relais tourbières, 203 pp.
- Gressette S. (CEN Centre). 2007. Gestion expérimentale pour l’élimination du Solidage du Canada (*Solidago canadensis*) – Prairies des Chênevières à Déols – Année 2007.
- Chorein A. (CEN Centre). 2009. Gestion expérimentale pour l’élimination du Solidage du Canada (*Solidago canadensis*) – Prairies des Chênevières à Déols – Année 2009.
- Chorein A. (CEN Centre). 2010. Gestion expérimentale pour l’élimination du Solidage du Canada (*Solidago canadensis*) – Prairies des Chênevières à Déols – Année 2010.
- Chorein A. (CEN Centre). 2011. Gestion expérimentale pour l’élimination du Solidage du Canada (*Solidago canadensis*) – Prairies des Chênevières à Déols – Année 2011.
- Chorein A. (CEN Centre). 2013. Gestion expérimentale pour l’élimination du Solidage du Canada (*Solidago canadensis*) – Prairies des Chênevières à Déols – Année 2012.





Water finger grass

(*Paspalum distichum*)

Originated in South America. It first appeared at the end of the 1800s in the Mediterranean region (Montpellier, 1886), then spread to Western France, along the Loire River and most recently to the Bretagne region.

Description

- A perennial grass forming dense groups of plants
- Stems range in length from 20 centimetres to 1 metre:
 - they first run along the ground, then stand upright, are round and hollow, with hairy, bulging internodes
 - they produce numerous stolons that grow rapidly (up to 25 to 35 centimetres per week)
- Long, straight leaves:
 - length 5 to 15 cm, width 0.2 to 0.7 cm
 - membranous ligule, ciliated with white hairs 2 to 3 mm long
- The inflorescence is made up of two, V-shaped stems, from 2 to 7 centimetres in length:
 - each stem has two rows of seeds
 - black stigmates and stamens are clearly visible
 - exclusively on the emergent part of the plant
- Strong root system producing multiple rhizomes

Ecology and reproduction

- The species can develop on different types of wetlands (fresh water to brackish):
 - banks of rivers and ponds/lakes, swards and wet meadows, marshes
 - cropland (rice paddies, irrigated maize fields), along roadsides
- Sexual reproduction and dissemination of the fruit by water
- Vegetative multiplication via fragmented stolons and rhizomes

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

Classification	
Order	Cyperales
Family	Poaceae
Genus	<i>Paspalum</i>
Species	<i>P. distichum</i> (Linnaeus, 1760)





Water finger grass (*Paspalum distichum*)

Managing water finger grass in Mas Lake

Auvergne 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 Riom (Puy-de-Dôme department).
- The objectives of the Auvergne nature conservatory are to protect nature, landscapes and all the components of the natural heritage by preserving species, maintaining ecological balances and protecting natural and semi-natural environments and the biological diversity of the region.
- Work at the conservatory covers all the natural areas in the four departments making up the region, namely mountain forests and peat bogs, the Allier and Loire Rivers, flatland marshes, dry hills with orchids, etc. Over 2 000 hectares spread over 250 sites are managed by the Auvergne conservatory.
- Contact: cen-auvergne@espaces-naturels.fr

Intervention site

- Mas Lake is located on the Val d'Allier-Alagnon Natura 2000 site (FR 830138), in the town of Issoire.
- The site comprises 83 kilometres of river and all the aquatic environments and linked wetlands (side channels, gravel pits, streams).
- Management, implementation and monitoring of the set objectives have been ensured by the Auvergne conservatory since 2007.
- Immediately in 2008, the conservatory produced a characterisation report and maps on the aquatic invasive alien plants found on the Natura 2000 site and in the surrounding areas.
- The management strategy for these species on the site was to:
 - take action as early as possible against newly established species (curly waterweed, water finger grass, large-flowered waterweed and summer lilac);
 - conduct preventive monitoring on side channels not yet colonised;
 - intervene on the invasion front of water primrose at Issoire.
- Water finger grass was discovered in Mas Lake in 2010, the only known site for the species in alluvial areas in the Auvergne region.
- Since the fall of 2011, management experiments have been conducted by the conservatory in view of eliminating the species from the site.



1. Mas Lake, the intervention site.

Disturbances and issues involved

■ Impacts on use of the site

- The site is used for an array of socio-economic purposes (relaxation, summer tourism, commercial fishing) year round.
- Over the short to mid term, widespread colonisation by water finger grass would have a severe negative impact on the landscape and site uses (tourism and fishing).

■ Risk of dispersal via flooding

- Flooding of the Allier River could disseminate the water finger grass. It was there deemed necessary to intervene on the Issoire site to limit the risk of propagation downstream.

Interventions

- The limited distribution of water finger grass in Auvergne meant that time was of the essence in halting its spread. The management techniques employed had to take into account:

- the economic activities on the peri-urban site;
- the high reproductive and dissemination capability of the species, an obstacle to its elimination;
- the presence of native plants, notably sea clubrush (*Bolboschoenus maritimus*), a species close to being threatened in Auvergne;
- the long shoreline to be treated (250 metres);
- management of the plant waste;
- varying hydric conditions.

■ Given the significant recreational activities on the site, it was decided not to mechanically scrape the lower edges of the banks using a backhoe. The work was done in the fall to hinder the fishing activities as little as possible and to limit the visual impact of the work.

However, in light of the objective to totally eliminate the plants, it was necessary to intervene prior to fruition (in June) in order to limit the dispersal of seeds at the end of the summer and in the fall.

■ A method targeting eradication and combining several components was experimented:

- manual uprooting and use of a brushcutter without dispersing the aerial parts of the plants;
- thermal weed control of the plants and rhizomes;
- manual turning of the soil;
- replanting of the area with creeping bentgrass (*Agrostis stolonifera*) and reed canary grass (*Phalaris arundinacea*) to compete with the water finger grass. The first produces large numbers of creeping stolons and the second grows in large, dense groups.

■ The combination of the various techniques was tested in a sector with six different plots, each measuring 4 square metres.

■ Phytosociological studies on the vegetation were conducted using abundance-dominance coefficients. Two studies (September 2011 and August 2012) were run on each of the six plots.

Results and costs

■ Results

■ The water finger grass recolonised all the plots in 2012, but occupied less surface area. This result demonstrated the difficulty of total elimination, even by combining uprooting, turning of the soil and burning of the roots and rhizomes.

■ The planting of reed canary grass was a failure (95% mortality).

■ The clearing of the soil surface is an important factor for the colonisation by pioneer species, which may explain the dominance of water finger grass following the work and the isolated presence of large-flower water primrose in a plot.

■ In light of the above, more extensive manual work was not deemed feasible because it would produce only limited results.

■ Monitoring should, however, be pursued to determine whether the creeping bentgrass can effectively compete with the water finger grass.

■ In addition to the phytosociological studies on the plots, an inventory of the points where water finger grass was present was conducted around the entire lake in order to assess the spread of the species on the site.

■ Between 2010 and 2012, the number of points increased 50%, with an increase in the shoreline of 20% and in surface areas of 30%.



2. A plot prior to the work in September 2011.
3. A plot after the work in August 2012.

Work done on plot 3:

- manual uprooting of plants in the water and use of the brushcutter;
- thermal weed control of all vegetation, over an area 1 to 2 metres wide;
- manual turning of the soil;
- thermal weed control to burn the rhizomes.

■ Technical and financial aspects

- The technical work was done on 27 September 2011.
- Preparatory work was done by the team manager (1 day) and the study manager (1 day).
- The intervention team consisted of 3 conservatory personnel and 2 interns, with oversight by the study manager, for 1 day.
- The equipment included a manual burner (20 cm in diameter), spades, garden forks, hoes and broadforks.
- For replanting, 20 grammes of creeping-bentgrass seeds (supplied by Semences du Puy, 43000 Le Puy-en-Velay) and 80 large sods of reed canary grass (supplied by AquaTerra, 26270 Cliouscat) were used.
- 600 litres of plant waste were removed from the site.
- The waste was burnt in the open air on the conservatory site.
- Monitoring of the flora took 1 day.
- Assessment of the work and awareness raising took 2.5 days.
- The work cost 1 400 euros, the monitoring and assessment cost 1 000 euros.

■ Outlook

- Given the poor results achieved by the thermal weed control, another set of techniques to eliminate water finger grass was proposed.

■ Landfill on colonised points and planting of local species

- This solution will be tested in the spring of 2014 in a partnership with the technical department of Issoire, an active participant in the project.
- The work will take place on a spring day (the low-flow period begins in June), on a plot measuring 5 to 10 square metres:
 - 20 centimetres of sand and gravel (from the gravel pits in the Issoire basin), without any alien plant debris, will be deposited on the bank and at the foot of the bank to cover the water finger grass;
 - 10 centimetres of topsoil will then be deposited on top. In the dry (top) section, ray grass will be sown, in the aquatic and semi-aquatic sections, water mint (*Mentha aquatica*) or flowering rush (*Butomus umbellatus*) will be planted or sown.
- In parallel, suggestions for differentiated management of the banks were put forward:
 - regular mowing outside the vegetative phase to limit the risks of dispersing the aerial parts of the plants;
 - early mowing of fishing spots exclusively on non-colonised sites.

■ Information on the project

- Efforts to raise the awareness of local stakeholders on the site were undertaken to avoid the dispersal of water finger grass to a wider area:
 - anglers were informed via the certified association for fishing and protection of aquatic environments (AAPPMA) and the fishing federation. Further information on water finger grass and water primrose will be published in the AAPPMA bulletin for the members;
 - a meeting on the site between the Auvergne conservatory and the head of the municipal technical department (urban sports and parks) set up differentiated management techniques in order to limit the spread of the species on the site (mowing exclusively on the tops of banks, leaving an unmown strip at least 1-metre wide along the water edge).



4. Reed canary grass.
5. Creeping bentgrass.
6. Phytosociological monitoring.
7. Manual uprooting.

For more information

- Sylvain Pouvaret and Sylvie Martinant, Auvergne nature conservatory
- <http://www.cen-auvergne.fr>
- Auvergne nature conservatory 2013. Managing water finger grass in Mas Lake. Report on experimental work in Issoire. 22 pp.