

Invasive alien species in aquatic environments

Practical information and management insights

Vol. 2 Management insights

Emmanuelle Sarat, Emilie Mazaubert,
Alain Dutartre, Nicolas Poulet
and Yohann Soubeyran (editors)

The French National Agency for Water and Aquatic Environments

Onema is a public agency operating under the supervision of the Ecology ministry. It was created by the 2006 Water law and launched in April 2007. Onema is the principle technical organisation in France in charge of developing knowledge on the ecology of aquatic environments and monitoring water status. Its mission is to contribute to comprehensive and sustainable management of water resources and aquatic ecosystems. The agency contributes to restoring water quality and attaining the goal of good chemical and ecological status, the objective set by the European water framework directive. Onema, with a workforce of 900, is present throughout continental France as well as in the overseas territories in the framework of the national interbasin solidarity policy. In carrying out its mission, Onema works closely with all stakeholders in the water sector.

The French committee of the International union for the conservation of nature

The French committee constitutes the network of French organisations and experts working for the IUCN and serves as a knowledge base and platform for discussion on biodiversity issues. This novel partnership comprises two ministries, 13 public organisations, 41 NGOs and over 250 experts grouped in special commissions and topical work groups. The committee addresses biodiversity issues in France and promotes French research and know-how internationally.

The IBMA work group

This book was drafted by the Biological invasions in aquatic environments (IBMA) work group that Onema and Cemagref (now Irstea) launched jointly in 2009. Its mission is to assist all water stakeholders working on the topic of invasive alien species (IAS) by facilitating access to new knowledge on IASs and developing management tools. Since 2014, the work group has been managed by the IUCN French committee and Onema.

This book continues the *Knowledge for action* series that makes new research findings and science-advice work available to professionals in the water and aquatic-environment sector (scientists, engineers, managers, instructors, students, etc.).

The book is available on the Onema site (www.onema.fr), in the Resources section, on the IBMA site (www.gt-ibma.eu) and at the national portal for "Water technical documents" (www.documentation.eaufrance.fr).

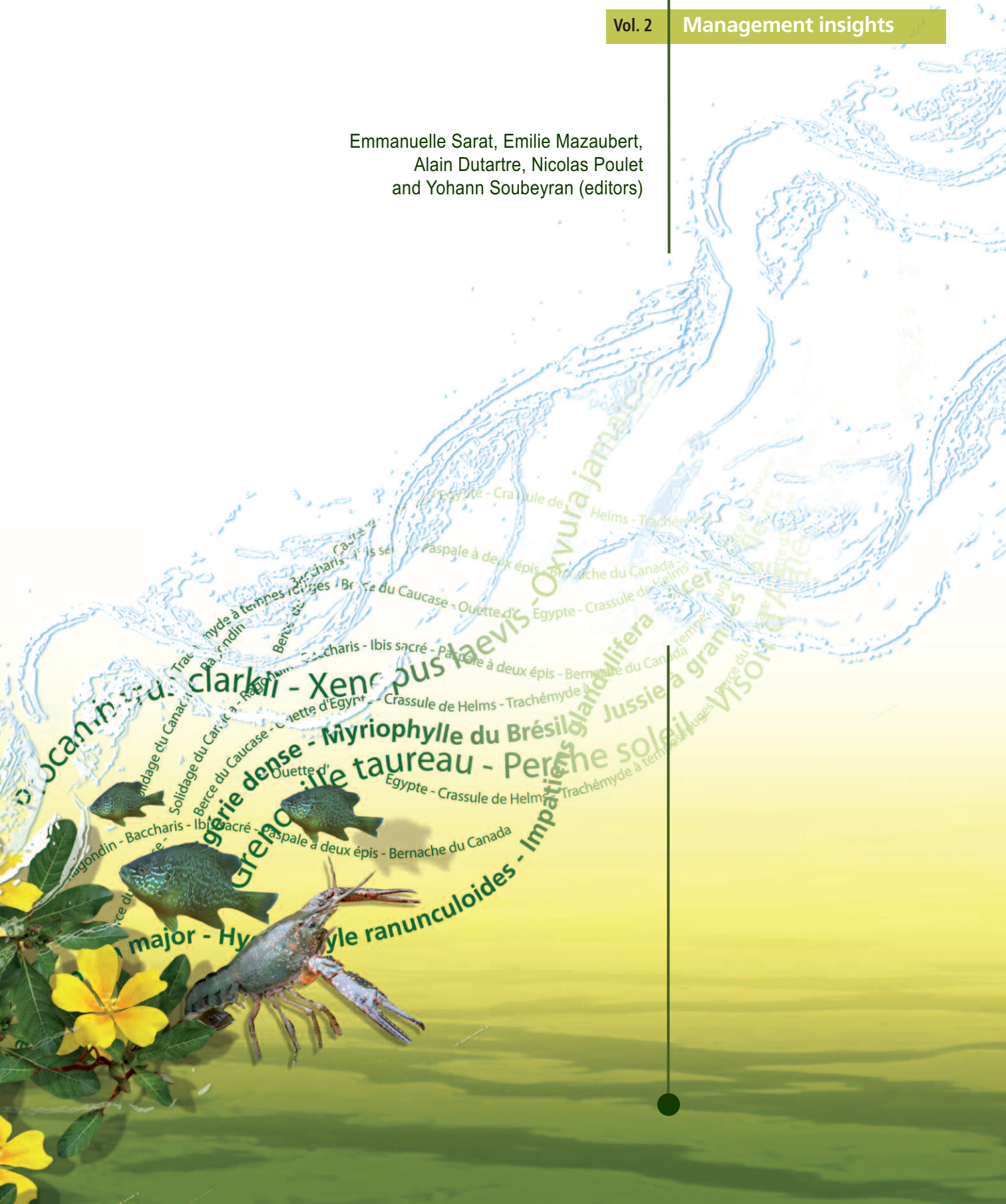


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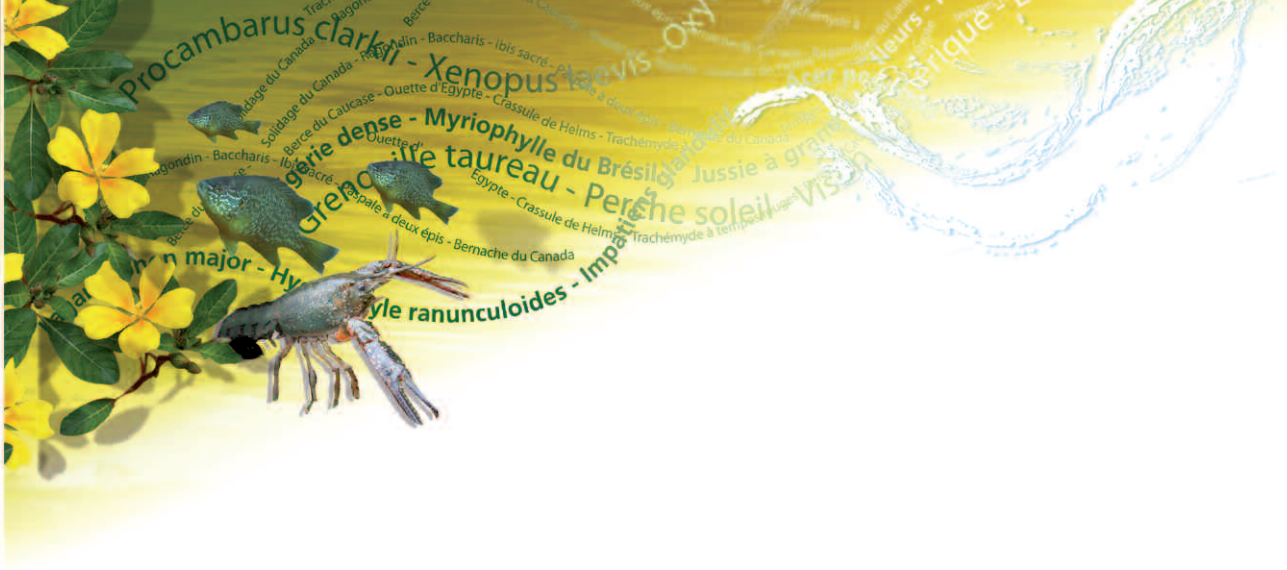




The list of contributors to the second volume of this book in the *Knowledge for action* series includes a total of almost 70 names. The geographic and professional diversity of those people illustrates the necessary collaboration that is progressively coming into being for IAS management.

The list is however simply the tip of the “human iceberg” comprising a much greater number of people already engaged in trading information and ideas on the damage caused by invasive alien species and on how to approach their management. More generally speaking, these stakeholders all contribute to our understanding of our relationship with nature as we progress in assessing the impacts of our activities.

That is why, in addition to the people listed at the end of this volume, we wish to address our sincere thanks to all the other, unnamed stakeholders whose questions, requests, opinions, comments, disagreements and criticism have progressively revealed that iceberg during the many discussions that bring life to our shared field of interest.



Foreword

Invasive alien species (IAS) are acknowledged as one of the main causes of biodiversity loss worldwide. This issue is so important that the Convention on biological diversity decided to include it among its major lines of work and the 2011-2020 strategic plan approved by the convention set a specific objective that the ratifying States, including France, have committed to achieving by 2020. The European Union has made the management of invasive alien species a major objective and a new regulation on preventing and managing their introduction and propagation was recently voted and entered into force in the beginning of 2015.

France as well is confronted with the situation and there are many examples in aquatic environments of both plants (water primrose, knotweed, etc.) and animals (crayfish, coypu, etc.). These species enter into competition with native species, modify the functioning of natural habitats and the services provided by ecosystems, affect economic activities and can even undermine human health. These problems have become one of the major concerns for the managers of natural areas and for policy makers, and the numerous media reports over several years have even begun to evoke regular echoes among the general public.

Over the past 15 years, a growing number of managers in areas spanning highly diverse administrative and geographic scales have entered the fray in an attempt to overcome the difficulties created by invasive alien species. Specific needs rapidly became apparent in terms of coordinating work, organising monitoring, assessing the impacts, establishing research programmes, defining strategies and producing effective results. This led to the creation of local work groups attempting to coordinate the many aspects of the overall problem.

It was in this context that the national Biological invasions in aquatic environments (IBMA) work group was created. Since 2009, the group has brought together over 40 people representing an array of stakeholders (managers of natural areas, researchers, associations, public organisations, State services and local governments) to set up and run various projects. Intended primarily for managers, the objective of the projects is to contribute, to date in continental France, to the development of information networks on all the issues raised by invasive alien species in aquatic environments, notably by making available the knowledge gained on these species. The IBMA internet site is an effective means of disseminating information. Management of the work group, initially assumed by a partnership between Onema and Cemagref (now Irstea), shifted to Onema and the IUCN French committee in January 2014.

The IUCN French committee has two main projects concerning invasive alien species, the first was launched in 2005 in the French overseas territories and the second consists of managing the IBMA work group with Onema. The committee also acts as a liaison with the IUCN on the international level and is in close contact with its Invasive species specialist group (ISSG) that provides data to assist in formulating the major international agreements.

Work at Onema on invasive alien species takes place on two levels, the first being financial and technical support for research projects to develop operational knowledge for IAS management. An example is the programme for the Louisiana crayfish in a partnership with INRA, CNRS and the Brière regional nature park, which resulted in the first national symposium on invasive crayfish and in publications presenting background information. On the second level, Onema provides its know-how to State services and to the Ecology ministry on issues concerning regulations and the management of invasive alien species, examples being Wels catfish, Asian carp and crayfish.

The objective of these two volumes in the *Knowledge for action* series, based on the work of the IBMA work group in conjunction with almost 100 contributors, is to contribute to the debates on how to manage IASs, to provide a general outline on current knowledge (volume 1) and a number of specific examples (volume 2) to assist managers of aquatic environments and policy makers in their respective tasks to better manage these species.

We hope that these volumes will be of use to the full range of stakeholders dealing with IASs, including managers of natural areas, the coordinators of territorial groups and policy makers. We further hope that they will contribute to raising awareness of the issues involved in managing invasive alien species in aquatic environments in France.

Sébastien Moncorps
Director of the IUCN French committee

Philippe Dupont
Research and development department, Onema

Brief outline

Invasive alien species (IAS) and their impacts represent a growing concern for the managers of natural areas. That is particularly true for aquatic environments where an array of stakeholders are now taking action. In parallel, public policies are coming into play on the national level and the European Union recently adopted a new regulation in this field.

What is the status of current knowledge on biological invasions? What is the applicable legal framework and what recommendations should be made?

In the field, which species are managers attempting to address? Which techniques are used, where and how, and what are the objectives and the results achieved?

These two volumes of the *Knowledge for action* series clearly present the situation and propose a scientifically based approach to assist environmental managers in setting up management projects. Though no “cure alls” currently exist, this volume offers highly useful information while attempting to address the specific aspects of each situation, including the site, the species to be managed and the necessary technical and financial resources.

Vol. 1 Practical information

The first volume presents the current situation concerning invasive alien species in aquatic environments in continental France.

Six chapters provide a detailed outline on:

- current scientific knowledge on IASs, including definitions, colonisation processes, impacts and topics for future research;
- current legislation and regulations addressing IASs on the international, European and national levels;
- IAS strategies and action plans, including the main participants and existing projects;
- the general approach to IAS management, i.e. prerequisite knowledge, prevention, monitoring and action taken;
- IAS management, including a presentation on the overall situation for interventions, a panorama of existing techniques, the management of waste and assessments of management work;
- the existing tools available to managers, e.g. coordination of projects, lists of species, databases, platforms for information exchange and collections of feedback from management projects.

Vol. 2 Management insights

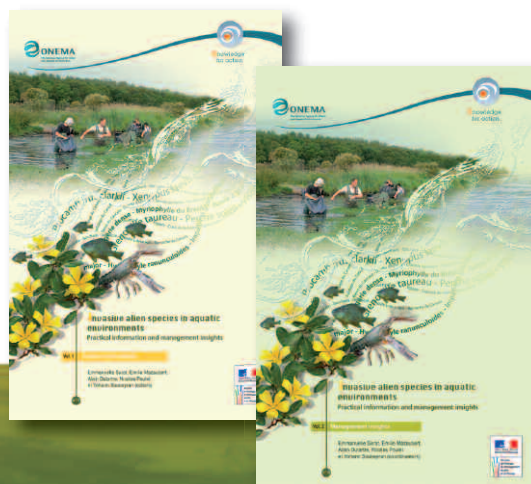
The second volume is a collection of fact sheets on invasive alien species and management projects carried out in continental France and Europe.

A total of 26 fauna and flora species are covered in 52 examples presenting management projects, drafted in conjunction with the managers.


Each sheet includes descriptive information on species identification, biology and ecology.

The project-feedback information comprises:

- the organisation managing the project;
- a description of the project site with maps;
- the problems on the site and the issues at hand;
- the intervention techniques, e.g. the selected method, each operational step, schedules, technical constraints;
- project results and budget;
- the outlook following the project;
- efforts to promote the project and its results;
- available documentation and the contact person for more information.



Invasive alien species in aquatic environments Practical information and management insights

Volume 2	Management insights
	<p>8 Introduction</p> <p>Plant species</p>
	<p>14 Hydrophytes</p> <p>38 Amphibious plants</p> <p>74 Riparian plants</p> <p>Animal species</p>
	<p>128 Invertebrates</p> <p>148 Fish</p> <p>152 Amphibians</p> <p>170 Reptiles</p> <p>182 Birds</p> <p>210 Mammals</p>
	<p>236 Acknowledgements and contributions</p>



I ntroduction

The overall objective of these two volumes is to provide managers with a source of information that can help them in improving their management techniques for invasive alien species in their area. The animal species are handled in a manner identical to that for the plant species, which is rarely the case in the documents available to date.

The first volume presents the current situation concerning invasive alien species in aquatic environments in continental France. This second volume presents an illustrated panorama of management projects for invasive alien species (IAS) in aquatic environments, discusses issues and outlines processes for management work, for and by managers taking into account the specifics of each situation (including the site itself, the alien species and the human issues involved).

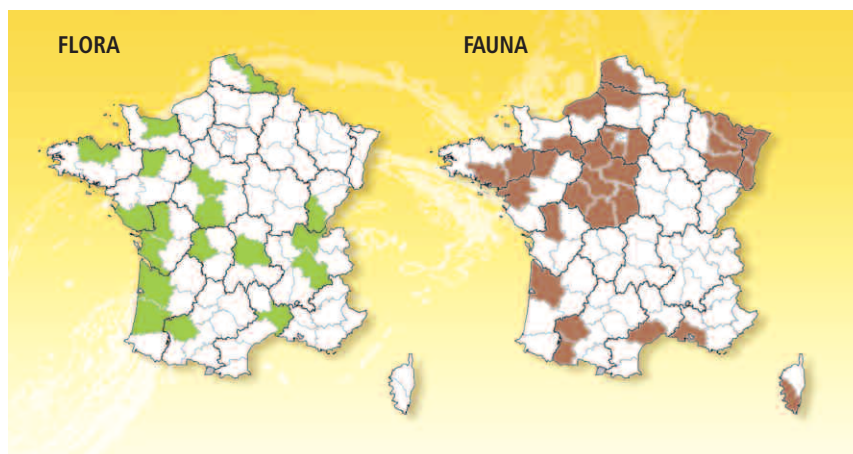
This unique collection of management insights is the product of a collaborative approach that mobilised over 60 managers of natural areas both in France and in neighbouring countries. A total of 26 different species and 52 management projects are presented (see Table 1 and Figure 1). Several examples of management for a given species may be presented if the types of sites and approaches differ significantly.

The objective was to collect a fairly wide set of management projects, the purpose being not to suggest “one size fits all” solutions, but rather to assist managers in understanding their particular problem and in identifying the methods and techniques best suited to the local management needs.

Table 1 Breakdown of the management projects presented in this volume.

	Flora	Fauna
Number of species	13	13
Number of management projects	27	25
Countries involved	6	6
French departments involved	24	44
Organisations involved	30	28
Contributing managers	30	33

Figure 1



French departments involved in the management projects.

Organisation of the presented management projects

Managers are confronted with the disturbances caused by particular species in their areas and generally adopt an approach focussing on the species rather than on the type of environment. The detailed management projects presented in the following pages adopt the same approach.

For example, the management projects concerning plant species are grouped according to the following types of plants (see Box 1 on the next page):

- hydrophytes;
- amphibious plants;
- riparian plants.

Similarly, the management projects concerning animal species are grouped according to the following types of animals:

- invertebrates;
- fish;
- amphibians;
- reptiles;
- birds;
- mammals.

In addition, a brief, illustrated “species fact sheet” precedes the management examples for the species in question and provides a succinct presentation comprising:

- species taxonomy;
- a description (morphology, distinctive characteristics, etc.);
- species biology and ecology (types of habitat, living and reproductive conditions, etc.);
- sources of information.

To the degree possible and depending on the effectively available information, each management example is structured similarly, in a number of sections:

- a brief description of the management organisation with contact information;
- geographic location and description of the area concerned by the management project;
- detailed information on each intervention:
 - initial causes (disturbances and issues related to the presence of the species),
 - practical details and results (methods employed, costs, results of interventions, e.g. quantities removed, use of waste, etc.),
 - general assessment of the project and outlook,
 - promotion of the project (articles, etc.);
- sources of information, links, other contacts.

Plant species growing in or near water

The plant species discussed in the management projects are divided among the main types of plants growing in or near water (Fare et al., 2001, see Figure 2).

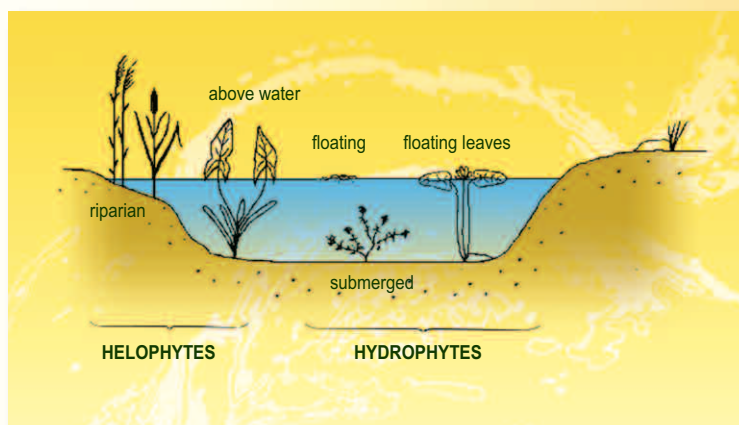
Hydrophytes

“Plant whose entire vegetative structure is located in a water body or on its surface. A hydrophyte may float on the surface and, in the fall, release buds (hibernacles) that spend the winter lying on the bottom of the water body. A hydrophyte may also have roots in the soil beneath the water body. Generally speaking, the reproductive organs of hydrophytes spend the winter below the water surface.” Hydrophytes necessarily grow in an aquatic environment and their entire vegetative structure develops in water.

Helophytes

“Plant whose vegetative and reproductive components rise into the air, but whose roots lie in water-permeated soil. During the winter, helophytes consist solely of their stalk rooted in the soil.”

Figure 2



Different types of helophytes and hydrophytes (according to Moreau and Dutartre, 2000, modified by Mazaubert, 2013).

Amphibious plants

“Plant capable of living both on land and in water.” These plants can withstand major variations in water levels.

Riparian plants

The invasive alien species listed in the various nomenclatures include species that are not strictly aquatic. That is why another category was created to include species that are not absolutely dependent on a body of water, i.e. riparian plants that may be defined as species that are not strictly aquatic, but live near water.

Data pooling and collaboration with other initiatives

The feedback from the management projects was shared with other recent initiatives, documents and projects having similar objectives. That was particularly the case for the document on invasive alien vertebrate species (not including fish) in the Loire basin, produced by the National agency for hunting and wildlife (Sarat (ed.), 2012, see Figure 3b), that comprises 16 management reports, some of which are included here.

(http://www.oncfs.gouv.fr/IMG/file/dir_CIDF/vertébres_exotiques_Loire.pdf)

Information was also exchanged with the Federation of conservatories for natural areas (FCEN) which also intends to publish a collection of IAS-management reports.

Other management examples were drawn from Chapter 5 of the Managing invasive alien plants and coordinating the work document published in the framework of the Water, land and species project for the Loire Grandeur Nature plan (Hudin (ed.), 2013, see Figure 3a), notably concerning knotweed, water primrose and efforts to create a coordination network.

(http://www.plan-loire.fr/fileadmin/pce/PF_EauEspaceEspèces/RecueilV2/Receuil_BD_complet.pdf)

The species fact sheets were designed simply as a complement to existing fact sheets because many sources of information on plant and animal species already exist. For that reason, the fact sheets presented here are particularly succinct and propose, wherever possible, references to fact sheets that have already been validated by experts, for example those in the identification guide published by the Loire-Bretagne work group (Hudin and Vahrameev, 2010) or those drafted by the Federation of national botanical conservatories (FCBN) for plants and, for animals, those contained in the document on invasive alien vertebrate species in the Loire basin (the above documents are available on line at the Loire Nature resource centre:

(http://centrederesources-loirenature.com/home.php?num_niv_1=1&num_niv_2=4&num_niv_3=11&num_niv_4=58).

Figure 3



Information was shared with documents on management projects carried out in the Loire basin.

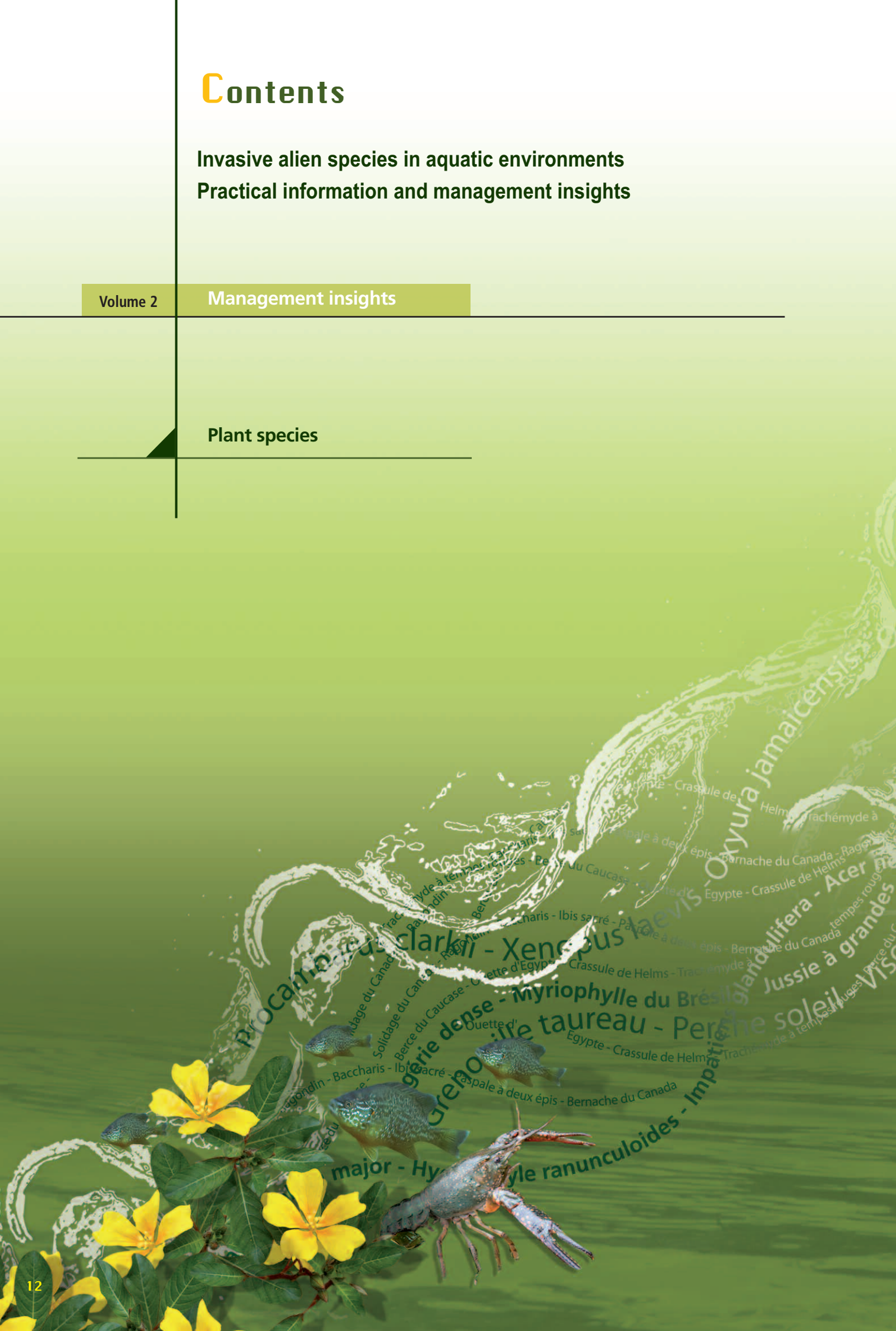
Contents

Invasive alien species in aquatic environments
Practical information and management insights

Volume 2

Management insights

Plant species



Hydrophytes

- 14 ■ **Large-flowered waterweed**
- Species fact sheet
 - Managing large-flowered waterweed in the Marans La Rochelle canal
 - Management and scientific monitoring of large-flowered waterweed in the Vendée River
- 22 ■ **Curly waterweed**
- Species fact sheet
 - Managing curly waterweed in the Blanc Pond
 - Managing curly waterweed in Lough Corrib, Ireland

Amphibious plants

- 30 ■ **Water pennywort**
- Species fact sheet
 - Management of water pennywort by the Union of sanitation boards in the Nord department
 - Managing water pennywort in the Bourret basin
- 38 ■ **Parrot-feather watermilfoil**
- Species fact sheet
 - Managing parrot-feather watermilfoil and water primrose in the Jaunay and Gué-Gorand marshes
 - Managing parrot-feather watermilfoil in the Chicheboville-Bellengreville fens
- 46 ■ **New Zealand pigmyweed**
- Species fact sheet
 - Managing colonisation of a pond by New Zealand pigmyweed
 - Managing New Zealand pigmyweed in the Netherlands
- 54 ■ **Water primrose**
- Species fact sheet
 - Experiments in managing water primrose in meadows of the Barthes de l'Adour area (part 1)
 - Experiments in managing water primrose in meadows of the Barthes de l'Adour area (part 2)
 - Managing water primrose using mechanical uprooting and sediment dredging
 - Managing water primrose in the Vistre basin
 - Managing colonisation and proliferation of water primrose in the Marais Poitevin marshes

Riparian plants

- 74 ■ **Box elder**
- Species fact sheet
 - Project to eliminate box elder by the Biogeco joint research unit
- 80 ■ **Asian knotweed**
- Species fact sheet
 - Experiments in mechanical removal of invasive alien knotweed in France, Switzerland and Germany
 - Managing Japanese knotweed in the Gardons basin
 - Managing Bohemian knotweed in the Garaye River
 - Experiments in using grazing to manage Japanese knotweed in the Mayenne department
- 98 ■ **Groundsel bush**
- Species fact sheet
 - Managing groundsel bushes at the Pirailan reservoirs
 - Managing groundsel bushes in the Arès - Lège-Cap-Ferret National salt-meadow nature reserve
 - Managing groundsel bushes in the Spanish Basque country
- 110 ■ **Garden balsam**
- Species fact sheet
 - Managing Himalayan balsam in the Graine basin
- 114 ■ **Giant hogweed**
- Species fact sheet
 - Managing giant hogweed in the Pays d'Honfleur intermunicipal association
- 118 ■ **Goldenrod**
- Species fact sheet
 - Experiments in managing Canadian goldenrod in the Chenevières meadows
- 122 ■ **Water finger grass**
- Species fact sheet
 - Managing water finger grass in Mas Lake



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

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

Author: Emilie Mazaubert, Irstea

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.
- Unightly.
- 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

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mental council
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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
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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

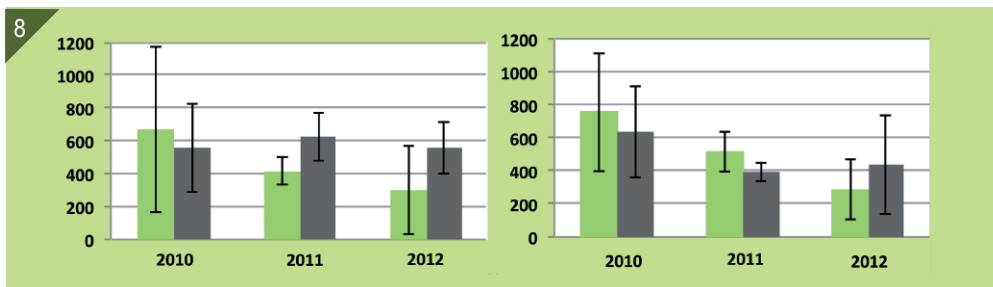
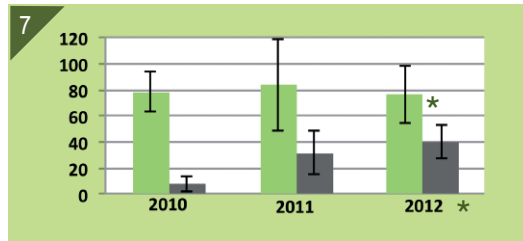
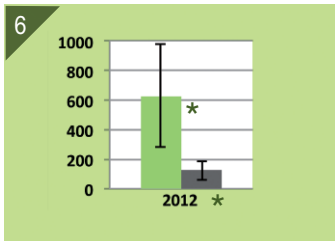
- In 2012, a total of 1 200 cubic metres of *Egeria densa* (fresh plants) were removed over a river section 3.5 km long.

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
- Technical specifications for the work to harvest and transport *Egeria densa*, 2012.
- 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 ».
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- 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

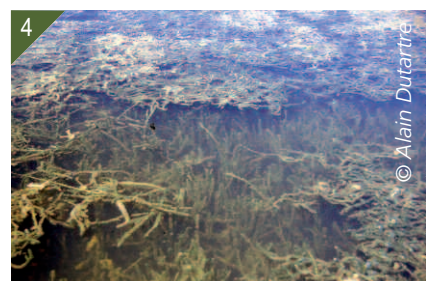
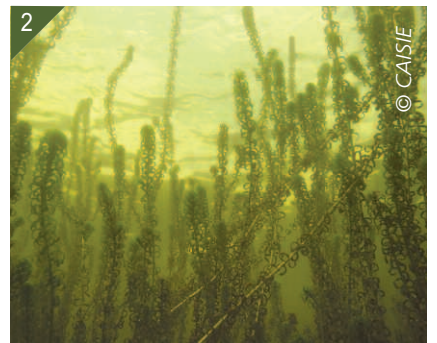
Documentation

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

Author: Emmanuelle Sarat, IUCN French committee

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.

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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.

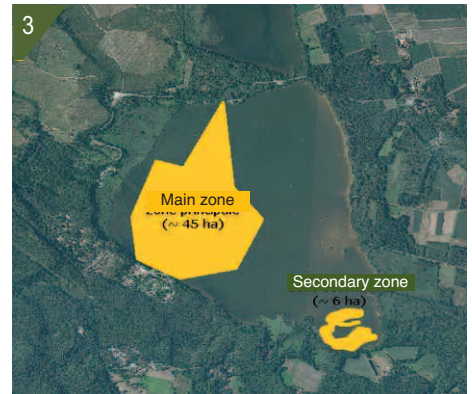
In 2012 and 2013, prior to the work, echo-sounding systems were used by the CARMA research unit from Irstea along transects to detect the most infested sectors in the important areas in order to set up the harvesting plan.

■ 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)

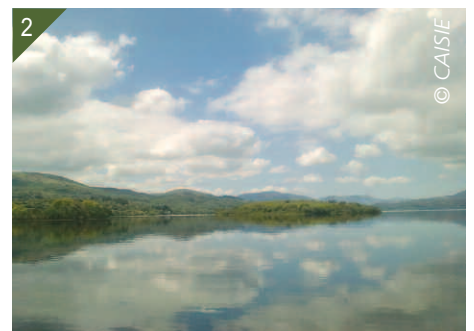
IFI is the public agency in charge of protecting, managing and conserving Irish inland fisheries and ocean fish stocks. The agency was created in 2010 and manages 74 000 kilometres of river and 120 000 hectares of lakes and ponds in Ireland.

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.

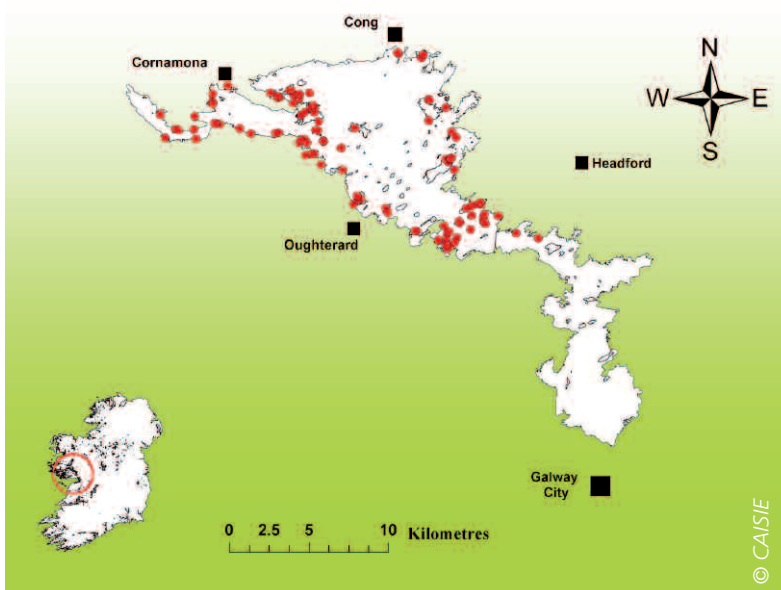
Curly waterweed colonised the sites very rapidly, creating a thick blanket on the water surface that blocked the light and hindered the development and even the continued existence of native macrophytes. This had an effect on the structure of the macroinvertebrate community and on the salmonid population.

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.

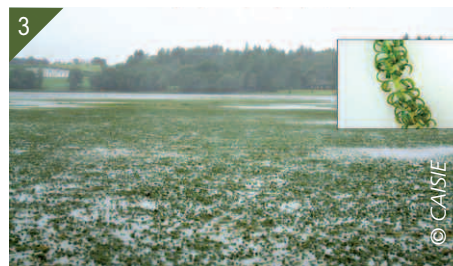
■ Mechanised operations (cutting and harvesting) were carried out on 98 hectares. The harvested plants were dried and composted on site. Manual uprooting was done in very small areas (a total of 0.5 hectare) and made it possible to selectively manage *L. major* in sections where its density was low. 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.
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- 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

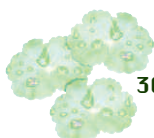
- Dortel F., Lacroix P., Magnanon S. 2011. Plan de lutte contre l'Hydrocotyle fausse-renoncule (*Hydrocotyle ranunculoides* L.f.) en région Pays de la Loire, 85 pp.
- Fried G. 2012. Guide des plantes invasives. Belin, Paris, 272 pp.
- Fried G., Hussner A., Newman J., Schrader G., Triest L., Van Valkenburg 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

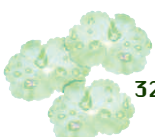
- The project was a success thanks to the constant monitoring of the river section following the work in 2006. The section was inspected every 2 months up to 2009 and then every 4 to 6 months until 2011.
- No new colonisation by water pennywort had been noted as of the last inspection in 2011.
- Burial 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

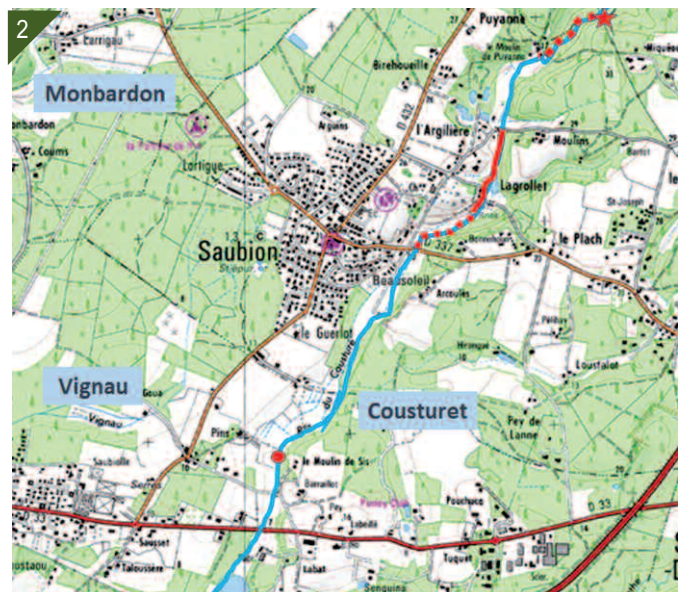
■ The river board worked on the Cousturet stream, a part of the Bourret basin colonised by water pennywort. The Cousturet is 7 kilometres long and flows through the towns of Tosse, Saubion and Angresse. Water pennywort was also present in 2 ponds near the stream, on the site called Lagrollet in the town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

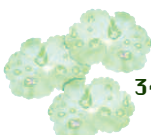


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1. 2. Intervention sites.

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

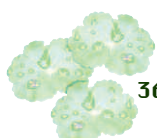
- The number of man-days required was high, but necessary given the quantities harvested and the need to contain the species and avoid its propagation to the entire hydrographic network.

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:

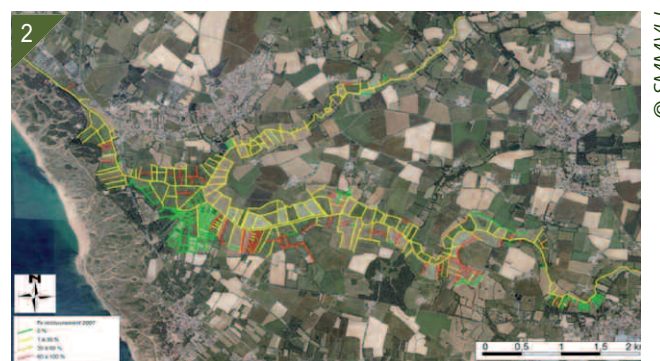
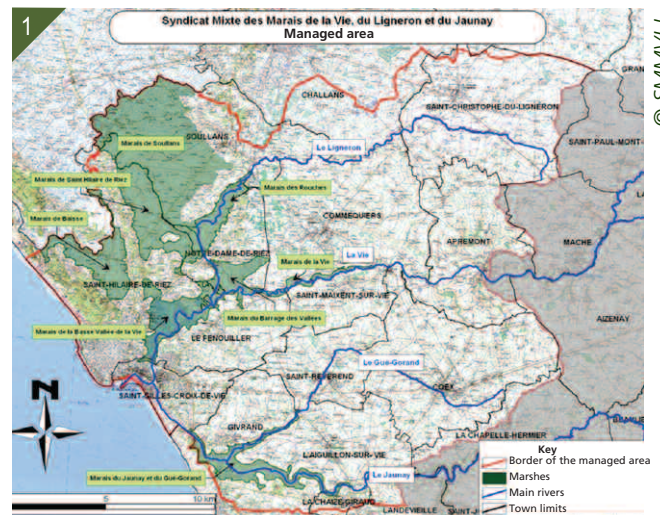
Pierre Travert - p.travert.smmvlj@orange.fr.

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

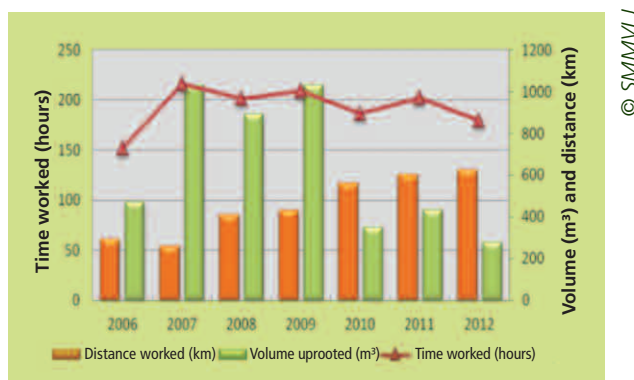
■ Results for 2012

	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

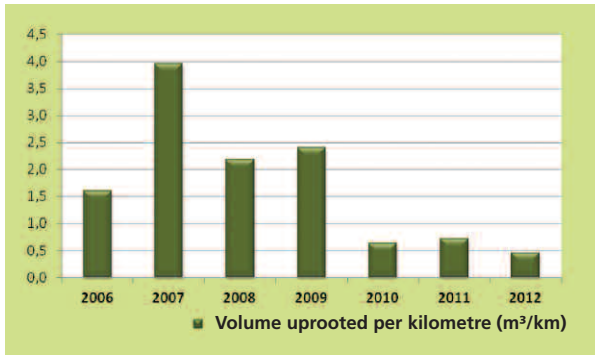
- Certain ditches remained highly colonised (over 60% of the surface covered) due to the high initial level of colonisation (100% coverage), the shallow water and trampling by livestock which facilitates propagation of the plants.
- Comparison between 2011 and 2012:
 - larger area worked in 2012 than 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*)

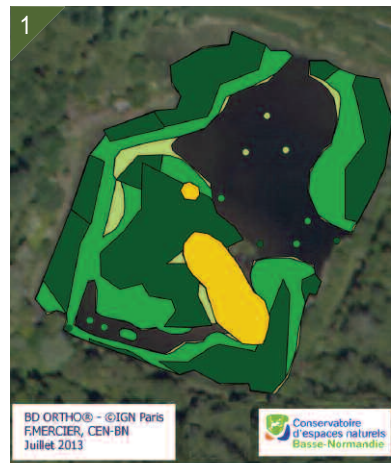
Managing parrot-feather watermilfoil in the Chicheboville-Bellengreville fens

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,



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 bannière imprimée dans 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 de REVEL

Enseignements :
 - Financement innovateur à mobiliser.
 - Suivi fin du chantier nécessaire.
 - Matériau du matériel réutilisé.
 - Création d'un espace pour le stockage des plants récoltés.
 - Choix des sites pour la mise en dépôt des plants.

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

Author: France Mercier, CEN-BN



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-averées/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

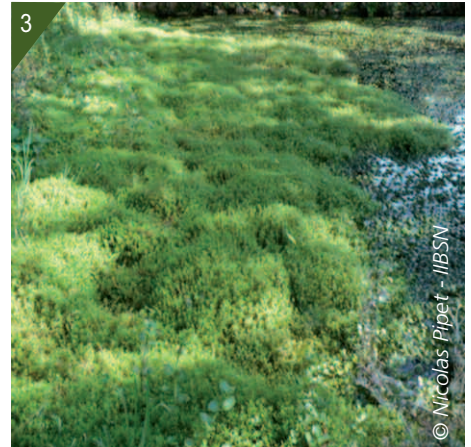
■ Manual work was preferred for very small beds and to collect stalk fragments.

■ 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.	April	May	Aug.	July	April	May	Aug.	July	Sept.	April	May	Aug.	July	Sept.
2011	2012	2012	2012	2013	2012	2012	2012	2013	2013	2012	2012	2012	2013	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.

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 IIBSN, 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



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

For more information

- IIBSN 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. IIBSN, 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

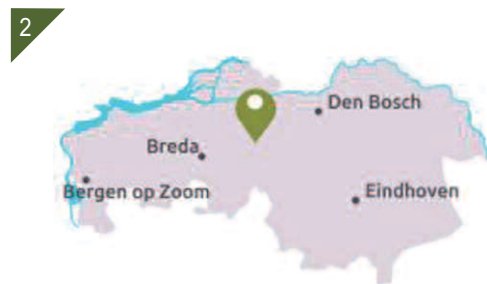
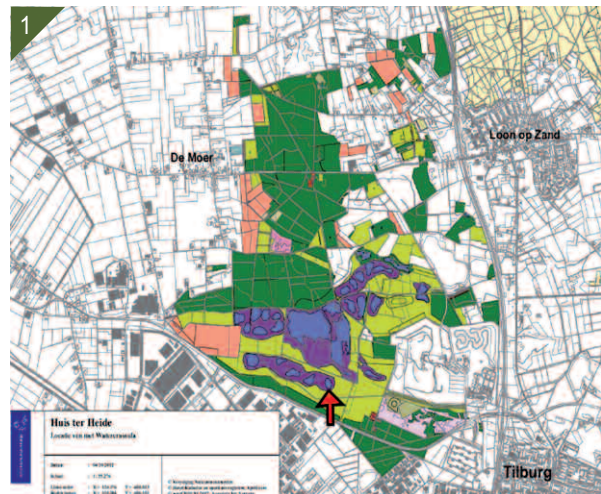
- The European RINSE project (Reducing the impacts of non-native species in Europe) attempts to determine the best management strategies for IASs in the Two seas region (along the English Channel and the southern section of the North Sea).
- The objective of the project is to develop cross-border instruments 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

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■ RINSE 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)



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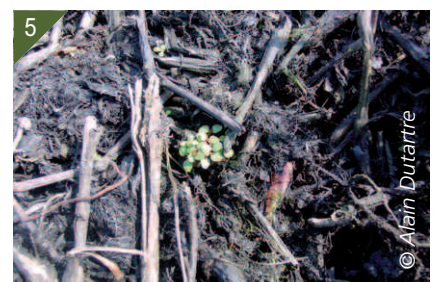
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1. Creeping water primrose (*Ludwigia peploides*).
2. Large-flower water primrose (*Ludwigia grandiflora*).
3. The pond colonised by water primrose in the Var department.
4. Root system.
5. Sprouting water primrose.



Water primrose

(*Ludwigia* spp.)

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

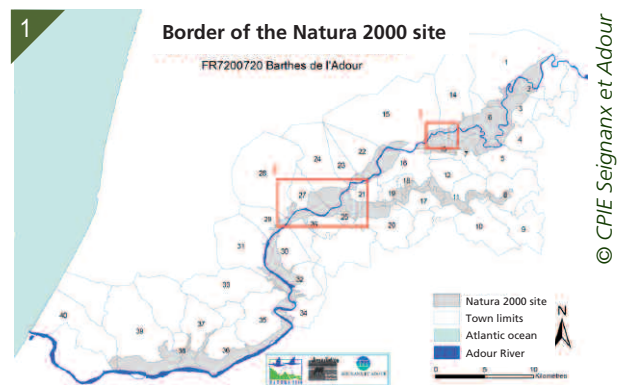
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Seignanx and Adour centre for environmental initiatives (CPIE)

- 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 Castetbieilh (town of Tercis-les-Bains);
- amphibious environments in riparian zones along the edges of the Barthe de Castetbieilh 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

2 / 2

Seignanx and Adour centre for environmental initiatives (CPIE)

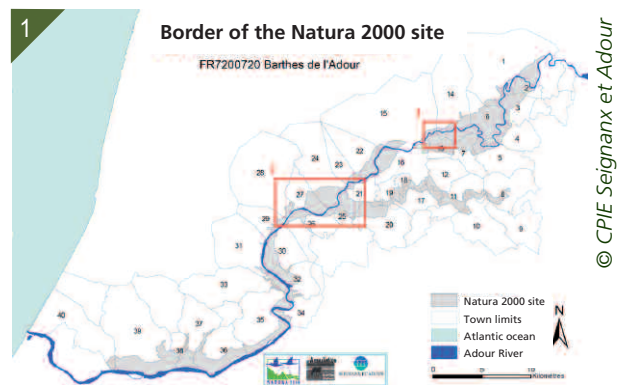
- The non-profit association *Nature et Loisirs* was created in 1990 by the local governments in the Seignanx area and was certified as a CPIE in 1999.
- The centre has set up a management-coordination project for water primrose:
 - assistance in project management for towns owning wetlands (*barthes*);
 - 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 buffaloes 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)

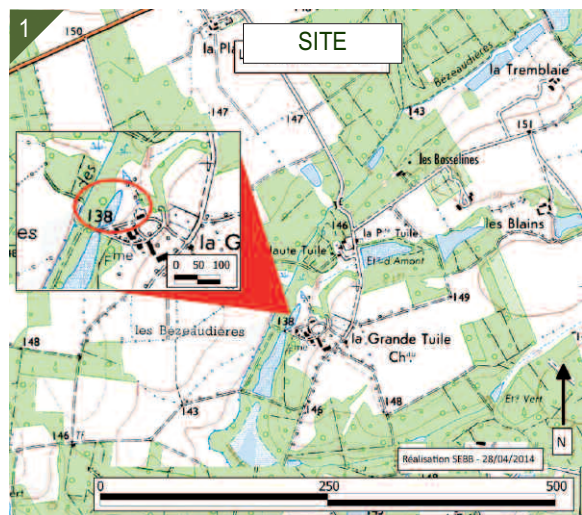
- The SEBB is a local government created in 1996.
- Its main missions are to manage the rivers in the Beuvron basin, including restoration and maintenance of the rivers, and to conduct the necessary studies on management of the rivers and of invasive alien species (both plant and animal).
- Workforce 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)

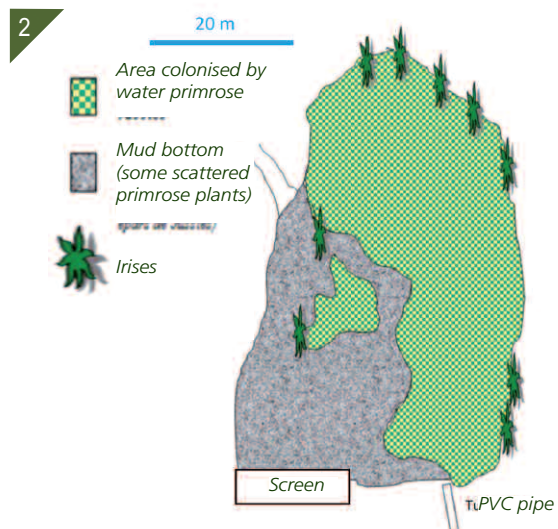
- A non-profit association certified for environmental protection, based in the city of Blois, grouping 40 certified associations for fishing and protection of aquatic environments (AAPPMA) and the certified departmental association of recreational fishermen using nets and traps, representing a total 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.*)

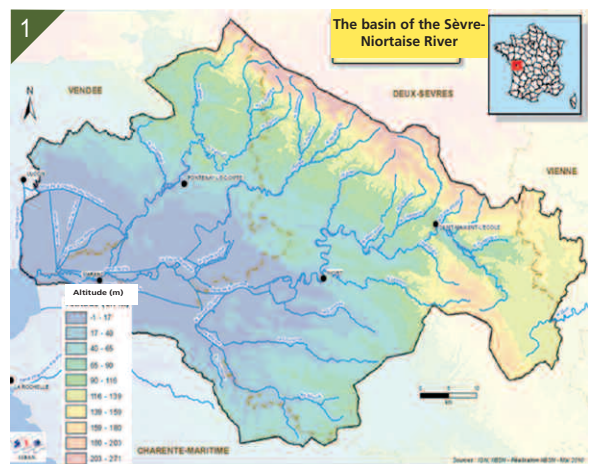
Managing colonisation and proliferation of water primrose in the Marais Poitevin marshes

Sèvre-Niortaise basin interdepartmental institution (IIBSN)

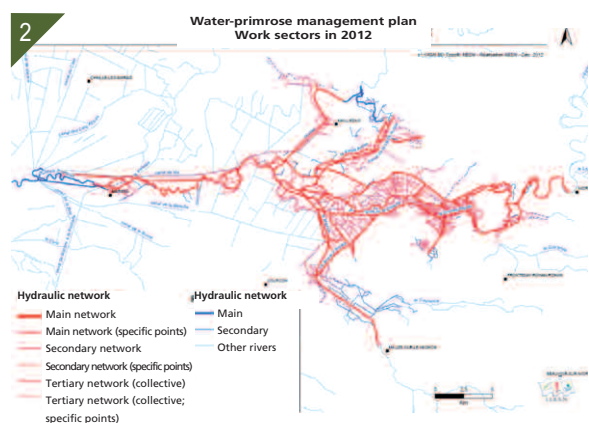
- Public agency set up by the Charente Maritime, Deux-Sèvres and Vendée departmental councils in 1987.
- The main missions include:
 - restoring and maintaining the main channels in the Marais Poitevin marshes in a partnership with the State and the marsh boards;
 - modifying the hydraulic installations 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.

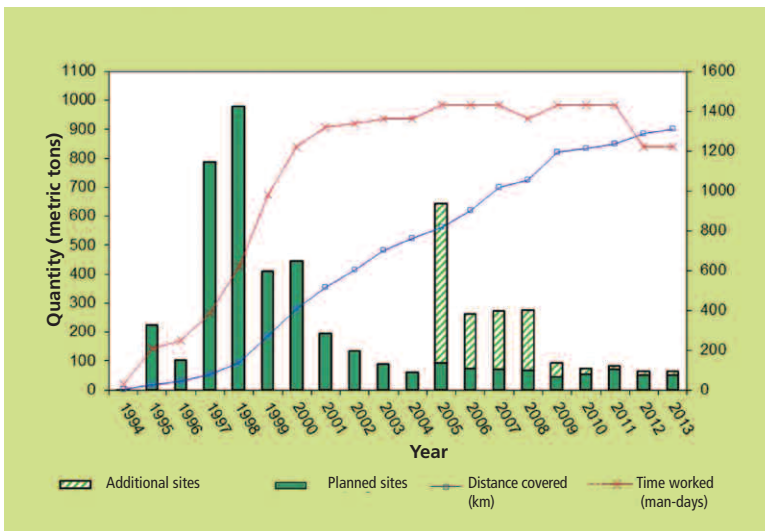
Results and assessment

■ 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)

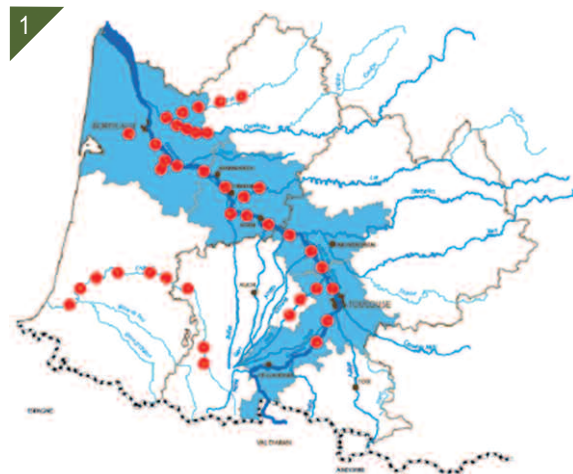
- The joint research unit comprises three teams from the Ecology of forests, prairies and aquatic environments department at INRA and a team from the University of Bordeaux 1.
- The research focusses on analysis of the mechanisms governing the evolution of diversity on different hierarchical levels (communities, 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

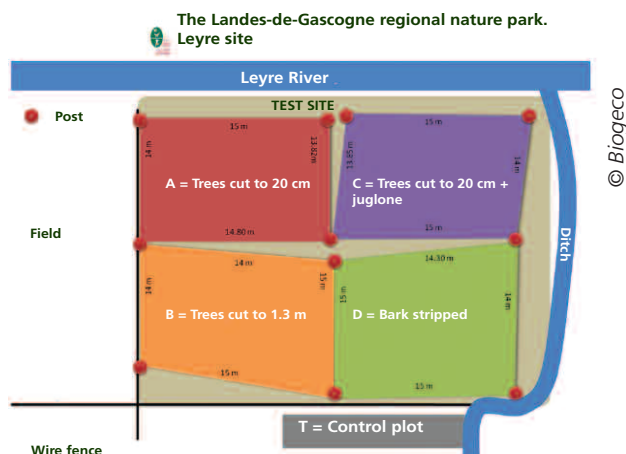
- Box elder can impact alluvial communities in different ways:
 - possible modification of the structure and composition of fauna and flora;
 - superficial root system that does not stabilise river banks.
- The study on the potential methods for box-elder management was launched at the request of the 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

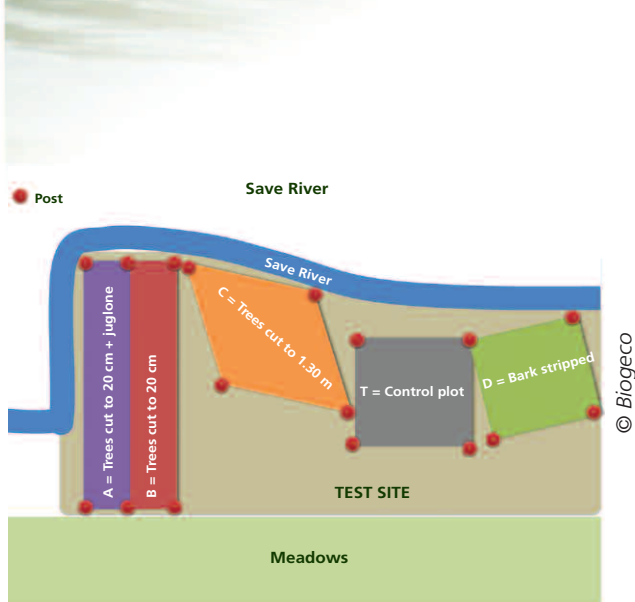
- Selection of different treatments following a review of the literature:
 - treatment C, where all the trees are cut using a chainsaw to a height of 10 to 20 centimetres above ground level. This is the standard treatment used by river technicians and served as the reference for the others;
 - treatment 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).



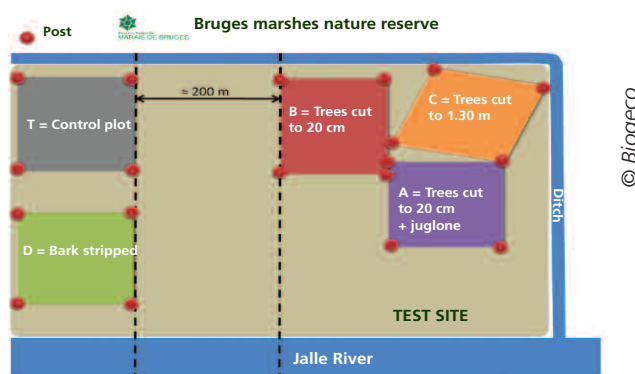
3. Box elder.



Plots on the Leyre site.



Plots on the Marestaing site.



Plots on the Bruges site.



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

Results and assessment

■ Results

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

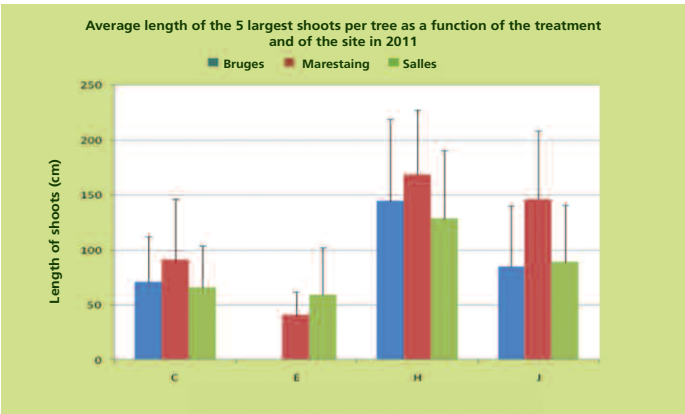
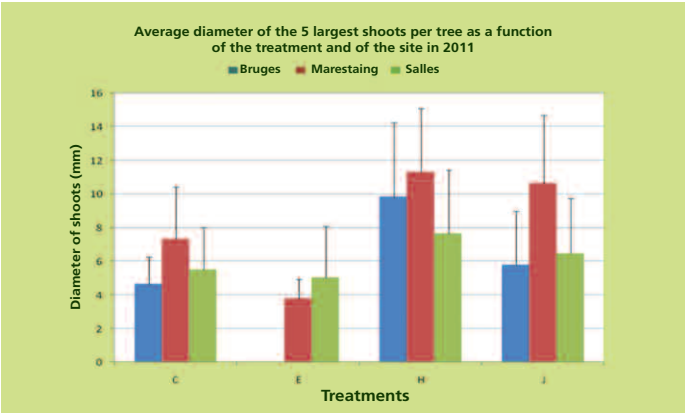
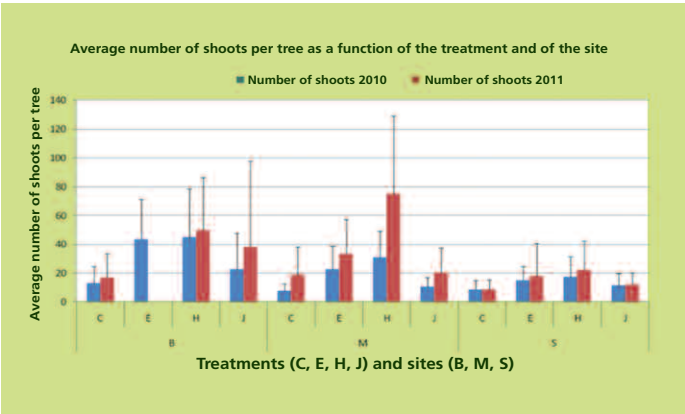
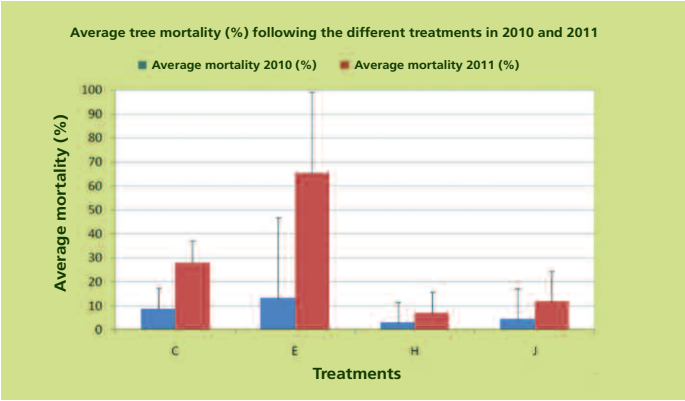
- mortality
- total number of new shoots;
- diameter and length of the five largest new shoots.

■ 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.



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)



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

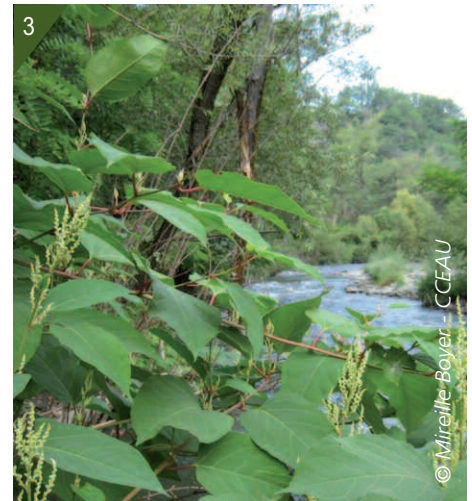
- Reduced yields and/or available land.

■ 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

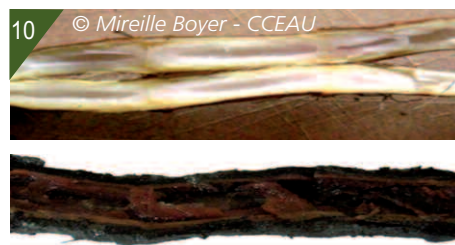
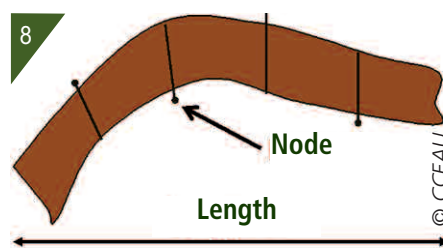
Tool	Number of grindings	Average length of rhizomes (cm)	Standard deviation
Stone crusher	2	7.9	4.4
Bucket grinder	2	6.5	4
Bucket grinder	2	10	3.3
Bucket grinder	5	10.4	5.6
Bucket grinder	3	12.2	4.8
Bucket grinder	5	13.1	7.6
Bucket grinder	2	13.2	6
Bucket grinder	1	14	8.2
Bucket grinder	1	16	8

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.

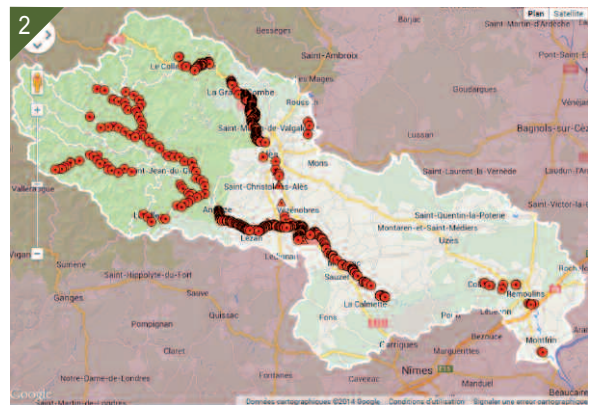
■ The Gardons basin comprises many remarkable aquatic environments (Cévennes national park, Galeizon biosphere reserve, Natura 2000 sites, the Gardon gorges) that are home to an array of emblematic species such as the European beaver and the otter, Bonelli's eagle, shad, eels, bug orchids and summer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

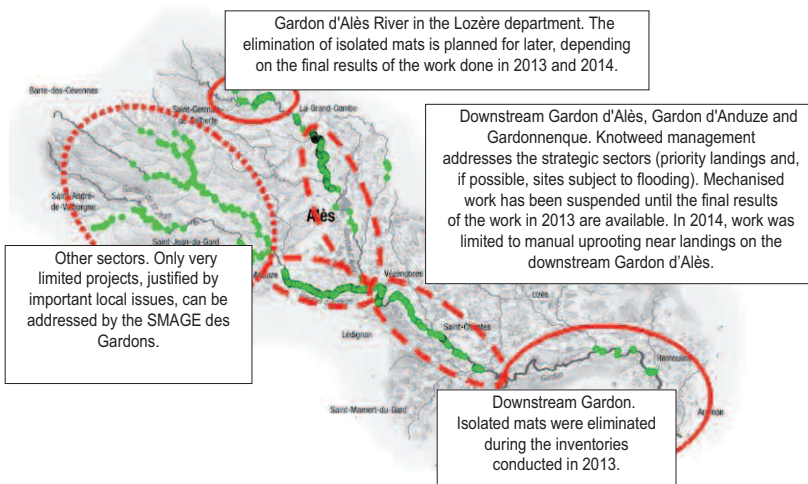
Site	Technique	Linear distance	Surface area *	Cost not incl. VAT (2013)	Duration
Grand'Combien	Manual uprooting	3 km	Widespread colonisation over 50% of linear distance	34 220	29 weeks per year since 2009
Cendras	Manual and mechanical uprooting	2 km	18 mats with scattered regrowth	4 890	1 week per month 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 bohemica* 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 bohemica* 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 bohemica* 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 bohémica* 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 bohémica* 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 bohémica* 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 bohémica*.
- 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 bohémica*) 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 Bohème 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);

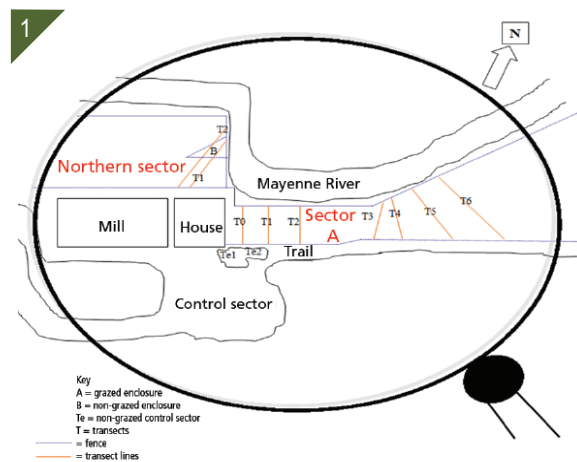
- control sector, located to the south of the house, not grazed and divided into two parts. Te.1 is the non-grazed control sector for transects T1 to T6 in sector A and Te.2 is the non-grazed and tarped control sector for transect T0 in sector A.

■ 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

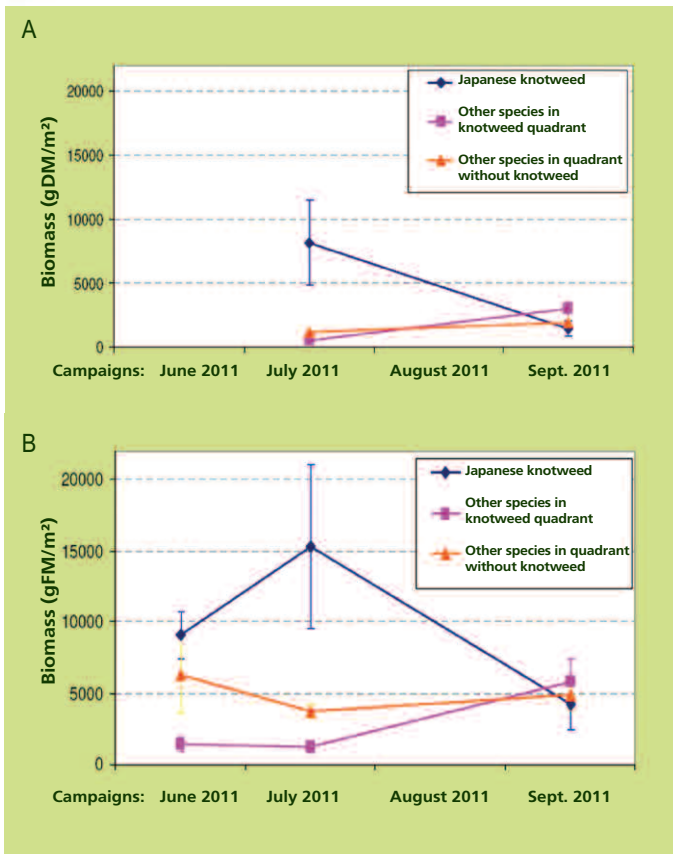
■ The impact of *Reynoutria japonica* on the other species was confirmed prior to grazing:

- 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

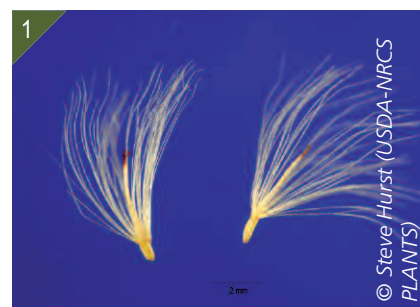
Documentation

- 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*)

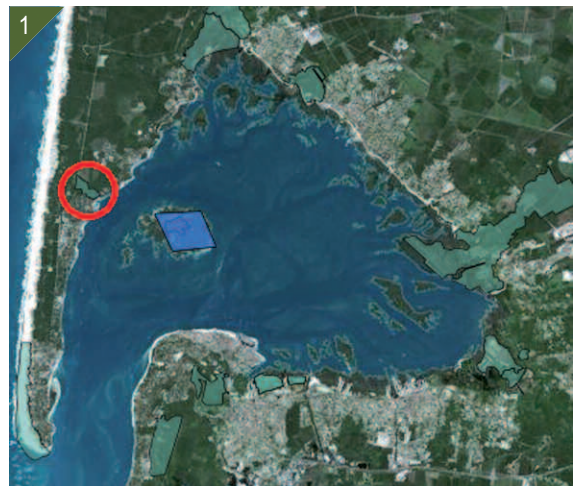
Managing groundsel bushes at the Pirailan reservoirs

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*)

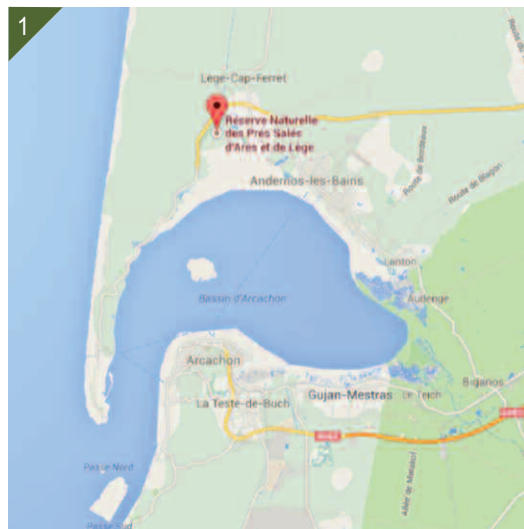
Managing groundsel bushes in the Arès - Lège-Cap-Ferret National salt-meadow nature reserve

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

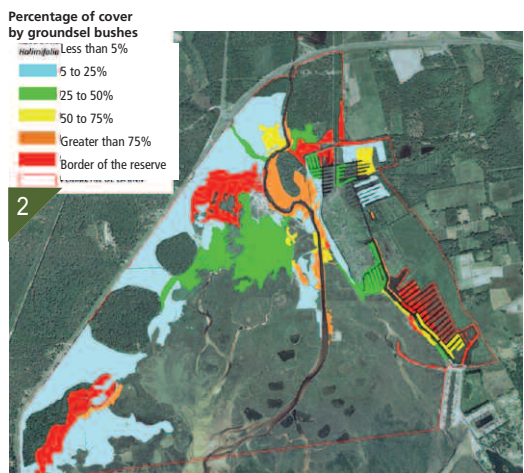
- The area was acknowledged as a national nature reserve by the Ecology ministry in 1983.
- It has been managed by the National agency for hunting and wildlife (ONCFS) since 2007 as part of the ONCFS network of reserves, in collaboration with the French national network of nature reserves.
- The management 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 participatory 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 €	16 156.60 €	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	Rapid work in heavily colonised areas.	<p>Environmental disturbances (soil and fauna).</p> <p>Accessibility for machines.</p> <p>Non-selective technique.</p>
Mechanical uprooting	None	<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.

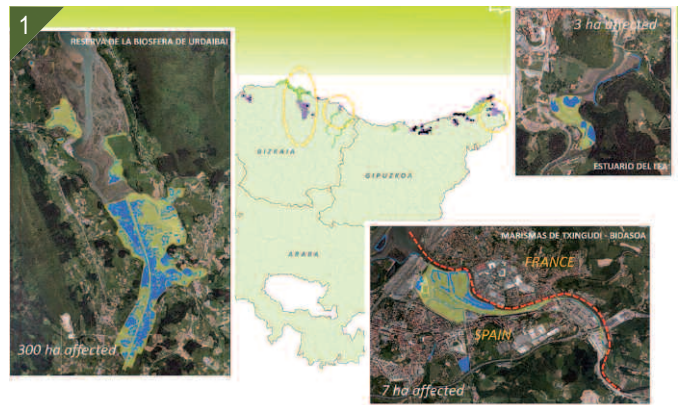
■ Contact: Estela Beteta – estela.beteta@ihobe.net

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

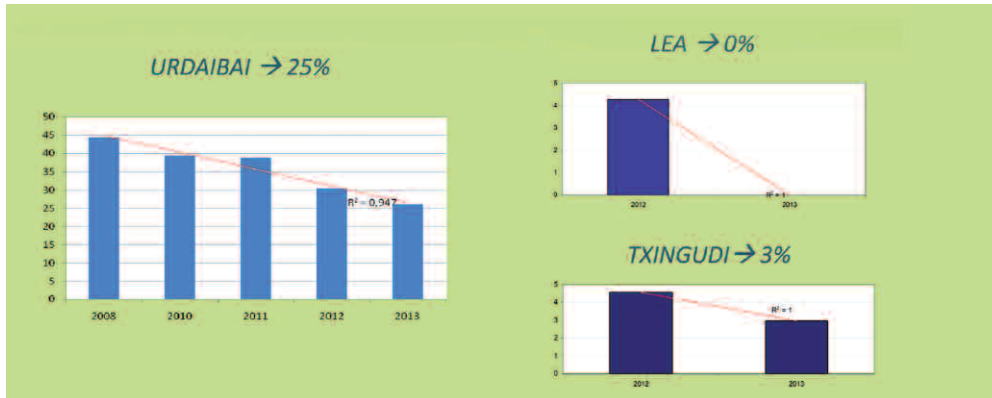


2. Urdaibai biosphere reserve.
3. Manual uprooting.
4. Use of a herbicide.
5. Monitoring regrowth of groundsel plants.

■ 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).

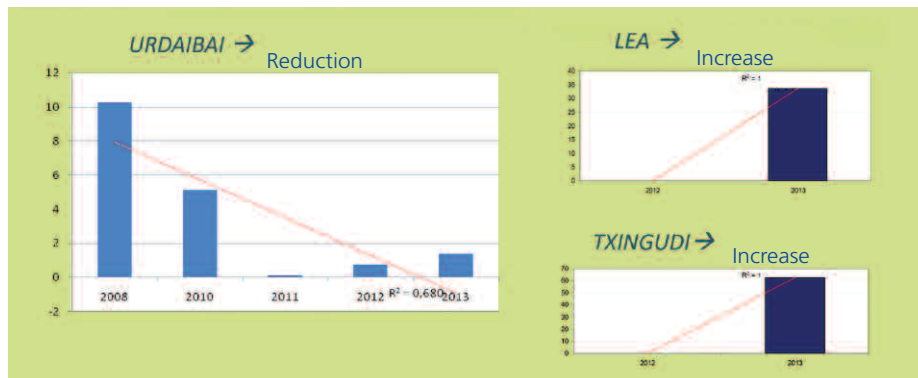
Change in the observed number of groundsel plants starting to grow again.



■ 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.

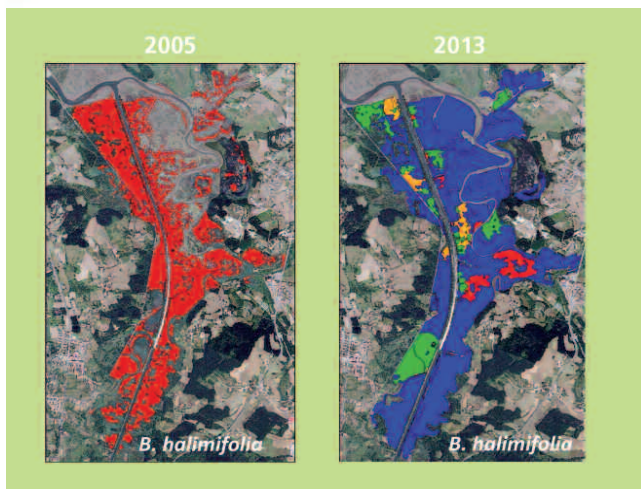


■ Detailed results for the Urdaibai reserve (2012)

- 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



© IHOBÉ

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.

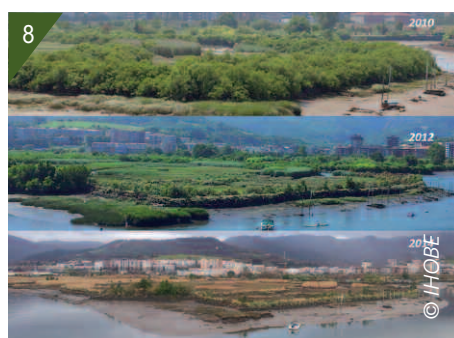
■ Finally, further scientific research is required on the species biology, intervention techniques and the response of groundsel plants to the management work.

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

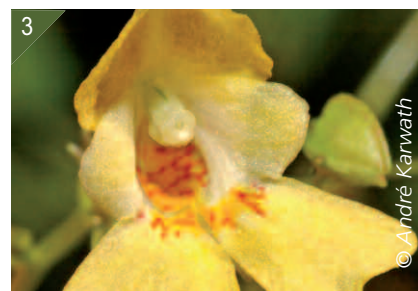
Order	Geraniales
Family	Balsaminaceae
Genus	<i>Impatiens</i> (Linnaeus, 1753)



© 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.)

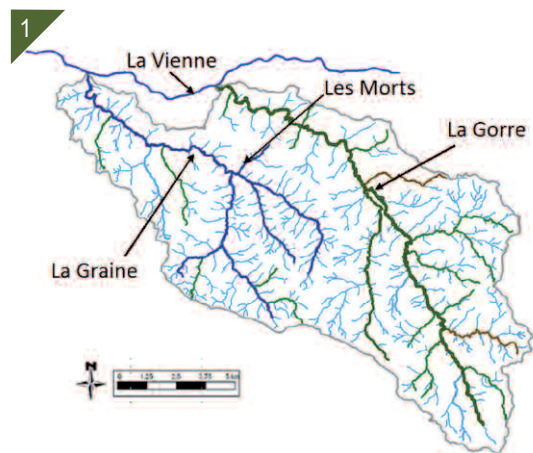
Managing Himalayan balsam in the Graine basin

Vienne Gorre river board (SMVG)

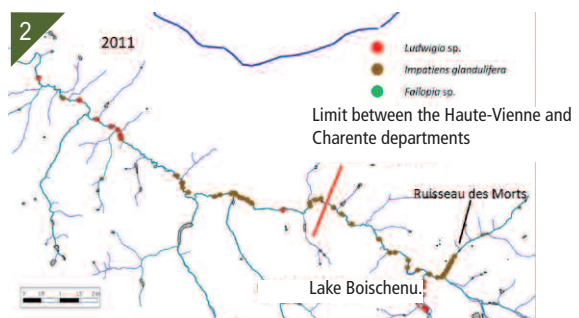
- The public board for inter-municipal cooperation was created in 1965.
- For its work on rivers, the SMVG represents 14 towns, 11 in the Haute-Vienne department and 3 in the Charente department.
- The main projects in the framework of the 2009-2013 contract for river restoration and maintenance (extended 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

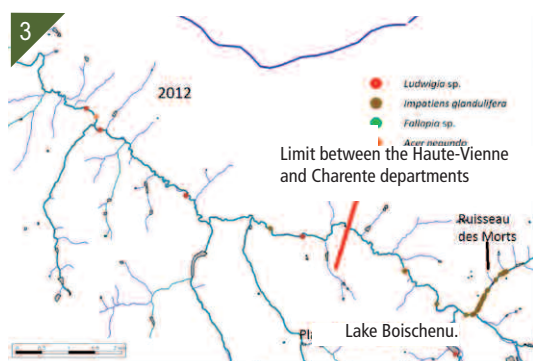
- The area managed by SMVG partially overlaps with that of the Périgord-Limousin regional nature park. The hydrographic network is fairly dense (approximately 500 kilometres of river) and comprises two main rivers, the Gorre and the Graine, two large tributaries and a large number of small streams.
- 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.

Author: Sandra Fernandez, Irstea



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.



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.

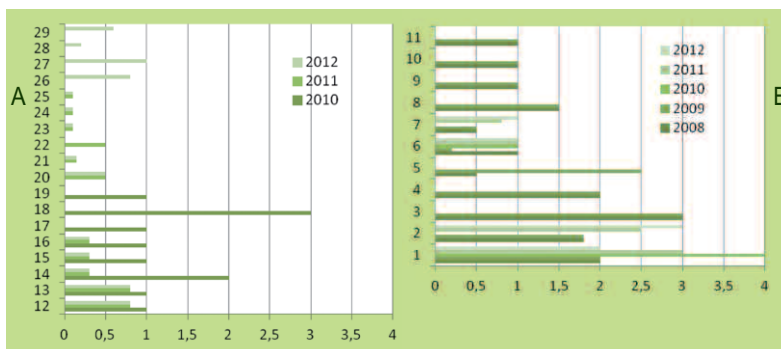
Results and assessment

■ 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://etreetboulot.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.

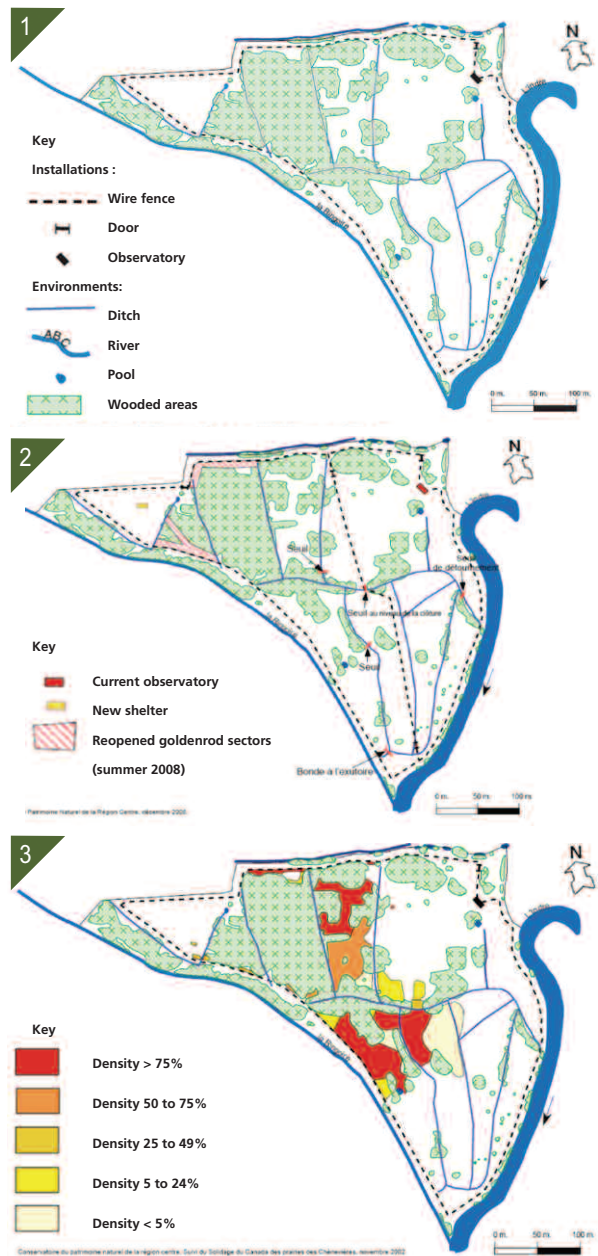
■ Contact: Jean-Baptiste Colombo - antenne18-36@CEN-Centre.org

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

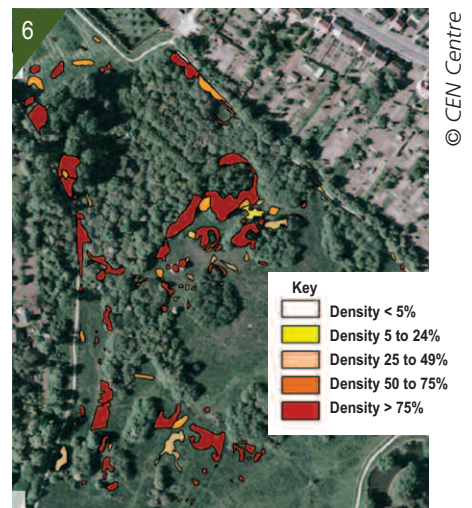
- The work was done in the month of July by the technical department of the town of Déols.
- The surface areas ranged from 0.98 hectares to 0.35 ha from 2002 to 2012.
- Mechanical cutting:
 - a tractor equipped with a rotary cutter was used in the accessible areas;
 - the areas most densely colonised 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.



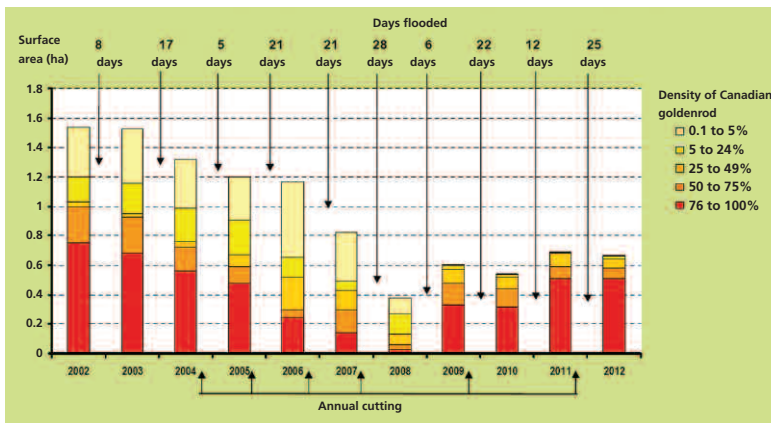
4. Mechanical shredding using a rotary cutter.
5. Mechanical means used to uproot the plants and strip the top layer of soil.
6. Densities of Canadian goldenrod in the Chènevières meadows in 2012.

■ 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)



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MNHN-CBNBP



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

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Contents

Invasive alien species in aquatic environments
Practical information and management insights

Volume 2

Management insights

Animal species



Invertebrates

- 128 ■ Red swamp crayfish**
- Species fact sheet
- Experiments on controlling red swamp crayfish stocks using traps and natural predators in the Brière regional nature park
- Experiments on managing red swamp crayfish in ponds in the Vosges department
- 138 ■ Signal crayfish**
- Species fact sheet
- Managing signal crayfish by sterilising males in the Sarthon basin
- Experiments on managing signal crayfish in ponds in the Vosges department

Fish

- 148 ■ Pumpkinseed**
- Species fact sheet
- Proposed protocol for pumpkinseed management in the Trait marshes

Amphibians

- 152 ■ American bullfrog**
- Species fact sheet
- 2003-2007 multi-year programme for the management of American bullfrogs in the Aquitaine region
- Managing the American bullfrog in Sologne (Loir-et-Cher department)
- Managing the American bullfrog on Vancouver Island, BC, Canada
- 164 ■ African clawed frog**
- Species fact sheet
- Managing the African clawed frog in the Argentonay area

Reptiles

- 170 ■ Red-eared slider turtle**
- Species fact sheet
- Management programme for red-eared slider turtles on Corsica (Corse)
- Managing alien turtles on the Mauguio Pond Natura 2000 site in the framework of the European LIFE + LAG'Nature programme
- Managing red-eared slider turtles in an urban setting (Navarra, Spain)

Birds

- 182 ■ Ruddy duck**
- Species fact sheet
- Managing ruddy ducks in France
- Programme to eradicate ruddy ducks in the U.K.
- 190 ■ Sacred ibis**
- Species fact sheet
- Eradicating the sacred ibis around the Mediterranean basin
- Managing the sacred ibis in Western France
- 200 ■ Canada goose**
- Species fact sheet
- Managing Canada geese in the Centre and Île-de-France regions
- 204 ■ Egyptian goose**
- Species fact sheet
- Managing Egyptian geese in Eastern France

Mammals

- 210 ■ Coypu**
- Species fact sheet
- Controlling populations of harmful aquatic rodents (coypu and muskrats) in the Loire-Atlantique department
- Coypu management by the Association of certified trappers for the Gironde department
- 218 ■ Muskrat**
- Species fact sheet
- Managing muskrats in the Somme department
- Managing muskrats in the Audomarois marshes
- 226 ■ American mink**
- Species fact sheet
- Control programme for American mink in the Midi-Pyrénées region
- Collective management of the American mink in Scotland



Red swamp crayfish

(*Procambarus clarkii*)

Originated in Northern Mexico and southern sections of the United States. Introduced in France in 1976 for human consumption.

Description

- The maximum size is approximately 150 millimetres
- Generally red in colour, but can also range from grey to blue
- Cephalothorax with a rough surface (part 1 in Figure 1)
- Incurved rostrum with converging edges (part 2 in Figure 1)
- Inward-facing points (parts 1 and 2 in Figure 1), spurs on the proximal segment above the claws (part 3 in Figure 3)
- Red tubercles on the large claws (part 4 in Figure 3)

Ecology and reproduction

- Common habitats are rivers, lakes, ponds, marshes and canals
- The species prefers calm, turbid waters, with grass beds
- It digs tunnels into banks
- It is active primarily during the daytime
- It is an opportunistic omnivore, however it consumes primarily plants
- Sexual maturity is achieved at 6 months
- Reproduction can occur several times per year (50 to 600 eggs)

Documentation

- GISD worldwide database on invasive species. Invasive species specialist group, IUCN:

<http://www.issg.org/database/species/ecology.asp?si=608>

- Lorraine fishing federations. 2012. Crayfish identification guide for continental France. 28 pp.
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Author: Emilie Mazaubert, Irstea

Classification

Order	Decapoda
Family	Cambaridae
Genus	<i>Procambarus</i>
Species	<i>P. clarkii</i> (Girard, 1852)





Red swamp crayfish

(*Procambarus clarkii*)

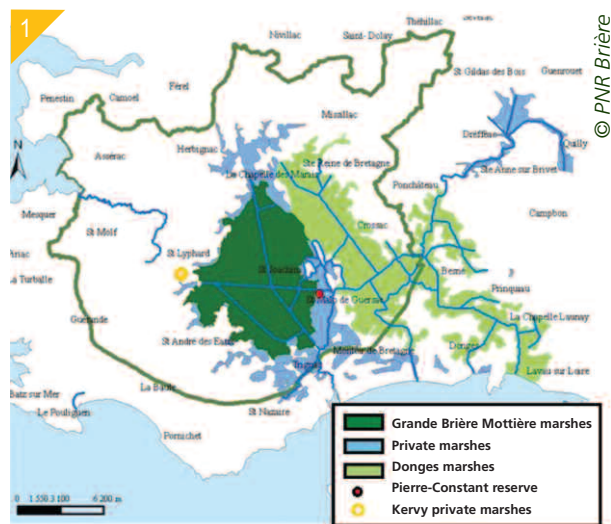
Experiments on controlling red swamp crayfish stocks using traps and natural predators in the Brière regional nature park

The Brière regional nature park

- The regional nature park was approved by the Ecology ministry and is run by a board, with representatives from the departmental council, the Pays-de-la-Loire regional council, neighbouring towns and stakeholders, that manages the marshes and works with towns, the marsh boards and private individuals.
- One of the main objectives of the park is to preserve biodiversity and restore the wetlands (marshes, wet meadows, reed ponds, canals, etc.).
- Contact: Jean-Patrice Damien - jp.damien@parc-naturel-briere.fr

Programme to preserve biodiversity from the invasion by red swamp crayfish

- The programme included applied research from 2010 to 2012, managed by INRA and funded primarily by Onema.
- The general objective was to identify the mechanisms involved in the successful invasion by red swamp crayfish (*Procambarus clarkii*) via a five-point approach:
 - development of a monitoring method for crayfish populations and testing of new molecular techniques to detect crayfish in large aquatic environments;
 - study on the population response of red swamp crayfish as a function of various environmental conditions (hydroperiod, salinity, etc.);
 - study on trophic determinism in the invasive success of red swamp crayfish and the position of the species in the upper links of the food chain (with respect to fish);
 - study on biodiversity patterns as a function of colonisation (or lack of colonisation) of pool networks by the invasive species;
 - experiments on controlling red swamp crayfish stocks using traps and a natural predator, the European eel (*Anguilla anguilla*).
- Contact: Jean-Marc Paillisson - jean.marc.paillisson@univ-rennes1.fr



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

Intervention site

- Since 2009, attempts to draw down the stock of red swamp crayfish through continuous trapping have been undertaken in small ponds and lakes (isolated using a small-mesh barrier) in the Pierre-Constant reserve.
- The reserve, owned by the park, is located to the east of the Grande Brière Mottière marsh among the Rozé private marshes in the town of Saint-Malo-de-Guersac (Loire-Atlantique department).
- It covers a surface area of 25 hectares, of which 40% are ponds and lakes (some are watered year round, others are dry in the summer).
- In 2009, the initial trials to regulate crayfish stocks were conducted exclusively in pond A. These initial experiments will not be discussed here.
- In 2010 and 2011, trapping trials were carried out on two ponds (A and B, with respective surface areas of 225 and 715 square metres). In 2012, new trials to regulate the stocks were conducted on three ponds, including A and B:
 - pond A, continuous trapping combined with the introduction of a natural predator, the European eel;
 - pond B, continuous trapping with different types of traps to test their effectiveness (the results concerning trap effectiveness are not presented here);
 - pond C, a new pond covering 680 square metres, served as a control environment.

■ These three ponds colonised by red swamp crayfish are good examples of the ponds in the Brière marshes. They are shallow (approximately 60 centimetres deep in April), generally dry from August to October, have slightly sloping banks and a peaty substrate.

Disturbances and issues involved

■ The presence of red swamp crayfish in the Brière marshes is thought to be due to the accidental dispersal of the species from a crayfish farm located near the marshes in the 1980s. Since that time, red swamp crayfish have colonised the entire wetland area (20 000 hectares), a situation that has had numerous impacts on the ecosystem:

- a significant reduction in aquatic plant beds to the point that some species have disappeared, e.g. water lilies, resulting in a proliferation of cyanobacteria;
 - modification and simplification of the food chain. Crayfish are a highly consumed source of food for a wide range of predators (birds, fish, mammals, etc.);
 - tunnels dug into banks degrade the water quality (increased turbidity) and damage the banks;
 - given the lack of a baseline, it is difficult to assess the impact on fish populations.
- However, it is important to note a reduction in the carrying capacity of the environment for phytophilic fish species.

Interventions

■ Trapping experiments in 2010 and 2011

■ The objective of the tests to draw down the stock of red swamp crayfish is to determine the feasibility of controlling populations in small ecosystems and to assess the response of plant and animal communities to the expected drop in the pressures exerted by crayfish. In 2010 and 2011, the initial experiments consisted solely of trapping in the Pierre-Constant reserve.

■ Experiments in 2012 combining trapping and the introduction of a natural predator

■ Given the limited results of the experiments in 2010 and 2011, it was decided to attempt to regulate the stock of red swamp crayfish in 2012 by pursuing trapping, but also by introducing European eels.

■ Eels are a common, native species in the Brière marshes and a known predator of crayfish.

■ The objective of the experiments is to compare the impact on crayfish stocks of a method combining trapping and natural predation to the method tested in 2010 and 2011 involving only trapping.

■ The experiments were conducted on the three ponds from 2 April to 25 August 2012 and were organised as follows:

- pond A, continuous trapping and introduction of eels. 15 wire hoop nets were used, i.e. one for every 15 square metres of pond, and checked every 24 to 72 hours. On 11 April 2012, 31 eels (average length 550 millimetres and average weight 330.5 grams) were released, each with a PIT-tag;
- pond B, continuous trapping. A total of 70 traps of different types (traditional and wire hoop nets, large cage traps, experimental traps) were used, i.e. one for every 10 square metres of pond, and were checked every 24 to 72 hours;



2. A pond in the Pierre-Constant reserve with a barrier installed around it.

- pond C, a control pond where no trapping took place prior to 2012. Trapping was used to assess the crayfish population (density over time). It took place in two 24-hour sessions per week using 10 wire hoop nets installed at the start of the session (hour 0) and removed at the end (hour 24).

■ At the end of each session:

- the crayfish captured in each trap over the 24-hour session were counted and weighed;

- the crayfish from each trap were frozen.

■ The study took place in 3 phases, namely a phase prior to the introduction of the eels (sessions 1 to 3), a 3-month phase during which the eels were present (sessions 4 to 23) and a phase during which some of the eels were removed (sessions 24 to 28).



3- Red swamp crayfish (*Procambarus clarkii*).

Results of the interventions.

Year	2010	2011
Trapping period	14 April to 19 July	11 April to 22 July
Trapping organisation	<ul style="list-style-type: none"> • Pond A. 15 wire hoop nets in the water approximately 1 metre from the bank, 1 trap for every 15 square metres. • Pond B. 70 traps of different Types (traditional and wire hoop nets, large cage traps, experimental traps) in the water approximately 1.5 metres from the bank, 1 trap for every 10 square metres. • Bait (dog kibble) was placed in the traps each time they were checked. 	<ul style="list-style-type: none"> • Pond A. Same as in 2010 + 7 additional traps starting on 4 July. • Pond B. Same as in 2010. • Bait (dog kibble) was placed from 24 June to 1 July in the traps in pond B and from 4 July onward in the traps in pond A, each time the traps were checked.
	<ul style="list-style-type: none"> • The traps were totally submerged (optimal capture conditions). • The traps were checked twice per week in both ponds. 	
Handling after capture	<ul style="list-style-type: none"> • The crayfish in each trap were counted (except in 2010 in pond B). • The biomass in each trap was weighed. • The captured crayfish were frozen. 	
Assessment	<ul style="list-style-type: none"> • A reduction in the numbers and total biomass captured from 2010 to 2011, but no significant reduction in spite of the relatively limited surface areas. • Trapping of red swamp crayfish requires significant human resources even for small ponds. It would be difficult to implement this technique in larger ecosystems. 	

Results and assessment

■ Results

■ Total biomass captured:

- 2010. Pond A: 30 100 g (6 417 crayfish captured), i.e. 134 g per square metre.

Pond B: 70 800 g, i.e. 99 g/m²

- 2011. Pond A: 24 960 g (1 973 crayfish captured), i.e. 111 g/m². Pond B: 41 445 g, i.e. 58 g/m².

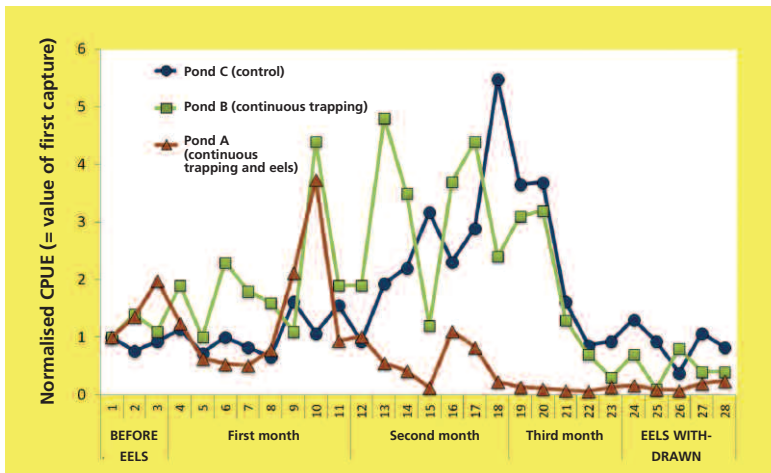
■ Experiments in 2012

■ The initial stock, measured in average captures per unit of effort (CPUE = average number of crayfish per trap per 24 hours), was higher in pond A (6.27 ± 1.18) than in ponds B and C (respectively 1.16 ± 0.46 and 2.60 ± 0.63).

■ Trapping had little effect on the crayfish stock in pond B. The drop at the end of the period was due to the drop in crayfish activity at that time of year.

- The combined action of continuous trapping and the introduction of the predator produced a significant reduction in pond A (3 070 crayfish were removed from the pond, i.e. a density of 13.6 per square metre).
- The major reduction in the numbers of crayfish in pond A was due to the high level of predation by the eels, probably in conjunction with a change in behaviour on the part of the crayfish (drop in activity) due to the presence of the eels.
- This hypothesis is supported by the CPUE results in pond C.

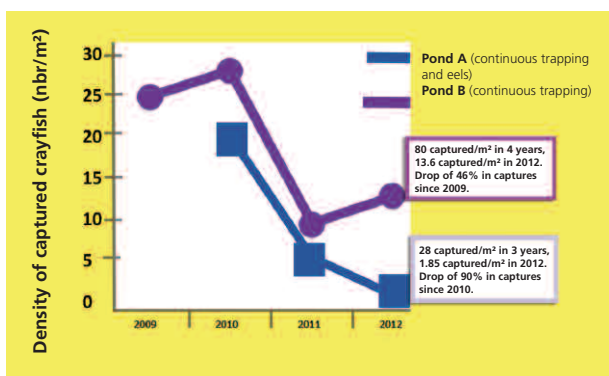
Normalised captures per unit of effort (CPUE) in the three ponds. (The CPUE values were normalised to the initial CPUE value in each pond in order to take into account the differences in the initial stocks in the ponds.)



■ Assessment

- Experiments in 2010 and 2011:
 - a reduction in the numbers and total biomass captured from 2010 to 2011, but no significant reduction in spite of the relatively limited surface areas;
 - trapping of red swamp crayfish requires significant human resources even for small ponds. It would be difficult to implement this technique in larger ecosystems.
- Trapping in 2012 in the Pierre-Constant reserve produced limited results:
 - densities dropped significantly from 2009 onward, but remained at high levels;
 - the variations in biomass between 2011 and 2012 may indicate changes in the population structure (the studies on the population structure are not discussed here). Strong increases in the numbers of juveniles may be observed the year following large reductions in the crayfish stock.
- The presence of the predators has a significant effect that is however difficult to interpret (direct predation and/or effect on the activity of the crayfish).
- A significant reduction in the population of red swamp crayfish becomes difficult once it has reached high density levels.
- Total results since 2009: 10 371 traps checked, 138 "sessions", 580 man-hours in the field, 3 408 hours to lay the traps, 38 000 crayfish captured, i.e. 40.4 per square metre and approximately 120 kilograms of biomass captured, i.e. 128 grams per square metre.
- The effort made for continuous trapping would be difficult to extend to a large, open environment.





Density of captured crayfish in ponds A and B.

Overall captures in ponds A and B.

	2010	2011	2012
Density (nbr/m²)	28.5	10.2	13.6 (↗)
Biomass (g/m²)	133.8	128.1	60.6 (↘)

Outlook

- Efforts will be made to perfect the combination of captures and predation over the long term:
 - selective trapping will be implemented if a major trapping effort is made and/or if emblematic species are present. Tests on selective trapping were run during the experiments and proved the effectiveness of the technique. An assessment of the technique in terms of the applicable regulations is in progress;
 - the stock of predatory fish will be optimised to enhance their impact on the population of red swamp crayfish;
 - particular efforts will be made for sites in the early stages of colonisation.

Information on the project

- The first national meeting on invasive alien crayfish, held from 18 to 20 June 2013 in Saint-Lyphard (Loire-Atlantique department), was organised by INRA Rennes, the Brière regional nature park, the Forum of Atlantic marshes, the CNRS Rennes and Onema:
 - a paper was presented on the trials to draw down the stock of red swamp crayfish *Procambarus clarkii* using trapping and biocontrols;
 - the project results were published in an *Onema Meetings* document and in the *Aestuaria* collection of documents.

Author: Sandra Fernandez, Irstea

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Red swamp crayfish

(*Procambarus clarkii*)

Experiments on managing red swamp crayfish in ponds in the Vosges department

Onema, the French national agency for water and aquatic environments, NE regional office

■ Onema is a public agency under the supervision of the Ecology ministry and was created by the Law on water and aquatic environments (30 December 2006) in response to the requirements of the Water framework directive (23 October 2000) which set quality objectives for water and aquatic environments with a deadline in 2015.

Onema is the principle technical organisation in France in charge of developing knowledge on the ecology of aquatic environments and managing aquatic ecosystems. Its mission is to contribute to comprehensive and sustainable management of water resources and aquatic environments.

■ Five main missions:

- provide technical support for water polices (local governments, Water agencies, State services, etc.);
- stimulate research on the major challenges facing water and aquatic environments (climate change, new forms of pollution, etc.);
- improve knowledge on the status and uses of water and aquatic environments and make the information available to the public;
- play an essential role in the police for water and aquatic environments, in support of State services;
- fund specific water policies, such as solidarity funding between river basins and the Ecophyto plan.

Three organisational levels:

- the general management develops science-advice capabilities in support of public water policies, manages the agency and coordinates the Water information system (WIS-FR);
- the nine regional offices corresponding to one or more administrative regions in France. They represent the agency in its dealings with local authorities and they manage the local offices in their region;
- the local offices are the basic building blocks of Onema. Their mission is to inspect and monitor water uses and to provide technical support to the water police. They also collect data on the status and uses of water and aquatic environments, as well as on species.

■ Contact: Marc Collas - marc.collas@onema.fr



1. Intervention site.

Intervention site

■ The site is located in the town of Bellefontaine, in the southern section of the Vosges department in the Semouse river basin (Rhône-Méditerranée-Corse basin).

■ The site consists of two ponds/reservoirs on a tributary to the Semouse River. They are also supplied by springs and rainfall. The two ponds are equipped with a draining system and can be drained. The upstream pond has a surface area of 2 500 square metres and the downstream a surface area of approximately 8 000 m².

■ They are privately owned and are intended for recreational fishing. Legally speaking, the ponds were authorised for a period of 30 years. At the time of the intervention, the 30-year period had expired and the owner was obliged to correct the situation by submitting an application to the departmental territorial agency.

Disturbances and issues involved

■ The announcement concerning the presence of *Procambarus clarkii* was only the second in the Lorraine region. It entails a number of consequences for the local environment, including:

- a risk that certain native species (native crayfish, molluscs, invertebrates, fish, amphibians) may regress or simply disappear;
- the crayfish may be healthy carriers of “crayfish plague” (aphanomycosis), a disease that kills native crayfish;



- the crayfish may be carriers of chytridiomycosis, a pathology affecting amphibians;
- destruction of cyprinid spawning grounds due to the reduction in aquatic plant beds where many fish species spawn;
- the crayfish can damage structures and hydraulic installations by digging into banks (tunnels up to 1 metre deep, even 2 metres in Spain) and completely destabilising them at great economic cost.

* Disturbances on the local level:

- risks of colonising new sites;
- competition with native species.

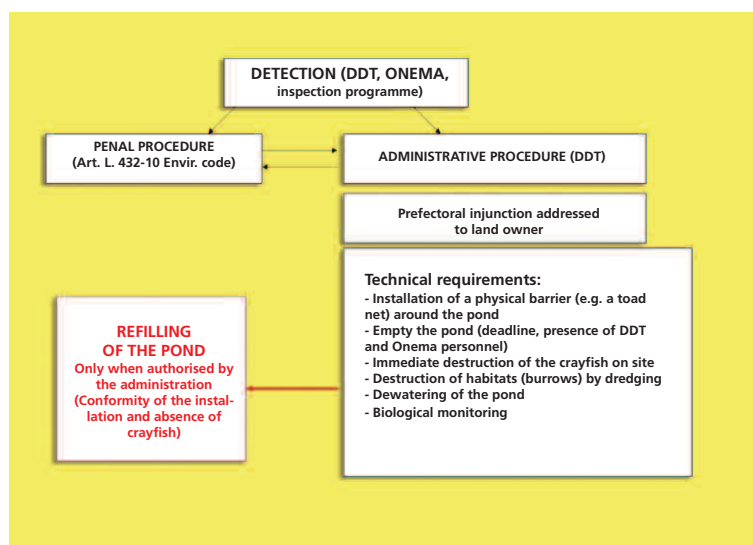


2. Red swamp crayfish (*Procambarus clarkii*).

Interventions

- September 2009, an exuvia discovered during a check on pond conformity signalled the presence of red swamp crayfish.
- October 2009, the presence of the species was confirmed by trapping using hoop nets with bait. Gravid females were captured and numerous juveniles were observed. All size classes were noted.
- The crayfish had not colonised the tributary, i.e. they were present exclusively in the two ponds.

Diagram of the administrative and penal system in the Vosges department.



■ Intervention period and method

■ Fall 2009:

- November 2009, slow emptying of the ponds by the owner in the presence of the State services, DDT and Onema, following the prefectoral injunction;
- installation of a physical barrier (plastic tarp) with pails as traps around the perimeter to avoid any escape of the crayfish;
- netting to collect a maximum number of crayfish, plus manual collection of any visible crayfish and searches in the various habitats;
- use of quicklime in pools remaining in the pond;
- total dewatering with filtration systems in the pond fish trap to avoid the escape of any remaining crayfish to the stream.

■ 2010:

- the pond was dewatered in the winter and summer, with monitoring of the filtering system and collection of the crayfish in pond fish trap;
- regular monitoring of the site to check for the presence of crayfish.

■ 2011:

- the pond was dewatered in the winter and summer, with monitoring of the filtering system;
- regular monitoring of the site to check for the presence of crayfish.

■ 2012:

- the pond was dewatered in the winter and summer, with monitoring of the filtering system;
- regular monitoring of the site to check for the presence of crayfish.

■ 2013, the owner received permission to refill the pond.

Results and assessment

■ Results

■ Following the three years of successive dewaterings and the end of the experiment, the combined techniques resulted in the complete eradication of red swamp crayfish in the two ponds where the species had naturalised (reproduction, growth).

■ This result is the product of several factors:

- early detection;
- rapid intervention on the site in the framework of regulatory constraints weighing on the pond owner;
- and all the measures implemented following the emptying of the ponds.

■ The work must be followed by biological monitoring on the site and the surrounding area. The monitoring showed that in this particular case, the red swamp crayfish had not colonised the downstream environment and the surrounding ponds.

■ Costs

■ In this case, the costs were not calculated and fell entirely on the pond owner who had introduced the crayfish.

■ However, the costs incurred by the fishing operations, the quicklime operation and purchase of equipment (physical barrier) may be estimated at around 5 000 euros.

■ Monitoring consisted of two annual visits following the emptying of the ponds.

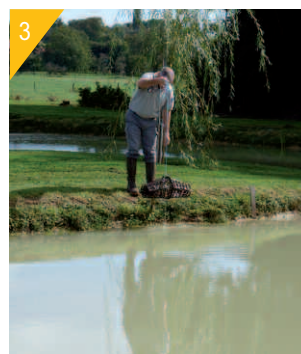
■ A further element is the loss of use of the ponds for three years and the destruction of the fish in order to avoid transporting crayfish larvae to other ponds.

Outlook

■ Total emptying of the colonised ponds and control over the water levels were indispensable elements in the success of the management work against the invasive crayfish.

■ This case showed that in efforts against an invasive species, the work must be adapted to each situation and each site. It also showed that an intervention may last a fairly long time (three years in this case).

■ Finally, during the intervention, ample information must be provided in the local press as well as to elected officials and the owners of ponds and lakes.



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3. Detection of the species.
4. The physical barrier around a pond.
5. Use of quicklime in pools remaining in the pond.
6. Draining the pond in the winter.
7. Filtering systems in the pond fish trap.



Information on the project

■ The first national meeting on invasive alien crayfish, held from 18 to 20 June 2013 in Saint-Lyphard (Loire-Atlantique department), was organised by INRA Rennes, the Brière regional nature park, the Forum of Atlantic marshes, the CNRS Rennes and Onema. The project results were published in an *Onema Meetings* document and in the *Aestuarium* collection of documents.

Note on applicable regulations

■ The introduction of a “species likely to provoke biological imbalances”, as per articles R432-5 and L432-10 in the Environmental code, is subject to a fine of 9 000 euros.

Author: Marc Collas, Onema



8. Dead red swamp crayfish following emptying of the pond.

For more information

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Signal crayfish

(*Pacifastacus leniusculus*)

Originated in the Northwest of the United States. Introduced in France in the 1970s for commercial farming tests.

Description

- The maximum size is approximately 180 millimetres
- The animals tend to be light brown in colour
- Cephalothorax with a smooth surface (part 1 in Figure 1)
- Rostrum with parallel edges (part 2 in Figure 1)
- Large, smooth claws:
 - with a whitish or bluish spot at the joint of the claws (part 3 in Figure 2)
 - with a red underside

Ecology and reproduction

- Habitats vary significantly, ranging from small streams and large rivers to ponds and lakes
- It digs tunnels into banks
- It is active primarily during the night
- Omnivorous:
 - adults consume primarily plants
 - juveniles consume primarily other animals
- Sexual maturity is reached between 12 and 24 months
- Reproduction occurs once per year (150 to 400 eggs)

Documentation

- Species fact sheet drafted by the University of Metz: http://www.invabio.univ-metz.fr/z_pacifastacus_leniusculus.htm
- Lorraine fishing federations. 2012. Crayfish identification guide for continental France. 28 pp.
- Nepveu C. 2002. Les espèces animales et végétales susceptibles de proliférer dans les milieux aquatiques et subaquatiques - Fiches espèces animales (Les espèces exotiques). Agence de l'eau Artois-Picardie. 98 pp.

Author: Emilie Mazaubert, Irstea

Classification

Order	Decapoda
Family	Astacidae
Genus	<i>Pacifastacus</i>
Species	<i>P. leniusculus</i> (Dana, 1852)



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© Théo Duperray





Signal crayfish

(*Pacifastacus leniusculus*)

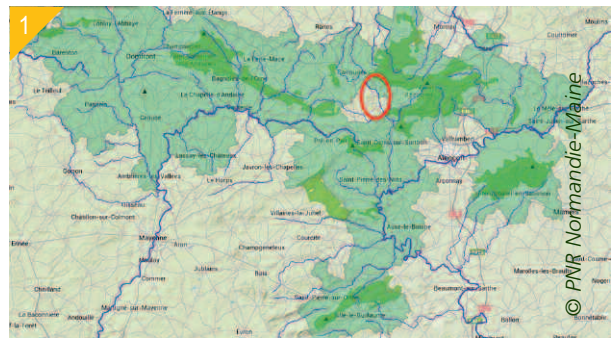
Managing signal crayfish by sterilising males in the Sarthon basin

Saules et eaux consulting firm

- The consulting firm was founded in 2009 and is specialised in work in rivers and the restoration of aquatic environments.
- Fields of expertise:
 - protection of river banks using plant-based technologies;
 - preservation of biodiversity by studying crayfish, notably study of invasive alien crayfish and white-clawed crayfish (*Austropotamobius pallipes*) in the framework of experiments in artificial environments to study their behaviour, diet and interspecific predation, as well as in the framework of impact studies and Natura 2000 inventories in the natural environment;
 - breeding of native crayfish species in basins to save the gene pool and/or to grow reproducers for restocking operations;
 - training and awareness raising concerning native and invasive alien crayfish, advice on management options to encourage the development of native crayfish populations;
 - advice on and participation in managing invasive alien crayfish, with the development of an experimental protocol to sterilise the males, tested first in basins, then in the natural environment. This technique blocks reproduction and produces imbalances in the sex ratio and in the relative sizes, with as a result a major reduction in population numbers. The objective is to achieve total elimination of the species after applying the protocol for a few years.
- Contact: Théo Duperray - theo.duperray@sauleseteaux.fr

Intervention site

- The management work on signal crayfish (*Pacifastacus leniusculus*) by sterilising the males was conducted in the Normandie-Maine regional nature park in the Orne department, along 2 kilometres of the Sarthon River and its tributary, the Rouperroux.
- For the purposes of the work, the rivers were divided into 29 sections, each 100 metres long and numbered from downstream to upstream.
- The work also took place on two water bodies:
 - the old washing area (50 square metres) on the Rouperroux between sections 26 and 27;



1. Map showing the regional nature park.
2. Intervention site.

- the pond (500 m²) located approximately 7 metres from the Rouperroux in section 27.
- The sterilisation technique was implemented on the two rivers starting in 2010, except in sections 1 to 5 located downstream of the colonised area (no signal crayfish) and in the most upstream sections 18 to 29 where sterilisation was started in 2011.
- This report presents the work done in 2011.

Disturbances and issues involved

- In 2006, during inventories of white-clawed crayfish (*Austropotamobius pallipes*) conducted by Onema for the Normandie-Maine park, signal crayfish (*Pacifastacus leniusculus*) carrying “crayfish plague” (aphanomycosis) were discovered in the Roupperroux.

- Their presence represented a threat for the 6 remaining populations of white-clawed crayfish in the Sarthon basin.

- The white-clawed crayfish is a protected species whereas the introduction of signal crayfish is prohibited in all environments (article L432-10.1 in the Environmental code).

■ Impacts of signal crayfish on the native fauna

- Signal crayfish compete with white-clawed crayfish in that their habitats and diet are similar.

- They are predators of white-clawed crayfish and of many other aquatic species (fish, invertebrates).

- Signal crayfish are potential carriers of the water mould responsible for aphanomycosis (*Aphanomyces astaci*), a deadly disease for white-clawed crayfish transmitted by direct contact or via equipment used for human activities such as fishing.

Interventions

■ Capture and sterilisation

- The sterilisation protocol for males, previously experimented by Théo Duperray from the Saules et eaux consulting firm, was set up starting in 2010.

- This technique is based on observations concerning the dominance of large males during mating and on the retreat of the females to their burrows following mating.

- There are four steps, namely 1) capture of a maximum number of crayfish, 2) sterilisation of the large males, 3) euthanasia of the females and small males, and 4) release of the sterilised larger males prior to the reproduction period (mid-September).

- Signal crayfish were caught at night, section by section:

- the work was done over two weeks, from 29 August to 1 September and from 11 to 15 September 2011;

- two runs were carried out each night (between 21.30 and 04.00) on a dozen sections from downstream to upstream;

- the crayfish were captured either by hand or using an aluminium gripper, then placed in pails carried by the personnel;

- a periscope, designed by T. Duperray, was used in deep and turbid areas;

- at the end of each run through a section, the captured crayfish were placed in pails located at the head of the section.

- Artificial “lodging” was installed to increase capture rates, particularly for the large males:

- building bricks with 54 x 54 mm holes were placed in the water in sections 12 to 29;

- they were checked during the day.



3. Signal crayfish (*Pacifastacus leniusculus*).

Checks in 2011.

Date	29/08/11	01/09/11	13/09/11	15/09/11
Sections	12 à 21	22 à 29	12 à 21	22 à 29

■ Hoop nets were used to increase the capture rates in high-density areas (old washing area and sections 24, 26 and 29) and in low-density areas (sections 5 to 11):

- 24 traps (olfactory guidance), designed by T. Duperray, were set up from 30 August to 13 September;
- they were installed in the water, aligned with the current and baited with liver or fish;
- checks were run every day just before or after noon.

■ Handling after capture

■ The protocol stipulated the measurement of the captured crayfish and sorting into two groups:

- adult males to be sterilised;
- females and “small” males (small in size and/or not yet adult) to be euthanised. The crayfish were euthanised in groups at the end of each week of capture (2 and 17 September). They were put in a pail that was then filled with very hot water.

■ Prior to sterilisation, the large males were stored in basins with oxygen pumps and “lodging” until the end of the capture operations. The first week, the males were kept in washing-machine drums lowered into a pond. This technique was halted because many crayfish (366 sterilisable males) died.

■ The sterilisation technique was “mechanical”, i.e. did not use chemical products.

■ The sterilised males were marked with a white dot (glue) on the underside of a tail segment and released on 17 September:

- in sections 6 to 10 (low number of males captured), the number of released males was greater than the number of captured males in order to reduce the probability of females mating with non-sterilised males;
- in sections 11 to 29 (high number of males captured), the number of released males was less than the number of captured males in order to release a sufficient number of males in the other sections.

■ Monitoring after sterilisation

■ Onema carried out three types of monitoring after the sterilisation phase:

- the purpose of the first was to monitor the distribution and survival rate of the sterilised males;
- the two other types of monitoring attempted to assess the rate of successful reproduction following the sterilisations. Females and spawns were monitored in November, juveniles were monitored in September (before the new captures).

■ Monitoring of the sterilised males:

- the work was done on 28 September and on 6 and 11 October 2011;
- monitoring was conducted on three groups of “typical” sections, namely sections 6 to 9, the Sarthon invasion front, sections 12 to 14, the most densely populated area, and sections 22 to 28, a very densely populated, upstream area where the sterilisation procedure was implemented for the first time in 2011.

■ The captured crayfish (with the exception of the sterilised males) were euthanised in sections 6 to 9, the invasion front, whereas in the other sections, the crayfish were simply observed.



4. The periscope.

■ Main results:

- few sterilised males were observed in sections 6 to 9 (only one compared to the 32 previously released) and in sections 12 to 14 (two males observed among the 34 released);

- a large number of sterilised males were found dead, up to one-quarter of all the males observed.

■ Winter monitoring to assess the percentage of spawning females and the percentage of non-viable spawns:

- the work was done on 23 November 2011;

- 400 artificial “lodgings” (bricks) were checked and the viability of the eggs in females was examined (on the basis of the colour of the eggs);

- the captured crayfish (with the exception of the sterilised males) were euthanised in sections 6 to 9, the invasion front, whereas in the other sections, the crayfish were simply observed.

■ Summer monitoring by scraping the substrate to estimate the density of juveniles:

- the work was carried out between the end of August and the beginning of September;

- a fine dip net was used to collect the substrate containing debris and juveniles present under stones and pieces of wood (one sample per river section);

- juveniles were captured and counted, and their development stage was noted.

Results and assessment

■ Results

Captures.

Types of crayfish captured	Manual capture	Capture using hoop nets	Capture using bricks	Total
Females	1 209	131	365	1 705
Small males	694	0	16	710
Adult males	468	116	227	811
Non-identified crayfish	105	0	0	105
Total	2 476	247	608	3 331

■ Results of handling after capture

■ Among the 3 331 crayfish captured, 445 males were sterilised and released (out of a total of 811 sterilisable males, the other 366 died during the operation) and 2 504 crayfish were euthanised.

■ Results of the winter monitoring

■ A total of 226 crayfish were captured.

■ Among the 80 spawning females, 46.3% of the spawns were viable, 25% were not viable and 28.7% could not be determined (the colour did not allow for a clear result).



5. Viable eggs (brown colour).

6. Non-viable eggs (orange colour).

Results of the winter monitoring.

Not sterilised			Females captured	
Not sterilised	Sterilisedv	Not adult	Spawning	Not spawning
72	47	4	80	23

■ Results of monitoring by scraping the substrate

- Fewer juveniles born during the year were observed in the sections where sterilisation was carried out prior to 2011.
- An increase in the proportion of adults was observed in the sections 22 to 29 where sterilisation was first carried out in 2011.

■ Assessment

- The capture technique using hoop nets was effective in the downstream sections where there were few crayfish and in the deep-water sections.
- The low percentage of non-viable spawns (25%) would likely not have a significant impact on the growth dynamics of the population.

● Outlook

- The management protocol was implemented again in 2012, but not in 2013 because four new populations of signal crayfish were discovered in the meantime and the results of the spawn monitoring were not encouraging (only 20% of the spawns were non-viable).
- The park planned to block off a part of the river to prohibit the signal crayfish from travelling upstream toward the tributaries where there were populations of white-clawed crayfish.

Information on the project

- Students from a nature protection and management course participated in the winter monitoring of the bricks in the framework of a partnership between the Normandie-Maine regional nature park and the Sées agricultural school.
- The project was presented in a number of symposia. An oral report and posters on the work were presented during the first French symposium on invasive alien crayfish, organised by INRA and the Brière regional nature park in June 2013.
- Reports on the work can be downloaded from the site of the consulting firm (<http://sauleseteaux.fr/>).

Remarks

- The white-clawed crayfish is protected by the law dated 10 July 1976 and by the decree dated 21 July 1983, modified by the decree dated 18 January 2000 on the protection of native crayfish, and is mentioned in Annexes II and V of the Habitats directive.

Author: Sandra Fernandez, Irstea

For more information

- Internet site of the Saules et eaux consulting firm:
<http://sauleseteaux.fr/>
- Duperray T. 2012. Protocole expérimental d'éradication de l'Écrevisse de Californie *Pacifastacus leniusculus* par stérilisation des mâles. Compte rendu des opérations réalisées sur le Sarthon et le Rouperroux en 2011.





Signal crayfish

(*Pacifastacus leniusculus*)

Experiments on managing signal crayfish in ponds in the Vosges department

Onema, the French national agency for water and aquatic environments, NE regional office

■ Onema is a public agency under the supervision of the Ecology ministry and was created by the Law on water and aquatic environments (30 December 2006) in response to the requirements of the Water framework directive (23 October 2000) which set quality objectives for water and aquatic environments with a deadline in 2015.

Onema is the principle technical organisation in France in charge of developing knowledge on the ecology of aquatic environments and managing aquatic ecosystems. Its mission is to contribute to comprehensive and sustainable management of water resources and aquatic environments.

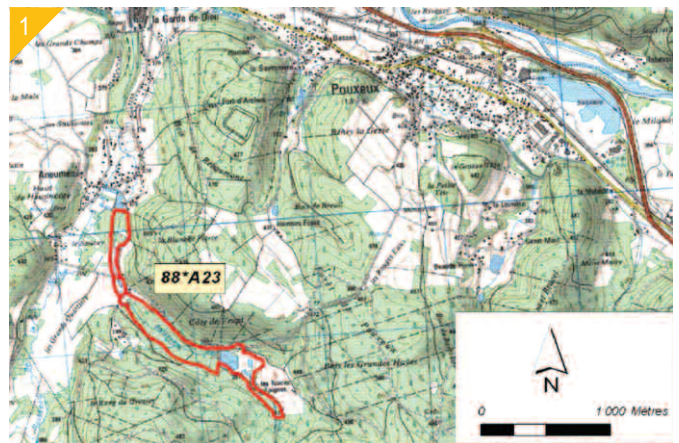
■ Five main missions:

- provide technical support for water polices (local governments, Water agencies, State services, etc.);
- stimulate research on the major challenges facing water and aquatic environments (climate change, new forms of pollution, etc.);
- improve knowledge on the status and uses of water and aquatic environments and make the information available to the public;
- play an essential role in the police for water and aquatic environments, in support of State services;
- fund specific water policies, such as solidarity funding between river basins and the Ecophyto plan.

■ The agency is organised around three hierarchical and geographical organisational levels:

- the general management develops science-advice capabilities in support of public water policies, manages the agency and coordinates the Water information system (WIS-FR);
- the nine regional offices corresponding to one or more administrative regions in France. They represent the agency in its dealings with local authorities and they manage the local offices in their region;
- the local offices are the basic building blocks of Onema. Their mission is to inspect and monitor water uses and to provide technical support to the water police. They also collect data on the status and uses of water and aquatic environments, as well as on species.

■ Contact: Marc Collas - marc.collas@onema.fr



1. Map showing the intervention site.

Intervention site

■ The site is listed among the sensitive natural areas in the Vosges department and covers a total of 30 hectares. This report deals essentially with the management of the ponds and of the signal crayfish (*Pacifastacus leniusculus*).

■ The two ponds lie on private land. Following the discovery of signal crayfish during an inspection carried out by Onema in September 2009 and given the illegal nature of the ponds, legal proceedings were initiated at the end of 2009 by the departmental territorial agency against the owners, in order to regularise the situation.

■ The injunction (signed in March 2010) stipulated that:

- the ponds be drained to eradicate the population of signal crayfish;
- a wetland and ecological continuity be restored by setting up a bypass. The towns of Arches and Pouxoux volunteered to provide the technical oversight. The policy of the Vosges departmental council concerning sensitive natural areas applied and was implemented by the Lorraine nature conservatory.

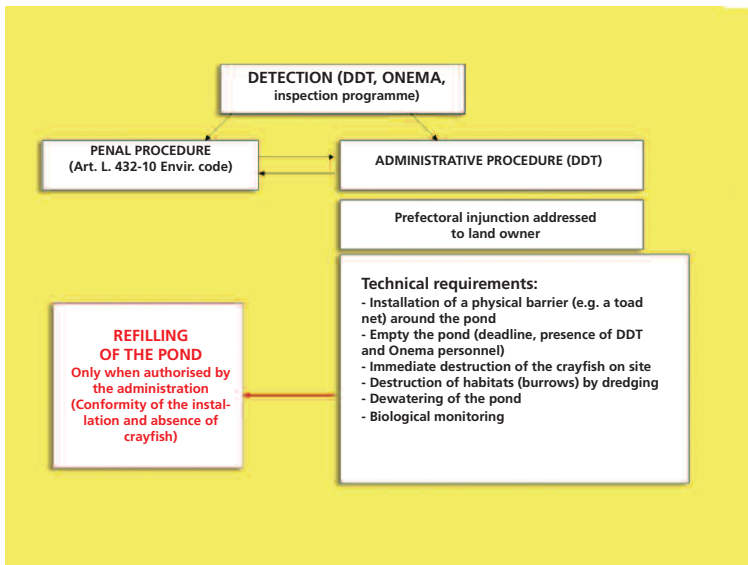
■ The site consists of two ponds/reservoirs on a tributary to the Noires Feignes stream (Rhin-Meuse basin).

The ponds, with a respective surface area of 21 ares and 1.5 hectares are also supplied by springs.

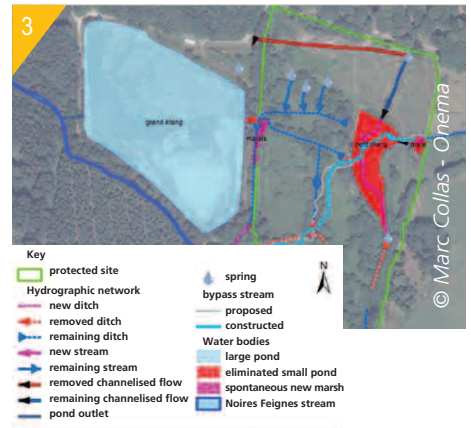
■ The two ponds are each equipped with a draining system and can be drained.

- The inspections on site noted, however, that the signal crayfish had already colonised the Noires Feignes stream downstream of the ponds.

Diagram of the administrative and penal system in the Vosges department.



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Disturbances and issues involved

- The presence of the signal crayfish entails a number of consequences for the local environment, including:
 - a risk that certain native species (native crayfish, molluscs, invertebrates, fish, amphibians) may regress or simply disappear;
 - the crayfish may be healthy carriers of “crayfish plague” (aphanomycosis), a disease that kills native crayfish. The infection rate for crayfish plague of the observed population was high.
- On the local level, the objective of the intervention was to eliminate the “source population”, introduced to the ponds by the owners via living animals transported from Lake Geneva, and to limit the spread of the population both upstream and downstream in the stream.

Interventions

- The two ponds were drained and the signal crayfish were eliminated.
- The smaller pond was purchased by the public authorities and eliminated:
 - ecological continuity was restored by destroying the draining systems and reinstating the normal flow toward the Noires Feignes stream;
 - functioning of the wetland was restored by recreating the riverbed in the tributary. Previously, the small pond drained directly into the larger pond. Restoration of ecological continuity required that the water from the small pond flow directly to the Noires Feignes stream. The selected technical solution consisted of recreating a riverbed to enable the movement of fish;
 - the landscape was restored by partially lowering the dike and reprofiling the former banks.

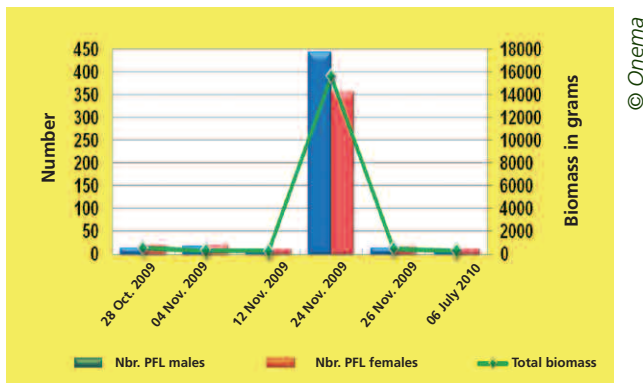
2. *Pacifastacus lenisculus* (signal crayfish).
3. Map showing the hydrographic network and the restoration work.

■ Small and large pond

■ Fall 2009:

- November 2009, slow emptying of the ponds by the owner in the presence of the State services, DDT and Onema, following the prefectural injunction;
- netting to collect a maximum number of crayfish, plus manual collection of any visible crayfish and searches in the various habitats. Over 800 crayfish were captured during the draining of the ponds;
- use of quicklime in pools remaining in the pond;
- total dewatering with filtration systems in the pond fish trap to avoid the escape of any remaining crayfish to the stream.

Numbers and total biomass of crayfish removed during the interventions in 2009 and 2010.



© Onema

■ Large pond

■ 2010, the pond was dewatered in the winter and summer, with monitoring of the filtering system and collection of the crayfish in the pond fish trap.

■ 2011:

- mechanical means were used to dredge and restructure the bed. The burrows in the banks and other habitats of the signal crayfish were destroyed;
- biological monitoring was organised on the site.

■ 2012, the pond was refilled.

■ Small pond

■ 2010, the small pond was eliminated and restoration work was undertaken for the wetland and stream.

Results and costs

■ Results

■ The measures implemented in this particular case succeeded in eliminating the population of signal crayfish found in the two ponds. Concerning the colonised stream, no work was undertaken against the crayfish population in the absence of effective techniques.

■ Costs

■ For the large pond, the costs were not calculated and fell entirely on the pond owner who had introduced the crayfish.



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4. Work to eliminate the small pond.

5. Dredging in the large pond.

6. Captured signal crayfish.

7. View of the large pond following the work.

8. Restoration of the stream on the site of the small pond.



■ The elimination of the small pond and the accompanying measures cost 25 761,84 euros including VAT and were carried out in November 2011. The work required the use of a 20-ton excavator on special “marsh tracks” and equipped with a support system to improve stability and reduce the impact on the soil.

Outlook

■ Total emptying of the colonised ponds and control over the water levels were indispensable elements in the success of the management work on the invasive crayfish.

■ This case showed that in efforts against an invasive species of crayfish, the work must be adapted to each situation and each site. It also showed that an intervention may last a fairly long time (two years in this case).

Information on the project

■ The Lorraine nature conservatory conducted a number of informational sessions on site for the owners prior to the work.

■ Several articles were published in the local press on the method and work.

Note on applicable regulations

■ The introduction of a “species likely to provoke biological imbalances”, as per articles R432-5 and L432-10 in the Environmental code, is subject to a fine of 9 000 euros.

Author: Marc Collas, Onema

For more information

■ <http://www.onema.fr/Les-rencontres-de-l-Onema>

■ <http://www.onema.fr/collection-lesrencontres-syntheses>

■ <http://www.set-revue.fr/la-gestion-des-ecrevisses-exotiques-envahissantes-dans-le-departement-des-vosges/texte>

■ Collas M., Julien C. et Monnier D. 2007. Note technique : La situation des écrevisses en France. Résultats des enquêtes nationales réalisées entre 1977 et 2006 par le Conseil Supérieur de la Pêche. Bulletin Français de la Pêche et de la Pisciculture (386) :1-39. <http://www.kmae-journal.org>

■ Collas M. 2014. La gestion des écrevisses en plan d'eau dans le département des Vosges. *In* Premières rencontres françaises sur les écrevisses exotiques invasives. Damien J-P., Gallicé A. Miossec G. et Paillisson J.M. (eds) Aesturia - Paroles des Marais Atlantiques.

■ Holdich D.M., Reynolds J.D., Souty-Grosset C., Sibley P.J. 2010. A review of the ever increasing threat to European crayfish from non-indigenous crayfish species - Knowledge and Management of Aquatic Ecosystems (2009) 394-395, 11. <http://www.kmae-journal.org>

■ Souty-Grosset C., Holdich D.M., Noël P.Y., Reynolds J.D. et Haffner P. (eds) 2006. *Atlas of Crayfish in Europe*. Muséum national d'Histoire naturelle, Paris, Patrimoines naturels, (64), 187 pp.



Pumpkinseed

(*Lepomis gibbosus*)

Originated in the Northeastern section of North America. Introduced in France in 1877 for recreational fishing and for its ornamental value in aquariums. The population is currently growing.

Description

- Adults vary in size between 8 and 15 cm
- Tall, narrow body shape
- Terminal mouth, small and slightly oblique
- Fins:
 - the tail fin is only slightly forked
 - the two dorsal fins are joined
 - the pectoral fins are long and pointed
 - the anal fin has three sharp spines
- Brilliant colours with touches of green and blue on the back and reddish spots on the sides
- Bright blue lines on the cheeks, particularly of males
- The operculum is wide with a black spot and an adjacent bright red spot in males, that is absent or less pronounced in females
- Males are larger and more brightly coloured than females

Ecology and reproduction

- Habitats include shallow waters in ponds, lakes and rivers with slow currents, fairly warm waters with abundant submergent vegetation
- Sedentary and gregarious species, active during the day, defensive of its territory
- Juveniles consume plankton, adults are carnivorous (insect larvae, crustaceans, worms and small molluscs, fish roe and larvae)
- Sexual maturity is attained at the age of 3 to 4 years (but 1 year is possible):
 - spawning from May to August in shallow waters
 - 1 500 to 3 000 eggs are laid in a nest guarded by the male up to a few days after hatching

Documentation

- Pascal M., Lorvelec O., Vigne J.D. 2006. Invasions biologiques et extinctions : 11 000 ans d'histoire des vertébrés en France. Quae, Versailles. 350 pp.
- Observational data to identify subaquatic fauna and flora (DORIS). For the fact sheet on *Lepomis gibbosus*, see: http://doris.ffessm.fr/fiche2.asp?fiche_numero=287
- Nepveu C. 2002. Les espèces animales et végétales susceptibles de proliférer dans les milieux aquatiques et subaquatiques - Fiches espèces animales (Les espèces exotiques). Agence de l'eau Artois-Picardie. 98 pp.

Author: Emilie Mazaubert, Irstea

Classification

Order	Perciformes
Family	Centrarchidae
Genus	<i>Lepomis</i>
Species	<i>L. gibbosus</i> (Linnaeus, 1758)





Pumpkinseed

(*Lepomis gibbosus*)

Proposed protocol for pumpkinseed management in the Trait marshes

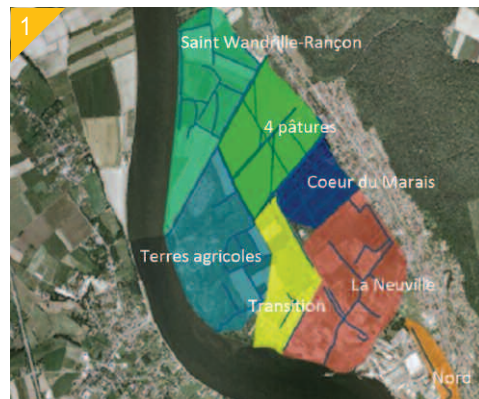
The Boucles de la Seine Normande regional nature park

- The park was created in 1974 in the Seine-Maritime and Eure departments as the Brotonne regional nature park. The name was changed to the Boucles de la Seine Normande regional nature park in April 2001.
- The main missions are to conserve natural environments, biodiversity and the landscape by:
 - setting up programmes to preserve biodiversity;
 - achieving good ecological status of water bodies in compliance with the Water framework directive (WFD) and the 2006 Law on water and aquatic environments;
 - generating knowledge through scientific research and monitoring;
 - managing and restoring environments (and notably wetlands) through direct project management or by accompanying project promoters. A management plan for the period 2011 to 2014 was set up for the marshes in the town of Trait for the Rouen-Elbeuf-Austreberthe urban area (CREA).
- In the framework of a policy to control the invasive alien species on the site, a management protocol for pumpkinseed (*Lepomis gibbosus*) was proposed.
- Contact:

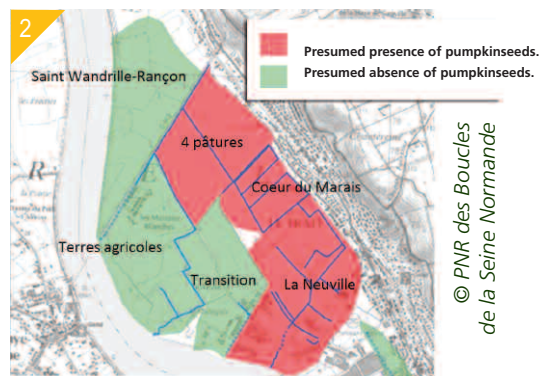
Florian Rozanska (Boucles de la Seine Normande regional nature park) - florian.rozanska@pnr-seine-normande.com
 Vincent Targosz (CREA) - vincent.targosz@la-crea.fr

Intervention site

- The protocol was proposed for the management of the pumpkinseed populations in the marshes in the town of Trait (Seine-Maritime department). Trait lies on the right bank of the Seine, approximately 25 kilometres downstream of Rouen and over 70 kilometres upstream of Le Havre.
- The Trait marshes are located in the Trait-Yainville loop of the Seine, within the floodplain of the river. The Trait marshes are a Natura 2000 site that is part of the Boucles de la Seine Aval Natura 2000 zone (FR2300123).
- The marshes cover a surface area of 114 hectares. The fish in the marshes travel via a dense network of interconnected ditches (representing a total distance of 14 325 metres).
- The hydraulic network is divided into eight sectors: “Saint Wandrille-Rançon”, “Terres agricoles”, “zone de transition”, “La Neuville”, “Nord”, “Cœur du marais”,



© PNR des Boucles de la Seine Normande



© PNR des Boucles de la Seine Normande

1. Sectors of the hydraulic network in the Trait marshes.
 2. Sectors of the marshes with pumpkinseed populations.

“Les quatre pâtures” and “Yainville” (the latter lies to the south and is not shown on the map).

- The protocol will be implemented in the sectors “Cœur du marais”, “La Neuville” and “Les quatre pâtures”.

Disturbances and issues involved

- In 2008, the park conducted an assessment on the status of the marshes in view of the future management plan. The surveys on the fish populations revealed a large pumpkinseed population.
- The species is seen as a “species likely to provoke biological imbalances” (articles L432.10 and R432-5 in the Environmental code).
- Given its reproductive capabilities, it is considered invasive and its presence can produce a number of impacts, including:
 - competition with native fish species with as a result a possible reduction in cyprinid communities;
 - possible impacts on different insect larvae, crustaceans, worms and small molluscs, but also the eggs and alevins of amphibians.

Interventions

■ Surveys of fish populations

■ A survey was conducted in 2008 to determine the status of the Trait marshes prior to setting up the management plan. It was an occasion to draw up an inventory of the ditches and other hydraulic networks in the Trait-Yainville loop.

Survey protocol:

- a trapping campaign was conducted from 9 to 12 June;
- fyke nets were set in all the ditches (three sectors) still containing water during the campaign. Seven were set in the “Cœur du marais” sector (green dots in Figure 4), five in a ditch in the “La Neuville” sector (yellow dots) and one in a ditch near the “Maisons blanches” site, between the “Terres agricoles” and “Saint Wandrille Rançon” sectors (red dot);
- the traps were checked once daily.

■ A survey was conducted in 2010 in the framework of a study specifically on eels (*Anguilla anguilla*) in certain river loops in the park, including the Trait marshes. One objective of the study was to compare the methods (fyke nets and electrofishing) employed for fish surveys. To that end, electrofishing was carried out in two sectors surveyed using fyke nets in 2008.

Survey protocol:

- electrofishing was used for point abundance sampling (PAS) on 29 June 2010;
- the sectors surveyed were “Cœur du marais” and “Nord”.

■ A survey was conducted in 2011 in the framework of an inventory of fish populations in the hydraulic networks of all the Seine loops.

Survey protocol:

- the survey on the Trait loop was carried out from 4 to 7 July 2011;
- eight fyke nets were set up for three days at three points in the “Coeur du marais” sector;
- the traps were checked once daily.



© Cephas, aquarium du Québec



3. Pumpkinseed (*Lepomis gibbosus*).
4. Positions of the fish traps in the Trait marshes.

© PNR des Boucles de la Seine Normande

Results and assessment

■ Main results of the 2008 survey

Sector	“Cœur du marais”	“La Neuville”	“Terres agricoles”
Average number of fish caught per day and per trap (CPUE)	11	6	7
Percentage of pumpkinseed caught	77 %	3 %	0 %

■ Main results of the 2010 survey

- “Cœur du marais” sector: 22.4% of the fish caught were pumpkinseeds.
- “Nord” sector: no pumpkinseeds were caught.

■ Assessment

- The data produced by the fish surveys indicate:
 - the proven presence of pumpkinseed populations in the “Coeur du marais” and “La Neuville” sectors;
 - the absence of pumpkinseed populations in the “Nord” and “Saint Wandrille-Rançon” sectors.
- The connections between the ditches in the various sectors mean that the “Les quatre pâtures” sector must be presumed to be colonised by pumpkinseeds.

■ As a result, the total length of the ditches presumed to be colonised by pumpkinseeds is thought to be 8 046 metres out of a total of 14 325 metres. It should be noted that not all of the colonised ditches are filled with water year round

■ Proposal for a pumpkinseed management protocol

■ In view of controlling the pumpkinseed population in the Trait marshes, the Boucles de la Seine Normande regional nature park devised a management protocol in 2011 for CREA. The protocol presents methods to experiment different types of traps with estimates on the human and financial resources required.

■ The experimentation phase was intended to select the best possible trap, providing sufficient catch per unit effort, based on a number of parameters:

- the type of trap (hoop net or fyke net);
- the netting mesh, between 10 and 20 mm to capture fish of all sizes;
- the size of the trap, large enough to catch several fish, but small enough that the entry is completely submerged in the water of the ditch;
- the material used for the traps, taking into account the probability of damage by mammals (coypus, muskrats) present at the site and the perception (attraction/repulsion) of the trap by fish;
- the effectiveness of the trap (bait).

■ The protocol was proposed for use on the 8 046 metres of ditches colonised by pumpkinseed:

- the ideal period for trapping is in April and May, i.e. when the marshes are not flooded and before the reproductive period in order to catch adult fish before they reproduce. If it is decided not to intervene during the spring period (e.g. low temperatures limit the activity of the fish), then the summer period (July to October) should be selected to ensure effective catches;
- the traps are laid for 24-hour periods to limit the risks of mortality and cannibalism in the traps;
- the protocol foresees approximately 20 traps laid every 4 metres (a compromise between the “inventoried” surface area and the “attractiveness” of the trap), thus covering 80 metres of ditch;
- three replicates.

■ In that the protocol is experimental, the parameters will be adjusted to meet the conditions encountered in the field and in step with the effectiveness of the traps.

■ Cost estimate:

- estimates are difficult as long as the protocol has not been finalised;
- one indication is that a trap costs between 60 and 200 euros (before VAT) depending on the size and the mesh of the netting..

Assumptions on the time required to manage pumpkinseed populations in the Trait marshes as a function of different conditions.

Length of ditch (metres)	Number of replicates	Hours required to lay and check the traps
80	1	2
80	3	6
8 046	1	201
8 046	3	603

● Outlook

- CREA will purchase four double-entry hoop nets with 10 mm netting.
- Experiments on the equipment and the method will be run to test their effectiveness as soon as the authorisation for the management work has been received. The request has been made to the State services.

Author: Sandra Fernandez, Irstea

For more information

■ Internet site of the Boucles de la Seine Normande regional nature park:

<http://www.pnr-seine-normande.com/>

■ Rozanska, F. (PNR des Boucles de la Seine-Normande). 2011.

Proposition d'un protocole pour la régulation de la Perche soleil (*Lepomis gibbosus*), Marais du Trait.





American bullfrog

(*Lithobates catesbeianus*)

Originated in North America. Introduced in the Gironde department in 1968 and later in the Sologne area.

Description

- Skin colour varies from olive green to dark brown
- Creamy white underside with yellow throat in adult males
- Length 15 to 20 centimetres from nose to cloaca, 40 cm from nose to end of fully extended hind legs
- Adults vary in weight between 500 and 800 grams
- Large-diameter tympanum:
 - equal in size to the eye in females
 - two times the size of the eye in males
- A fold in the skin runs from the eye, above the tympanum, to the base of the hind legs (no folds across the back)
- The hind feet are palmed
- The characteristic call of the American bullfrog resembles the lowing of a cow.

Ecology and reproduction

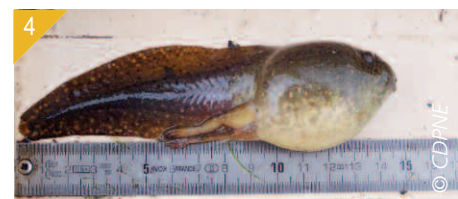
- Habitats in all types of lentic aquatic environments
- They can travel via rivers with slow currents
- Bullfrogs are active during both the night and the day
- Adults hibernate starting in the middle of the fall, tadpoles spend the winter in water
- Bullfrogs are opportunistic predators, feeding on amphibians, fish, small mammals, reptiles, insects, etc.
- Reproduction occurs between May and August, generally in the form of a single spawn comprising up to 25 000 round, transparent eggs in a gelatinous mass
- The eggs hatch after 4 or 5 days
- In France, the larvae metamorphose after 2 to 3 years and the frogs become sexually mature 2 to 4 years later

Documentation

- Sarat E. (coord.) 2012. Vertébrés exotiques envahissants du bassin de la Loire (hors poissons) : connaissances et expériences de gestion. Office national de la chasse et de la faune sauvage, Plan Loire Grandeur Nature, 128 pp.
- Nepveu C. 2002. Les espèces animales et végétales susceptibles de proliférer dans les milieux aquatiques et subaquatiques - Fiches espèces animales (les espèces exotiques). Agence de l'eau Artois-Picardie. 98 pp

Classification

Order	Anura
Family	Ranidae
Genus	<i>Lithobates</i>
Species	<i>Lithobates catesbeianus</i> (Shaw, 1802)



1. Male American bullfrog.
2. Rear foot.
3. Spawn.
4. Tadpole.





American bullfrog

(*Lithobates catesbeianus*)

2003–2007 multi-year programme for the management of American bullfrogs in the Aquitaine region

Gironde federation for fishing and the protection of aquatic environments

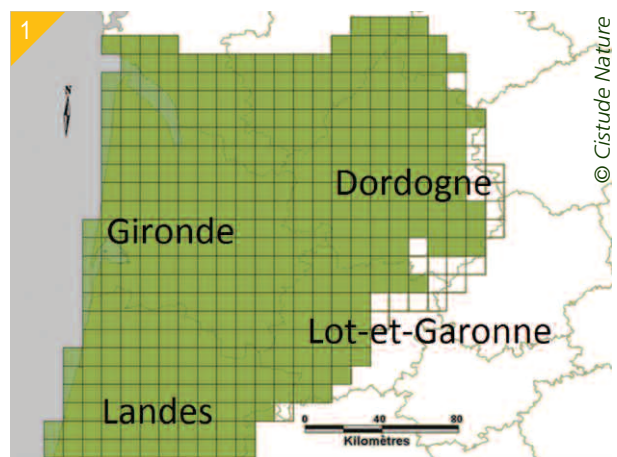
- The federation was recognised as a “public service” organisation by the Water law (30 December 2006) and operates under the stipulations of the 1901 law on non-profit associations.
- It groups 58 certified associations for fishing and protection of aquatic environments (AAPPMA) and a certified departmental association of recreational fishermen using nets and traps (ADAPAEF).
- It oversaw the 2003-2007 multi-year programme for the eradication of American bullfrogs.

Cistude Nature Association

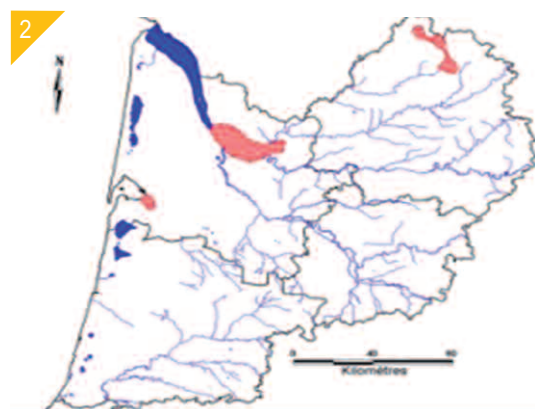
- The association provided technical and scientific management of the 2003-2007 multi-year programme to eradicate American bullfrogs.
- The main missions included:
 - managing all work in the field, including surveys, tests on traps, population monitoring (distribution, ecological characteristics, etc.);
 - training and assistance for the initial interventions in the field and for the checks on the presence of American bullfrogs;
 - work to raise awareness, consisting of distributing brochures in the mailboxes of owners of colonised sites and the drafting of announcements in the letters sent by the towns confronted with the problem.
- Contact: Matthieu Berroneau - matthieu.berroneau@cistude.org

Intervention site

- In the Aquitaine region, American bullfrogs were introduced in 1968 in the town of Arveyres. The main management issue concerning the species is the preservation of native amphibians impacted by its presence:
 - large quantities of other amphibians have been found in the stomachs of bullfrogs;
 - high densities of American bullfrogs result in inter-species competition because the animals fill an important ecological niche that is very similar to that of native species, particularly green frogs (*Pelophylax* spp.);
 - they can be a health carrier of the fungus responsible for chytridiomycosis (*Batrachochytrium dendrobatidis*), a disease that kills native species.



© Cistude Nature



© Cistude Nature

1. Area studied for the eradication programme.
2. The red zones indicate the presence of American bullfrogs in the Aquitaine region.

Disturbances and issues involved

- In the Aquitaine region, American bullfrogs were introduced in 1968 in the town of Arveyres. The main management issue concerning the species is the preservation of native amphibians impacted by its presence:
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 - they can be a health carrier of the fungus responsible for chytridiomycosis (*Batrachochytrium dendrobatidis*), a disease that kills native species.

Interventions

■ The multi-year programme to eradicate American bullfrogs

■ Objectives of the programme:

- determine the distribution of American bullfrogs in the Aquitaine region;
- understand the dispersal and colonisation mechanisms of the species;
- determine the most effective capture and eradication techniques;
- raise awareness concerning invasive alien species.

■ Numerous regional stakeholders participated, including ONCFS 40, ONCFS 33, the Landes de Gascogne regional nature park, the Périgord Limousin regional nature park, the Onema local office in Dordogne and Cistude Nature.

■ Study on the American bullfrog population in the Aquitaine region

■ The distribution of the species was determined by listening for the calls of males in two phases. During the first, seven water bodies were randomly selected in each grid sector (10 x 10 km each) and 386 sectors were surveyed. During the second phase, the sectors where the species was previously detected were divided into 5 x 5 km sectors and all water bodies were surveyed.

■ Species dispersal and colonisation mechanisms:

- radio-monitoring of 25 bullfrogs captured randomly to learn more on their vital habitats, habitat use, mortality rates and migratory movements;
- monitoring of the dispersal of juveniles by setting up nets with capture buckets (trap barriers);
- study of bullfrog diets by analysing stomach contents.

■ The results of the study were used to propose recommendations for the trapping and eradication tests:

- concentrate eradication efforts during the summer when bullfrogs gather near permanent water bodies;
- shoot the adults rather than draining and drying the ponds because almost 30% of bullfrogs hibernate outside of the water, under leaves or in burrows;
- limit development during the juvenile stage when the species disperses over short distances.

■ Trapping tests

■ In order to formulate the most effective possible protocol for the elimination of American bullfrogs, Cistude Nature conducted trapping tests on sites in the towns of Ambarès-et-Lagrave and Izon in the Gironde department.

■ 2003 and 2004, tests were run on different types of traps taking into account the biological stages of the bullfrogs.



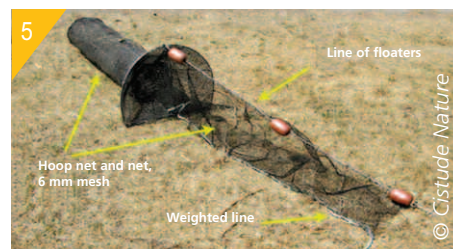
3. Trap barrier used to monitor juveniles.

4. Equipment used to collect spawns.



Trapping tests carried out in 2003 and 2004.

Year	2003	2004
Types of traps	<ul style="list-style-type: none"> ■ Hoop net for minnows ■ Hoop net for catfish ■ Fyke net made of white nylon ■ Large shelter trap ■ Small shelter trap ■ Floating shelter trap 	<ul style="list-style-type: none"> ■ Hoop net for catfish; fyke net with finer mesh, large shelter trap ■ New system with fyke nets (a net positioned near the banks in the water)
Conclusions	<ul style="list-style-type: none"> ■ The most effective traps for American bullfrogs are: ■ hoop nets for catfish to trap tadpoles and to a lesser degree juveniles, fyke nets for tadpoles, adults and subadults ■ Large and floating shelter traps for adults and subadults 	<ul style="list-style-type: none"> ■ Shelter traps are effective for adults and subadults ■ Juveniles are difficult to capture ■ Shooting is advised for adults and juveniles ■ Fyke nets were abandoned because they were too fragile and less effective than hoop nets for catfish



5. Single-entry hoop net with net.
6. American bullfrog.

- 2005 and 2006, tests were run on the best trap layout and densities for catching bullfrog tadpoles:
- single and double-entry hoop nets with attached netting, developed in conjunction with a specialised firm;
- prior to each trapping campaign, capture-mark-recapture (CMR) was carried out to determine the tadpole population and measure the effectiveness of the method.

Summary of the work done in 2005 and 2006.

Year	2005	2006
Study protocol	<ul style="list-style-type: none"> ■ Intervention on the Saint-Denis site (town of Ambarès-et-Lagrange) <ul style="list-style-type: none"> ■ CMR from 12 to 18 May ■ Intervention from 01 July to 10 August, 40 days of effective trapping ■ 30 traps laid in water, along the banks, every 8 metres 	<ul style="list-style-type: none"> ■ Intervention in the town of Ambarès-et-Lagrange <ul style="list-style-type: none"> ■ CMR in April ■ Intervention from 28 April to 08 June, 19 days of effective trapping ■ Two sessions to test the positioning of traps were run in the water body

■ Shooting trials

- Cistude Nature also participated in setting up shooting trials to determine the effectiveness of the technique in eliminating American bullfrog juveniles and adults.
- The trials were conducted in conjunction with the National agency for hunting and wildlife (ONCFS in the Gironde department), following authorisation by the Prefect, in the concerned towns from 2004 to 2006.
- The main site was located in the town of Izon.
- The method involved:
 - interventions in the pools on the Gabauds site (1 200 square metres) and in the nearby ponds (La Naude and the wastewater-treatment plant) in the town of Izon;
 - a total of six sessions from 2004 to 2006;
 - night-time hunting by a two-man team where the first person must identify the animals with a flashlight and the second shoots the identified frogs with an air rifle or a .22 long rifle;
 - retrieval of the animals immediately or during the following shooting trial.

Results

■ Study of animal populations

- Study of isolated groups spread over two departments.

Distribution of isolated populations of American bullfrogs.

Department	Gironde		Dordogne		
Sector	Libourne / St André-de-Cubzac	Arcachon bay	St-Saud-Lacoussière	Piégut-Pluviers	Thiviers
Surface area	250 km ²	12 km ²	9 km ²	6 km ²	7,5 km ²
Number of colonised water bodies	300	18	29	25	24

- American bullfrogs are a versatile species, capable of adapting to very different environments. Individuals differ widely in terms of their home range and their use of the habitat.

- Ideal sites for colonisation are those with abundant aquatic and riparian vegetation.

- Their diet varies, but consists essentially of aquatic prey:

37% amphibians (American bullfrog, green frogs (*Pelophylax* spp.) and the Mediterranean tree frog (*Hyla meridionalis*)), 32% insects and 13% crustaceans (Cistude Nature, 2007 annual report).

■ Trapping tests

- 2005:

- 5 772 tadpoles captured out of an estimated 8 400 ($\pm 2\ 200$);

- the tests were halted after 40 days because the number of catches dropped after the 30th day.

- 2006:

- a total of 9 380 tadpoles were caught (it was not possible to compare this data with the CMR results);

- trapping results were better when the traps were laid in areas with ample vegetation and when single-entry hoop nets were used with the nets running toward the bank.

■ Shooting trials

Results of the shooting trials.

Dates	01 Sept. 2004	07 Sept. 2004	03 May 2004	18 July 2004	19 July 2005	20 July 2005
Length of trial (one team)	160 minutes	190 minutes	360 minutes	220 minutes	110 minutes	105 minutes
Shots fired	26	29	38	16	8	5
Animals retrieved	16	19	20	12	4	3
Animals hit, but not retrieved	4	5	12	1	1	1



- Observations on the site following the trials:
 - no American bullfrogs were observed in September 2005;
 - one American bullfrog and large numbers of green-frog tadpoles were observed in May 2006. A shooting campaign was organised during which 12 frogs were killed and retrieved. The recommended air rifle was used because higher firing rates are possible targeting both adults and juveniles (the ammunition is inexpensive), even though it is much less powerful than a .22 long rifle.

■ Assessment

- Protocols were drafted for shooting adults, trapping tadpoles and collecting spawn.
- A plan to eradicate American bullfrogs from the Périgord Limousin regional nature park is under way using the proposed protocols.
- The project to set up an eradication plan for the Arcachon basin and the area around the town of Libourne was not launched due to a lack of funding.

Information on the project

- A total of 24 000 brochures and 350 posters were produced and distributed to raise awareness concerning the invasion of American bullfrogs and present the management programme.
- An internet site on the topic existed from 2004 to 2010.
- Information on the project was supplied via press articles as well as radio and television programmes.

Author: Sandra Fernandez, Irstea



7. Documents to raise awareness.

For more information

- Cistude Nature:
<http://www.cistude.org/>
- Cistude Nature. 2007. Rapport annuel d'activité. Programme pluriannuel de mise en place d'une éradication de la Grenouille taureau : répartition, colonisation, tests d'éradication, sensibilisation. 38 pp.
- Information on American bullfrogs on the Cistude Nature site:
<http://www.cistude.org/index.php/conservation/especes-exogenes/grenouille-taureau>





American bullfrog

(*Lithobates catesbeianus*)

Managing the American bullfrog in Sologne (Loir-et-Cher department)

Beuvron basin management board (SEBB)

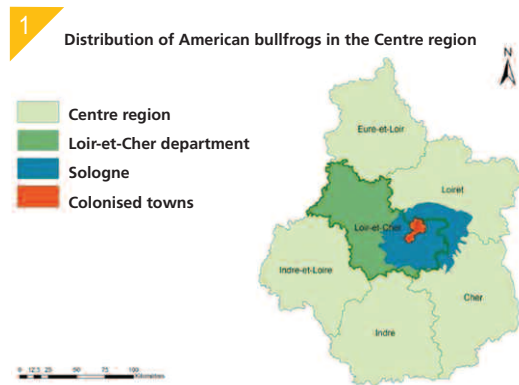
- SEBB is the project supervisor.
- SEBB is a local government created in 1996.
- Its main missions are to manage the rivers in the Beuvron basin, including restoration and maintenance of the rivers, conducting the necessary studies on river management and projects against invasive alien species (both 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

Loir-et-Cher departmental committee for the protection of nature and the environment (CDPNE)

- CDPNE is the project manager.
- It is a non-profit association.
- The main missions include managing nature reserves (Grand Pierre et Vitain national nature reserve, Pontlevoy regional geological nature reserve, Vallées aux Fleurs - Fossé archeological reserve, Grouais de Chichery - Pezou archeological and geological reserve), providing environmental training to school children and adults, consulting and environmental studies (fauna, flora, habitats, waste, water, carbon footprint).
- Workforce of 13 in the Loir-et-Cher department.
- Contact: Gabriel Michelin - gabrielmichelin.cdpne@orange.fr

Intervention site

- 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;



1. Distribution of American bullfrogs in the Centre region.

- the wine-growing section in the western part of the river basin.

- This area is home to a very large number of wetland species and is an important ecological site in Europe.
- The 10 000 hectares of stagnant waters constitute a good habitat for amphibians and the two large rivers, the Beuvron and the Tharonne, flowing through the area are open channels for movement.
- The dense network of ditches between ponds, supplying pools and along roads also facilitate the movement of aquatic species.
- American bullfrogs were first observed in Sologne in 2002.
- Since then, three towns in the middle of the ponds section of Sologne have been colonised.

Disturbances and issues involved

■ Impacts on native species

- There is a significant loss of biodiversity on colonised sites due to competition and predation. In Sologne, analysis of stomach contents revealed that the bullfrogs consume amphibians, invertebrates, reptiles, fish and even small mammals and birds. American bullfrogs represent a direct threat to 13 protected species of amphibians.
- The species is also a healthy carrier of chytridiomycosis, a pathology transmitted to native amphibians. In Sologne, the Chytridiomycota phylum was analysed and found to be non-lethal.



■ Impacts on land use

- Competition with and predation on fish communities, i.e. impact on fishing. It is necessary to check any caught fish to avoid transporting American bullfrog tadpoles outside the colonised areas.
- Direct predation of alevins.

Interventions

In Sologne, a management programme was established for the period 2003 to 2008. During that time, a number of elimination methods were tested. On the basis of the results obtained over the five-year period, an eradication programme was established for the period from 2009 to 2013 using the most effective techniques.

■ Environmental monitoring

- Monitoring was conducted prior to the eradication operations on colonised and nearby sites to pinpoint the range of the species and the invasion front.
- The work was initiated at the end of the month of May when American bullfrogs exit hibernation.
- A large-scale survey was run in 2009 on 9 areas, each comprising 10 sectors (2 x 2 km) in the colonised territory, covering a total of 36 000 hectares (219 ponds in 11 towns).
- A team of 2 people inspected each area twice.
- Night-time listening:
 - the team went to 2 sites in each sector and listened for 15 minutes. If calls were heard in a sector, all sites in the sector were then inspected during the day;
 - in addition to listening, searchlights and binoculars were used, as were dip nets to find tadpoles.
- Daytime inspections:
 - observations using binoculars for adults, juveniles and spawn, dip nets for tadpoles and spawn;
 - using binoculars, between 1 and 10 observations were made on each site (10 minutes per observation, every 100 metres);
 - using a dip net, 3 samples were taken on each site in vegetation-rich areas in order to catch tadpoles;
 - since 2010, standard monitoring techniques have been used during the daytime on small sites and environmental-DNA monitoring has been used on larger sites.
- Environmental DNA:
 - this technique has been used since 2011. It consists of detecting in water samples DNA fragments left by organisms in the environment (see Figure 4);
 - the technique enhances species detectability when small numbers of the species inhabit the site, provides information on the invasion front and can be used to check that a species has been effectively eradicated from certain ponds;
 - it takes much less time in that more precise detection can be achieved in 2.5 times less time than a standard survey at night using searchlights;
 - in 2013, water samples (one every 20 metres along the banks on each site) were taken on two different days during the last half of July and sent to a lab (Spygen in the Savoie department) for analysis.



2. Adult female frog, 550 grams, with a 77 cm grass snake in its stomach.
3. Sorting American-bullfrog tadpoles following their capture in a pond.
4. Drawing water samples for analysis using environmental DNA to detect the presence of American bullfrogs.

■ Work to control the population of American bullfrogs

- A number of methods are used in parallel.
- Search and remove spawn:
 - spawn is destroyed as soon as it is discovered to prohibit the reproduction of the population;
 - this work has been carried out since 2006 on priority sites;
 - every 4 days, a team inspects the sites.
- Shooting campaigns:
 - the work is done at night (22.00 to 05.00) in teams of two people, two nights per week;
 - following authorisation by the Prefect;
 - males are located by their calls, females and juveniles are located using a searchlight;
 - the targets are first checked prior to shooting to avoid confusion with green frogs;
 - assistance has been provided by ONCFS since 2002 and by volunteers since 2010.
- Trap barriers, fishing and draining of ponds:
 - barriers are a means to catch all the amphibians entering or leaving a site;
 - the traps are checked daily to free the native species;
 - seine fishing is used to catch the fish prior to draining ponds.
- Screens are placed in outlets to block the passage of tadpoles:
 - once the water level has dropped, the tadpoles can be removed.

Results and assessment for the period 2003 to 2013

■ Environmental monitoring

Since 2002, American bullfrogs have been detected on a total of 90 sites. In 2013, 37 sites were colonised in the beginning of the year and 22 were still colonised after the management work.

The species had been completely eradicated from 20 sites by 2013.

■ Work to control the population of American bullfrogs

- Removal of 11 spawns from 7 sites, compared to 57 on 20 sites in 2012. Tadpoles were found on 10 sites in 2012, but on only 3 sites in 2013.
- Shooting, organised in 68 sessions on 32 sites, eliminated 96 bullfrogs weighing over 100 grams and 891 weighing less than 100 grams. Since the start of the shooting campaigns, the average weight of adult bullfrogs has dropped from 461 to 200 grams, i.e. a drop of over half the average weight of the eliminated bullfrogs compared to the initial measures launched in 2003.
- The species continues to reproduce on only 10 sites and the number of reproducers per site has dropped from 9 to 3.
- Only one site was fished and drained in 2013 and no bullfrogs were caught

■ Human resources in 2013

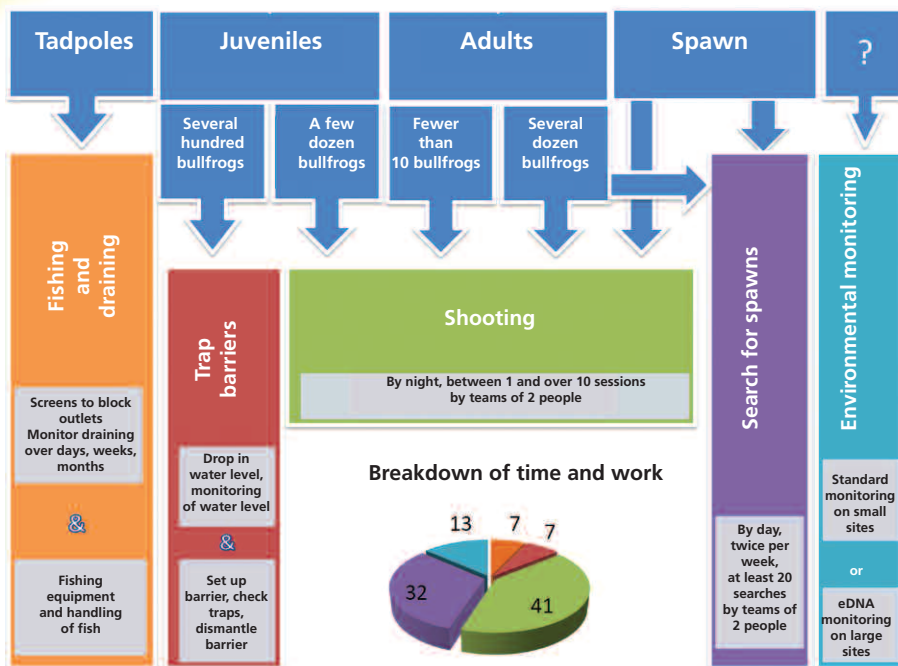
- 52 man-nights by volunteers.
- 69 man-nights with funding.
- 32 volunteers.

■ Coût du programme 2009-2012 : 342 645 €

- Of which, 15 850 euros (85 kits) for environmental-DNA analysis.



5. A team for night-time shooting.
6. Barrier and traps set up for American bullfrogs around a pond.
7. Document to raise awareness.



Source: Departmental committee for the protection of nature and the environment 2014

Decision aid for the work required on sites depending on the biological stage of the species.

■ Funding

- Pays-de-Grande-Sologne (LEADER programme) (32%);
- Centre region (25%);
- Centre regional environmental directorate (14%);
- SEBB (17%);
- Beauval Nature association (12%).

Information on the project

- Annual reports were produced on the preliminary and operational phases.
- Efforts were made to raise the awareness of the general public (brochure, public meetings).
- A documentary film was made by Philippe Henri, titled "La Grenouille taureau, une intruse en Sologne".
- Articles appeared in the press.
- Scientific articles were published in "Science Eaux et Territoires" and in a collective document on the Loire Grandeur Nature plan.
- Presentations of the work have been made in symposia and in professional training courses.

Outlook

- The results of the management plan are positive, but the work must be pursued on approximately 30 sites.
- The 2009-2013 programme ended and the search has begun for funding partners in 2014. Plans are being made for a national programme on invasive amphibians.
- Future work:
 - continued monitoring using the environmental-DNA technique;
 - inspections for spawns and shooting campaigns primarily on sites where reproduction of juveniles has been observed (36 priority sites).

Author: Emmanuelle Sarat, Comité français de l'UICN

For more information

- www.bassin-du-beuvron.com
- www.cdpne.org
- The initial version of this document was first published in: Sarat E. (coord.) 2012. Vertébrés exotiques envahissants du bassin de la Loire (hors poissons) connaissances et expériences de gestion. Office national de la chasse et de la faune sauvage, Plan Loire Grandeur Nature, 128 pp.
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American bullfrog

(*Lithobates catesbeianus*)

Managing the American bullfrog on Vancouver Island, BC, Canada

Context and issues involved

- Vancouver Island is the largest island on the western coast of North America (32 134 square kilometres). The species was introduced to the island after the Second World War, in the framework of a project for war veterans in view of breeding the animals for human consumption. The commercial endeavour was a failure and the American bullfrogs were released to the natural environment.
- The species dispersed via small populations along the entire south-eastern coast of the island and to a number of nearby, smaller islands. It has also spread to the city of Vancouver and the nearby coastline.
- American bullfrogs compete with several species of native frogs, including the northern red-legged frog (*Rana aurora*), the foothill yellow-legged frog (*Rana boylei*) and the Pacific tree frog (*Pseudacris regilla*). They are also a healthy carrier of *chytridiomycosis*, a disease causing death in native amphibian species.
- In 2006, a programme was launched by the Water department (Vancouver regional authorities) to design, field test and improve new equipment and techniques to capture the American bullfrogs.

Interventions

- Modified electrofishing equipment was used. A prototype of an electrofrogger shock wand was developed and subsequently patented in 2012. The wand is supplied with power from a 24 V battery.
- The manual capture technique targeting adult and juvenile American bullfrogs was tested three years, from 2007 to 2009, on two sites colonised by the species since 2006, namely Amy Pond and Glen Lake.
- Capture operations:
 - adults and juveniles are caught at night, from April to October, using a boat;
 - the team consists of 2 people;
 - each operation lasts 4 hours;
 - operations are conducted 3 to 5 nights per week, depending on the weather conditions;
 - bullfrogs are located using a searchlight and listening for calls;
 - one person manoeuvres the boat, the second locates and catches the adults and juveniles;
 - blinded by the searchlight, the bullfrogs tend to freeze;



1. Study site and distribution of American bullfrog populations on Vancouver Island.

- the electrofrogger shock wand generates an electric field on the water surface approximately 50 centimetres in diameter around the targeted bullfrog. The electric field temporarily paralyses the bullfrogs for 30 seconds, enough time to catch them;
- the captured bullfrogs are placed in a modified freezer that reduces their body temperature to 2°C. After 12 hours, the bullfrogs are transferred to a standard freezer where they die.

Results and assessment

■ Results from 2007 to 2011

At the end of the season in 2009, the two age groups (adults and juveniles) of American bullfrogs had been eliminated from the two sites:

- Amy Pond, spawning was blocked starting in 2007 by eliminating the adults prior to the reproductive period. In 2009, there were no longer any tadpoles on the site, however a few juveniles arrived from nearby ponds.
- Glen Lake:
 - in 2007, a single spawn was observed in the lake, as well as a few tadpoles first observed in 2006;
 - during the summer of 2007, management operations focussed on areas with high densities of juveniles. The presence of many thickets and willows made the work difficult;

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- in 2009, a few adults and juveniles from nearby ponds were observed.

■ Financial aspects

- The average cost of a night of work was 400 Canadian dollars (276 euros). A total of 3 361 bullfrogs were caught, for an overall cost of 25 600 CAD (17 100 €) over 3 years on the two sites.
- From 2006 to 2014, over 30 000 American bullfrogs were caught in approximately 20 colonised lakes on the Saanich peninsula.



2. Capturing American bullfrogs.

Table showing the operational results and costs (2007 to 2011).

Site	Perimeter	Nights			Bullfrogs captured			Annual cost (€)			Bullfrogs captured over 3 years	Total cost (€)
		2007	2008	2009	2007	2008	2009	2007	2008	2009		
AMY POND	0.4 km	8	10	5	871	661	55	2 200	2 700	1 400	1587	6 300
GLEN LAKE	2 km	16	16	9	1376	366	32	4 400	4 400	2 000	1774	10 800
TOTAL		24	26	14	2247	1027	87	6 600	7 100	3 400	3361	17 100

Information on the project

- The electrofrogger shock wand was patented and the equipment will be marketed in conjunction with the Smith-Root company.
- An article was published in the IUCN document titled *Island Invasives, eradication and management*.
- The bullfrog control group works with CABI on invasive alien species (*Invasive species compendium*).
- An article was published in *Neobiota* on the stomach contents of American bullfrogs.

Outlook

- In the two study areas, where a single case of successful reproduction was observed, eradication should be possible after three more years of work.
- Sites that have been colonised for longer periods will require operations spanning more time. Early detection is of the utmost importance.
- The electrofrogger shock wand has no effect on tadpoles. Additional management measures (draining, seine netting) are required to control this development stage.
- The degree of effort required varies from one site to another, depending on the local situation (accessibility, layout, proximity to a colonised site and migratory habits of American bullfrogs).
- The management work has been done since 2006 in the Victoria basin on Vancouver Island.
- From 2007 to 2011, the work was conducted on 16 sites and 445 passage ways. A total of 15 508 bullfrogs were removed. However, the species continues to progress.
- Local authorities are considering additional measures (habitat restoration, informing and raising the awareness of the public).
- The management work will be pursued and reinforced with the creation of a second team in 2014. The work will be carried out on over 20 lakes along a corridor on the isthmus of the largest peninsula and focussing on areas recently colonised by American bullfrogs.

For more information

- www.smith-root.com
- www.bullfrogcontrol.com
- www.crd.bc.ca
- Shock wand for aquatic creatures. U.S. patent number 8 091 269. United States Patent and Trademark Office.
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- City of Langford. 2012. Park, recreation, culture and beautification committee. Bullfrog eradication program results, 2011. 5 pp.
- Errico C. 2013. American bullfrog management on Vancouver Island. 20 pp.



African clawed frog

(*Xenopus laevis*)

Originated in South Africa. Introduced in France in the 1950s for biological research. Unintentional introduction (escape from a breeding centre) in the Deux-Sèvres department in the 1980s.

Description

- The eyes are located on the upper part of the head
- Colours vary depending on the environment, from yellowish to brown with spots
- Sexual dimorphism in adults with females 11 to 14 centimetres in size and males 6 cm
- The rear feet are palmed with three dark claws
- The front feet are short and characteristic in shape
- The frogs have whitish "ribs" along the side
- Tadpoles have two barbels and move in groups with their head facing downward
- The frogs are thought to live for over 15 years

Ecology and reproduction

- Habitats span a wide range, including human-impacted and highly modified environments, notably stagnant aquatic environments (pools, ponds and lakes), rivers, canals, etc.
- The highest population densities are found in eutrophic waters
- The animals can migrate in large numbers if reproduction ponds begin to dry up and the weather is fairly wet
- The diet consists essentially of invertebrates, but direct predation of fish and amphibians is also possible
- The reproductive potential is high with 2 to 3 spawns per year (several thousand eggs each) and with females arriving at sexual maturity at the age of 6 to 8 months

Documentation

- Sarat E. (coord.) 2012. Vertébrés exotiques envahissants du bassin de la Loire (hors poissons) : connaissances et expériences de gestion. ONCFS, Plan Loire Grandeur Nature, 128 pp.
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- Tinsley R., Minter L., Measey J., Howell K., Veloso A., Núñez H. et Romano A. 2009. *Xenopus laevis*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. www.iucnredlist.org.

Author: Emilie Mazaubert, Irstea

Classification	
Order	Anura
Family	Pipidae
Genus	<i>Xenopus</i>
Species	<i>Xenopus laevis</i> (Daudin, 1802)



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1. Rear foot.
2. Front foot.
3. The "ribs" along the side.
4. Different stages of tadpole development.





African clawed frog

(*Xenopus laevis*)

Managing the African clawed frog in the Argentonnay area

Bressuire urban area (Agglo2b)

■ This management project was carried out from 2011 to 2013 by the Argentonnay intermunicipal association (CCA). Following the local-government reform, the CCA was folded into the Bressuire urban area (Agglo2b) on 1 January 2014.

■ One of the responsibilities assumed by Agglo2b concerns the protection and development of the environment and of living conditions:

- restoration, maintenance and preservation of rivers, management of the Argenton valley Natura 2000 site;
- management of invasive species with an action plan against the African clawed frog initiated in 2011.

■ Contact:

Centre for the environment and sustainable development:
Guillaume Koch, environmental policy officer - guillaume.koch@agglo2b.fr and Benjamin Audebaud, environmental technician - benjamin.audebaud@agglo2b.fr

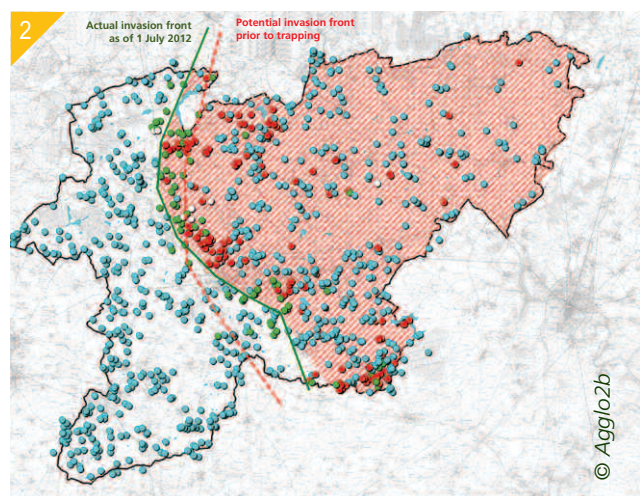
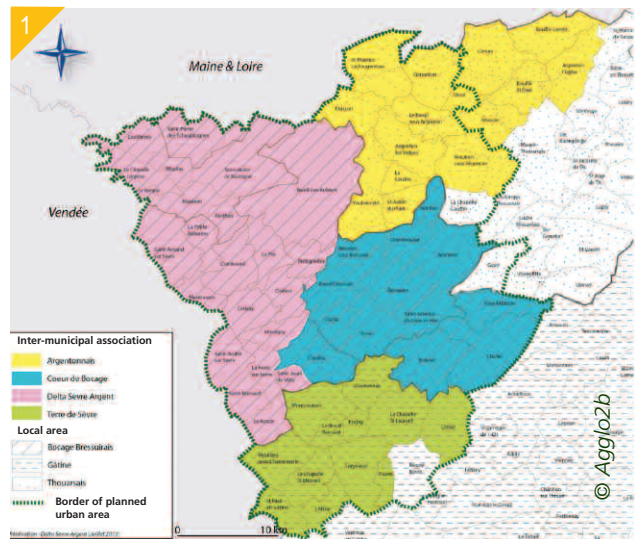
Intervention site

■ The Argentonnay area

- This area is crossed by the Argenton River which flows through several types of territory, ranging from bocage landscapes to plains. Fauna and flora are particularly rich and diversified, including the European otter.
- The main economic activity is farming. The crops in the plains give way to meadows in the bocage areas where hedgerows still exist and there are pools in virtually each plot of land, for the greater benefit of amphibians.
- The area colonised by the African clawed frog covers a surface area of between 102 and 139 square kilometres in 26 towns, including 11 in the Maine-et-Loire department and 15 in the Deux-Sèvres department (2012 estimates).

■ Distribution of the African clawed frog

- First reports of African clawed frogs were made following the discovery of a few colonies in the Argentonnay area in 1998. The unintentional introduction occurred in the 1980s when the animals escaped from a breeding centre run by the National scientific research centre (CNRS) in the town of Bouillé-Saint-Paul.
- In 2012, traps were set in 201 water bodies and African clawed frogs were caught in 113.



1. The Bressuire urban area.
2. Invasion front of the African clawed frog in 2012

Disturbances and issues involved

■ Impacts on native species

- Predation on amphibian eggs, notably those of the marbled newt (56% of plant stalks had at least one newt egg in water bodies without African clawed frogs compared to only 9% in water bodies where the African clawed frog was present).
- On the basis of stomach contents, the frogs consume the larvae and adults of amphibians, as well as fish, insects and molluscs.
- Species richness has dropped in colonised areas over the past few years from 3.2 species in areas without African clawed frogs to 1.8 in those with.

■ Impacts on ecosystems

- The frogs interfere in food webs and in species successions.

■ Impacts on animal health

- The species is suspected of transmitting diseases to native amphibians (salmonellosis, sparganosis and especially chytridiomycosis for which the species is a healthy carrier)

Interventions

- Two studies, conducted from 2003 to 2008 by environmental-protection associations with support from the Deux-Sèvres departmental council and the Loire-Bretagne water agency, determined the distribution and rate of advance of African clawed frogs in the Argentonay area and their impact on the native species. A number of management methods were tested.
- Following the studies, the species was listed as invasive first on the regional level (2009), then on the national level (ministerial decree dated 30 July 2010).

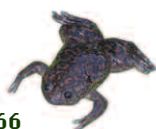
■ Tests on different management methods

Chemical method

- The resistance of African clawed frog adults and larvae to different concentrations of Rotenone, an organic substance naturally produced by certain tropical plants, was tested. The substance is toxic for many species of poikotherm (cold blooded) animals. The use of Rotenone in aquatic environments was subsequently prohibited in France in 2009.
- Ten frogs were placed in 100-litre containers with different concentrations of Rotenone (300 ppm, 600 ppm and 1 200 ppm):
 - 83% of the frogs died from the 300 ppm concentration after 7 to 9 hours of exposure;
 - 50% of the frogs died from the 1 200 ppm concentration after 90 minutes of exposure;
 - 50% of the larvae died from the 300 ppm concentration after 90 minutes of exposure.
- The use of Rotenone produced useful results, but could lead to the death of other species if it is used in the natural environment.
- The same protocol was used to test the resistance of African clawed frog adults and larvae to quicklime (0.4 grams per litre):
 - no deaths were observed;
 - burns and non-lethal alterations to limbs were nonetheless observed.



3. African clawed frog.



Mechanised method

■ A standardised trapping technique was employed using hoop nets baited with kibble or liver:

- at least one trap was installed for every 100 square metres of water body;
- the traps were checked every morning for five days;
- the captured African clawed frogs were counted.

■ Seine nets were used on occasion in the water bodies where reproduction was observed (presence of large groups of tadpoles).

■ If the tipping point (a reduction in the number of African clawed frogs caught) was not reached after one week, trapping continued to achieve effective results.

■ Local action plan in the Argentonnay area

■ In 2011, the Argentonnay intermunicipal association (CCA) launched an action plan over its entire territory and hired a policy officer to ensure its implementation. The tasks of the policy officer included the points below.

■ Trapping of adults and tadpoles from April to November:

- traps were set in 15 to 20 water bodies per week, starting from the invasion front and heading toward the source;
- the hoop nets were not fully submerged in order to avoid killing non-targeted species;
- the traps were laid on Monday and checked every day until Friday. If frogs were still being trapped toward the end of the week, trapping was continued the next week;

- tadpoles were caught using a seine net (fine mesh, 0.5 x 0.5 cm) and dip nets;
- on private property, direct access was possible thanks to the previous information efforts addressing the owners, who also participated in the trapping work (an agreement was signed with CCA for the provision of the equipment and recommendations);
- captured frogs were put to death by freezing and then transferred to the rendering service.

■ Monitoring of native amphibians in parallel with trapping:

- night-time visits to count amphibians using searchlights;
- counting of amphibians accidentally caught in the traps;
- a monitoring sheet (environment, species) for each water body was used in conjunction with a geographic information system.

■ Provision of information year round to the population:

- on different topics, e.g. African clawed frogs and other invasive species, native amphibians, aquatic environments, food chains, etc.;
- to different groups, e.g. school classes, elected officials, owners of water bodies.

■ Monitoring the impacts of the action plan:

- visits to previously trapped water bodies, one week, month and year later;
- monitoring over several years of other amphibian species before and after trapping;
- assessment of captures to determine any changes in the distribution of African clawed frogs.



4. 5. 6. Preparation and installation of hoop nets for African clawed frogs.

Results and costs

■ Results

Table of the main results.

Water bodies trapped	295
Water bodies with proven presence of the species	174
Water bodies seine netted	24
Frogs captured	
Adults	15 792
Juveniles (< 4 cm nose to cloaca)	1 948
Tadpoles	62 174
Number of owners met	≈ 100
Owners participating in trapping	23
Informational meetings held	42
Total number of people informed	> 1 000

■ Costs

■ Total cost of management operations from June 2011 to June 2013 = 64 300 euros, including:

- 49 250 euros for payroll costs (policy officer);
- 8 300 euros for personnel costs (vehicle, clothes, etc.);
- 4 000 euros for equipment (hoop nets, seine nets, dip nets, etc.);
- 2 000 euros for informational material;
- 360 euros for storage material;
- 390 euros for mapping of data.

Sources of funding for the management plan.

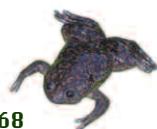
Source of funding	%
Poitou-Charentes regional council	20
Deux-Sèvres departmental council	40
CCA (internal funding)	40

Outlook

- Expand the action plan to neighbouring areas (Thouarsais, Saint-Ventais, southern section of the Maine-et-Loire department) to ensure the effectiveness of trapping over the long term.
- Inform a maximum number of persons (land owners, farmers, the public, etc.) to create an area-wide surveillance network for early detection of sites colonised by the African clawed frog.
- Use the environmental-DNA technique to detect the presence of the species (in conjunction with the standard method in the field).
- Study the long-term impacts, the foreseeable final distribution, the most heavily used dispersal channels, behavioural traits of assistance in capturing the species, the most critical developmental stages, etc.



7. Captured African clawed frogs.
8. A presentation to a school class.



Information on the project

- A brochure presenting the African clawed frog and the action plan was published.
- A sequence on the issue was aired on 7 June 2011 on a regional television news show.
- Information has been provided on local and national radio shows.
- Articles have been published in the press.
- A poster presents the species, its origin, distribution and impacts.
- Half-day field sessions were organised by ONCFS on the African clawed frog in 2012 and 2013, during a continuing-education course on invasive alien vertebrates in the Loire basin.
- The results of the action plan were presented during symposia and workshops, and notably the Meetings on invasive alien species in the Loire basin, held on 29 and 30 October 2013 in Tours.

Author: Guillaume Koch and Benjamin Audebaud, Agglo2b, Emmanuelle Sarat, IUCN French committee and Emilie Mazaubert, Irstea



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9. A brochure on African clawed frogs

For more information

- The initial version of this document was first published in:
Sarat E. (coord.) 2012. Vertébrés exotiques envahissants du bassin de la Loire (hors poissons) : connaissances et expériences de gestion. Office national de la chasse et de la faune sauvage, Plan Loire Grandeur Nature, 128 pp.



Red-eared slider turtle

(*Trachemys scripta elegans*)

Originated in North and Central America. Imported in France up to 1997 as a pet.

Description

- Yellowish stripes along the head and neck
- Characteristic red "ears" posterior to the eyes
- Shell up to 24 cm (males) and 29 cm (females) long in adults:
 - black carapace (yellow and light-green stripes in juveniles)
 - yellow plastron with dark-green spots
- Average adult weight is 3.2 kilograms
- Sexual dimorphism in adults with, for males:
 - a longer and thicker tail
 - larger claws on the front feet
- Maximum life span approximately 30 years

Ecology and reproduction

- Habitats in many types of aquatic environments, primarily in stagnant water
- Carnivorous diet for juveniles and omnivorous for adults
- Reproductive activity starting at an age between 3 and 8 years
- Mating in the spring and/or fall
- Females lay eggs once or twice per year, approximately a dozen eggs in nests dug into banks
- Incubation for 70 to 90 days
- Newborn vary in size between 23 and 35 mm

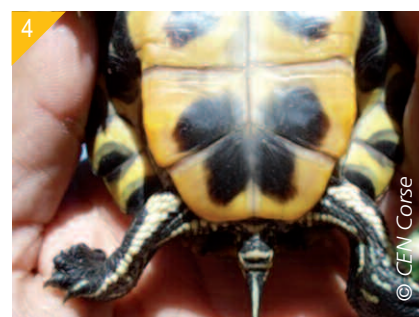
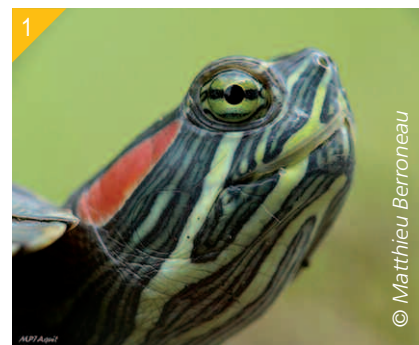
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Author: Emilie Mazaubert, Irstea

Classification

Order	Testudines
Family	Emydidae
Genus	Trachemys
Species	<i>Trachemys scripta elegans</i> (Wied, 1839)





Red-eared slider turtle

(*Trachemys scripta elegans*)

Management programme for red-eared slider turtles on Corsica (Corse)

Corse nature conservatory

■ The Friends of the Corse regional nature park association (non profit), created in 1972 and a member of the Federation of conservatories for natural areas since 1992, became the Corse nature conservatory (CENC) in 2011.

■ The main missions include:

- sustainably managing and preserving the ecologically important natural sites through land purchases and controlled use;
- improving knowledge on the habitats and species present on natural sites, whether managed or not by CENC;
- promoting sustainable development of the island by reconciling the preservation of natural areas with human activities;
- enhance the value of the natural environment in the eyes of the general public through events, on-site developments and naturalist excursions.

■ Contacts: Julie Peinado - julie.peinado@espaces-naturels.fr, Richard Destandau - richard.destandau@espaces-naturels.fr, Valérie Bosc - valerie.bosc@espaces-naturels.fr

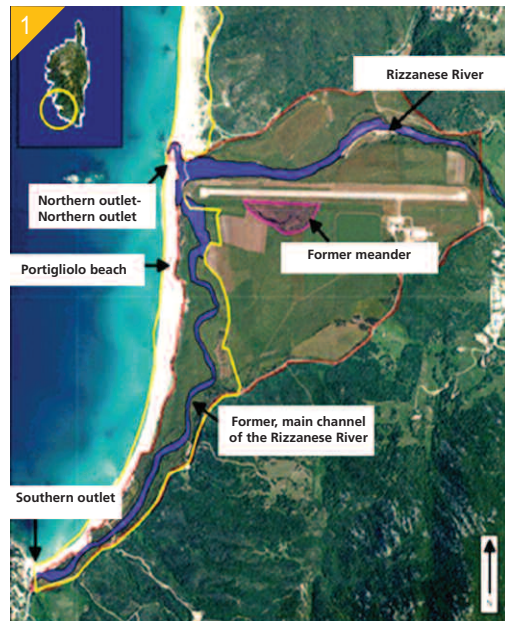
Management programme for red-eared slider turtles 2009-2011

■ The programme was funded by the Corse regional environmental directorate and the Rhône-Méditerranée-Corse water agency.

■ A scientific committee for the project included members from the National scientific research centre (CNRS) in Montpellier and from INRA in Rennes.

■ The project consisted of two main parts:

- “preparation of a method to manage and limit the populations of *Trachemys scripta elegans*” by acquiring knowledge on the biology and ecology of the subspecies in the area where it was introduced, acquiring experience in trapping and by testing the devised method;
- “raising awareness and informing on the issues concerning the subspecies and new pets in general”.



© CEN Corse

1. The sectors where trapping took place.

Intervention site

■ The programme study and work site (outlined in red on the map) is located at the mouth of the Rizzanese River, at the southern end of the Gulf of Valinco in the town of Propriano.

■ On arriving near the coast, the Rizzanese River forms a vast wetland of 180 hectares. The mouth of the river was divided into two outlets by the construction of the Tavarica airport in 1974:

- the channelised, northern outlet that became the main outlet;
- the southern outlet located at the end of the former, main channel of the river that is now a string of small water holes that are periodically interconnected. The old channel and the Portigliolo beach are listed as a type-1 ZNIEFF (natural zone with high ecological value) and are part of the Rizzanese outlet and Olmeto beaches Natura 2000 zone (outlined in yellow on the map) that is managed jointly by CENC, the Seaside and Lake Conservation Trust and the Corse-du-Sud departmental council.

■ In 2009 and 2011, studies were conducted on several sectors of the site whereas in 2010, the studies dealt exclusively with a former meander now cut off from the river (outlined in pink on the map).

Disturbances and issues involved

■ Red-eared slider turtles (*Trachemys scripta elegans*) were first observed and captured on the study site during a study on European pond turtles (*Emys orbicularis*) conducted from 2002 to 2008.

■ Management of the invasive subspecies is an important ecological issue in that it can impact native turtle species and European pond turtles in particular, the sole freshwater turtle in Corsica listed in Annexes II and IV of the Habitats directive and listed as “near threatened” in the Red list of threatened species in France (reptiles and amphibians) drawn up by IUCN France.

■ To date, the impacts have not been extensively studied and not a great deal is known, however a number of studies, including those by Cadi and Joly (2003, 2004) and Verneau *et al.* (2007 and 2009 not published; 2011) indicate that:

- competition exists and is being won by red-eared slider turtles, particularly for access to sunning spots, which leads to loss of weight and higher mortality rate for European pond turtles;

- exogenous parasites carried by the red-eared slider turtle are transferred to native turtles, including the European pond turtle.

■ In 1998, the EU prohibited the import of red-eared slider turtles into Europe (EC No 2473/98). In France, possession of the *Trachemys* species is subject to authorisation (ministerial decree dated 10 August 2004) and since the decree dated 30 July 2010, it has been prohibited to release red-eared slider turtles to the natural environment.

Interventions

■ Study of animal populations

■ To improve the available knowledge on red-eared slider turtles and set up an effective management technique, CENC launched a study on the population on the Rizzanese site in the framework of the 2009-2011 programme.

■ The objectives of the study were to:

- determine the population size and structure, and its success in reproducing;
- learn more on the phenology of the subspecies;
- monitor site occupation and the movements of individual turtles;
- inspect upstream sites to detect any isolated population groups.

■ The methods employed included:

- capture-marking-recapture (CMR);
- radio-monitoring;
- observations using binoculars to assess the relative abundance in each type of environment.

■ Trapping campaign

■ In order to offer managers with an effective management technique for red-eared slider turtles, CENC conducted tests in different phases.

■ **Phase 1 in 2009.** Trapping test to compare four different types of traps (fyke nets, sundeck turtle traps, cage traps, hoop nets) in two different types of environment.

Study protocol:

- CMR technique;
- traps of one type were laid in each of the four sectors for one week;
- four trapping sessions were conducted during the month of July;
- the captured turtles were measured, weighed and marked. Their sex and age were estimated..



2. Red-eared slider turtle (*Trachemys scripta elegans*).

3. Work sectors (Phase 1). Free-flowing river circled in blue and stagnant areas in green.

4. Hoop net.



■ **Phase 2 in 2010.** Attempt to eradicate the turtles in the former meander and assessment of the attempt. The meander was selected because it is isolated and because of the large number, on the basis of the population study, of red-eared slider turtles living there.

Protocol:

- traps were set along the banks, one trap every 15 metres, including 38 hoop nets from 8 June to 31 August, 5 fyke nets and 15 sundeck traps from 1 to 16 September;
- traps were removed two weeks after the last capture;
- they were checked once daily, toward the end of the day;
- the captured turtles were euthanised (frozen).

■ **Phase 3 in 2011.** Trapping campaign in three sectors in the northern part of the site.

■ The protocol was the same as for Phase 2, but only hoop nets (approximately 40) were used.

Results and costs

■ Study of animal populations

■ Main results of the three-year study period:

- 84 turtles were identified (including one dead) on the site, with 35 juveniles and 48 adults, of which 70% were female;
- in the former meander, the estimated population consisted of 46 red-eared slider turtles and 120 European pond turtles;
- the preferred habitats are stagnant waters surrounded by reed beds, located in the northern part of the study zone (with maximum densities in the former meander);
- three red-eared slider turtles were observed upstream of the study zone.

■ Trapping campaign

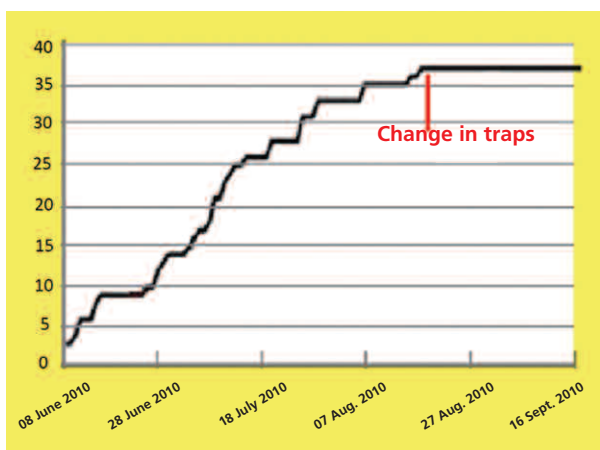
■ Phase-1 results:

- hoop nets were the most effective in the two types of environment;
- turtles were caught in the hoop nets on a regular basis throughout the trapping campaign;
- a larger number were captured in the area around the former meander.

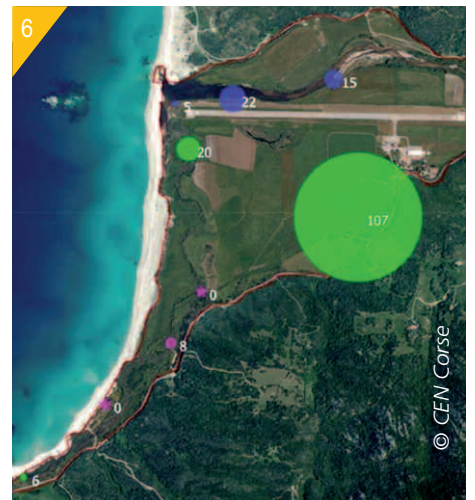
■ Phase-2 results:

- a total of 37 turtles were captured over the 101 days (out of the estimated 46 turtles present), including 12 juveniles and 25 adults;
- more captures were made in narrow, sunny sectors out of the wind, with natural sunning areas.

Cumulative number of captured turtles (Phase 2).



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5. Work sectors (Phase 3).

6. Distribution of observed turtles according to the type of habitat (green = reed bed, blue = running water, pink = stands of salt cedar/irises).

7. Informational poster.

■ Phase-3 results:

- a total of 34 turtles were captured;
- the results confirmed and provided further information on the data from 2010. A large number of turtles were captured in areas around reed beds, in narrow (side) channels with steep banks, deep water (at least 1.5 to 2 metres), out of the wind, but well exposed to the sun.

■ Results of the "management" section of the programme

- In the lower Rizzanese valley, the red-eared slider turtle population is capable of reproducing and dispersing, and has been observed upstream.
- The trapping technique is effective in confined and isolated areas, but did not eradicate the species. During the project, only 72 of the 84 identified turtles were captured.
- Management costs over the 3-year period amounted to 79 500 euros (34 500 in 2009, 25 000 in 2010 and 20 000 in 2011).

Outlook

- The distribution map for the subspecies in Corsica will be updated.
- A network of managers will be created to feed a joint database and share results and information.
- The stakeholders in the network will be trained on monitoring and capturing red-eared slider turtles.
- A technical guide will be drafted for the managers.
- Trapping will be conducted in Corsica.e.

Information on the project

- Informational documents were prepared and distributed from 2010 to 2012:
 - a three-part document (5 000 copies), comprising a description of the subspecies, a presentation of the work done and an observation sheet, was distributed to organisations involved in protecting and/or managing natural areas, stores and veterinarians;
 - an exhibition with a total of six panels;
 - an informational poster (1 000 copies) with a sticker;
 - teaching material (booklet and kit) for the "Turtles and more" campaign intended for school children and the general public;
 - pages on the CENC site on the red-eared slider turtle programme, providing access to the informational documents and an occasion for the public to comment on the programme.
- The "Turtles and more" presentation, lasting 45 minutes and including three workshops, is intended for school children and the general public.
- Information for the managers of natural areas:
 - an information sheet was sent by mail to the partners (nature reserves, ONCFS, the Seaside and Lake Conservation Trust, etc.);
 - information on the protocols drafted and the results obtained during the population study and the tests to trap and eradicate the animals is available on the internet site;
 - assessment information on the management programme is also available on the internet site.

Author: Sandra Fernandez, Irstea

For more information

- CENC internet site:
<http://www.cen-corse.org/>
- Cadi A., Joly P., 2004. Impact of the introduction of the red-eared slider (*Trachemys scripta elegans*) on survival rates of the European pond turtle (*Emys orbicularis*). Biodiversity and Conservation, 13 : 2511-2518 (1,31).
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- Verneau O. 2007 et 2009. Rapports scientifiques n°1 et n°2 rédigés pour l'a DIREN Languedoc-Roussillon. Taxonomie et systématique des parasites d'amphibiens et de tortues d'eau douce en Languedoc-Roussillon.
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Red-eared slider turtle

(*Trachemys scripta elegans*)

Managing alien turtles on the Étang de Mauguio Natura 2000 site in the framework of the European LIFE + LAG'Nature programme

LIFE + LAG'Nature programme 2009-2013

■ The programme was coordinated by the Languedoc-Roussillon conservatory for natural areas (CENLR) and implemented in a partnership with five managers of Natura 2000 pilot sites, namely the board for the Camargue in the Gard department (SMCG), the inter-municipal board for littoral ponds (SIEL), the inter-municipal board for the enhancement, development and management of the Salses-Leucate Pond (RIVAGE), the board for the lower valley of the Aude River (SMBVA) and the Or Pond board (SYMBO).

■ The main objective was to create a network of demonstration sites in lagoon and dune environments in order to improve the conservation status of the habitats.

■ "Pilot" projects were launched, focussing on three aspects on the five Natura 2000 sites:

- restoration of lagoon, peri-lagoon and dune habitats;
- managing visits to the sites;
- managing invasive alien species, namely littoral flora (lily of the valley vine, pampa grass, Hottentot figs) and alien turtles.

■ The programme was funded by the Languedoc-Roussillon region, the LR regional environmental directorate, the Rhône-Méditerranée-Corse water agency and the departmental councils of the Aude, Hérault, Gard and Pyrénées-Orientales departments.

■ Contact: Thomas Gendre - thomas.gendre@cenlr.org

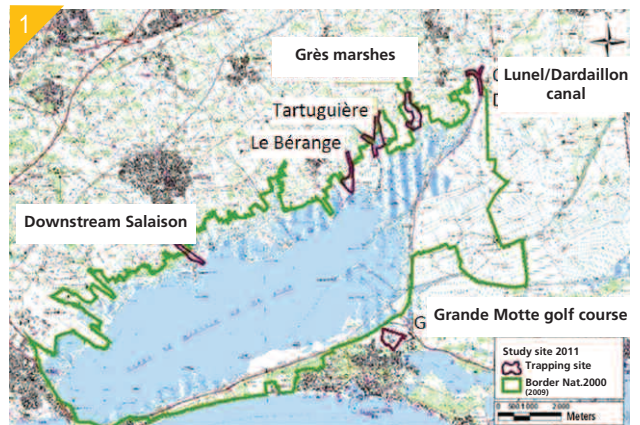
Or Pond board (SYMBO)

■ The board for inter-municipal cooperation was founded in 1991 and groups 34 towns around the Or Pond.

■ It manages the document listing objectives for the Étang de Mauguio Natura 2000 site.

■ It is also the project supervisor for the management of alien turtles in the Or Pond in the framework of the LIFE + LAG'Nature programme.

■ Contact: Ludovic Cases - lcases@symbo.fr



© SYMBO 2011

1. The sectors where trapping took place.

Intervention site

■ The LIFE + LAG'Nature programme deals with five lagoon and dune Natura 2000 pilot sites in the Languedoc-Roussillon region, namely "Basse plaine de l'Aude", "Camargue gardoise", "Étang de Mauguio", "Étangs Palavasiens" and "Salses-Leucate".

■ SYMBO is in charge of managing alien turtles on the "Étang de Mauguio" Natura 2000 site, a 2 960 hectare lagoon surrounded by 2 000 hectares of wetlands.

■ The lagoon, located for the most part in the town of Mauguio, belongs to the French State (maritime public domain).

■ In 2011, management work (trapping) was carried out on five sites:

- sector 1: Grès marshes (town of Saint Nazaire de Pézan);
- sector 2: Bérange (town of Candillargues);
- sector 3: Tartuguières (town of Lansargues);
- sector 4: Lunel/Dardaillon canal (towns of Lunel and Saint Nazaire de Pézan);
- sector 5: Downstream Salaison (town of Mauguio).

■ In 2012, sectors 1, 2, 3 and 5 were trapped, in 2013, sectors 1 to 4 and a new sector, the Grande Motte golf course (sector 6).

Disturbances and issues involved

- Alien turtles (*Trachemys scripta elegans* and *Trachemys scripta troosti*) outgrew their welcome and were released by pet owners to the natural environment.
- Today, large population groups of primarily *Trachemys scripta elegans* (red-eared slider turtles) have been observed to reproduce in the Manguio Pond.
- Management of the species is an important ecological issue in that it can impact native turtle species, namely European pond turtles (*Emys orbicularis*) and Spanish pond turtles (*Mauremys leprosa*). The two species are listed in Annexes II and IV of the Habitats directive and are covered by national action plans.
- To date, the impacts have not been extensively studied and not a great deal is known, however a number of studies, including those by Cadi and Joly (2003, 2004) indicate that:
 - competition exists and is being won by red-eared slider turtles, particularly for access to sunning spots, which leads to loss of weight and higher mortality rate for European pond turtles;
 - exogenous parasites carried by the red-eared slider turtle are transferred to native turtles, including the European pond turtle.

Interventions

- Since 2009, SYMBO has managed invasive alien turtles via the EU LIFE+ LAG'Nature programme in order to check the spread of the species and to assist the native species.
- To that end, it conducted trapping campaigns in two phases. Phase 1 in 2009 served to test different types of traps in order to select the most effective. This phase will not be discussed here.
- Phase 2, under way since 2010, includes large-scale trapping on the Étang de Manguio Natura 2000 site (the first year of Phase 2 will not be discussed here).
- The traps used were:
 - double-entry hoop nets, fyke nets and/or cage traps (Fresquet cages measuring 1 x 2 metres or 0.5 x 1 metre with one entry, made by a volunteer using a roll of wire fencing);
 - the traps were laid near the sunning spots;
 - they were not totally submerged;
 - bait consisted of frozen sardines and anchovy cream placed in little bags attached inside the hoop nets or to the nets.
- Each site was trapped four nights per week:
 - traps were laid on Monday;
 - they were checked each morning;
 - traps were removed on Friday;
 - trapping occurred on an irregular basis.
- Trapping occupied a SYMBO technician and two interns (students from a technical school).
- The captured turtles were measured and their sex determined.
- They were then sent to the "Tortue passion" centre in the Gard department.



2. Red-eared slider turtle (*Trachemys scripta elegans*).



Table listing trapping periods.

Year	2011	2012	2013
Period	February to July	End of May to July	Mid-April to September
Duration	20 weeks	8 weeks	20 weeks

Results and assessment

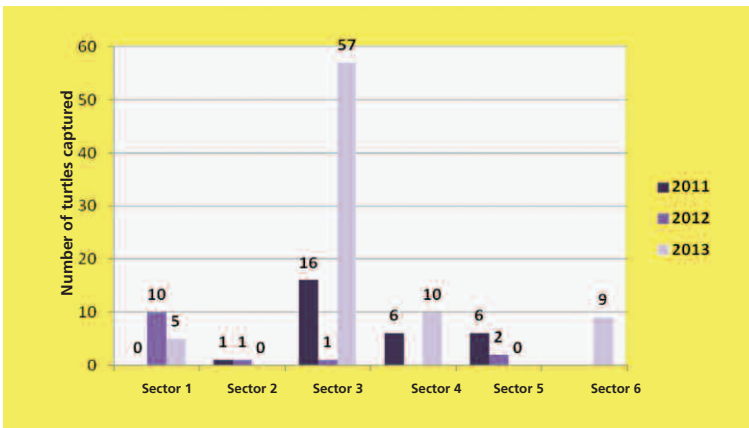
■ Results

- Differences in capture data between sectors from one year to the next are difficult to explain. Trapping pressure, annual variability in densities per sector, the layout of sectors, the types of traps used, etc. may have influenced the results.
- The Fresquet cage traps were used starting in 2012 and turned out to be very effective.

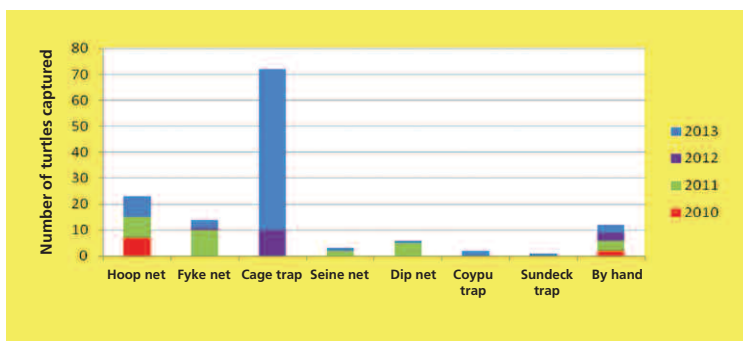


3. Checking a Fresquet cage trap.
4. Checking a Fyke net.

Numbers of turtles captured per sector (2011-2013).



Captures per type of trap (2010-2013).



■ Assessment

- From 2010 to 2013, 133 alien turtles were captured (*Trachemys scripta elegans*, *Trachemys scripta troosti*).
- The estimated average cost per captured turtle was a total of 184 euros, including all equipment (traps, bait, etc.), travel costs and the payroll costs of the technician.

Results of trapping from 2011 to 2013.

Year	Sector 1			Sector 2			Sector 3			Sector 4		Sector 5		Sector 6
	2011	2012	2013	2011	2012	2013	2011	2012	2013	2011	2013	2011	2012	2013
Weeks trapped	1	9	6	3	2	1	6	6	5	6	5	4	2	4
Hoop nets	23	-	5 to 10	14 to 24	6 to 15	12	24 à 25	0 à 25	0 to 14	18 to 27	12 to 15	21 to 27	16	14 to 16
Fyke nets	-	-	-	-	-	-	0 à 2	2	-	0 to 2	0 to 2	0 to 2	2	1
Cage traps	-	2	0 to 2	-	-	-	-	0 to 1	0 to 7	-	1 to 2	-	-	-

Table listing captures of European pond turtles.

European pond turtles captured	2011	2012	2013
New turtles	20 (+ 1 Spanish pond turtle)	63	51
Marked (recaptured) turtles	26	151	34

Outlook

- The work will be pursued with the interns from the technical school and the SYMBO technician.
- The Fresquet cage traps should be used wherever possible in all the trapping sectors.

Information on the project

- A number of articles were published in various media:
 - the regional press (Midi Libre newspaper);
 - the Lagunes bulletin;
 - the ONCFS book titled *Invasive alien vertebrates in the Loire basin (not including fish), Knowledge gained and management feedback* (Sarat, 2012);
 - the "Tortues d'Oc" internet site on the results of the trapping campaign in 2013 and the use of the Fesquet cage trap.
- A sequence on the work was aired in 2010 on a regional television news show.
- Participation in a sequence aired on the ARTE channel during a show on invasive alien species.
- Reports on the work during meetings with elected officials, land owners (private, the Seaside and Lake Conservation Trust, etc.) and managers of the sites in question.
- Informational meetings with professional fishermen and certified trappers on species identification and on how to increase trapping pressure.
- Workshops on aquatic turtles for school classes during projects on bullfighting traditions in the Camargue.
- For the past five or six years, an annual role game and project on European pond turtles has been under way with a high school in Montpellier.

Author: Sandra Fernandez, Irstea

For more information

- SYMBO internet site: <http://www.etang-de-l-or.com/>
- LIFE+ LAG'Nature internet site: <http://www.lifelagnature.fr/>
- Cadi A., Joly P. 2004. Impact of the introduction of the red-eared slider (*Trachemys scripta elegans*) on survival rates of the European pond turtle (*Emys orbicularis*). Biodiversity and Conservation, 13 : 2511-2518 (1,31).
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Red-eared slider turtle

(*Trachemys scripta elegans*)

Managing red-eared slider turtles in an urban setting (Navarra, Spain)

Herpetology department of the Aranzadi scientific society

■ The department strives to conserve amphibian and reptile populations and their habitats. It produces and disseminates scientific knowledge on the topic.

The objectives are to:

- establish specialised research teams;
- conserve amphibian and reptile populations;
- provide professional training in the field;
- inform the general public.

■ The study on the distribution and management of red-eared slider turtle populations in Navarra was conducted in a partnership with the city of Pamplona and the Navarra regional government.

Context and issues involved

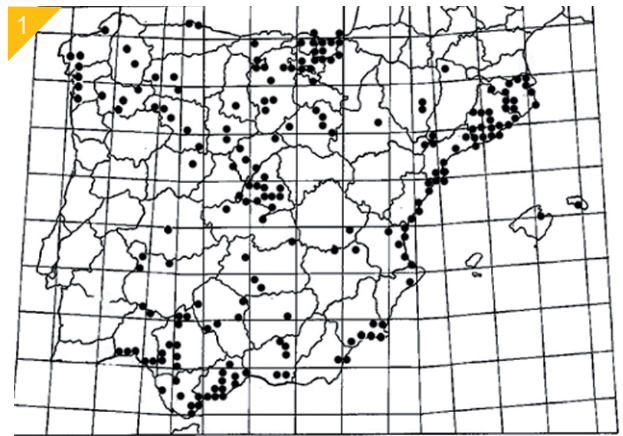
■ Red-eared slider turtles were first observed in Spain in 1983 in a pond near Madrid, after having been released by people who no longer wished to keep their pet.

■ In 1997, the species was present in 45 towns, essentially in Catalonia and in Andalusia. In 2010, the species was observed in 32 provinces and 17 regions, an increase of 78% with respect to the previous survey.

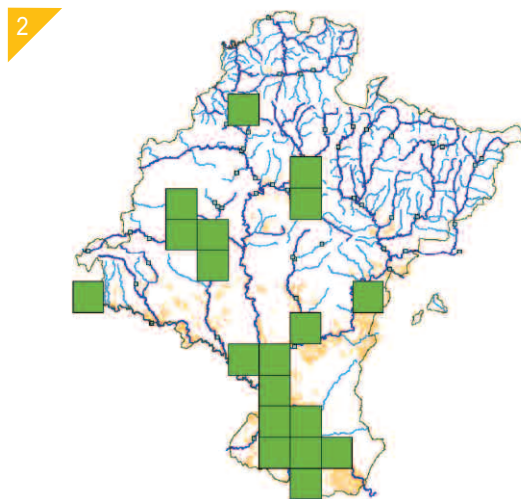
■ Population groups are now found in all types of freshwater aquatic environments, both natural and artificial, including estuaries, rivers, ponds, irrigation reservoirs, etc. There are urban populations, the result of the turtles regularly released by people, and feral populations in natural environments located far from towns.

■ Red-eared slider turtles are seen as one of the most troublesome invasive species in Spain, due to their significant reproductive capabilities (between two and three spawns per year with 12 to 17 eggs per spawn in Catalonia) and their long life expectancy (up to 30 years in natural environments).

■ The species competes for food and habitats with native turtles such as Spanish pond turtles (*Mauremys leprosa*) and European pond turtles (*Emys orbicularis*).



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1. Distribution of red-eared slider turtles in Spain in 2010.
2. Observations of red-eared slider turtles in the Navarra region.

Interventions

■ Test of trapping techniques

■ Several techniques have been developed to eliminate alien turtles, ranging from capture by hand to shooting and an array of trapping techniques. In certain regions of Spain, including Navarra, red-eared slider turtle populations are located in areas frequently visited by the public and close to urban centres, which makes management more difficult in terms of:

- access to private water bodies;
- finding sunning spots used by the turtles;
- people vandalising traps and releasing trapped turtles;
- limited possibilities for shooting.

- In Navarra, the main objectives of the study conducted by the Herpetology department of the Aranzadi scientific society and the Navarra regional government were to:

- update the information on the distribution of red-eared slider turtles in Navarra;
- develop and test an effective trap for use in urban areas.

- The sunning spots for the turtles were detected and characterised. They were located in areas where water depths exceeded 2 metres and where the turtles used emerged tree trunks to sun.

- Several types of traps were laid and tested on the Arga River in the city of Pamplona.

■ A modified “Bolue” trap

- The “Bolue” trap is a sundeck trap comprising a round, floating platform. The turtles climb up on the platform which tips over and the turtles find themselves caught in a net. The platform was originally made of wood, but subsequently cork was used. The netting under the platform was attached using fishing line to the bank so that the captured turtles could be easily retrieved.

■ “Aranzadi” turtle trap

- This trap is an adaptation of the sundeck turtle trap that comprises a floating cage with a slippery inside frame that turtles cannot climb. The frame is made of PVC tubes on top of which cork is fixed. The traps are attached to the banks using fishing line. Some of the traps were baited.

- The trapping campaigns took place from June to August 2008 in two sections of the Arga River in Pamplona. The two types of traps (modified Bolue and Aranzadi) were installed in sites where red-eared slider turtles had been frequently observed.

- The baited traps were checked daily and the other traps were checked once weekly.

- The captured turtles were weighed, had their sex determined, the shell measured, and were then euthanised (frozen).

■ Study of animal populations

- In addition, population monitoring was conducted on all the rivers, dams and ponds of Navarra.

Results and assessment

■ Test of trapping techniques

- A total of ten slider turtles were captured in the two test zones, including the subspecies *T. scripta elegans* and *T. scripta scripta*, as well as a hybrid of the two species.

- In the areas where the traps were laid, the Aranzadi were the most effective with over 70% of the captures made.

- One Aranzadi trap was vandalised during the trapping campaign and a Bolue trap was stolen.

- The Aranzadi traps were effective in the sunning spots already used by the turtles, including in river reaches where the water was less than 2 metres deep.

- The baited traps and the Bolue traps were not as effective due to the slow tripping mechanism which provided the turtles with enough time to escape and due to the wariness of the turtles concerning the most commonly used baited traps (notably hoop nets).



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3. Red-eared slider turtle.

4. Bolue trap.

5. 6. Aranzadi turtle trap.



- The Aranzadi traps are cumbersome and difficult to move, which made them more difficult to steal in an urban setting.
- The cork on the top of the traps attracted the turtles in the sunning spots.

■ Study of animal populations

- The species was observed in areas used for sport fishing (ponds and reservoirs) and near dense urban areas (the cities of Pamplona, Tuedla, Estalla and Logrono). A single specimen was observed in a rural area, near a village with approximately 100 residents (Gallipienzo). Turtles of both sexes were observed in the Pamplona area. The species is therefore likely to reproduce in the area and monitoring is required.

Information on the projects

- The results of the project were presented during a symposium on freshwater alien species introduced in the Iberian peninsula, held in Pamplona on 12-13 November 2009.

Outlook

- A much larger project is currently under way in the framework of the LIFE + Trachemys (*Strategy and proven techniques for the eradication of freshwater invaders*) (LIFE09 NAT/ES/000529) programme. The project will deal with 13 sites around Valencia and 4 sites in Portugal, from 2011 to 2015.
- Approximately 100 sundeck traps and hoop nets are used to trap the turtles. The objective is to capture 1 000 turtles per year.
- The management techniques will be presented during seminars and training sessions in the other regions of Spain and in other countries confronted with invasive alien turtles.
- A manual on management and capture techniques will be published. It will present the applicable legislation, how to set up an operational monitoring network, trapping protocols and techniques, and communication strategies for dealing with the general public.
- The project will also work on improving available knowledge on the biology and reproduction of *Trachemys scripta elegans*. Finally, the LIFE + programme includes a project to reintroduce European pond turtles.

Author: Emmanuelle Sarat, Comité français de l'UICN

For more information

- LIFE Trachemys programme:
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Ruddy duck

(*Oxyura jamaicensis*)

Introduced in Great Britain in 1949 for ornamental purposes. The birds escaped from captivity and reproduced for the first time in 1960. They arrived in France in 1974.

Descriptif

- A small, diving duck 35 to 45 cm long, with a wingspan of 53 to 62 cm
- The ducks have a large tail, short wings and a large bill
- Clear sexual dimorphism:
 - the average weight of females is 510 grams, of males 610 grams
 - breeding males are ruddy brown in colour with white cheeks and black top of head, a sky blue bill and white under the tail. Their eclipse plumage is greyish brown, but the head is identical
 - females and immature males are a drab brown with a brown bill and yellowish cheeks with a brown stripe

Ecology and reproduction

- Habitats include:
 - water bodies with dense riparian vegetation
 - fresh or brackish water, however in France, they are found exclusively in fresh waters
- The animals may be aggressive with congeners and other species during the breeding season, but are peaceable otherwise
- Their diet consists of aquatic plants, molluscs, crustaceans, worms and insects
- Reproduction occurs from June to the end of August:
 - during the period, the animals are highly dispersed with their nests hidden in the riparian vegetation
 - broods count 6 to 14 eggs that incubate for 25 days
 - the young take off on their own after 50 to 55 days
 - first reproduction at age of 2 years

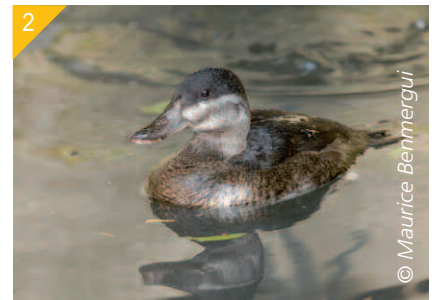
Documentation

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- Caizergues A., Fouque C. 2008. Zoom sur l'Érismature rousse, une espèce à éradiquer en France. Faune Sauvage, 280 : 64-66.

Author: Emmanuelle Sarat, IUCN French committee

Classification

Order	Anseriformes
Family	Anatidae
Genus	<i>Oxyura</i>
Species	<i>O. jamaicensis</i> (Gmelin, 1789)



1. Male ruddy duck with breeding plumage.
2. Female ruddy duck.
3. Aggressive males during the breeding season.





Ruddy duck

(*Oxyura jamaicensis*)

Managing ruddy ducks in France

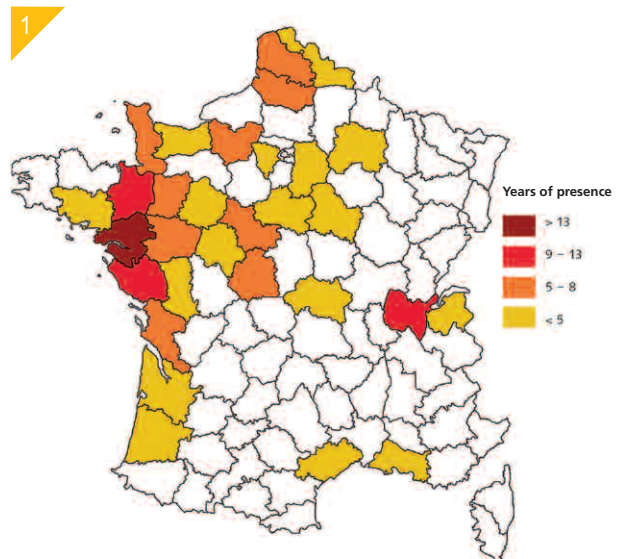
National agency for hunting and wildlife (ONCFS)

■ Research department - Bretagne-Pays-de-la-Loire regional office

- ONCFS is a public agency placed under the supervision of the Ecology and Agriculture ministries.
- Five of its main missions correspond to the guidelines contained in the Grenelle environmental agreement:
 - policing activities for the environment and hunting;
 - research and studies on wildlife and its habitats;
 - technical support and advice;
 - develop environmentally friendly hunting practices and management techniques for rural areas;
 - organise and run examinations for hunting permits.
- The Bretagne-Pays-de-la-Loire regional office covers 9 departments with a work force of 130.
- Contact: Research department
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 Bretagne-Pays-de-la-Loire regional office
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Intervention site

- The presence in Western Europe of the ruddy duck, a small, diving duck from the Americas, is due to ducks that in 1953 escaped from breeding centres, notably from the Wildfowl and Wetlands Trust in Slimbridge (U.K.).
- The presence of ruddy ducks in France was documented in 1974 and initial proof of its breeding was obtained in 1988 (Perennou, 1997). The regular presence of potential breeders was observed in the Pays-de-la-Loire region, in particular in the Mayenne and Loire-Atlantique departments (Grand-Lieu Lake).
- Since the creation of a monitoring system and the start of eradication operations in 1997 by ONCFS and its partners, ruddy ducks have been observed on 75 sites in 30 departments. The Loire-Atlantique, Mayenne, Vendée and Ile-et-Vilaine departments represent the strongholds of the species.
- During the winter period (November to February), virtually the entire population gathers in the Grand-Lieu Lake in the



1. Sites where ruddy ducks have been observed in France since 1997.

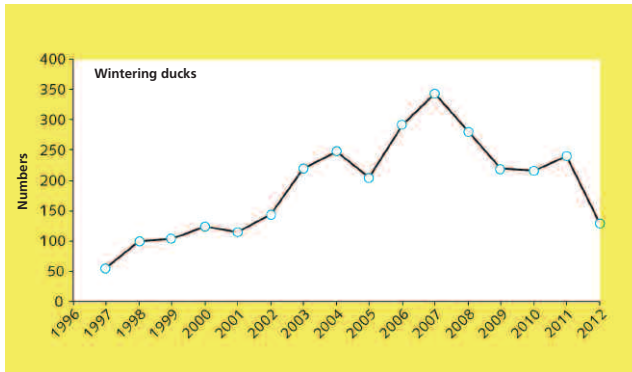
Loire-Atlantique department, where the numbers reach a peak in December (Reeber, 2012). The numbers of ducks gathering in the winter rose sharply from 1997 to 2007, then fell rapidly. The drop in numbers coincided with a fall in the population in the U.K., where an intense eradication effort had been undertaken.

Disturbances and issues involved

- The invasive potential of ruddy ducks is high in that, in the U.K., its numbers were estimated at 350 ten years after its introduction and at almost 6 000 by the time eradication measures were launched shortly after 2000.
- In addition to its invasive potential, the presence of ruddy ducks is a problem because it can create a hybrid with white-headed ducks and thus compromise the long-term survival of the latter (Muños-Fuentes *et al.* 2007).
- The total population of white-headed ducks probably numbers less than 15 000, spread over three main areas (Eastern Mediterranean, Western and South-western Asia, Spain/Morocco and Northern Africa). They are considered threatened and a European action plan exists for their survival.

■ Hybridisation with ruddy ducks is seen as the main threat to the survival of white-headed ducks, particularly for the population in South-western Europe (Hughes *et al.*, 2004).

Numbers of ruddy ducks wintering in France (1996-2012).



2. Male white-headed duck.

Interventions

■ In 1992, when the threat had become clear, a monitoring and management strategy was set up and included a study on the feasibility of eradication.

■ The eradication trials in the U.K. and Spain produced rapid results and it was decided to generalise the successful approach to all European countries, including France. France committed to eradicating the species by 2015. The country is thus in compliance with its international obligations, notably the recommendation of the Berne convention concerning the eradication of the ruddy duck in the Western Palearctic, but also more generally with the recommendations of numerous international agreements on the management of invasive alien species.

■ Since 1997, almost 1 200 birds have been eliminated, of which almost half on Grand-Lieu Lake by the personnel of the nature reserve.

■ Population monitoring and reports

■ The objectives of the monitoring programme for ruddy ducks set up in 1996 were to:

- estimate the size of the breeding population via counting operations during the summer;
- estimate the size of the wintering population;
- assess the effectiveness of the eradication work.

To that end, special surveys were conducted with the assistance of observer networks in the framework of more general surveys on water birds, carried out in a partnership with hunting federations, naturalist surveys and those conducted by the managers of protected zones.

■ The observations made during these surveys as well as those made regularly throughout the year enabled the elimination of the birds by authorised ONCFS personnel and by personnel of the Grand-Lieu Lake national nature reserve.

■ Processing of the protocol data and organisation on the national scale was done by the ONCFS research department. The data was then transmitted to the Ecology ministry for inclusion in the report to the EU commission.

■ Elimination of the ducks

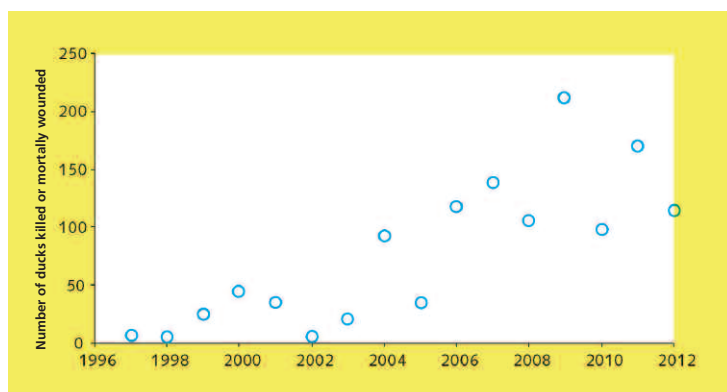
- The ministerial decree dated 12 November 1996 authorises shooting of ruddy ducks anywhere and any time by authorised personnel of the ONCFS and the nature reserves.
- The work is subject to prior agreement with pond and lake owners.
- Two main techniques are used, depending on the layout of the site and the period of the year.
 - Shooting from a hide at mid to long distance:
 - one person alone or in a group of two;
 - when the birds are nesting during the breeding season;
 - using a 22 long rifle equipped with a moderator to limit disturbances and a magnifying scope;
 - the shooters are hidden in the vegetation;
 - precise safety measures are implemented.
 - Driving and shooting from a short distance:
 - this technique requires a group of people;
 - the ducks are driven by a boat or canoe toward to shooters in boats or on land;
 - this technique is used essentially during the moulting and/or wintering season (the birds are grouped together);
 - 12-gauge shotguns are used with steel shot;
 - good coordination is indispensable to ensure safety.

Results and assessment

■ Results

- The wintering population of ruddy ducks would appear to be declining in France.
- This result is without doubt due to the joint eradication efforts in France and particularly in the U.K. where the population numbers dropped from 6 000 just after the year 2000 to 130 today.
- In spite of the eradication efforts, the number of breeding ducks has not dropped as significantly (the number is currently estimated at 40 couples), but the increase in numerical and geographic terms would seem to have been halted.
- The current range is limited to 6 or 7 departments, particularly in the Pays-de-la-Loire region.

Numbers of ruddy ducks shot in France (1997-2012). Source: Caizergues and Maillard, 2013.



3. Shooting across water.
4. Driving the ducks to the shooters.
5. Monitoring and management work for ruddy ducks by ONCFS personnel on the Grand-Lieu Lake.
6. Brochure to raise awareness concerning ruddy ducks.

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Outlook

- A national action plan requested by the Ecology ministry is in the process of being finalised by ONCFS in view of reaching the international objectives.
- The management work undertaken over the past 15 years provides a number of ideas on how to improve the strategy:
 - improve detection of the breeding population, notably on secondary sites;
 - increase the human and financial resources available for projects;
 - develop additional control methods (call ducks, float tubes, etc.);
 - target the females that are more discreet when the couples have nested;
 - work on improving regulations, raising awareness and informing the legal owners of ruddy ducks.

Information on the project

- Monitoring and management work was presented during a number of international workshops (U.K. 2007, France 2008, Spain 2010).
- ONCFS and the Ecology ministry published a brochure on ruddy ducks in 2012.
- Articles were published in the ONCFS bulletin.
- Management techniques and results are presented during training courses and national events.

Authors: Alain Caizergues, Jean-François Maillard, Jean-Baptiste Mouronval, ONCFS

For more information

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Ruddy duck

(*Oxyura jamaicensis*)

Programme to eradicate ruddy ducks in the U.K.

Food and Environment Research Agency (FERA)

■ The agency operates under the supervision of the U.K. department for the environment, food and rural affairs (DEFRA). FERA is active in developing sustainable agriculture, in managing and conserving the environment and in ensuring food safety.

Context and issues involved

■ Ruddy ducks were introduced to the U.K. in 1949 and the first reproduction in the natural environment was observed in 1960, following the escape of ducks from captivity. In the 1970s and 1980s, the species increased its range in the U.K. and colonised neighbouring countries, notably Spain, where it menaced the white-headed duck through hybridisation.

■ In 2000, the population of breeding ruddy ducks in the U.K. had reached 6 000 and attempts to reproduce had been observed in 7 European countries.

■ The threats weighing on the white-headed duck led to the creation of an action plan requiring the cooperation of all European countries confronted with the ruddy duck in view of its eradication.

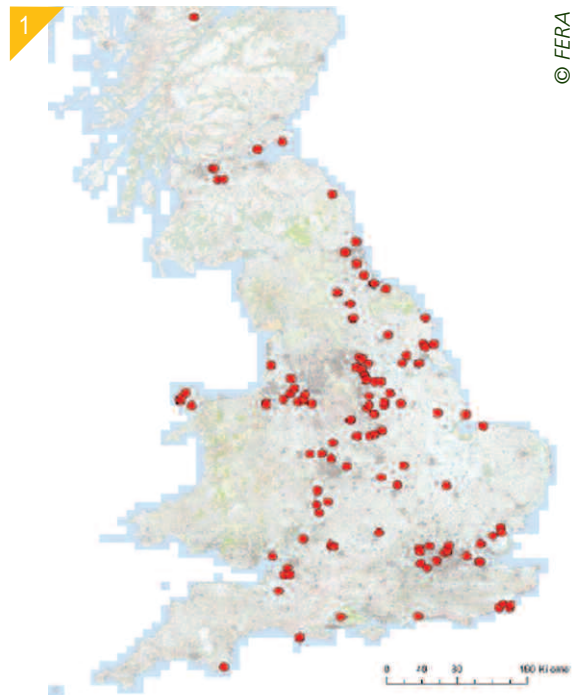
Interventions

■ In the beginning of the 1990s, when 95% of the ruddy-duck population were concentrated in the U.K., the Wildfowl et Wetlands Trust (which originally introduced the species in 1949) tested from 1993 to 1996 various methods to control the species (different capture methods, shooting techniques, sterilisation of eggs).

■ Fewer than 100 ducks were eliminated and the efforts had no effect on the population.

■ That being said, these preliminary studies determined the best management techniques and the seasons most conducive to their implementation, namely shooting during the breeding and wintering seasons.

■ Eradication was deemed possible on the condition that measures be undertaken on a larger scale.



© FERA

1. Shooting sites.

■ The Food and Environment Research Agency (FERA) assumed responsibility for the work in 1999-2005 and launched two programmes, the first on a regional scale from 1999 to 2002 and the second on the national scale from 2003 to 2005).

■ These programmes served to improve shooting techniques during the wintering season. Each year, between 700 and 900 ruddy ducks were eliminated, leading to a slight decline in the national population.

■ European LIFE programme

■ In 2005, FERA obtained a total of 3.3 million pounds (50% LIFE, 50% FERA and a contribution from the Spanish government) for the eradication programme.

The main objectives were to:

- protect the European populations of white-headed ducks by eradicating ruddy ducks from the U.K.;
- share and disseminate information on the control methods and the results of the work to the other European nations in order to enhance the effectiveness of management measures on the European scale.

■ The shooting campaigns launched in the framework of the new programme led to a significant drop in population numbers (6 000 ducks in January 2000, 3 000 in January 2003), however the rate of decline was deemed insufficient. FERA conducted an econometric study and an analysis of project feedback to devise a new strategy optimising the effectiveness to cost ratio. A team of ten people was assigned the full-time job of eradicating the species within five years, from 2007 to 2011.

■ Techniques employed

■ Wintering ducks were designated as the priority target in that 80% of the ruddy-duck population gathered on 25 sites during the winter. Management work also concentrated on the sites with high breeding rates.

■ Management techniques during the wintering season:

- shooting from boats or from the shore near the vegetation;
- the ducks are driven close to the shore;
- shooting sessions every 10 to 14 days to avoid having the ducks leave the site definitively;
- pauses were organised during shooting sessions to enable the ducks to regather.

■ Management techniques during the breeding season:

- moderators were used more frequently;
- visits were more frequent, but shorter;
- shooting sessions took place from April to June, prior to the hatching of eggs;
- female ducks were the priority target;
- decoys were used to attract ducks of both sexes.

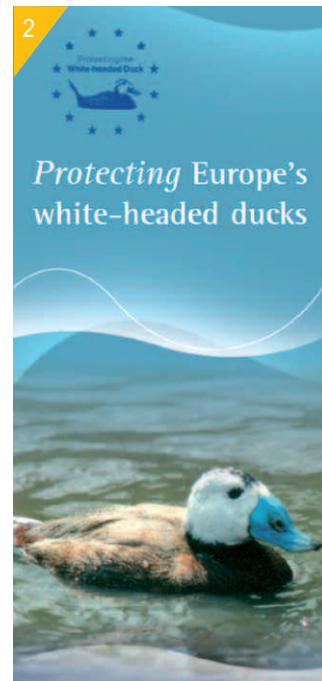
Results

■ Shooting took place on a total of 132 sites throughout the U.K., with the agreement of all land owners. In 2013, 45 ruddy ducks remained in the U.K. The remaining ducks continued to go to the known wintering sites in spite of the shooting. The population is spread over a few regional sites with 5 to 10 ducks each.

Results of the shooting trials.

Programme (time)	Ducks eliminated	Breeding population
First programme 1993-1995	134	6 000
Second programme 1999-2005	5 065	2 000
LIFE programme 2005-2011	7 100	114
2011-2013	124	45
TOTAL	12 557	

■ In addition to the management work, the population of ruddy ducks is counted annually by the Wildfowl and Wetlands trust. In January 2013, 110 sites throughout the U.K. were counted. Counts were also conducted in Ireland.



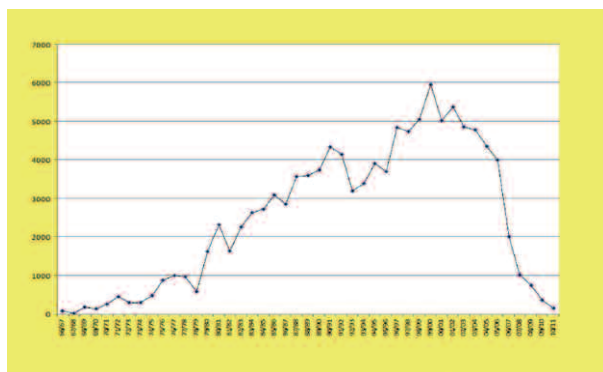
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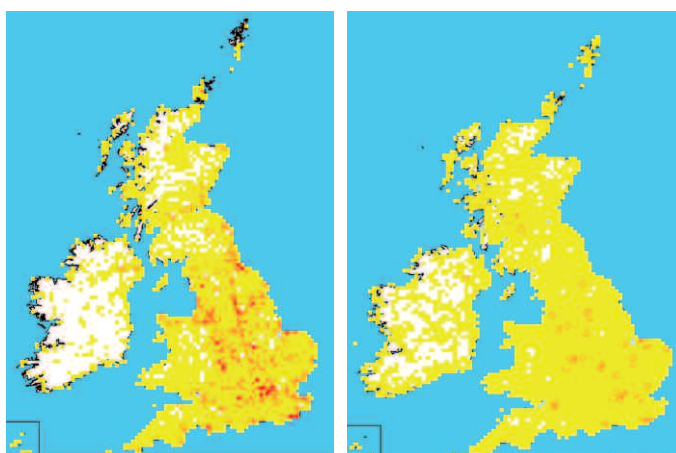
2. Informational brochure.



Numbers of ruddy ducks in the U.K. from 1967 to 2011.
Source: FERA/WWT.



Distribution of ruddy ducks (red and orange dots) before and after (2013) the management work. Source: FERA.



Outlook

- The programme will be pursued to achieve full eradication of ruddy ducks in the U.K. by the year 2015, in compliance with the recommendations of the Berne convention.
- Eradication of the species, the objective of projects in other countries (Netherlands, France, Spain), should be achieved if the operations in the U.K. are successful.
- The project for ruddy ducks is an example of European cooperation in managing invasive alien species, an indispensable feature if the efforts in other European countries are to succeed.

Information on the project

- Efforts to inform and raise the awareness of land owners was required to access and work on key sites.
- The results of the eradication programme were presented during the Fifth Meeting of the parties to the African-Eurasian Waterbird Agreement (AEWA) in La Rochelle, 2012.
- Information is available at the GB Native secretariat (www.nonnativespecies.org).
- An informational brochure titled *Protecting Europe's whiteheaded ducks* was published to explain the LIFE programme.

Author: Emmanuelle Sarat, IUCN French committee

For more information

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Sacred ibis

(*Threskiornis aethiopicus*)

Originated in Sub-Saharan Africa. Introduced as an ornamental species in France.

Description

- White birds with a featherless black head and neck (the skin is black) and wing feathers tipped in black
- The birds stand 65 to 75 centimetres tall with a wingspan of 110 to 120 cm
- Weight approximately 1.5 kilograms
- The long, thick bill is black and curves down
- The average life span is approximately 20 years
- Young birds have feathers on the head and neck, but progressively lose them at the age of 2 to 3 years

Ecology and reproduction

- Preferred habitats are large, open spaces near wetlands:
 - agricultural areas, tilled land, bird farms in open fields
 - dumps containing food waste
 - more or less wet meadows, marsh fields and flooded reed beds, coastal habitats, etc.
- The birds gather at night in groups of up to several hundred
- The species is an opportunistic carnivore consuming a wide range of prey, including invertebrates, amphibians, fish, bird eggs and chicks, etc.
- The birds often feed in groups and with other species
- Breeding takes place in large groups with nests positioned very close to one another
- Eggs are laid between April and July:
 - 2 to 3 eggs on average per season
 - incubation for approximately 28 days
 - the chicks leave the nest after 14 to 21 days and can fly after 40 days
- The species is gregarious and highly tolerant of human contact

Documentation

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Author: Emilie Mazaubert, Irstea

Classification

Order	Pelecaniformes
Family	<i>Threskiornithidae</i>
Genus	<i>Threskiornis</i>
Species	<i>T. aethiopicus</i> (Latham, 1790)





Sacred ibis (*Threskiornis aethiopicus*)

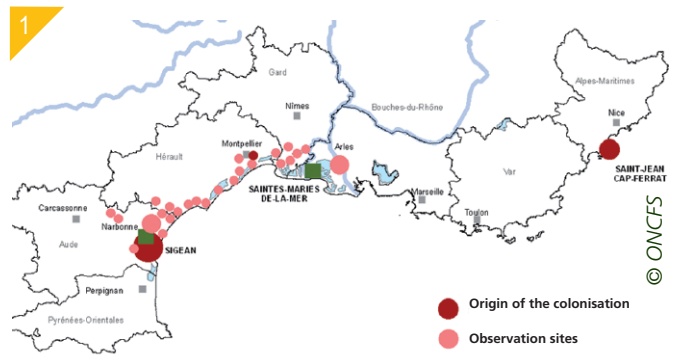
Eradicating the sacred ibis around the Mediterranean basin

National agency for hunting and wildlife

- The public agency was created in 1972.
- The main missions include:
 - enforcing hunting and environmental regulations, assisting the Prefects in maintaining law and order and carrying out administrative procedures in the hunting and environmental fields;
 - conducting studies, research and experiments on conserving, restoring and managing wildlife and its habitats;
 - contributing, as part of the technical and scientific missions set by the 2012-2014 Statement of objectives, to controlling invasive alien animal species (essentially mammals and birds) and species disrupting ecosystems or harming human activities;
 - participating in monitoring, studies and management of alien species found to be invasive;
 - assisting the Prefects concerning interventions on invasive species.
- Contact: Jean-Baptiste Mouronval - jean-baptiste.mouronval@oncfs.gouv.fr

Intervention site

- The intervention was initiated in the spring of 2007, at a time when the populations of sacred ibis had already reached a large number and had spread widely over the lagoons in the Languedoc and Camargue regions.
- It took place in the five departments (Aude, Hérault, Gard, Bouches-du-Rhône and Alpes-Maritimes) where the species had clearly established habitats.
- The inventories and monitoring of sacred ibises along the Mediterranean coast in France involved counting operations on 55 sites. Management work (elimination and capture) was conducted on four overnight roosting sites, on four nesting sites and on approximately 25 daytime feeding sites.
- The work took place in agricultural areas (rice paddies and meadows), private marshes, nature reserves, sensitive natural areas and parks open to the public (zoological and ornithological parks).
- The installation of the sacred ibis along the French Mediterranean coast took place in several steps:
 - the birds present in the natural environment along the Mediterranean coast come from the zoological park in the



1. Distribution of the sacred ibis around the Mediterranean basin.
2. Sites on which sacred ibises were observed in the Camargue.

- town of Sigean (Aude department) where eight of the birds were imported from the U.K. in the 1980s to see whether they could adapt to the climate;
- the birds were allowed to fly freely and started to reproduce in the natural environment around the year 2000. The numbers increased regularly and reached a maximum of 105 breeding couples on the nearby Bages Pond in 2005. Starting in 2000, a few birds from Sigean were observed in Camargue, 130 kilometres to the east of their introduction site;
- during the summer of 2007, a net in an aviary was torn and 38 sacred ibises escaped from the zoological park in the town of Saint-Jean-Cap-Ferrat (Alpes-Maritimes department). The same year, a private breeder of ornamental birds in the Hérault department released the two sacred ibises that he owned;
- the minimum number of sacred ibises living in the wild in the five Mediterranean departments was estimated in 2007 to represent a total of 360 birds.

Disturbances and issues involved

- The main concern along the Mediterranean coast is the long-term conservation of the breeding colonies of certain species of water birds, including herons, glossy ibises, gulls and terns.

- Sacred ibises have a number of proven and some supposed impacts on nesting birds.

- They are known to be predators for the eggs and chicks of Ardeidae (heron) species, e.g.:

- cattle egrets (*Bulbulcus ibis*) (observations at the Bages Pond in the Aude department in 2004 and in the town of Saintes-Maries-de-la-Mer in the Bouches-du-Rhône department in 2013) and squacco heron (*Ardeola ralloides*) (in the town of Aigues-Mortes in the Gard department in 2003).

- The reduction in the number of Ardeidae (heron) couples nesting in the Bages Pond (from 680 in 1998 to fewer than 100 in 2007) coincided with the installation of the sacred ibis on Planasse Island. The assumed cause of the reduction is the possible competition for space and/or food.

Interventions

■ Regulatory aspects

- In 2005, the Ecology ministry requested that ONCFS and INRA assess the situation. Their report concluded that it was necessary to limit or to eradicate the populations of sacred ibis in France in compliance with the precautionary principle.

- In March 2006, the Ecology ministry requested that the Prefects of the concerned departments proceed with the elimination of the birds. In 2008, this decision was reinforced by the agreement on the conservation of African-Eurasian migratory waterbirds (AEWA, resolution 4.5).

- Prefectoral orders to eliminate the birds were issued starting in 2007 in four departments (Aude, Hérault, Gard and Bouches-du-Rhône) in the framework of policies for pests and/or invasive alien animals (articles L427-6 and L411-3 in the Environmental code, ministerial decree dated 30 July 2010 prohibiting the introduction of the species into the natural environment in continental France).

- The ministerial order dated 25 March 2004 concerning the operation of zoological parks enabled interventions in the parks where sacred ibises were not constrained.

■ Inventory of populations

- Starting in 2007, ONCFS personnel initiated a number of operations:

- contacts (telephone or email) with the main organisations involved in studying and managing wildlife or in managing natural areas (environmental-protection associations, the managers of protected zones, etc.), with the park in Sigean, and with hunters, land owners and marsh managers to collect information on the habitats of the sacred ibis and to request their participation in the inventory;

- the contacts were a means to inform the managers and land owners concerning the presence of the sacred ibis and its potential impacts in order to obtain permission to access the sites as needed.

- Inventories were carried out regularly to identify the main sites and to monitor changes in population numbers.

- The main ornithological sites were monitored and databases accessible on-line were regularly consulted (particularly Obsmedit).



3. 4. Sacred ibis (*Threskiornis aethiopicus*).

■ A total of approximately 20 organisations participated in locating and counting the sacred ibises

■ Elimination of populations

■ A number of methods were used to remove the sacred ibises from the natural environment with the assistance of approximately 20 people. The initial interventions took place in 2007, in the Aude department.

■ Shooting of adult birds:

- the sessions were organised taking into account the constraints imposed by human activities (sites open to the public, hunting, etc.);
- the shooting occurred on feeding sites, roosting sites and along the itineraries used by the birds;
- different weapons were used, including shotguns, .22 long rifles and .222 Remingtons equipped with scopes and moderators;
- wooden decoys were installed at times to attract the birds;
- where possible, the shot birds were retrieved;
- they were frozen in order to study the stomach contents.

■ In the nesting colonies, nests, eggs, chicks and occasionally adults (shooting) were captured and eliminated from April to October.

■ The birds in the zoological parks in Sigean and Saint-Jean-Cap-Ferrat were captured:

- using bait made of fish treated with chloralose, a sedative;
- in compliance with the requests of the authorised personnel of the parks, the birds were reanimated (warmed) and returned to the aviary or buried if they had died.

■ The participants included:

- ONCFS personnel, the main group of people authorised to eliminate the birds in the natural environment using any means and at any time;
- the authorised personnel of the zoological parks;
- a number of other participants, on the condition for some that they follow a short training course, including wolf-hunting officers, ONF (National forestry agency) and Onema personnel, authorised personnel of protected zones and of land belonging to the Seaside and Lake Conservation Trust, and game wardens in their specific areas.

Results and costs

■ Results of elimination work

■ A total of 395 adult sacred ibises and 90 chicks were removed from the natural environment between 2007 and 2013:

- in 2007, 234 adult birds and 30 chicks were removed from the natural environment, i.e. two-thirds of the total counted that year along the Mediterranean coast, of which 90 were sent to aviaries and the rest were eliminated;
- the 38 birds that had escaped from the zoological park in Saint-Jean-Cap-Ferrat were captured in 2007 and 2008;
- all the sacred ibises present in the Aude and Hérault departments were removed from the natural environment from 2007 to 2009;
- in 2013, only three sacred ibises remained in Camargue.



5. A chick caught in the nest.

■ Costs

- To date, it has not been possible to precisely cost the eradication programme.
- The average cost of elimination per bird by ONCFS personnel was calculated by analysing the activity reports of the local offices. This figure varies significantly depending on the situation:
 - it is lower for groups of birds (-) very close to the introduction site and very high for birds (+++) spread in small groups and located far from the source;
 - in addition, the average cost increases when the number of birds to be eliminated decreases.

Summary table of the intervention results and costs.

Site	Interventions	Sacred Ibis captured/eliminated	Dispersion	Unit cost
Saint-Jean-Cap-Ferrat	First intervention over 2 days	36	-	39 €
Aude	Intervention on first site over 2 days	87	+	38 €
Camargue	2007-2013	Approx. 40	+++	711 €
	Last 8 months of intervention	< 10	+++	1 303 €

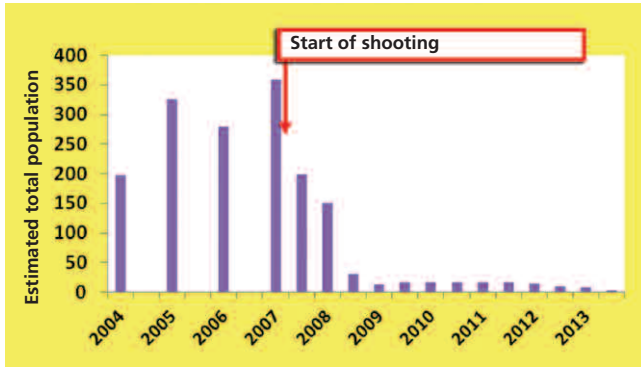
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■ Assessment

- The management work was deemed effective in that only three birds were observed in the natural environment in 2013.
- A number of difficulties were encountered (in terms of logistics and the eco-ethology of the birds):
 - there were no specific regulations suited to exogenous species until 2010 and it was necessary to obtain yearly authorisations with long publication lead times;
 - certain naturalists were hesitant to indicate the locations of the birds;
 - there were restrictions concerning the persons authorised to eliminate the birds and a lack of human resources;
 - certain land owners refused entry to their property;
 - there were safety considerations inherent to work on sites open to the public;
 - reactions to announcements concerning observations were occasionally slow;
 - the time required to organise often exceeded the residence time of the birds on a site;
 - work was complicated by multi-species colonies, roosting and feeding sites given the risk of impacting non-targeted, emblematic species;
 - it was often difficult or impossible to approach the birds within shooting range given that they prefer very open spaces;
 - the great mobility of the birds made it difficult to precisely locate them within their home range;
 - participants were less motivated when the potential numbers of sacred ibis were so low that the probability of a capture fell almost to zero.



Estimated population numbers from 2004 to 2013 (per half year).



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Outlook

- The remaining birds should be eliminated as soon as possible.
- Regular monitoring along the Mediterranean coast, through contacts with the managers of natural areas, will be required to avoid recolonisation by the population from the Atlantic coast in France or by the small groups of birds that may remain in Italy or Spain.

Information on the project

- Efforts are made to inform and raise the awareness of stakeholders concerning the sacred ibis, including the managers of natural areas, the owners of wetlands, naturalist associations, hunters. A memo is distributed explaining the objectives and the resources invested in the management of the sacred ibis along the Mediterranean coast and encouraging the transmission of information on the species.
- A report on the management work for sacred ibises was aired by French public television in March 2013.

Author: Sandra Fernandez, Irstea

For more information

- Clergeau P., Reeber S., Bastian S. et Yésou P. 2010. Le profil alimentaire de l'Ibis sacré *Threskiornis aethiopicus* introduit en France métropolitaine : espèce généraliste ou spécialiste ? Rev. Écol. (Terre Vie), vol. 65 : 331-342.
- Clergeau P., Yésou P. et Chadenas C. 2005. L'Ibis sacré (*Threskiornis aethiopicus*). État actuel et impacts potentiels des populations introduites en France métropolitaine. Ministère de l'Écologie et du Développement. 52 pp.
- Kayser Y., Clément D. et Gauthier-Clerc M. 2005. L'Ibis sacré *Threskiornis aethiopicus* sur le littoral méditerranéen français : impact sur l'avifaune. Ornithos 12 : 84-86.
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- Yésou, P. et Clergeau, P. 2005. *Sacred Ibis: a new invasive species in Europe*. *Birding World*, 18 : 517-526.



Sacred ibis

(*Threskiornis aethiopicus*)

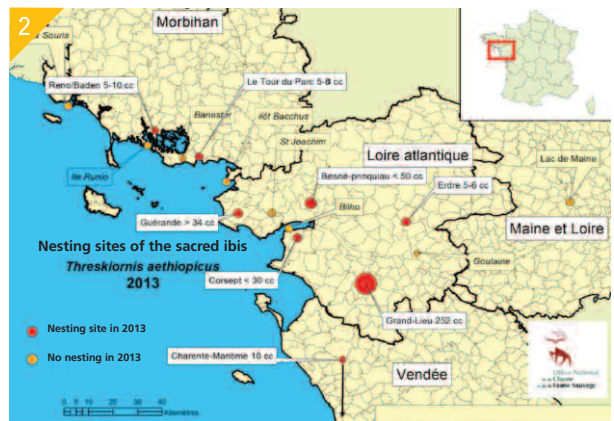
Managing the sacred ibis in Western France

National agency for hunting and wildlife

- **Bretagne-Pays-de-la-Loire regional office**
- ONCFS is a public agency placed under the supervision of the Ecology and Agriculture ministries.
- Its missions correspond to the guidelines contained in the Grenelle environmental agreement, including research on wildlife and its habitats and participation in the management of invasive alien species.
- The Bretagne-Pays-de-la-Loire regional office covers 9 departments with a work force of 130.
- Contact: ONCFS Bretagne-Pays-de-la-Loire regional office - dr.bretagne-paysdeloire@oncfs.gouv.fr

Intervention site

- **History of species colonisation and management**
- 1974-1987. A zoological park imported 30 sacred ibises. The birds born in captivity were allowed to fly freely and dispersed along the Atlantic coast.
- 1991. The first attempt at nesting was observed at Grand-Lieu Lake (Loire-Atlantique department).
- 1994. Scientists and farming representatives drew the attention of the local government to the presence of the sacred ibises and to the risks involved.
- 1997. The young birds were no longer allowed to escape from the zoological park.
- 2004. The managers of natural areas in the Loire-Atlantique, Vendée and Morbihan departments requested that the sacred ibis be included in conservation policies.
- 2005. The Ecology ministry requested that ONCFS and INRA assess the situation and propose management solutions. Their report acknowledged the risks created by the increased numbers and wider geographic area covered by the sacred ibis and proposed scenarios with progressive management solutions. Following a referral by the Ecology ministry, the National council for the protection of nature advised eradicating the species.
- 2006. A total of 1 700 couples and 5 000 birds were inventoried in Western France.
- 2007. Prefectoral orders were signed enabling the start of operations to reduce the numbers of sacred ibises.



1. Site of the Grand-Lieu nature reserve.
2. Nesting sites of the sacred ibis in the Bretagne and Pays-de-la-Loire regions in 2013.

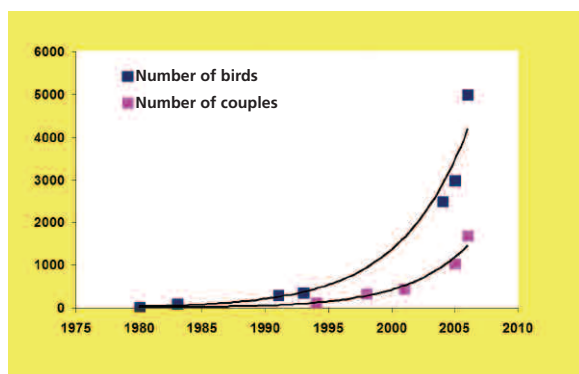
- 2013. Only 280 to 300 breeding couples were inventoried, a significant drop since 2006 that may be attributed to the management work.

Disturbances and issues involved

- **Impacts on native species**
- The birds are predators for a wide range of prey that are already confronted with habitat degradation. The overall impact has not been quantified, however predation has been observed on the nests and chicks of sensitive species (marsh terns, herons, terns and waders).



Numbers of sacred ibises in Western France prior to the management work.



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■ Health risks

■ The alternate food sources on pathogen-rich sites (dumps, bird farms, etc.) represent a health risk for the fauna in wetlands.

Interventions

■ Monitoring the breeding of the sacred ibis

■ In parallel with the prefectural orders to eliminate the sacred ibises in the Loire-Atlantique, Morbihan and Vendée departments, the Bretagne and Pays-de-la-Loire regional environmental directorates requested that ONCFS monitor population numbers in Western France.

■ The ornithological community, the managers of natural areas and ONCFS in the concerned departments all participated in the annual counting of colonies.

■ An annual, regional report was drafted with a map of the colonies, the numbers of couples and of fledglings per colony, the change in the overall population from year to year and the impact of the measures to limit the population.

■ Management work

■ An attempt to remove the eggs from the main colony was undertaken in 2006. This operation resulted in the birds moving to another site and laying new eggs, consequently this method was not implemented twice.

■ In 2007, a first prefectural order in the Loire-Atlantique department was signed to test shooting over a limited period as a management method. Following the experiment and starting in 2008, annual prefectural orders were issued in the Loire-Atlantique, Morbihan and Vendée departments, and in 2009 in the Maine-et-Loire and l'Ille-et-Vilaine departments.

■ Since 2009, another prefectural order has filled out the approach. The National association for the protection of nature (SNPN), in its role as the manager of the Grand-Lieu national nature reserve, the site of the largest colony, was charged with sterilising sacred-ibis eggs.

■ The combined implementation of egg sterilisation in the main colony and shooting of flight-capable birds around the edges of colonies and on feeding sites is a means to limit:

- the number of reproducers the following season (this is due to shooting flight-capable birds that are primarily adults);
- the number of juveniles replacing the eliminated adults (due to the drop in the number of fledglings caused by the sterilisation operations).



3. 4. Sacred ibises in the Massereau Pond.

■ Elimination by shooting:

- the shooting is done by ONCFS personnel, occasionally assisted by other authorised persons acting, for this work, under the responsibility of ONCFS;
- the operations take place on feeding sites or near the colonies;
- safety measures and efforts to avoid impacts of the shooting campaign on other species are important factors during the work to limit the populations of sacred ibis;
- during this work, the personnel also drew biological samples used for studies on the parasites carried by the birds, on the viruses (detection of the avian influenza virus strain H5N1) and on the diet of sacred ibises.

■ Sterilisation of eggs:

- the objective is to limit as severely as possible the number of young sacred ibises capable of leaving the colonies established at Grand-Lieu Lake;
- the process consists of simply running a spike through the eggs;
- this work was carried out by authorised personnel of the nature reserve who were extremely knowledgeable concerning the local conditions, which made it possible to limit the disturbances and the impact on sensitive species nesting nearby.

Results and assessment

■ Nesting of the sacred ibis in Western France in 2013

- In 2013, approximately 280 to 300 couples nested, including 10 couples in the Charente-Maritime department (outside the area currently covered by the prefectural orders to eliminate the species), which represents a decrease of 17 to 27% compared to the 350 to 410 couples in 2012.
- The distribution of the colonies is similar to that in the previous four years, i.e. approximately 90% of the regional nesting population is located at Grand-Lieu Lake.

■ Results of management work from 2006 to 2013

■ Sterilisation of eggs:

- SNPN put great effort into complying with the prefectural order concerning the sterilisation of eggs at the Grand-Lieu Lake;
- in 2013, 422 nests and a total of 1 270 eggs were treated;
- the operation took place during two periods (April and May) in order to sterilise the replacement eggs laid following the first passage;
- the operation was successful in that very few juveniles were born at Grand-Lieu Lake and only a few dozen became fledglings.

■ Shooting campaigns:

- a total of 274 sacred ibises were eliminated in 2013;
- the results indicate that the number of young birds born is significantly lower than the number of birds eliminated;
- consequently, the drop in the regional population should continue in 2014. However, the shooting and sterilisation work must be pursued with vigour to avoid any regrowth of the population;
- the means to halt the development of a colony of breeders in the Charente-Maritime department must be found.



5. Chicks in a nest.
6. Threskiornis aethiopicus.

Results of management work on the sacred ibis in Western France.

Year	Birds shot	Nests sterilised	Couples observed
2006			1 700
2007	226		1 430-1 860
2008	2 939		1 400
2009	1 252	157	850
2010	887	1013	670
2011	413	880	560-600
2012	635	248	350-410
2013	274	422	280-300
TOTAL	6 626	2720	- 82%

© ONCFS/SNPN

Information on the project

- An annual report on monitoring results for the breeding population is submitted to the government and made available via the internet.
- Scientific research has been put into learning more on the biology of the sacred ibis and its impacts (a partnership between INRA, MNHN, SNPN, Oniris and ONCFS). This work resulted in a number of reports and publications on the following topics:
 - the primary aspects of its reproduction (Alauda, 2006);
 - a status report on the current situation (*Biological Invasions*, 2006);
 - the absence of a positive relationship between the sacred ibis and the Eurasian spoonbill (Oryx, 2010);
 - an assessment of the health risks (presentation to the European Wildlife Disease Association, 2010);
 - feeding habits and impact on sensitive species (*Revue d'Écologie – Terre et Vie*, 2010).
- Informational articles have been published for amateur ornithologists in the journals *Ornithos* and *Birding World* (2005).

Authors: Pierre Yésou, Jean-François Maillard and Luc Simon, ONCFS

For more information

- Bretagne-Pays-de-la-Loire regional office: www.oncfs.gouv.fr
- Publications are available via the link below:
<http://www.oncfs.gouv.fr/La-luttecontre-les-especes-exotiques-envahissantes-ru152/LIbis-sacre-ar282>
- Yésou P. et Maillard J.F. 2013. Bilan de la reproduction des opérations de destruction de l'Ibis sacré en Bretagne Pays de la Loire pour l'année 2013. Office national de la chasse et de la faune sauvage. Nantes. 7 pp.
- Clergeau P., Yésou P., Chadenas C. 2005. Ibis sacré *Threskiornis aethiopicus*, état actuel et impacts potentiels des populations introduites en France métropolitaine. Rapport Inra-ONCFS, Rennes et Nantes. 53 pp.



Canada goose

(*Branta canadensis*)

Originated in North America. Introduced in Europe in the 1700s for ornamental purposes. The species started to colonise France in the 1960s and 1970s.

Description

- Large goose with a black head and neck that contrast sharply with the white cheeks and breast
- Brown body with a white underside
- The plumage is identical for the two sexes
- Adults stand 1 metre tall with a wing span of between 160 and 175 cm
- The average weight is approximately 5.2 kilograms
- The average life span is approximately 24 years

Ecology and reproduction

- The birds adapt to highly diverse habitats:
 - natural or artificial wetlands near agricultural areas
 - ponds, quarries, lakes, rivers, golf courses, parks, reed ponds, etc.
- In France, the species is sedentary with the birds grouped together in wintering zones and dispersed in the summer
- The species is herbivorous and feeds on reeds, grain, stalks, leaves, roots and tubers
- In Europe, the birds can nest in colonies.
- Adults and young can group in maternity colonies:
 - 3 or 4 chicks constitute an average brood
 - incubation lasts for 28 to 32 days
 - juveniles begin to fly at 10 weeks
 - first reproduction at age of 3 to 4 years
- The species is gregarious and highly tolerant of human contact

Documentation

- Sarat E. (coord.) 2012. Vertébrés exotiques envahissants du bassin de la Loire (hors poissons) : connaissances et expériences de gestion. Office national de la chasse et de la faune sauvage, Plan Loire Grandeur Nature, 128 pp.
- Cramp S., Simmons K.E. 1977. *Handbook of the birds of Europe, the Middle East and North Africa. The birds of the Western Palearctic (1) Ostrich to Duck*. Oxford, UK ; Oxford University Press. 913 pp.
- Fouque C., Schricke V., David Y., Serre D. 2011. La Bernache du Canada : une espèce exotique devenue envahissante. Diagnostic, plan de lutte et régulation. Faune Sauvage, 290 : 18-31.

Author: Emmanuelle Sarat, IUCN French committee

Classification

Order	Anseriformes
Family	Anatidae
Genus	<i>Branta</i>
Species	<i>B. canadensis</i> (Linnaeus, 1758)





Canada goose

(*Branta canadensis*)

Managing Canada geese in the Centre and Île-de-France regions

National agency for hunting and wildlife (ONCFS), Centre and Île-de-France regional office

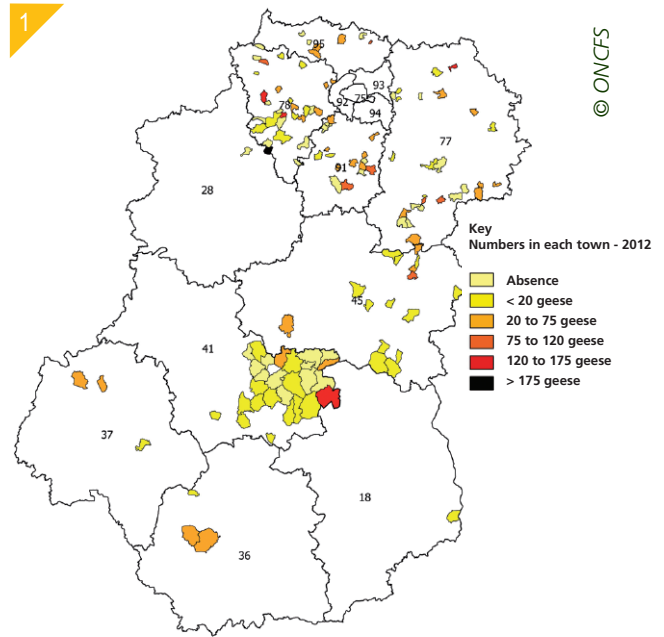
- ONCFS is a public agency placed under the supervision of the Ecology and Agriculture ministries.
- Its missions correspond to the guidelines contained in the Grenelle environmental agreement, including general surveillance of rural areas and policing activities for the environment and hunting, and research on wildlife and its habitats.
- The Centre and Île-de-France regional office comprises a workforce of 119 based in six departmental offices in the Centre region, two in the Île-de-France region and in the regional office itself.
- Contact: Centre and Île-de-France regional office - dr.centre-iledefrance@oncfs.gouv.fr

Intervention site

- In the Centre and Île-de-France regions, Canada geese were first observed in the natural environment in 1976 and 1985. They had escaped from recreational parks or from private owners.
- The species colonised natural and artificial wetlands in the two regions, notably the park and national nature reserve in the town of Saint-Quentin-en-Yvelines, as well as the recreational park in Cergy-Pontoise where efforts to limit the species were undertaken due to the pollution of the bathing water caused in part by the population of Canada geese.
- The Centre region is home to over 5% of all wetlands in continental France, primarily in the Brenne area (1 300 ponds) and in the Sologne area (3 000 ponds). Colonisation of these areas by Canada geese can cause problems in terms of degraded environments and competition with the native species.

Disturbances and issues involved

- **Impacts on native species**
 - There is a risk of hybridisation with the barnacle goose, a protected species, and the greylag goose (ten cases were observed in 2012 in the Centre and Île-de-France regions).



1. Winter counting of Canada geese in the Centre and Île-de-France regions.

Impacts on the environment

- The animals can damage the environment (banks and reed beds) through excessive trampling.
- They can also cause eutrophication of water due to the high input of nutrients (droppings).

Impacts on human activities and health risks

- The birds can pollute bathing waters, overgraze meadows and leave their droppings in public areas.
- These disturbances required the rapid intervention of ONCFS at the request of prefectural authorities, in the form of efforts to limit the numbers and to count the populations during the winter.

Interventions

Monitoring populations by counting in the winter

- Annual counting operations have been carried out on wintering sites since 2006. The work is done during the period prior to dispersal of the birds in search of their breeding sites.

- The populations of Canada geese were counted in ten departments of the two regions, starting with the towns where ONCFS personnel were aware of their presence and then expanding the search to new towns where the species had been observed.

- In 2013, Canada geese were noted in 140 towns and a total of 3 397 birds were counted. The Île-de-France region was home to 70% of the total.

- The annual monitoring revealed a strong increase in the numbers starting in 2010 in the Île-de-France region and apparent stability in population numbers in the Centre region.

■ Management work

- In addition to the counting, operations to limit the populations were launched by ONCFS starting in 2007. Since 2011, in response to a ministerial circular, the control work by the ONCFS has targeted primarily protected natural areas.

A number of management methods may be used. They complement each other and must be adapted to the specific situation.

- Sterilisation of eggs:

- spray the eggs with glycerol or with formaldehyde;
- shake the eggs to destroy the internal membrane;
- pierce the eggs with a spike.

- The first two techniques avoid rotting of the eggs and consequently any renewed attempt to lay eggs. To be effective, sites must be systematically searched and at least 80% of the eggs must be destroyed over a period of several years.

- Shooting using a shotgun or a rifle:

- during operations organised year round by ONCFS with prefectural authorisation, adult and subadult geese are eliminated using firearms (shotguns and .222 Remington rifles);
- this method is highly effective and results in a long-term reduction in populations, however qualified personnel are required and attention must be paid to the safety measures and to the impact of the shooting on other species.

- Netting:

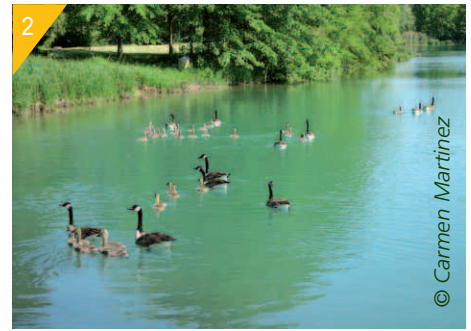
- the birds are captured during their post-nuptial moulting (when they cannot fly) on the feeding sites, using nets (5 x 5 cm mesh);
- great skill is required and only a part of the population can be targeted, however a large number of birds can be captured in a limited amount of time.

Results and assessment

■ Results

- This initial control operation made clear that to have any real impact on the Canada goose population, it is necessary to have a comprehensive, strategic approach capable of limiting the dispersal of the population and eliminating the breeding centres.

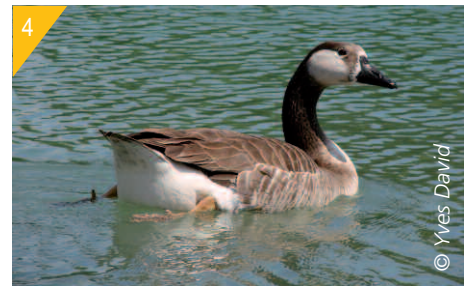
- Shooting was highly effective on sites where there were few possibilities to disperse. On other sites, e.g. a string of wetlands, a combination of the three techniques is indispensable to limit the spread of the species. To obtain any significant results, the management work must be pursued over the long term.



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2. Canada geese.
 3. Geese grouped in a field.
 4. A hybrid of a Canada goose and a swan goose.
 5. Sterilisation of Canada goose eggs by spiking them.
 6. 7. Shooting operations.



■ Assessment

- The table below is an example of the results from 2011.

Results of control work and human resources required (man-days) in 2011.

2011	Adults	Juveniles	Eggs	Total	Man-days
Loiret	189	22	317	528	10
Cher	25			25	0 (special authorisations)
Indre-et-Loire	No operations in 2011				0
Loir-et-Cher	121	36	112	269	25
Indre	No operations in 2011				0
Eure-et-Loir	50	0	0	50	6
Yvelines	47	3	262	312	25
Essonne	97	6	119	222	38
Val d'Oise	0	0	132	132	2
Seine-et-Marne	179	0	82	261	18
TOTAL	683	67	1 024	1 799	124

Information on the project

- Two articles on the work to control Canada geese in the Centre and Île-de-France regions were published in the *Faune sauvage* journal that devoted a report to the species in the beginning of 2011. A report and a map presenting the situation for the species are published each year by the ONCFS regional office.
- The issues surrounding the Canada goose were also presented to the general public during various events (agricultural fair, etc.).

Outlook

- This work requires a large number of man-days in the field, which represents a considerable cost for ONCFS.
- Classification of the Canada goose as a huntable pest should result in a reduction in numbers at less cost, however other control measures must also be taken, notably in areas where hunting is not possible (parks, recreational areas, protected natural areas).
- It is also necessary to take into account the risk of the birds dispersing during the operations, particularly in wetlands such as Sologne, Brenne and the Loing valley.

Rote on applicable regulations

- The species may not be introduced into the natural environment (ministerial decree dated 30 July 2010).
- The species may be hunted until February 2015 (ministerial decree dated 23 December 2011).
- The species is considered a pest throughout continental France.

Author: Emmanuelle Sarat, IUCN French committee



8. Raising awareness concerning the Canada goose during a public event.

For more information

- Centre and Île-de-France regional office: www.oncfs.gouv.fr
- The initial version of this document was first published in: Sarat E. (coord.) 2012. Vertébrés exotiques envahissants du bassin de la Loire (hors poissons) connaissances et expériences de gestion. Office national de la chasse et de la faune sauvage, Plan Loire Grandeur Nature, 128 pp.
- Fouque C., Schricke V., David Y., Serre D. 2011. La Bernache du Canada : une espèce exotique devenue envahissante. Diagnostic, plan de lutte et régulation. Faune Sauvage, 290 : 18-31.
- ONCFS, délégation interrégionale Centre-Ile de France. 2012. La Bernache du Canada en régions Centre et Ile-de-France : expérience de suivi et de gestion des populations 2011-2012. Office national de la chasse et de la faune sauvage. 15 pp.



Egyptian goose

(*Alopochen aegyptiaca*)

Originated in Sub-Saharan Africa. Introduced into the U.K. at the end of the 1600s, then into Germany during the 1700s. It escaped from captivity and colonised the Netherlands, Belgium, Spain and France where the first reproduction was observed in 1985.

Description

- The bird looks like a goose, but with a special plumage:
 - light-coloured head, darker neck
 - chocolate-brown spot around the eye
 - greyish-brown back with a brown spot
 - green underwing, black tail
- Pink legs
- Adults stand 70 cm tall with a wing span of 140 cm
- The average weight ranges from 1.5 to 2.25 kg
- The average life span is between 15 and 20 years

Ecology and reproduction

- Habitats include urban water bodies, quarries and rivers
- Herbivorous diet (grass, leaves, seeds and grain). The birds can fill out their diet with insects, frogs and worms
- Reproduction can occur year round. In France, laying of eggs is observed from March to May
- The birds are gregarious during the pre-nuptial period, but aggressive during the breeding season
- Couples defend a territory of approximately one hectare
- Broods count 8 to 9 eggs that incubate for 28 to 30 days
- The young can fly after 70 to 75 days
- First reproduction at age of 2 years

Documentation

- Sarat E. (coord.) 2012. Vertébrés exotiques envahissants du bassin de la Loire (hors poissons) connaissances et expériences de gestion. Office national de la chasse et de la faune sauvage, Plan Loire Grandeur Nature, 128 pp.
- Fouque C., Benmergui M., Bullifon F., Schricke V. 2012. L'Ouette d'Égypte : une espèce exotique en plein essor en France, Faune Sauvage N°296 : 15-25.
- Benmergui M., Bullifon F., Fouque C. 2011. L'Ouette d'Égypte *Alopochen aegyptiaca*. Synthèse bibliographique et perspectives de gestion pour la France. Office national de la chasse et de la faune sauvage, Station de la Dombes, Birieux. 42 pp.
- Cramp S., Simmons K.E. 1977. Handbook of the birds of Europe, the Middle East and North Africa. The birds of the Western Palearctic (1) Ostrich to Duck. *Oxford University Press*, Oxford, UK. 913 pp.

Author: Emmanuelle Sarat, IUCN French committee

Classification

Order	Anseriformes
Family	Anatidae
Genus	<i>Alopochen</i>
Species	<i>A. aegyptiaca</i> (Linnaeus, 1766)





Egyptian goose

(*Alopochen aegyptiaca*)

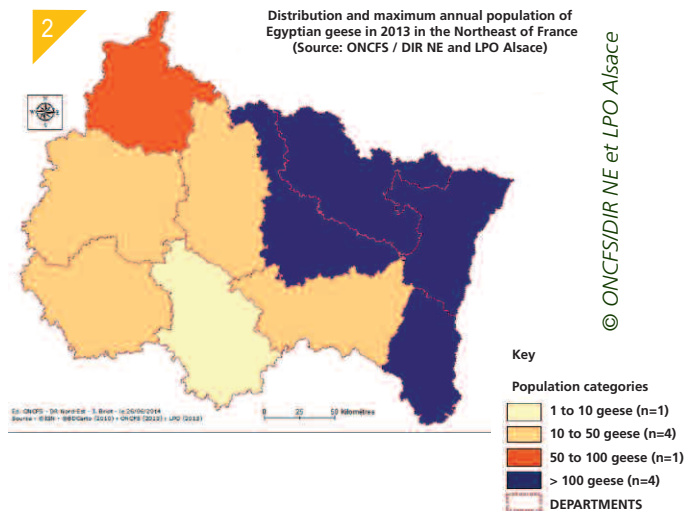
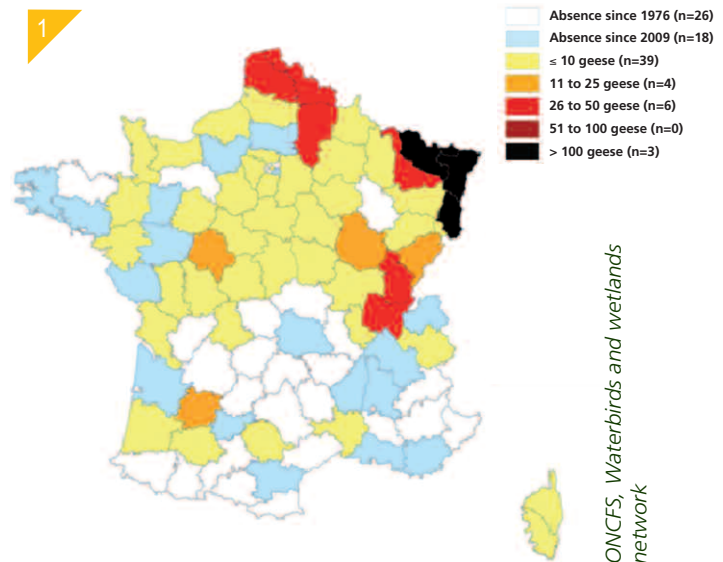
Managing Egyptian geese in Eastern France

National agency for hunting and wildlife (ONCFS), Northeast regional office

- ONCFS is a public agency placed under the supervision of the Ecology and Agriculture ministries.
- Its missions correspond to the guidelines contained in the Grenelle environmental agreement, including general surveillance of rural areas and policing activities for the environment and hunting, and research on wildlife and its habitats.
- The Northeast regional office covers ten departments and three administrative regions (Alsace, Lorraine and Champagne-Ardenne) with a workforce of over 100 in the local offices and 16 for administrative and technical tasks.
- Contact: ONCFS - Northeast regional office
- dr.nord-est@oncfs.gouv.fr

Situation in the Northeast of France

- Most of the Egyptian geese observed in the Northeast of France come from neighbouring countries. Large populations exist in Germany, Luxembourg and Belgium. The three countries are in direct contact with the three regions that make up the Northeast regional office, namely Alsace, Lorraine and Champagne-Ardenne. An increase in the home range and in the numbers of the population in Northeast France are due to the influx from the neighbouring countries.
- The initial observations were undertaken by ONCFS in 1988 in the Moselle department and the first brood was discovered in 1996 in the town of Bousse (Moselle department).
- Today, colonisation of the territory continues with increasingly large populations along the Moselle and Rhine Rivers which act as incoming corridors for the species from the neighbouring countries. It follows that the departments bordering the rivers, namely Moselle, Meurthe-et-Moselle, Bas-Rhin and Haut-Rhin, are the most affected. However, increasing numbers of breeding couples have been observed in the neighbouring departments, namely Meuse, Vosges, Aube and Ardennes. The species is clearly in an expansion phase and the entire territory of the Northeast regional office is likely to be affected by the spread of the Egyptian goose.



1. Distribution and maximum annual population of Egyptian geese in France during the period 2009 to 2011.
2. Distribution and maximum annual population of Egyptian geese in the Northeast of France.

Disturbances and issues involved

Impacts on native species

- The observations carried out in the field by ONCFS personnel or by naturalists revealed aggressive behaviour of the species during the reproductive season toward protected, native species such as the great crested grebe (*Podiceps cristatus*).

Monitoring the populations

- Following numerous observations of the species, a regional survey was launched in 2008 via the departmental offices to determine the status of the species. The survey consisted of collecting information on nesting, on the numbers of nesting couples and on their location.
- In 2009, the national survey managed by the *Oiseaux d'eau et zones humides* network replaced the regional survey.
- Then in 2010, the regional survey was reactivated and a map was drawn up indicating the towns where the species nested.
- This monitoring work made it possible to precisely locate the nesting couples and to determine the departments where populations were growing rapidly. In compliance with the precautionary principle, it was decided to launch an operation to control the species and to limit its expansion.

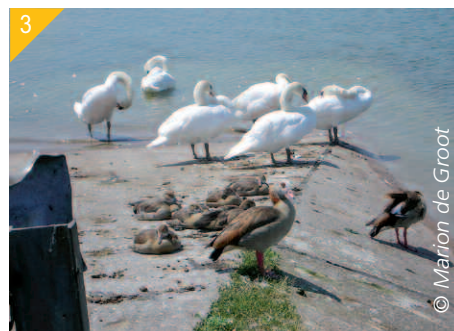
Shooting

■ Obtaining the prefectural orders

- Starting in 2009 with a request by the Moselle departmental office, prefectural orders authorising the shooting of Egyptian geese were progressively issued in several departments covered by the NE regional office on the basis of regulations concerning pests. The orders stipulated the conditions under which the Egyptian geese were to be controlled. Generally speaking, they authorised the holders of hunting rights, their beneficiaries and official personnel in charge of enforcing hunting regulations to shoot the species.
- In order to monitor implementation of the measure and assess its effectiveness, each bird shot must be reported at the end of the month or the end of the hunting season to the departmental territorial agency, to the ONCFS departmental office or to the local hunting federation. Certain orders include models of shooting reports indicating the place and date, the number of birds eliminated and their estimated age (juvenile or adult).
- Two periods would appear to be particularly suitable for control operations, namely March-April when the couples have formed on the nesting sites and July-August when the young birds are present. The results of operations are better when the participants have in-depth knowledge of the habits and needs of the species, and of the area where the operation takes place.

■ Example of shooting techniques used in the Bas-Rhin department

- The use of both shotguns and rifles was found to be advantageous in eliminating the birds.
- Number 2 steel shot was used successfully in shooting Egyptian geese.
- In terms of rifles, the .17 HMR (1-gram projectiles) and .22 Hornet calibres produced good results.
- In step with the repetition of operations, the geese became increasingly wary to the point that the approaches in open terrain became impossible. Surprise is of the essence.
- Approaches using a vehicle often produced better results than on foot. However, the use of a vehicle must be explicitly mentioned among the equipment listed in the prefectural order.
- The partnership with the river police made it possible to use a patrol boat for one operation and to eliminate a few birds that were too far from the banks.



3. Egyptian geese.
4. 5. 6. Shooting operations.



- Dogs were used to retrieve the dead birds and avoid them being seen by the public.
- Given public sensitivities, birds inhabiting certain sectors cannot be eliminated. These sectors effectively become refuge zones for the species.

Results and assessment

■ Results

- The tables below list the prefectural orders issued in the three regions and present the results of the control operations over the years.

Results of control operations for the Egyptian goose in the Lorraine region.

Lorraine	Prefectoral order	Period	Authorised persons	Conditions	Birds eliminated
Moselle (57)	Annual order since 2009	23 August to 1 February	Holders of hunting rights and their beneficiaries Hunting police	Shooting as per hunting rules On or near water bodies Report at end of season to federation 77	2009-2010 = 29 (DO) 2010-2011 = 11 (DO) 2011-2012 = 34 (DO) / 100 (hunters) 2012-2013 = NI 2013-2014 = 137 (hunters)
Meurthe-et-Moselle (54)	Order dated 5 July 2012	Same dates as geese listed as game (21 August to 10 February)	Holders of hunting rights and their beneficiaries ONCFS personnel	Shooting under same conditions as goose hunting throughout the department Report at end of February to DO 54 by ONCFS personnel	2011-2012 = 27 (hunters) 2012-2013 = NI 2013-2014 = 12 (hunters)
Vosges (88)	Annual order since 2011	21 August to 10 February	Holders of hunting rights and their beneficiaries Hunting police	Shooting as per hunting rules On or near water bodies Report by end of February to DO 88	2011-2012 = 2 (hunters) 2012-2013 = NI 2013-2014 = 1 (hunters)
Meuse (55)	Order dated 18 July 2012	21 August to 10 February All year for authorised personnel and game wardens	Holders of hunting rights and their beneficiaries Hunting police Authorised game wardens	Shooting as per hunting rules Authorised sites for hunters Entire department for the hunting police Report by 15 March to DDT 55	2012-2013 = NI 2013-2014 = 3 (DO) / 3 (hunters)

DO = departmental office, NI = no information

Results of control operations for the Egyptian goose in the Alsace region.

Alsace	Prefectoral order	Period	Authorised persons	Conditions	Birds eliminated
Haut-Rhin (68)	Permanent order since 2010	1 October to 1 February	Holders of hunting rights and their beneficiaries Hunting police	Shooting as per hunting rules On open waters and restricted waters for hunters Entire department for the hunting police Report by 10 February to DDT 68	2010-2011 = 7 (DO) / 10 (hunters) 2011-2012 = 21 (DO) 2012-2013 = NI 2013-2014 = 34 (DO) / 5 (hunters)
Bas-Rhin (67)	Permanent order since 2011	15 April to last day of February All year for authorised personnel and game wardens	Holders of hunting rights and their beneficiaries Hunting police Authorised game wardens	Shooting as per hunting rules On open waters and restricted waters for hunters All areas where game wardens are authorised Entire department for the hunting police Report by 15 March to DDT 67	2011-2012 = 18 (DO) / 7 (wolf-hunting officers) / 36 (hunters) 2012-2013 = NI 2013-2014 = 57 (DO in 2013) / 161 (hunters)

Results of control operations for the Egyptian goose in the Champagne-Ardenne region.

Champagne-Ardennes	Prefectoral order	Period	Authorised persons	Conditions	Birds eliminated
Aube (10)	Order dated 17 June 2012	Same dates as geese listed as game (21 August to 10 February) All year for authorised personnel and game wardens	Holders of hunting rights and their beneficiaries Hunting police Authorised game wardens	Shooting as per hunting rules Entire department for the hunting police Report within 48 hours to ONCFS which produces final report at end of April	2012-2013 = NI 2013-2014 = 0
Ardennes (08)	Order dated 26 December 2012	Same dates as geese listed as game (21 August to 10 February) All year for authorised personnel and game wardens	Holders of hunting rights and their beneficiaries Hunting police Authorised game wardens	Shooting as per hunting rules On open waters and restricted waters for hunters Entire department for the hunting police Report within 1 week and final report by end of February to DDT 08	2012-2013 = NI 2013-2014 = 3 (hunters)

■ Total :

- 2009-2010: 29 (department 57);
- 2010-2011: 28 (departments 57 and 68);
- 2011-2012: 245 (departments 54, 57, 67, 68, 88);
- 2012-2013: no information;
- 2013-2014: 416 (departments 57, 68, 67, 54, 55, 88, 08, 10);
- Total for the four seasons: 718

Information on the project

- Articles were published in the *Faune Sauvage* journal.
- Annual reports and maps.

Outlook

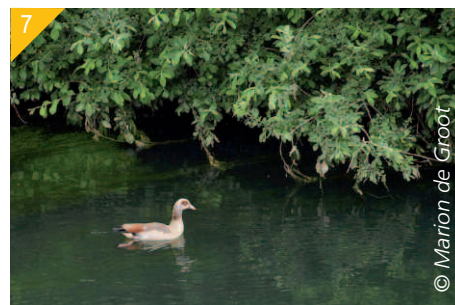
■ When a biological invasion occurs, it is imperative to act quickly. Prevention is the name of the game. In spite of early observations of Egyptian geese, it was not clear that the species was invasive and control measures were not implemented immediately, thus enabling the species to establish in the region. Today, the species is clearly an invasive alien species. Eradication is no longer a realistic option and the objective of the current measures is to contain the species in the north-eastern section of France and avoid colonisation of the rest of the country.

■ In addition to the efforts to limit the populations in the northeastern section of France, it is indispensable that the neighbouring countries take similar measures because the largest feral populations of Egyptian geese are located in those countries. Uniform action by the French regions and the neighbouring countries confronted with the invasion is essential to produce effective results.

■ Under the current conditions, prefectoral orders authorising the shooting of Egyptian geese are the most rapid means of limiting the spread of the species. The species is also highly recognisable which limits the risks of shooting errors. However, this control measure must not be interpreted by hunters as the addition of a new type of game, but as a special effort against an invasive alien species in order to limit the negative impacts.

- Given the results since 2009 (over 700 geese eliminated), efforts to control the species by shooting would appear to be insufficient in light of the overall population and the growth rates of the species.
- This situation suggests that the measure should be expanded to include all of the Moselle and Rhine basins in order to unify management techniques and exert real pressure on the species.
- It is important to continue informing hunters, particularly the waterfowl hunting associations, on the negative aspects of biological invasions and on current regulations in order to expand their role in controlling the species.
- Other measures, such as the creation of an observation network or interventions during the nesting period, should be studied in order to make the management of the IAS more effective.
- Finally, it would be useful to add this species to the “invasive species” category (group 1) in the new regulations concerning animal species listed as pests. The management work could then be conducted on the national scale.

Authors: Emmanuelle Sarat, IUCN French committee, Marie-Laure Schwoerer, Paul Hurel and Blandine Guillemot, ONCFS NE regional office



7. Egyptian goose.

For more information

- www.oncfs.gouv.fr
- The initial version of this document was first published in:
Sarat E. (coord.) 2012. Vertébrés exotiques envahissants du bassin de la Loire (hors poissons) connaissances et expériences de gestion. Office national de la chasse et de la faune sauvage, Plan Loire Grandeur Nature, 128 pp.
- Fouque C., Benmergui M., Bullifon F., Schricke V. 2012. L'Ouette d'Égypte : une espèce exotique en plein essor en France, Faune Sauvage N°296 ; pp 15-25.
- Benmergui M., Bullifon F., Fouque C. 2011. L'Ouette d'Égypte *Alopochen aegyptiaca*. Synthèse bibliographique et perspectives de gestion pour la France. Office national de la chasse et de la faune sauvage, Station de la Dombes, Birieux. 42 pp.
- Hurel P. 2011. Les espèces exotiques envahissantes animales du Nord-Est de la France. Inventaire, évaluation, hiérarchisation et plan d'action. Application du plan d'action sur le Castor canadien et l'Ouette d'Égypte. Rapport de stage Master Environnement et aménagement. Université Paul Verlaine, Metz, 53 pp + Annexes.



Coypu

(*Myocastor coypus*)

Originated in South America. The species was introduced in France in the 1800s initially for research purposes, later for the fur industry.

Description

- A semi-aquatic rodent that can weigh up to 10 kilograms adult weight (6 kg on average)
- The fur is brown with guard hairs and a waterproof undercoat
- A massive body approximately 50 to 60 centimetres long
- The tail is cylindrical, approximately 40 cm long, with little hair
- The front paws have strong claws
- The rear feet are palmed
- Nostrils have valves to seal out water
- Orange-coloured incisors are always visible
- Females have 8 to 10 teats (two dorsolateral rows)
- Life expectancy is approximately 4 years in the natural environment

Ecology and reproduction

- The species can adapt to diverse habitats, including marshes, rivers, drainage ditches, ponds and lakes, dikes, reed ponds
- The animals dig burrows for protection against the weather and to bear young
- They are active primarily at dusk and during the night
- Gregarious tendencies, but also territorial
- Almost exclusively herbivorous, the species feeds on all types of aquatic and terrestrial plants depending on availability, which means the animals can adapt to a wide range of environments
- Prolific species with up to three litters per year and up to six young per litter

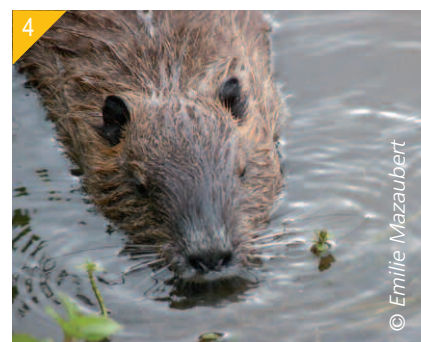
Documentation

- Sarat E. (coord.) 2012. Vertébrés exotiques envahissants du bassin de la Loire (hors poissons) : connaissances et expériences de gestion. Office national de la chasse et de la faune sauvage, Plan Loire Grandeur Nature, 128 pp.
- Léger F. 2009. Les mammifères aquatiques exotiques envahissants – Formation Onema sur les espèces exotiques envahissantes en milieu aquatique, 25/05/2009 – 29/05/2009, Fouencamps, FRA, 209 pp. (Communication orale).
- Nepveu C. 2002. Les espèces animales et végétales susceptibles de proliférer dans les milieux aquatiques et subaquatiques - Fiches espèces animales (Les espèces exotiques). Agence de l'eau Artois-Picardie. 98 pp.

Author: Emilie Mazaubert, Irstea

Classification

Order	Rodents
Family	<i>Myocastoridae</i>
Genus	<i>Myocastor</i>
Species	<i>M. coypus</i> (Molina, 1792)





Coypu

(*Myocastor coypus*)

Controlling populations of harmful aquatic rodents (coypu and muskrats) in the Loire-Atlantique department

Loire-Atlantique departmental federation of pest-control groups (FDGDON 44)

- FDGDON 44 is a professional farming group that is supervised by the Regional food service (SRAL).
- The executive board comprises 13 members elected by the 60 intermunicipal and municipal groups during the annual meeting.
- The federation has a permanent workforce of 11.
- The objectives are contained in the Rural code, with more precise goals stipulated in ministerial decrees and, where applicable, prefectural and/or municipal orders. They include the organisation of collective projects against pests attacking crops, plants and plant products in the department.
- Contact: Marc Pondaven, Director
- marcpondaven-fdgdon44@wanadoo.fr

Intervention site

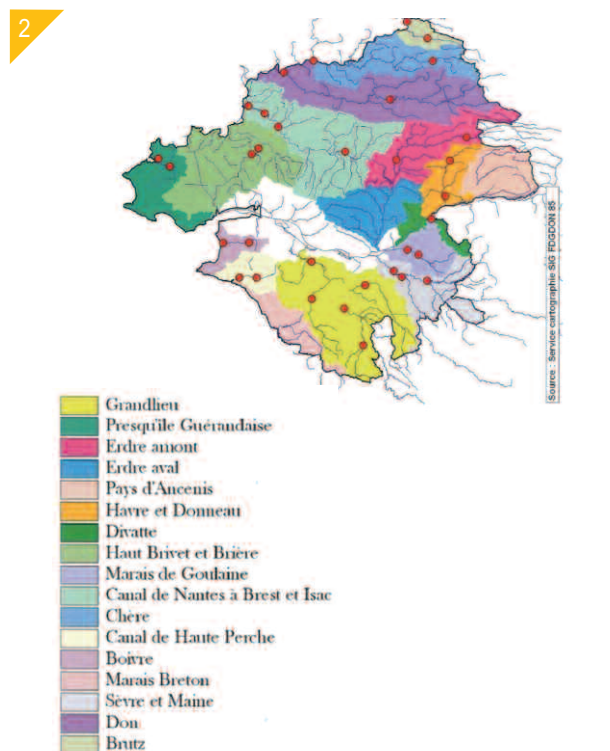
- The Loire-Atlantique department covers a total surface area of 6 815 square kilometres.
- The hydrographic network is very dense.
- There are two main river basins:
 - the Loire, comprising the Loire itself, its tributaries and the many wetlands and littoral areas in contact with its estuary;
 - the Vilaine, comprising the basins of the Chère, Don, Aron and Isac Rivers, as well as a part of the canal from Nantes to Brest.
- There are a number of coastal rivers.
- The department is made up of highly diverse environments, including large and small rivers, streams and canals, estuarine salt meadows, marshes (fresh, brackish and salt waters), ponds and lakes, littoral areas.
- Certain areas are emblematic, due to both their hydrographic functioning and their outstanding heritage value, namely the Loire estuary, the Brière area, Grand-Lieu Lake, the Mazerolles marsh and the Marais Breton marsh.

Disturbances and issues involved

- **Impacts on the environment**
 - Coypus dig burrows that can lead to the collapse of river banks and to sedimentation modifying the morphology of the environment.
 - They can also reduce plant cover.



© Wikipedia



© FDGDON 44

1. Map of the Loire-Atlantique department.
2. Sites of population-density monitoring in the river basins.

■ Impacts on agriculture

- The animals eat crops.
- The damage to river banks creates risks for farm vehicles.

■ Impacts on hydraulic structures

- The damage to river banks can weaken structures (dikes, bridges).

■ Impacts sanitaires

- Contamination des eaux douces par l'urine et les excréments.
- Possible transmission de maladies au bétail et à l'homme (leptospirose, grande douve du foie).



3. Damage to a maize field caused by coypus.

Interventions

■ Monitoring the populations

- Prior to control work and in compliance with the ministerial order dated 8 July 2003, FDGDON conducts checks, twice per year in the spring and fall, on the densities of rodent populations in the river basins.
- This monitoring is carried out in different parts of the department according to a strict protocol (cage traps every 50 metres).
- The animals captured in the traps are counted, weighed and their sex determined.
- The resulting data can be plotted graphically and indicates whether the populations in a given river basin are increasing or decreasing. This information is used to organise the control work.
- Monitoring is a necessary and mandatory component, according to the prefectural order organising the management efforts against coypus and muskrats.

■ A collective effort

- FDGDON intervenes on the primary hydrographic network and volunteers on the secondary and tertiary networks.
- FDGDON uses a number of control techniques, primarily trapping, but also shooting during collective operations and protection systems for river banks (occasionally, during maintenance work). Poison has not been used since 2003.
- Trapping campaigns are organised by zone and an operation in a zone lasts three weeks.
- Cages are set up every 50 metres and remain in place for the duration of the operation. They are checked daily.
- No particular type of cage or certification is required:
 - cages may be of different lengths;
 - treadles may be made of sheet metal, horizontal bars or wire mesh, and installed more or less deeply in the cage;
 - the cages are attached to a raft made of resin-coated cellular polycarbonate and anchored to trees or vegetation on the banks.
- FDGDON 44 owns between 250 and 300 traps with a service life of approximately ten years:
 - if vandalism and losses due to flooding are excluded, frequent causes of damage to cages are their transport and shooting the animals;
 - renewal rates therefore vary significantly.

- The type of cage used and their installation on the rafts makes them highly selective. Very few non-targeted species are captured. Any animals accidentally captured can be released without harm.
- The captured animals are killed immediately, in the cage, using a .22 long rifle:
 - technically speaking, this is the best solution because the regulations require that the animals be killed rapidly and without suffering;
 - this technique is not advised for volunteers for safety reasons and due to regulations (difficulties in applying both the trapping and firearms regulations);
 - alternate methods are drowning (authorised in the Loire-Atlantique department) and clubbing.
- Technical personnel may not take action against animals on the river banks:
 - different regulations apply and a hunting license is required;
 - the person must have hunting rights and/or be a certified game warden for the area in question;
 - in addition, .22 long rifles are not authorised for hunting.
- The work takes place primarily during the fall and winter and in two-man teams (driver and shooter) when access to the traps requires a boat.
- The dead animals are placed in containers in the boat and then transported to the federation.
- The rendering service picks them up free of cost if the total weight exceeds 40 kilograms (approximately a dozen coypus). It follows that the rendering service comes fairly often.



4. A baited cage trap with a trapped coypu.

© Emile Mazeubert

Results and costs

■ Results

- In terms of the density monitoring, the unit of comparison is the average number of animals per kilometre of river.
- A drop in the average number of animals captured per kilometre is an indication of the effectiveness of the management work.
- A drop in the average weight of the captured animals highlights the value of maintaining the trapping pressure in that the animals do not have the time to age.
- Collective shooting operations organised in certain areas (Brière and Grand-Lieu Lake) produced divergent results:
 - due to variable environmental factors (water levels, temperature);
 - due to the high cost of ammunition, a demotivating factor for volunteers.
- The work nonetheless reduced the population of rodents and limited the level of infestation that would have increased if not measures had been taken.

Number of animals eliminated during the collective operations against harmful aquatic rodents from 2004 to 2010.

	2004	2005	2006	2007	2008	2009	2010
Shooting	6 931	4 818	4 282	3 493	2 395	4 426	3 791
Volunteer trapping: elimination	35 624	43 073	33 584	41 160	43 160	46 174	41 418
Volunteer trapping: surveys	962	1 946	1 250	1 354	2 031	1 333	980
FDGDON 44 technicians	2 492	2 612	2 175	2 125	2 851	2 322	2 192
TOTAL	46 009	52 449	41 291	48 132	50 437	54 255	48 381

FDGDON 44: Table drawn from the general meeting held on 1 April 2011

■ Intervention costs

- Costs varied depending on tariffs and environmental conditions:
 - in areas accessible by boat, costs were approximately 900 euros per kilometre;
 - in areas not accessible by boat, costs were higher due to the time required to access difficult spots and the more expensive equipment required;
 - costs for density monitoring were lower because FDGDON 44 paid for some expenses.
- Management costs were lower than the potential restoration costs of the avoided impacts.
- The participation of volunteers reduced the costs while producing good results.

Information on the project

- Of the 220 towns in the Loire-Atlantique department, over 190 are members of FDGDON for the management work against coypus and muskrats. The other towns have hydrographic networks that do not require work against these species (e.g. no ponds or rivers).
- FDGDON prepares the volunteer networks in conjunction with the towns and manages them:
 - organisation, training;
 - dissemination of information (regulations, etc.);
 - organisation of an annual meeting to discuss results, new regulations, map sites and trapped areas;
 - meet all the trappers in the field to monitor captures and collect the tails for the bounty.
- FDGDON regularly informs the managers of natural areas and newly formed river boards about the obligations concerning species that must be controlled.

Note on applicable regulations

- According to the interministerial decree dated 6 April 2007, coypus and muskrats are pests that must be controlled in the framework of plant-protection regulations.

Author: Emilie Mazaubert, Irstea

For more information

■ <http://www.fdgdon44.fr>





Coypu

(*Myocastor coypus*)

Coypu management by the Association of certified trappers for the Gironde department

Association of certified trappers for the Gironde department (ADPAG)

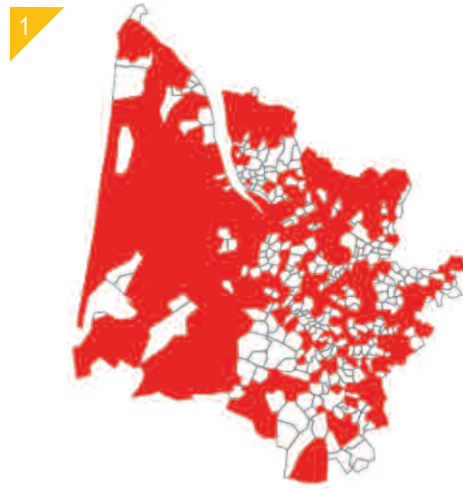
- The non-profit organisation was founded in 1997 and is certified for environmental protection.
- The main missions include:
 - representing the certified trappers in the Gironde department in their dealings with the administrative, professional and hunting authorities;
 - managing and informing the certified trappers concerning regulations and safety;
 - organising the capture of pests.
- Contact: Gérard Delas - gerard.delas@club-internet.fr

Intervention site

- ADPAG represents the certified trappers (both professional and volunteer) that operate in the towns of the Gironde department.
- The association coordinates trapping by signing agreements with various entities (towns, intermunicipal associations, river boards, farmers, the Bordeaux urban area, the departmental council, etc.).
- Coypus have been trapped in the Gironde department since 1997. During the 2011-2012 season, certified trappers were active in 263 out of the 542 towns in the department.
- The traps are generally positioned near aquatic environments (rivers, wetlands), on the banks, in compliance with the applicable regulations (annual prefectural order).

Disturbances and issues involved

- **Impacts on the ecosystem**
 - The animals consume aquatic macrophytes and the roots and bark of shrubs on banks in the winter.
 - They undermine banks by digging burrows and eating the shrubs on the banks.
- **Impacts on health**
 - Coypus may transmit leptospirosis to humans and livestock.
- **Impacts on agriculture**
 - The animals eat crops (wheat, maize, etc.).



1. Towns in the Gironde department where coypus are captured by certified trappers.

Interventions

- ADPAG coordinates trapping by the certified trappers in the Gironde department and draws up an annual report on coypu trapping on the basis of the data supplied by the trappers. Trapping activities are reported to the administrative authorities in each town.
- **Trapping:**
 - operations are conducted throughout the year and the results are assessed at the end of June;
 - cage traps with a single entry are used;
 - bait consists of apples, carrots or maize;
 - the traps have escape holes (5 x 5 cm) for European mink that must be open from April to the end of July when the traps are laid less than 200 metres from water bodies and wetlands in compliance with the prefectural order;
 - the traps are supplied by ADPAG;
 - traps are checked daily in compliance with the applicable regulations.
- **Capture data:**
 - data is compiled on the basis of the "capture-data sheets" sent to trappers at the end of June;
 - the sheets list the captures of pests such as coypus, indicating the number per town, species by species (pests and released other species).

- The trapping effort is assessed on the basis of “trapping-pressure sheets” indicating the number of trapping days and the number of traps laid in each town.

Results and costs

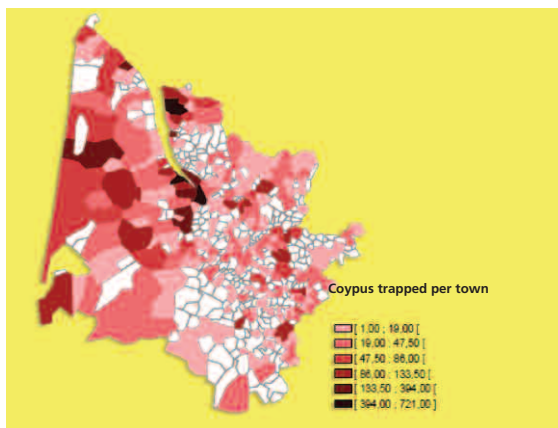
■ Results of the 2012-2013 season

- 1 118 capture-data sheets were submitted by trappers.
- 9 813 coypus were captured in 261 towns throughout the department (706 925 hectares).
- 357 certified trappers took part in the campaign.
- 28 coypus were caught on average by each trapper.
- 235 769 trap-days for the department as a whole.

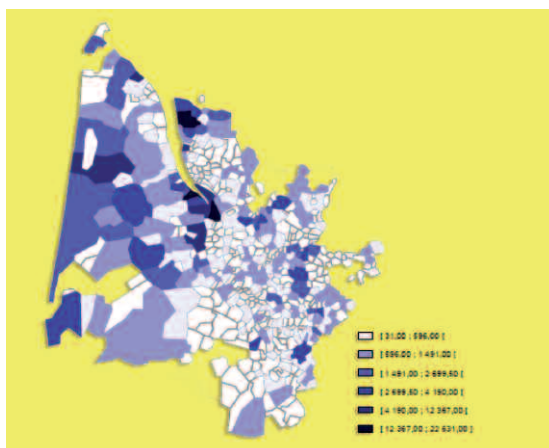
■ Costs

- The overall increase in trapped coypus was probably due to the greater number of trappers.
- Starting in 2009, there was a decrease in the total number of animals captured and in the number of coypus trapped per square kilometre.
- ADPAG decided to calculate the density of coypus per square kilometre because that would appear to correspond to the home range of the species.
- The operations since 2006 cost 50 000 euros for the equipment and 30 000 euros in bounties for the trappers (3 euros per animal) and operating costs.
- The main difficulty encountered concerned the theft of or damage to the traps.

Average number of coypus captured per square kilometre per town during the 2011-2012 season.



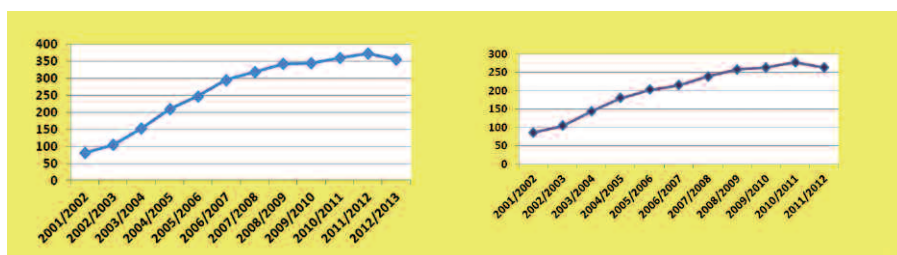
Total number of trap-days per town during the 2012-2013 season.



2. A coypus on a bank.
3. A coypus captured in a cage trap.
4. A cage trap for coypus with an opening for European mink.

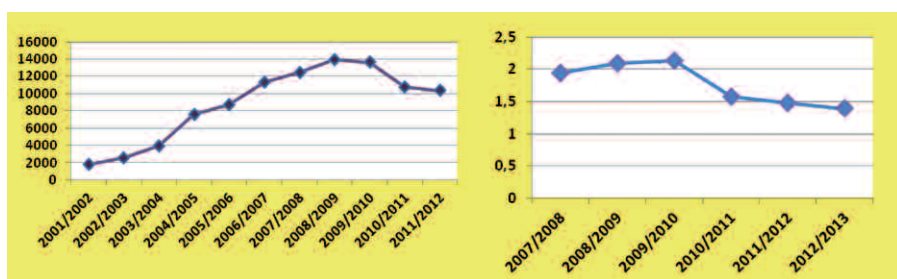
Total number of trappers from 2001 to 2013.

Number of towns in which at least one coypu was trapped from 2001 to 2013.



Annual number of coypus trapped from 2001 to 2013.

Average number of coypus trapped per square kilometre from 2007 to 2013.



Information on the project

- Mandatory upgrade courses on techniques, regulations and awareness raising are provided for certified trappers every five years in agricultural training schools.
- The annual trapping report is published on the ADPAG internet site with information on initial and upgrade training courses for trappers.

Outlook

- An effort is under way to determine the cause of the reduction in the coypu population (trapping pressure, weather conditions, etc.).
- A policy officer will be hired to encourage the pursuit of the trapping operations and to coordinate the volunteer trappers.

Note on applicable regulations

- The species is considered a pest throughout continental France (ministerial decree dated 24 March 2014).
- The species is harmful to plants and must be controlled (ministerial decree dated 31 July 2000, modified by ministerial decree dated 25 August 2011).
- The conditions for the control of coypu and muskrat populations were set by decree dated 6 April 2007.
- Trapping conditions for animals declared as pests were set by decree dated 27 June 2009, modified by the decree dated 13 December 2011.

Author: Sandra Fernandez, Irstea

For more information

- ADPAG internet site: <http://www.adpag.fr/>
- ADPAG, avril 2012. Le ragondin en Gironde – Saison 2010/2011.
- ADPAG, avril 2013. Le ragondin en Gironde – Saison 2011/2012.
- ADPAG, mai 2013. Synthèse du piégeage en Gironde – Saison 2011/2012.
- ADPAG, novembre 2013. Synthèse du piégeage en Gironde – Saison 2012/2013.





Muskrat

(*Ondatra zibethicus*)

Originated in North America. Introduced in France in 1920 for the fur industry

Description

- Semi-aquatic rodent weighing between 0.6 and 2 kilograms
- Dark brown, thick, waterproof fur, grey fur on the stomach
- A stocky body approximately 30 centimetres long
- A thin tail flattened vertically, approximately 20 cm long, with scaly skin
- Short snout, small eyes and short ears hidden under the fur
- The rear feet are not palmed, but the toes are covered with tufts of hairs
- Chisel-shaped incisors, yellow-orange in adults
- Two musk glands are located under the skin near the rectum
- Life expectancy is approximately 4 years in the natural environment

Ecology and reproduction

- Habitats range from running to stagnant waters with high levels of aquatic vegetation
- The animals dig burrows into banks and build huts
- They are active primarily at dusk and during the night
- The species is essentially herbivorous, though it occasionally eats molluscs and crustaceans
- The females bear young 3 to 4 times per year with 3 to 7 young per litter

Documentation

- Sarat E. (coord.) 2012. Vertébrés exotiques envahissants du bassin de la Loire (hors poissons) : connaissances et expériences de gestion. Office national de la chasse et de la faune sauvage, Plan Loire Grandeur Nature, 128 pp.
- Nepveu C. 2002. Les espèces animales et végétales susceptibles de proliférer dans les milieux aquatiques et subaquatiques - Fiches espèces animales (Les espèces exotiques). Agence de l'eau Artois-Picardie. 98 pp.

Author: Emilie Mazaubert, Irstea

Classification

Order	Rodents
Family	<i>Muridae</i>
Genus	<i>Ondatra</i>
Species	<i>O. zibethicus</i> (Linnaeus, 1766)





Muskrat

(*Ondatra zibethicus*)

Managing muskrats in the Somme department

Departmental river and maritime agency

- The agency became part of the operational and infrastructure-maintenance directorate of the departmental council as of 1 January 2008.
- The agency works on the public river and maritime domain of the Somme department, i.e. 720 hectares comprising 120 kilometres of waterways and tow-paths as well as 30 km of natural rivers and discharge channels.
- The main missions include:
 - management of visits to and activities in the river domain (river tourism and traffic, fishing, boating, hiking, etc.);
 - maintenance and work on the banks;
 - maintenance and upgrading of structures;
 - IAS management by an "IAS unit" that traps rock doves and European rabbits, manages invasive alien plant species along the Somme canal (Japanese knotweed, water primrose, summer lilac, giant hogweed, garden balsam and goldenrod) and controls muskrats.
- Contacts: David Dhennin - d.dhennin@somme.fr, head of the Canal operating and infrastructure service, Somme departmental council;
- Jean-Louis Derosière - jlderosiere@somme.fr, head of the IAS unit.

Intervention site

- The Somme department comprises over 1 000 kilometres of river, 6 000 hectares of water bodies and a wide array of highly diverse wetlands. The basin of the Somme River spans the entire department. The river begins in the Aisne department and flows to the Somme Bay.
- The IAS unit operates in part in the public river and maritime domain, which is simply the river basin from Sourmont to the estuary.
- For muskrats, the unit also works in sectors outside the domain on tributaries to the Somme, on the Bresle and Authie Rivers (two coastal rivers just outside departmental limits) and on the Marquenterre area (low-lying fields, ditches, etc.).
- On the other hand, the unit is not responsible for other types of water bodies (public and private marshes, ponds).



1. The basin of the Somme River and the hydrographic network of the Somme department.

Disturbances and issues involved

- Muskrats have very few predators in France, with the exception of humans, foxes and skunk, which explains their very wide dispersion
- **Impacts on the environment**
 - The animals dig burrows, leading to the collapse of river banks.
 - They can also reduce plant cover.
 - Muskrats compete with native species such as the European water vole.
 - They are also predators of native species (amphibians and anodonta (freshwater mussels)).
- **Impacts on agriculture and vegetable farming**
 - The animals occasionally eat crops.
- **Impacts on structures**
 - The damage to river banks can weaken structures (dikes, bridges).
 - Muskrats eat the bark of willow trees planted on the banks.
- **Impacts on health**
 - The animals can pollute fresh waters with their urine and feces, creating a risk of transmission of diseases (leptospirosis and echinococcosis) to humans and livestock.
 - These disturbances resulted in the signing of a prefectural order on 28 June 2007, listing muskrats among "pests" in the Somme department.

Interventions

- In managing muskrats in the Somme department, the IAS unit decided in favour of a highly regulated technique, trapping. Trapping activities must be declared annually in each town hall.
- Human resources and equipment:
 - four professional trappers including one general purpose (maintenance of river equipment, operations);
 - the trappers each work a separate geographic sector except along the Somme canal where they work together;
 - three 4-wheel drive vehicles are used;
 - a motorised boat is available.
- Two types of trap are used:
 - category-1 traps (declaration in town hall required, but no certification), e.g. cage traps with plant bait;
 - category-2 traps (require certification), e.g. conibear traps, steel-jaw traps.
- Trapping is carried out throughout the year. Sites are selected depending on the number of animals present.
- The abundance of muskrats is determined according to the damage done to banks.
- Traps are checked daily before noon in compliance with the applicable regulations.



2. Burrows dug into a bank.

Results and assessment

■ Results for 2012

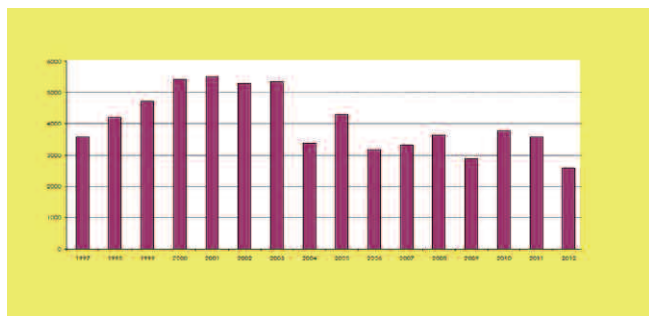
- Traps were laid approximately 10 000 times.
- A total of 2 594 muskrats were captured.
- Quantitative capture data has been collected since 1997. The number of captures varies from one year to the next, depending on several factors, including the reproductive success of the species, weather conditions, hydrological (water-level) conditions and possible access to areas by trappers. It should be noted that the number of trappers can also vary from one year to the next.

Muskrat captures in 2012. Source ADFM.

Mois	Musk rats trapped in the public river and maritime domain	Musk rats trapped outside of the public river and maritime domain	Total per month
January		457	457
February		345	345
March		314	314
April	53	34	87
May	30		30
June	80	26	106
July	32		32
August			0
September		9	9
October	25	287	312
November	67	512	579
December		323	323
Annual total	287	2 307	2 594



Muskrats trapped per unit of effort from 1997 to 2012.



© ADFM



3. A muskrat captured in a cage trap.

■ Assessment of Jean Louis Derosière, trapper and head of the IAS unit

- On the whole, the number of trapped muskrats has decreased.
- The decrease in the number of muskrats in the Somme department is linked to the increase in the red fox (*Vulpes vulpes*) population.
- Captures have increased from September to March and particularly from November to March, the reproductive season.

■ Difficulties encountered

- The safety distances for category-2 traps (more than 200 metres from homes and 50 metres from public roads) were a major constraint, particularly along the Somme canal.
- Volunteer trappers rarely worked on private properties and on ponds and lakes, most likely given the insufficient financial incentives.
- It was difficult to access the banks of certain rivers and ditches not maintained by local residents.

Information on the project

- An annual report on muskrat management is drafted and distributed to partners (departmental territorial and maritime agency, Somme hunting federation and the National agency for hunting and wildlife).
- Information on the trapping campaigns is included in the declarations to each town hall.
- Training is provided to volunteers on the equipment used to trap muskrats, e.g. for the game wardens of the Somme fishing federation.

Outlook

- The presence of new invasive alien species in the hydrographic network is monitored:
 - information is relayed to the managers of the hydrographic network;
 - personnel are trained to recognise the species by the Bailleul national botanical conservatory.

Note on applicable regulations

- The species may not be introduced into the natural environment (ministerial decree dated 30 July 2010).
- Possession of the species is subject to an authorisation (ministerial decrees dated 10 August 2004).
- The species is listed among those that may be hunted (ministerial decree dated 26 June 1987).
- The species is considered a pest throughout continental France (ministerial decree dated 24 March 2014).
- The species is harmful to plants and must be controlled (ministerial decree dated 31 July 2000, modified by ministerial decree dated 25 August 2011).
- The conditions for the control of coypu and muskrat populations were set by decree dated 6 April 2007.
- Trapping conditions for animals declared as pests were set by decree dated 27 June 2009, modified by the decree dated 13 December 2011.

Author: Sandra Fernandez, Irstea

For more information

- Internet site of the Somme hunting federation:
<http://www.fdc80.com/20-la-fdc80/45-le-piegeage.html>
- Internet site of the National union of certified trappers:
<http://www.unapaf.com/pieges.php>
- Meresse G. 2008. La lutte contre le Rat musqué dans la Somme. État des lieux, proposition. Rapport de stage, 48 pp.
- ADFM, 2013. Évolution des captures de rat musqué par l'unité "gestion des espèces invasives" du Conseil général.
- ADFM, 2013. Indicateurs de lutte contre les espèces invasives 2012.
- Boidin R. 2012. L'agence départementale fluviale et maritime. La lutte contre les espèces invasives et la maintenance des équipements de loisir, 29 pp.
- Présentation « Régulation du Rat musqué *Ondatra zibethicus* par le Conseil général de la Somme », séminaire Onema-Cemagref « Gestion des espèces invasives en milieu aquatique », oct. 2010.
- Document de France nature environnement : « Ragondin, Rat musqué, stop au poison. Les alternatives à l'utilisation des anticoagulants en milieu naturel ».
- Presentation of the Somme river basin on the site of the Somme basin management board:
<http://www.ameva.org/?q=content/lebas-sin-versant/>





Muskrat

(*Ondatra zibethicus*)

Managing muskrats in the Audomarois marshes

Ondatra pest-control group

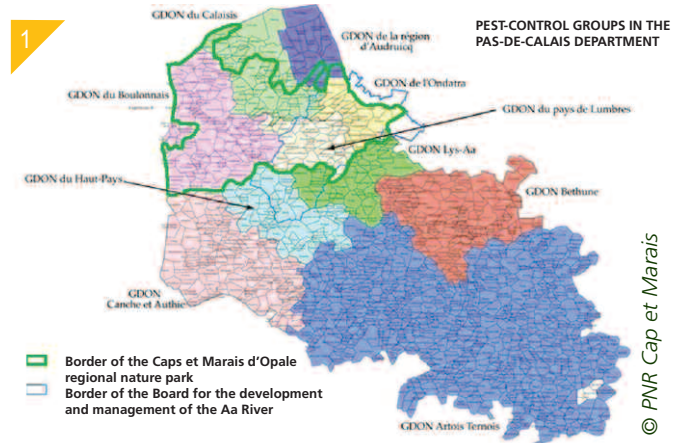
- Non-profit organisation founded in 1955, transformed into a pest-control group in 2003 (ministerial decree).
- The main missions include:
 - coordinating volunteer trapping of muskrats in the Saint-Omer urban area (CASO), e.g. collecting the muskrat tails, paying the trappers, providing the traps;
 - raising awareness and organising training courses for trappers.
- Contact: Marie Lefebvre, President
- mairie-de-serques@wanadoo.fr

The Caps et Marais d'Opale regional nature park

- The park was created in March 2000 by merging the Boulonnais and Audomarois parks. It is managed by a board comprising 152 towns, 6 intermunicipal associations, 5 consular bodies, the Pas-de-Calais departmental council and the Nord-Pas-de-Calais regional council.
- The park provides technical and administrative assistance to the Ondatra pest-control group (organisation of tail collections, informational activities, assessments and board meetings, etc.).
- Contacts: Luc Barbier - lbarbier@parc-opale.fr, Clémentine Coulon - ccoulon@parc-opale.fr

Intervention site

- The Caps et Marais d'Opale regional nature park is located in the northern part of the Pas-de-Calais department. The landforms are highly diverse and include littoral environments (dunes, cliffs and estuaries), marshes and wetlands, forests, bocage landscapes, limestone swards and heathlands.
- The Ondatra pest-control group works in the Saint-Omer urban area (CASO), which is made up of 19 towns belonging to the regional nature park.



1. Map of the Caps et Marais d'Opale regional nature park, March 2005. DDAF 82, Nord-Pas-de-Calais regional council, Smage Aa, Cap et Marais d'Opale regional nature park.

Disturbances and issues involved

■ Ecological impacts

- Muskrats compete with native species such as the European water vole.
- They are also predators of freshwater mussels that are required for the reproduction of the Amur bitterling (*Rhodeus sericeus*), a freshwater fish species.
- They dig burrows that destabilise banks and canals.
- Muskrats are a vector of disease and parasites (*fasciolosis*, *leptospirosis*, *tularemia*, *alveolar echinococcosis*).

■ Impacts on human activities

- Damage to crops (cereals, beets, vegetables) and to meadows.
- Damage to banks and dikes.
- Damage to roads (undermining).
- Problems for fishing and fish farming (loss of water from ponds, damage to nets, destruction of spawning grounds).

Interventions

- The Ondatra pest-control group manages trapping of muskrats by volunteer and professional trappers in the Saint-Omer urban area (CASO) in a partnership with the Caps et Marais d'Opale regional nature park.

■ Trapping

- Trapping is carried out year round.
- Conibear and cage traps are supplied by the pest-control group to the volunteers.
- The group collects the muskrat tails from the volunteer trappers and pays a bounty of 1.50 euros per tail.
- An annual trapping report compiles the data from:
 - the volunteer trappers (approximately 40);
 - the professional trappers, including two from CASO, one from the town of Saint-Omer and one from Eden 62, the Board for the management of sensitive natural areas in the Pas-de-Calais department.

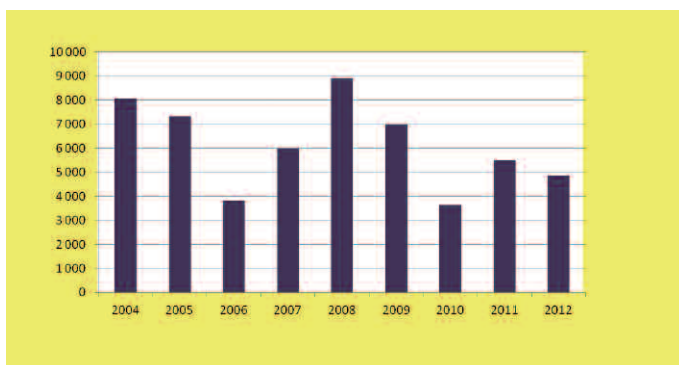
■ Results

- Muskrat populations have been in decline since 2011. The pest-control group has the unconditional financial support of its local partners in balancing its budget, which means it can pursue its work over the long term.
- The number of volunteer trappers has stabilised at around 40, with a majority of retired persons. It is difficult to convince new trappers because the work takes a great deal of time.
- It is probable that chemical means, though prohibited, continue to be used to a certain degree.
- It is necessary to continue efforts to recruit new trappers, to reward them and maintain their enthusiasm, notably by organising meetings.



2. 3. *Ondatra zibethicus*.

Annual captures.



*Annual captures by type of trapper. (NI: no information, * up to October 2013, ** up to 18 November 2013).*

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
CASO trappers	1 949	2 644	1 432	1 541	1 863	1 473	1 382	2 058	1 776	1 012 *
Departmental brigade	NR	245	NR	NR	0	0	0	0	-	-
Tail bounty	5 929	4 440	2 393	4 439	6 890	5 417	2 144	3 334	3 182	2 893
(incl. high-impact operation)	-	-	-	-	-	-	-	-	[1 145]	[549]
Saint-Omer trapper	-	-	-	-	154	73	110	126	227	114 *
Romelaere protocol	78	45	31	24	50	23	16	-	-	-
Eden 62	-	-	-	-	-	-	-	58	106	51 **
TOTAL	7 956	7 374	3 856	6 004	8 957	6 986	3 652	5 576	5 291	4 070

Funding of traps and tail bounties for the year 2013.

Source of funds	Amount
CASO	10 000 €
7th section Wateringues	1 500 €
AAPPMA la Concorde	400 €
Fees	91 €
Total	11 991 €

Information on the project

- Every two years, a training programme for trapping certification is organised in a partnership with the Pas-de-Calais departmental hunting federation.
- In March, a meeting is organised with the volunteer and professional trappers to check traps in the field, talk shop, review regulations and sit down for a good meal.
- During February and March, over a three-week period, a “high-impact operation” is organised in a favourable trapping period. The objective is to lay as many traps as possible over a short period, involving a maximum number of volunteer and professional trappers.
- A brochure, prepared in conjunction with a doctor on the health risks involved in trapping, was distributed to the trappers.
- Articles on the work (meetings, tail collections, high-impact operations) are regularly published in the local press (*Indépendant* newspaper, *Voix du Nord* newspaper).

Outlook

- The yearly meetings in March will be continued to bring together and motivate the trappers.
- An exhibition on muskrats and trapping will be prepared to inform the public and elected officials, and to recruit new trappers.
- Information on the pest-control group will be supplied to the press.

Note on applicable regulations

- The species may not be introduced into the natural environment (ministerial decree dated 30 July 2010).
- Possession of the species is subject to an authorisation (ministerial decrees dated 10 August 2004).
- The species is listed among those that may be hunted (ministerial decree dated 26 June 1987).
- The species is considered a pest throughout continental France (ministerial decree dated 24 March 2014).
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- Trapping conditions for animals declared as pests were set by decree dated 27 June 2009, modified by the decree dated 13 December 2011.

Author: Sandra Fernandez, Irstea



4. Cage trap.

For more information

- Internet site of the Saint-Omer urban area (CASO): <http://www.ca-stomer.fr/>
- Ondatra pest-control group, 2013. Note on operating conditions.





American mink

(*Neovison vison*)

Originated in North America. Imported in France for the fur industry (first seen in breeding centres in the Savoie and Haute-Savoie departments in 1926).

Description

- A thin, fusiform body, 41 to 62 centimetres long for adults
- Adults vary in weight between 0.6 and 1.8 kilograms
- Sexual dimorphism with males larger than females
- Flattened snout
- Short legs
- Small, round ears
- Dark brown fur over the entire body
- The animals may have a white spot on the chin and/or the throat, in rare cases on the upper lip

Ecology and reproduction

- A semi-aquatic species, living exclusively in wetlands:
 - small to mid-sized rivers, forest rivers
 - floodable wooded areas
 - marshes, wet meadows and streams through farm land
 - in maritime environments along inlets, on islands, etc.
- The animals live in burrows dug into river banks and between tree roots, but they can also sleep in the open or in hollow trees
- The species is a generalist carnivore that consumes amphibians, crustaceans, semi-aquatic mammals, birds and eggs, fish, etc.
- The animals can hunt both in water and on land
- Sexual maturity is reached quickly, after just one year:
 - mating season from the end of February to the beginning of April
 - birth of young from March to June, 2 to 7 young per litter
- Life expectancy is 3 to 6 years in the natural environment

Documentation

■ Sarat E. (coord.) 2012. Vertébrés exotiques envahissants du bassin de la Loire (hors poissons) : connaissances et expériences de gestion. Office national de la chasse et de la faune sauvage, Plan Loire Grandeur Nature, 128 pp.

■ A page on the American mink on the *Les petits carnivores de Bourgogne et Franche-Comté* internet site:

<http://droitnature.free.fr/NouveauSite/visionamerique.htm>.

Author: Emilie Mazaubert, Irstea

Classification

Order	Carnivores
Family	<i>Mustelidae</i>
Genus	<i>Neovison</i>
Species	<i>Neovison vison</i> (Schreber, 1777)





American mink

(*Neovison vison*)

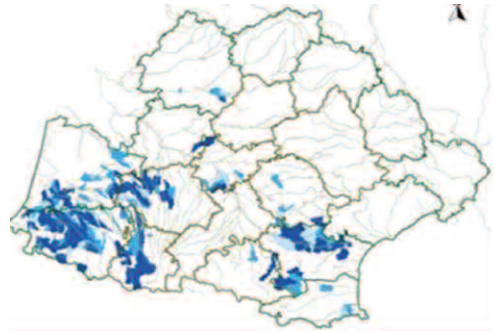
Control programme for American mink in the Midi-Pyrénées region

Midi-Pyrénées regional hunting federation

- The federation is a non-profit organisation, certified for environmental protection, with articles drafted in compliance with the applicable ministerial decree. It represents the departmental federations in the region and is in charge of coordinating regional and inter-departmental projects.
- It is a member of the technical committee in charge of reducing the pressure exerted by the American mink, in the framework of the 2007-2011 national plan to restore the European mink (*Mustela lutreola*).
- Manager of the control programme for American mink (*Neovison vison*) in the Midi-Pyrénées region, in a partnership with the hunting federations of the Hautes-Pyrénées and the Gers departments.
- Contact: Karine Saint-Hilaire - frcmp@chasseurde-france.com

2010-2013 control programme for American mink

- The programme was set up in response to the objectives of the second national plan to restore the European mink (2007-2011), namely to “reduce the competition with the American mink”.
- The control programme included five aspects:
 - project management;
 - purchase of equipment and development of skills;
 - organisation of trapping and verification of captures;
 - consolidation of knowledge on the American mink in the Midi-Pyrénées region;
 - information on the project.
- The objectives were to:
 - determine the distribution of the American mink in the Midi-Pyrénées region;
 - pursue and expand control work (reduce population numbers, limit the spread) on the American mink along the edges of the range of the European mink;
 - provide additional information for the report and the outlook of the national restoration plan for European mink.
- The project was run by the regional and departmental hunting federations, in a partnership with the trapper association of the Hautes-Pyrénées and Gers departments and the ONCFS regional office, with support from the EU and the Midi-Pyrénées regional environmental directorate.



1. Distribution of European mink in the Midi-Pyrénées region and the adjacent departments from 2007 to 2012.
Map: FRC MP Anaïs Borrell, August 2012.

Intervention site

- In 1999, three feral populations of American mink had been observed in France, including one located in several hydrographic sectors of the Adour River in Southwest France (Aquitaine and Midi-Pyrénées regions).
- In 2012, as part of the control programme for American mink, a study was conducted in the Midi-Pyrénées region and neighbouring departments to determine the distribution of the American mink population in Southwest France.
- The campaigns to capture American minks took place only in the Hautes-Pyrénées and Gers departments (the only ones taking part in the plan for European minks).

Disturbances and issues involved

- The presence of American mink in the natural environment in France is the consequence of the animals regularly escaping from farms set up for the fur industry starting in 1926.
- The population in Southwestern France appeared in the 1980s, in the Pyrénées-Atlantiques and Hautes-Pyrénées departments. In the 1990s, this population spread to the Gers and Landes departments.
- In the Midi-Pyrénées region, the primary objective of the work to control American-mink populations is to preserve native species.
- In the competition with the European mink, the American mink has the upper hand:
 - the European mink is a protected species in Europe (Bern convention and listing in the Annexes II and IV of the

© FDC 31, 32, 65, 81, 82, 12, 46, 09, 64, 40, 47, 24, 19, 15, 48, 30, 34, 11, 66.
 Map: FRC MP Anaïs Borrell, August 2012.

Habitats directive) and on the national level (interministerial decree dated 23 April 2007), and a species for which two national restoration plans have been set up (2000 to 2004 and 2007 to 2011);

- the native species occupies the same ecological niche as the American mink and its populations have regressed severely. However, the Hautes-Pyrénées and Gers departments are acknowledged as areas in which the European mink could stage a comeback.

■ The invasive species is a generalist and opportunistic predator of a wide range of prey, including:

- birds in contact with aquatic environments, amphibians, poultry, fish (impacts on fish farms), etc.;

- occasionally the Pyrenean desman (*Galemys pyrenaicus*), an insectivorous mammal endemic to the Pyrenees and for which a national action plan exists.

■ The species can transmit diseases to the native fauna and to humans (canine distemper, parvovirus, leptospirosis, etc.).

Interventions

■ Study on the distribution of the American mink in the Midi-Pyrénées region

■ The national survey launched in 1999 by ONCFS and the data-collection work carried out in 2011 for the Atlas of mammals in the Midi-Pyrénées region noted the presence of an American-mink population in Southwestern France (Hautes-Pyrénées, Pyrénées-Atlantiques, Landes and Gers departments), but also mentioned a dozen observations of individual animals in the *Montagne Noire* area (Aude and Tarn departments).

■ In the framework of the control programme for American mink in the Midi-Pyrénées region, a regional survey was conducted in 2012 to update the available knowledge on colonisation by the species in Southwestern France and anticipate any possible spreading of the population.

■ The survey was conducted under the following conditions:

- collection of data spanning the period from July 2007 to June 2012;

- in the Midi-Pyrénées region and the adjacent departments;

- the recipients of the survey results included the 19 departmental hunting federations, the 8 departmental associations of certified trappers in the Midi-Pyrénées region (following information provided to the National union of certified trappers and to the existing regional unions), ONCFS local offices, naturalist groups (Nature Midi-Pyrénées, nature conservatories, etc.), the regional environmental directorate, the departmental territorial agencies, Onema, the regional nature parks, etc.;

- participants filled out two Excel tables sent via email. The first served to identify the respondent and the second contained the data on each observation (date, geographic coordinates, observation conditions and circumstances), any information on the possible presence of a litter, on the possible origins of the animal(s) and any information confirming the observation (photos, cadaver, etc.);

- where possible, on-site meetings with local stakeholders, essentially in the Hautes-Pyrénées and Gers departments.

■ Trapping campaigns

■ The campaigns to capture American minks took place in the Hautes-Pyrénées and Gers departments (the departments participating in the national restoration plan for European minks).



2. American mink.

3. 4. American minks captured in a cage trap.

- The work was done by a network of volunteer trappers who received:
 - cage traps (category-1 traps) free of cost from the departmental hunting federations. Use of this type of trap requires certification and a declaration in the town hall of each town where traps are set;
 - assistance from a federation technician who confirmed the type of species captured. Confirmation was mandatory for the 2011-2012 campaign in the Gers department, but not in the Hautes-Pyrénées department (according to the prefectural orders);
 - compensation for costs incurred for protocol compliance in the form of 20 euros for each American mink captured alive and confirmed by a technician.
- * Each trapper filled out a sheet listing the captures.
- * The captured minks were euthanised (shot).

Results and assessment

■ Survey results

- The range of American mink in Southwestern France increased after the 1999 survey.
- The survey confirmed the existence of a fourth population in the eastern section of the Midi-Pyrénées region, in the *Montagne Noire* area.
- In the future, there is a risk that the various populations will merge in the Haute-Garonne department, coming together via the *Canal du Midi* and its tributaries.

■ Results of the trapping campaigns in 2011-2012 and 2012-2013

*Trapper activity during the 2011-2012 season.
Source: Departmental hunting federations.*

Department	65	32
Total number of trappers in the department	350	282
Trappers that contacted the technician for confirmation	10	10
Trappers that captured at least one American mink	9	7

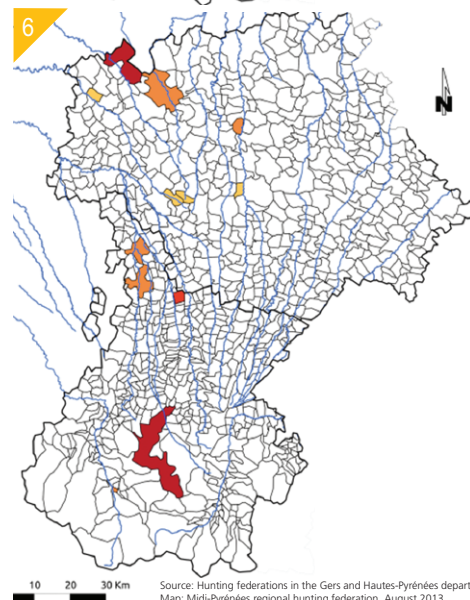
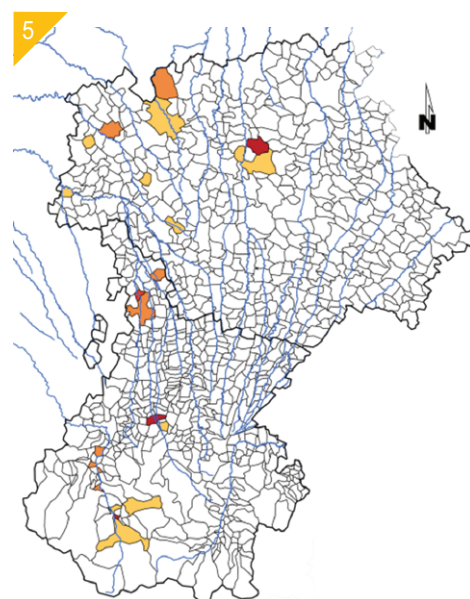
© 2011-2012 (FRC MP)

Captures during the 2011-2012 season.

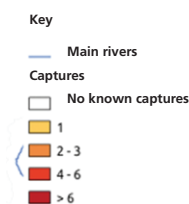
Department	65	32
Towns with confirmed captures	≈ 10	11
Checked captures	57	27
Confirmed American minks	54	19
Other species	3 skunks	8 skunks

■ Costs

- The results were achieved by a dozen trappers actively targeting the American mink (regular trapping in areas with confirmed presence of the species).
- The captures are not particularly representative of the actual presence of the species in the departments because trapping was often carried out in the same places throughout the year.
- The objectives in terms of the numbers of captures (based on the trapping declarations of the previous years) were not met:
 - Hautes-Pyrénées department: 150;
 - Gers department: 100.



Source: Hunting federations in the Gers and Hautes-Pyrénées departments.
Map: Midi-Pyrénées regional hunting federation, August 2013.



5. Captures of American minks in the Gers and Hautes-Pyrénées departments. Season 2011-2012.

6. Season 2012-2013.

- It was difficult to motivate the trappers in the Gers department due to the modifications and uncertainties in trapping conditions between 2012 and 2013.
 - According to experienced trappers, there are areas (“sinks”) with heavy concentrations of American minks and others without any animals. No explanation has been provided for the moment.
- The total budget for the two campaigns (2011 to 2013) amounted to 44 849 euros.

Information on the project

- The results of the trapping campaigns in the two departments were presented to the steering committee.
- A poster presenting the survey results was displayed during the naturalist symposium for the Midi-Pyrénées region, organised in February 2013 by the Nature Midi-Pyrénées association.
- The results of the trapping campaigns were presented during the Agricultural Fair in Tarbes in 2013.
- An article was published in the *Dépêche du Midi* newspaper (28 June 2013) on the trapping campaigns for American minks.
- The internet site of the Midi-Pyrénées regional hunting federation includes:
 - pages on the control programme for the American mink;
 - an article on the results of the survey conducted by the Midi-Pyrénées regional hunting federation in 2012 on “The situation with the American mink in the Midi-Pyrénées region”;
 - a fact sheet describing the species.

Outlook

- The programme as currently organised may be abandoned given the spread of the species and the uncertainty surrounding the intentions of the national authorities concerning the future of the national restoration plan for the European mink and the control of the invasive American mink. The programme may simply provide information via the trapping training courses.
- An effort will be made to remobilise the network in the framework of the project to exchange traps in the Midi-Pyrénées region.

Author: Sandra Fernandez, Irstea

For more information

- The internet site of the Midi-Pyrénées regional hunting federation: <http://www.frc-midipyrenees.fr/>.
- Borrell, A. 2012. Statut et lutte contre une espèce exotique envahissante : le Vison d'Amérique (*Neovision vison*) en Midi-Pyrénées. Rapport de fin d'études pour l'obtention du diplôme d'Ingénieur de l'Institut Supérieur des Sciences Agronomiques, Agroalimentaires, Horticoles et du Paysage, Angers. 103 pp.





American mink

(*Neovison vison*)

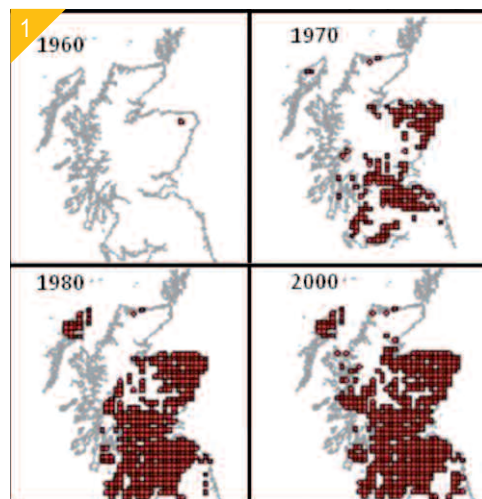
Collective management of the American mink in Scotland

Scottish Mink Initiative

- The Scottish mink initiative (SMI) for the American mink is a joint project between the Rivers and Fisheries Trust of Scotland, the Scottish Wildlife Trust, the Scottish Natural Heritage, the university of Aberdeen and the Cairngorms national park.
- The SMI is managed by the Rivers and Fisheries Trust of Scotland and is part of a larger project, the Biosecurity and invasive non-native species programme.
- The initial phase of the project lasted 24 months from August 2011 to August 2013.
- The main objective of the SMI is to eliminate the American mink from several river basins in order to protect the native species such as voles, salmonids, birds nesting on the ground and birds prized for hunting, by:
 - eliminating all reproduction of the American mink in the project zone;
 - ensuring the long-term sustainability of the American-mink control programme by transferring the know-how, knowledge and the responsibility for the continued management of the species to local organisations;
 - sharing the methods and data with researchers in order to spread the benefits of joint management adapted to invasive alien species.
- The estimated annual cost of the SMI is 156 000 euros, of which 73% is funded by the Rivers and Fisheries Trust of Scotland.

Context and issues involved

- The American mink settled in the U.K. starting in the 1950 following releases and escapes from farms for the fur industry. The species has now spread throughout the country, except in the extreme northern section. The species is firmly established in continental Scotland, as well as in the Western and Hebrides Islands.
- The American mink is commonly found in aquatic environments, notably along the coast where the species is particularly abundant.
- The mink is an opportunistic predator that feeds on a wide range of small mammals, birds and fish.



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1. Spread of the American mink in Scotland from 1960 to 2000.
2. Intervention area.

- In Scotland, the species has had a clear impact on voles, Atlantic salmon, black-throated loons, common scoters, northern lapwings, curlews and oystercatchers.
- Above and beyond the local biodiversity, the species creates indirect economic difficulties for fish farming and recreational activities such as hunting and fishing.
- The objective of the Scottish mink initiative was to set up, test and maintain collective management of the American-mink populations on over 20 000 square kilometres of the Scottish mainland.
- To facilitate project implementation, the project was divided into four large areas, namely Rural Aberdeenshire, Cairngorms-Moray, Highlands and North Tayside.

Interventions

- Control of American-mink populations consists of setting up a network of traps in the intervention area.
- The first step was to detect where the species was located in order to facilitate its capture.
- The strategy was to expand the trapping zone while maintaining detection efforts along the invasion front.
- A team was employed full-time in each sector of the intervention area to train, support and coordinate a network of volunteers, fisheries' employees and managers of natural areas.

■ Equipment used

- The type of trap used is the mink raft, developed in 2002 by the Game and Wildlife Conservation Trust (GWCT).
- The mink raft is made up of:
 - a floating platform (a slab of polystyrene between two pieces of plywood);
 - a metal grid along the edges of the platform to facilitate access by the animals;
 - a basket filled with clay and sand for footprints;
 - a wooden tunnel positioned above the basket.
- This type of device can be used both to detect and to trap minks:
 - for detection, the footprints left in the mix of sand and clay in the basket serve to identify the species that visited the device;
 - for trapping when minks have been detected, a cage trap can be placed inside the tunnel to capture the animals alive and release any species captured accidentally (European otter, voles, European pine marten).
- The rafts can be purchased commercially or made by volunteers. Construction costs have been estimated at approximately 75 euros per raft. Detailed plans and a list of the necessary materials are provided by the Game and Wildlife Conservation Trust.

■ A network of traps

- In each project area, trap densities varied according to the conditions in the area and were regularly adjusted to take into account detections and captures.
- On average, one trap per kilometre of river was set up.
- The density of traps was increased in reproductive and nursing areas, and reduced in areas above an altitude of 300 metres where the species was rarely observed in Scotland.
- Each trap was numbered and its location precisely registered by GPS.
- A map of the habitats preferred by American minks was drawn up by the University of Aberdeen to select the priority trapping areas.
- The rafts were placed in water, with vegetation to mask them, near the bank and attached to the bank by a string long enough to handle variations in the water level.
- The rafts (without a cage trap) were checked every two weeks. A system to exclude the European otter was installed, given that the two species live in the same environments.
- If the footprints of an American mink were detected, a cage trap was installed in the tunnel.



3. An American mink and its prey.

Breakdown of volunteers (in %).

Year	2011
Forestry workers, game wardens	24
Fisheries employees	15
Public institutions and agencies	5
Environmental-protection groups	7
Tourism sector	2
Farmers	2
Other	6

■ Captures

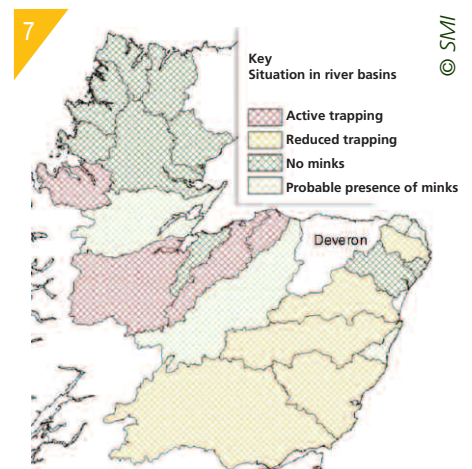
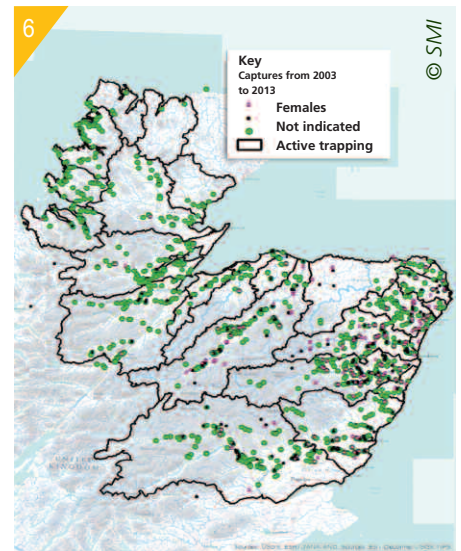
- At least 472 American minks were captured throughout the area from 2011 onward.
- After three years of trapping work, the level of mink presence and of trapping activity was assessed in each river basin:
 - absence of mink if no females were trapped for two consecutive quarters;
 - probable presence if an animal of either sex was captured over the last six months, in which case trapping activity was reduced;
 - active trapping with a campaign under way.
- The results indicated that American minks were absent from 10 of the 24 river basins. The basins with no minks were located primarily in Northern Scotland. The presence of American minks was considered possible in five river basins.
- Of the nine basins where American minks are still present, four are in direct contact with areas where no control work has been undertaken. These areas constitute a potential source of minks for recolonisation.

Information on the project

- A communication strategy was established comprising:
 - the creation and management of a dedicated internet site, www.scottishmink.org.uk;
 - information on the project on the local and national levels with over 150 articles;
 - a twice yearly information bulletin presenting SMI news in each geographic sector;
 - teaching material for schools (addressing four different class levels);
 - presentations of the SMI during public events, symposia, to local groups;
 - training courses for trapping volunteers with over 300 people trained.

Outlook

- The project will be pursued in the coming years.
- Improvements are required, notably concerning:
 - identification of American minks and checks on observation reports in order to reduce mistakes concerning the European polecat, erroneous reports and unnecessary laying of traps;
 - the long-term implication of volunteers by providing them regularly with information and inviting them to meetings on project results;



6. Map showing the trapping network.
7. Presence of American minks and trapping activity in the river basins.

- the geographic distribution of volunteers, who are unevenly spread or even absent in certain regions (Highlands), due to the very low population densities, difficulties in accessing rivers and the very discreet presence of American minks;
- strengthening links with research programmes to ensure that results are of use for management work (population genetics, ethology, etc.);
- transfer of management responsibilities and the implication of local communities to ensure the pursuit of the project in an increasingly large area.

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8. Raising awareness during events intended for the general public.

For more information

- Internet site of the Scottish Mink Initiative: www.scottishmink.org.uk
- *Scottish Mink Initiative*. 2013. Final report. 14 pp.
- Bryce R., Oliver M., Davies L., Gray H., Urquhart J., et Lambin X. 2011. *Turning back the tide of American mink invasion at an unprecedented scale through community participation and adaptive management*. *Biological Conservation*, 144(1), 575-583.
- *Game and Wildlife Conservation Trust*. 2013. *Guidelines for the GWCT Mink raft*. 11 pp.
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The *Knowledge for action* series makes new research findings and science-advice work available to professionals in the water and aquatic-environment sector (scientists, engineers, managers, instructors, students, etc.).

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Invasive alien species (IAS) and their impacts represent a growing concern for the managers of natural areas. That is particularly true for aquatic environments where an array of stakeholders are now taking action. Public policies on the French and European levels are also coming into play.

What is the status of current knowledge on biological invasions? What is the applicable legal framework and what recommendations should be made? In the field, which species are managers attempting to address? Which techniques are used, where and how, and what are the objectives and the results achieved?

For these two volumes of the *Knowledge for action* series, almost 100 experts collected the information required to clearly present the situation and propose a scientifically based approach to assist water managers in setting up management projects.

The first volume, titled *Practical information*, presents the current situation concerning the management of invasive alien species in aquatic environments. Though no “cure alls” currently exist, the volume offers highly useful information while attempting to address the specific aspects of each situation.

This second volume, titled *Management insights*, illustrates the situation discussed in the first volume with feedback from management projects in continental France and Europe.

Emmanuelle Sarat, a scientific officer for invasive alien species at the IUCN French committee, has managed the Biological invasions in aquatic environments (IBMA) work group since 2014.

Emilie Mazaubert, a research engineer at Irstea from 2009 to 2013, participated extensively in the work at IBMA over the period, drafting a large number of research reports and promoting the work, while managing the work group and acting as group secretary.

Alain Dutartre, an independent hydrobiologist (formerly at Irstea), has worked for almost 40 years on aquatic plants (native and alien) and their management. As a founding member of the IBMA work group, he has contributed to research work and efforts to assist water managers in improving the management of invasive alien species.

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