



Invasive alien species

Practical information and management insights

Vol. 4

Management insights (ter)

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N°45

The French Biodiversity Agency (OFB)

As of 1 January 2020, AFB and the National Agency for Hunting and Wildlife (ONCFS) merged to form the new French Biodiversity Agency (OFB), a public entity that reports to the Agriculture and Ecology ministries. In both continental France and the overseas territories, the agency produces new knowledge and provides science-advice spanning all aspects of nature and contributes to administrative and judicial policing activities concerning water, natural areas, fauna, flora, hunting and fishing. It supports public institutions in designing, implementing and assessing policies and it assists socio-economic actors in their efforts in favour of biodiversity. The agency also manages and restores protected areas (marine and terrestrial). A further task is to reach out to the public in order to mobilise citizens for projects to encourage biodiversity. Concerning IAS, in addition to its legal missions pertaining to the introduction and detention of alien species, the agency provides support in the efforts against IAS to the State, to river-basin committees, to local governments and to public organisations in charge of managing water and biodiversity.

The French committee of the International Union for the Conservation of Nature (IUCN)

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, 47 NGOs and a network of approximately 250 experts grouped in five special commissions and eleven topical work groups. The committee addresses biodiversity issues in France and promotes French research and science-advice work internationally. Concerning invasive alien species, the committee has undertaken two main projects. The first is an invasive alien species (IAS) initiative in the French overseas territories that started in 2005 and has since become the Overseas IAS Network.

The second concerns co-management with OFB of the Invasive Alien Species Resource Centre. The centre is the successor to the Biological Invasions in Aquatic Environments work group (IBMA), for which the committee assumed management responsibilities in 2014, in conjunction with Onema (which became AFB in 2017 and OFB in 2020). 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.


The Invasive Alien Species Resource Centre

This book is the result of work done by the IAS Resource Centre. The centre, co-managed by the IUCN French committee and OFB, provides practical assistance and contributes to reinforcing the effectiveness of IAS policies in France. Among other functions, it develops methods, training courses, and disseminates knowledge, know-how and good practices to all concerned stakeholders, including managers of natural areas, non-profits, researchers, local governments, companies, State services, public agencies, etc.

www.especes-exotiques-envahissantes.fr

This book continues the **Knowledge for action** series that makes new research findings and science-advice work available to professionals in the biodiversity sector, including scientists, engineers, managers, instructors, students and concerned persons in general. It can be accessed and downloaded from the IAS Resource Centre site (<http://especes-exotiques-envahissantes.fr/>), from the OFB technical portal (<https://professionnels.ofb.fr/en/node/1527>) and from the Water & Biodiversity document portal (<https://www.documentation.eauetbiodiversite.fr/>).





Almost 50 people contributed to this fourth volume on invasive alien species in the *Knowledge for action* series. The geographic and professional diversity of those people illustrates the collaboration on IAS management that has been growing over the years.

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

With that in mind and in addition to the persons listed in the Acknowledgements at the end of this volume, we wish to extend our sincere thanks and acknowledgement to the many people not mentioned, whose questions, requests, opinions, comments, disagreements and criticism all contribute to our innumerable discussions and assist us in collectively building up an IAS community that is of vital importance in drawing the attention of society to the importance of the issues involved in biological invasions and the responsibilities that we humans must assume in this field.



Editors' preface

The introduction and development of invasive alien species (IAS) are acknowledged as one of the main causes of biodiversity loss worldwide. Consequently, the Convention on biological diversity decided to include this issue as a specific objective of the 2011-2020 strategic plan that the ratifying States, including France, committed to achieving by 2020. In October 2014, a new EU regulation on the prevention and management of the introduction and spread of invasive alien species became applicable in all the Member States. In France, the national IAS strategy was published in 2017 and now provides a framework to mobilise all the concerned stakeholders and meet the international objectives.

France is obviously confronted with the same problems and there are numerous examples of invasions by alien species in both continental France and the overseas territories. Islands are particularly vulnerable to the problems caused by IAS. Depending on the specific situation, 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. The issue has become one of the main concerns of managers of natural areas and of decision-makers in a large number of local governments. IAS are increasingly the topic of statements and reports in the media, and consequently citizens have begun to take note.

Over the past 20 years, a growing number of actors in areas spanning highly diverse administrative and geographic scales have entered the fray in an attempt to prevent and 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.

It is in the above context that the IAS Resource Centre, co-managed by the IUCN French Committee and OFB, works to assist all the concerned participants in their efforts to counter biological invasions. The centre's Science-advice and Technical Network (REST) comprises approximately 100 representatives of various actors (managers of natural areas, researchers, non-profits, public agencies, State services and local governments). The centre works essentially with professionals and biodiversity managers in an effort to improve the effectiveness of projects to prevent and manage biological invasions and to support ad hoc national policies, notably the national IAS strategy.

To address overseas issues, the centre calls on the Overseas IAS Network (formerly the Overseas IAS Initiative) managed by the IUCN French Committee since 2005. Similar to REST, the network enables productive discussions and the sharing of data between the overseas actors in the IAS field. The centre and the network work together closely to achieve the shared objectives and to meet the increasing needs of the actors in the overseas territories.

One of the main expressed needs of IAS managers is the availability of management methods and techniques. Rather than offering "solutions" that are generally not applicable to most local situations, it was decided from the start to compile project management reports drafted in close collaboration with the managers of each IAS project. These reports have the advantage of being highly practical and of proposing, if not solutions, at least actionable ideas to be tested as well as the contact information of the project managers.

This approach, launched in 2012, has already produced a large number of project management reports that, though they represent only a fraction of the work and projects undertaken throughout France, provide useful information on the relative importance of the species managed, of the techniques used and of the regions active in setting up IAS projects.

To improve the visibility of the overseas territories, which have significant experience in the IAS field that has been insufficiently publicised, the approach was extended to include the overseas territories in 2017, in conjunction with the Overseas IAS Network. IAS have significant ecological consequences in continental France, however they are an even greater cause of biodiversity loss in the overseas territories which are made up of many islands whose evolution far from the continents has resulted in unique and fragile ecosystems representing almost 80% of biodiversity in France as a whole. The resulting management reports, almost a dozen in number, represent a valuable instrument for the territories that are confronted with the need to take action quickly given their vulnerability.

Similar to volumes 1 and 2 published in 2015 and volume 3 published in 2018 in the **Knowledge for action** series, this fourth volume is the product of the work by the IAS Resource Centre and the Overseas IAS Network. It would not exist without the contributions and the involvement of many managers of natural areas, whose knowledge and know-how are thus made available to a wide audience. The objectives of this volume are to encourage new initiatives in IAS management, provide a general framework of information and present a wide array of practical examples to assist managers and decision-makers in their respective efforts to improve IAS management. We hope that this volume will contribute to raising awareness of the issues involved in managing invasive alien species in both continental France and in the overseas territories.

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Abstract

Invasive alien species (IAS) and their impacts represent a growing concern for the managers of natural areas. In both continental France and the overseas territories, a large number of people and organisations have taken action to limit the damage. Recent public policies launched on both the EU and national levels facilitate the work, however significant new knowledge is needed before any real progress can be made in both continental France and the overseas territories.

This is because numerous and diverse species of fauna and flora from an array of freshwater, terrestrial and marine ecosystems are involved in the biological invasions and it is necessary to share experience and knowledge in order to improve the methods and techniques currently used.

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? What new initiatives have been launched?

These four volumes in the **Knowledge for action** series clearly present the situation and propose a scientifically based approach, with information on the specific factors of each situation, including the site, the targeted species and the relevant technical and financial data.

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 IAS, including definitions, colonisation processes, impacts and topics for future research;
- current legislation and regulations addressing IAS 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 - 3 and 4 Management insights

These three volumes are a collection of fact sheets on invasive alien species and reports on management projects carried out in continental France, the French overseas territories and Europe.

The management of 49 species (fauna and flora) is examined in 111 management reports drafted in direct collaboration with the concerned managers. The second volume, published in 2015, contains 51 reports, the third volume 35 and the fourth volume fills out the collection with a further 25 reports.

The fact sheet for each species includes descriptive information on species identification, biology and ecology.

The management reports include:

- 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 at the end of each project;
- efforts to promote the project and its results;
- available documentation and the contact person for more information.



Invasive alien species
Practical information and management insights

Volume 4	Management insights (ter)
8	Introduction
Plant species	
Aquatic	
16	Hydrophytes
20	Amphibious plants
Terrestrial	
50	Herbaceous plants
93	Cacti
99	Trees and shrubs
Animal species	
120	Reptiles
146	Mammals
161	Contributions and acknowledgements



Introduction

The overall objective of these successive volumes is to provide managers with a source of information that can help them in improving their management techniques for plant and animal IAS in their area.

The first volume presents a general outline of the available knowledge on IAS in aquatic environments in continental France (scientific data, regulations, management strategies and techniques). The second, third and fourth volumes present an illustrated panorama of management techniques for various IAS, discuss issues and outline processes for setting up management work. The transformation of the Biological Invasions in Aquatic Environments work group (IBMA) into a resource centre specifically addressing IAS issues led to a widening of the scope to include terrestrial, marine and overseas environments (Box 1). Consequently, the range of topics covered by the project management reports progressively shifted to include more types of environments and territories. That is why this fourth volume presents reports on terrestrial environments as well and, thanks to the Overseas IAS Network (Box 2), a more balanced approach including IAS management projects in both continental France and the overseas territories.

Box 1



The Invasive Alien Species Resource Centre

To assist all participants in managing biological invasions, the IUCN French Committee and OFB have operated since 2018 the IAS Resource Centre, the successor to the Biological Invasions in Aquatic Environments work group (IBMA) that launched its activities in 2008. The centre works to improve the effectiveness of projects to prevent and manage biological invasions and to support ad hoc national policies, notably the national IAS strategy. The centre reaches out primarily to professionals and biodiversity managers, and focusses on both plant and animal species in marine, freshwater and terrestrial ecosystems in continental France as well as the overseas territories.

To that end, it attempts to:

- contribute to the steadily expanding proficiency and capabilities of actors;
- produce, implement and disseminate knowledge and know-how;
- develop collective training for actors and a common approach concerning objectives in terms of knowledge and management.

The Science-advice and Technical Network (REST), a central component of the IAS Resource Centre, comprises approximately 100 members representing various IAS stakeholders (managers of natural areas, researchers, non-profits, State services, public agencies, etc.). For the overseas territories, the IAS Resource Centre counts on the Overseas IAS Network (formerly the Overseas IAS Initiative) (Box 2).



The Overseas Invasive Alien Species Network

French overseas territories, located in or along all three oceans under different latitudes, are home to exceptional biodiversity. A majority are islands and their evolution far from the continents resulted in the emergence of a large number of endemic species that are, consequently, highly vulnerable to biological invasions. Given the seriousness of these threats, the IUCN French Committee in 2005 launched an initiative to mobilise all French overseas territories in confronting the problem. With 15 years of experience in IAS management, in 2020 the initiative became the Overseas IAS Network, the obvious partner of the IAS Resource Centre for overseas IAS issues. In order to assist IAS stakeholders in the overseas territories, the Overseas IAS Network:

- provides support in disseminating knowledge and raising awareness concerning biological invasions;
- acts as a knowledge centre to improve anticipation, prevention and to enhance the effectiveness of management operations;
- works to federate efforts against biological invasions throughout the overseas territories and in each region.

The network comprises almost 100 experts and go-to persons. Together, the network and REST cover all French territories (continental and overseas) worldwide and can bring to bear a full range of knowledge to meet the shared objectives of the network and the IAS Resource Centre.

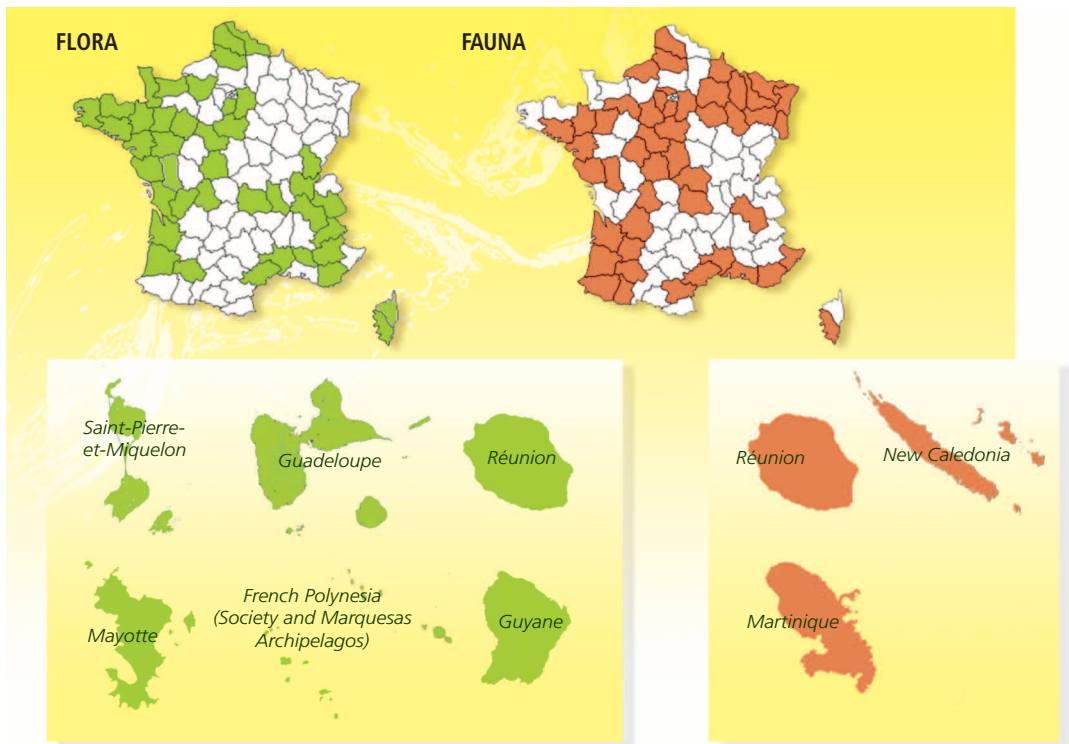
These three volumes are the product of a collaborative approach that mobilised over 150 managers of natural areas in continental France, the overseas territories and in neighbouring countries. A total of 49 different species and 111 management projects are presented. Several examples of management for a given species may be presented if the types of sites and situations differ significantly.

The objective was to collect and disseminate a wide set of management reports, the purpose being not to suggest “one size fits all” solutions that often disappoint, 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 Numerical data on the management reports presented in volumes 2, 3 and 4.

	Volume 2		Volume 3		Volume 4	
	Flora	Fauna	Flora	Fauna	Flora	Fauna
Species	13	13	14 (including 8 new species)	7 (including 4 new species)	16 (including 9 new species)	4 (including 3 new species)
Management projects	27	24	27	8	20	5
Countries	6	6	4	2	1	1
Departments in continental France	24	44	19	7	13	1
French overseas territories	/	/	2	1	4	2
Organisations involved	30	28	30	10	26	5
Contributors	30	33	32	12	32	12

Figure 1



French departments and overseas territories involved in the management projects.

Organisation of the presented management projects

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

To facilitate their study, the management projects concerning plant species are grouped according to the types of plants listed below.

Aquatic plants

- hydrophytes
- amphibious plants

Terrestrial plants

- herbaceous plants
- cacti
- trees and shrubs

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

- invertebrates;
- reptiles;
- fish;
- birds;
- amphibians;
- 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.);
- documentation.

Wherever possible and depending on the available information, each management report is divided into an identical set 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);
 - objectives;
 - practical details (methods employed, results including the quantities eliminated, animals captured, use of waste);
- technical results and costs;
- promotion of the project (articles, etc.);
- the outlook at the end of each project;
- any applicable regulations (for fauna);
- sources of information, links, other contacts.

All the management reports contained in the three volumes may also be downloaded (PDF format) from the IAS Resource Centre site (<http://especes-exotiques-envahissantes.fr/>) and from the OFB technical portal (<https://professionnels.ofb.fr/en/node/1527>). The overseas management reports may also be downloaded from the Overseas IAS Network site (<https://especes-envahissantes-outremer.fr>).

Box 3

Aquatic, semi-aquatic and terrestrial plant species

The plant species discussed in the management projects are divided into different categories.

Aquatic plants

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 water¹.

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”¹.

Amphibious plants

“Plant capable of living both on land and in water.”¹ These plants can withstand major variations in water levels.

Terrestrial plants

Herbaceous plants

Plants whose stalk and branches are not woody. Their substance remains tender.

Cacti

Plants with fleshy, green stalks filled with more or less viscous liquid (hence the name succulents) and whose leaves take the form of spines.

Trees and shrubs

Plants whose stalk and branches are woody, i.e. consist of wood or are similar to wood. Shrubs are shorter than trees. A tree is at least seven metres tall.

1. Fare A., Dutartre A. and Rebillard A., 2001. *The main aquatic plants in south-west France*. Adour-Garonne Water Agency, 189 pp. (In French)

Benefits derived from the management reports and the overall project

■ The origins of the project

The project to collect management reports was started by IBMA in 2013 following an open call for contributions. The objective was to assist managers in designing projects and to enable them to develop their own methods tailored to local situation, consequently the reports had to include the knowledge and know-how of the people working in the field. This practical knowledge on managing IAS was wide ranging and difficult to collect in a systematic manner, which meant that it often remained unused unless it was presented during special meetings addressing practical aspects, meetings that have become less rare in the past few years.

■ Availability and use of the knowledge gained by managers

This approach, based on regular contacts (meetings, forums) between network members from all types of organisations (local governments, non-profits, managers, etc.) and the drafting of detailed management reports with the people in the field, resulted in the establishment of a wide-based network and in better use and awareness of the knowledge that had been scattered geographically and difficult to detect. These shared experiences now cover the needs that have been clearly identified on the international level and constitute a useful source of operational information for managers. The collected reports, constantly growing in number over time, represent an indispensable source of precise data on management projects that can be widely disseminated.

■ Improvements in collecting management data and information

In drafting the management reports, the managers of natural areas, in conjunction with the coordinating team at the IAS Resource Centre, are in a position to clearly identify the information that previously was not systematically gathered during projects, for example certain quantitative data, cost data, subsequent monitoring work and the local constraints imposed by the actual conditions in the field. That data is, however, indispensable in precisely assessing project characteristics, in justifying management work to funding entities and in better defining objectives and adapting management techniques. The organised management of this data is also the means to preserve the information on IAS interventions for the future, thus ensuring the consistency of work and reducing any losses in skills and know-how that may occur when people change jobs or retire.

■ Improvements in methods and techniques

The frequent sharing of information and data is also a means of identifying missing links and potential improvements in management practices and in the technical and scientific information required in carrying out the management work. The changes made over time in this systematic collection of project data resulted in improved techniques, in developing management plans better adapted to the local context and in pooling numerous data points that can subsequently be analysed more effectively to produce more relevant results. The identification of obstacles frequently encountered by several managers serves as an encouragement to put more thought during planning processes into aspects previously considered secondary, but that are nonetheless integral parts of a project, e.g. communication efforts prior to starting actual work and the management of the waste produced by the work.

■ An increased commitment to sharing information

Regional initiatives to reinforce the sharing of information are increasingly frequent, thus confirming the interest in and value of the process. Increasing numbers of management reports are available on various platforms and the IAS Resource Centre is attempting to coordinate with the different networks in order to select and centralise, among locally drafted documents and received proposals for publication, the reports providing the greatest value on the national level. For example, management work done on emergent species or on species for which little information has been made available, notably animal species, is considered of particular interest. Similarly, regions that have not yet shared their know-how, e.g. the overseas territories, also receive special attention.

■ Reinforced networking of stakeholders

These collections of management reports are a clear encouragement to establish contacts between managers, particularly when large distances are involved, for example between the French overseas territories, but the species and issues involved are the same. The inclusion of the overseas territories in this project is the occasion to establish contacts between overseas and continental participants who have, to date, not cooperated enough on IAS issues and whose discussions will enhance the overall process. What is more, to enhance and facilitate contacts on IAS issues with neighbouring countries, continental and overseas actors can use the English translations of the management reports in their work on the international level.

Figure 2



The sharing of information in the Science-advice and Technical Network (REST) and the Overseas IAS Network, and the drafting of management reports make available the knowledge gained by stakeholders in the field and improve the data-collection system for IAS management.

a, b © E. Sarat, IUCN French Committee

Contents

Invasive alien species
Practical information and management insights

Volume 4

Management insights

Plant species

Aquatic plants

Hydrophytes

- 16 ■ **Water fern***
- Species fact sheet
 - Manual uprooting to eradicate water fern from the Coste pond (Côtes d'Armor department)

Amphibious plants

- 20 ■ **New Zealand pigmyweed***
- Species fact sheet
 - Detection and removal (scraping) of New Zealand pigmyweed in the Acheneau and Tenu marshes (Loire-Atlantique department)
 - Managing colonisation of a town pond by New Zealand pigmyweed in Luré (Loire department)
- 30 ■ **Water primrose***
- Species fact sheet
 - Uprooting work on water primrose in the port of Biganos (Gironde department)
- 34 ■ **Parrot-feather watermilfoil**
- Species fact sheet
 - Managing parrot-feather watermilfoil in the Riondaz pond in Viriat (Ain department)
- 38 ■ **Water hyacinth**
- Species fact sheet
 - Managing plant development, including water hyacinth, in the channels of the Yiyi marshes (French Guiana)
- 43 ■ **Water pennywort***
- Species fact sheet
 - Managing water pennywort in the village of Beaumont-Pied-de-Boeuf (Sarthe)



Terrestrial plants

Herbaceous plants

- 50 ■ **Garden balsam***
- Species fact sheet
 - Manual eradication of Himalayan balsam on several sites along the Risle River (Eure department)
- 54 ■ **Hottentot fig**
- Species fact sheet
 - Managing Hottentot fig on the Natura 2000 sites of the islands of Ouessant, Molène and Sein
 - Management of Hottentot fig on several sites in Finistère and Côtes-d'Armor
- 64 ■ **Alligator weed**
- Species fact sheet
 - Experiments on management techniques for alligator weed along the Ouvèze River (Vaucluse department)
- 70 ■ **Asian knotweed***
- Species fact sheet
 - Industrial composting to avoid dissemination of Asian knotweeds. Study on the survival of stalks, rhizomes and seeds (Savoie department)
 - Experiment to compost Asian knotweed in the Orge river basin (Essonne department)
- 83 ■ **Caladium bicolor**
- Species fact sheet
 - Managing *Caladium bicolor* in the Mount Hachiroungou departmental forest (Mayotte)

- 88 ■ **Pampas grass**
- Species fact sheet
 - Managing pampa grass in the Salazie and Mafate cirques (Réunion island)

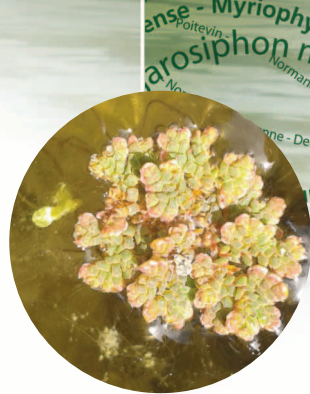
Cacti

- 93 ■ **Hudson pear**
- Species fact sheet
 - Project to eradicate Hudson pears from the town of Celles (Hérault department)

Trees and shrubs

- 99 ■ **Brown salwood**
- Species fact sheet
 - Experiment on techniques to regulate brown salwood in the savannahs of Guiana
- 104 ■ **Miconia trees**
- Species fact sheet
 - Introduction of a pathogenic fungus to check the growth of Miconia trees and restore the wet forests of Tahiti (French Polynesia)
 - Managing a Miconia invasion on Fatu Hiva (French Polynesia)
- 113 ■ **Groundsel bush***
- Species fact sheet
 - Managing a small population of Groundsel bush located in the south of Corsica

* Management reports for these species are also available in volume 2 (2015) and volume 3 (2018).



Water fern

(*Azolla filiculoides*)

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

Description

- A small fern, approximately 1-2 cm in diameter, that floats freely on the water surface
- Small, scaled fronds, hydrophobic in the upper section:
 - green, tinted red toward the end of the summer
 - alternating, tightly nested together
 - the fronds spread horizontally over the water surface in step with the growth of the plant
- A short, branching rhizome

Ecology and reproduction

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

Documentation

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

Classification

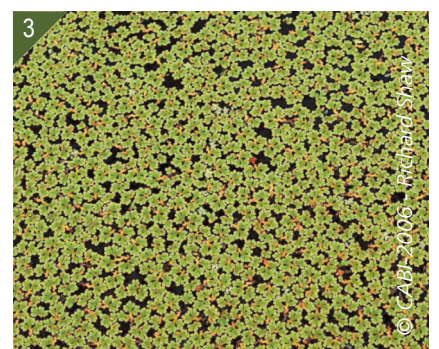
Order	Salviniales
Family	Azollaceae
Genus	Azolla
Species	<i>A. filiculoides</i> (Lam., 1783)



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Water fern (*Azolla filiculoides*)

Manual uprooting to eradicate water fern from the Coste pond (Côtes d'Armor department)

Saint-Brieuc Armor Urban Area (SBAA)

- SBAA federates 32 towns in the department and includes rural, coastal and urban areas.
- Within the local government, the Catchments unit in the Water and Sanitation service is active in numerous fields dealing with the water cycle and wetlands, including management of the bocage landscape, wetlands, rivers and ponds, water quality, information, technical assistance for farmers, towns, individuals and companies, etc. It is in this capacity that it also works on invasive alien species observed in the area.
- Contact : David Étienne, river technician - david.etienne@sbaa.fr

Intervention site

- The Coste pond is located in the town of Saint-Julien, just to the south of Saint-Brieuc. It covers a total surface area of 8 000 square metres, has a maximum depth of four metres and is situated 500 metres downstream of the source that supplies it with water. Downstream of the pond, a stream flows into the Gouët, a small river that flows 1.2 km further downstream into an 80 hectare reservoir used for drinking water.
- The Coste is a private pond managed by a hunting society that signed an agreement with the owner.
- The presence of the water fern was first noted by the Saint-Julien hunting society during the summer of 2015, by which time the pond had been almost completely colonised. An initial management effort was undertaken and the plants were partially uprooted using pitch forks from the banks or from boats, however the species reappeared in the pond in the spring of 2016, at which point the hunting society contacted SBAA.
- The water fern had grown very densely and covered the entire pond, with in addition a significant layer of dead stems under the water surface.



1. The Coste pond (red circle) and the reservoir behind the Saint-Barthélemy dam (blue circle).
2. The pond entirely covered by water fern.

Disturbances and issues involved

■ Ecological impacts

- A thick blanket of fern covering the entire pond reduces the light in the water and results in anoxic conditions that are lethal to many species of fish (pike, roach, perch, rainbow trout), molluscs and plants.

■ Impacts on various uses

- Access to the pond was blocked off to prevent any risk of drowning given that the water was not visible under the layer of plants.
- The fishing competitions and all fishing activities were halted by the hunting society.

Interventions

- In March 2016, a partnership was launched between the local stakeholders, including the pond owner and the hunting society, the Departmental Territorial and Maritime Directorate (DDTM), Departmental Council, Town of Saint-Julien and Saint-Brieuc Quintin Binic Certified Association for Fishing and Protection of Aquatic Environments (AAPPMA). A day of manual collection of the plants was organised on 2 July 2016, using the available means provided by the various stakeholders.
- The objective was to control the growth of the plants in the pond and, if possible, to eradicate the species.
- Prior to the work and to avoid any risk of dispersal downstream, a siphon was installed at the outlet of the pond, with a floating barrier of the type used to contain hydrocarbon pollutants in water.
- Using dip nets and nets with a one-centimetre mesh, the beds of water fern were gathered and pulled to the banks. Boats were used to access the centre of the pond.
- Any fish caught were extracted from the nets before they were pulled up on the bank and immediately put back into the water.
- The collected water fern was laid out in swaths near the pond to drain and then transported to a disposal centre at the end of the summer and folded into a compost-production line (in the “green algae” circuit where it is first dried before being mixed with standard green waste).
- A monitoring programme was set up for the pond to detect any regrowth of forgotten fragments and stems. Water fern fragments are very small and in spite of the precautions taken, it is difficult to remove all fragments from a site. SBAA personnel inspected the site every two weeks for two months following the work, then once per month thereafter. They also maintained regular contact with the local hunters and with the game warden in charge of the site, who was trained to recognise the plant.
- In the beginning of August 2016, approximately one month after the work, the technician in charge of inspecting the site found some water fern growing on about 2.2 square metres of wetland (saturated soil comprising mud and sand) to the north of the pond, just a few metres from the water. With the help of the president of the hunting society and using a shovel, the technician carefully scrapped up the plants, starting from the outside and working in to avoid missing or dispersing any fragments. This additional work took approximately one hour. The removed water fern was transported in a plastic garbage bag and added to the swath of water fern collected in July.

Results and costs

- **Results**
- In July 2016, the work covered the entire pond and approximately 50 cubic metres of water fern were removed from the water, drained, dried and transported. With the exception of the small, isolated section to the north of the pond discovered in August 2016, no further discoveries of water fern were reported during the inspections.
- Two and a half years after the work, no water fern has been observed on the site.



3. Stream feeding into the pond.
4. Net full of water fern, pulled up on the bank.
5. Barrier used to avoid the dispersal of water fern.
6. Swath of water fern for draining and drying prior to transport.
7. The pond the day after the work.

Costs

- The operation as a whole required the equivalent of ten man-days from SBAA personnel (management, meetings, work site, press contacts) and two man-days by the Departmental Council (meetings). The personnel who took part in the manual gathering of the plants did so on a volunteer basis.
- A total of 35 volunteers participated in the work on the pond.
- The town of Saint-Julien paid for the meal during the work day (200 euros).
- The Departmental Council funded the work to create the siphon at the pond outlet (approximately 100 euros).
- The nets and boats were supplied by AAPPMA.

Volunteers for the work on 2 July 2016.

Origin	Number
SBAA personnel	2
Departmental personnel	2
Town personnel	2
AAPPMA members	10
Hunters	10
Residents and elected officials from Saint-Julien	9

Information on the project

- An article was published in the municipal bulletin of Saint-Julien on the preparations for the day of work.
- The colonisation of the pond by water fern was a topic in the national media (TF1, Canal+ and France 2 TV stations and on radios), however, only the local press followed and informed on the management operations.

Outlook

- The site continues to be monitored annually by an SBAA technician and contacts are maintained with the hunters to monitor any observations of the species.
- Water fern was detected around the same time in a small, private pond (5 x 10 metres) in the town of Plaintel, five kilometres in a straight line from the pond in Saint-Julien. Water birds are suspected to have transported fragments of water fern. The owner of the second pond was informed of the technique implemented for the Coste pond and used the same technique, with identical success.
- No other invasive alien species have been detected to date in the Coste pond.

Authors: David Etienne, SBAA, and Doriane Blottière, IUCN French committee, for the Resource Centre on invasive alien species. July 2019. Published by the French Biodiversity Agency.

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10 Étang rouge à Saint-Julien. Mobilisation citoyenne ?

Dimitri Bouchon-Borie

Une « mobilisation citoyenne » pour nettoyer l'étang rouge de Saint-Julien ? C'est la solution envisagée par le maire de la commune, pour régler le sort de la fougère invasive qui a donné ses belles couleurs au point d'eau.

À Saint-Julien, l'étang rouge était devenu, au temps, une véritable courtoisie locale.

Les curieux sont moins nombreux au bord du petit étang du château de la Coste, à Saint-Julien, en cette fin de mois de mai. Le plan d'eau, lui, est toujours couvert de cette fougère invasive qui avait fait, bien malgré lui, sa notoriété. Un végétal exotique aux qualités esthétiques remarquables, mais dévastateur pour l'environnement, l'aune asphyxiée, risque de contaminer aux plans d'eau voisins. Le phénomène avait quelque peu inquiété les autorités locales... d'autant que la situation juridique de l'étang (il est sur un terrain privé) compliquait sérieusement le dossier. La semaine dernière, Claude Blanchard, le maire de Saint-Julien, a réuni autour de la table les services de l'État, du département, de l'agglomération briochine, les chasseurs, et aussi le propriétaire du site. Objectif : engager les solutions.

Coût exorbitant

« On s'est mis d'accord, d'abord, pour mener des analyses, rechercher la présence de « symbiotiques », explique le maire. Pour le reste, ce n'est pas simple. Il faudrait nettoyer mais les coûts techniques seraient exorbitants. Et de toute façon, « c'est un étang privé ». En fait, « personne » n'a les moyens » de se lancer dans une opération coloniale. « On pense plutôt à une journée de nettoyage, où l'on ferait appel aux bonnes volontés. Une journée citoyenne, cela me semble la moins mauvaise solution. »

Les fougères seraient ensuite compostées. Et l'étang serait régulièrement curé « on n'a aucune garantie que ça ne revienne pas ». Pas d'urgence sur les canaux de l'invasion : « Il y a forcément un aquarium qui a été vidé quelque part, et un escouade qui est passé par là ». Seule certitude : il n'y a pas de risque avéré pour les cours d'eau proches. « La fougère ne colonise que les eaux stagnantes, il ne faut pas de courant, ou de cascades. Elle a profité à Saint-Julien de conditions favorables, des eaux mortes, et notamment un hiver doux ».

- 8. The small group of water-fern plants found to the north of the pond in August 2016.
- 9. The pond four months after the work.
- 10. An article published in the Télégramme newspaper on 24 March 2016.



New Zealand pigmyweed

(*Crassula helmsii*)

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

Description

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

Ecology and reproduction

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

Documentation

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

Author: Emilie Mazaubert, Irstea

Classification

Order	Saxifragales
Family	Crassulaceae
Genus	Crassula
Species	<i>C. helmsii</i> (Kirk) Cockayne 1907)



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New Zealand pigmyweed

(*Crassula helmsii*)

Detection and removal (scrapping) of New Zealand pigmyweed in the Acheneau and Tenu marshes (Loire-Atlantique department)

Sud-Loire Hydraulic Board (SAH Sud-Loire)

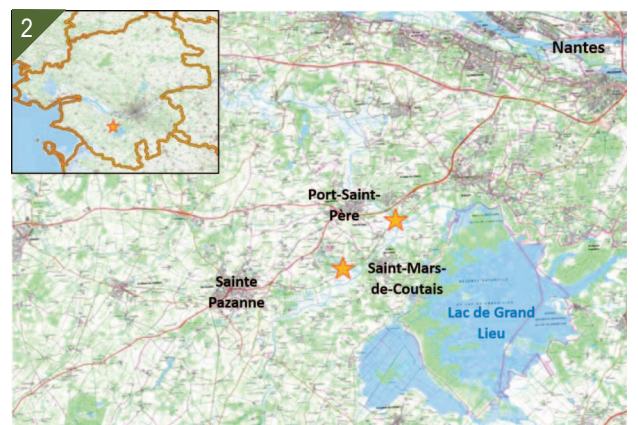
- The area managed by SAH Sud-Loire covers parts of the Loire-Atlantique and Vendée departments, from the Loire estuary to north of the Breton Marshes and from the outlet of the Grand-Lieu Lake to the ocean.
- Since 2010, the board has implemented a policy to improve the quality of water and aquatic environments in the Tenu basin (a sub-basin in the Loire Estuary SBMP) including management of invasive aquatic plants.
- Contacts: Pierre Guinaudeau and Olivier Fandard, river technicians -
pguinaudeau@sahsudloire.fr and ofandard@sahsudloire.fr

Intervention site

- In the Loire-Atlantique department, New Zealand pigmyweed (NZP) was first reported in 2010 in Guérande and has since spread considerably throughout the department.
- In August 2017, it was observed by the volunteer network of the Brest National Botanical Conservatory (CBNB) at the confluence of the Acheneau and Tenu Rivers, in the town of Saint-Mars-de-Coutais.
- That was the first observation of the species in the area at the point of junction between two Natura 2000 sites, the Loire Estuary site (FR5200621) and the Grand-Lieu Lake site (FR3600048).
- To assess the degree of colonisation and determine, if possible, the site of introduction, the main hydraulic network, i.e. 40 km of river, was inspected by boat using binoculars by members of the Loire Nature Conservatory (CEN PDL), the CBNB, the Fishing Federation of the Loire-Atlantique department, the National Association for the Protection of Nature (SNPN) for Grand Lieu and the SAH.
- It was determined that the plants most probably spread via water channels, from a moat in a marsh receiving water from a catchment comprising private properties in the town of Port-Saint-Père.
- The flow direction of this hydraulic network changes depending on the season, due to the very slight slope



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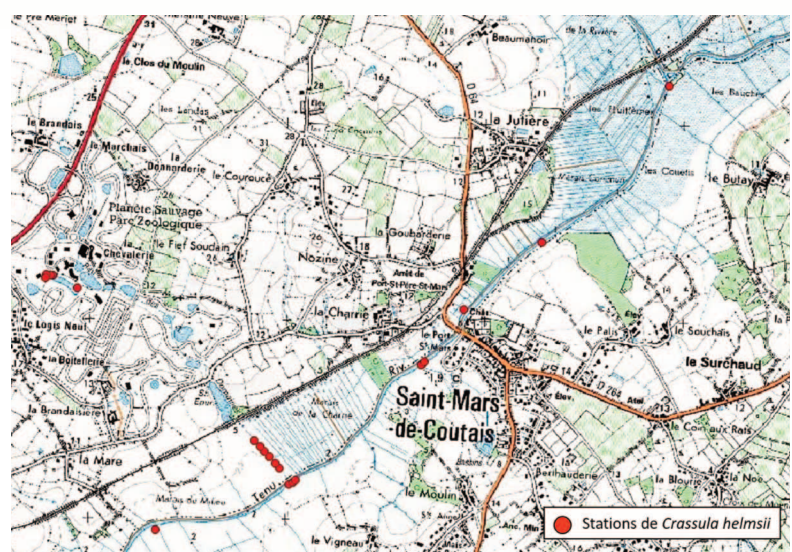
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1. Area managed by SAH Sud-Loire.
2. Intervention sites.

(1 cm per kilometre) and to the effects of summer draw-offs of Loire water via locks (that collect fresh water from the estuary pushed upstream by high tides) and upstream pumping stations that reverse the flow direction.

- This unusual hydraulic system that flows in both directions offers NZP a chance to colonise all favourable environments in the marshes down to the Loire, i.e. a potential area of approximately 1 800 hectares. The risk of propagation via hydraulic channels to the Grand-Lieu Lake is slight, however the risk of future colonisation due to the movement of fauna and humans is great.

■ The low population densities and the currently limited ranges would indicate a recent arrival in the area and enable interventions to reduce the risks of NZP dispersal and avoid a widespread invasion.



Sectors colonised by New Zealand pigmyweed.

Disturbances and issues involved

- The plants colonise easily and can establish single-species populations, in direct competition with native species.
- NZP can also block canals and ditches, creating problems for the flow of water.

Interventions

- For the field work, SAH and the CEN formed a partnership and were supported by the CBNB for the detection campaigns, on the work sites and for monitoring. The towns of Port-Saint-Père and Saint-Mars-de-Coutais took part in the work to uproot the most densely colonised areas by providing equipment and a storage area, informing on the work and by determining the perimeter of a colonised site.
- In September and October 2017, manual interventions (scraping of plants and roots) took place on all NZP sites, except on private land upstream of the marshes.
- The banks of the Tenu River were inspected by boat. Small NZP sites were detected using binoculars and directly eliminated using trowels and shovels to remove the substratum in order to avoid fragmentation of the fragile plants (the roots do not go deep).
- The waste was transported in large recipients and rolled into an agricultural tarp, in a dry area. Particular care was taken during travel to and from sites by personnel to avoid any dispersal caused by trampling on the plants and transporting segments under boots. When landing, the CBNB systematically marked out the colonised area before the uprooting work was started.



3. New Zealand pigmyweed mixed in with native vegetation.

4. Scraping spots colonised by NZP on the banks of the Tenu River.

5, 6. Identification of the colonised area and removal of the root system.

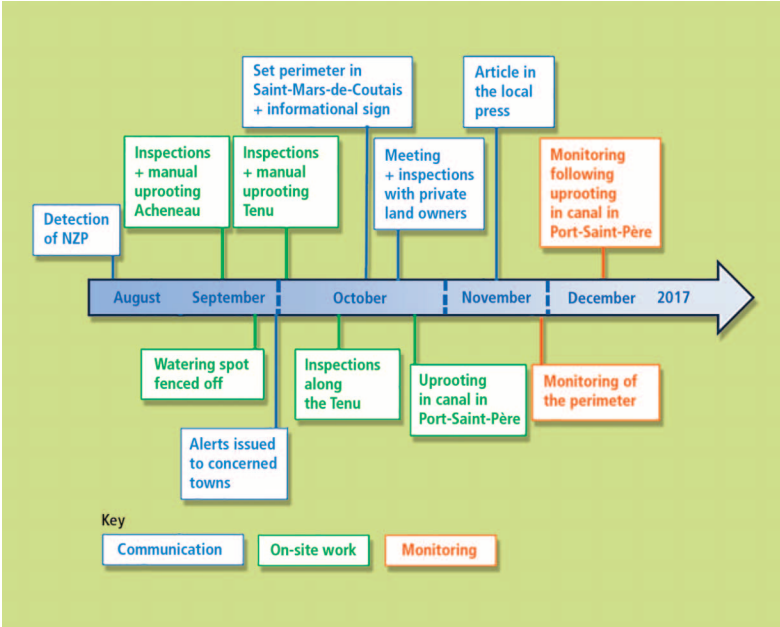
■ The 350 metres of moat in Port-Saint-Père represented a full day of manual intervention by eight people (6 from SAH, 1 from CBNB and 1 from CEN). The work took place in a number of steps:

- the two banks were first inspected on foot and the NZP sites were marked with paint, then all the marked areas were scraped manually;
- the workers entered the water to collect any floating cuttings and eliminate any plants not visible from the bank (overhangs);
- an initial inspection run was undertaken to check the work and remove any plants that had been missed;
- finally, after letting the sediment settle, a second inspection run was carried out.

■ The harvested NZP was transported using a tractor made available by the town.

■ Even though great care was taken in uprooting and transporting the plants, some NZP may still remain in the treated areas. To avoid any risk of propagation, two areas were fenced off to avoid passage that could disperse the plants. The first was a break in the river bank, approximately ten metres long, in a pasture. It was used by cows to access the river to drink. Informed by SAH, the farmer accepted to fence off the zone. The second was located on the right bank in the port of Saint-Mars-de-Coutais, where access to approximately 50 metres of the bank, used by anglers, was prohibited by prefectural order.

■ The green waste was transported and stored under a tarp in a town depot, far from any circulation of people or vehicles. The soil removed during uprooting of the plants was placed in a tarp that was sealed to avoid contact with the air and the underlying ground. The contents of the tarp will be monitored to detect any regrowth of the plants and to determine their resistance to confinement (dryness and obscurity).



Chronology of the interventions.

7. Transport and elimination of the waste.
8. Second intervention in the moat.
9. Third intervention in the moat.
10. Prohibited area in the port of Saint-Mars-de-Coutais.

Results and costs

■ Results

■ On 20 December 2017, SAH and CEN inspected the main uprooted sites to check for any new sprouts. In spite of favourable weather conditions for the plants (relatively warm fall and winter, limited rainfall, i.e. low water level), only a small number of new-growth plants were detected and uprooted. These results bear witness to the meticulous work done.

■ Costs

■ The work done by SAH was financed directly by the board.

■ The operational assistance for the project managers provided by CEN and CBNB was financed in the framework of the Pays-de-la-Loire IAS network, funded by the Loire-Bretagne Water Agency (60% for CEN and 30% for CBNB) and the Pays-de-la-Loire Regional Environmental Directorate (35% for CEN, 45% for CBNB). The remainder was funded directly by the two organisations. The personnel costs per person and per day were estimated at 450 € for CEN and 467 € for CBNB.



11. Depot for green waste, protected by a tarp.

Work dates and sites.

Date	Place	On-site work	Participants	Number of persons	Time (hours)	Cost (€)
25 Sept. 2017	Canal (outlet of Grand-Lieu Lake)	Inspection + removal of plants	SNPN + CEN	3	4	422*
25 Sept. 2017	Acheneau (Port-St-Père to Rouans)	Inspection	Fishing Federation 44	NA	4	30*
25 Sept. 2017	Tenu (St-Mars-de-Coutais to Ste-Pazanne)	Inspection + removal of plants	CBNB + SNPN	3	8	833*
26 Sept. 2017	Thérèse Island (confluence)	Watering spot fenced off	SAH	1	2	42*
02 Oct. 2017	Site in St-Mars (Le Vigneau)	Uprooting in lower section	CBNB + SAH	4	6	641*
17 Oct. 2017	Tenu (Ste-Pazanne to Machecoul)	Inspection	CEN+CBNB+SAH	3	4	571*
19 Oct. 2017	Port of St-Mars-de-Coutais	Fencing off + sign	SAH	1	3	63
19 Oct. 2017	Port-Saint-Père (private property)	Inspection + information	SAH + CEN	2	4	308
26 Oct. 2017	Canal Port-Saint-Père	Uprooting	SAH + CEN + CBNB + Town	8	7	1860
17 Nov. 2017	Port of St-Mars-de-Coutais	Press article	SAH	1	2	42
20 Nov. 2017	Canal + Port of St-Mars-de-Coutais	Monitoring of sprouts	SAH + CEN	2	4	308
					Total	5120

Personnel costs were estimated on the basis of an hourly cost of 21 euros per person for personnel from SAH, SNPN and the town. Use of the motorboat is indicated by an asterisk and the cost was estimated at 30 euros per day. NA: Not available.



Information on the project

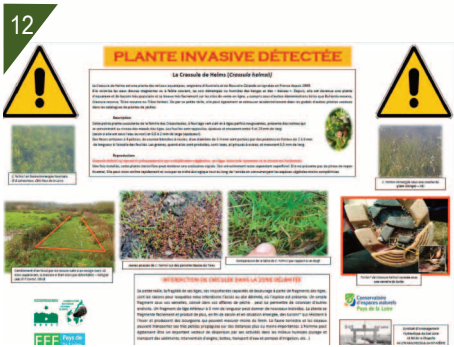
- An article informing the population concerning the presence of the species in the area was published in the *Courrier du Pays de Retz* (the local weekly) on 17 November 2017.
- An informational sign was put up on 17 October 2017 next to the fenced off area in the port of Saint-Mars-de-Coutais.
- SAH also alerted the towns to the situation by sending an image of the sign via email. The relevant boards, the Buzay Canal managers and the steering committees for the two Natura 2000 sites, Grand Lieu and Estuaire de la Loire, were all informed of the situation in their respective meetings.

Outlook

- Monitoring of the entire hydrographic network has been planned for the spring of 2018, as soon as the water levels have subsided. SNPN will also inspect the water courses in the Grand Lieu catchment in the vicinity of those already colonised.
- CEN and SAH will work with private property owners to jointly manage the source areas and to reduce the dispersal risks of the species, as well as strengthen the resilience of the environment, for example by protecting river banks with fences to assist the development of helophytes capable of competing with the NZP.

Authors: Pierre Guinaudeau, SAH Sud-Loire, Emmanuel Leheurteux, CEN Pays-de-la-Loire, Doriane Blotti re, IUCN French committee and Fabien Dortel, CBNB, for the Resource Centre on invasive alien species. July 2018. Published by the French Biodiversity Agency.

2022 edition



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12. An informational sign set up next to an NZP site.

13. Article published in the *Courrier du Pays de Retz* newspaper.

For more information...

- Dortel, F. et Dutartre, A. 2017. La Crassule de Helms (*Crassula helmsii* Cockayne, 1907) : Fiche d'alerte d taill e, premi re analyse des risques, possibilit s de r gulation et mesures de bio-s curit . CBNB et GT IBMA. 23 p.



New Zealand pigmyweed

(*Crassula helmsii*)

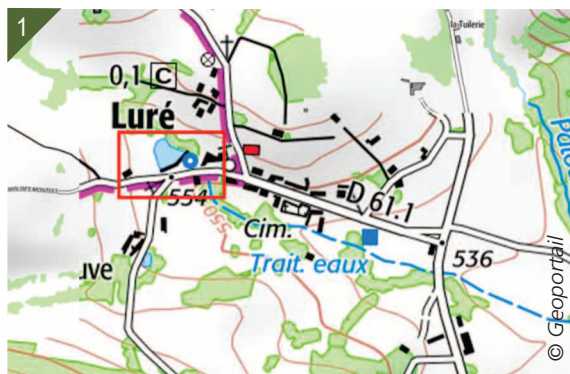
Managing colonisation of a town pond by New Zealand pigmyweed in Luré (Loire department)

The Loire department

- The Loire department has set up a strategy to combat invasive alien plants, focussing on three priority species (ragweed, Asian knotweed and alien water primrose) and a small number of emergent plant species. The latter are species that have been observed, but have only one or very few populations in France. Elimination is thought to be possible if immediate action is undertaken. A status report on alien species in the department was produced in 2014 by the National Botanical Conservatory for the Massif Central (CBNMC) and served to identify the emerging species. Among those species, six were selected for monitoring and management work in view of their eradication, including New Zealand pigmyweed.
- In 2017, the department and the Loire Departmental Territorial Directorate (DDT), in conjunction with the CBNMC and the Monts du Pilat Centre for Environmental Initiatives (CPIE), the manager of the Centre for Invasive Plants, met with elected officials from the town of Luré to set up the project to eliminate the only colony of New Zealand pigmyweed in the department.
- Contacts: Julie Fargier, Head of the Environmental service of the Loire department - julie.fargier@loire.fr
Emilie Moine, co-director of the Monts du Pilat CPIE - emilie.moine@cpie-pilat.fr

Intervention site

- The pond colonised by New Zealand pigmyweed is located in the town of Luré, in fact a village with 146 inhabitants and a member of the Vals d'Aix et d'Isable intermunicipal board.
- The pond was created in 1999 very close to the centre of the village. It covers a surface area of 1 990 square metres and has an average depth of one metre. It receives the run-off water from the catchment. Water exits the pond either directly through a ditch linked to the Patouse River, located approximately 850 metres from the pond, or via the town wash house and then to the ditch.



1. Map showing the pond in the town of Luré.

- The pond is used for fishing and as a reservoir in case of fire.
- The CBNMC first observed *Crassula helmsii* in the pond in 2006. The plants progressively colonised the edge of the pond, spreading from approximately 5 square metres in 2013 to over 350 square metres in 2017.
- It is unknown how the plants first arrived in the natural environment. They may have come in when the site was planted, however the current managers are unaware of how that might have happened.
- The pond in Luré is one of three sites in the Rhône-Alpes region where the species has been observed. The other sites are in Decines-Charpieu in the Rhône department and Niévroz in the Ain department.

Disturbances and issues involved

- New Zealand pigmyweed is considered a priority among the emerging invasive alien species (IAS) in the department due to its highly invasive nature and its rapid spread in other areas, notably in western France.
- It can form dense, single-species beds that hinder the development of native plant species and disturb the ecological balance of the local environment.
- The pigmyweed developed in separate clumps along the banks of the pond. However, the development of a thick mat of plants along the edge of a pond could reduce its



recreational value and constitute a risk for young children. It could also block the wash house and the ditch.

■ The species could be disseminated by humans (on boots, via fishing equipment, etc.), dogs and wild animals (notably birds) to the basin of the Aix River. It could also disperse naturally to new sites downstream of the pond.

Interventions

■ Elimination of the plants from the site to avoid dispersal was considered feasible given the small size of the population.

■ Meetings were organised in 2017 and 2018 with the town of Luré, the Loire department, the Loire DDT, the CBNMC and the Vals d'Aix et d'Isable intermunicipal board (the entity in charge of the river contract) to prepare and organise the intervention.

■ It was decided to empty and dredge the pond. The work was done in the spring and autumn of 2018.

■ Complete draining of the pond

■ In order to avoid dispersal of any plant fragments and reduce the impact of draining on the river (e.g. suspended solids), the town wash house was used as an initial settling basin. Bales of straw were placed at the entry point in the wash house and a foam filter was placed on the overflow channel. A second concrete basin located just before the ditch was used as a second settling basin. Three successive filters (two made of straw and one foam filter) were positioned in the second basin. All the straw filters were replaced during the emptying process to avoid clogging. The filters were in place throughout the operation until the dredging was completed. The wash house and the second basin were emptied and cleaned at the end of the operation.

■ To avoid clogging the filters and maintain their filtering capacity, the discharge rate during emptying was kept to a low level. The fish in the pond were caught with nets and taken to the local rendering service. Boots and fishing equipment were cleaned after use.

■ Dredging of the pond

■ The pond and the edges where the species was present were dredged to a depth of 50 to 70 centimetres. The input culvert to the pond was also cleaned.

■ The work was carried out by a private company and involved two tracked excavators and a dump truck for six days. The movements of the machines were precisely determined and the dredging took place from the outer edges to the middle to avoid dispersal of the pigmyweed.

■ Precautions

■ A number of precautions were taken during dredging to avoid dispersal of plant fragments. Information on the plant species, the operational process and the precautions required during the work was supplied to the company before the start of the project in order to inform the intervention personnel. During the dredging, the excavators, which served exclusively for dredging, avoided running over colonised areas as much as possible. All the machines and equipment used for the work were cleaned with a high-pressure cleaner on a specific site. A single entry and exit point to the pond for the machines was set up to limit the risks of transporting plants and/or seeds to other areas. A "clean" access ramp was created for filling the dump truck and the soil used for the ramp was later removed with the dredged soil.



2a, b and c. Red lines showing the position of the pigmyweed in the pond on 2014.
3a and b. Filters installed in the ditch (a) and the wash house (b).

Results and costs

■ Results

■ A total of 1 000 cubic metres of soil potentially containing fragments of pigmyweed were removed. The entire area colonised by the pigmyweed was cleaned.

■ A relatively low water level was observed over the first year of monitoring. The steep banks of the pond (a drop of approximately 60 centimetres) hinder the rapid recolonisation of vegetation. The grass and moss storeys cover 5 to 10% of surfaces in spots. Some flatter areas have formed at the bottom of the banks due to erosion (small landslides). It would appear that colonisation by the pigmyweed cannot proceed top-down because the conducive substrate was removed wherever the pigmyweed was present. The swards around the pond are not favourable for pigmyweed because the substrate is too dry and the vegetation is too dense.

■ Many species with different ecological preferences have been observed along the banks of the pond, including *Carex hirta*, *Equisetum arvense*, *Equisetum palustre*, *Gallium mollugo*, *Juncus bulbosus*, *Lotus corniculatus*, *Mentha aquatica*, *Polygonum aviculare*, *Ranunculus repens*, *Sagina apetala*, *Veronica beccabunga* and *Physcomitrium pyriforme*.

■ Costs

■ The Loire department provided the town with technical and administrative assistance.

■ The work involved two people to install the filters, clean the basins and install tarps, for a total of one day, and four people for the dredging over six days.

■ During emptying of the pond, the different project partners regularly monitored the progress, checking the filters and the overall situation.

■ During the work on-site, three monitoring meetings were organised.

■ The total cost of the operation amounted to 14 745.10 euros (not including VAT). The town received 8 809.12 euros in financial aid from the Regional Environmental Directorate and 2 986.87 euros from the Loire department. The town supplied the remainder, 2 949.11 euros, from its own budget.

■ Fishing is now prohibited on the site.

Information on the project

■ The project was the topic of an article published in the bulletin of the Centre for Invasive Plants and sent to managers of natural areas and policy officers for invasive plants in the Loire department.

■ A one-day training course on invasive plants, including a visit to the site, was organised prior to the work on 19 October 2017 for the personnel and elected officials of local governments.

■ A meeting of policy officers for invasive plants in the Loire department, including



4. The pond during emptying.

5. Removal of the fish from the pond.

6a and b. Dredging.

a visit to the site, was organised on 21 November 2018, following the dredging work.

- An article on the project was published on the CBNMC site.
- Other forms of dissemination are currently being assessed.

Outlook

- Two annual monitoring visits, in June-July and in September-October, are planned for at least five years to assess the effectiveness of the intervention. Each visit, requiring four to five hours for a complete inspection, checks for the presence of the species in the pond and nearby (around the pond, the zone upstream, the zone downstream of the wash house, around a pool in the meadow). Searches were run on the stream downstream of the pond to determine whether the species had disseminated. No pigmyweed was found during the first monitoring visit at the end of 2019.
- Plans have been made to tarp areas where the pigmyweed reappears, given that the species does not like shaded areas. A small ditch, 20 to 30 cm deep, will be dug around the colonised area to secure the tarp.
- The landscape around the pond was somewhat altered by the intervention. Work to consolidate the banks and/or enhance the landscape may be decided, taking all the necessary precautions.

Authors and contributors: Emilie Moine, Monts du Pilat CPIE, Doriane Blottière, IUCN French committee, Alain Dutartre, independent expert, Emmanuelle Sarat, IUCN French committee, for the Resource Centre on invasive alien species. July 2020. Published by the French Biodiversity Agency.



7. Mound of extracted soil.

8. The emptied pond.

9. The pond after the work.

For more information...

■ CBNMC article:

<https://www.cbnmc.fr/actualites/144-la-crassule-de-helms-maitrisee-dans-le-departement-de-la-loire>

■ Article in the Pays newspaper:

http://static1.le-pays.fr/lure-42260/actualites/plan-deau-un-curage-necessaire-pour-supprimer-une-plante-invasive_13044514/



Water primrose (*Ludwigia* spp.)

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

Description

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

Ecology and reproduction

- High adaptation (long stalks along the surface, branches) and colonisation capabilities (complete occupation of the available space, growth above the water level)
- Very resistant plant (strong root system)
- Production of large quantities of biomass, layer of plant litter on some sites
- Sexual reproduction is possible
- Wide range of favourable biotopes:
 - shallow wetlands
 - edges of ponds and lakes
 - channels, ditches, side channels
 - rivers with low discharges during the summer
 - wet meadows

Documentation

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

Author: Emilie Mazaubert, Irstea

Classification

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



© Emilie Mazaubert



© Alain Dutartre



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© Alain Dutartre



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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.)

Uprooting work on water primrose in the port of Biganos (Gironde department)

Arcachon Bay Board (SIBA)

- The board is active in ten townships on Arcachon Bay (those in the South Arcachon Urban Board and six towns along the northern edge of the bay).
- In parallel to its missions dealing with the quality of aquatic environments and the living conditions of residents (boating, water quality, management of rainwater and septage, etc.), SIBA has also been in charge of GEMAPI policy (management of aquatic environments and flood prevention) since 2018.
- Contact person for invasive alien plants:
Adelyne Rolland, policy officer for maritime affairs -
a.rolland@siba-bassin-arcachon.fr

Intervention site

- The port of Biganos lies in the town of Biganos on the Leyre (or L'Eyre) River. It is one of two river ports for the Arcachon Bay and is used for recreational boating.
- Due to its proximity with the river delta, water and salinity levels vary depending on the tides.
- In July 2018, SIBA was contacted concerning beds of aquatic plants developing in the central section of the port. The National Botanical Conservatory for South-west France (CBNSA) was called in to identify the plants and reported that they consisted of two species of water primrose, *Ludwigia grandiflora* and *Ludwigia peploides*.
- The colonised area spanned a total of 1 200 square metres and consisted of ten beds, located primarily near the moorings, but spreading to the centre of the central section.

Disturbances and issues involved

- The water primrose hindered the free travel and manoeuvring of the boats.
- Due to the considerable production of biomass, the plants contributed to the silting of the port. They also modified the level of dissolved oxygen in the water and blocked the movement of aquatic fauna.



1. Map showing the site.
2. A bed of primrose in the port of Biganos.

Interventions

■ Preparation

- After reviewing the management reports for water primrose collected by the National Work Group on Biological Invasions in Aquatic Environments (IBMA¹), CBNSA made a number of recommendations:
 - identify and characterise the invaded areas, detect the possible sources of plants and cuttings;
 - uproot the beds (manually or mechanically) while taking care to avoid the dispersal of the plants downstream by setting up fine nets around the beds;
 - establish monitoring procedures and undertake any necessary uprooting work in subsequent years.
- Given the small surface areas requiring work and the technical constraints (earthen banks and a bridge to the central section incapable of supporting heavy machinery), the decision was made in favour of manual uprooting rather than the mechanical uprooting.

1. At the end of 2018, IBMA became the Scientific and technical network (REST) at the Resource Centre on invasive alien species (www.especes-exotiques-envahissantes.fr).

■ The work took place on 24 and 25 September 2018. These dates were selected because low tide occurred in the middle of the day, meaning workers could access the central section on foot. Boat owners had been requested to remove their boats from the moorings to provide access to the beds.

■ SIBA requested assistance from local entities, including the Landes de Gascogne Regional Nature Park, the technical department of the town of Biganos and the boaters from the Lou Batel'Eyre company who were hired to participate in the project.

■ Intervention steps

■ A net (mosquito netting) was placed at the entry of the central section. It spanned the entire width of the section (ten metres) and also blocked off a bed of water primrose detected near the entry. Two small boats were positioned in the colonised area while the tide was dropping. They served to collect the uprooted plants that were far from the banks. The boats rested on the bottom until the tide came back in and they could be moved for unloading.

■ The uprooting was done by hand, using rakes and garden forks. The plants were placed in oyster baskets or directly in the boats.

■ In the middle of the first morning, the boats were already full and it turned out that the weight of the plants was so great that the tide could not lift the boats. A backhoe loader was then made available by the technical department of the town. The loader was positioned on the bank and the bucket was filled manually, then emptied into a dump truck or on a geotextile fabric laid out on the bank.

■ Subsequently, the loader was used directly to remove the largest beds of plants, which also resulted in the removal of large quantities of sediment.

■ The unloading zone for the water primrose was located near a parking lot, on land well above the high-tide mark. The uprooted plants were drained of water on the geotextile fabric and then transported to the town technical centre. After drying in a blocked off area of the technical centre, they were transported to composting units with other waste from the town.

Results and costs

■ Results

■ A total of 5.74 tons of waste (water primrose and sediment) were removed.

■ Young plants remained visible following a tide cycle and several new colonised areas were detected during the work. These areas will be treated in 2019.

■ The use of the net to avoid dispersal was not satisfactory because the wind hindered its effectiveness. A system of floats and weights may be more effective and would adapt to the changing water level due to the tides.

■ Costs

■ On average, six people were involved in the work. Five people uprooted the plants and one person managed the work from the bank.

■ An employee from the town was also on hand to operate the dump truck and the backhoe loader.

■ The cost of the work provided by the Lou Batel'Eyre company amounted to 1 800 euros.

■ Most of the equipment used was made available by the various participants. The purchase cost of new equipment amounted to approximately 200 euros.



3. The net intended to prevent dispersal.

4, 5. Manual uprooting of water primrose in the central section.

6. The backhoe loader operating from the bank.

7, 8. A bed of water primrose at low tide (7) and following the work (8).

Equipment supplied by the various participants.

Equipment	Supplied by
Two boats	Lou Batel'Eyre
Mosquito netting (0.8 mm mesh, 2.2 metres wide) + wooden stakes	Purchased
Geotextile fabric	Purchased
Garden forks, rakes	All participants
Oyster baskets	Lou Batel'Eyre
Buckets	All participants
Individual protection equipment (gloves, boots, waders)	All participants
Dump truck	Town technical department
Backhoe loader	Town technical department

Information on the project

■ A poster providing information on water primrose and on the work was set up near the work site and a brochure on invasive alien plants, drafted by the Landes de Gascognes Regional Nature Park, was made available to the public in the port.

■ The project was covered by the local press (*Val de l'Eyre*) and in television and radio programmes.

(France Bleu <https://www.francebleu.fr/infos/climat-environnement/biganos-operation-arrachage-des-plantessinvasives-sur-le-port-1537796209>,

Arcachon Bay television

<http://www.tvba.fr/vie-locale/biganos-arrachage-jussie-siba-ville-2018/>).

Outlook

■ The technical means should be improved to provide better access to the middle of the central section and for the removal of the uprooted plants. Under the current conditions, participants occasionally found themselves up to the hips in mud, which made movement difficult and even dangerous.

■ Visual monitoring of any regrowth of the beds will be carried out by people in addition to their regular activities on the site. Aerial photographs taken by a drone before the work and each subsequent year prior to uprooting work will be used to record the development of the beds.

■ Annual uprooting work of sprouts and any new beds will be organised each September over the next five years.

■ It is also recommended to maintain the vegetation on the banks because the shade provided can limit the growth of the water primrose.

Authors: Doriane Blottière, IUCN French committee, and Adelyne Rolland, SIBA, for the Resource Centre on invasive alien species. March 2019. Published by the French Biodiversity Agency.

2022 edition



9. Storage and drying area for the uprooted plants.

10, 11, 12. A bed of water primrose at high tide (10), at low tide (11) and following the work (12).

For more information...

■ Syndicat intercommunal du Bassin d'Arcachon. 2018. Bilan de l'intervention d'arrachage manuel de la jussie au port de Biganos. 14 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 in the Riondaz pond in Viriat (Ain department)

The Reyssouze river-basin board (SBVR)

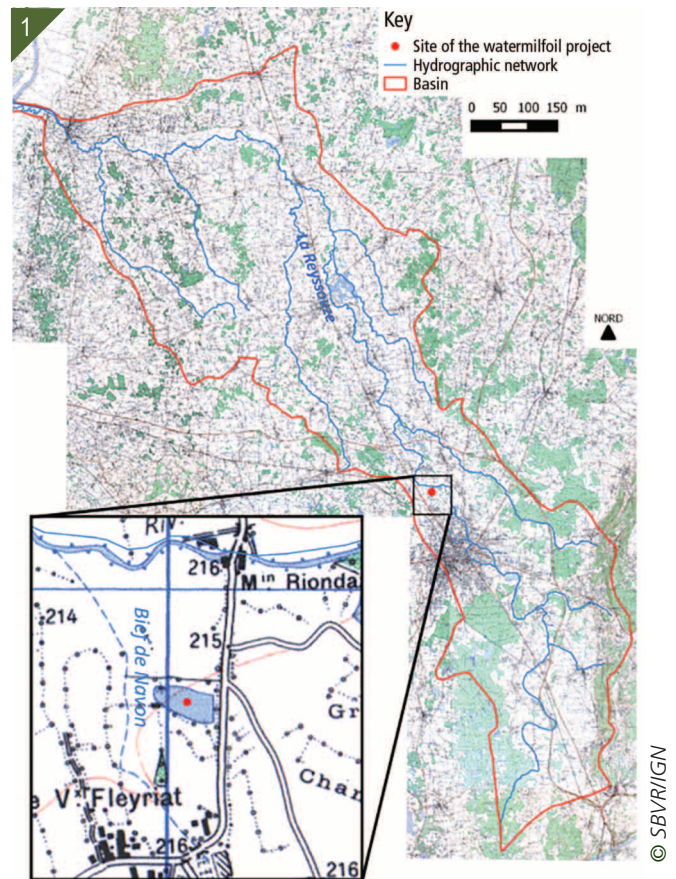
- SBVR works to improve the quality of the water courses and aquatic environments of the Reyssouze River and its tributaries. The board undertakes studies and work on the water courses of the basin, a territory representing 500 square kilometres and 38 towns.
- It also provides science advice to both public and private entities, as well as to private persons who want to work on aquatic environments.
- Contact: Dimitri Mercier, river policy officer - dimitri.mercier@syndicat-reyssouze.fr

Intervention site

- The Riondaz pond covers a surface area of 7 000 square metres in the town of Viriat (Ain department). The man-made pond is now used for recreational activities and is managed by the Works' council of the Ain psychotherapeutic centre (CPA).
- The bottom of the pond consists of alluvial stones covered by a thick layer of fine sediment. A source supplies most of the water and the precise depth of the pond is unknown. Three-quarters of the total surface area are exposed to sunlight and to winds from the north-west.
- A nearby discharge ditch is available to release the water from the pond to the natural environment. The ditch is linked to the pond at two points via culverts equipped with screens. The ditch flows into the Navon stream, a left-bank tributary that flows into the Reyssouze 200 metres downstream.
- The parrot-feather watermilfoil (PFW) was first observed in the pond in 2015. In 2017, the pond was the only known spot colonised by the species in the Reyssouze basin.

Disturbances and issues involved

- Over the two-year period, the PFW developed considerably in the pond. In 2017, it had covered the entire surface area of the pond and replaced the previous beds of aquatic plants.



1. Mapping showing the Riondaz pond.

- Due to the excessive growth, recreational fishing, the main activity, and stocking were halted in 2016.

Interventions

Interventions in 2017

- SBVR decided to launch a project to manage the PFW in order to avoid any risk of species dispersal to other sites in the river basin and to restore the recreational activities desired by the pond owner.
- The work consisted of uprooting the PFW using an excavator loaded onto a barge that enabled it to access the entire surface area of the pond. The excavator was equipped with a special bucket with "claws" designed to gather a maximum amount of plants while leaving the fine and coarse sediment.

■ The work took place over seven days in August, including five days of uprooting.

■ Prior to the work, several precautions were taken to avoid dispersal of plant cuttings:

- closing of the discharge gate;
- installation of a floating net and of fine-meshed screens just upstream of the discharge gate;
- installation of a natural filter (straw bales) in the discharge ditch.

■ Following the work, any floating plants along the pond banks and near the discharge gates were collected.

■ In September and October, two sessions of manual uprooting from a boat were organised to reduce the quantity of new growth.

■ The green waste was stored on a site where there was no danger of flooding. The waste was placed on a geotextile fabric to avoid contact with the soil. The PFW drained and dried *in situ* over a period of several weeks before being transported to a special centre for burial.

■ Interventions 2018

■ To avoid regrowth of the plants, four sessions of manual uprooting by volunteers were organised in 2018:

- two days in conjunction with FRAPNA (environmental-protection non-profit) on 5 May and 29 September;
- two five-day sessions in conjunction with Concordia (work programmes for young volunteers) from 16 to 20 July and from 13 to 17 August.

■ The work was done using plastic boats.

■ The manually uprooted plants were stored on site, in a spot where there was no danger of flooding, then destroyed using quicklime.

Results and costs/assessment

■ Results

■ The mechanical uprooting in 2017 covered almost the entire pond and approximately 40 metric tons of drained plants were later transported from the site. A small island was removed manually because the low water level during the summer hindered the access of the barge.

■ In 2018, the sessions of manual uprooting by volunteers collected:

- 4.5 cubic metres of plants in May;
- 10 m cubic metres in July and August;
- 5 m cubic metres in September.

■ Costs/assessment

■ The total cost of the project in 2017 amounted to 35 730.25 euros (including VAT), of which 4 753.45 euros were required solely for the declaration of public interest (work authorisation). Processing of the green waste cost approximately 6 000 euros (including VAT). A number of partners funded the project, namely the Rhône-Méditerranée-Corse Water Agency (50%), the Ain department (20%) and the CPA Works' council (30%).

■ On 5 May 2018, the first uprooting session brought together 25 volunteers, the sessions in July and August involved 15 young volunteers from different countries (Concordia) and ten people participated in the session in September. The equipment (nets and boats) was provided free of charge by the project partners (Plaine Tonique recreational centre, Ain Fishing Federation, CPA Works' council) and the noon meals were provided by the site owner.



2. The pond colonised by parrot-feather watermilfoil.

3. Mechanical uprooting by the excavator on a barge.

4. Follow-up manual uprooting from a boat.

5. Green waste produced by the mechanical uprooting in 2017.



- Manual uprooting was not limited to the pond itself. Inspections on the ditches and water courses connected to the pond revealed several new PFW sites that could be uprooted before they colonised the Reyssouze River.
- The years 2017 and 2018 were highly favourable for the growth of PFW due to the temperate winters and long, hot summers. The effectiveness of the uprooting work was relatively limited. In 2018, the plants could develop to the emerged phase between two uprooting sessions.
- Manual uprooting from a boat is not an easy task. The boats were difficult to manoeuvre and the wet plants are very heavy, two conditions that hindered movements about the pond. The participants rapidly showed signs of fatigue.

Information on the project

- The information disseminated on the project and the creation of a warning network covering the entire Ain department are the main positive points of the project. Several articles on the project were published in town bulletins, the local press (*La voix de l'Ain*, *L'Ain agricole*) and a regional newspaper (*Le Progrès*). Thanks to the warning network, a new, colonised site was discovered in July 2018 in Attignat (Ain department).
- Agence France Press sent a team to the site in August 2018 and made the information available to the regional, national and international press. (<https://france3-regions.francetvinfo.fr/auvergne-rhone-alpes/ain/bourgbesse/menace-etangs-ain-plant-invasive-fait-objet-campagne-arrachage-1526910.html>).
- SBVR produced an informational document. Information on the project was also disseminated via the social networks and the internet sites of SBVR and FRAPNA.

Outlook

- Communication with pond owners in the Ain department is an objective that is difficult to implement given the small number of existing networks outside of the Dombes area. Contacts with mill owners were initiated in 2017 and will be pursued in the future.
- Technical meetings were held starting in September 2018 with the Ain Departmental Territorial Directorate, the Departmental Council, river boards and the farming profession to start thinking about a management strategy for invasive aquatic plants in the department.

Authors: Dimitri Mercier, SBVR, and Doriane Blottière, IUCN French committee, for the Resource Centre on invasive alien species. December 2018. Published by the French Biodiversity Agency.

2022 edition



6. The manual-uprooting team on 5 May 2018.
7. The young volunteers from Concordia at work in August 2018.
8. The project displayed on the front page of the local, weekly paper *Le Progrès*.

For more information...

- Informational document on watermilfoil and water primrose, and the Reyssouze bulletin:
<http://syndicat-reyssouze.fr/publications/>
- Articles on the SBVR site concerning the watermilfoil uprooting operations:
<http://syndicat-reyssouze.fr/gestion-myriophylle/> et <http://syndicat-reyssouze.fr/arrachage-myriophylle/>





Water hyacinth

(*Eichhornia crassipes*)

Originated in South America. The plant was introduced for its aesthetic value and is now found in tropical regions around the world.

Description

- A floating, perennial plant, that can reach up to 60 cm in height
- Leaves are arranged in a pseudo basal rosette, have a rounded blade, no hairs and are 3.5 to 16 cm long and 4 to 14 cm wide, with very pulpy stems that serve as floaters
- Sessile flowers, highly odorous, in groups of 4 to 25 on a central stem, light purple in colour with a yellow spot on the upper tepal, the tepals being 3 to 4 cm long and 1.5 to 2.7 cm wide

Ecology and reproduction

- Calm, shallow waters that are high in nutrient content
- Can accept major variations in the water level (it can survive on wet sediment in dewatered areas) and a wide range of pH values (4 to 10)
- Cannot tolerate temperatures lower than 5°C
- Flowering from June to October, at a temperature of 18°C or higher
- Rapid vegetative multiplication (generation of stolons at the base of the leaves)
- Can produce up to 300 tons of biomass (freshly cut) per hectare

Documentation

- Fried G. 2012. Guide des plantes invasives. Belin, Paris, 272 pp.
- Dutartre A. et Rebillard J-P. 2015. Les principaux végétaux aquatiques du Sud-Ouest de la France. Agence de l'eau Adour-Garonne et Irstea, 204 pp.
- Coetzee J. *et al.* 2017. Monographs on invasive plants in Europe n°2 : *Eichhornia crassipes* (Mart.) Solms. Botany Letters, 164 (4) : 303-326.
- CABI. 2017. Invasive Species Compendium : *Eichhornia crassipes* (Water hyacinth). <https://www.cabi.org/isc/datasheet/20544>

Author: Doriane Blottière, IUCN French committee, for the Resource Centre on invasive alien species in conjunction with the overseas IAS initiative. March 2018. Published by the French Biodiversity Agency.

Classification	
Order	Commelinales
Family	Pontederiaceae
Genus	Eichhornia
Species	E. crassipes (Mart.) Solms, 1883





Water hyacinth (*Eichhornia crassipes*)

Managing plant development, including water hyacinth, in the channels of the Yiyi marshes (French Guiana)

Preface

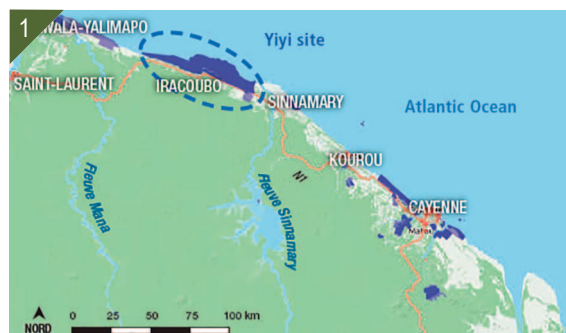
This management report is exceptional in that it deals with managing native plant species in Guiana. Among those species, water hyacinth is a plant deemed alien and invasive in many parts of the world, and it is currently establishing itself in Southern Europe. That is why we found it interesting to document the management of the plants in the the Yiyi Pripris (i.e. the Yiyi freshwater marshes) in order to provide information to managers confronted with the species in parts of the world where it is alien and perhaps also invasive.

Town of Sinnamary and the Sèpanguy non-profit association

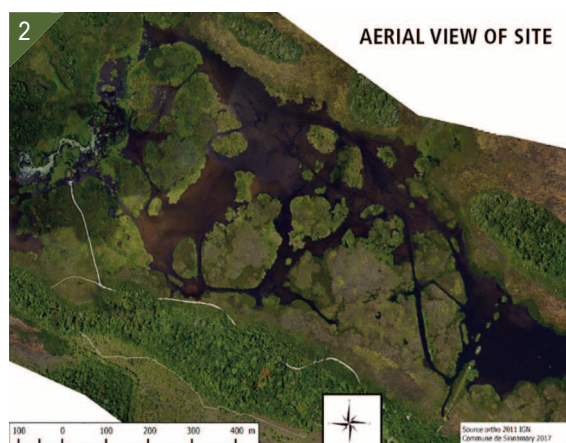
- The town of Sinnamary has been the main manager of the Yiyi wetlands since they were purchased by the Seaside and Lake Conservation Trust in 1996.
- The Sèpanguy non-profit (study, protection and management of nature) has been the co-manager since 2009.
- The Sinnamary House of Nature, founded in 1999, welcomes visitors and informs them on the richness of the various local environments and on the need to protect them. It is also an educational centre for local schools.
- Contact: Charles Bergère, guard and manager of the Yiyi marshes - charles.bergere@ville-sinnamary.fr

Intervention site

- The Yiyi marshes are located along the western section of the Atlantic coast in Guiana between the towns of Sinnamary and Iracoubo.
- No management work has been undertaken on these large wetlands, spanning almost 27 000 hectares, with the exception of a small area comprising 680 hectares where protective measures and efforts to raise public awareness have been launched. An initial management plan initiated in 2007 served to begin the management work and the plan was updated in 2016.



© Conservatoire du Littoral



© Commune de Sinnamary

1. Map showing the Yiyi site.
2. Aerial view of site.

- The marshes are one of eight sites selected among the French overseas territories in the framework of the MANG programme. The objective of this experimental programme is to optimise the management of wetlands in the French overseas territories (<http://www.pole-tropical.org/les-actions-du-pole-relais-outremer/>).
- The managed sector of the Yiyi marshes comprises a set of highly diversified biotopes, e.g. wet savannah, “floating” meadows (called “tremblants” locally), freshwater marshes, mud flats, littoral mangroves, etc. The area is home to exceptional biodiversity, including almost 400 plant species, 127 bird species and 44 mammal species, which led it to being declared a Ramsar zone in 2009.

■ The savannahs are invaded by alien species, but free-standing waters are colonised by native species such as *Cabomba aquatica*, water hyacinth (*Eichhornia crassipes*) and a species belonging to the genus *Utricularia* (*Utricularia foliosa*). The water edges are colonised essentially by a species of helophyte with large leaves, locally called Moucou-moucou (*Montrichardia arborescens*).

Disturbances and issues involved

- The development of these plants leads to the loss of open areas (open water and savannah) and hinders the circulation of water.
- They also create barriers, primarily for canoes used to present the site to tourists.

Interventions

- The management work for aquatic plants spans 200 hectares with the objective of maintaining open channels throughout the site following the departure of the previous occupants (farmers, inhabitants, hunters) and the lower level of human presence due to its protected status.
- The work consists of regularly clearing the plants from the channels before the latter become blocked.
- The equipment used to harvest the plants is a BPH 8, a boat with hydraulic equipment designed by the CDO Innov company, that is only two metres wide for access to narrow areas. The boat can be equipped with either a cutting bar or an uprooting fork equipped with a basket to collect the aquatic plants and any floating debris. The cutting bar is useful for rooted plants, particularly *Cabomba aquatica* and more rarely for a lily species (*Nymphaea rudgeana*) which are then drawn out by the current to the sea. The fork is used to collect submergent plants, such as bladderworts (*Utricularia foliosa*), or surface plants such as water hyacinth, and to deposit them along the banks where the plants are stored to decompose.
- This work is done on a regular basis during the year. The work done by the partners in managing the site (the elected officials from Sinnamary, the Sépanguy non-profit and the Seaside and Lake Conservation Trust) resulted in the drafting of technical specifications for environmental preservation and the creation of a system to monitor the impacts of the cutting and removal of the plants.
- The system aims to assess changes in floristic diversity and in the recolonisation of the channels and deposit areas, and to monitor the populations of fish, birds and capybara (*Hydrochoerus hydrochaeris*), the largest rodent worldwide, in order to determine whether the management work has an impact on biodiversity in the marshes.

Results and costs

Results

- Approximately 6 000 metres of channel are maintained. The image on the next page indicates the work sites in 2013.
- Since the beginning of the management programme, 145 interventions, each lasting approximately two hours, have been carried out.



3. Floating leaves of the *Cabomba aquatica* plant.
 4. Water hyacinth (*Eichhornia crassipes*).
 5. Bladderworts (*Utricularia foliosa*).
 6. Moucou-moucou (*Montrichardia arborescens*) along the edges of channels.
 7. The cutting bar in action.

- The average volume of fresh plants uprooted by the fork and deposited on land is approximately 30 cubic metres per intervention.
- Six deposit sites were used representing approximately 30 square metres each.

■ Costs

Table of intervention costs.

Item	Details	Hourly cost (€)
Fuel	Average consumption per hour: 6 litres of diesel fuel	10
Equipment	Purchase of the machine and transport: 121 462.13 € Depreciation over 8 years, i.e. 15 182.77 € per year (on the basis of 240 operating hours per year)	63
Supplies and maintenance	10% of hourly depreciation cost	6.3
Labour	Operator	13
	Total hourly cost	92.3

■ Assessment of impacts

- The plant demonstrating the strongest recolonisation dynamics in the channels is *Cabomba aquatica*. The intervention method would not appear to encourage the development of water hyacinth, however it remains the primary colonising species in the areas where it dominated prior to the work. The existence of isolated water hyacinth plants in certain parts of the marsh requires enhanced observation of its growth dynamics in the Yiyi marshes. Regular harvesting of the water hyacinth in conjunction with passage of the harvesting boat is advised.
- Regular interventions would appear, however, to be sufficient to keep the two species in check. The recommended intervention frequency is 45 days.
- The work should preferably be done during the rainy season because the organic matter remobilised by the work is carried away from the site, thus avoiding its accumulation in the slower sections where it contributes to the development of invasive plants.
- The deposit sites receiving essentially *Cabomba aquatica* are fairly rapidly colonised by several helophyte species, whereas colonisation is slower on sites where water hyacinth is stored.



8. The fork in action.
9. Deposit zone for water hyacinth.
10 and 11. Photos of the colonised channel before and after the work.



Work sites in November and December 2013.

- The deposits would not appear to modify the overall dynamics of the marsh flora, but would appear to encourage the development of certain significant native species such as *Vigna trichocarpa* (a small plant with yellow flowers from the Fabaceae family) and two orchids, *Habenaria longicauda* and *Eulophia alta*.
- The assessment did not reveal any significant impact of the work on fish populations. Of note is the fact that the assessment discovered five new species on the site, bringing the current list of fish species to 57.
- Concerning birds, the assessment did not reveal any negative impacts, however changes were noted in the behaviour of opportunistic species, due to the expansion of the open-water zones. For example, the passage of sungrebes (*Heliornis fulica*) and anhingas (*Anhinga anhinga*) would appear to have increased, resulting in more regular observations on the site. In addition, the deposit sites serve as migratory stations for Charadriiform birds (waders) such as the spotted sandpiper (*Actitis macularius*) and the solitary sandpiper (*Tringa solitaria*), and also benefit opportunistic species such as the wattled jacana (*Jacana jacana*) and the striated heron (*Butorides striata*).
- Finally, it was not possible to assess the impact of the work on the capybara populations, but it may be advisable to limit the use of the boat in areas where there are clear signs that the species is present.

Information on the project

- An informational document on the management work undertaken to control the development of the aquatic plants was posted at the end of 2014 on the internet site of the Wetland Centre for Overseas Territories (<http://www.pole-tropical.org/>).
- Information on the management of the Yiyi marshes is also available on the internet site of the Sinnamary House of Nature.

Outlook

- In addition to pursuing the regular maintenance work, one possibility would be to restore other aquatic areas in view of developing ecotourism on the site, an effort already undertaken by the Sinnamary House of Nature.
- The impact assessment of the work could include long-term monitoring of the deposit areas (accumulation of organic matter, plant recolonisation, changes in fauna) and address the reptile and amphibian communities in the maintained open-water areas and the deposit areas. Funding must be found for this work.

Authors: Charles Bergère, Town of Sinnamary, Clément Lermyte, Biotope, Alain Dutartre, independent expert, and Doriane Blottière, IUCN French committee, for the Resource Centre on invasive alien species in conjunction with the overseas IAS initiative. July 2018. Published by the French Biodiversity Agency.

2022 edition



12. A channel cleared of invasive plants.

For more information...

- Site of the Sinnamary House of Nature: <http://www.sepanguy.com/site/maison-de-la-nature>
- Lermyte C. 2015. Suivis scientifiques liés au programme de faucardage des Pripis de Yiyi. Service Environnement de Sinnamary. Rapport Biotope, 40 pp.
- Facebook page devoted to the work in the protected natural area of the Yiyi marshes: <https://www.facebook.com/Pripideyiyi/>
- Brochure on the management programme for the Yiyi marshes prepared by the Seaside and Lake Conservation Trust: www.conservatoire-du-littoral.fr/publications_liste/102/10-publication.htm
- Impact Mer, Hydero, BIOS. 2016. Plan de gestion simplifié des Pripis de Yiyi – État des lieux et diagnostic – version finale actualisée. Rapport pour le Conservatoire du littoral, 92 pp.
- Impact Mer, Hydero, BIOS. 2016. Plan de gestion simplifié des Pripis de Yiyi – Enjeux, objectifs et plan d'actions – version finale actualisée. Rapport pour le Conservatoire du littoral, 101 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	Hydrocotyle
Species	<i>Hydrocotyle ranunculoides</i> (L. f., 1782)





Water pennywort

(*Hydrocotyle ranunculoides*)

Managing water pennywort in the village of Beaumont-Pied-de-Bœuf (Sarthe)

Loir-Lucé-Bercé intermunicipal board (CCLLB)

- The CCLLB covers a territory with over 25 000 inhabitants in 24 towns, including Beaumont-Pied-de-Bœuf where the first cluster of water pennywort in the Sarthe department was found.
- The CCLLB has been in charge of managing aquatic environments and flood prevention (GEMAPI) since the first of January 2018 and recently launched an initial diagnostic study of its territory which includes the northern tributaries to the Loir River in the Sarthe department.
- The CCLLB was assisted, in the framework of the "Early detection - Fast reaction" system of the IAS (invasive alien species) network set up by the Pays-de-la-Loire region, by the Pays-de-la-Loire nature conservatory (CEN) and the National Botanical Conservatory in Brest (CBNB) in managing this initial colony.
- Contact : Guillaume Chapin, Gemapi technician - guillaume.chapin@loirluceberce.fr

Pays-de-la-Loire nature conservatory (CEN)

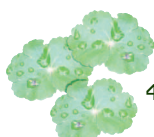
- Since 2016, the Pays-de-la-Loire nature conservatory (CEN) has been the leader of the Pays-de-la-Loire IAS regional network, the first such regional network created in France (2001) to enable the stakeholders involved in IAS issues to discuss how to manage IASs.
- Its main mission is to organise the network and to pool the available expertise in view of managing IAS issues in conjunction with the national IAS strategy and the strategy implemented by the Loire-Bretagne river basin.
- The CEN implements an action programme in close conjunction with an array of partners.
- It is the regional IAS coordinating entity and provides nature managers and local governments with operational solutions by pooling expertise and means on the regional level.
- Contacts : Guillaume D'hier - g.d-hier@cenpaysdelaloire.fr ; Emmanuel Leheureux - e.lheureux@cenpaysdelaloire.fr



1 - Intervention site.

National botanical conservatory in Brest (CBNB)

- The CBNB provides the Pays-de-la-Loire CEN with technical and scientific assistance in leading the IAS regional network.
- It drafts detailed alert documents intended to facilitate the identification and reporting of emergent IAS plants by people in the field and assists in setting up rapid management procedures.
- It assisted in the current project during the inspections to identify the water pennywort and in setting up the management protocols for the invasive species.
- Contact : Dortel Fabien - f.dortel@cbnbrest.com



Intervention site

- The site is located in the village of Beaumont-Pied-de-Bœuf (Department 72), at the place called Pied-de-Bœuf.
- The cluster of water pennywort was situated in the upper river basin of the Loir River, in the Yre River. It covered a distance of 230 metres, plus another 70 m in a tributary stream that constitutes the most upstream colonised section.
- The species was detected and identified in the beginning of August 2018 by a volunteer agent for the CBNB. The water pennywort was the dominant species over the entire distance of the site and even covered the entire width of the river in some sections. At the site, the Yre River runs along pastures and there is a ford for the cattle to cross. The cattle can also access the river via two watering pools created by the farmer.
- The colony of water pennywort was located near the "Narais, Bercé, Dinan" Natura 2000 zone. The site was the only site colonised by water pennywort upstream of the town of Château du Loir. Some downstream sections of the Yre River to the point of confluence with the Loir River are not conducive to colonisation by water pennywort (fast currents, continuous riparian vegetation).

Disturbances and issues involved

- A colony of *Hydrocotyle ranunculoides* can have highly negative impacts on biodiversity. The river banks are home to a succession of diversified vegetation with a high level of species richness (strings of wet meadows, megaphorbias, sedge wetlands and pioneer reed beds comprising yellow iris). In the water, they are replaced by "floating meadows" of watercress, wideleaf water parsnip and fool's watercress, as well as by beds of horned pondweed. Together, they constitute a favourable habitat for the southern damselfly (*Coenagrion mercuriale*), a species protected on the national level, listed in Annex 2 of the European Habitats directive, but also a decisive ZNIEFF species in the Pays-de-la-Loire region and recently observed on the intervention site. The replacement of the existing communities by a single-species colony of water pennywort would represent a considerable loss of diversity for the environment and could threaten the southern damselfly.
- This was the first colony located in the upper section of a river basin in the Pays-de-la-Loire region. The other known colonies are located near the Atlantic coast and in the Loir Valley. It is an emerging species in the region and the clear objective was to avoid colonisation of virgin territories and its permanent installation.
- A development of the species could have significant socio-economic impacts in various sectors:
 - some farmers are already familiar with the negative impacts of certain IASs such as water primrose on yields (Brière marshes). If a new IAS were to colonise the area, the agricultural land could simply be abandoned;
 - dispersal of water pennywort via hydraulic vectors must be taken into consideration because management costs could rise steeply if the species were to spread widely;
 - if the species were to proliferate, it could hinder and even render impossible recreational activities (fishing, water sports and activities, etc.) on the Yre River and further downstream on the Loir River.



2 - Meadow along the Yre River at the intervention site.

Interventions

■ Discussions with the local partners

■ A technical committee (Cotech) was rapidly set up by the CEN in order to assess the risks, communicate on the management objectives and establish an operational plan of action. The committee includes the Sarthe Departmental Council, the Departmental Territorial Directorate (DDT), the French Biodiversity Agency (OFB), the Chamber of Agriculture, the CCLLB, the land owner, the farmer, the mayor of Beaumont-Pied-de-Bœuf, the CEN, the CBNB, the Loir Public River-basin Territorial Agency, the Loire-Bretagne Water Agency and the Fishing Federation (FDPMA 72).

■ Objectives

- The objective on all the colonised sites was to uproot all detected water pennywort, including the stolons, i.e. eradicate the plant in order to preserve the wet and floating meadows on the site. To attain that objective, it was necessary to:
- gain knowledge on the dispersion zone of water pennywort in order to confirm its effective installation on the site;
 - avoid its dispersal downstream in the river and generally in the river basin;
 - avoid the growth/dispersal of plant cuttings;
 - push back against the forward edge of the colonised zone and if possible totally eradicate the species on the intervention site.

■ History

The river was inspected over a distance of 20 kilometres. It was divided into five sections, each 3 to 6 km long, and inspected by teams of two people.



3 - Removing the nets intended to catch any fragments and cuttings following uprooting of plants.

4 - Map of the area inspected for water pennywort. (Source: PdL CEN)

Table 1. List of events.

2018	August	Species reported by the CBNB.
	December	Activation of the "Early detection - Fast reaction" system for inspection and definitive identification of the species by the CBNB and the CEN.
2019	May	Drafting of the management protocol subsequently approved by the French Biodiversity Agency (OFB) and the Departmental Territorial Directorate (DDT).
	June	Inspections to precisely determine the distribution zone of the water pennywort, starting from the village of Beaumont-Pied-de-Bœuf downstream to the town of Château du Loir, then along the Loir River to the town of Vaas. No other clusters were detected.
	July	Manual uprooting and stripping of the heavily colonised sectors in Beaumont.
	August	Second uprooting operation to remove all visible plants, followed by an inspection to eliminate any new sprouts.
	September	Installation of an electric fence to block access of cattle and wild animals to the river.
	October	Inspections and uprooting of sprouts, discovery of a few plants 100 metres downstream of the known cluster.
	November	Inspections and uprooting.
	November	Inspections and uprooting.
2020	March	Inspection of the intervention site, one sprout observed and uprooted.
	May	Inspections and uprooting, six sprouts uprooted (rhizomes and stalks 20 to 50 cm long).
	June	Inspections to precisely determine the distribution zone of the water pennywort along the Yre and Loir Rivers, down to the town of Vaas. No other clusters were detected.
	July	Monitoring and uprooting, 7-8 sprouts uprooted (rhizomes and stalks 20 to 50 cm long).
	August	Monitoring and uprooting. Discovery of a few sprouts over the entire intervention site.
	September	Monitoring and uprooting. Discovery of a few sprouts over the entire intervention site.
	September	Second Cotech meeting on water pennywort in Beaumont. Field trip (no sprouts detected) and discussion of future objectives for the plan of action.
	October	Monitoring. Mowing of banks not grazed and trampled in 2020. No sprouts observed.

■ Intervention techniques

■ Installation of nets downstream of the intervention site to catch any fragments of water pennywort carried off by the current:

- prior to uprooting, a net was installed downstream of the cluster to catch any fragments and cuttings;
- a second net was installed between the two parts of the colonised site, i.e. at the confluence of the Yre and its tributary;
- finally, prior to removing the first two nets, a third was installed downstream and left in place for 24 hours to catch a maximum of green waste and avoid the dispersal of fragments and cuttings.

■ Uprooting the beds of water pennywort:

- careful manual uprooting was done progressively from downstream to upstream by removing the leaves without pulling on the stalks, in order not to break the stolons;
- the stolons were then extracted from the mud as completely as possible, though in some cases they did break. Use of a pull fork was occasionally necessary in heavily colonised sectors to remove clumps of soil and reach deeper stolons;
- unfortunately, uprooting using a pull fork is less precise than manual uprooting and other plant species may be unintentionally removed. However, the end effect was negligible because the indigenous species grew back quickly after the work.

■ Precautions taken to avoid dispersal:

- personnel made efforts to avoid trampling colonised sites in order not to disperse the species via their boots;
- all equipment and tools were cleaned after use;
- a fence was installed to block cattle from trampling the colonised sectors. Trampling of the soil by cattle results in an area becoming muddy and conducive to the establishment of water pennywort. It also makes the spread of indigenous species more difficult.

■ Waste management

■ The uprooted water pennywort was removed from the site and transported in a dump truck covered with a tarp to a composting unit.

Results and costs

■ 2019

■ The work was done on the entire length (almost 300 metres) of the colonised area, however new sprouts reappeared in some places, but were apparently dominated by the indigenous species.

■ No floristic monitoring was undertaken to precisely determine the improvement of the ecological status of the site, however the personnel observed expansion on the treated site of indigenous species similar to those present prior to the colonisation by the water pennywort. This good result was probably due to the rapid launch of the management operations (early detection - fast reaction) and to the resilience of the river banks.



5 - Uprooting using a pull fork.
6 and 7 - Sections of the Yre River in August (6) and September 2019 (7), following the uprooting work.

■ 2020

■ The seven sessions of inspections, uprooting and monitoring in 2020 resulted in a clear reduction of the species. The banks that were completely covered in 2019 by a single-species colony of water pennywort were virtually free of the species, except for a few sprouts. This would appear to be due not only to the work done over the two years, but also to the fact that the cattle no longer had access to the river banks and bed. The installation of a fence may be considered an effective means to avoid the propagation of water pennywort.

A few sprouts were detected and removed in areas where the river banks were the most severely degraded upstream of the colonised section, as well as in a few sectors that continued to be trampled by the cattle (the ford crossed by the livestock).

■ Costs

Table 2. Costs incurred by the plan of action in the years 2019 and 2020.

2019		2020	
Item	Cost (€ incl. VAT)	Item	Cost (€ incl. VAT)
Management, meetings, logistics (6 days x 564 €)	2 892	Management, meetings, logistics (4 days, 2 x 450 € and 2 x 564 €)	2 028
Inspection, diagnosis (5 days, 2 x 450 € and 3 x 564 €)	2 592	Inspection, diagnosis (5 days, 2 x 450 € and 3 x 564 €)	1 464
Manual uprooting (17 days, 8 x 450 € and 9 x 564 €)	7 548	Manual uprooting (17 days, 8 x 450 € and 9 x 564 €)	7 548
TOTAL	13 032	TOTAL	11 040
TOTAL OPERATIONS 2019-2020	25 692		

Table 3. Funding provided by each organisation in 2019 and 2020.

Organisation	Funding (€) in 2019	Funding (€) in 2020
LLB intermunicipal board	5 500	4 500
Pays-de-la-Loire CEN	6 524	5 412
CBNB	1 128	1 128
Total funding 2019-2020	13 152	11 040

Information on the project

■ The work done in 2019 and 2020 has been presented in numerous symposia and meetings of the Pays-de-la-Loire IAS network. There are currently plans to highlight the project as a textbook case of the "Early detection - Fast reaction" system of the regional network. Further efforts to communicate and showcase the project will depend on the results of the upcoming dissemination campaign.



8 - Detection of sprouts in the most upstream section of the cluster in August 2020.
9 - Regrowth of indigenous species along the fence.

Outlook

- The sections of the river banks near the watering pools and the ford continue to be trampled by the cattle. It will be necessary to preserve these areas from this disturbance.
- During the Cotech meeting held in September 2020, it was decided to re-orient the management programme toward a complete renaturalisation of the river, including a return to the original bed and the re-creation of meanders, in the framework of the GEMAPI policy. This proposal was approved by the Water Agency and will include the creation of a suitable watering spot. Made of stone, the watering spot will avoid trampling of the river banks by the cattle and the disturbed soil that is conducive to the installation of water pennywort.
- To make sure that the vegetation on the river banks does not return to scrub and eventually to riparian forest, the banks will be mowed each year at the end of the summer season. In 2020, they were mowed on 16 October.
- Management work targeting the preservation of a diversified hydrophilic strip along the river, a factor favourable to biodiversity, may be undertaken in an effort to go beyond simply eliminating the water pennywort. That work may consist of annual mowing and removal of the waste.

Authors: Guillaume d'Hier, Pays-de-la-Loire CEN, Clara Singh, IUCN French committee, for the Resource Centre on invasive alien species. April 2021. Editor: French Biodiversity Agency.

2022 edition



10 - Coenagrion mercuriale detected on intervention site.

For more information

- CEN PdL, CBNB, 2019. Managing water pennywort in Beaumont-Pied-de-Bœuf (72), IAS network of the Pays-de-la-Loire region, 43p. (In French).





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



Himalayan balsam

(*Impatiens glandulifera*)

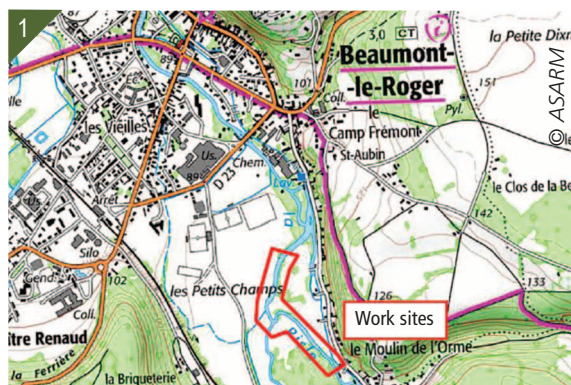
Manual eradication of Himalayan balsam on several sites along the Risle River (Eure department)

Official river board for the mid-Risle River (ASARM)

- ASARM is a public administrative agency that federates the land owners, the 18 towns and the three intermunicipal boards along the mid-section of the Risle River and its tributaries. The river board works to maintain and restore aquatic environments, and in general coordinate river management in the public interest and with a view to reconciling uses.
- In the framework of its mission to preserve, restore and valorise the river and wetlands, the river board is also in charge of managing any invasive alien species present in the board's territory.
- Contact: Régis Royer, administrative and technical manager – regis.royer@asa-risle.fr

Intervention site

- The Risle originates in the Perche hills and flows to the Seine estuary. The section managed by ASARM comprises 110 km of the Risle and its tributaries.
- The intervention sites were located on the banks of the mid-section of the Risle, primarily in the town of Beaumont-le-Roger.
- A field inspection in September 2015 revealed the presence of several stands of Himalayan balsam. The colonised areas consisted of wet meadows, megaphorbias and a small number of wooded areas. Two main sites (approximately 1 500 and 1 800 square metres) were identified where the balsam is the dominant species, as well as some 20 smaller sites located downstream and consisting of between a few and 30 plants. An additional inspection was run on the upstream section of the territory managed by ASARM.
- The sites were located on the property of several land owners. An agreement authorising the work was signed between ASARM and the land owners.



Change in colonised sites from September 2015 to October 2018.

● 2015 ● 2018

1. Main work sites.
2. Spread of colonised sites.

Disturbances and issues involved

- Due to its rapid growth and high reproductive capabilities, balsam is detrimental to the native vegetation.
- In addition, the weak root system and annual nature of the plant may result in weakening of the river banks and greater erosion.

Interventions

- Following the discovery of the species, an initial work site involving volunteers was set up in September 2015 to limit the propagation of seeds downstream and subsequent new colonies of the plant.

- The inflorescences containing the seed capsules were gathered manually by some ten volunteers and burned.
- The volunteers included local people, anglers and kayakers who responded to a call made to ASARM members. This work took place one week after the discovery of the colonised sites and lasted one and a half days. Costs were covered by ASARM.
- In 2016, a new work agreement was signed between the concerned land owners and ASARM.
- In parallel, ASARM launched a partnership with the Social-Reintegration Centre (CIAS), an organisation run by the Bernay Terre de Normandie intermunicipal board, to set up a work site to uproot the plants and attempt to eradicate the species from the area.
- The uprooting team, comprising ten people equipped with gloves and waders, moved in a line along the banks and in the water to detect a maximum number of plants.
- Manual uprooting was made easier due to the weak root system of the plants. Following uprooting, the stems were broken in pieces and the plants stored in sealed plastic bags. The green waste was then transported to an incineration centre.
- Five days of work (four in July and one in September) were required in 2016 to uproot all the balsam plants that had been detected.
- From July to October, additional inspections were run on the worksites and in the Risle, ranging from the town of Vieille-Lyre (where a stand of balsam was found in a garden) to Nassandres on the Risle to detect any further colonies. The inspections revealed the presence of isolated, individual plants downstream of Beaumont-le-Roger.
- During the summers of 2017 and 2018, the inspections were continued, in part by the participants from the CIAS (2.5 days on the two main sites) and the rest by ASARM personnel.

Results and costs

■ Results

- Between 2015 and 2018, a total of more than 8 000 balsam plants were uprooted and incinerated, primarily in the framework of the first uprooting campaign in 2016. The plants represented an uprooted surface area of over 3 300 square metres and 890 kilogrammes of biomass.
- The inflorescences cut in 2015 weighed 340 kg.
- In 2017, approximately 100 plants on the two main sites were discovered and uprooted. No balsam plants were found on the isolated sites. In 2018, only a dozen isolated plants were found on one of the two main colonised sites and were uprooted.

■ Costs

Funding information.
The expenditures consisted of the daily salaries of the CIAS personnel, various equipment (bags, gloves), rental of a dumpster and incineration of the plants. ASARM assumed all in-house costs incurred for inspections and monitoring.

Funding entity	Percentage of total	Amount (in euros incl. VAT)
Seine-Normandie water agency (AESN)	80	3 198.00
ASARM	20	978.80
Total	100	4 176.80



3, 4. Balsam plants on the banks of the Risle River.
5. One of the two main balsam sites.
6. Cutting the balsam inflorescences.

Man-days spent on the project.

	2015	2016	2017	2017
ASARM personnel	3 people 10 days	3 people 10 days	3 people 10 days	3 people 10 days
Volunteers	10 people 1.5 days			
Work by a social-reintegration group		10 people 5 days	8 people 2.5 days	8 people 2.5 days

Information on the project

- A video on the work was made by the Normandie Regional Environmental Agency (AREN).
(https://www.youtube.com/watch?time_continue=21&v=KolrYzp-dpA)
- The operation was also presented to elected officials and local-government personnel during a technical workshop organised by AREN in Rouen on 19 October 2017.
- ASARM produced a poster on Himalayan balsam.
(<http://www.asa-risle.fr/wp-content/uploads/2016/03/POSTER-INVASIVES-BALSAMINE-ASARM.compressed.pdf>)
- The annual meetings of local residents were also an occasion to raise awareness of the problems caused by Himalayan balsam and by invasive alien species in general.

Outlook

- Following the four years of work, Himalayan balsam has virtually disappeared from the mid-section of the Risle.
- Monitoring of the intervention sites and any necessary uprooting will be pursued by ASARM during the flowering period (July and August). The small number of plants observed in 2018 confirmed the effectiveness of the work and lent weight to the prospect of totally eradicating the species from the area.

Authors: Régis Royer, ASARM, and Doriane Blottière, IUCN French committee, for the Resource Centre on invasive alien species. July 2019. Published by the French Biodiversity Agency.

2022 edition



7, 8, 9. Manual uprooting of Himalayan balsam.
10. Inspections along the Risle River.

For more information...

- ASARM. 2018. Control programme for Himalayan balsam (2015-2018). Management report. 2 pp. (In French)



Hottentot fig

(*Carpobrotus* sp.)

Originated in South Africa and was imported to Europe during the 1900s for ornamental purposes and to stabilise soil against erosion.

Description

- Perennial, succulent plant, either creeper or overhanging on cliffs, that forms large beds
- V-shaped, pulpy leaves, opposing, green to red in colour, 8 to 11 cm long and 8 to 13 mm thick, with the cross section forming an equilateral triangle (*C. edulis*) or an isosceles triangle (*C. acinaciformis*)
- Single flowers at end of stalk, linear petals that are yellow (*C. edulis*) or purplish pink (*C. acinaciformis*), 5 to 12 cm in diameter
- Pulpy fruit, fig shaped, edible, with many seeds in a very sticky mucilage

Ecology and reproduction

- Littoral, rocky or sandy areas, e.g. dunes, back sides of dunes, cliffs, rocky slopes
- Flowering in the beginning of spring (March to May), self-pollinating or cross-pollinating due to pollinating insects
- Dispersal of fruit via endozoochory (vertebrates) or myrmecochory (ants)
- Vegetative multiplication via layering or cuttings
- Hybrids between the two species are possible

Documentation

- Lamand F. (ed.), 2015. Invasive alien species in aquatic and related environments in continental France. Set of identification sheets. Onema. p. 35-36. (In French)
- Haury J. and Clergeau P., 2014. Invasive species in Brittany, continental vertebrates and plants. AgroCampus Ouest and MNHN. p. 45-46. (In French)
- Muller S. (ed.), 2004. Invasive plants in France. MNHN, Paris, 168 p. (In French)
- Fried G., 2012. Guide to invasive plants. Éditions Belin, 272 p. (In French)

Authors: Doriane Blotti re, IUCN French committee, for the Resource Centre on invasive alien species. October 2019. Published by the French Biodiversity Agency.

Classification	
Order	Caryophyllales
Family	Aizoaceae
Genus	Carpobrotus
Species	<i>C. edulis</i> ((L.) N.E.Br, 1926) <i>C. acinaciformis</i> ((L.) L. Bolus 1927)





Hottentot fig

(*Carpobrotus edulis*)

Managing Hottentot fig on the Natura 2000 sites of the islands of Ouessant, Molène and Sein

Armorique regional nature park (PNRA)

- PNRA is the second regional nature park to have been created in France. It covers an area of 125 000 hectares and comprises 44 towns in the Finistère department, ranging from the islands in the Iroise Sea to the heathlands and peat bogs east of the Monts d'Arrée hills.
- Its missions are laid out in its 2009-2023 charter targeting "desired landscapes in Amorique". PNRA manages seven Natura 2000 sites, including the terrestrial parts of the islands in the Iroise Sea, and it is for this reason that it also manages the invasive alien species on the islands.
- Contact: Agathe Larzillière, PNRA biodiversity policy officer - agathe.larzilliere@pnr-armorique.fr

Intervention site

- Management work takes place on the islands of Ouessant, Molène and Sein. The islands are listed as Natura 2000 sites (FR 5300018 Ouessant – Molène and FR 5302007 Chaussée de Sein). They are also listed as biosphere reserves (UNESCO).
- A number of habitats of Community interest may be found on the islands, including vegetation of drift lines with sea beets (1210), vegetated crevices in sea cliffs with rock samphire (1230), salt-tolerant grass (1230), dry heaths with western gorse and bell heather (4030), etc.
- There are also several species of Community interest, including sea kale (*Crambe maritima*), shore dock (*Rumex rupestris*), and protected species, including least adder's-tongue (*Ophioglossum lusitanicum*), land quillwort (*Isoetes histrix*), etc.
- Inventories carried out on the three islands have revealed that emblematic shore habitats have been colonised by a number of invasive alien species, including Hottentot figs (*Carpobrotus edulis*).



Position of the three islands off the coast of Brittany.

Disturbances and issues involved

- Hottentot figs colonise cliffs, dry heaths and swards of salt-tolerant grass. They enter into competition with and can supplant the local flora, including protected species such as least adder's-tongue and land quillwort. The result is a loss of plant biodiversity.

Interventions

- On easily accessible sites, the objective is to eliminate the species. Along cliffs, the objective is to avoid colonisation of the swards of short grass.
- On the accessible sites, the management technique employed is to manually uproot each plant. The stalks can be fairly easily uprooted by gripping the base of the plant. The waste is put directly into a bag to avoid dissemination.
- Once all the plants have been removed from a site, the dead leaves of the plant on the ground are collected using a rake. It is important not to leave any plant fragments on the site because the species sprouts easily.
- Special equipment (see the Costs section) is required for work along cliff edges to ensure safe work conditions and avoid any risk of a fall. Workers using a harness and rope tied the other end of their rope to a vehicle (three people maximum for a light truck) or to a large rock. The objective is to remove all Hottentot figs from a strip three metres wide along the cliff edge. The same manual uprooting technique is used and the waste is placed directly in bags once uprooted.

■ Ouessant Island

■ In the summer of 2015, an inventory of the colonised areas listed 86 Hottentot-fig sites covering a total surface area of 23 000 square metres, most of which were difficult to access.

■ Only two sites were easily accessible on the island and they were treated in 2012 and 2016. The first was small (one square metre). A park employee uprooted the plants in 2012. This work took about two hours. In 2016, a social-reintegration group was brought in to handle the second site (approximately five m²). Eight people worked for two hours to uproot the plants.

■ In both cases, the plants were stored on a special platform in a disposal centre and subsequently burnt.

■ The two sites are monitored annually and any new sprouts are eliminated.

■ A map setting priorities for work on sites along cliffs was established, based on criteria concerning habitats and flora.

■ Sein Island

■ In 2013, in the framework of an information campaign on invasive plants for the general public, a participatory effort was organised to uproot Hottentot fig from an area ten square metres in size. This work occupied six people for four hours. Subsequently, the park employee based on the island since 2015 eliminated virtually all the Hottentot-fig plants remaining on the island. The uprooted stalks were disposed of with standard household waste.

■ The employee also monitored the treated sites once annually for a period of three years.

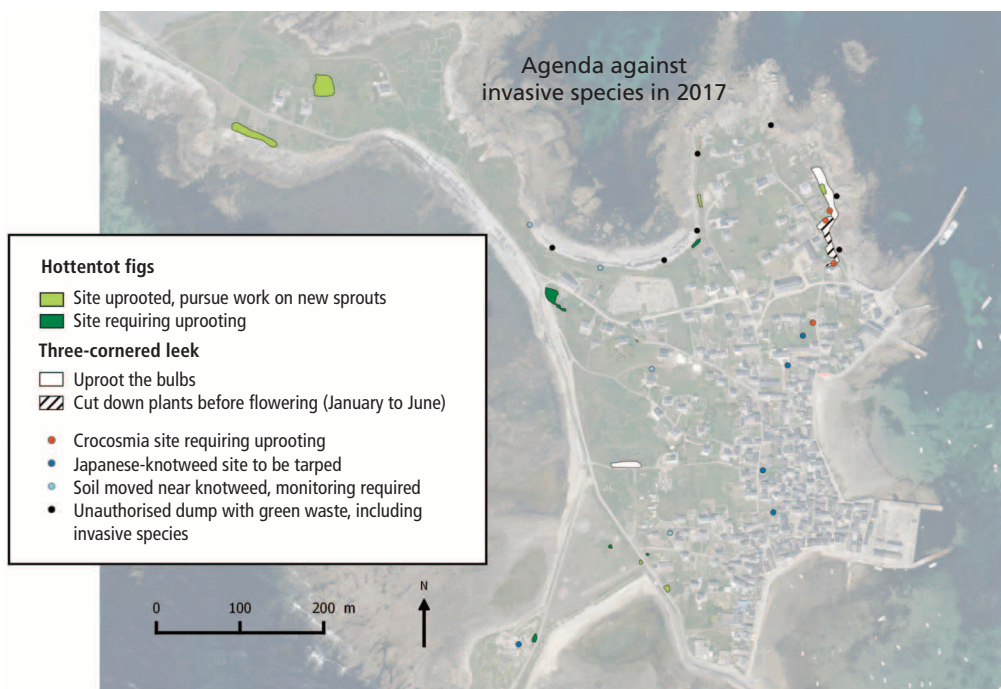
■ This uprooting and monitoring work over three years, for a total surface area of approximately 1 500 m², required a total of 140 hours.

■ Molène Island

■ In 2014, Hottentot-fig plants on two sites representing a total of 15 m² were uprooted by volunteers in the framework of a European exchange programme. The work occupied approximately 15 young people over two days.



1. The Hottentot fig (on the right) is a threat to the swards of salt-tolerant grass comprising least adder's-tongue and land quillwort, two very rare species.
2. Uprooting Hottentot-fig plants on Ouessant.
3. Uprooting Hottentot-fig plants on Molène.



Map of uprooting sites on Sein in 2017. Agathe Larzillière, PNRA.



■ During the management operations, a test was run on the results when the litter (dead leaves, etc.) was collected with the plants or left behind. When the litter was removed, the original flora redeveloped, however numerous Hottentot-fig seedlings also sprouted. When the litter was not removed, brambles developed. Currently, the litter is removed from all sites. This required regular monitoring over three years to eliminate any new sprouts.

Results and costs

■ Results

Number of sites and uprooted surface areas on each island.

	Number of sites	Surface area treated (square metres)	Time spent (hours)
Ouessant	2	10	4
Sein	22	1500	140
Molène	2	15	12

■ Inspections are run monthly on the sites to eliminate any new sprouts. This work takes approximately one to two hours per month on each island. Over time, a reduction in the number of new sprouts has been observed.

■ Costs

■ The cost of the uprooting work by volunteers was not calculated. It did not require any specific equipment with the exception of the plastic garbage bags.

■ The cost of uprooting work by salaried employees was estimated at between 15 and 30 euros per hour, depending on the employee.

■ The special equipment for the work along cliff edges comprises the following (per person):

- 1 harness (EU standard EN361);
- 1 static rope, 60 metres long, diameter 11.5 mm;
- 1 fall arrester sized for the rope diameter;
- 3 carabiners minimum (EN362);
- 1 safety helmet;
- 1 big bag;
- 3 slings (loops), EN795 class B, 80 cm, 1.20 m and 1.50 m long;
- 4 metal stakes, one meter long each, and a sledge hammer.

The total cost of the special equipment for one person is approximately 300 euros.

■ For the work on Ouessant by the social-reintegration group, a partnership agreement was signed between the Landscape and Horticultural Association in Saint-Grégoire (35), PNRA and the town of Ouessant. In the agreement, PNRA provided funding for lodging up to 2 000 euros for five days. Given that the work on Hottentot figs lasted only one half-day, the cost was 200 euros.

Information on the project

■ Reports on the work were made during the meetings of the management committees of the island Natura 2000 sites in the park and were made available to the public via the PNRA internet site.

■ Articles published in the municipal bulletins made the information available on the local level.

■ The organisation of participatory work sites, where the conditions allow, served to raise awareness in the local population and enable people to become active stakeholders in the preservation of natural areas.

Outlook

- On Ouessant, photo surveys are run every five years on a number of sites on the Stiff cliffs (NW part of the island) to monitor the colonisation speed of Hottentot figs and one particular site is monitored to determine the colonisation speed on a sward of salt-tolerant grass comprising least adder's-tongue and land quillwort. Work has been planned on priority sites along cliff edges starting in 2020.
- On the islands of Molène and Sein, treated sites are monitored annually. In the meantime, other sites have been discovered and are systematically treated by personnel or with the assistance of volunteers.
- PNRA also undertakes management work on other invasive alien species on the islands, including three-cornered leek (*Allium triquetrum*), Japanese-knotweed (*Reynoutria japonica*), pampa grass (*Cortaderia selloana*), etc.

Authors: Harmonie Coroller, Agathe Larzillière, PNRA, and Doriane Blottière, IUCN French committee, for the Resource Centre on invasive alien species. October 2019. Published by the French Biodiversity Agency.

2022 edition

For more information...

- PNRA. 2010. Document presenting objectives for the Natura 2000 sites Ouessant-Molène and Chaussée de Sein, 608 pp. (In French)
- Ecological and naturalist monitoring on the terrestrial sections of Natura 2000 site FR5300018, Ouessant Island, reports for the years 2014, 2015, 2016, 2017. (In French) Documents available on request.



Hottentot fig

(*Carpobrotus edulis*, *Carpobrotus acinaciformis* and their hybrid)

Management of Hottentot fig on several sites in Finistère and Côtes-d'Armor

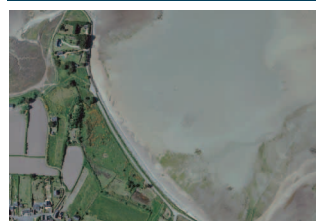
Association of Managers of Breton Natural Areas (AGENB)

- Association created in 2016 as project operator of the Network of Managers of Breton Natural Areas (AGENB).
- Its actions are based on two areas of intervention:
 - optimising the management of natural areas by networking stakeholders;
 - supporting projects in favour of natural areas.
- In 2019, AGENB received a trainee to draw up an inventory of the presence of Hottentot fig species in Brittany (distribution of the three taxa, abundance of populations, habitats colonised, management implemented and formulation of guidelines for the management of the species).
- The management of the AGENB was transferred to the Breton Biodiversity Agency in 2020.
- Contact: Maud Bernard, Breton Biodiversity Agency - maud.bernard@biodiversité.bzh.

National Botanic Conservancy of Brest (CBNB)

- A local public institution created in 1987 which has the legal status of a local authority grouping.
- As independent scientific and technical contact persons, the national botanic conservancies carry out their knowledge enhancement, conservation, consultancy and awareness-raising remits for local authorities, professionals and citizens.
- As part of the management of invasive alien species (IASs), the CBNB is assigned by its various public partners to:
 - monitor the distribution of invasive plants in the area for which it is responsible;
 - put forward and keep up-to-date the lists of invasive species so as to support and guide public policies on biodiversity conservation: identify species requiring management, regulatory and/or informative and prevention measures to slow their spread; prioritise IAS works, in agreement with the existing regional invasive species monitoring committees.
- The CBNB contributed to the supervision of the course.
- Contacts: Agnès Lieurade - a.lieurade@cbnbrest.com, Eva Burquin - e.burquin@cbnbrest.com

Intervention site



1 - Chemin du Sillon noir



2 - Ploumanac'h



3 - Îlot aux vaches



4 - Île Callot



5 - Pointe du Dibennou



6 - Cap de la chèvre



7 - Postolonnec



8 - Saint-Nicolas-des-Gléan

1 - Map of intervention sites Source: CBNB.

- Due to their significant presence on the Breton coast, management work on these species has been carried out on many sites have been the subject of and this feedback on experience covers 8 of them, located in 7 communes.
- In Brittany, Hottentot fig species develop in dune habitats, high on pebble beaches and on cliffs. The technical itineraries and complexity of the worksare determined by the accessibility of the colonised areas.

Accessibility of different worksites

Sites	Towns	Accessibility
Chemin du Sillon noir	Pleubian (22)	Easily accessible
Landrellec-îlot aux vaches	Pleumeur-Bodou (22)	Easily accessible
Ploumanac'h	Perros-Guirec (22)	Easily accessible
Île Callot	Carantec (29)	Easily accessible
Île de Saint-Nicolas dans l'archipel des Glénan	Fouesnant (29)	Easily accessible
Pointe de Dibennou	Guissény (29)	Easily accessible
Postolonnec	Crozon (29)	Not accessible without equipment
Cap de la Chèvre	Crozon (29)	Not accessible without equipment

Disturbance and issues involved

- In Brittany, Hottentot fig species are mainly found in Habitats of Community Interest (EU 2110, EU 2120, EU 1230, EU 1220). They strongly modify the floristic composition of the plant communities characteristic of these habitats and thus affect their conservation status.
- Stands of plant species with high natural heritage value may be impacted, particularly those characterised by the presence of *Crambe maritima*, *Eryngium maritimum*, *Isoetes histrix* or *Ophioglossum lusitanicum*.
- Hottentot fig can alter the physico-chemical balance of soils through the emission of tannins and antibacterial substances causing their acidification and an increase in their nitrogen concentration. The hydrological characteristics of invaded soils can also be modified and become less favourable to native species and more conducive to establishment of alien species. This can also have a decisive impact on revegetation following uprooting operations.
- Depending on the site, social and economic issues such as accessibility to recreational sites or landscape impact were among the reasons for the work carried out.

Intervention

■ Objectives

- In the short term: limit Hottentot fig proliferation in high-stake sectors in areas where colonisation is low and where action is technically possible in order to preserve species with natural heritage value;



2 - Easily accessible station on Île Callot (condition before works).

3 - Cliff site with difficult accessibility on the Toulinguet Signal Station site.

*Community of Communes of Crozon peninsula and Aulne Maritime.



- In the long term: eradicate the species on all sites.
- The decision to carry out the work is based on:
 - the presence of species and/or habitats with conservation issues (protected, rare or threatened plants, habitats of community interest, breeding, feeding or resting sites for avifauna) threatened by Hottentot fig invasion;
 - socio-economic issues (public access to the site, leisure, landscape impact);
 - the age of the Hottentot fig population: the more recent the invasion, the greater the chance of successful eradication and the lower the costs;
 - as for site accessibility, resource availability at each site was also a decisive factor in the decisions to intervene (financial, human and material resources).

■ Methods used

- Due to the shallow rooting of Hottentot fig, manual uprooting, involving few technical means, was carried out on all accessible sites (Table on previous page). The uprooted plants were stored in big bags and then transported to a trailer, or a horse-drawn plough, or a tractor, depending on the site.
- On several stations, annual monitoring was carried out to remove any regrowth. This monitoring is mainly carried out on sites where Hottentot fig occupied limited areas, such as on the site of the Island of Saint-Nicolas in the Glénan archipelago.
- On sites with difficult accessibility, officers specialised in cliff work (rope access technicians) were involved. The Postolonnec station in the Regional Nature Reserve of the geological sites of the Crozon Peninsula, managed since 2015, required regular work by rope access technicians.
- The plant waste was then incinerated or transported to waste disposal sites. The Hottentot fig removed after management on Île Callot were reused via a composting process. However, there is still a risk of regrowth following this process due to the possibility of cuttings propagating or seed resistance.
- Following the uprooting operations, an annual monitoring must be carried out to remove any regrowth.
- This monitoring is to continue for 10 years.

Results and assessment

■ Technical results

- The scale of the works depends largely on the resources available, particularly human resources. Works often involve volunteers and students supervised by managers (see table on next page).
- The main difficulties brought up by the operators are the storage, drying and export of the uprooted plants, which are bulky and heavy. In addition, no fragments should be left on site to avoid any risk of further spread.
- On all the sites treated, regrowth was observed following the works, but regrowth decreased as monitoring and work progressed.



4 - Manual uprooting on Landrellec-îlot aux vaches.

5 - Hottentot fig removed after management on Île Callot.

6 - Waste *Carpobrotus* sp from works on Île Callot.

7 - Removal by animal power, Île Callot, May 2019.

Technical results and human resources involved per site.

Sites	Managers	Worksddate	Accessibility	Number of people involved	Composition of teams	Works duration (hours)	Works duration x number of people involved (hours)	Land area covered (m²)	Amount of waste removed* (m³)
Chemin du Sillon noir, Pleubian (22)	Lannion Trégor Community	25/06/19	Easily accessible areas	10	4 volunteers + 3 LTC officers + 3 nature reserve officers	2	20		10
Landrellec - îlot aux vaches, Pleumeur-Bodou (22)	Lannion Trégor Community	05/07/17	Easily accessible areas	15	12 volunteers + 3 officers	2	30		12
		04/07/18	Easily accessible areas	22	19 volunteers + 3 LTC officers	2	44		10
Ploumanac'h, Perros-Guirec (22)	Perros-Guirec Commune	07/09	Easily accessible areas	3	2 coastal rangers + 1 seasonal worker	7	14h – 21	100	9
Île Callot, Carantec (29)	Morlaix Community/ Finistère Departmental Council	05/19	Easily accessible areas	31	29 nature management students + 2 teachers	14	434		23
Île de Saint-Nicolas dans l'archipel des Glénan, Fouesnant (29)	Glénan Islands National Nature Reserve	09/05	Easily accessible areas	26	6 technicians + 20 students	14	364, or 52 days	300	16
		10/11	Easily accessible areas	28	6 technicians + 19 students + 1 trainee + 2 volunteers	14	392, or 56 days	450	23
Pointe de Dibennou, Guissény (29)	Natura 2000 Site-Guissény	08/16	Easily accessible areas	25	Volunteers	4-5	64h - 100	150	20
Postolonnec, Crozon (29)	Crozon Peninsula-Aulne Maritime Community of Communes - Nature Reserve	05/16	Non-accessible area (on cliffs)	1	1 specialised officer – rope access technician	7	7	5	0,8
Cap de la Chèvre, Crozon (29)	Crozon-Aulne Maritime Peninsula Community of Communes	11/12	Non-accessible area (on cliffs)	1	1 specialised officer – rope access technician	21 (3 days)	21		5

* Volume calculation was based on equivalent mass in tonnes.

■ Costs

■ Financial details are available for the following three sites:
Postolonnec Crozon (29), Île Callot (29), Ploumanac'h, Perros-Guirec (22).

Financial details.

Sites	Accessibility	Duration	Number of people	Total expenses (€)
Postolonnec, Crozon (29)	On cliffs, rope access technician	7 h	1	2 500
Île Callot, Carantec (29)	Area accessible with students	2 days	+/- 30 school children and students	3 500
Ploumanac'h, Perros-Guirec (22)	Accessible area, action by officers	7 h	3	777 (for labour only)



- The resources needed strongly depend on site accessibility. The need for rope access on the cliffs has led to higher costs. The involvement of a large number of volunteers and students during works on accessible sites made it possible to balance the overall management costs.

Detailed financial aspects for the management of the Île de Callot site (easily accessible).

Details of costs (€)	
Preparation, installation and removal of the trailer (Driver, crane truck, trailer)	240
Green waste composting	200
Works coordination	~ 300
Animal-power removal	1 040
Grant for Susicinio High school (Morlaix Commune)	1 500
Total	3 280 (~3 500)

N. B. For these works, a financial assessment of entrusting them to a social integration company was estimated at €18,000, including €16,000 for labour.

Information on the project

- Raising public awareness through volunteer uprooting operations.
- Press articles.
- Communication on the digital social networks of the Île Callot management site.

Outlook

- Continuation of uprooting operations on several sites in Brittany.
- Consideration of how to reuse the uprooted residues (e.g.: recovery by the company Yves Rocher).
- Improvement in the sharing of experience at regional level, through the development and implementation of a regional IAS strategy (under development).

N. B. The 2019 course was financially supported by the company Yves Rocher, which uses *Carpobrotus edulis* in a range of cosmetic products. Considerable management feedback from a broad network of managers was consulted and summarised. Out of the 420 managers and partners contacted via the AGENB mailing list, 25 responded to the survey.

Authors: Eva Burguin, National Botanic Conservancy of Brest, Marion Thery, AGENB, and Clara Singh, IUCN French committee in the framework of the Invasive Alien Species Resource Centre. November 2021. Published by the French Biodiversity Agency (OFB).

2022 edition



8 - Publication of a post on digital social networks of the Île Callot management site.



Alligator weed

(*Alternanthera philoxeroides*)

Originated in South America, introduced for ornamental pools and aquariums. In France, it was first observed in the natural environment in the 1960s.

Description

- Perennial, herbaceous plant, amphibious, with stolons and widely spread leaves
- Leaves are dark green, opposing, sessile and lanceolate, both sides are smooth
- Hollow, cylindrical stem, up to 1 metre in length, smooth, but with clumps of white hairs around the base of the leaves
- A main taproot at the base of the plant, but with rootlets starting from nodes
- Axillary inflorescence with a stem, ovoid, 1 to 1.5 cm in diameter, with small white flowers

Ecology and reproduction

- Habitats include running and stagnant waters, banks, riparian vegetation, wet meadows, environments impacted by human activities
- Vegetative multiplication, via stolon fragments and stalks
- No sexual reproduction has been observed where the plant has been introduced

Documentation

- CBNMed Porquerolles. 2018. *Alternanthera philoxeroides*. Espèces végétales exotiques envahissantes. http://www.invmed.fr/src/listes/fiche_taxon.php?cd_ref=81831
- GISD. 2019. Global Invasive Species Database. *Alternanthera philoxeroides*. <http://www.iucngisd.org/gisd/speciesname/Alternanthera+philoxeroides>
- CABI. 2019. Invasives Species Compendium. *Alternanthera philoxeroides* (Alligator weed). <https://www.cabi.org/ISC/datasheet/4403>

Author: Doriane Blottière, IUCN French committee, for the Resource Centre on invasive alien species. February 2019. Published by the French Biodiversity Agency.

Classification	
Order	Caryophyllales
Family	Amaranthaceae
Genus	Alternanthera
Species	A. philoxeroides (Mart. Griseb., 1879)





Alligator weed

(*Alternanthera philoxeroides*)

Experiments on management techniques for alligator weed along the Ouvèze River (Vaucluse department)

National botanical conservatory in Porquerolles (CBNMed)

■ This agency, awarded public status in 1990, works under the auspices of the Port-Cros national park. Its duties cover nine departments in the southern section of the PACA region and the eastern section of the Occitanie region.

■ The main missions include:

- gaining knowledge on wild plants and Mediterranean vegetation (inventories, counting populations of threatened species, organising local networks, etc.);
- conserving rare and threatened species (*in situ* and *ex situ* conservation, management of plant invasive alien species (IAS));
- science-advice work for State services and local governments (examining requests for waivers to eliminate protected species, support work for the State and local governments, etc.).

■ Contact: Cyril Cottaz, IAS policy officer - c.cottaz@cbnmed.fr

Intervention site

■ Alligator weed was first noted in July 2013 by the Aquascop engineering firm in the centre of the town of Sorgues (Vaucluse department), on the right bank of the Ouvèze River that originates in the Drôme department and is a tributary to the Rhône River. In 2015, the weed covered an area spanning 300 linear metres (over 1 000 square metres).

■ The site belongs to the town of Sorgues and is managed by the Ouvèze Provençale board (SMOP). It lies next to a walking path along the river used by numerous walkers throughout the year.

Disturbances and issues involved

■ *Alternanthera philoxeroides* is listed as a regulated species of Union concern (European regulation 1143/2014). In the PACA region, according to the regional IAS policy, it is considered an “emerging” threat, i.e. a priority species requiring rapid action to avoid its widespread dispersal.



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1, 2. The site of the alligator weed on the right bank of the Ouvèze River.

■ The species can form dense, single-species beds that severely affect native species and modify the landscape.

■ The location of the site, only three kilometres upstream of the confluence with the Rhône, represented a serious risk of dispersal to the Rhône.

Interventions

■ Following the discovery of the plants, a status report was prepared by CBNMed and students from the University of Aix-Marseille, followed by a letter alerting the Prefect of the Vaucluse department to the situation at the end of 2014.

■ In September 2015, a meeting was held to discuss various intervention scenarios and to train the local operators on identifying the plant. Participants in the meeting included the Rhône-Méditerranée-Corse Water Agency, the Pays de Rhône et Ouvèze intermunicipal board (CCPRO), the town of Sorgues, the Vaucluse departmental council, the PACA Nature Conservatory (CEN PACA), the Vaucluse Departmental Territorial Directorate (DDT 84), the PACA Environmental Directorate (DREAL PACA), the Vaucluse Fishing Federation and SMOP.

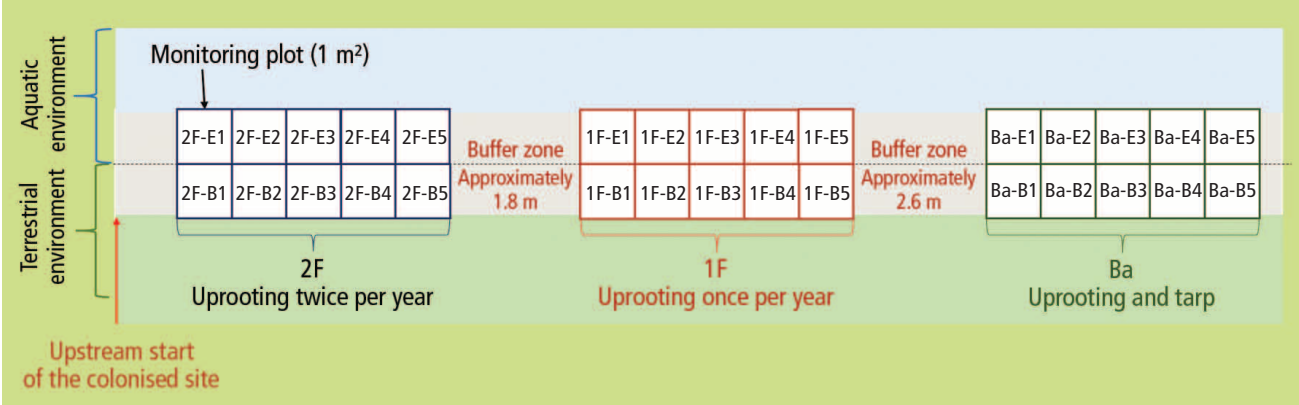
■ In 2016, a request for funding from the State was made and a protocol was drafted for an experiment on a technique to eradicate the species. According to the available literature, manual uprooting of the aquatic and terrestrial stalks is one of the most effective methods. This technique was therefore tested in 2016 on three sets of ten plots (1 square metre each) under three different conditions:

- one uprooting per year, in the summer;
- two uprootings per year, in the summer and fall;
- a single uprooting in the summer and installation of an opaque tarp (comprising several layers of black plastic), fifty metres long and secured to the ground with large, metal staples.

■ First, a fishing net was set from the middle of the river to the bank, a few metres downstream of the uprooted area, to avoid dispersal of plant fragments.



3, 4. Uprooting work done by the volunteer students.



Layout of the monitoring plots according to the different test conditions.

■ The stalks that were underwater on the intervention dates were manually uprooted by volunteers working in the water, using waders. On the river bank, in addition to manual uprooting, part of the underground rhizome system was removed using a pickaxe, to a depth of 10 to 20 centimetres.

■ A monitoring protocol was established for the test areas, including phytocological and mesological surveys carried out prior to each uprooting operation.

■ The green waste produced by the uprooting was removed for incineration, taking care to avoid the loss of any fragments.

■ In 2017, the tarp used in 2016 was deemed too thin because light filtered through. In addition, sprouts were observed around the staples used to secure the tarp. In 2018, a more opaque tarp was used.

■ In the fall of 2017, the CBNMed used kayaks to monitor the banks upstream and downstream of the colonised area, but no other colonised sites were discovered along the Ouvèze River. Monitoring in 2018 produced the same results, i.e. no new colonised sites.

■ Of interest is the fact that another site colonised by *Alternanthera philoxeroides* was discovered on the Petit Rhône, in the town of Saintes-Maries-de-la-Mer in the Bouches-du-Rhône department, i.e. 110 kilometres downstream from Sorgues. The plants were immediately uprooted by the CBNMed in an effort to rapidly eradicate the colony. In January 2019, the site was monitored in conjunction with the Camargue regional nature park and a 450 square metre colonised zone was found. Management work is now in the planning stage.

Results and costs

■ Results

■ No significant differences were observed between one uprooting per year and two per year. Uprooting was relatively effective the first year with the colonised surface areas dropping from respectively 55% and 65% of the total monitored area to less than 20% in September 2017. However, a limited increase in the colonised surface areas was subsequently observed in July 2018.

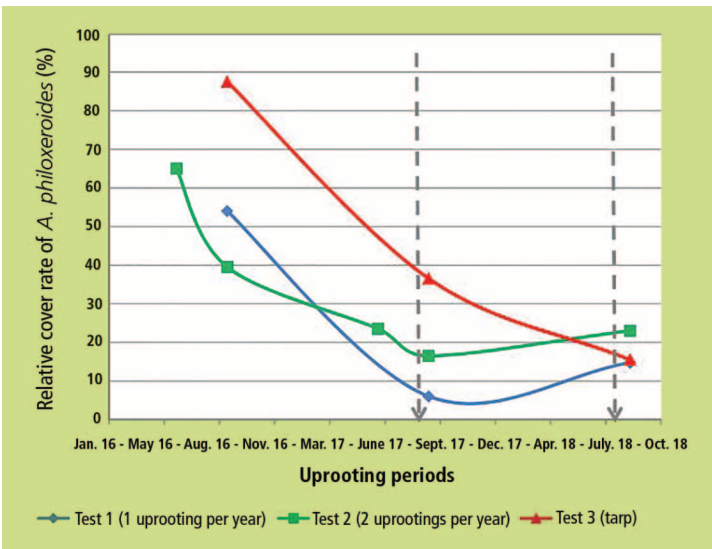
■ It should be noted that clearing work, using a brush cutter, took place on the site prior to the monitoring visits in 2017 and 2018, due to communication errors between the municipal services in charge of maintaining the river banks. These incidents complicated the assessment of the surface areas covered by the alligator weed, however the actual impact was probably limited due to the low-lying nature of the plant.

■ In these areas, the growth of new vegetation was highly variable, depending on the topology and the hydrographics (above the water line or below). Taxonomic diversity varied only slightly, however species with high cover rates, e.g. water finger grass (*Paspalum distichum*, another IAS) and *Carex riparia* (a native species), dominated in areas where they had not been abundant previously. Other invasive alien species were observed following the interventions, namely *Xanthium orientale subsp. italicum* and *Ludwigia peploides subsp. montevidensis*.

■ In the tarped area, the surface area covered by the species dropped continuously, from 87% in 2016 (surface area prior to uprooting) to 37% in September 2017 (when the tarp was changed) and to 16% in 2018. The remaining plants had wilted and were in the process of dying. It should be noted that the tarp led to the virtual disappearance of all vegetative components of the species present, both native and alien, and resulted in bare soil.



5. Installing the tarp.



Cover rates of *A. philoxeroides* depending on the three intervention modes.

■ Costs

- The total cost of the work done over the years 2016 to 2018 amounted to approximately 10 000 €. That included all travel, the purchase of equipment and the payroll costs of CBNMed, the project coordinator. The project was made possible by financial aid by the French State (80%) and in-house financing by CBNMed (20%).
- A number of organisations were involved to various degrees in the project, including the Rhône-Méditerranée-Corse Water Agency, CEN PACA, ANSES, the town of Sorgues, Compagnie Nationale du Rhône, Pays de Rhône et d'Ouvèze intermunicipal board, Vaucluse Departmental Council, Vaucluse Departmental Territorial Directorate, AFB PACA-Corse interregional office, PACA Environmental Directorate, Vaucluse Fishing Federation, PACA region, Camargue Regional Nature Park, Ouvèze Provençale board, Intermunicipal board to protect the banks of the Eygues, Sorgues basin board, Camargue Gardoise board, RMB Bucchi company, Les amis des marais du Vigueirat environmental-protection group.
- A large part of the uprooting work was done by volunteer students from the “Managing natural environments and fauna” programme at the La Ricarde agricultural high school in Isle-sur-Sorgue (representing over the three years a total of 68 students who each contributed 2.5 days of work). They were accompanied by volunteers from CEN PACA, AFB, Vaucluse Fishing Federation and CBNMed.

Salient project figures.

Date	Opérations	Time invested (man-days)	Linear distance (metres)	Volume removed (cubic metres)
June 2016	Inventory	2	-	-
	Uprooting	3	9	0.9
September 2016	Inventory/Training	3	-	-
	Uprooting/Tarping	20	22	3.15
June 2017	Inventory	1	-	-
	Uprooting	1	9	0.15
September 2017	Inventory/Training	6	-	-
	Uprooting	25	9	1.02
	Inspections by kayak	2	-	-
June 2018	Submerged plots, uprooting planned but not done	2	-	-
September 2018	Inventory/Training	3	-	-
	Uprooting	23	9	0.48
	Inspections by kayak	2	-	-

Information on the project

- Information on the work was provided via:
 - communication documents (warning alert, species fact sheet, etc.);
 - CBNMed Facebook site (<https://www.facebook.com/CBNMediterraneen>);
 - class work by the students at the La Ricarde agricultural high school;
 - a one-day training session in May 2016, organised by CBNMed and Onema (now OFB), to inform the river technicians on the problem. Approximately 30 per-

sons from different organisations attended the training programme that addressed the following points:

- invasive alien plants;
- the regulatory context in both France and Europe;
- the regional strategy in the PACA region;
- management techniques for a few aquatic and river-bank species;
- alligator weed, its habitats, the context in PACA, how to recognise the plant, the experimental project on manual uprooting.

Outlook

- The results observed in 2018 were subsequently confirmed and the tarp was definitively removed in 2020. No new sprouts were observed.
- Uprooting followed by tarping would appear to be the best solution. After removing the tarp, it would be necessary to replant the banks with native plants (using the local Végétal brand of plants, for example). Annual inspections will be necessary to check that the alligator weed does not recolonise the area. In areas with stone banking, manual uprooting is difficult and it is often not possible to fully remove the plant, particularly the roots. This aspect must be taken into account for future operations in order to ensure the complete eradication of the plants. Similarly, the presence on the site of *Paspalum dilatatum* and *Ludwigia peploides*, two species that can spread rapidly, should be taken into account in the strategy for the work.
- In 2019 and 2020, CBNMed undertook new inspections on the Ouvèze and the Rhône Rivers. Alligator weed had spread widely between Sorgues (Ouvèze) and Avignon (Rhône). In 2019, a multi-year provisional budget to manage the species was drawn up by CBNMed and presented to site managers and local stakeholders. For the Ouvèze River, the budget represented almost 240 000 euros. Currently, the Ouvèze manager cannot initiate management of the species and no work has yet been undertaken. In September 2020, CBNMed trained stakeholders along the Rhône on the identification and management of the species. Initial work on manual uprooting, with support from the national agencies (Vaucluse DDT and PACA DREAL) was undertaken on the downstream section of the Rhône, near Avignon, by the Compagnie nationale du Rhône (CNR), the French Biodiversity Agency, the Avignon Urban Board, the Camargue Regional Nature Park (a Natura 2000 site) and CBNMed.
- The participation of the Ouvèze and Rhône managers in managing alligator weed is highly necessary and urgent. Over the past three years, the species has spread rapidly. CBNMed can help site managers by providing updated observation data of the species and providing scientific and technical support for their management work.

Authors: Cyril Cottaz, CBNMed, Éléonore Terrin, CBNMed and Doriane Blottière, for the IAS Resource Centre. March 2019. Editor: French Biodiversity Agency

2022 edition



6 - Training session on how to identify alligator weed.
7 - Part of the fact sheet used to identify the species.

For more information...

- BNMed Porquerolles, 2018. *Alternanthera philoxeroides*. Plant invasive alien species. (In French)
http://www.invmed.fr/src/listes/fiche_taxon.php?cd_ref=81831
- Cottaz C., Paquier T. and Diadema K., 2018. Alligator weed, *Alternanthera philoxeroides*. An experiment in managing an emergent IAS in the PACA region, on the Ouvèze River (Sorgues, 84). CBNMed, 47 pp. (In French)
<http://www.fcbn.fr/vegetal-local-vraies-messicoles>
- CBNMed resource centre, see the file on alligator weed.
<http://www.cbnmed.fr/src/ress.php>
- Fried G, Magoga E. and Terrin E., 2016. Alligator weed. A topic requiring attention. The work group on biological invasions in aquatic environments. (In French)
<http://especes-exotiquesenvahissantes.fr/lherbe-a-alligator/>



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_inv_a/fiches_FCBN/Fiche%20-%20Reynoutria-japonica-sr.pdf; http://www.centrederessourcesloirenature.com/mediatheque/especes_inv_a/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	Polygonaceae
Genus	<i>Reynoutria</i> (Houtt, 1777)



© Emilie Mazaubert



© Nicolas Poulet



© Alain Dutarte



© Alain Dutarte

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.)

Industrial composting to avoid dissemination of Asian knotweeds. Study on the survival of stalks, rhizomes and seeds (Savoie department)

Savoie department

- The Savoie Departmental Council has 2 500 employees active in a wide range of sectors, including the social sector, education, territorial planning, the environment, culture, etc.
- Since 1990, it has assisted the local governments in managing rivers and aquatic environments in general via the observatory on environmental quality, technical and financial aid for river restoration and maintenance programmes, and management trials for invasive alien plants.
- Since 2005, the Council has been active in informational, prevention and management efforts concerning invasive alien species in the framework of maintenance work on its property and departmental roads, in a partnership with the concerned local governments.
- Contact: Claire Rameaux – claire.rameaux@savoie.fr

Concept.Cours.d'EAU (CCEAU) SCOP Aquabio

- CCEAU is an environmental consulting firm specialised in riparian vegetation and invasive alien plants, with its headquarters in the town of Sainte-Hélène-du-Lac (Savoie department).
- Its main missions include:
 - assessing the invasion stages of various plants along rivers in view of setting up action plans to avoid their dissemination;
 - monitoring work sites using mechanical equipment to remove Japanese knotweed;
 - providing training and raising awareness on how to manage invasive alien plants;
 - research and development work on management methods for invasive alien plants.
- Contact: Louise Barthod & Mireille Boyer – louise.barthod@aquabio-conseil.com & mireille.boyer@aquabio-conseil.com

Study context and goals

- Numerous amenity centres now refuse the green waste from management operations because they are aware of the high impact of Asian knotweeds and want to avoid any risk of dissemination. This is because very little data is



1. What solution for knotweed cuttings when they cannot be left on site?

2. What should be done with a rhizome drawn from a reed bed (Bourget Lake)?

available on the survival rates of the plants when treated using processes such as industrial composting.

- In the Savoie, this situation has created problems for site managers who do not know what to do with the green waste that is, in some cases, collected in large quantities.

■ In order to assess the risks of dissemination after composting, the Savoie department initiated an experiment to determine the survival capabilities of different parts of Asian knotweed plants during composting.

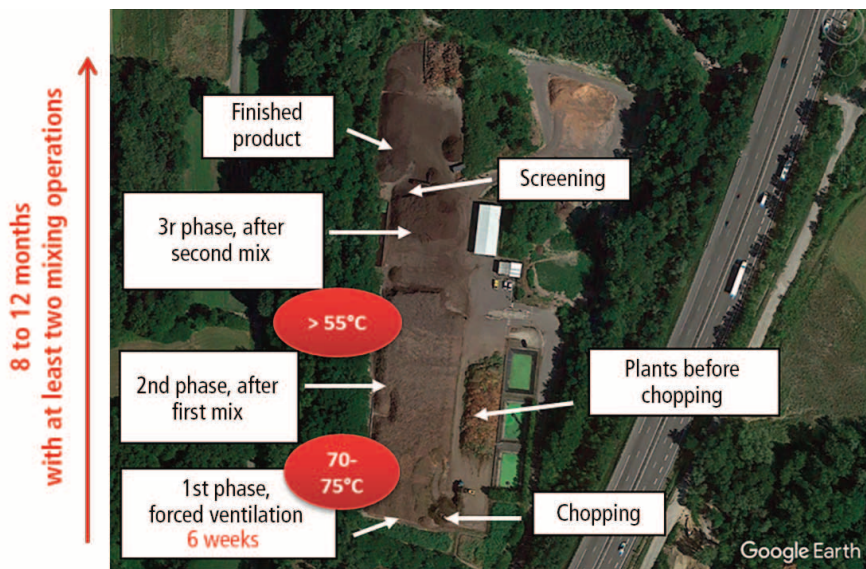
- The objective was not to develop a system to eliminate the rhizomes, but to study the risks created by their presence in green waste produced by cutting or uprooting the plants. Due to their woody composition and their contact with the soil, rhizomes are not accepted by composting units.

Intervention site

- The experiment was carried out at the composting unit of the Grand Chambéry metropolitan board with the assistance of the SUEZ Organique company, the site manager. The unit composts approximately 15 000 metric tons of green waste from local parks and gardens, each year.
- The composting process lasts eight to twelve months and includes a number of phases:
 - chopping the plants;
 - storage in long mounds with forced ventilation for six weeks to provoke temperature rise in the compost up to 70-75°C;
 - at least two mechanical mixing sequences to oxygenate and homogenise the compost;
 - screening the compost at the end of the process.
- The stalks and rhizomes of the Asian knotweed were collected and transported by the departmental council. The rhizomes were collected in the town of Villard-Léger, on a site that had been colonised for several years with a high density of rhizomes in the soil. The stalks were collected in the town of Viviers-du-Lac.
- The seeds were collected by Concept.Cours.d'EAU on a bar in the Isère River that had also been colonised for years and where the development of seeds had been observed.



3. Green waste undergoing composting at the Grand Chambéry composting unit.



Aerial view of the Grand Chambéry composting unit, showing the different phases of the project.

Disturbances and issues involved

- Asian knotweed produces great quantities of biomass, in some cases over ten tons of dry matter per hectare. Its growth is rapid with the stalks surging up to ten centimetres per day in the spring and reaching three to four meters in height. On certain colonised sites intended for specific purposes, the knotweed must be cut several times per year (three to five times on average). Manual uprooting is also an option for plant management.
- As a result, regular upkeep of sites colonised by knotweed produces considerable quantities of green waste, consisting essentially of the aerial parts of the plants, but also of rhizome fragments pulled out from the below-ground parts of the plants. If the plants are cut late in the season (August and September), there may also

be seeds in the green waste. This waste cannot always be left on site, due either to the specific purpose intended for the site or to the risks of dispersal.

■ The reproductive capabilities of Asian knotweed via vegetative multiplication are exceptional. In that it can also reproduce via the seeds, it was necessary to assess the risks of dispersal via composting units before selecting the technique as a means to dispose of the plants.

Interventions

■ The experiment consisted of injecting the stalks, seeds and rhizomes of Asian knotweed in an industrial composting process to study their mortality during the treatment and to determine the risks of species dispersal following composting.

■ The test was carried out at full scale, i.e. by integrating a large quantity of the plants in the production cycle for compost and by studying the survival rates of propagules and seeds over a complete cycle, lasting eight months. The inclusion of the plants in the compost cycle made it possible to take into account the diversity of parameters affecting the mounds and those of the rhizomes, which can be more or less long and woody, i.e. more or less degradable. The experimental conditions were set such that the plants systematically encountered the most favourable situation for their survival.

■ For practical reasons related to the seasons and the development of the plants, the experiment took place in two main steps:

- December 2016 to October 2017, composting of the rhizomes and seeds;
- June 2017 to February 2018, composting of the stalks.

■ Composting of the rhizomes and seeds

■ The rhizomes were collected using a backhoe and then sorted manually. A total of ten cubic metres of rhizomes were harvested.

■ They were mixed with 40 cubic metres of fresh compost, i.e. the rhizomes represented 20% of the overall volume.

■ The mix then received over one million seeds and was sent to the production line.

■ The batch containing the rhizomes and seeds was ventilated for six weeks and then remixed mechanically at three months and six months into the production cycle.

■ The total cycle lasted eight and one-half months.

■ Composting of the stalks

■ Seven cubic metres of stalks were cut manually. The stalks were mixed with 28 cubic metres of fresh compost, i.e. the stalks represented 20% of the overall volume. The mixture was then sent to the production line.

■ The batch was ventilated for six weeks and the remixed mechanically at three months into the production cycle. A second remix, at six months, could not be carried out for technical reasons. The forced-ventilation system was restarted to oxygenate the mound that could not be mixed.

■ The total cycle lasted eight months.

■ Monitoring and assessment

■ Measures were taken throughout the experiment to limit the risk of dispersal of the plants, including the presence of the consulting firm each time the plants were handled or mixed, inspections and cleaning of machines, scraping of the topsoil, markers indicating the position of the knotweed, tracing of each batch, etc.



4. Ten cubic metres of rhizomes were collected, ranging widely in age and diameter.
5. A mixture of rhizomes and fresh compost.

■ During the mixing procedures, the experimental batches were not mixed more than one metre beyond the markers for the knotweed in order to avoid dispersing the plants further in the mound. This nonetheless resulted in considerable dilution of the plants given that the final volume of the experimental compost represented approximately 180 cubic metres for each batch.

■ The temperature in the mounds was monitored continuously.

■ The experimental results were based on a series of observations and planting trials:

- the stalks were inspected each month (each week in July and August) in order to detect any regrowth on the surface of the mounds;
- a sample of the rhizomes and stalks was collected during the third-month mixing operation in order to assess their status (decomposition and/or drying);
- seeds in small bags were placed in the compost and then planted in a laboratory after two, five and eight months of composting. Their germination rates were compared to those of a control group of seeds;
- finally, all of the experimental compost containing the rhizomes and seeds was spread on public land in the town of Viviers-du-Lac for two months (September and October 2017) to check for any regrowth. Control zones were created in the spread compost to check that any propagules or seeds still alive could regrow. The control zones consisted of five plots where fresh rhizomes and seeds were planted.

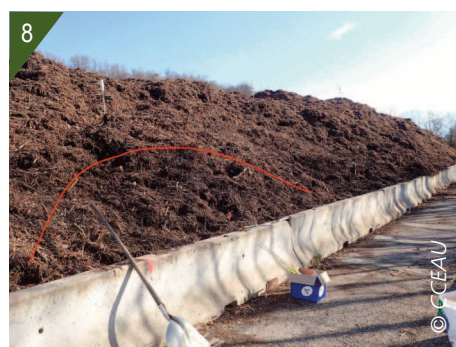
Results and costs

■ Impact of composting on the rhizomes

■ After eight and one-half months of composting, the mortality rate for rhizomes was 100%. This result was confirmed by a comparison with 55 control rhizomes that produced 80 sprouts after being planted in the compost and subjected to the same weather conditions (see the figure on the following page).

■ However, the experiment revealed major differences in processes and decomposition/drying speeds between the interior and the surface of the mound. Inside the mound, the rhizomes dried due to the effects of the high temperatures ($\approx 70^{\circ}\text{C}$), whereas on the surface, certain rhizomes continued to sprout over a long period and others rotted in areas with high levels of humidity. These phenomena were observed for up to five months in the parts of the mound not mixed (see the figure on the following page).

■ On the Grand Chambéry site, the compost was mixed two times, which was sufficient to produce a homogenised mixture that resulted in the 100% mortality rate for the rhizomes.

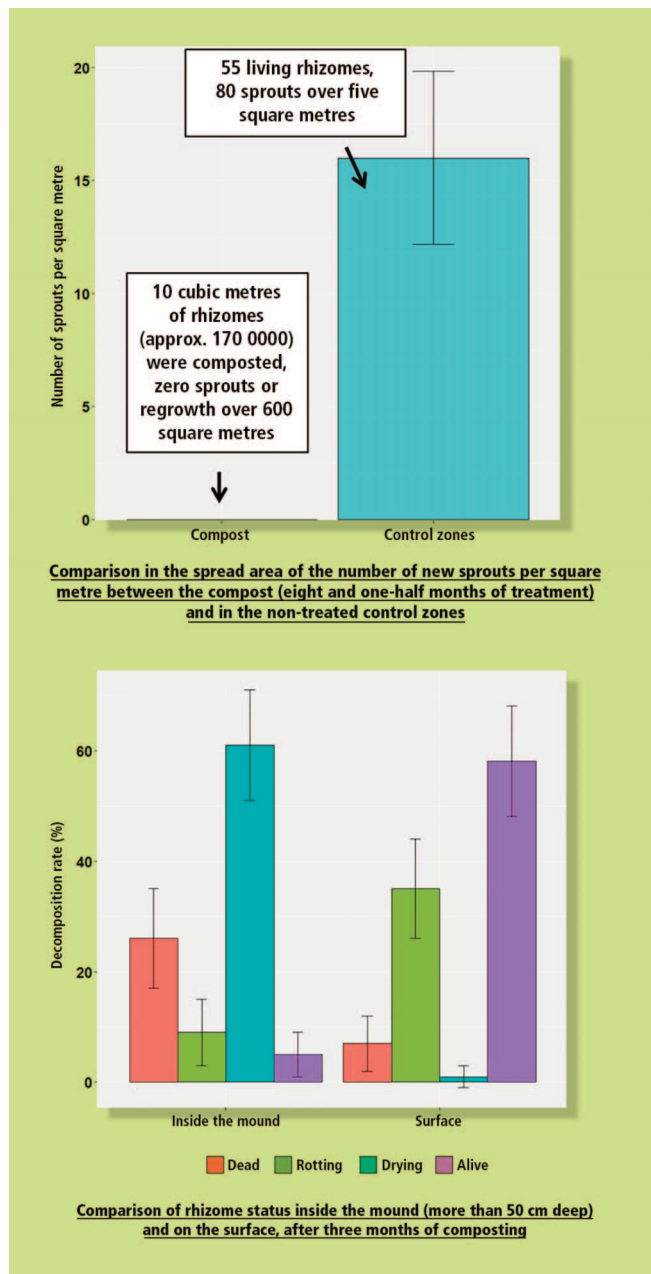


6. Incorporation of the knotweed seeds in the compost.

7. Mixing the stalks in fresh compost.

8. Integration of the experimental batch in the production cycle.

Impact of composting on the rhizomes.

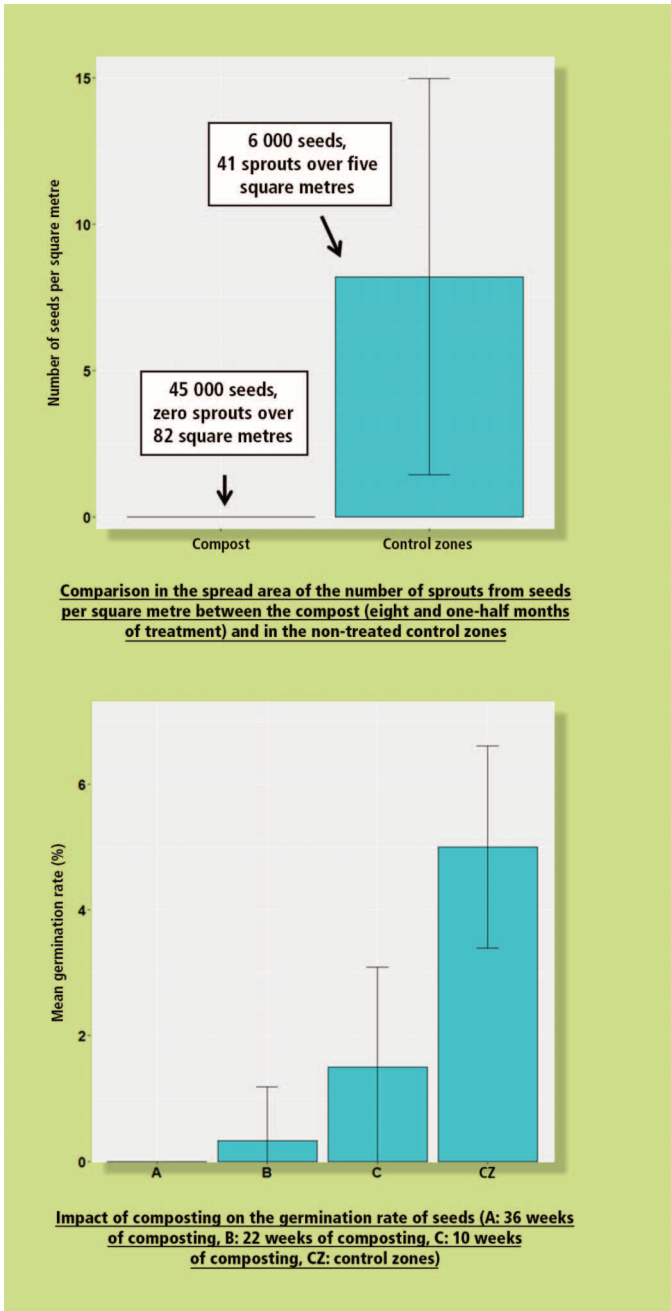


■ Impact of composting on the seeds

- No sprouts were observed in the compost spread after eight and one-half months of treatment (82 square metres were carefully inspected), whereas in the control zones, 41 sprouts were observed following the incorporation of 6 000 seeds (see the figure on the following page). It is clear that after the composting process as executed on the Grand Chambéry site, there is no risk that the final product contain any seeds capable of germinating.
- However, seeds located on the surface of a mound, where the temperatures are lower, may remain capable of germinating for up to five months of the treatment (see the figure on the following page). Similar to the rhizomes, it is the mixing that homogenises the compost and buries the seeds, thus eliminating any risk of subsequent sprouting.
- On the Grand Chambéry site, two mixing operations are sufficient over the eight and one-half months of treatment to eliminate any risk of subsequent regrowth of the knotweed seeds.



Impact of composting on the seeds.



13. Seeds after eight and one-half months of composting on the left and control seeds on the right.
14. Knotweed sprout observed in a control zone and a green-yellow marker stick.

■ Impact of composting on the stalks

- Drying of the stalks proceeds much faster than that of the rhizomes. After three months of composting at temperatures of approximately 70°C, the seven cubic metres of stalks incorporated in the compost had fully dried.
- A sprout on a stalk, observed after one month of treatment on the surface of the mound in an area that had remained relatively humid, did not survive more than one week. The stalks on the surface of the mound are capable of sprouting, however this is a rare and temporary phenomenon. No sprouts from stalks had survived after three months of treatment.

■ Costs

- The experiment was funded (45%) by the Savoie department (10 457.50 euros before VAT) and for the remainder by Concept.Cours.d'EAU in the framework of its R&D programme.

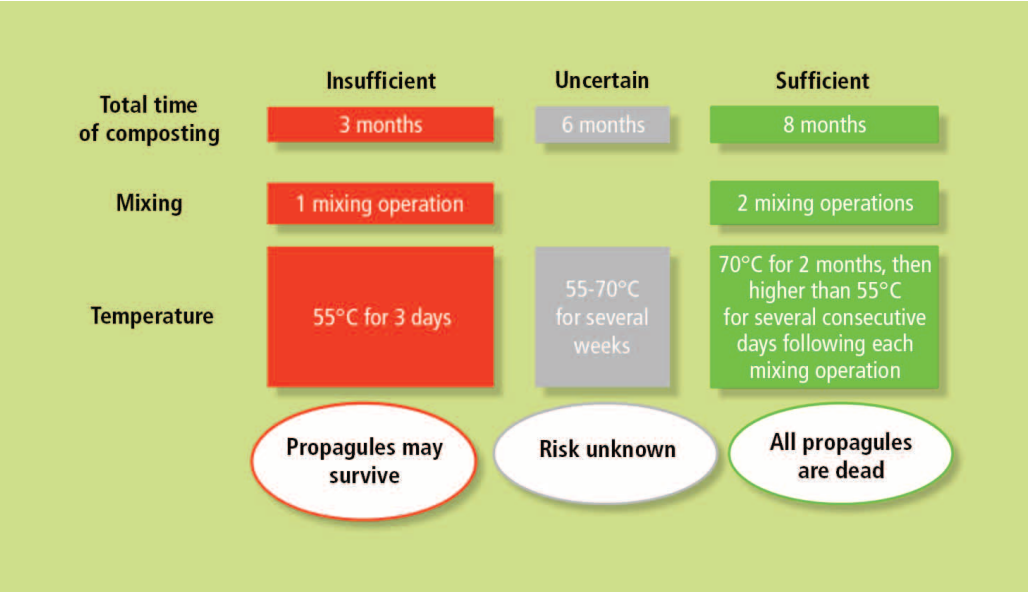
Recommendations

- The experiment demonstrated that the composting technique, as implemented on the Grand Chambéry site, resulted in 100% mortality rates for the stalks, seeds and rhizomes of Asian knotweed.
- Similar to any worksite handling invasive alien plants, there are a number of specific risks concerning the movements of the equipment and tools used for certain operations on the site. On the Grand Chambéry site, the site layout and the existing procedures considerably reduce those risks. Even greater control over the risks may be achieved by implementing additional measures during the chopping operations and the handling of the green waste.
- The experiment further demonstrated that the minimum conditions imposed by the decree dated 22 April 2008, setting the rules for regulated composting units¹, are not sufficient to avoid any risk of dissemination. During the experiment, sprouts were observed following the first mixing operation, in spite of temperatures significantly higher than 55°C. Consequently, a composting cycle comprising only one mixing operation may allow some of the knotweed plants to survive.
- These results suggest a number of more general recommendations for other installations. Composting units may accept the green waste produced by management work on Asian knotweed without any risk of disseminating the plants if all the following conditions are met:
 - the composting cycle must last eight months;
 - the compost must be mechanically mixed two times;
 - high and constant temperatures must be maintained in the mounds, approximately 70°C during the first month of treatment and then higher than 55°C for several consecutive days following each mixing operation;
 - the dispersal risks of propagules and seeds by the equipment and tools must be systematically assessed and suitable preventive measures must be implemented.
- For industrial composting units operating with much shorter production cycles and/or lower temperatures, the risk of dissemination remains. Additional study, specific to each site and addressing the differences in composting techniques, is required to eliminate the risk of dissemination.



15. Sprouts on a stalk after one month of composting.
16. Dry stalks after three months of composting.

Assessment of the survival potential of plant propagules under different composting conditions.



1. Two weeks of forced ventilation resulting in temperatures exceeding 55°C for three consecutive days, plus one mixing operation after which the temperature must exceed 50°C for 24 hours.

Information on the project

■ The results of the experiment have already been presented to various services of the Savoie Departmental Council (roads, environment). The current objective is to disseminate this information more widely to people in the biodiversity field and in waste management (local governments, the region).

Outlook

■ The experiment improved the available knowledge on the survival conditions of Asian knotweed propagules during industrial composting. Asian knotweed may be accepted without any risk of subsequent dissemination if the conditions and techniques used on the Grand Chambéry site are implemented. The results are also useful in better assessing the dissemination risks for the plant following composting in other types of composting units using other techniques. However, an in-depth assessment of the risks is required for each type of composting process.

■ Further study on the capability of rhizome fragments to resist drying would be most helpful in order to propose the conditions required to devitalise rhizomes in a number of existing composting processes and assist in developing several new techniques to devitalise the plant *in situ*.

Authors: Louise Barthod & Mireille Boyer, Concept.Cours.d'EAU SCOP Aquabio, and Doriane Blottière, IUCN French committee, for the Resource Centre on invasive alien species. July 2018. Published by the French Biodiversity Agency.

Proof readers: Claire Rameaux & Juliette Arrighi, Savoie department, Alain Dutartre, independent expert, and Emmanuelle Sarat, IUCN French committee.

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For more information...

- Barthod L. & Boyer M., 2017. Prévention du risque de dissémination des plantes invasives via la filière de valorisation des déchets verts par compostage – Étude de la survie des tiges, des rhizomes et des graines de renouées asiatiques intégrées dans un compost industriel. Concept Cours d'EAU. 52 pp.
- Internet site of Concept.Cours.d'EAU SCOP Aquabio: www.cceau.fr



Asian knotweed

(*Reynoutria spp.*)

Experiment to compost Asian knotweed in the Orge river basin (Essonne department)

Orge River Board

- The river board comprises 62 towns et 9 intermunicipal boards and urban communities in the Essonne department.
- Founded on 1 January 2019, the board is the successor to three former boards, namely the Board for the lower Orge valley (SIVOA), the Board for the upper Orge river basin (SIBSO) and the Board for intermunicipal cooperation on hydraulics and water treatment in the Limours region (SIHA).
- The main missions include:
 - valorisation of the territorial ecology;
 - achieving good ecological status of aquatic environments;
 - flood prevention;
 - control over water-treatment issues;
 - management of wastewater-treatment plants.
- Contact : Mathieu Gouirand - mathieu.gouirand@syndicatdelorge.fr

Zymovert compost company

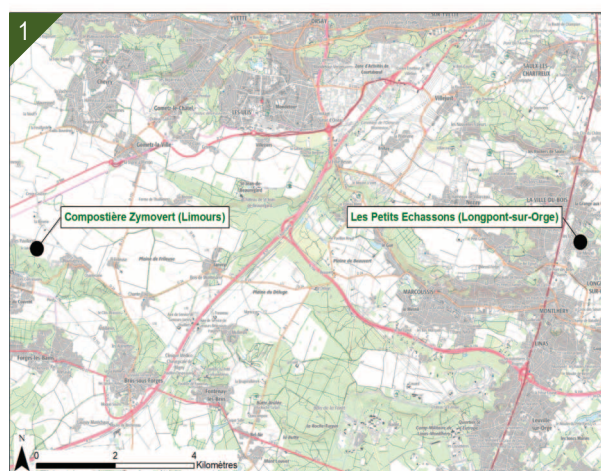
- The composting company is located in the town of Limours (Essonne department).
- Its main missions include:
 - recycling of plant waste;
 - sale of compost, top soil, acid compost and mulch.
- Contact : Bruno Daix - contact@zymovert.com

Intervention site

- The knotweed was composted by the Zymovert company and the compost was spread on the Petits-Échassons site, a property of the Orge River Board in the town of Longpont-sur-Orge. The site limited the risks of plant dispersal in case the experiment failed in that it is a former agricultural site surrounded by stone walls and closed to the public.

Disturbances and issues involved

- Asian knotweeds are considered plant IASs (invasive alien species) in France. Japanese knotweed is widely present in the Orge Valley and in some places threatens the richness of the local fauna and flora.
- Large beds of knotweed must be regularly cleared because they can hinder automobile traffic. They can grow to the point that they block roads and require expensive maintenance work.



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1 - The composting and experimental sites.
2 - The territory of the Orge, Rémarde and Prédecelle River Board.
3 - Beds of Asian knotweed along the banks of the Orge River.

Interventions

Context

- Since 2004, the Orge River Board has implemented a management programme for Asian knotweed throughout its territory. Different methods have been tested (cutting, uprooting, grazing, stripping of infested soil, tarping, etc.) to find the best suited to the different contexts and constraints encountered. Each year, several metric tons of green waste, including that of plant IASs, are produced in the framework of environmental management programmes and development projects.
- In 2018, 392 metric tons of green waste, including 4 tons of Asian knotweed produced by an uprooting campaign, were processed by the Orge River Basin.
- According to normal management procedures, IAS waste is placed in sealed bags and stored in a container on a dedicated platform. A company then transports the container to an incineration centre.
- To avoid incineration and make use of the biomass produced by management operations, a composting experiment was carried out in 2018.

Objectives

- Improve the carbon balance of IAS processing.
- Return organic matter to soil without risk of later IAS dispersal.

Steps in the experiment

- The composting unit received 3.85 metric tons of Asian knotweed, in the form of stalks, leaves and rhizomes. A further 8 tons of cut grass and woody waste were added to the biomass.

Phase 1. Composting

- Composting took place from July to November 2018.

Table 1. The different composting steps.

Dates	Step
04 July 2018	Start of the composting process
05 July 2018	Start of airing
09 July 2018	Watering and mixing
23 July 2018	Watering
26 July 2018	Mixing
02 August 2018	End of airing
14 September 2018	Mixing
24 September 2018	Mixing
13 November 2018	Screening
20 November 2018	End of the composting process

- Following mixing, the plants were chopped to make fragments more uniform in size and then placed in long mounds. The chopping of the green waste took place in a dedicated zone of the composting unit.
- Over the first 15 days, the mounds were aired five minutes every hour, then airing was reduced to three minutes every hour. At the same time, the mounds were watered to stimulate the composting process.
- A constant temperature of 70 to 80°C for several days was necessary to ensure that the compost was aseptic. Sensors were placed in the centre of the mounds for continuous monitoring of the temperature. The data was transmitted to and stored on a computer.



4 - Depositing the knotweed waste.
5 and 6 - Chopping and placing in mounds.

- Six to eight weeks were required to obtain an organic compost that was considered satisfactory. Over that period, watering was reduced and the mounds were regularly mixed by a "mixer".
- The compost was then screened to produce a uniformly fine texture. The resulting homogeneous compost, compliant with applicable standards, was then stored in a dry place to limit the impact of winter rains.

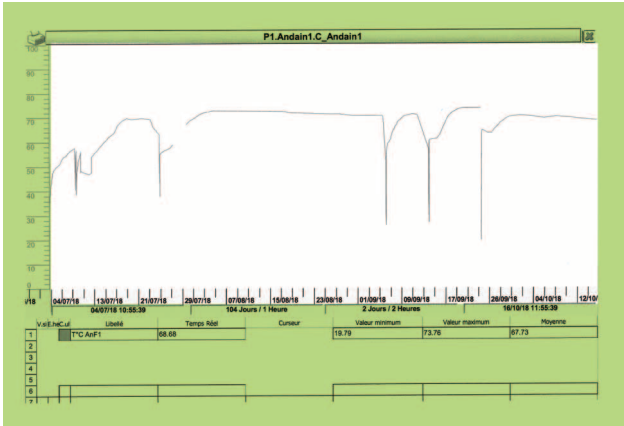
Phase 2. Spreading the Asian-knotweed compost

- The compost comprising the Asian knotweed was stored in a dedicated hanger until the beginning of April (the start of the growing period for knotweed). The mounds were kept separate from the other types of compost to avoid any mixing. The compost was then transported to the spreading site.
- The compost was spread in two different ways:
 - a first test plot where it was simply spread on the ground, without any mixing;
 - a second test plot where an excavator mixed the compost with the underlying soil (to a depth of a few dozen centimetres).
- Once the compost had been spread, the site was fenced off with barricade tape.
- Monitoring was carried out every month over two growing seasons to check for any knotweed sprouts.

Results and costs

■ Technical results

- An increase in the temperature of the mounds was noted during the first week of composting, before stabilising until the end of the composting process. The drops in the recorded temperature corresponded to measurements taken during mixing.



Temperatures recorded in the mounds. The drops in temperature correspond to measurements taken during mixing.

- Initial degradation of the organic matter was observed 15 days after being placed in the mounds. The leaves started to break down and the stalks of Asian knotweed became dry and brittle. Several weeks in the hot environment resulted in the progressive degradation of the woody tissue of the rhizomes.
- In November, four months after the initial chopping of the plants, prior to screening, all knotweed residue had dried and no sprouts had been observed in the mounds.
- The spreading plots were monitored starting in the spring of 2019 and no sprouts were observed that year on either plot. No sprouts of Asian knotweed were noted in 2020 as well.



Spreading of the Asian-knotweed compost.
7 - Compost simply spread on top of the soil.
8 - Compost mixed with the underlying soil.

- The vegetation on the plot with the compost simply spread over the ground was ruderal, essentially herbaceous, and rather meagre with some bare ground. The second plot where the compost was mixed with the soil had the same type of vegetation, but denser.
- In 2020, the plot had become completely covered with plants and one part had reverted. The dominant species observed during the field survey were Creeping thistle (*Cirsium arvense*), Prickly ox-tongue (*Helminthotheca echinoides*) and Common thistle (*Cirsium vulgare*). No knotweed was observed.
- Composting of knotweed is an effective technique with no risk of dispersal if the composting process is correctly implemented.

■ Financial aspects

- Financially speaking, in the context confronting the Orge River Board, the use of composting to manage Asian knotweed turned out to be less expensive than incineration.
- Incineration of one ton of knotweed costs 233 euros (before VAT), whereas one ton of knotweed processed in a composting unit costs 30 euros (before VAT), i.e. composting is almost eight times less expensive. What is more, composting the knotweed could contribute to the development of local economic activities.
- Composting also reduces the workload involved in transporting the green waste because it can be collected on the work site using the Board truck and transported directly to the Zymovert company. The personnel in charge of uprooting the knotweed is no longer required to first transport the waste to an intermediate storage site (requiring two to three persons per truck). Consequently, more time is available for the actual management work.

Information on the project

- A study report was drafted as well as an information document, that were sent to the technical and financial partners of the Orge River Board.
- A video was made available on the internet in November 2018.
- A management report was published in the Bulletin n° 24 of the Forum des Marais Atlantiques in September 2020.

Outlook

- The Orge River Board decided to continue with composting Asian knotweed in 2020. At some point, tests will be run on composting other IASs such as Himalayan balsam (*Impatiens glandulifera*).

Authors: Mathieu Gouirand, Orge river board, Madeleine Freudenreich and Clara Singh, IUCN French committee, for the Resource Centre on invasive alien species. April 2020. Editor: French Biodiversity Agency.

2022 edition



9 - Situation on the plot with the compost simply spread over the ground.
10 - Situation on the plot with the compost mixed with the soil.

For more information

- Reports for the years 2005-2009 and 2019 drafted by the Natural environment forward-planning and studies department of the Orge River Board (AVELINE N., 2011 and LACHIZE N., 2019). (In French)
- Internet site:
<http://www.syndicatdelorge.fr/>
- Vidéo :
<https://www.youtube.com/watch?v=KKx7nmzzHjE>
- LACHIZE, N. and GOUIRAND, M. 2019. Report on a composting experiment for Asian knotweed 2018-2019. Natural environment forward-planning and studies department. (In French)



Caladium bicolor

(*Caladium bicolor*)

The plant is known by various common names around the world, including angel wings, heart of Jesus and elephant ear. It originated in South and Central America and is used for ornamental purposes.

Description

- Perennial, herbaceous plant, bulbous, no hairs, stands straight to a height of approximately 50 cm
- Pointed, heart-shaped leaves arranged in a rosette, measuring 20 by 30 cm, pulpy stem 35 to 55 cm long, green with or without white or pink spots, primary and radiating secondary veins, in some cases white or pink to red in colour
- Axillary inflorescence with a spathe in a cone-shaped envelope, green base and white extremity, up to 14 cm long and 5 cm wide. Male spadices in the upper section, female in the lower
- Fruit in the form of orangish berries

Ecology and reproduction

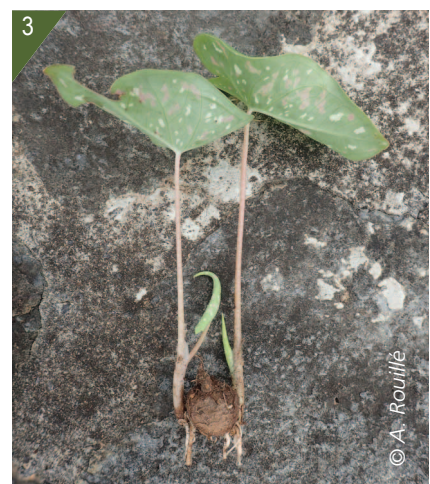
- The preferred habitat is wetlands, e.g. riparian forests, river banks, swampy areas
- Rapid development with deciduous leaves during the dry season in the natural environment
- Entomophilous pollination
- Vegetative multiplication is possible via cuttings of the bulbs
- All parts of the plant are toxic

Documentation

- CABI. 2019. Invasive species compendium. *Caladium bicolor* [On line] <https://www.cabi.org/ISC/datasheet/121808>

Author: Doriane Blottière, IUCN French committee, for the Resource Centre on invasive alien species in conjunction with the overseas IAS initiative. July 2019. Published by the French Biodiversity Agency.

Classification	
Order	Alismatales
Family	Araceae
Genus	<i>Caladium</i>
Species	<i>C. bicolor</i> (Aiton, Vent., 1801)





Caladium bicolor

(*Caladium bicolor*)

Managing *Caladium bicolor* in the Mount Hachiroungou departmental forest (Mayotte)

Mayotte Environmental Directorate (DEAL), Environmental and Risk-prevention Service, Biodiversity Unit

■ DEAL operates under the authority of the Prefect and is in charge of formulating and implementing State policies in the fields of the environment, economic growth and sustainable development.

■ The mission of the Biodiversity Unit, among other objectives, is to implement data-gathering programmes, manage national action plans and IAS networks, set up protected areas, develop suitable management techniques and regulations, and protect remarkable sites and landscapes.

■ Contacts: Miguel Lamalfa Díaz, policy officer for terrestrial fauna and flora - miguel.lamalfa-diaz@developpement-durable.gouv.fr and Antoine Rouillé, policy officer for ecological networks and landscapes - antoine.rouille@developpement-durable.gouv.fr

Mayotte Departmental Council, Environmental Directorate (DEDDE), Environmental Service (SE)

■ This service is in charge of managing several sites owned by the French Seaside and Lake Conservation Trust in Mayotte. It organises the visitor service for the general public, site development, ecological restoration and the management and monitoring of fauna and flora, with particular emphasis on the protection of sea turtles.

■ Contact: Bacar Ousseni Mdallah, head of the Site-management Office - bacar.ousseni-mdallah@cg976.fr

Mayotte Departmental Council, Land and Marine Resources Directorate (DRTM), Forest Service (SRF)

■ This service is primarily in charge of managing, protecting, developing and valorising the natural heritage of the departmental forests. Its three main lines of work are the protection of remarkable environments and species, marketing of forest products and welcoming the general public. The service actively monitors and reports on any offences committed in departmental forests and works to restore illegally cleared areas.



1, 2. *Caladium bicolor* plants in the Mount Hachiroungou departmental forest.

■ Contact: Chanrani Soidri, head of the Forest Planning and Works Office - chanrani.soidri@cg976.fr

Mascarin National Botanical Conservatory (CBNM)

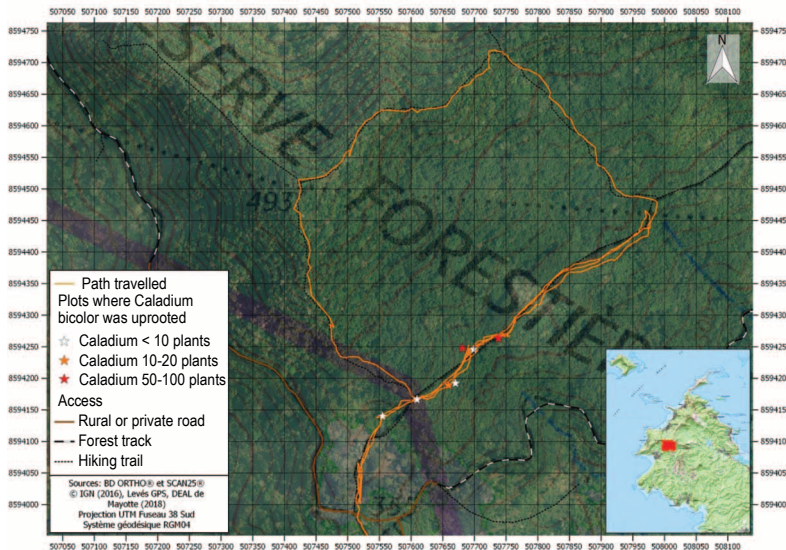
■ CBNM is a non-profit founded in 1986. Its mission consists of gaining new knowledge, conservation, providing science advice and raising awareness concerning the issues dealing with the preservation of plants on the islands of Réunion and Mayotte and the Scattered Islands. It was in charge of the strategy against invasive alien plants on Mayotte from 2016 to 2018.

■ Contact: Sébastien Traclet, policy officer for knowledge and conservation of flora and habitats on Mayotte - straclet@cbnm.org



Intervention site

- The species was discovered on 22 November 2018 by a DEAL technician during a project to map land use on the island.
- The site is located in the northern section of the island, in the town of Mtsamboro, itself in the Mount Hachiroungou departmental forest, on leg four of the hiking trail, near the path leading up to the forest from Acoua.
- *Caladium* is an ornamental plant commonly found in gardens and can easily colonise environments that have been severely modified by humans. This part of the hiking trail is heavily used by farmers in the area who lead their herds to the river that flows year round, between the trail and the forest track somewhat downstream. The movements of the livestock may disperse the plants from the environments impacted by human activities to the nearby natural environments.
- The colonised area consisted of eight plots, five with less than 10 plants, one with 10 to 20 plants and two with 50 to 100 plants. The eight plots covered a total surface area of 20 square metres.
- The plots are located in a section of the trail where a strong edge effect and easier access to light would suggest that the species is less likely to colonise heavily wooded areas where there is less light reaching the ground.



Plots where *Caladium bicolor* was discovered.

Disturbances and issues involved

- The Mount Hachiroungou departmental forest is a protected area that is home to several native species, some of which are endemic. It is one of the few environments that remain only slightly modified on Mayotte.
- *Caladium bicolor* is a potentially invasive species (2P¹) and had never been mentioned in the area previously. Rapid work to eradicate the species could avoid significant colonisation of the regeneration layer and subsequent risks for the survival of the forest. If the species were to proliferate, it could enter into competition for space and resources with the native species on the forest floor. That could result in a major reduction in forest regeneration via natural regrowth (seedlings) with a direct impact on the plant communities, the number of trees and forest structure and dynamics² in general.



3, 4, 5. Uprooting bulbs and rhizomes.

1. Classification by Lavergne, 2016. 2P (potentially invasive species): cultivated, escaped from a garden/field or naturalised locally, invasive behaviour on one or two sites on the island, considered invasive elsewhere in the world (alien species of concern).
2. Forest dynamics consist of processes such as growth, death and regeneration of plants that modify environmental conditions and resources (quantity of light, soil aeration, litter quantity and quality, etc.).

Interventions

- Following detection by the DEAL technician, an early-detection report was filed in the framework of the strategy against invasive plants for Mayotte. CBNM was consulted in order to confirm the identity of the species and assist in determining the necessary management work.
- DEAL and the departmental services appointed to manage the early-detection system (SRF) and rapidly organise the work (SE) within the Flora Invasive Species Group for Mayotte (GEIM) set up a management programme as quickly as possible.
- The work took place on 19 December 2018.
- The bulbs and rhizomes of the plants were removed using pickaxes and shovels. Efforts were also made to find and remove any bulbs hidden underground.
- The green waste was removed in plastic bags to dry on the DEAL compound, a site removed from the natural environment. Transportation of the plants was made easier by the fact that the plots were located on the hiking trail near a track accessible to vehicles.
- The green waste was laid out on the DEAL lawns and monitored.

Results and costs

■ Results

- All visible plants in the plots, representing a total volume of approximately 90 litres (three garbage bags, 30 litres each) were removed and transported from the site.
- In the drying area, following a rainy period, some bulbs, even those cut into parts to accelerate the drying, rapidly developed rhizomes and sprouted. Subsequently, the green waste turned over twice and placed on a concrete floor to ensure complete drying with no regrowth.

■ Costs

- This work occupied four people (two DEAL personnel and two from the Departmental Council) for half a day.
- Beyond the time spent by the personnel, no further outlays were required given that all the necessary equipment was lent by DEAL, CBNM and the Departmental Council.

Information on the project

- An early-action report was drafted for this operation. It described the populations of plants and presented the people taking part, a simplified version of the interventions, the amount of work and how the waste was processed. The report was submitted to GEIM, the local entity in charge of efforts against invasive plants.

Outlook

- Monitoring has been planned in conjunction with other work in the area.
- Concerning the green waste produced by uprooting, it would appear preferable to place it immediately on a concrete surface or to dip it in salt water to avoid any regrowth.



6. An uprooted *Caladium* plant.
7. An unearthed *Caladium* bulb.
8. Bagged *Caladium* waste.
9. Drying the green waste



■ This operation was the first time that an early-detection report was made, followed by rapid organisation of the necessary work. It was a success given the rapid reactions of the partners and the quick launch of the work. That is an encouraging sign for future operations of the same type in Mayotte.

■ The momentum created by this operation led to the submission of a new alert for pine-cone ginger (*Zingiber zerumbet*) and bamboo (*Bambusa vulgaris*). The work should take place in 2019.

Authors: Miguel Lamalfa Diaz, Mayotte DEAL, Sebastien Traclet, CBNM, and Doriane Blottière, IUCN French committee, for the Resource Centre on invasive alien species in conjunction with the overseas IAS initiative. July 2019. Published by the French Biodiversity Agency.

2022 edition

For more information...

- DEAL Mayotte, 2018. Report on an early-action operation. Operational strategy against invasive alien plants on Mayotte. 12 pp. (In French)
- Lavergne C., 2016. Proposed hierarchy of invasive and potentially invasive alien plant species on Mayotte. Note on methods in drafting a hierarchical list of invasive alien species for their management. Version 1.1, November 2016. Note not published, National Botanical Conservatory and Mascarin Centre for Environmental Initiatives (CPIE), Saint-Leu, 56 p. (In French)



Pampas grass

(*Cortaderia selloana*)

Originated in South America (Chile, Brazil, Argentina). Introduced as an ornamental plant around the world, but also used as fodder, for wind breaks and to stabilise soil.

Description

- Perennial, herbaceous plant
- Grows in clumps up to 2 metres in diameter and 4 metres high
- Numerous, smooth leaves, narrow, long and straight, 0.8 to 1.5 metres long, 5 to 10 mm wide, sharp edges. The leaves curve toward the ground
- The inflorescences are made up of dense, fluffy, feather-like panicles, whitish in colour, 0.3 to 1 metre long
- Rows of 2 to 7 flowers, the lemmas of male flowers are almost smooth, those of female flowers have long, silver hairs

Ecology and reproduction

- Wide range of habitats (dunes, wet swards, marshes, ditches, river banks, roadsides, reverted land, etc.) The plants prefer sunny, humid areas, but can survive dry periods
- Life cycle of 10 to 15 years
- The plants produce large quantities of seeds that are easily carried by the wind
- Generally a dioecious species

Documentation

- Fried G. 2012. Guide des plantes invasives. Belin, Paris, 272 pp.
- Muller S (coord.), 2004. Plantes invasives en France. MNHN, Paris, 168 pp.
- Brunel S (coord.), 2003. Plantes envahissantes de la région méditerranéenne. Agence méditerranéenne de l'environnement, Conservatoire botanique national méditerranéen de Porquerolles, Agence régionale pour l'environnement Provence-Alpes-Côte d'Azur. 48 pp.
- CABI, 2018. Invasive Species Compendium : *Cortaderia selloana* (pampas grass). <https://www.cabi.org/isc/datasheet/11872>

Author: Doriane Blottière, IUCN French committee, for the Resource Centre on invasive alien species. March 2019. Published by the French Biodiversity Agency.

Classification	
Order	Poales
Family	Poaceae
Genus	Cortaderia
Species	C. selloana ((Schult. & Schult.f.) Asch & Graebn, 1900)





Pampas grass (*Cortaderia selloana*)

Managing pampa grass in the Salazie and Mafate cirques (Réunion Island)

French National Forestry Agency (ONF)

- ONF is a public agency that manages over 100 000 hectares of public forest on Réunion Island, representing 40% of the total island surface area. The managed forests cover 85% of the central zone of the Réunion national park.
- ONF is in charge of implementing forestry policy (monitoring, execution of development plans, work planning) and of running studies and projects dealing with ecosystem conservation, wood production and installations to welcome the public.
- Contact: Julien Triolo, ecologist - julien.triolo@onf.fr

Intervention site

- In the natural environment, pampa grass has been observed since 2001 in the Salazie and Mafate cirques. Elsewhere on the island, the grass is generally limited to gardens where it is used as an ornamental plant.
- The two cirques, formed by the collapse of the *Piton des neiges* mountain, include numerous areas with ramparts that are very difficult to access. The cirques and ramparts on Réunion Island have been listed as part of the world cultural and natural heritage since 2010 and the invasive alien species (IAS) are considered the main threat to the ecological integrity of the sites.
- The species had developed a sizeable colony in the Salazie cirque with numerous, dispersed groups, in particular along the Mât River. Several thousand individual plants were identified, ranging from large clumps occupying several square metres to individual juveniles only 10 cm tall. In the Mafate cirque, small populations were observed along the Galets River, the Col des Boeufs pass, the Merles plain and the Scout path.

Disturbances and issues involved

- Pampa grass is a highly competitive species that consumes considerable quantities of resources to the detriment of the native flora. The proliferation of the species provokes profound changes in the structure and composition of vegetation.
- The grass is highly inflammable and can increase the risk of fires.



1. Position of the cirques on Réunion Island.
2. First stands of pampa grass found in the Merles plain in 2001.

- It also constitutes a favourable habitat for brown rats (*Rattus norvegicus*), an invasive alien species that destroys native bird populations and is a potential carrier of leptospirosis.

Interventions

■ Past interventions

- Since 2012 in the framework of the operational plan against invasive species on Réunion, the species has been the target of a regional plan, where the local Environmental Directorate (DEAL) funded the work done by the National Forestry Agency (ONF). Since the initial inventory phase, the purpose of the work has been to eliminate stands of grass early in the invasion process in order to avoid massive colonisation of the natural environment.

- Uprooted sites were then monitored annually to eliminate any sprouts and new plants.

[illegible]

Results and costs

■ Results

- Surveys run after the work done requiring helicopters indicated that the pampa grass had disappeared from certain work areas, which was an encouraging sign.
- On the other work sites, a reduction in pampa grass and a slight amount of new growth were observed, except in the areas downstream of the Manouilh source where numerous sprouts and new seedlings were noted. These areas were subjected to a particular effort in 2016 and in 2017 with 372 plants uprooted and buried, plus over 1 200 seedlings destroyed during a total of 24 work days.
- Most of the new sprouts did not have enough time to flower between two uprooting operations.
- The introduction and/or return of the species would appear to be slowed by the presence of a dense, herbaceous cover or by forest given that the most heavily invaded and recolonised areas are those exposed to the sun and with no plant cover.

■ Costs

Human resources invested in the uprooting work.

Year	2013	2014	2015	2016	2017	2018
Forest workers (man-days)	24	27	40	22	24	40
ONF agents (man-days)	4	5	7	6	NA	
Helicopter (flight hours)	2	3	4.5	5	3	5

NA: Not available.

- Teams doing surveys and removing plants on foot consisted of at least five people, teams transported by helicopter consisted of four (the number of passengers per trip).
- Contrary to the other years, the work requiring mountaineering equipment was not carried out by ONF forest workers in 2017 and 2018 because it took place on one of the most difficult sites, namely a rampart 600 metres high in the area downstream of the Manouilh source, in the Salazie cirque. This work was contracted out to a specialised company, GTOI, thanks to funding from the DEAL.
- The work to remove sprouts and regrowth is funded by the Departmental Council via European EAFRD funding.

Funding for uprooting work since 2012.

Year	Amount (€)	Origin of funds	Interventions
2012	3 850	Funded by ONF	Mapping
2013	19 716	DEAL	Uprooting in Salazie
	5 320	Funded by ONF	
2014	15 800	DEAL	Uprooting in Salazie
	3 880	Funded by ONF	
2015	20 580	DEAL	Uprooting in Salazie
	4 560	Funded by ONF	
2016	14 260	DEAL	Uprooting in Salazie + Mafate
	5 420	Funded by ONF	
	19 527	EAFRD	
2017	16 493	DEAL	Uprooting of Salazie ramparts subcontracted to GTOI
	3 000	Funded by ONF	
	19 527	EAFRD	
2018	44 057	DEAL	Uprooting of Salazie ramparts subcontracted to GTOI
	2 650	Funded by ONF	
	19 527	EAFRD	



6, 7, 8. Uprooting work using mountaineering equipment.
9. Green waste in big bags.

Information on the project

- Efforts to raise awareness were made in parallel with the management work. During monitoring work for sprouts and regrowth, any inhabitants encountered were informed on the risks of dispersal and in some cases people themselves uprooted plants observed near homes.
- In 2014 and 2015, people were offered native plants in exchange for uprooting pampa grass from private gardens in order to avoid the spread of the private plants to the natural environments of Réunion.
- Numerous press articles and reports on the invasion of the natural environment by pampa grass appeared in the local press (*Le Journal de l'Île, Réunion 1ère, Antenne Réunion*, etc.).

Outlook

- Only a very small population of pampa grass in Terre-Plate (Salazie) has not yet be subjected to uprooting work. However, the work has been planned for 2019.
- Site monitoring will be continued and any sprouts and regrowth will be uprooted by the ONF personnel, thanks to EAFRD funding.
- The species is still present in a large number of private gardens. A procedure is now under way to prohibit the introduction and all uses of the species on Réunion, as per article L 411-6 in the Environmental Code. Work to remove the plants from the gardens of people who did not wish to voluntarily uproot the plants will subsequently be undertaken by the State in order to finalise the regional plan against the species.

Authors: Doriane Blottière, IUCN French committee, Julien Triolo and Dominique Chery, ONF, for the Resource Centre on invasive alien species in conjunction with the overseas IAS initiative. March 2019. Published by the French Biodiversity Agency.

2022 edition



10, 11. Unloading the big bags containing uprooted pampa grass and burial.

For more information...

- ONF. 2016. Mise en œuvre du Plan régional de lutte contre l'Herbe de la Pampa à La Réunion. Actions 2016, compte rendu d'exécution. ONF et DEAL Réunion. 8 pp.
- ONF. 2017. Mise en œuvre du Plan régional de lutte contre l'Herbe de la Pampa à La Réunion. Actions 2017, compte rendu d'exécution. ONF et DEAL Réunion. 8 pp.
- ONF. 2017. Méthodes de lutte contre les plantes envahissantes, fiches techniques. Ile de la Réunion. ONF, Deal et Groupe espèces invasives de la Réunion. 35 pp.
- AVE2M. 2016. Compte rendu action de lutte contre l'herbe de la Pampa 2015-2016



Hudson pear

(*Opuntia rosea*)

Originated in Mexico and introduced worldwide as an ornamental plant. May be found in the natural environment in Southern France. The long spines may cause serious wounds.

Description

- A cactus with branches, up to 1.5 metres high and 3 metres wide, a cylindrical trunk with connected segments
- Cylindrical segments, green to grey-green in colour, up to 90 cm long and 4 cm wide, easily detachable
- Segments are studded with white spines up to 3.5 cm long with hooks at the end
- Pink flowers up to 5 cm wide, stamens with yellow anthers and light yellow stigmates
- Yellow, oblong fruit, 2 to 4.5 cm long

Ecology and reproduction

- Dry, even arid and rocky environments, areas suffering disturbances, e.g. reverted land, road sides, degraded scrubland, rocky slopes, etc.
- The plant can reproduce via cuttings where the segments detach, root and produce a new plant
- Dissemination thanks to the hooks on the spines of segments that attach to hair, clothes, skin

Documentation

- Invasive Species Compendium. 2017. Datasheet: *Cylindropuntia rosea* (Hudson pear). [On line]. Document available at: <http://www.cabi.org/isc/datasheet/115975>
- Johnson S. B. et al. 2009. The biology of Australian weeds 53 : *Cylindropuntia rosea* (DC.) Backeb. and *Cylindropuntia tunicata* (Lehm.) F.M.Knuth. Plant Protection Quarterly. 24 (2): 42 - 49.

Author: Doriane Blottière, IUCN French committee, for the Resource Centre on invasive alien species. December 2018. Published by the French Biodiversity Agency.

Classification	
Order	Caryophyllales
Family	Cactaceae
Genus	Opuntia
Species	O. rosea (DC, 1828)





Hudson pear (*Opuntia rosea*)

Project to eradicate Hudson pears from the town of Celles (Hérault department)

Grand Site Salagou - Cirque de Mourèze (SMGS) board

- The board was founded in 2006. Members include the Hérault department and the Clermontais, the Lodévois et Larzac and the Grand Orb intermunicipal boards.
- Its mission is to manage the entire Grand Site Salagou-Cirque de Mourèze area, which covers a total of almost 10 000 hectares.
- In its work to preserve landscapes, the board coordinates management projects for invasive alien species (water primrose, curly waterweed, etc.).
- Contact: Victoria Dubus, Natura 2000 policy officer - victoria.dubus@lesalagou.fr

Intervention site

- The purpose of the Salagou reservoir, created following the construction of the dam on the Salagou River in the 1960s, was to provide water for irrigation and regulate the flow of the Hérault River. The reservoir covers 750 hectares in the towns of Clermont l'Hérault, Liausson, Octon, Salasc, Celles and Le Puech.
- The humid environment stands in stark contrast to the surrounding dry landscape of ruffes¹. The mouth of the Salagou River and the banks of the reservoir are listed under the Landscapes law (1930) and as Natura 2000 (special protection zone for birds) and ZNIEFF (natural zone with high ecological value) sites.
- A Hudson pear was discovered for the first time in the region by an ONCFS (National Agency for Hunting and Wildlife) agent in 2005. The site lay to the north-west of the reservoir, on the western slopes of Mount Cébérrou, above the village of Celles.
- In 2007, there were four distinct sites, covering approximately 2 000 square metres each.

Disturbances and issues involved

- The cactus has long spines that can easily pierce skin, shoes and even automobile tires. It represents a serious risk



1. Hudson pear sites in Celles.
2. A site in 2009, prior to the intervention.

of injury to livestock and wildlife, as well as a danger for people working in colonised areas.

- The segments making up the plant can easily detach and the spines enable them to cling to passing objects (animals, shoes, etc.), thus ensuring their dissemination. Once dispersed, the segments throw roots and develop into new plants. The species can thus rapidly colonise favourable habitats.

Interventions

■ Meetings

- In the beginning of 2009, meetings were held between the Porquerolles National Botanical Conservatory (CBNMED), the Hérault Departmental Council (CD 34), the town of Celles, the SMGS, the National Agency for Hunting and Wildlife (ONCFS) and the Agriculture ministry (DGAL/SDQPV).
- It was decided to attempt to eradicate the plants, given their limited number in a relatively small area.
- Mechanical uprooting was planned to the greatest extent possible, given the high risks of injury involved in manual uprooting due to the spines.

■ Initial uprooting work

- The work started with mechanical uprooting using a backhoe loader on 3, 6 and 7 April 2009.
- It continued with several days of manual uprooting on 7, 8 and 9 April and 4, 18 and 19 May 2009. Manual uprooting was carried out using a number of tools (rakes, hoes, cultivators, pickaxes, etc.) and the plants were collected in pails, tubs and baskets before being carried to a dumpster.
- The use of gloves was prohibited to avoid any attempts to pick up the plants with the hands given that the spines can pierce work gloves.
- The uprooted plants were subsequently buried in a ditch two metres deep.

■ Annual monitoring and additional uprooting

- After the initial work, a number of plants were found outside the uprooted areas.
- Given the difficulty in spotting fallen segments and small plants, and the ease of dissemination of the species, it was decided to monitor the situation annually and to proceed with additional manual uprooting.
- Each year, at the end of the winter or the beginning of spring, the entire area was inspected by board personnel and any detected plants were uprooted. This generally amounted to a morning of work.

Summary of additional manual uprooting done.

Date	Number of people	Approximate quantity of Hudson pear uprooted (in litres)
19 April 2010	10	100
16 May 2011	7	100
2 April 2012	8	75
9 April 2013	14	195
13 November 2013	5	A few plants
18 March 2014	15	120
5 October 2015	7	300
7 March 2017	7	240
Total	-	1 130



3. A Hudson pear developing from a segment.
4, 5, 6. Mechanical uprooting.

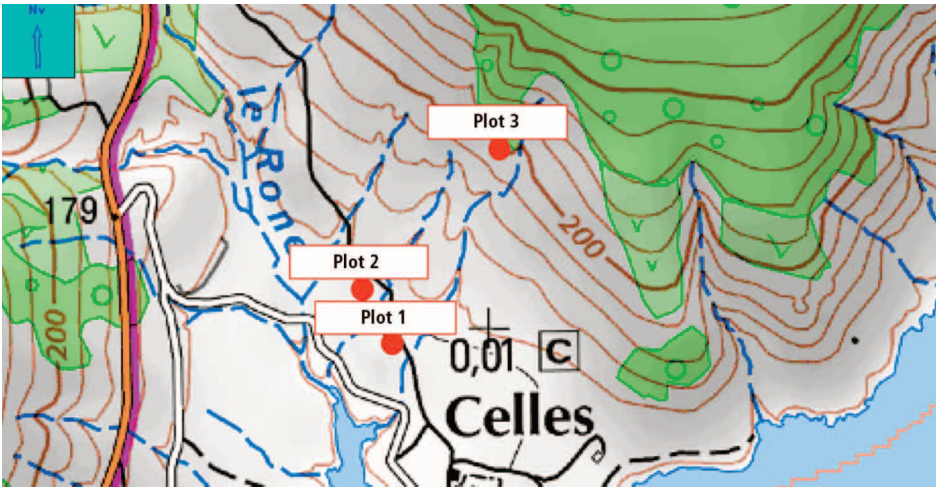
■ **Monitoring dissemination of the species**

- In order to study the dissemination process, three plots were selected during the fall of 2013 for a special monitoring effort. In each plot, the plants and any fallen segments were counted within a radius of five metres around a central point (a stake in the ground).
- In plot 1, 60 plants were counted. All the plants were uprooted, with the exception of one in the centre.
- In plot 2, no plants were found.
- In plot 3, 20 plants were detected and painted blue in order to monitor the dissemination of segments.
- In March 2014, an additional plant was found in plot 1 and the two plants were both uprooted. In plot 2, there were still no plants. In plot 3, 18 blue plants were still present (the two missing plants would suggest a counting error during the marking process). Six non-coloured plants were also found, as well as five blue segments on the ground. Only the 18 blue plants were left untouched, the non-coloured plants were uprooted and the fallen segments were collected.
- In May 2014, no plants were found in plots 1 and 2. In plot 3, in addition to the 18 blue plants, the monitors found 19 blue segments on the ground, 4 non-coloured plants and 1 non-coloured segment on the ground.
- The results in plot 3 are indicative of the difficulty involved in detecting the plants and of the ease of dissemination of the species.



7, 8. Manual uprooting.

Position of the monitoring plots.



- In May 2014, following counting in plot 3, all the plants were uprooted and all the fallen segments were collected.

Number of plants in the monitoring plots.

Date	Number of plants detected		
	Plot 1	Plot 2	Plot 3
13 November 2013	60 plants	0	20 plants (painted blue)
18 March 2014	2 plants (1 new)	0	18 blue plants + 6 non-coloured plants + 5 blue segments on the ground
23 May 2014	0	0	18 blue plants + 19 blue segments on the ground + 4 non-coloured plants + 1 non-coloured segment on the ground

Results and costs

■ Results

- During the initial interventions in 2009, the equivalent of four dumpsters (5 cubic metres each) of plants were removed, i.e. 20 000 litres.
- The additional uprooting over the following years represented a total of 1 130 litres.
- The species is still present on the site.

■ Costs

- The initial uprooting work in April and May 2009 was done by approximately 12 people over six and one-half days.
- The equipment (backhoe loader and dumpster) was supplied by the Hérault Departmental Council.
- The personnel came from the Hérault (CD 34) departmental services, including the Natural Areas and Departmental Land Agency and the Rural Land Management Directorate, the regional botanical network of the National Agency for Hunting and Wildlife (ONCFS), the Porquerolles National Botanical Conservatory (CBNMED), the SMGS and the town of Celles. Each entity covered the cost of its personnel.

Man-days of work (2009-2017) supplied by each entity.

Organisation	Man-days
CD 34	24.5
ONCFS	25
CBNMED	5.5
SMGS	10.5
Volunteers / Local officials	37.5
Total	103.0

Information on the project

- An article on Sunday, 18 April 2010, in the Midi Libre newspaper.
- On 7 June 2012, a visit to the site and a presentation of the project was given by the ONCFS botanical network to a delegation of the European plant protection organisation (EPPO) guided by Pierre Ehret (French Agriculture Ministry).
- A presentation of the project to eradicate the Hudson pear by P. Arnaud (ONCFS SD 34), R. Majurel (CD 34) and P. Ehret (Agriculture Ministry) was given during the EWRS symposium on invasive plants in Montpellier from 18 to 23 May 2014, with a visit to the site on 21 May.

Outlook

- The annual monitoring and uprooting have been continued because the smallest fragment of the plant on the site can take root and launch the start of a new colony.



9. The site in 2016 after the work.
10. Visit to the site during the EWRS symposium in May 2014.

■ The continued detection of new sprouts in spite of the fact that the interventions took place before the species had spread widely and that the area was carefully inspected each year raises doubts as to any real possibility of eradicating the species from the site.

■ In the current situation, grazing in the area is strongly not advised to avoid any risk of dispersal. It should be noted that the area was grazed by sheep up until 2009 and that signs of animals (that overcame the fences) were noted in 2014. In addition, it is impossible to stop the transport of segments by wild animals.

Authors: Doriane Blottière, IUCN French committee, and Victoria Dubus, Grand Site Salagou - Cirque de Mourèze board, for the Resource Centre on invasive alien species. July 2018. Published by the French Biodiversity Agency.

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Brown salwood

(*Acacia mangium*)

Originated in Australia, Papua New Guinea and Indonesia. Introduced in numerous tropical regions for its wood (firewood, paper, etc.) or for reforestation of land.

Description

- The trunk can grow to a height of 30 metres with a diameter at the base of 50 centimetres
- Rough bark, with longitudinal furrows, ranging in colour from light grey-brown to brown
- Phyllodes (stems that have transformed into leaves) range from 11 to 27 cm in length and 3 to 10 cm in width, are dark green in colour, have a smooth pulvinus (a thick section at the base of the stem) 6 to 10 mm in length and longitudinal veins, generally 4 in number
- Inflorescence in loose off-shoots, between 5 and 12 cm long, small flowers white to yellowish in colour
- Long pods that curl when mature, 7 to 8 cm long and 0.3 to 0.5 cm wide
- Bright black seeds, oval to oblong in shape, 3 to 5 mm long and 2 to 3 mm wide, with a yellow to bright orange funiculus (stalk attaching to the ovary wall)

Ecology and reproduction

- A pioneer species that grows in open areas (savannahs, plains), but also in forests
- It follows on fires and can tolerate a wide range of pH levels in the soil
- Rapid growth, up to 2.5 metres per year
- Hermaphroditic, self-pollinating plant, produces viable seeds starting at 18 to 20 months of age
- The trees flower from February to May in their original range

Documentation

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Author: Doriane Blottière, IUCN French committee, for the Resource Centre on invasive alien species in conjunction with the overseas IAS initiative. December 2018. Published by the French Biodiversity Agency.

Classification

Order	Fabales
Family	Fabaceae
Genus	Acacia
Species	<i>A. mangium</i> (Willd, 1806)



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Brown salwood

(*Acacia mangium*)

Experiments on techniques to regulate brown salwood in the savannahs of Guiana

Bird study and protection group of Guiana (GEPOG)

- GEPOG is an environmental non-profit active in studying and protecting birds in Guiana, in managing natural areas, in contributing to public debates on environmental issues and in raising environmental awareness of different segments of the public in Guiana.
- It launches and participates in scientific studies, and plays an active role in managing protected areas in Guiana as a member of various management committees. The group is a founding member of the *Guyane Nature Environnement* federation and currently presides the Guiana Nature Conservatory.
- Contacts: association@gepog.org or Anna Stier, environmental policy officer - anna.stier@gepog.org

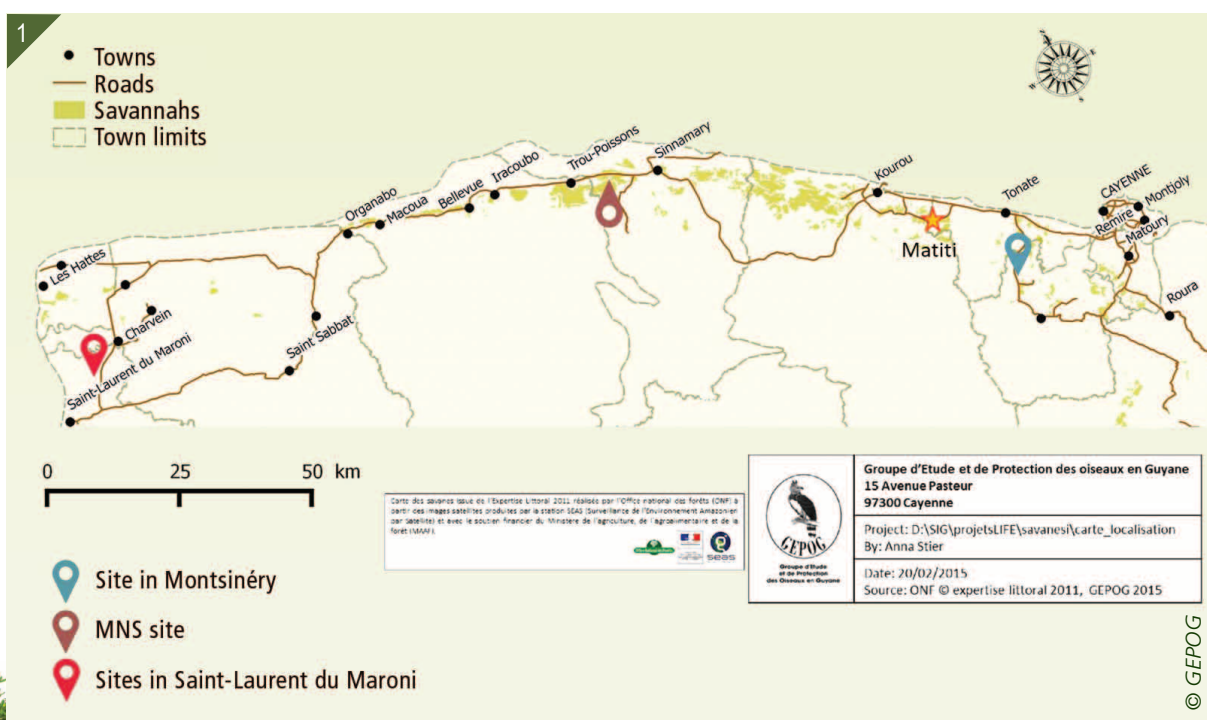
Intervention site

- Savannahs are herbaceous environments in which bushes and trees are relatively rare and isolated. They represent only 0.3% of the total land area in Guiana (260 square kilometres) and exist as a narrow band on clay-sand soil

lying between the coast and land further inland. These areas are vulnerable and threatened in that they tend to disappear in step with economic development and population growth along the coast. However, they are home to over 20% of the protected plant species in Guiana. Though small in size, these rich environments represent an exceptional, natural heritage that must be protected.

- A conservation project specifically targeting the savannahs (2011-2015), in the framework of the LIFE + Cap DOM programme (efforts in favour of birds and threatened habitats in the overseas territories), included three experiments, launched in 2013, to develop effective management techniques for *Acacia mangium*.

- The two initial phases of the project were launched in Matiti (see the map below) on abandoned farm land that had previously been savannah and was subsequently invaded by the species. The five lots in the third phase were distributed east to west along the coast with two in natural areas (savannah) in Montsinéry and at the House of Nature in Sinnamary (MNS), one in an agricultural area (Saint-Laurent du Maroni) and two on previously forest land that had been cleared and then rapidly invaded by the brown salwood (also in Saint-Laurent du Maroni).



1. Experimental sites along the coast in Guiana.

Disturbances and issues involved

■ *Acacia mangium* has been identified as one of the two most troublesome, naturalised species in Guiana. The trees grow rapidly and can form single-species stands. Their propagation in the open ecosystem of a savannah is encouraged by the frequent fires.

■ The species closes in the environment and results in higher nitrogen levels in the soil and in dryer soil. The falling phyllodes create a layer of litter on the ground that decomposes very slowly. Even when the trees have been eliminated from an area, the highly modified soil conditions hinder the re-establishment of plant communities native to the local savannahs.

Interventions

■ Efforts against adult trees

■ Adult trees, i.e. those with a diameter of more than 15 cm at a height of 1.3 metres, were split into four groups and treated using different techniques:

- girdling (removal of the bark around the tree) over a total height of 40 cm from the base;
- girdling with application of a phytocide (triclopyr diluted to 4%) at the bottom of the girdled section;
- sawing at the base of the tree;
- sawing at the base of the tree and application of a phytocide to the cambium layer.

■ The treated trees were then monitored for one year.

■ Study on depleting the seed bank

■ A first phase of the study (not presented in detail here) consisted of determining the distribution of seeds by taking soil samples around the issuing trees. It revealed that a major part of the seed bank was located under the crown of a tree and that the density fell off rapidly with the distance beyond the projection cone of the crown. Seed density per square metre as a function of the distance from a tree could thus be modelled. It also revealed that no seeds were found at depths exceeding 10 cm.

■ During the second phase, experiments were run on two techniques designed to deplete the seed bank. Forty plots (2 x 2 metres) were set up along a hedgerow of adult brown-salwood trees:

- ten were hoed manually to a depth of 15 cm (corresponding to a disturbance equal to that of uprooting the bushes);
- twenty plots were burned (using 500 grams of hay per square metre or more if the ground was wet);
- ten plots served as a control group that were not hoed or burned.

■ Any young sprouts were counted every three days. The seedlings were uprooted during each inspection to avoid subsequent counting errors.

■ Samples were also taken to determine the number of viable seeds remaining in the soil after burning, in comparison with the number of seeds modelled during the first phase of the study.



2. The advancing line of brown salwood in the savannah.

3. Girdling a tree trunk.

4. Study on depleting the seed bank using fire.

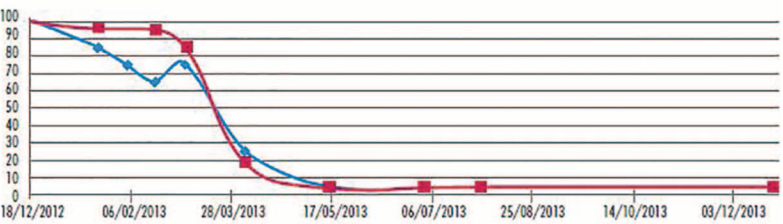
■ **Test on eliminating the trees and seed banks over entire study areas**

- The techniques described above were used on the five experimental sites.
- Juvenile trees were uprooted manually, adult trees were sawed at their base.
- On two of the sites, fire was used to eliminate the seed banks.
- During subsequent monitoring, any seedlings and sprouts were uprooted. Any trees that were missed during the first passage were also removed.

Results and costs

■ **Results**

- No sprouts were observed on trees sawed off at the base, whether or not a phytocide was used.
- All of the girdled trees had died after a period of five months, with or without application of the phytocide (two surviving trees had been incorrectly girdled).
- Outside of the study plots, sprouts were regularly observed on trees that had been sawed at various heights.
- In the framework of the study on the seed banks, no sprouts were observed on the plots making up the control group and only one sprout was seen on the plots that had been hoed manually.



Percentage of trees still with sap over time, following girdling.
(■ : girdling ; ■ : girdling + phytocide).

- The use of fire destroyed 43% of the seeds in the soil, on average, or caused their germination, which facilitated subsequent uprooting. This technique can be used in certain cases because it partially eliminates the seed banks, but it is necessary subsequently to eliminate any sprouts. In addition, its use in protected areas may be problematic and the impact on other species must be taken into account.
- The tests carried out over entire study areas revealed that when the trees were sawed at a height of less than 20 cm from the ground, the probability of new sprouts fell to below 5%.
- The elimination of adult trees results in the growth of new trees and it is necessary to pursue the uprooting work until the seed bank has been depleted.

■ **Costs**

- The total cost of the experiments on management techniques for brown salwood amounted to 66 910 euros (including 34 820 € for personnel costs).
- For the GEPOG, three employees and an intern (Master 2) spent time on the project. Among the contributing partners, seven employees participated in the work, as well as a dozen volunteers.



5. The removal of juvenile brown-salwood trees from a site.
6. Monitoring sprouts and seedlings on treated sites.



Information on the project

- Numerous efforts were made to communicate on the work:
 - posters were displayed in the museum of the MNS and at the national IAS conference;
 - reports were sent to an array of internet sites; www.savanes.fr, www.lifecapdom.org ;
 - conferences were held;
 - a LIFE+ Cap DOM exhibition toured Guiana during the project;
 - presentations were given to students at the agricultural school of Matiti;
 - articles were published in the information bulletins for the Yiyi marshes and the IUCN overseas IAS initiative;
 - events were organised with the town of Sinnamary;
 - explanatory videos were produced (<http://www.savanes.fr/mediatheque/>).

Outlook

- The study showed that the use of phytocides is not necessary and that chainsawing is the most rapid and least expensive management method for adult trees. Girdling is also an effective technique for trees that cannot be sawed, but particular care must be taken to completely remove the cambium layer to ensure that the tree does indeed die.
- Regular monitoring is absolutely required for the treated areas to eliminate sprouts produced by the seed banks that can remain active for dozens of years. To say nothing of the fact that birds can constantly spread new seeds.
- The use of these techniques on a much larger scale in the coastal savannahs is planned in the framework of one part of the LIFE+ Biodiv'OM programme starting in September 2018.

Authors: Doriane Blottière, IUCN French committee, and Anna Stier, GEPOG, for the Resource Centre on invasive alien species in conjunction with the overseas IAS initiative. December 2018. Published by the French Biodiversity Agency.

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7. Poster displayed in the museum of the Sinnamary House of Nature.

For more information...

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Miconia trees

(*Miconia calvenscens*)

A tree native to tropical rainforests in Central and South America. Introduced as an ornamental species in French Polynesia in 1937 and New Caledonia in the 1970s.

Description

- The trunk is 4 to 12 metres tall and can reach 16 m in some cases
- Large, oval leaves, 20 to 80 cm long and 8 to 30 cm wide, smooth, dark green on the upper side, purple on the under side, acuminate tip, smooth or slightly indented edges, with three, clearly marked longitudinal veins
- The inflorescences are made up of panicles 20 to 35 cm long, sessile flowers in groups of five, with bracts 2 to 3 mm long, smooth, white petals
- Round fruit, purple to black at maturity, 3.5 to 4.5 mm in diameter, seeds oval to pyramidal in shape and 0.5 mm long

Ecology and reproduction

- May be found in wet, tropical forests, from sea level to 1 400 metres altitude in Tahiti
- The trees form dense, single-species thickets
- Rapid growth (up to 1.5 m per year), capable of reproduction after 4 to 5 years, capable of vegetative multiplication
- Seeds are dispersed by birds (ornithochory), on slopes (barochory) and by water (hydrochory). They germinate immediately on being exposed to light or following a dormant period in soil

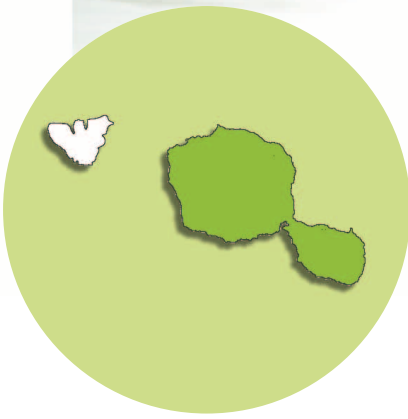
Documentation

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Author: Doriane Blotti re, IUCN French committee, for the Resource Centre on invasive alien species in conjunction with the overseas IAS initiative. May 2018. Published by the French Biodiversity Agency.

Classification	
Order	Myrtales
Family	Melastomataceae
Genus	Miconia
Species	M. calvenscens (DC., 1828)





Miconia trees

(*Miconia calvescens*)

Introduction of a pathogenic fungus to check the growth of Miconia trees and restore the wet forests of Tahiti (French Polynesia)

Research Agency for French Polynesia and the Louis-Malardé Institute

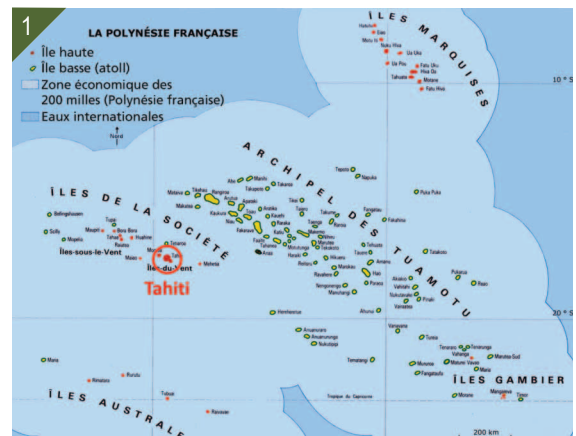
- The primary task of the Research Agency is to prepare, coordinate, stimulate and monitor the implementation of research policy in French Polynesia.
- The Louis-Malardé Institute, a publicly funded institute in French Polynesia, contributes through its work to preserving health, public sanitation and the natural environment of French Polynesia.
- Contact: Jean-Yves Meyer - jean-yves.meyer@recherche.gov.pf

Intervention site

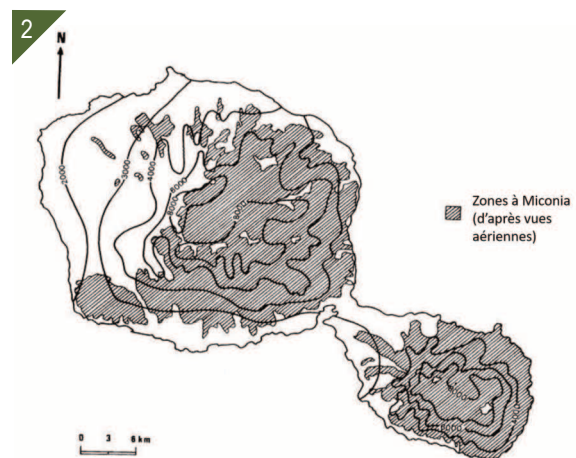
- The tropical forests of the Pacific islands, including those of French Polynesia, are hotspots of biodiversity, particularly in terms of the endemic plants. However, numerous invasive alien species threaten that biodiversity.
- Miconia trees were introduced to Tahiti for the first time in 1937 as an ornamental plant in a private botanic garden and subsequently dispersed to several islands in the Society and Marquesas groups. They have since become a major priority in efforts to preserve the wet forests of the islands. Over the past 50 years, the species has spread to over 70% of Tahiti and may now be found up to altitudes of 1 400 metres in the “cloud forests”.
- A number of techniques are used to combat the species, depending on the point in the invasion process and the development of the plants, and on the available means (uprooting, manual or chainsaw cutting, use of herbicides on stumps).
- Due to the limited effectiveness of those methods and the extent of the colonisation, work was put into finding a biological means to manage the plants.

Disturbances and issues involved

- Miconia trees develop into dense, virtually single-species stands and thus severely reduce the light for native plants in the understories, particularly herbaceous plants, shrubs and young trees. They directly threaten approximately one hundred species endemic to Tahiti.
- Their presence is also thought to lead to erosion on steep slopes.



© Cartograph.fr



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1. Position of Tahiti and the archipelagos of French Polynesia.
2. Colonisation by Miconia trees in Tahiti..

Interventions

■ Search for a biological-control agent

- In 1997, a pathogenic fungus, *Colletotrichum gloeosporioides* forma *specialis miconiae* (CGM), was discovered in Brazil by the phytopathologist Robert Barreto. The fungus causes anthracnose disease (drying) in the leaves and necrosis of the plant as a whole.
- According to laboratory tests run in Hawaii, CGM is highly specific to Miconia and does not attack native and endemic plants (Killgore et al., 1997).

■ A test in Tahiti

■ In 2000, with the approval of the Polynesian government, the pathogenic agent was released on two invaded sites located at an altitude of approximately 600 metres in the wet forest (precipitation > 3 000 mm per year). The development of almost 100 *Miconias* at various growth stages, ranging from seedlings to adult trees, was monitored for six years.

■ For the test, the fungus spores, grown in a lab at the Louis-Malardé Institute, were placed in a solution and sprayed on the targeted trees.

■ Thirty days after spraying, spots were observed on leaves and after three months, 100% of the trees on the test sites were infected, with damage on 90 to 99% of leaves. The observed mortality rate was 15% for the species as a whole and reached 30% for plants less than 50 cm in height.

■ Monitoring changes in *Miconia* populations

■ Over a period of three years, the fungus spread to the entire island of Tahiti and infected virtually all *Miconias*. It was also observed on Moorea, an island located 20 kilometres to the north-west of Tahiti, though the fungus had not been intentionally released there.

■ No infection of any non-targeted plants was observed at any time.

■ The degree of observed defoliation increased with the altitude, from 5 to 45% between 600 and 1 000 metres, suggesting the influence of temperature and humidity rates on the development of the infection and on the reproduction and dissemination of the pathogen.

■ Monitoring over five years (2005-2010), on eleven test sites representing 100 square metres each, positioned along an altitude gradient, revealed a return of native plants, particularly pioneer species requiring larger amounts of light. Recolonisation by other invasive plants remained limited at the lower altitudes. Rare endemic plants, such as *Pittosporum taitense* trees or the *Liparis clypeolum* orchid, were observed on one site at an altitude of 600 metres, whereas they had not been seen in that area for twenty years.

Results and costs

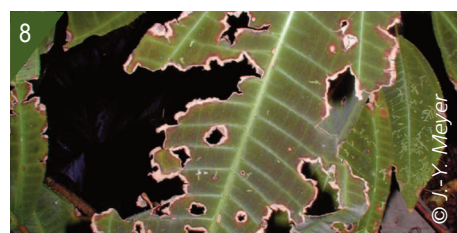
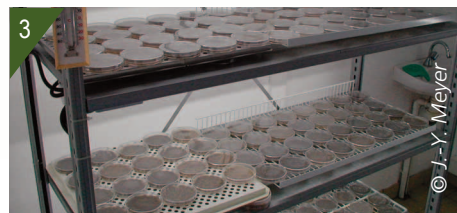
■ Results

■ Even though CGM did not totally eliminate *Miconia* from Tahiti, even 16 years after its introduction and in particular in the lower altitudes where the higher temperatures would seem to limit its activity, the monitoring nonetheless confirmed its relative effectiveness in restoring mid-altitude wet forests.

■ The partial defoliation of the *Miconia* trees benefited native plants, including threatened endemic species on the French IUCN red list, such as *Myrsine longifolia* (EN), *Psychotria speciosa* (EN) et *Ophiorrhiza subumbellata* (VU).

■ Costs

■ The overall programme for research and interventions against *Miconia* in French Polynesia, funded by the Polynesian government, was estimated to represent 71 million CFP francs, i.e. approximately 595 000 euros, for the period 1988 to 2008. The cost for the work since 2008 was not available.



3. CGM grown in Petri dishes in the lab.
4, 5. Applying CGM to *Miconia* trees.
6, 7, 8, 9. Damage to leaves caused by the fungus.

Information on the project

- A chapter in the book titled *Suppressing over-abundant invasive plants and insects in natural areas by use of their specialized natural enemies*, (Van Driesche & Reardon, 2017) was devoted to the Miconia programme (Meyer, 2017).
- The interventions were the topic of numerous articles in the local press and on various internet sites, as well as of television and radio programmes (Polynésie Première, La Dépêche de Tahiti, etc.).
- The research on Miconia in French Polynesia has been the topic of numerous scientific articles and conferences.

Outlook

- Use of the biological control agent slows the colonisation of Miconia and enabled the partial restoration of the wet forest in Tahiti, particularly at higher altitudes.
- The agent could not, on its own, eradicate Miconia from the island, but it represents a tool in conjunction with other techniques used to manage the species.
- Another biological agent, *Coccodiella miconiae*, is currently being tested in Brazil. It would seem to attack Miconia leaves at an earlier growth stage than CGM and could be used as a second, complementary technique.

Authors: Doriane Blottière, IUCN French committee, and Jean-Yves Meyer, Research Agency for French Polynesia, for the Resource Centre on invasive alien species in conjunction with the overseas IAS initiative. July 2018. Published by the French Biodiversity Agency.

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10. Regrowth of endemic species following defoliation of Miconia trees.

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Miconia trees

(Miconia calvescens)

Managing a Miconia invasion on Fatu Hiva (French Polynesia)

Environmental Directorate for French Polynesia (DIREN)

- The directorate is a public agency for French Polynesia in charge of preserving and valorising the natural environments and resources of the islands.
- Contacts: Christophe Brocherieux - christophe.brocherieux@environnement.gov.pf and Matai Depierre - matai.depierre@environnement.gov.pf

Intervention site

- The tropical forests of the Pacific islands, including those of French Polynesia, are considered hotspots of biodiversity, particularly in terms of the endemic plants. However, numerous invasive alien species threaten that biodiversity.
- *Miconia* trees were introduced to Tahiti for the first time in 1937 as an ornamental plant in a private botanic garden and subsequently dispersed to several islands in the Society and Marquesas groups. They have since become a major priority in efforts to preserve the wet forests of the islands.
- They were reported on the island of Fatu Hiva (southern Marquesas) for the first time in 1995-1996, where they were probably introduced accidentally by road-building equipment arriving from Tahiti to make the road between the villages of Omo'a and Hanavave.
- Subsequent inspections revealed its presence in a number of small valleys near the road.
- The presence of the pathogenic fungus *Cgm* was also observed on Fatu Hiva (see the management report titled *Introduction of a pathogenic fungus to check the growth of Miconia trees and restore the wet forests of Tahiti*¹). The fungus was not introduced voluntarily to the island, however the spores may have been transported on clothes, shoes, backpacks or other field equipment during inspections on the sites. Its effectiveness would seem to be more limited than on Tahiti, probably due to the different climatic conditions.



1. Position of Fatu Hiva in the Marquesas group.
2. Fruition of a *Miconia* tree.

Disturbances and issues involved

- The development of *Miconia* trees into dense, virtually single-species stands results in a severe reduction of light for native plants in the understories, particularly herbaceous plants, shrubs and young trees.
- Of the 75 species endemic to the Marquesas group that are found on Fatu Hiva, over half are located in the wet, tropical forests and would possibly be threatened by competition with *Miconia*, examples being *Ochrosia fatuhivensis*, *Geniostoma hallei* var. *fatuivense* and *Lepinia marquisensis*.
- Dense *Miconia* populations on steep slopes could also result in soil erosion.



Interventions

Past interventions

- The first Miconia trees were discovered in 1995-1996 on the Teumukeukeu site and were uprooted in 1997 by an employee of the Rural Development Service (SDR). That particular group comprised three trees, between four and five metres tall. The absence of seedlings was interpreted to mean that the trees were not reproducers.
- In February 2002, a second population was discovered on the Teahaua site. It included four trees, each several metres high, of which two had panicles and fruit. There were also several thousand seedlings and young plants on a surface area of approximately 400 square metres. They were immediately uprooted, transported to the village and burnt.
- Subsequently, the SDR manager for the island organised uprooting campaigns of young Miconia plants on the site in June each year, with assistance of a social-reintegration group employing young people. Between 2003 and 2006, over 3 000 plants were eliminated and no new trees in the reproductive stage were observed on the known sites.
- Starting in 2006, the DIREN commissioned a farmer on Fatu Hiva to uproot and destroy Miconia plants.
- In 2009, a new, large population was discovered in the Hu'eï valley, near Teahaua. In the following years, isolated trees or small populations were found in several other valleys in the area.
- Since 2013, the work of the farmer has been assessed every two years by a botanist visiting the island. The purpose of the visit is to monitor the development of the Miconia populations on the known sites and to search for new sites.

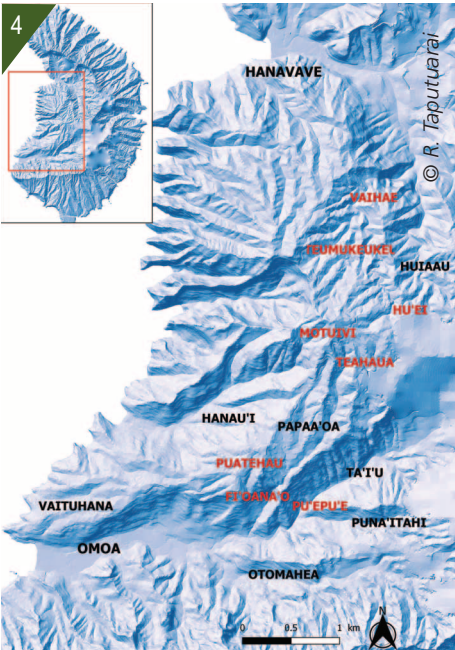
Management method

- The young plants are uprooted manually and hung upside down in nearby trees to avoid any regrowth. It is not advised to burn the plants to avoid any risk of forest fires.
- The trees with a highly developed root system are sawn at a height of less than 50 centimetres from the ground. The stump is then treated within ten minutes using a herbicide (glyphosate base diluted to 20%) to avoid any regrowth. A sprayer is used to apply the product until the stump is saturated.
- If fruition has occurred, the infructescences are carefully gathered and placed in plastic garbage bags for later incineration on a controlled site. Each infructescence contains several thousand seeds that may live up to 15 years.
- The uprooting campaigns are carried out every year to target young plants that are easy to uproot prior to their maturity. The trees become fertile after four to five years.

Results and costs

Results

- In 2014, seven sites were known and monitored. The Teahaua and Hu'eï sites were the only ones where fruit bearing trees were observed and it is thought that they were perhaps the original sites from which the seeds dispersed to the other sites.



3. A single, large, isolated tree discovered on Fatu Hiva.
4. The various sites (in red) colonised by Miconia.
5. An isolated plant discovered during the inspections.

■ In 2016, the inspections in the framework of the monitoring programme revealed seven plants in the Huiaau valley, near the Hu'e'i valley, two plants one metre high near Motuivi and three seedlings less than 50 cm high near Teahaua. All the plants were uprooted. Almost one hundred plants and seedlings were uprooted in the Hu'e'i valley and a large number of very small seedlings were observed. No new colonised patches were detected outside of the known sites, however further inspections are required given the very dense plant cover.

■ In February 2018, a tree, five metres tall and bearing fruit was discovered and cut on a new site (Puatehau). During the monitoring inspections in September 2018, the site was visited again. No sprouts were observed on the stump of the adult tree and a single seedling, less than 20 cm tall, was found and uprooted.



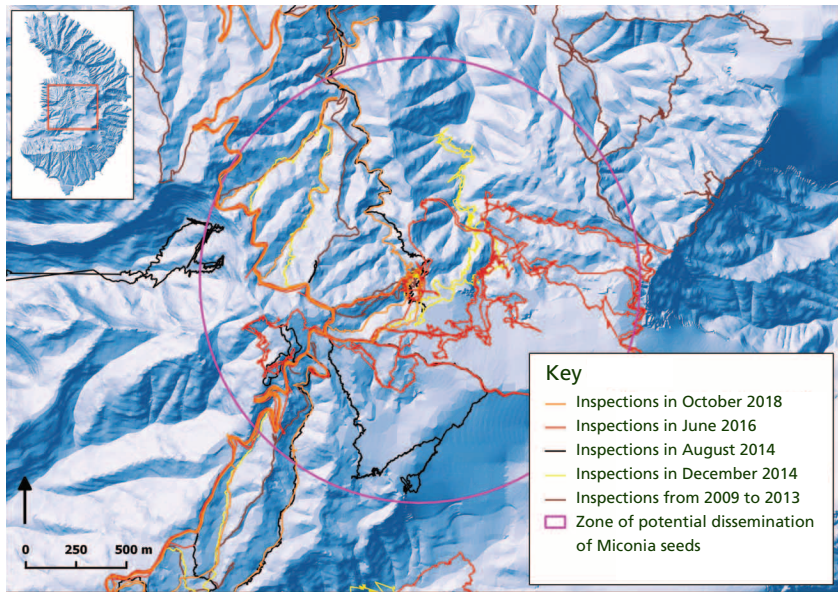
6. *Miconia* plants uprooted and hung on the Teahaua site.

Table of site data.

Sites	First observation	Most recent observation	Miconia elevation range	Number of plants eliminated since 2009	Number of reproducer trees observed (potential reproducers)	Last observation of reproducers on the site (potential reproducers)
Fi'oana'o	2002 - 2009	2014	230 - 370	19*	-	-
Hu'e'i	2009	2018	560 - 630	9101	9 (28)	2014 (2014)
Motuivi	2014	2018	660 - 690	76	- (1)	- (2014)
Puatehau	2018	2018	320 - 500	51	1 (-)	2018 (-)
Pu'epu'e	2011	2011	200	8	-	-
Teahaua	2002	2018	590 - 650	4390*	2 (61)	2002 (2018)
Teumukeukeu	1995 - 1996	1995-1996	?	0	- (3)	- (1995 - 1996)
Vaihae	2009	2009	400	19	-	-

N.B. The table does not include the 871 plants uprooted by the contracted farmer since 2009 in Teahaua and Fi'oana'o because the authors do not have any information on the numbers from each site. Trees taller than four metres are considered potential reproducers.

■ In 2018, the work done by the contracted farmer covered a surface area of approximately 135 hectares, including 25 ha for uprooting work (upper section of Teahaua + Hu'e'i + Motuivi) and 110 ha for monitoring work on the known sites of past colonisation (Teahaua-Fi'oana'o catchment + Hu'e'i Vaihae catchment).



Map of inspections carried out on Fatu Hiva from 2009 to 2018.

■ Costs

- The management work on Miconia done by the contracted farmer requires the presence of two people on average for a total of 52 days spread over the entire year.
- A four-wheel drive vehicle is needed to access the colonised zones and the uprooting work involves an array of equipment, including machetes, gloves, 100-litre garbage bags for any inflorescences and infructescences found, the herbicide and a GPS device to note the position of the plants.
- In addition to uprooting Miconia trees, the farmer is also in charge of managing other invasive alien plant species, e.g. luck plants (*Flemingia strobilifera*), Panama rubber trees (*Castilla elastica*) and rose apple (*Syzygium jambos*), called kehi'a hao'e in the Marquesas group.
- Monitoring and exploratory inspections to discover new sites have been carried out regularly since 2007 by a botanist, occasionally accompanied by a DIREN technician. The local farmer in charge of the uprooting work and several volunteers also participate in the monitoring operations in the field. Two or three teams comprising two people each spread out over the monitored sites, looking for Miconia trees. The known sites, managed by the farmer, are those visited last in order to avoid dispersal of seeds.
- In 2018, the monitoring work and the assessment of the management operations for plant species on Fatu Hiva represented seven days of field work and two additional days to draft the report. All travel costs in the field are assumed by the farmer.
- During monitoring work, the inspection teams have on hand the equipment used for uprooting work in order to immediately uproot any plants that may be discovered.

Summary of monitoring work since 2007.

Date	Days of field work
August 2007	4
March 2009	3.5
November 2009	2
August 2014	9
December 2014	1.5
June 2016	3
September 2018	7

- Detailed information on costs was not available.
- Miconia trees are also detected thanks to observations made by hunters and the employees of a local bird-protection group (SOP Manu), who regularly hike through the Ta'i'u valley, particularly on the northern side of Omoa, Fi'oana'o valley and the lower section of Papaa'oa.

Information on the project

- Numerous efforts have been made to inform the population of the island and avoid propagation of Miconia plants, including annual information meetings in the two villages, announcements on Radio Marqueses (broadcast to all the islands in the archipelago), posters in the villages, etc. Similar efforts have also been made on the other islands of the group.
- An article was published in the information bulletin of the invasive-species network of French Polynesia.



7. The poster displayed in the villages.

Outlook

- Given the limited surface area colonised by *Miconia* trees on Fatu Hiva, it should be possible to eradicate the species from the island if the management work is carried out regularly over a number of years.
- The sites of long-standing presence are regularly inspected and any plants are uprooted. The number of plants uprooted would not seem to have dropped in the Vaihae-Hu'eï area, but numbers have dropped continuously in the F'ioana'o-Teahaua area and there is real hope that the seed bank in the latter area is being depleted.
- This good news is, however, countered by the discovery in the beginning of 2018 of a reproducer in Puatēhau that almost certainly spread its seeds in the surrounding area. More intense monitoring of the adjacent valleys is required and the management work must not let up.
- Inspections in areas other than the known sites must also be pursued in order to detect any plants that were too small to be detected during prior inspections, as was the case in 2018.
- The next uprooting campaigns are planned for 2019-2020 and the next monitoring operations and inspections of new sites are planned for 2020.
- Among the Marquesas islands, *Miconia* plants are also present on Nuku Hiva, however they have spread to the point that eradication is no longer an option. The purpose of the uprooting work there is to contain the species and to protect the "cloud forests" on the island.
- It should be noted that in Polynesia, transportation of soil from an island colonised by *Miconia* to a non-colonised island has been prohibited since 1996 (Article 22 in Decision 96-43 dated 29 February 1996).

Authors: Doriane Blottière, IUCN French committee, Christophe Brocherieux, Environmental Directorate, Marie Fourdrigniez, BioConsulting, and Ravahere Taputuarai, botanical expert, for the Resource Centre on invasive alien species in conjunction with the overseas IAS initiative. March 2019. Published by the French Biodiversity Agency.

2022 edition

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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.

Description

- 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

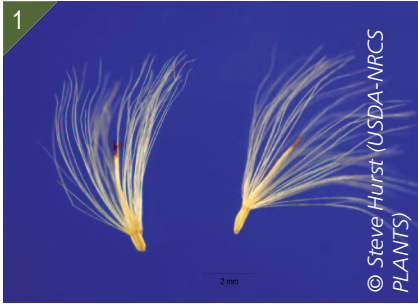
Documentation

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Author: Emmanuelle Sarat, IUCN French committee

Classification

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



© Steve Hurst (USDA-NRCS PLANTS)



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Groundsel bush

(*Baccharis halimifolia*)

Managing a small population of Groundsel bush located in the south of Corsica

National botanical Conservancy of Corsica

■ A department of the Office of the Environment of Corsica, in 2008 the Botanical Conservancy of Corsica obtained the approval of the ministry in charge of ecology allowing it to become the 11th national botanical conservancy.

Its remit is:

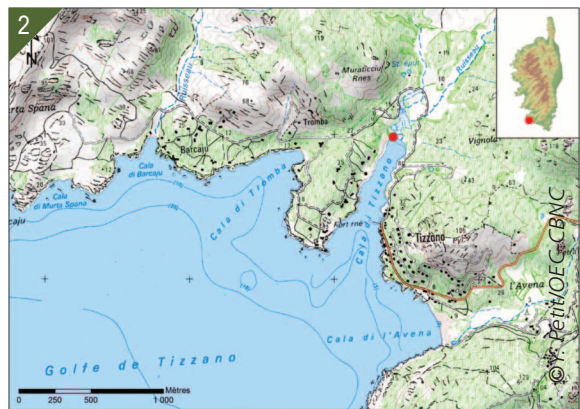
- to identify and contribute to the conservation of the wild flora and natural and semi-natural habitats of Corsica;
- to provide information and technical assistance to the State, public institutions and local authorities to implement national and regional policies for nature protection and land-use planning;
- to inform and educate the public about the conservation of plant diversity.

■ Contact: Yohan Petit, contact-person for invasive exotic species - petit@oec.fr

Intervention site

■ In Corsica, Groundsel bush was observed for the first time in the wild on 22 September 2015 in the commune of Tizzano (2A), south of Sartène, in Southern Corsica (G. Paradis, pers. comm.). To date, this is the only known mention of this species in Corsica, and the vector of this introduction has not been identified.

■ The north end of the Bay of Tizzano has a marsh with the same name. This marsh is located between a narrow, low-lying barrier beach and fluvial deposits carried by short streams, the longest of which is nearly 3.5 kilometres long. The barrier beach has the particular feature of being covered throughout the year by deep layers of *Posidonia* seagrass debris brought by the sea, particularly during winter storms. The Tizzano marsh and its surroundings, although not classified as a natural area of ecological, faunistic and floristic interest (ZNIEFF), are of great phyto-ecological interest. Numerous rare (R), very rare (RR)



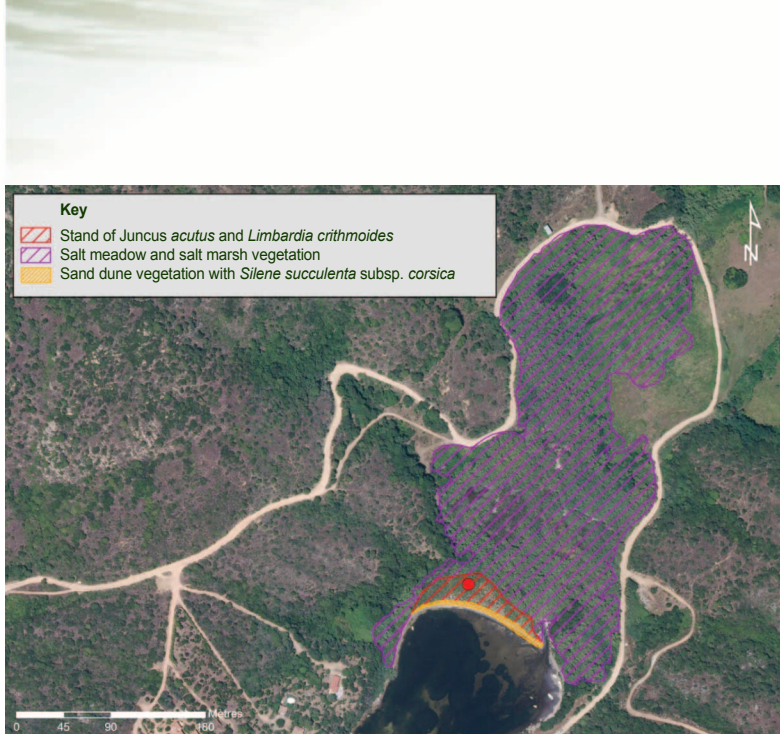
1 - *Baccharis halimifolia* individuals in a tangled thicket amongst *Tamarix africana*.

2 - Siting map of the stand of *Baccharis halimifolia* in Corsica.

or protected (P) species have been identified, namely *Heliotropium supinum* (R), *Ranunculus sceleratus* even *Tamarix africana* (P). This sector also has a broad diversity of vegetation groups some of which are rare in Corsica.

■ In 2015, the stand harboured 6 individuals forming a tangled thicket amongst *Tamarix africana*.





Vegetation in the direct vicinity of the *Baccharis halimifolia* stand.

Harmful effects and issues

■ The few Groundsel bush individuals currently present cannot cause any significant impact on the site. However, in view of the local environmental conditions which are very favourable to the rapid development of a population, the management of this species, which is known to have a very high capacity for colonisation, was considered essential to conserve the ecological diversity of the site.

■ Possible effects on the ecosystem

■ *B. halimifolia* can form very dense thickets impacting the structure of local plant communities and the proper functioning of ecosystems, causing in particular a decrease in access to light for native species, thus limiting the growth of heliophilous species, changes and impoverishment in the diversity of the colonised community, the closure of habitats and the reduction of the areas occupied by herbaceous species. These thickets can also increase the fire risk.

■ Possible health effects

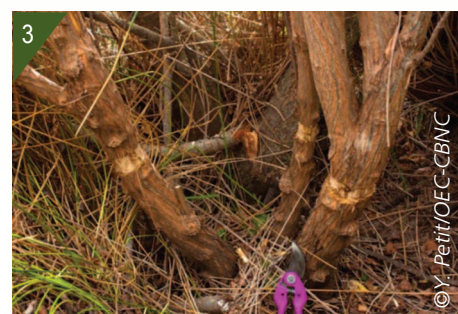
■ The abundant production of *B. halimifolia* flowers with recognised allergenic potential could induce an aggravation of hay fever among the users of the site.

■ The habitat being colonised by the species is a favourable area for mosquito larvae development. The dense vegetation cover that could be offered by its development could protect the larval sites from environmental pressures and the effects of possible anti-mosquito treatments carried out.

Interventions

■ The first surveys were carried out in October 2015 around the individuals identified to specify the distribution of the species. Surveys were extended to all the habitats favourable to the species in the vicinity of Cala di Barcaju, Cala di Tromba, Cala di Tizzano and Cala di l'Avena.

■ In order to react quickly, work on these individuals was carried out as soon as they were discovered. The objective was to stop the spread of the species and, given that they were located on an island and the small number of individuals, to try to eradicate this small population. The action was continued in 2017 and then in 2019.



3 - Banding the trunks of an old individual.
4 and 5 - *Baccharis halimifolia* shoots before the second banding operation carried out in 2017.

- During the works, particular care was taken to avoid the dispersion and fragmentation of plants. The same care was taken to avoid any excessive disturbance of the habitat and the soil that could be caused by trampling and the works.
- The 2015 works involved 1 female individual nearly 3 meters tall and 5 young individuals less than 2 meters tall, results of root suckering no more than 1 meter from the mother plant. The young individuals as well as the tracer roots produced by the mother plant were extracted manually with a pickaxe.
- The stump removal method was not chosen for managing the old individual because of its entanglement with a thicket of *Tamarix africana* (a nationally protected taxon). In this case, the banding method was applied. Below the first branches, on nearly 90% of the trunk perimeters, the bark was removed with pruning shears down to the sapwood on a 4 to 5 cm wide strip. The individual, being at the start of fructification, was pruned beforehand to avoid all risks of production and dissemination of viable seeds.
- The operation was renewed in 2017 under the offshoots located directly under the first banding.
- Monitoring every 2 years was set up.

■ **Transportation, storage and removal of waste**

- To avoid the dispersal of propagules, waste was stored and transported in airtight bags before being incinerated.

Results and assessment

■ **Results**

- The equivalent of three 100L bags were extracted during the works in 2015 compared to less than a quarter of a 100L bag in 2017.
- In 2017, no new individuals were identified, and the banded trunks had largely dried up and started to deteriorate. These observations showed the effectiveness of the management measures put in place in 2015.
- On the aged individual, it is worth mentioning the presence of shoots on 2 trunks (less than 5 per trunk) located above (quite rare) and below the banding (more frequent). The management operation was therefore renewed in 2017.
- The 2019 observations found that all of the Groundsel bush trunks were dead. The dead wood remaining in place was in the process of decomposing.
- However, monitoring is still required to confirm this positive result.

■ **Costs of human and financial aspects**

Equipment required and estimated costs.

Equipment	Quantity	Characteristics	Unit price (€)
Pickaxe	1	Forged steel pickaxe, wooden handle	20
Shears	1	Garden shears	25
Gloves	1	Gardening	15
Plastic bags	10	100 Litres, 65 microns	10
TOTAL	-	-	70



6 and 7 - *Baccharis halimifolia* stand before the first works operation in 2015.
8 and 9 - *Baccharis halimifolia* stand before the second works operation in 2017.

- The operations were carried out by an officer of the National Botanical Conservancy of Corsica. The stump removal and the banding of the individuals present required 4 hours in total from 2015 to 2019, and the complementary surveys around Tizzano totalled 8 hours, i.e., 12 of work in total.
- The banding technique is quick, easy and inexpensive to apply. It also has the advantage of causing very little disturbance to the site and the death of individuals by exhaustion with little or no root suckering offshoots.

Information on the project

- Although started before the beginning of the project, these operations were included in the Interreg ALIEM project and presented during the international workshop on invasive alien species in the Mediterranean at Alghero, 25 October 2017. <http://interreg-maritime.eu/fr/web/aliem/-/evento-futuro-2>

Outlook

- Monitoring of the site over 5 years is planned to attest to the disappearance of the species.
- In Corsica, the species has not been identified in private gardens, although a new "wanted" notice will be launched in 2020 on the social networks and in observer networks to identify the possible presence of other Groundsel bush stands.

Authors: Yohan Petit, National Botanical Conservancy of Corsica and Doriane Blotti re, IUCN French Committee.

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10 - Decomposing groundsel bush stump (2019).

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Contents

Invasive alien species

Practical information and management insights

Volume 4

Management insights

Animal species



Reptiles

- 120

■ Red-eared slider turtle*

- Species fact sheet

- Test on trapping red-eared slider turtles in three waste-stabilisation ponds in La Foa (New Caledonia)
- 128

■ Striped iguana (Green iguana)

- Species fact sheet

- An effort to inform on striped iguanas, the main threat to the Lesser Antillean iguana on Martinique, by creating and running a travelling caravan intended to raise awareness among the general public

- Managing the Striped iguana on Martinique

Mammals

- 146

■ Siberian Chipmunk

- Species fact sheet

- Experiment to regulate Siberian chipmunks in the Isère department
- 152

■ Small Indian mongoose

- Species fact sheet

- Managing the small Indian mongoose on the nesting sites of sea turtles on Martinique



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

Documentation

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Author: Emilie Mazaubert, Irstea

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



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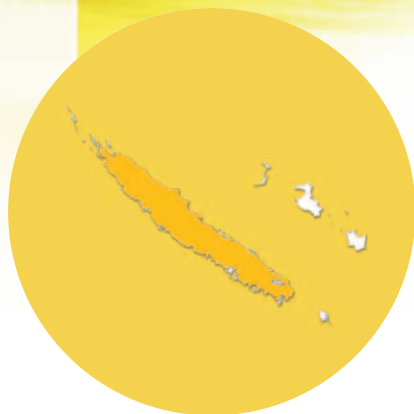


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Red-eared slider turtle

(*Trachemys scripta elegans*)

Test on trapping red-eared slider turtles in three waste-stabilisation ponds in La Foa (New Caledonia)

New Caledonian Nature Conservatory (CEN-NC)

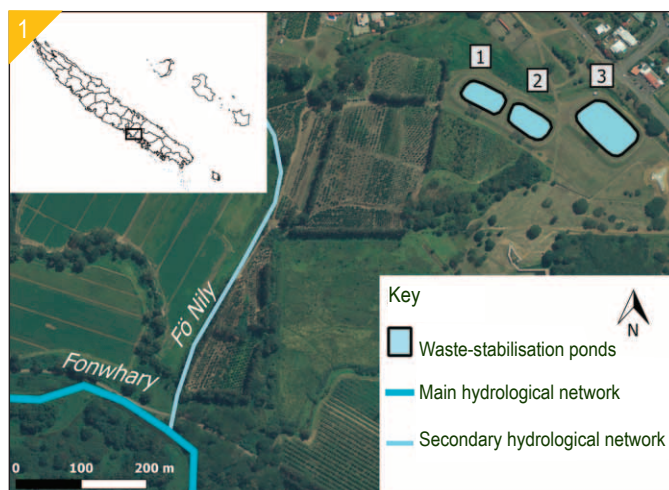
- The CEN-NC was founded in 2011 and is based in Koné. It works to encourage cooperation, facilitate negotiations and to assist in implementing the environmental strategies set by local governments in New Caledonia and the French State.
- Its mission is to study, protect and valorise the terrestrial and marine natural areas of New Caledonia in order to ensure their integrated and sustainable management. It is particularly active in conserving dry forests, coordinating management of areas on the World Heritage List, managing the Ifreco (coral reefs) and Dugong plans for New Caledonia and coordinating efforts against invasive alien species (IAS).
- The IAS department of the CEN-NC develops the regulatory and monitoring tools used to implement the strategy against IASs.
- Contact: Patrick Barrière, head of the IAS department, coordpee@cen.nc

Intervention site

- A situation conducive to a test on trapping the turtles existed in three waste-stabilisation ponds in the Nily sector of the town of La Foa (South province). The three ponds, numbered 1 to 3, covered surface areas of 2 390, 2 560 and 5 420 square metres respectively, i.e. a total surface area of 1.037 hectares. Between ponds 1 and 2, the distance is 16 metres, between ponds 2 and 3, the distance is 44 metres. The first known report of red-eared slider turtles on the site was in 2014.
- The site is managed by the personnel of the La Foa technical department. It is located near a main river (Fonwhary) and a secondary river (Fö Nily) that are respectively 722 and 319 metres distant from the closest pond (pond no. 1). This proximity represents a risk of dissemination of the IAS to the rivers.

Disturbances and issues involved

- Red-eared slider turtles are listed by the IUCN as one of the 100 most invasive species worldwide when introduced into a new environment.



1 - Location of the three waste-stabilisation ponds in the Nily sector of the town of La Foa. (Source: CEN-NC).

- In New Caledonia, red-eared slider turtles were sold as pets starting in the 1970s. The animals released by people or that escaped constituted populations in natural environments. The turtles are currently present on the island of Grande Terre, but not on the six main peripheral islands.
- The species has been listed as invasive and alien in the Environmental Codes of all three provinces (South, North and Loyauté Islands) and its import has been prohibited since 1984.
- The zoological and forest park in the town of Nouméa set up a programme to collect red-eared slider turtles found by people, particularly in the Nouméa urban area. Over the years 2008 to 2020, almost 750 turtles were received, i.e. 57 turtles per year on average.
- The turtles have been listed as a level-3 priority in the strategy against IASs in New Caledonia.
- The species has been regularly observed on the La Foa site since 2014 and would appear to have established a population there. Juvenile turtles have also been observed, indicating reproduction on the site and a risk of dissemination to the nearby rivers.
- Given that the species is omnivorous and its voracity, it represents a threat to the native fauna, though its precise impact on fish and freshwater invertebrates in New Caledonia has not yet been fully studied.
- The species also constitutes a vector for salmonellosis.

Interventions

■ Context

■ Given the known difficulties in trapping red-eared slider turtles around the world and the good results achieved in the Bassin de l'Or using the Fesquet cage traps¹, the technical committee of the IAS department decided in 2014 to take advantage of the conducive situation to develop and test a new model based on the Fesquet trap, but adapted to the local context.

■ Given low water levels in mangroves and in many rivers in New Caledonia, the lack of indigenous freshwater turtles, no regulations prohibiting lethal trapping or the use of fully submerged traps, and the objective of developing a multicapture (i.e. several turtles without having to lift the trap after each) trapping method requiring only one visit per month, the size of the new model was set at 50 centimetres in all three dimensions.

■ In addition, several baits were tested to select the most effective and capable of remaining effective in fresh water over a period of at least one month.

■ Approximately 20 cage traps based on the Fesquet model were constructed and the test was launched on 2 December 2014 with four traps placed in the three waste-stabilisation ponds. It was the first pilot test for trapping in New Caledonia using a Fesquet-type cage trap requiring only one visit per month.

■ A total of 4 animals were captured during the first two weeks of the test.

■ Subsequently, a test protocol and monitoring sheets were prepared in view of expanding the trapping test to include various partners. Starting in January 2015, in addition to the pilot test run in La Foa, the CEN-NC carried out three training sessions for ten nature surveillance personnel in each of the North and South provinces, and for three contact persons in environmental-protection groups. During each session, approximately 20 of the new cage traps were supplied to local governments and environmental groups in order to expand the trap assessment.

■ Method

Traps and baits

■ The main trap tested was a multicapture cage trap derived from the Fesquet trap. The traps were built using wire mesh (2 mm diameter wire) with a square grid pattern (2.5 x 2.5 cm). The traps were cubic (50 x 50 x 50 cm) and the entryway dimensions were 30 x 25 x 20 cm.

■ Two hoop nets (5 cm mesh) of two different sizes were also placed in pond no. 3 on 24 April 2015. The smaller measured 60 x 45 x 20 cm and the larger 83 x 60 x 25 cm.

■ Bait. At the beginning of the test on 2 December 2014, pieces of fish, cuttlefish and pork rind were placed in the traps. Pork rind resisted submersion for a month far better than the other baits and starting on 14 April 2015 was the only bait used. Pork rind may be obtained free of cost or for very little from butchers. The bait was placed in a glass jar with a punctured cover so that the smell could diffuse, but the bait could not be eaten by turtles or other predators.

■ Once the bait had been set, bailer twine was tied to the cages and they were placed in the pond two to three metres from the bank using a forked branch. Cages were positioned upright on a flat bottom, completely submerged with the entryway facing the pond.

■ A pair of thick, waterproof gloves were used in handling the captured turtles to avoid bites and the risk of salmonellosis.



2 - Training session on trapping for partners of the CEN-NC.

3 - Cage trap designed and tested (square mesh 2.5 cm, dimensions 50 x 50 x 50 cm).



Trapping effort and visits

■ The test took place from 2 December 2014 to 19 February 2020, i.e. a bit more than five years (63 months). One to four cages were placed in each of the three ponds, representing a total trapping effort of 2 628 trap-days (Table 1). One small and one large hoop net were also placed in pond no. 3 in 2015, 2017, 2018 and 2019, representing a total trapping effort of 1 664 trap-days.

Table 1. Visits and trapping effort using cage traps and hoop nets.

	2014	2015	2016	2017	2018	2019	2020	TOTAL
Number of visits to the site	3	17	7	6	4	6	1	44
Cage traps (trap-days)	116	1 213	443	348	346	62	100	2 628
Hoop nets (trap-days)		136		452	408	668		1 664

- In general, the traps were inspected once every month or two months. However, due to available resources and the seasons, three-month intervals occurred three times (February to May 2016, December 2016 to March 2017, December 2018 to March 2019) and there was one six-month interval (February to August 2018). It should be noted that the activity of turtles (and consequently the possibility of capturing them) is reduced during the cool season (June to August). Visits were made as much as possible on sunny days during the warmest hours (12 to 3) in order to count any turtles at the surface of the water or on the sunning sites (rocks along some sections of the pond banks).
- During each visit, the number of turtles observed in each pond was recorded to assess any changes in abundance (calculations were based exclusively on data collected during the summer). The traps were pulled from the water, cleaned and/or repaired if needed, and new bait was set. Data on each captured turtle included its condition (living, recent death, decomposition), sex and the length of its top shell to determine its age (juvenile, sub-adult, adult). The collected data were recorded on "trapping" and "capture" monitoring sheets.
- Living turtles were sent to the CEN-NC and euthanized.

Unforeseen events

- Over the five-year test period, six cage traps disappeared (suspected theft) and two were destroyed (one by a rotary cutter and one during a flood). In that the precise date of the disappearance or destruction was not known, the trapping effort was calculated by assuming that the incident occurred at the midpoint between the visits before and after the incident. Where possible, some or all of the missing traps were replaced.

Results and costs

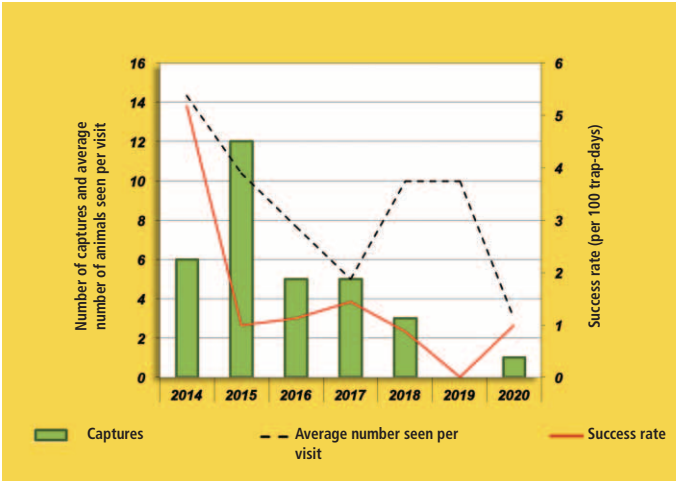
■ Results

- Between 2 December 2014 and 19 February 2020, a total of 47 red-eared slider turtles were captured, including 32 in the cage traps derived from the Fesquet model (a success rate of 1.22 turtles per 100 trap-days) and 15 in the larger of the hoop nets (success rate of 0.9 turtles per 100 trap-days) (Table 2 and graph next page).

Table 2. Results of monitoring and captures (numbers and trapping success).

	2014	2015	2016	2017	2018	2019	2020	TOTAL
Max. number of turtles seen per visit	20	16	13	10	11	31	3	104
Number of turtles captured in cages	6	12	5	5	3		1	32
Cage success rate (per 100 trap-days)	5.17	0.99	1.13	1.44	0.87		1	1.22
Number of turtles captured in hoop nets				5	3	7		15
Net success rate (per 100 trap-days)				1.1	0.7	1.0		0.9

The reduction in the number of captures and in the success rate for the cage traps between 2015 (6 captures; 5.17 turtles per 100 trap-days) and 2020 (1 capture; 1 turtle per 100 trap-days) would appear to correspond to the reduction in the estimated abundance based on the average number of turtles observed over the four months of the summer season (December to March), in spite of interannual variations, due notably to the differences in the trapping effort caused by the disappearance of six traps and the destruction of two others (see the graph on the next page).



Trapping success rate and the relative abundance for all ponds combined.

Among the 32 turtles captured in the cage traps, only two were found alive (Table 3). The 32 included 16 females, one male and 15 turtles whose sex could not be determined given the degree of decomposition. The age group could be estimated for 29 turtles, including 15 female adults (of the 16 identified) and 14 among those of indeterminate sex (8 adults, 1 sub-adult, 5 juveniles).

Table 3. Characteristics of turtles captured in cage traps.

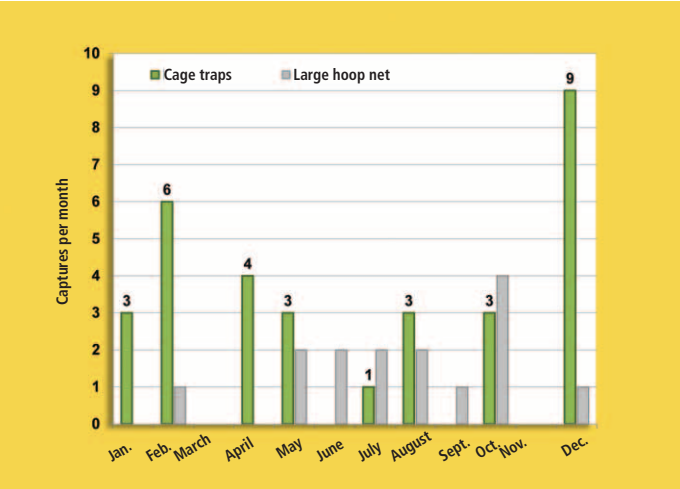
	2014	2015	2016	2017	2018	2019	2020	TOTAL
Living	2							2
Recently dead	2	1						3
Decomposed	2	11	5	5	3		1	27
Females	5 (4 Ad, 1 Ind)	7 Ad	2 Ad	2 Ad				16 (15 Ad, 1 Ind)
Males								1 (Ind)
Sex not determined		5 (2 Juv, 1 Sub, 1 Ad et 1 Ind)	3 Ad	3 Ad	3 Juv		1 Ad	15 (5 Juv, 1 Sub, 8 Ad et 1 Ind)

Age groups of turtles captured: Juv (juvenile), Sub (sub-adult), Ad (adult), Ind (indeterminate).

In addition to the turtles, five eels were captured in the cage traps, including three live eels that were released and two that were found dead.

Differences between ponds. In spite of the proximity between the three ponds and the addition of two hoop nets in the third, the success rate using the cage traps varied from 0.7 turtles per 10 trap days in pond 1 (3 captures for 419 trap days) to 0.9 in pond 3 (13 captures for 1 369 trap days) and 1.9 for pond 2 (16 captures for 840 trap days).

Differences between seasons. A total of 18 turtles among the 32 captured using the cage traps were captured during the hot season from December to March (56.2%, i.e. 1.7 turtles per 100 trap days), compared to only 4 during the cool season from June to August (12.5%, i.e. 0.7 turtles per 100 trap days, see the graph below).



Cumulative monthly captures. Hot season (December to March). Cool season (June to August).

Costs

- The cost of the materials for the tested cage traps was 1 300 FCFP (approximately 11 euros) and each trap took about 3.5 hours to build.
- The test took place over a period of 63 months, from December 2014 to February 2022, i.e. a bit longer than five years.

A total of 44 visits were made to the ponds, i.e. generally one visit per month. Given the distance between CEN headquarters (in the town of Koné) and the village of La Foa, and in spite of the fact that visits were generally combined with other trips to the area, each visit took approximately five hours including the travel time. Consequently, the 44 visits over 63 months represented a total of 220 hours or 27.5 work days.

Information on the project

- The poster to raise awareness on the impact of the turtles and inform on its management was produced and distributed in 2010 by the former Invasive Species Group (GEE).
- The poster listing the 68 priority invasive alien species for the IAS strategy, with the Red-eared slider turtle as one of the level-3 priorities, was widely disseminated among CEN partners and other stakeholders, notably in the town of La Foa.



4 - Poster to raise awareness concerning red-eared slider turtles (produced by the former GEE group).
5 - Poster listing the 68 priority IASs in New Caledonia (the turtles are a level-3 priority).

■ An information notice edited by the CEN was regularly distributed on the island of Grande Terre on sites where red-eared slider turtles were reported, notably by the environmental authorities, as well as during information campaigns by the CEN and via the internet.

Outlook

■ Following the test, a new cage trap was built using plasticized wire mesh (wire 2 mm in diameter) with a larger grid pattern (5 x 7.5 cm) in order to reduce the cost (725 FCFP, i.e. 6 euros per trap), the time required to build it (only two hours), the weight (2 kg) and to capture more selectively by allowing mid-sized eels and fish to escape.

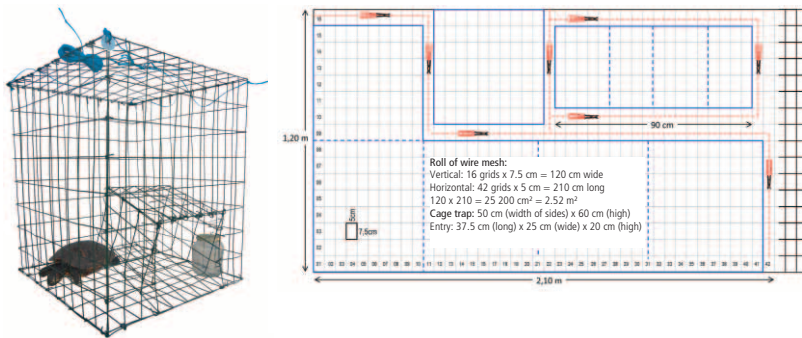
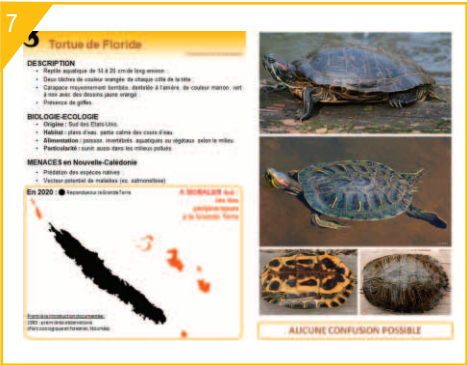


Illustration and cut-out drawing of the new cage trap (mesh 5 x 7.5 cm, trap size 50 x 50 x 60 cm).

- New cage traps will soon be made available to the technical personnel of the town of La Foa, to compensate the traps stolen and to pursue the trapping effort and monitoring in the three waste-stabilisation ponds.
- New cage traps will also be available for any persons wishing to participate in the test and to trap red-eared slider turtles near their homes.
- Efforts to raise awareness and to communicate with the public on the problem caused by red-eared slider turtles in the natural environment have been continued.
- In the framework of the territorial strategy to manage IASs in New Caledonia, seven new guides and seven posters specific to the seven main islands of the archipelago were disseminated in the beginning of 2021. The "STOP the INVADERS. If you see them, REPORT THEM" guides are designed for the entire Caledonian population to enable people to monitor and report any new IAS that may represent a threat. That is why red-eared slider turtles are listed in the documents for the six secondary islands (not Grande Terre) where they have not yet been observed.

Regulations

■ In the South province, the Environmental code prohibits "the introduction in the natural environment, whether through negligence or imprudence, the production, ownership, transport, use, trade, transfer at cost or free of cost, offer for sale, sale or the purchase of a live specimen" of the Red-eared slider turtle. Infractions are liable for two years of imprisonment, for a fine of 17 850 000 FCFP (148 750 €) and for the fine foreseen for class-4 offences in the Penal code.



6 - Information notice on red-eared slider turtles published by the CEN-NC.
7 - Identification sheet for red-eared slider turtles in the "STOP the INVADERS. If you see them, REPORT THEM" guide.



■ In the North province, the Environmental code prohibits "the breeding, raising or the multiplication by any means, the transport, trade, use, offer for sale, sale or purchase, introduction, whether intentional or non-intentional through negligence or imprudence, in the natural environment of a live specimen" of the Red-eared slider turtle. Infractions are liable for a fine of one million FCFP (8 333 €) and for the fine foreseen for class-4 offences in the Penal code.

■ Environmental codes of the three provinces in New Caledonia:

- Environmental code of the South province, 2020. Book II. Protection of the natural heritage, Title IV. Efforts against invasive alien species, Art. 261-1 to 262-3; 28 May 2020, p. 108 - 165;

- Environmental code of the North province, 2020. Book II. Protection and valorisation of the natural heritage, Title VI. Invasive alien species, Art. 250-1 to 250-9 ; 13 March 2020, p. 74 - 76 ;

- Environmental code of the Loyauté Islands province, 2020. Book II. Protection and valorisation of the natural heritage and of the associated cultural interests, Title V. Efforts against invasive alien species, Art. 251-1 to 253-4 ; 04 August 2020, p. 26 - 31.

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2022 edition

For more information...

■ <https://www.cen.nc/documents/espece-senvahissantes/>

■ CEN 2017. Strategy against invasive alien species in the natural environment of New Caledonia; framework document, 107 p. (In French)

■ CEN 2015. Trapping protocol, Monitoring sheet for trapping and capture of red-eared slider turtles, 3 p. (In French)

■ CEN 2019. Strategy against invasive alien species in the natural environment of New Caledonia; Summary and poster of the 68 priority IASs in New Caledonia, second edition, 12 p. (In French)

■ Fillon A., Gendre T. & Couronne M., 2013. The Fesquet trap, at last an effective trap for red-eared slider turtles! Record capture rates in the Or Pond using a new trap. Board for the Bassin de l'Or, CEN Languedoc-Rousillon, 9 p. (In French)

■ Hytec & Mary N., 2010. Study on the invasive nature of certain plant and animal species introduced in freshwater environments in New Caledonia. Part 4. *Trachemys scripta elegans* (red-eared slider turtle). Study report for the North province, Economic-development and environment department, Environmental service, and for the South province, Environmental department, Terrestrial-environments service, 428 p. (In French)

■ Pascal M., Barre N., De Garine-Wichatitsky M., Lorvelec O., Fretey T., Brescia F. & Jourdan H., 2006. Vertebrate communities in New Caledonia. Invasions and disappearances. IRD, Invasive species in the New Caledonian archipelago, p. 111-162. (In French)



Striped iguana

(*Iguana iguana*)

The Striped iguana originated in the Americas and was introduced in the 1800s to Guadeloupe, in 1960 to Martinique and in 1990 to Saint-Martin. According to INPN, they have also been introduced to Saint-Barthélemy.

Description

- A lizard that can grow up to two metres long (including the tail)
- Weight that ranges generally from 0.5 to 2 kg (5 kg maximum)
- Colour that can vary from green to grey, with reddish tinges in some cases. Juveniles are bright green, but darken with age. Wide stripes on the tail
- Males are larger and heavier than females and have larger femoral pores
- Feet with five clawed toes that enable the animals to climb trees
- Tail two to three times longer than the body. Can grow back if cut. Highly lacerating, can be used as a whip in defence if the animal feels threatened
- Dorsal spines at the back of the head can reach more than 15 cm in length
- Under the jaw, a flap of skin called a dewlap, with spines along the edge, plays an important role in communication

Ecology and reproduction in its original environment

- Habitat is essentially arboreal, but can vary widely from coastal environments and mangroves to dry forests and wet tropical forests, at altitudes ranging from sea level to 1 000 metres
- A general herbivore, feeds essentially on leaves, fruit and flowers
- Sexual maturity is reached at three years
- Mating at the start of the dry season (March-April), egg laying in April-May, birth in August-September at the start of the wet season when juveniles can benefit (survive) due to the greater food supply. Females dig nests in various types of soil to a depth of 10 cm to 1 metre. They lay 35 eggs on average
- The animals can live grouped or dispersed, depending on the environment

Documentation

- Biological invasions in the French Caribbean. Status report and current knowledge. (2013). Report by the Martinique and Guadeloupe Environmental Directorate. 88 pages. (In French)
- Angin B., 2018. Action plan against the green iguana (*Iguana iguana*) in the French Caribbean 2019-2023. ONCFS and Ardops Environnement. 71pp. (In French)
- <https://www.cabi.org/isc/datasheet/28477>
- https://inpn.mnhn.fr/espece/cd_nom/350756

Classification

Order	Squamate
Family	Iguanidae
Genus	Iguana
Species	<i>I. iguana</i> (Linnaeus, 1758)





Striped iguana

(*Iguana iguana*)

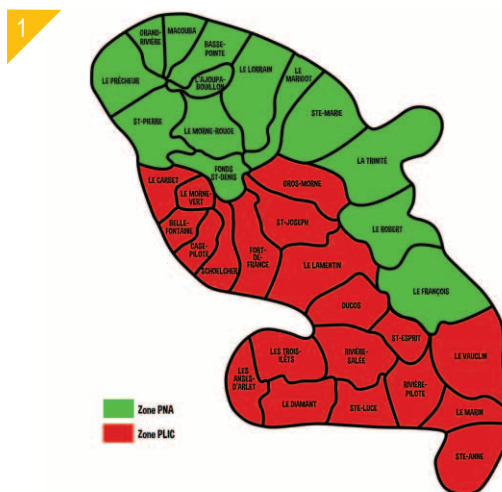
An effort to inform on striped iguanas, the main threat to the Lesser Antillean iguana on Martinique, by creating and running a travelling caravan intended to raise awareness among the general public

The Carbet des sciences

- This non-profit group, founded in 1993, is one of 30 scientific, technical and industrial information centres (CCSTI) in France, created by the Research ministry to promote the dissemination of knowledge and provide a wide public with a chance to learn about technical and scientific advances.
- The Carbet des sciences is the CCSTI for Martinique and is divided into several sections. The Ocean section raises awareness concerning the natural heritage, particularly threatened species in conjunction with the national action plans (PNA) for the Lesser Antillean iguana and the sea turtles of the French Caribbean. It is in the above framework that the group informs on certain invasive alien species (IAS) and their management.
- The group is a well-known partner for environmental managers on Martinique. Through information campaigns, it regularly contributes to conservation projects launched on the island.
- Contact: Mathilde Brassy, Head of the Ocean section
- mer.carbet.sciences@gmail.com

Intervention site

- The informational work can take place all over the island.
- However, certain towns have been designated as priority sites. They correspond to the areas targeted by the PNA for the Lesser Antillean iguana in the northern section of the island, on the flanks of the *Montagne Pelée*, a mountain where viable populations of the Lesser Antillean iguana (*Iguana delicatissima*) still live. The towns along the Atlantic coast, near Chancel island, the last isolated site of Martinique comprising exclusively the Lesser Antillean iguana, were also designated as priority sites.
- Informational efforts have already been made in other towns (Fort-de-France and Lamentin) in conjunction with particular events (e.g. Science Day) or in response to specific requests (e.g. assistance in management work on the Striped iguana).



1 - Map of towns on Martinique. The green zone indicates the priority towns for the conservation of the Lesser Antillean iguana. Source: Carbet des sciences, DEAL and ONF.

Disturbances and issues involved

- *I. delicatissima* is considered critically endangered worldwide on the IUCN red list, following a 70% decline in its population and a projected future decline of over 80%.
- The species has been protected on Martinique by ministerial decree since 1989 and that protection was expanded to include its habitat in 2019.
- It is one of the most threatened reptile species worldwide. Outside of Martinique, the species is now present only on a few isolated sites on Guadeloupe, Saint-Barthélemy, Dominica, Anguilla and Saint-Eustache.
- The last populations of *I. delicatissima* are confronted with a number of threats, e.g. degradation of feeding and nesting sites by introduced herbivores, such as sheep. Exogenous species such as rats, mongooses and chicken feed on the eggs and juveniles. What is more, since 2011, a bacteria (*Devriesea agamarum*) is prevalent among iguanas on Saint-Barthélemy and constitutes a risk for populations on small, isolated sites. Weather events such as dry periods and hurricanes also represent a threat, in particular for the population on Chancel island.
- The Striped iguana (also known as the Green or Common iguana), *Iguana iguana*, is an invasive alien species (IAS)

and the main threat to the survival of the endemic species (*Iguana delicatissima*), the Lesser Antillean iguana.

■ *I. iguana*, larger and more prolific, is a competitor of *I. delicatissima* for biotopes, food and reproduction. First-generation hybrids show a mix of the morphological and genetic characteristics of the two species, however, after a small number of generations, the far greater fertility of *I. iguana* results in descendants in which the morphological and genetic characteristics of *I. delicatissima* have virtually disappeared.

■ Generally speaking, *I. iguana* is a highly detrimental competitor for the other species of iguanas on the Antillean islands, such as the Blue iguana on Grand Cayman (*Cyclura lewisi*), the Lesser Caymans iguana (*Cyclura nubila caymanensis*), the Sainte-Lucie iguana (*Iguana iguana santaluciaae*) and its management requires a regional approach.

■ These herbaceous animals can live in highly dense population groups (over 5 000 iguanas per square kilometre on Grand Cayman in 2018) and have a major impact on the natural vegetation and crops. For example, on Porto-Rico, mangroves along the edge of the coast have been severely affected.

■ Health risks have not yet been extensively assessed, but due to the abundance of their droppings, a high concentration of animals in urban environments can cause sanitary problems.

■ Economic problems have also occurred, notably in Florida, and have drawn attention to the negative impacts caused by very dense populations. For example, the digging of nests can cause subsidence of roads and damage to dikes.

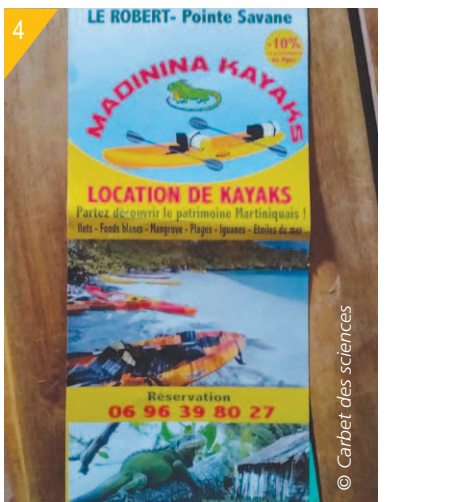
Interventions

■ Objectives

■ To raise awareness of the importance to preserve *I. delicatissima*, the need to inform the general public of the threat rapidly became clear. The informational tools and the messages had to present the two species. *I. iguana* is still too often considered an endemic and even a patrimonial species because it is often observed by the inhabitants of urban areas and due to false information circulating on the island.

■ One of the objectives of the informational caravan was to correct the false information in order to avoid any confusion between the two species. The main objectives were therefore to:

- present the two species and explain why the introduced species is a threat for the endemic species;
- make it easy for people to visually distinguish between the two species;
- encourage the public to report any striped iguanas observed in the priority towns in order to activate the surveillance network for a rapid intervention (gendarmes, fire departments, local governments) and to improve knowledge on the expansion of the species outside of Fort-de-France where its presence has already been clearly determined.
- make people understand that the management of *I. iguana* is part of an effort to preserve a native and endemic species that is gravely threatened. This effort is indispensable to help agents in their management work, particularly when capturing animals in areas with high-density iguana populations where uninformed observers may be upset.



2 - *Iguana delicatissima*.
3 - *Iguana iguana* or the *Striped iguana* along a hotel pool.
4 - False information that may have produced the confusion between the two species.



■ Discussions with the stakeholders

■ A steering committee comprising representatives of the National Forestry Agency (ONF, the organiser of the PNA for the Lesser Antillean iguana), the Environmental Directorate (DEAL, provisional organiser of the action plan against striped iguanas and head of the PNA for the Lesser Antillean iguana), non-profits working to inform via the network for the Lesser Antillean iguana (Sepanmar, Le Carouge and Karisko) and Carbet des sciences, held a meeting at the start of the project to discuss the choice of illustrations.

■ Numerous meetings took place with the Environmental Directorate, the National Forestry Agency and the Ardops Environnement engineering firm to validate the texts and the new common names assigned to the two species. Clarification of the names was necessary because a number of terms, often erroneous, are still used and contribute to the confusion. The common names were therefore modified to better distinguish between the two species and to create a more attractive name for the endemic species. That explains why:

- *Iguana iguana*, initially called the green or common iguana, is now called the Striped iguana due to the dark stripes on its tail;
- *Iguana delicatissima*, initially called the Lesser Antillean iguana, is now called the Péyi iguana.

These new names are now systematically used for the caravan and by all stakeholders.

■ The drafted documents were submitted to the steering committee for approval prior to printing.

■ Designing the caravan

■ The caravan was designed by the Carbet des sciences. The design phase lasted seven months.

■ Three people were involved in preparing the texts, the illustrations and the computer graphics:

- the project manager;
- an illustrator;
- a graphic designer.

■ The French texts were translated into English by a secondary-school teacher and into Creole by an expert in the Creole language.

■ The caravan can be transported in a small to mid-sized car or a light commercial vehicle, and can be used both indoors and outdoors.

■ It can be set up in half an hour by two people. In the form of a square tent, it attracts the attention of people. A total surface area of approximately 12 square metres is necessary so that people can move around it. The ground must be flat, not exposed to strong winds (40 km/h max.) and public lighting is required if presentations after six o'clock in the evening are planned.

■ Three sides of the tent present artwork in a "newspaper" style with amusing illustrations and short texts. The topics are:

- the "tireless rival";
- the "West Indies outlaw";
- the "invader of the Antilles".



5 and 6 - The artwork displayed on the sides of the tent.
7 - A kakemono (vertical banner) used in the caravan.

Four kakemonos fill out the display with short texts and interesting illustrations designed to reinforce the information provided by the presenter. They are numbered one to four and constitute a logical chain of information to provide precise and factual answers:

- Chapter 1. The Péyi iguana, a patrimonial species in danger;
- Chapter 2. The Striped iguana, the main threat, but not the only one;
- Chapter 3. The Péyi iguana confronted with numerous other threats;
- Chapter 4. Help in preserving biodiversity on Martinique.

■ Training of presenters

■ To ensure good results, presenters received all the necessary technical and scientific knowledge and were trained on how to effectively deliver the messages to highly diverse audiences. The non-profit groups participating in the network for the Lesser Antillean iguana took part in a training program organised on 13 September 2019 by the Carbet des sciences. A number of other people were trained in the field by the project manager. A guide manual for presenters was drafted and given to the participants. DEAL, ONF and OFB employees also received training.

■ A total of 12 presenters took part in the caravan.

■ Events

Table 1. Number of presenters from the non-profit groups participating in the network for the Lesser Antillean iguana.

Non-profits	Carbet des sciences	Le Carouge	SEPANMAR	Karisko	Independent ecologists
Number of presenters	5	3	1	1	2

■ The operation began on 21 and 22 September 2019, during the European patrimonial days in Fort Saint-Louis, where the animals were initially introduced and from where they dispersed.

■ A total of 25 sessions, generally involving two presenters, were held on the island. They consisted of full-day or morning sessions, depending on the context. The team of presenters occasionally changed between morning and afternoon.

■ The sessions took place in four types of events:

- the European patrimonial days, major awareness-raising occasions;
- travel synchronised with other events in the priority towns for preservation of the péyi iguana to take advantage of the larger audiences;
- awareness-raising days combined with management work on striped iguanas organised by DEAL in conjunction with ONF and the Martinique regional nature park (PNRM) in order to facilitate the management work in public areas of Fort-de-France with high densities of the animals;
- other events such as the IAS workshop organised in February 2020 by the IUCN French committee to present the caravan to all overseas stakeholders confronted with invasive alien species.

■ The project manager created a work group using an instant messaging service to facilitate coordination.



8 - The caravan in the town of Morne-Rouge
9 - The caravan at Fort Saint-Louis in Fort-de-France during the European patrimonial days.
10 - The caravan in the town of Carbet.
11 - The caravan in the town of Robert.



Results

■ Technical results

■ During the first year of the project, the caravan informed 4 863 people including 3 116 adults and 1 752 children. Intended as an informational campaign, it served to correct certain ideas and to introduce some nuance in the attitudes and opinions of the public. Less than 1% of the persons contacted disagreed with the information presented, most people were quite receptive.

Table 2. Session data and numbers of persons informed.

Date	Territory / Intermunicipal councils	Towns	Days	Man-days	Hours	Adults informed	Children informed	Total number of people informed
21/09/2019	Cacem	Fort-de-France	1	2	10	600	360	950
22/09/2019	Cacem	Fort-de-France	1	2	10	600	360	950
30/10/2019	Cap-Nord	Le Carbet	1	2	8	198	647	845
10/11/2019	Cap-Nord	Prêcheur	1	2	9	57	21	78
11/11/2019	Cap-Nord	Le Precheur	1	2	9	75	36	111
15/11/2019	Cacem	Le Lamentin	1	2	9	46	30	76
16/11/2019	Cacem	Le Lamentin	1	1.5	9	76	26	107
29/11/2019	Cap-Nord	La Trinité	0.5	1	5	32	12	46
01/12/2019	Cap-Nord	Grand'Rivière	1	2	6	22	7	30
08/12/2019	Cap-Nord	Ajoupa-Bouillon	1	2	6	24	3	28
20/12/2019	Cap-Nord	Le Lorrain	1	2	7	39	4	45
21/12/2019	Cap-Nord	Sainte-Marie	1	1	6.5	46	3	51
18/01/2020	Cap-Nord	Saint-Pierre	1	2	7	73	0	73
19/01/2020	Cacem	Le Lamentin	1	2	6	21	0	21
25/01/2020	Cap-Nord	Le Morne-Rouge	1	2	7	50	5	55
12/02/2020	Cacem	Fort-de-France	0.5	1	2	60	0	60
27/02/2020	Cacem	Fort-de-France	1	2	6	67	8	75
03/03/2020	Cacem	Fort-de-France	1	2	7	83	7	90
04/03/2020	Cap-Nord	Le Robert	1	2	9	58	15	73
27/06/2020	Cap-Nord	Grand'Rivière	0.5	2	5.5	40	0	40
16/07/2020	Cacem	Fort-de-France	0.5	2	3	15	15	30
29/07/2020	Cap-Nord	Robert	1	2	7	31	13	44
09/08/2020	Cap-Nord	Ajoupa-Bouillon	0.5	2	5	58	11	69
19/09/2020	Cacem	Fort-de-France	1	2	9.75	270	65	335
20/09/2020	Cacem	Fort-de-France	1	2	9.75	408	102	510
25/09/2020	Cacem	Schoelcher	1	1	7.25	67	2	69
TOTAL			23.5	44.5	172.25	3 116	1 752	4 863

Table 3. Distribution of man-days.

Le Carouge non-profit	10.5
Karisko non-profit	0.5
Sepanmar non-profit	2
Nathalie DUPORGE (independent)	4
Myriam BOUAZIZ (independent)	0.5
Marine DESCHERES (independent)	0.5
Carbet des sciences non-profit	26.5

- The start of the operation during the European patrimonial days in Fort Saint-Louis was a strategic decision in that, over two days, 1 900 people were informed in the main town where striped iguanas are observed and where the animals are seen favourably.
- During travel through the northern section of the island, 1 436 people in the priority towns for the preservation of the Péyi iguana were informed.
- The sessions synchronised with management work on striped iguanas in public places greatly facilitated the capture of the iguanas. The agents could calmly go about their work while the presenters occupied any inhabitants and tourists by explaining the situation and answering questions. Over the two days, 106 iguanas were captured on sites near the point of dispersal. Without the assistance of the caravan to occupy and inform the public, that number of animals could never have been captured.
- A long-term assessment will provide information on the effectiveness of the caravan in raising the awareness of the public and in increasing the number of reports. However, the presenters have already noted a positive impact on the frequency and content of comments on social networks. On the basis of those comments, the caravan would appear to be increasingly well perceived by inhabitants.
- Due to Covid, fewer people were informed during the two days in Fort-de-France in September 2020. The results were nonetheless encouraging, in spite of the unfavourable context, in that 845 people were informed.

Table 4. Design and operational costs of the caravan over the first year.

Items	Cost (€)
Design	11 000
Remuneration of three interns (illustrations, computer graphics, video clip), partial salaries of policy officer, assistant, project manager (FTE = full-time equivalents)	8 000
Equipment: Tent, kakemonos, table, bench, minor items	3 000
Sessions from September 2019 to September 2020	9 750
Coordination (FTE)	1 200
Remuneration of presenters (150 € per day)	6 750
Reimbursement of travel costs (40 € per day)	1 800
	20 750

■ Financial aspects

- Funding of phase 1. Design and sessions from September 2019 to March 2020

The design of the caravan and the informational sessions are part of a wider informational project to preserve the endemic iguana species of the Lesser Antilles, a project managed by Carbet des sciences with a total budget of 26 735 euros. The project was funded 95% by the French Biodiversity Agency (OFB) as part of a 2018 call for projects titled "Initiative to restore biodiversity overseas" and 5% by Carbet des sciences. The project, established taking into account the needs listed in the PNA for the Lesser Antillean iguana, included three main lines of communication:

 - **create and run a travelling caravan to raise awareness of the problems and issues involved in preserving the péyi iguana.** Two additional communication tools were created, namely a video clip and an information sheet presenting the issue;



- **raise awareness of tourist operators running "nature" excursions concerning good observation practices** via a training session, after which they received a "Trained Operator" sticker designating them as participating stakeholders in the PNA for the Lesser Antillean iguana. Prior to the start of the project, the Carbet des sciences updated the list of operators visiting Chancel Island as part of their excursions. The island, covered by a Biotope-protection decree, is home to the largest population of péyi iguanas. Following the training session, the Carbet des sciences ran a "mystery client" survey by telephone to assess the knowledge level of the trained operators and that of non-trained operators to adjust and clarify the training content;

- **activate or reactivate a surveillance network in the PNA priority towns** in the event a Striped iguana is observed in order to capture the animal(s) and, if necessary, dispose of them. The surveillance network comprises fire departments, the gendarmerie, municipal police, environmental agents and elected officials.

■ Funding of phase 2. Activities from July 2020 to October 2021

A funding agreement was signed between the National Forestry Agency (ONF) and the Carbet des sciences in order to pursue the activities. The total budget was 15 000 euros, with 90% provided by ONF and 10% by the Carbet des sciences.

Information on the project

■ The schedule for the caravan is announced on the Facebook page of the network for the Lesser Antillean iguana, which currently has 2 327 subscribers. The Carbet des sciences also publishes the schedule on its Facebook page (4 300 subscribers) and encourages the towns receiving the caravan to publish the information on their pages.

■ The information sheet drafted in conjunction with ONF and DEAL contains the essential information required to understand the issue and the management work. It was printed (A3 format) and sheathed in plastic as a poster to be given to tourist operators and used during training sessions. The sheet was published on the internet sites of the network for the Lesser Antillean iguana, the Carbet des sciences and the Martinique Biodiversity Observatory. It was also sent to the authors of tourist guides for Martinique. And finally, it is regularly sent out by email and published on the internet sites of local partners.

Outlook

■ The information sheet, printed in the smaller A5 format, can be used to communicate on the network for the Lesser Antillean iguana (caravan schedule, presentations in schools, etc.). It can also be distributed to hiking and running clubs.

■ Efforts to raise awareness of tourist operators will be pursued and expanded following a "mystery client" survey to identify prevalent opinions and adjust communication work. The initial results of the survey indicate that a two-hour presentation is not sufficient for operators to correctly transmit the information to the general public.

■ The Carbet des sciences contributed to setting up the surveillance network in the towns in the northern section of the island, as part of the implementation of the PNA for the Lesser Antillean iguana.



12 - Article on the work of the Carbet des sciences and ONF in setting up the surveillance network in the town of Prêcheur . Source: France Antilles.

13 - Post on social networks announcing the passage of the caravan.

- At the request of ONF, the Carbet des sciences adapted the caravan to the specific context of the Guadeloupean archipelago and the islands to the north (Saint-Martin and Saint-Barthélemy), in conjunction with the local stakeholders. These islands now have their own communication tool and the presenters were trained in November 2020.
- The caravan could potentially be used in many different forms to raise awareness on the need to preserve threatened species and on the management of invasive alien species (IAS). It would also be possible to design a caravan addressing the general topic of IAS management.

Regulations

- The introduction of the Striped iguana (*I. iguana*) on Martinique is prohibited by the ministerial decree dated 8 February 2018 on preventing the introduction and propagation of animal IASs on Martinique.
- The species is also on the list appended to the decree dated 7 July 2020 prohibiting the detention, transport, use and/or trade of IASs on Martinique.
- The species is named in the prefectural order dated 8 July 2013 authorising the capture and killing of certain IASs by certain competent organisations.
- The prefectural order dated 22 August 2019 authorises a specific list of environmental-protection groups, local governments and private structures to capture and kill striped iguanas.

Authors: Clara Singh, IUCN French committee, Mathilde Brassy (Carbet des sciences), Julie Gresser (DEAL Martinique), Fabian Rateau (ONF), Clarisse Courty (DEAL Martinique), for the IAS Resource Centre in conjunction with the Overseas IAS Initiative. April 2021. Editor: French Biodiversity Agency.

2022 edition

For more information...

- Signs posted on Chancel Island and in marinas in the towns of François and Robert.
<https://www.iguanesantilles.org/communication-1>
- Angin B., 2017. National action plan to restore the Lesser Antillean iguana, *Iguana delicatissima*, 2018-2022. Ardops Environnement, 67 pp + appendices. (In French)
- Angin B., 2018. Action plan against the green iguana (*Iguana iguana*) in the French Caribbean, 2019-2023. ONCFS and Ardops Environnement, 71 pp. (In French)
- Brassy M., 2020. Guide for presenters in the informational caravan for the network for the Lesser Antillean iguana (Martinique edition). Carbet des sciences. 27 pp. (In French)
<https://www.carbet-sciences.net/>
<https://www.iguanes-antilles.org/>
<https://www.facebook.com/CarbetDesSciences>
<https://www.facebook.com/iguanadelicatis-sima>



Direction
de l'environnement,
de l'aménagement et du logement
*Liberté
Égalité
Fraternité*





Striped iguana

(*Iguana iguana*)

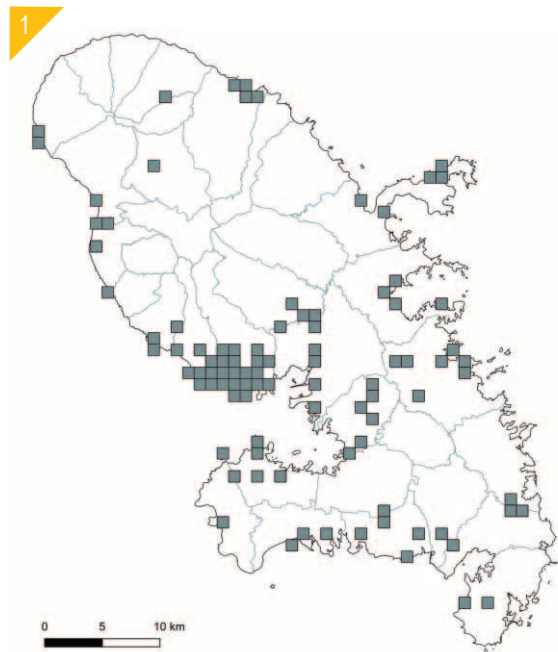
Managing the Striped iguana on Martinique

French National Forestry Agency (ONF)

- The French National Forestry Agency (ONF) is a public organisation in charge of managing public forests. It is supervised by the Agriculture and Ecology ministries.
- On Martinique, ONF manages 16 000 hectares of public forests (State, territorial, those of the Seaside and Lake Conservation Trust), certain mangroves and littoral State forests. In all these areas, one of the main objectives is to preserve biodiversity while continuing to welcome the public.
- On Martinique, ONF manages the stakeholder networks for the National Action Plans (PNA), including the plan to restore the Lesser Antillean iguana (*Iguana delicatissima*).
- ONF is also involved in managing invasive alien species (IAS) in the framework of the PNAs and the management plans for the biological reserves (RB).
- Contact: Network to preserve *Iguana delicatissima* – iguanepetitesantilles@gmail.com

Environmental Directorate

- The Martinique Environmental Directorate (DEAL) is active in all aspects of territorial development and it implements the policies of the Ecology ministry.
- The Landscape, Water and Biodiversity Service (SPEB) is in charge, *inter alia*, of preventing environmental damage, coordinating and putting to use knowledge, protecting and valorising the natural terrestrial and marine heritage and the landscapes of Martinique.
- DEAL is in charge of enforcing and adapting IAS regulations on the island.
- It manages the territorial IAS-management strategy and coordinates the various stakeholders and IAS projects.
- It also manages the PNAs for Martinique, including the plan to restore the Lesser Antillean iguana (*Iguana delicatissima*), and temporarily, while waiting for a new partner, the action plan against the Green iguana *Iguana iguana* (PLIC), now called the Striped iguana.



Source : ONF

1 - Distribution of striped iguanas in 2020.

Intervention site

- *I. Iguana* has been observed on Martinique since the 1960s and the greatest population densities are found in the towns of Fort-de-France (historic introduction site), Lamentin, Schoelcher, Carbet and on Ramiers Island. A few striped iguanas may be found in other areas, probably due to human transport given the distances involved and the breaks in the territories occupied by the animals. Work is done throughout the island, however the sites selected depend on the specific objectives.

Disturbances and issues involved

- *I. delicatissima* is considered critically endangered worldwide on the IUCN red list, following a 70% decline in its population and a projected future decline of over 80%.
- The species has been protected on Martinique by ministerial decree since 1989 and that protection was expanded to include its habitat in 2019.

■ It is one of the most threatened reptile species worldwide. Outside of Martinique, the species is now present only on a few isolated sites on Guadeloupe, Saint-Barthélemy, Dominica, Anguilla and Saint-Eustache.

■ The last populations of *I. delicatissima* are confronted with a number of threats, e.g. degradation of feeding and nesting sites by introduced herbivores, such as sheep. What is more, since 2011, a bacteria (*Devriesea agamarum*) is prevalent among iguanas on Saint-Barthélemy and constitutes a risk for populations on small, isolated sites. Weather events such as dry periods and hurricanes also represent a threat, in particular for the population on Chancel island.

■ The Striped iguana (also known as the green or common iguana), *Iguana iguana*, is an invasive alien species (IAS) and the main threat to the survival of the endemic species (*Iguana delicatissima*), the Lesser Antillean iguana.

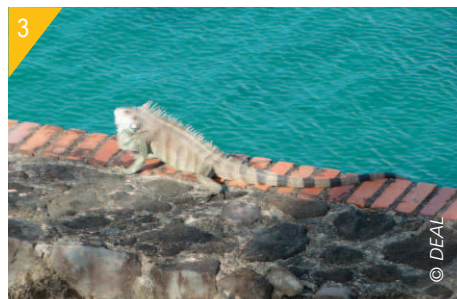
■ *I. iguana*, larger and more prolific, is a competitor of *I. delicatissima* for biotopes, food and reproduction. First-generation hybrids show a mix of the morphological and genetic characteristics of the two species, however, after a small number of generations, the far greater fertility of *I. iguana* results in descendants in which the morphological and genetic characteristics of *I. delicatissima* have virtually disappeared. To date, no hybrids have been observed on Martinique. They have, however, been observed on Guadeloupe.

■ Generally speaking, *I. iguana* is a highly detrimental competitor for the other species of iguanas on the Antillean islands, such as the Blue iguana on Grand Cayman (*Cyclura lewisi*), the Lesser Caymans iguana (*Cyclura nubila caymanensis*), the Sainte-Lucie iguana (*Iguana iguana santaluciaae*) and its management requires a regional approach.

■ These herbaceous animals can live in highly dense population groups (over 5 000 iguanas per square kilometre on Grand Cayman in 2018) and have a major impact on the natural vegetation and crops. For example, on Porto-Rico, mangroves along the coast have been severely affected.

■ Health risks have not yet been extensively assessed, but due to the abundance of their droppings, a high concentration of animals in urban environments can cause sanitary problems.

■ Economic problems have also occurred, notably in Florida, and have drawn attention to the negative impacts caused by very dense populations. For example, the digging of nests can cause subsidence of roads and damage to dikes.



2 - The endemic Lesser Antillean iguana a.k.a. the péyi iguana (*Iguana delicatissima*).

3 - The Striped iguana (*Iguana iguana*).

4 - A hybrid iguana observed on Guadeloupe.

Interventions

■ Objectives

■ There are two main objectives:

- limit the expansion of *I. iguana* toward sites located in the towns in the north of Martinique and on Chancel Island, where the species is currently absent and where there are viable populations of *I. delicatissima*. A priority project of the PNA to restore the Lesser Antillean iguana, managed by ONF, addresses this first objective;

- respond to reports of the presence of *I. iguana* and manage its populations in the urban areas where densities are high in order to limit its health and economic impacts, as well as avoid its expansion to the north, via a number of different management strategies. This second objective is covered by several projects in the action plan against the Striped iguana (PLIC) in the French Caribbean, managed by DEAL.



- Since 2019, towns on Martinique have been divided into two zones:
 - a strategic zone for the conservation of *Iguana delicatissima*, called the "PNA zone" and managed by ONF;
 - a strategic zone for the preservation of human activities, called the "PLIC zone" and managed by DEAL.
- To effectively manage the species, different approaches are used by the PLIC and PNA agents in order to maximise the chances of success. The management strategies depend on the given sector.

Table 1. Management strategy for striped iguanas in each sector.

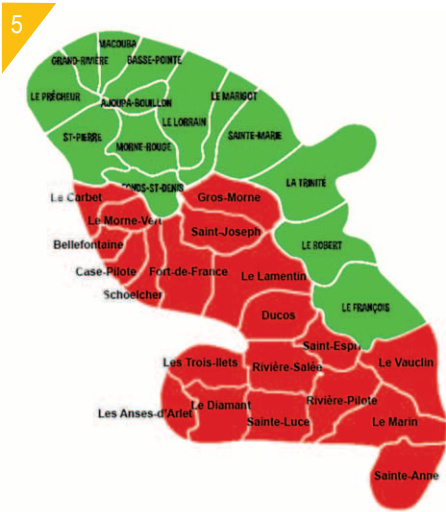
Objectives	Action plan and corresponding zone	Network manager	Management strategy				
			Removal of iguanas			Surveillance network and training	Awareness raising of population and elected officials
			Large-scale management	Isolated efforts (while waiting for large-scale management)	In response to reports		
Limit the expansion of <i>I. iguana</i> to the north of Martinique and to Chancel Island	PNA	ONF	NO	NO	YES	YES	YES
Manage high-density <i>I. iguana</i> populations in urban areas	PLIC	DEAL	Future project	YES	YES	YES	YES

■ Capture and killing

- Striped iguanas are captured using a long fishing pole with a slip knot (stainless-steel wire or string) at the end.
- Iguanas captured using the pole are then grabbed by an agent with gloves to avoid any risk of wounds and infection. Animals are placed in a bag (one animal per bag) to facilitate their transport to where they are to be put to death within a maximum of four hours following capture.
- Killing takes place with the iguana in a holding box, using a pellet gun (19.9 joules) that does not require a hunting license or a permit to carry.
- The procedure requires two agents, one to maintain the iguana in the holding box and the other to shoot the gun. Protection goggles are required for both agents. The muzzle of the gun is placed behind the skull next to the small dorsal spines, at an angle of 20 to 30° to ensure an instantaneous death without any unnecessary suffering.

■ Isolated interventions and large-scale management

- In the PLIC (red) zone, isolated interventions are undertaken by teams of three to six agents comprising public-service personnel (Martinique Regional Nature Park [PNRM], DEAL, French Biodiversity Agency [OFB] and ONF) and private partners in areas where *I. iguana* is found in high densities. During each intervention, whenever possible, all the animals observed in a high-density sector are captured and put to death. Isolated interventions slightly reduce local populations



5 - Division of towns according to the objective selected by the network managers (PNA zone in green and PLIC zone in red). Source: Carbet des sciences, DEAL and ONF.

in order to limit the expansion of striped iguanas to the northern section of the island. In parallel, inhabitants are informed of the problem with the striped iguanas.

■ To date, large-scale management efforts have not been undertaken, however project managers have been encouraged to do so. The large-scale strategy is considered the most effective in limiting the population of striped iguanas in the centre of the island, outside of the priority sectors for the conservation of the Péyi iguana. Large-scale management is therefore intended for the PLIC zone and DEAL is ready to assist project managers in the procedure.

■ **Surveillance network and response to reports**

■ Their propensity to live in trees, stealthy behaviour and camouflage make it difficult to detect isolated animals.

■ The response to reports by inhabitants makes it possible to work on private property, often less accessible during isolated interventions.

■ Surveillance networks have been set up to receive reports from the population and organise the capture of the detected animals:

- PLIC (red) zone: the network is composed of local-government personnel and private partners in order to react to the reports by inhabitants;

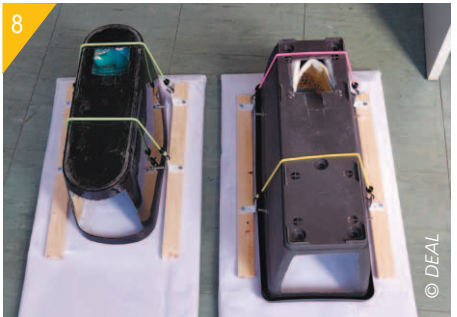
- PNA (green) zone: the network is composed of local-government personnel, the gendarmerie, fire departments and volunteers from non-profits to receive the reports on *I. iguana* and to capture the animals detected in areas only slightly invaded and considered priority zones for the conservation of *Iguana delicatissima*.

■ Members of the surveillance network have undergone training on the issues involved in managing *I. iguana* and on the criteria to differentiate between the two species, as well as practical training on the techniques used to capture, handle and kill the animals. Between 2017 and 2020, depending on the targeted sectors, several training courses have been organised by ONF and DEAL. A total of 69 people have been trained, including 14 for PNA activities and 55 for PLIC activities. The trained persons are included in the appendix to the prefectural order that lists the persons authorised to capture and kill striped iguanas. The appendix is updated in step with the training courses.

■ On written request by a mayor or president of an EPCI (public entity for cooperation between townships), capture equipment for towns or capture and lethal equipment for EPCIs can be made available to PLIC towns and EPCIs by DEAL (budget available at times) and to PNA towns by ONF. To date, only the town of Fort-de-France possesses the equipment. However, municipal police are authorised to take action and all towns can thus respond to reports.

■ A telephone call group comprising all the trained persons was created by the network manager in order to facilitate the coordination of responses to reports.

■ For Martinique as a whole and the PLIC zone in particular, it is also possible to fill out an on-line report form on the DEAL site to signal the presence of an IAS, including striped iguanas. DEAL then transmits the report to the local government or the private partner in charge of responding to the report. The call group is not used in the PLIC zone because there are too many reports and the response would not be improved.



6 - Capture of a Striped iguana using the pole with a slip knot.

7 - End of the pole showing the slip knot.

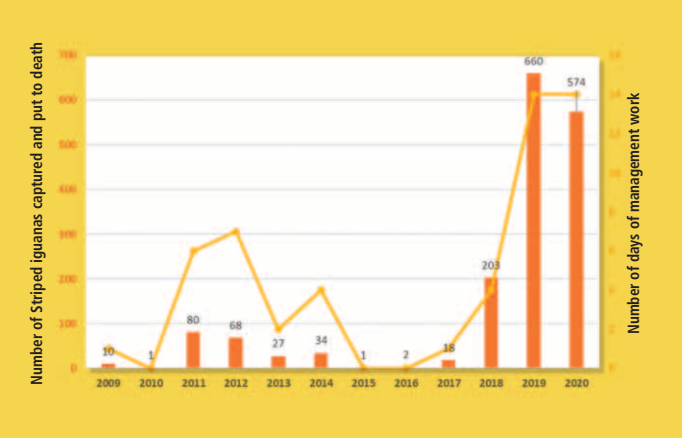
8 - Holding box designed specifically for putting striped iguanas to death. Two sizes are available for different sized animals.



Results

■ Technical results

■ Striped iguanas have been captured since 2009, but it was in 2011, in the framework of the PNA to restore the Lesser Antillean iguana (2011-2015), managed by ONCFS, that coordinated management efforts started. The work halted in 2015 and 2016 due to the lack of a PNA manager during the transfer from ONCFS to ONF. In 2017, management work was relaunched and even increased given the need to limit the expansion of the Striped iguana on Martinique.

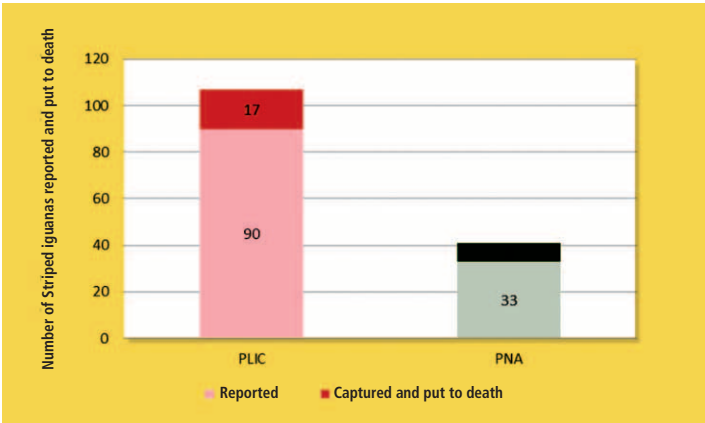


Number of striped iguanas (l. iguana) captured and put to death, and the number of days of management work from 2009 to 2020.

■ Isolated interventions take place essentially in Fort-de-France. The interventions organised outside of Fort-de-France often did not produce the expected results in spite of the significant resources involved (six agents, but no iguanas captured). That is why the creation of the surveillance network was deemed better suited to areas not heavily invaded by striped iguanas.

■ Since the start of the management work, 1 682 striped iguanas have been culled, including 1 640 in Fort-de-France, 14 in PNA towns and 28 in towns in the PLIC zone.

■ A total of 123 striped iguanas have been reported by the surveillance network or by citizens, including 33 in PNA towns and 90 in towns in the PLIC zone. On the whole, only 24% and 19% of reports, respectively in the PNA zone and the PLIC zone, resulted in the capture and killing of iguanas. This is because between the time of the report and the intervention, iguanas frequently move and are not found.



Breakdown of the numbers of l. iguana reported and put to death.



9 - Capture of a Striped iguana during a practical training course in Fort Saint-Louis.
10 - A captured Striped iguana.

■ **Financial aspects**

■ Management work on the Striped iguana on Martinique in the framework of the ONF and DEAL projects cost approximately 120 000 euros (ONF, DEAL, AFB, MIGBIO).

Table 2. Management costs of the ONF project.

Year	Equipment	Personnel	Total
2017	2 060 €		2 060 €
2018	2 648 €	11 423 €	14 071 €
2019	4 511 €	51 238 €	55 749 €
2020	4 346 €	26 796 €	31 142 €
Total	13 565 €	89 457 €	103 022 €

Table 3. Management costs in the DEAL project.

Year	Management work	Personnel
Mid 2018 to Sept. 2020	/	5% of an annual full-time job
Sept. 2019 to end of 2020	15 000 €	33% of an annual full-time job

Information on the project

- Given the lack of knowledge on the part of inhabitants concerning the two species of iguana, the invasive nature of the Striped iguana and in the meantime before greater awareness can be achieved, it was decided not to make this project widely known via the media and the social networks. Intervention personnel inform the general public as much as possible on the situation and the issues involved during work to capture the animals.
- In certain areas of Fort-de-France, e.g. Texaco and Volga, the density of striped iguanas is very high and their impacts on gardens, crops and fruit trees are considerable and visible. Local citizen groups and individual citizens have begun to request that local governments intensify the work to limit the numbers of iguanas.
- The informational caravan on the péyi iguana is operated by the non-profits in the network for the Lesser Antillean iguana each year during various events (patron saint fiestas, science days, etc.) (see the management report. on the caravan). A kakemono (vertical banner) titled "The Striped iguana, the main threat, but not the only one" is displayed by the presenters who attempt to raise awareness on the need to manage the invasive species in order to save the Péyi iguana and to limit the health and economic impacts. A kakemono titled "Help in preserving biodiversity on Martinique!" highlights the need to "multiply the number of watchful eyes" for the network for the Lesser Antillean iguana and to rapidly report any striped iguanas in the priority towns of the PNA zone. During two days of management work in busy public areas in Fort-de-France (February and March 2020), the informational caravan was on hand to explain the work to pas-



sers-by while the agents were capturing the iguanas. The caravan presenters noted a high majority of positive reactions on the part of persons informed as to the purpose of the management work.

- Letters were sent to elected officials to inform them on the issues involved, explain the need for the management work and justify the management strategy selected for each part of the island. A number of information meetings were also organised by the regional nature park and DEAL for elected officials from the towns and EPCIs. Participants were informed on IAS issues and more specifically on the need for management of the Striped iguana to save the Péyi iguana. They are now in a position to answer the questions of inhabitants on a range of topics (regulations, techniques used to capture and put to death the animals, organisation of the surveillance network to respond to reports, etc.).

- The techniques used to capture and put to death the animals were presented during the regional IAS workshop organised by the IUCN French committee in February 2020 that brought together all the overseas stakeholders confronted with the problem.

Potential improvements

■ Maintain the existing surveillance network and continue informing and mobilising the towns and EPCIs in order to develop the surveillance network and ensure a response to reports

- In the PNA zone, it is imperative to maintain the surveillance network with the call group in order to respond rapidly to reports of striped iguanas in priority areas for the conservation of the Péyi iguana.

- In the PLIC zone, it is important to continue distributing equipment in 2021 so that the EPCIs, towns and private partners can easily and quickly respond to reports. Management work by individual towns in the EPCIs is also expected to start in 2021.

■ Better assess the effectiveness of isolated interventions and large-scale management

- Following several interventions in high-density areas, the rapid reduction in the numbers of striped iguanas is clear. However, it is still necessary to assess the effectiveness of these isolated interventions.

- An estimation of the number of animals using the distance-sampling method was carried out in 2020 to obtain baseline data for an assessment of the effectiveness of the management work in the port sectors of Fort-de-France. The resulting estimate of abundance was 723 striped iguanas (confidence interval = 387 to 1 350), i.e. a density of 3.96 iguanas per hectare. This estimate represents the initial data point for iguana densities. New counts before and after future management work with differing time lapses between each count (one week, one, two, four or six months, one year) will make it possible to measure the changes in the numbers of striped iguanas and to assess the effectiveness of the management work.



11 - Informational caravan for the conservation of the péyi iguana, set up in Fort-de-France.

■ Improve the effectiveness of management work

■ Current management work on the Striped iguana is not sufficient to achieve a sustainable drop in numbers and reduce the risks of interbreeding with the populations of the Lesser Antillean iguana because interventions remain isolated and produce only local effects.

■ On Grand Cayman Island, the government launched in October 2018 a management programme involving 467 licensed companies and individuals who receive the equivalent of four to five euros for each iguana put to death. The iguanas are captured using a long pole and then put to death, or they are simply shot using a pellet gun. In 2019, the programme eliminated approximately 1.1 million striped iguanas. In 2020, fewer than 100 000 iguanas remained on the island.

■ This programme is one of the very few that resulted in a significant reduction in the population of *I. iguana* on an inhabited island. One of its strong points is that it is relatively inexpensive compared to management work done by public-sector employees. Adapting the programme to Martinique would require a significant effort to raise the awareness of inhabitants in order to avoid hostile reactions, a study on its feasibility in terms of local regulations and suitable training for participants to avoid unnecessary suffering of the animals when being captured and put to death.

■ Large-scale management efforts are required to ensure effective reductions in numbers. DEAL plans to accompany project managers (EPCIs, the regional nature park, non-profits, etc.) in preparing applications for funding and greater human resources for larger operations.

■ In parallel, a study will be launched to identify other management techniques. For example, work will be put into detecting and eliminating nests. This would be a more effective technique because 30 to 60 eggs can be eliminated in each nest. This work is planned for the nesting period (April 2021), notably in and around Fort Saint-Louis.

■ Valorise the animals put to death in order to improve acceptance of the work by the general public

■ The issue of valorising the iguanas put to death was raised by over 95% of the persons informed by the caravan. This would appear to be a highly important point because, according to these persons, an effort to make use of the animals, particularly by consuming the meat, would facilitate acceptance of the management work by inhabitants. Work will have to be undertaken locally with the Directorate for Food, Agriculture and Forestry (DAAF) to study this possibility. To date, the animals are not valorised and the bodies are simply sent to the local rendering service. This solution is currently acceptable, however it would certainly be worthwhile to study valorisation possibilities (meat, leather). To that end, ONF and DEAL have launched discussions with DAAF. It would also be worthwhile to run a study on current knowledge concerning pathogens potentially carried by striped iguanas.



Regulations

- The introduction of the Striped iguana in the natural environment is prohibited by the ministerial decree dated 8 February 2018 on preventing the introduction and propagation of animal IASs in the natural environment of Martinique.
- The species is also on the list appended to the ministerial decree dated 7 July 2020 prohibiting the introduction, detention, transport, use and/or trade of IASs on Martinique.
- The species is named in the prefectural order dated 8 July 2013 authorising the capture and killing of certain IASs by certain competent organisations and professional sectors.
- The prefectural order dated 22 August 2019 authorises a specific list of non-profits, local governments and private structures to capture and kill striped iguanas. The appendix to the order is updated in step with the training courses.

Authors: Fabian Rateau, National Forestry Agency in Martinique, Julie Gresser DEAL Martinique, Clara Singh, IUCN French committee, Alicia Bonanno, National Forestry Agency in Martinique, Marie-Laure Rizzi, DEAL Martinique, Clarisse Courty, DEAL Martinique, for the IAS Resource Centre in conjunction with the Overseas IAS Initiative. April 2021. Editor: French Biodiversity Agency.

2022 edition

For more information...

- Angin B., 2017. National action plan to restore the Lesser Antillean iguana, *Iguana delicatissima*, 2018-2022. Ardops Environnement, 67 pp + appendices. (In French)
 - Angin B., 2018. Action plan against the green iguana (*Iguana iguana*) in the French Caribbean 2019-2023. ONCFS and Ardops Environnement, 71 pp + appendices. (In French)
- <https://www.iguanes-antilles.org/>

<https://www.facebook.com/iguanadelicatisima>
<http://www.martinique.developpement-durable.gouv.fr/iguanes-a1417.html>
<http://www.martinique.developpement-durable.gouv.fr/reglementation-a1462.html>
<http://www.martinique.developpement-durable.gouv.fr/j-ai-observe-une-espece-envahissante-a1466.html>



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Siberian Chipmunk

(*Tamias sibiricus*)

Also called the common chipmunk. Originated in Siberia and Eastern Asia (China, Korea, Japan). It has been sold in Europe as a pet since the 1960s.

Description

- A small squirrel, weighing approximately 100 grams
- Brown to beige fur, with five black or dark-brown stripes on the back, light coloured fur on the underside
- No sexual dimorphism
- Lifespan estimated at approximately three years in the wild, eight years in captivity

Ecology and reproduction in its original environment

- Forest habitats (hardwood or conifer), woods and copses, urban parks
- Diurnal and solitary
- Simple burrow with only one entry, in which the chipmunk hibernates from October-November to February-March
- Sexually mature at age of one year, gestation period of 30 days, one to two litters per year with three to five young in each litter, in April-May and July-August
- Feeds on nuts (acorns, chestnuts, hazelnuts, etc.) in the fall, seeds of herbaceous plants, fruit and insects in the spring and summer
- Carries the bacteria causing Lyme disease

Documentation

- Chapuis J.-L., 2005. Range in France of a naturalised pet, the Siberian chipmunk (*Tamias sibiricus*). *Revue d'écologie*, 60:239-253. (In French)
- Chapuis J.-L., Gerriet O, Losinger-Chabod I. et Pisanu B., 2018. Management of invasive alien species and the case of squirrels in France. *Faune Sauvage*, n°321. (In French)
- Chapuis J.-L. & Pisanu B., 2017. National list of natural heritage. National Museum of Natural History. (In French) https://inpn.mnhn.fr/espece/cd_nom/61204/tab/fiche

Author: Doriane Blottière, IUCN French committee.

Classification	
Order	Rodentia
Family	Sciuridae
Genus	Tamias
Species	T. sibiricus (Laxmann, 1769)





Siberian Chipmunk

(*Tamias sibiricus*)

Experiment to regulate Siberian chipmunks in the Isère department

French Biodiversity Agency (OFB)

The French Biodiversity Agency is a public agency dedicated to preserving biodiversity. A main priority is to respond rapidly to serious issues concerning the preservation of plant and animal life. The agency was founded on 1 January 2020 by law number 2019-773, dated 24 July 2019, and it reports to both the Ecology Ministry and the Agriculture Ministry. OFB is the result of the merger of the former biodiversity agency (AFB) and the National Agency for Hunting and Wildlife (ONCFS). It is present in the regions via regional directorates. This new public agency has five complementary missions:

- provide knowledge, research and science advice on species, environments and their use;
- policing activities for the environment and wildlife (health concerns);
- support for public policies;
- manage and assist the managers of natural areas;
- mobilise society and support stakeholders.

Contacts: Isabelle Losinger-Chabod, Deputy head of the Knowledge department, Auvergne Rhône-Alpes regional directorate - isabelle.losinger@ofb.gouv.fr

Intervention site

- The experiment was carried out in two towns located to the south of Grenoble (Isère department) where Siberian chipmunks have been regularly observed.
- The chipmunks were first observed in the town of Échirolles in 2002. The number of chipmunks is not known. However, given the long-standing observations, the fact that reproduction is clearly taking place and the size of the potential area of colonisation, it is thought that a maximum of 50 animals may inhabit the site (analysis in November 2017 by the Centre for Ecology and Conservation Science (CESCO), a part of the National Museum for Natural History (MNHN), team headed by Jean-Louis Chapuis). This finding is consistent with the average densities observed in other chipmunk populations introduced in France and notably the population



1. Intervention site (blue area) and the access points in the towns of Échirolles and Pont-de-Claix.

in the Sénart Forest located in the south-east section of the Paris region, on a site straddling the Seine-et-Marne and Essonne departments (3 to 5 animals per hectare). The origin of the animals is not known, however two pet shops located nearby sold the species for a number of years.

- The chipmunks were first observed in the town of Pont-de-Claix (1.5 km distant from Échirolles) in 2017 and reported via the <https://ecureuils.mnhn.fr/> site. The chipmunks may be part of the population from Échirolles (the animals spread by approximately 100 metres per year), but they may also have been released by a pet owner.

■ The intervention site is a riparian zone interspersed with rock outcrops along the right bank of the Drac River, over a distance of seven kilometres, along the edge of the two towns.

Disturbances and issues involved

Siberian chipmunks are rodents that were sold as pets starting in the 1960s. Most of the chipmunks observed in natural areas were released by people who had tired of keeping them, though in some cases they escaped from breeding farms. Ownership of the species is now severely regulated (see the section below on Regulations).

■ Ecological impacts

■ The Siberian chipmunk would not seem to be a serious competitor for rodents native to European forests (notably the wood mouse, *Apodemus sylvaticus*, and the bank vole, *Myodes glareolus*) that share the same trophic niche.

■ The wild chipmunk populations amplify health risks due to an increase in the circulation of pathogens carried by castor bean ticks (*Ixodes ricinus*), essentially in low-land forests in temperate, oceanic and continental climates. This is because red squirrels (*Sciurus vulgaris*), following contacts, can be contaminated by two intestinal nematodes that originated in S.E. Asia (*Brevistriata skrjabini* and *Strongyloides callosiureus*) and were imported via the chipmunks.

■ Competition between these two squirrel species is possible during years when acorn production is low in low-land oak forests.

■ Health impacts

■ The Siberian chipmunk is a significant carrier of the bacteria (*Borrelia spp.*) that cause borreliosis, a sickness that can be transmitted to humans (Lyme disease) through tick bites. In Sénart Forest (Faisanderie site, Essonne and Seine-et-Marne departments, spring and fall 2007-2010), 30 to 70% of chipmunks were estimated to carry the bacteria (Marsot *et al.*, 2013), compared to less than 30% for the native carriers, i.e. wood mice and bank voles. It was calculated that in Sénart Forest, the chipmunks contaminated up to eight times more ticks (nymph stage) than the mice and voles, highlighting the "amplification" of health risks caused by chipmunks.

■ Economic impact

■ No economic impacts have been documented in France.

Interventions

■ Prefectoral order

■ Following repeated observations of chipmunks in the two towns, OFB alerted in July 2017 the Isère Departmental Territorial Directorate (DDT 38). Given the small area and estimated population numbers, eradication of the population was recommended. Of the eight chipmunk populations currently in France, the Isère population was one of three for which eradication was considered feasible (Chapuis *et al.*, 2018). Consequently, DDT 38 requested the opinion of the Regional Scientific Council for Natural Heritage (CSRPN) in view of obtaining a prefectoral order. Following approval by CSRPN, prefectoral order 38-2018-03-20-008 was signed on 20 March 2018.

■ The use of non-lethal traps was authorised, in compliance with a protocol tested and validated by MNHN, in order to eliminate the population. A time limit was set for the intervention, from the day the order was signed to 31 December 2021. Captured animals were euthanised by a blow to the head, in compliance with directive 1099/2009 dated 24 September 2010 on "the protection of animals when put to death". Cadavers are conserved by MNHN for further study and analysis.



2a and b. The Drac River in the town of Échirolles.

3. A trap hidden in the vegetation.



■ Methods

■ The main objective of the experiment was to eradicate the Siberian chipmunks observed in the two sectors identified in 2017.

■ To ensure the best chances of success, it was imperative to undertake the capture of the animals immediately after their hibernation (February-March) and before the births of the young (before mid-April and in August), in order to significantly and rapidly reduce the numbers of reproducers. In addition, the work is facilitated at that time of year due to the less dense vegetation.

■ OFB personnel used two methods to capture the animals, trapping and shooting.

■ Non-lethal Sherman traps baited with sunflower seeds were set up every 20 to 30 metres depending on the site configuration (outcropping rocks, vegetation, trails, etc.), in one or two parallel lines depending on the width of the potential and observed habitat of the Siberian chipmunks. The traps were camouflaged using vegetation to make them less visible to the public. They were checked every three hours between 7 o'clock in the morning and 6 o'clock in the evening, then deactivated for the night. If a non-targeted species was captured (passerines, small rodents), it was immediately released. If a Siberian chipmunk was captured, it was put to death by a blow to the head and stored in an OFB freezer (-20°C) until it could be transported to the MNHN for later analysis. To avoid any possible contamination, the personnel wore nitrile gloves under bite-resistant gloves.

■ Concerning the shooting of the animals, following the authorisation by DDT 38 and the CSRPN, a number of small-calibre weapons were tested before selecting a 9-millimetre rifle. Specially authorised OFB personnel used the weapons in addition to trapping when the animals were directly visible and favourable conditions prevailed (site, weather, distance, etc.) and safety could be ensured.



4. A Siberian chipmunk captured in a trap.

Results and assessment

■ Technical results

■ In 2018, trapping and shooting took place during two periods, from 26 March to 24 April and from 6 to 24 August. A total of 23 chipmunks were captured, including two by shooting.

■ In 2019, two more interventions took place, from 25 March to 3 April and from 26 to 30 August. A total of 7 chipmunks were captured, including two by shooting.

■ During each intervention period in 2018 and 2019, between 95 and 200 traps were set. It appeared that the most favourable time for the captures was between 10 o'clock in the morning and 3 o'clock in the afternoon on days with good weather. The animals move about very little in case of rain, wind and very high or low temperatures.

■ Certain non-targeted species were regularly captured, e.g. wood mice, great tits, garden dormice, and others were occasionally captured, e.g. shrews, weasels, stoats. Each non-targeted animal was alive and in good health on being released. However, a number of wood mice were captured in March-April 2018 by the MNHN for a comparison of their parasite complex with that of the chipmunks.

■ Analysis of the cadavers revealed that the chipmunks were infested with parasites, including ticks (*Ixodes ricinus*). This result highlighted the risks, even if limited, of pathogens circulated by communities of small rodents living on periurban sites and subject to castor bean ticks (Mori et al., 2018). High levels of intestinal nematodes (*Trichuris muris*) were also found in some chipmunks,

signalling that they are susceptible to the parasites affecting native rodents (notably wood mice), a fact already observed in other populations in continental France.

■ The only parasite transmitted to Échirolles by the chipmunks (a lice, *Enderleinellus tamiasis*) does not represent a manifest risk for the local wildlife, particularly for red squirrels.

■ Financial aspects

■ Over the two years 2018 and 2019, the interventions represented a budget of 2 835 euros for the equipment and 85 man-days of work.

■ The equipment used to capture the animals was purchased thanks to the BOP 113 programme of the Isère DDT. A total of 105 Sherman traps (<https://www.shermantraps.com/orderonline/product/42-lng-non-folding-trap>) were purchased from the Wildcare company for 2 600 euros.

■ In addition to the traps, various elements of small equipment and supplies were purchased, notably given the necessary health precautions in handling the animals and storing the cadavers, and bait for the cages, for a total of 246 euros.

A detailed list of the small equipment and supplies.

Item	Price (incl. VAT)
Sunflower seeds (40 kg)	€ 63.80
Bite-resistant gloves (2 pair)	€ 80.62
Storage and depollution boxes (x 2)	€ 13.90
Plastifying spray (x 2)	€ 18
Paper bags 18 x 25 cm (x 100)	€ 3.55
Nitrile gloves, size L (x 100)	€ 4.74
Nitrile gloves, size M (x 100)	€ 4.91
FFP2 masks (x 20)	€ 10.09
Self-adhesive labels	€ 3.28
UGAP delivery	€ 8.40
Paint sprays (x 2)	€ 34.50
Total	€ 245.79

■ In terms of the human resources involved, 85 man days were required to eliminate 30 chipmunks over a period of two years. The table below provides information on the trapping work per month and the number of chipmunks captured. On the basis of a daily rate of 348 euros (ONCFS tariff 2019 for an environmental technician), the human resources represented a total investment of 29 410 euros.

Trapping results from March 2018 to April 2020.

Session	Number of trapping days	Number of traps set per day	Man-days	Number of chipmunks captured
March 2018	4	162	25	10
April 2018	15	108	21	5
August 2018	12	37	16	8
April 2019	8	81	13	3
August 2019	5	60	10	4
April 2020	No work done due to Covid-19.			



Information on the project

- The DDT 38 made an effort to inform the municipalities, the law enforcement agencies (police and gendarmerie) and the DDPP (Departmental Directorate for the Protection of the Population).
- OFB published a brochure to explain the project to the general public. The brochure was available on the MNHN site and on the intervention site for any interested persons.

Conclusion and outlook

- A total of 30 animals were captured during the first two years of the experiment. It would appear that the population, initially estimated at approximately 50 animals, was in fact somewhat smaller.
- Each part of the intervention zone was monitored in September and October 2019 by the OFB Isère local office in an effort to shoot at least one of the remaining animals on each site, before they began their hibernation, but without success. In April 2020, the experiment was interrupted due to the Covid-19 lockdown. However, the work will resume at the end of the summer in 2020 and be pursued in 2021, the year at the end of which the prefectural authorisation ends.
- In spite of the theoretically favourable conditions for the eradication of the Siberian chipmunks, given the small population and its limited habitat (between the Drac River to the west and a shopping centre to the east) reducing the potential expansion, four trapping operations were not sufficient to completely eliminate the rodents. These results highlight the need to intervene immediately following the initial observations, before the population (even if very small at first) can establish itself and develop, in order to enhance the chances of success in eliminating Scuridae species that are highly proficient at establishing a population once they have been introduced to a natural environment. They also make clear that it is necessary to plan eradication work over the long term. Several years are often required to achieve the objective in semi-natural environments (that are not islands).

Regulations

- It has been forbidden to release Siberian chipmunks to the natural environment since 2010. Its introduction in France has been prohibited since the decree dated 14 February 2018, including transit under customs monitoring, release to the natural environment, ownership, transport, trade, use, exchange, sale or purchase. This reinforcement in the prohibition followed the EU regulation 1143/2014 listing the species of Union concern.
- The animals may no longer be held, except by zoos and parks with special authorisation. All Siberian chipmunks must be identified. Private persons may no longer purchase a Siberian chipmunk and those already possessed may not reproduce and must be declared to the Prefecture of the department of the owner.

Author: Isabelle Losinger-Chabod, OFB, Benoit Pisanu, MNHN, and Doriane Blottière, IUCN French committee, for the Resource Centre on invasive alien species. May 2020. Published by the French Biodiversity Agency.

2022 edition



5. Brochure on the Siberian chipmunks.
(In French)

For more information...

- <https://ecureuils.mnhn.fr/ecureuil-de-coree/dossiers-scientifiques/gestion>
- Brochure on the Siberian chipmunks (in French):
https://ecureuils.mnhn.fr/sites/default/files/documents/plaquette_oncfs_tamia_de_siberie.pdf
- Chapuis *et al.*, 2018. Management of invasive alien species and the case of squirrels in France. (In French) *Revue Faune sauvage* n° 321. P45-51.
https://ecureuils.mnhn.fr/sites/default/files/documents/chapuis_et_al_2018_gestion_ecureuils_exo.pdf
- Marsot *et al.* 2013. Introduced Siberian Chipmunks (*Tamias sibiricus barberi*) Contribute More to Lyme Borreliosis Risk than Native Reservoir Rodents. *Plos One* January 2013, Volume 8, Issue 1
https://ecureuils.mnhn.fr/sites/default/files/documents/marsot_et_al_plos_one_2013.pdf
- Mori, E., Pisanu, B., Zozzoli, R. *et al.* 2018. Arthropods and associated pathogens from native and introduced rodents in Northeastern Italy. *Parasitol Res* 117, 3237–3243.
<https://doi.org/10.1007/s00436-018-6022-4>.



Small Indian mongoose

(*Urva auropunctata*)

The mongoose originated in a large section of Asia and was introduced to Saint-Martin in 1885. The species was observed for the first time in Guadeloupe in 1888 and in Martinique in 1890.

Description

- A small mammal with short legs and an elongated body
- Average size of females is 54 cm long and of males is 59 cm long
- Average weight of 450 g, however the largest males can reach 1 kg
- Brown, yellowish fur, occasionally grey due to black and white rings on the hairs Underside a lighter colour than the rest of the body
- Pointed snout, muscular and bushy tail, short, round ears
- Non-retractile claws
- Small eyes with a brown iris

Ecology and reproduction in its original environment

- Variable habitats, the highly adaptable species is found in forests, in open environments, occasionally in developed areas, including residential buildings. In the Caribbean, it is more frequently found in dry environments than in wet forests
- Omnivorous, but tending toward carnivorous, a highly variable diet depending on the availability of food
- Sexual maturity at 10 months, no particular season for reproduction
- Females can produce up to three litters per year, with one to five young per litter (generally two), gestation lasts 42 to 50 days
- A solitary animal in its original range, but it tends to live in groups in areas where it has been introduced
- Life expectancy 3 to 4 years in the wild
- Diurnal species
- Carrier and vector of rabies

Documentation

- Lorgelec, O., Pascal, M., & Pavis, C., 2001. Inventory and status of mammals in the French Caribbean (not including bats and cetaceans). In Report n° 27 of the Association pour l'Étude et la Protection des Vertébrés et Végétaux des Petites Antilles, Petit-Bourg, Guadeloupe. 22 pp. (In French)
- Lorgelec, O., Pascal, M., Delloue, X., & Chapuis, J.L., 2007. Non-flying terrestrial mammals in the French Caribbean and the recent introduction of a squirrel. Rev.Ecol. (Terre Vie), 62 : 295-314. (In French)
- https://inpn.mnhn.fr/espece/cd_nom/850071/tab/fiche
- <https://www.cabi.org/isc/datasheet/8050856>

Author: Clara Singh, IUCN French committee.

Classification

Order	Carnivores
Family	Herpestidae
Genus	Urva
Species	<i>U. auropunctata</i> (Hodgson, 1836)





Small Indian mongoose

(Urva auropunctata)

Managing the small Indian mongoose on the nesting sites of sea turtles on Martinique

French National Forestry Agency (ONF)

- The French National Forestry Agency (ONF) is a public organisation in charge of managing public forests. It is supervised by the Agriculture and Ecology ministries.
- On Martinique, ONF manages 16 000 hectares of public forests (State, territorial, those of the Seaside and Lake Conservation Trust), certain mangroves and littoral State forests. In all these areas, one of the main objectives is to preserve biodiversity while continuing to welcome the public.
- On Martinique and Guadeloupe, ONF runs two national action plans (PNA) under the management of the Environmental Directorate (DEAL), including the PNA for sea turtles in the French Caribbean.
- Biological reserves (RB) are the instrument used to manage natural areas of high ecological and patrimonial importance. There are five RBs on Martinique, including three fully-protected biological reserves (RBI) and two managed biological reserves (RBD).
- ONF is also involved in managing invasive alien species (IAS) in the framework of the PNAs and the management plans for the biological reserves, including the RBD for sea turtles.
- Contact: Contact person for the PNA for sea turtles and the PNA for the Lesser Antillean iguana on Martinique - tortuesmarinesmartinique@gmail.com

Intervention site

- The work took place on three nesting sites of sea turtles:
 - Anse Lévrier (Lévrier Cove) and Anse à Voile in the town of Prêcheur, part of the Prêcheur Grand'Rivière RBI;
 - Anse Trabaud in the town of Sainte-Anne, part of the Sea Turtle RBD;
 - a group of small beaches between Pointe Rouge and Pointe à Bibi on the Caravelle peninsula.
- The trapping campaigns took place in 2012, 2014, 2018, 2019 and 2020. The initial campaigns were carried out in the framework of the first PNA for sea turtles in the French Caribbean (2010-2015). The work halted from 2015 to 2017 due to the lack of a PNA manager during the transfer from ONCFS to ONF, but then restarted in 2018 in the framework of the second PNA.



1 - Map showing the beaches where the work took place

Table 1. Trapping sites and years.

Sites	Years				
	2012	2014	2018	2019	2020
Northern coves (Anse Lévrier and Anse à Voile)	*	*	*	*	*
Anse Trabaud					
Caravelle peninsula		*	*	*	*
					*

- The sites were selected due to the high level of predation observed during monitoring work on sea-turtle nesting sites. The monitoring work is undertaken each year to assess the relative importance of each nesting site and changes in the population numbers of sea turtles.
- The beaches on the Caravelle peninsula were added to the trapping campaign in 2020 following reports of intensive predation by the volunteers doing the monitoring work on the sea turtles.

Disturbances and issues involved

- The small Indian mongoose is considered one of the 100 most invasive species worldwide.
- It was introduced on Martinique in 1891 to reduce the numbers of rats and the poisonous Martinican pit viper (*Bothrops lanceolatus*). The introduction was not successful in reducing the targeted species, but was the cause of the decline and even the disappearance of native species. It is considered the main cause of the extinction of several reptile species and of other vertebrates such as the Martinique muskrat (*Megalomys desmarestii*), Lacépède's ground snake (*Erythrolampus cursor*) and two skinks (*Mabuya mabouya* and *Mabuya metallica*).
- The mongoose is opportunistic and added turtle eggs to its diet. Three species of sea turtles lay eggs on the beaches of Martinique and are threatened with extinction according to the IUCN national Red List:
 - the Leatherback sea turtle (*Dermochelys coriacea*), ranked Vulnerable (VU);
 - the Green sea turtle (*Chelonia mydas*), ranked Endangered (EN);
 - the Hawksbill sea turtle (*Eretmochelys imbricata*), ranked Critically Endangered (CR).
- The mongoose is also suspected of eating the eggs of other threatened species such as the White-breasted thrasher (*Ramphocinclus brachyurus*) and the iguana endemic to the Lesser Antilles (*Iguana delicatissima*), both ranked Critically Endangered (CR).
- Sea turtles on Martinique are confronted with numerous threats due notably to the degradation of their nesting sites and accidental catches by fishing vessels. The small Indian mongoose is a factor in the reduced productivity of the rare nesting sites not severely affected by human activities and by other threats.
- A number of studies have indicated that mongoose predation rates on the nests of sea turtles can reach 80 to 100% if no management work is undertaken.

Interventions

■ Objective

- The objective of the work was to reduce the population of small Indian mongooses during the nesting season of sea turtles (March to October) in order to limit the predation of the nests. Complete eradication of the small Indian mongoose is not a realistic objective given its high population numbers on Martinique.
- Monitoring of sea-turtle nesting sites was carried out in parallel with the trapping campaigns in order to improve knowledge on the nesting sites and the numbers of nesting female turtles.



2 - A small Indian mongoose attacking a sea-turtle nest.
 3 - Predation on a sea-turtle egg.
 4 - A mongoose cage trap (old model).
 5 - Transporting the cage traps to the nesting sites.

■ Equipment used

- The trapping work was undertaken by forest technicians, agents from the PNA for sea turtles, ONF interns and volunteers from the Arompei non-profit. Counting operations for signs of nesting by sea turtles also involved ONCFS personnel and volunteers from the L'asso-mer, Reflet d'culture and Sepanmar non-profits.
- Non-harmful (cage) traps are used during 4 to 15 day periods between the months of April and September. The length of periods depends on the availability of participants and on the observed predation.
- Between 30 and 40 cage traps were set during each period, among three different types:
 - 1) double-entry tomahawk traps in 2012 and 2014;
 - 2) home-made traps made with wire mesh in 2018 and 2019;
 - 3) custom traps made by the BTTm company in 2020.
- A pellet gun (19.9 joules) was used to put the animals to death.
- Two coolers were required to transport the animals to the storage place.
- The traps were attached to trees using 18 chains and padlocks for the duration of each period and to avoid theft.
- Nine different types of bait were used to learn what the mongooses like best, to avoid the animals becoming habituated to one type and to adjust the system to achieve greater effectiveness. The bait most commonly used was frozen chicken sausage.
- The animals were transported in a cooler, then stored at the ONF site in a freezer used for the management of invasive alien species. The rendering service was called when the quantity of animals reached 40 kilograms, the point at which the service is free of cost.

■ Trapping work

- The traps were transported by backpack or by boat to the Anse du Prêcheur and the Anse de la Caravelle, and by car to the Anse Trabaud. The precise GPS location of each trap was noted when the trap was set.
- Several inspections took place each day with at least 90 minutes between each in order not to scare off the mongooses and to put to death or release any non-targeted animals, to reset and rebait the traps, to note the status of each trap (active, inactive, trapped animal) and to register the biometric data of the trapped animals (sex, weight, size). The traps remained in place overnight, except in 2018.
- Captured mongooses, rats and mice were put to death using a pellet gun (compressed air, 19.9 joules), then frozen and finally sent to the public rendering service.
- Below is a description of a day of trapping along the northern coves.

Table 2. A day of trapping along Anse à Voile et Anse Lévrier.

Time of day	Interventions
AM	Check and reset traps at Anse Lévrier
	Count signs of nesting by sea turtles at Anse Lévrier
	Check and reset traps at Anse à Voile
	Count signs of nesting by sea turtles at Anse à Voile
Mid-day pause	
PM	Check and reset traps on the two beaches
	Count signs of nesting by sea turtles at Anse Couleuvre (part of another monitoring programme, but included here to optimise organisation of field work)
	Count signs of nesting by sea turtles at Anse Céron (part of another monitoring programme, but included here to optimise organisation of field work)
	Check and reset traps on the two beaches



6 and 7 - A small Indian mongoose captured in the custom-made cage trap.

■ **Monitoring protocols for nesting by sea turtles**

■ The observers walked near the nesting area, along the forest edge, to detect signs of nesting in the sand and of nest predation by mongooses. The recorded data include the species of sea turtle, the width of turtle tracks, the result (eggs laid or not) and the GPS data of the nest (or of the predation), etc.

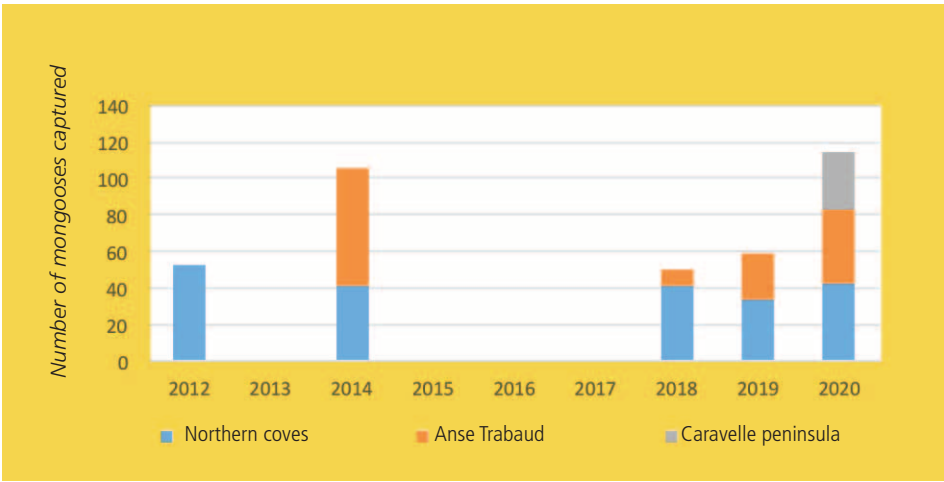
Technical results

■ **Captures**

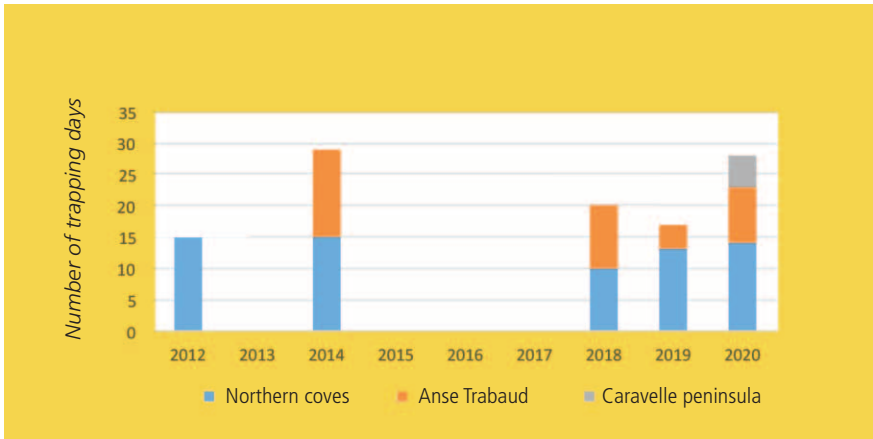
■ A total of 381 mongooses were captured during 109 days of trapping spread over five nesting seasons. Eight non-targeted species were also captured. black rats (*Rattus rattus*), brown rats (*Rattus norvegicus*) and house mice (*Mus musculus*) were put to death, whereas cats (*Felis catus*), common opossums (*Didelphis marsupialis*), the Blue land crab (*Cardisoma guanhumi*), the Red land crab (*Gecarcinus lateralis*) and the Caribbean hermit crab (*Coenobita clypeatus*) were released.

■ Crustaceans represented over 70% of the captures at Anse Trabaud and considerably reduced the effectiveness of the trapping work.

■ The sex ratio of the captured mongooses was uneven with 80% of male animals in 2019 and 2020. In addition, clear geographic differences in the sex ratio were noted between beaches and depending on the distance to the beach. The reasons for these imbalances are not known to date.



Number of captured mongooses per year and per site.



Number of trapping days from 2012 to 2020.



Table 3. Table showing annual CPUE values, i.e. captures per unit of effort (numbers of captured mongooses divided by the number of trapping days in the field).

Sites	Years				
	2012	2014	2018	2019	2020
Northern coves (Anse Lévrier and Anse à Voile)	6.07	7.07	5	2.54	2.16
Anse Trabaud	/	4.64	0.9	6.5	4.44
Caravelle peninsula	/	/	/		6.6

- In the northern coves, CPUE values have dropped since 2014 (Table 3). It will be necessary to check the results in future years to determine whether the trapping effort is sufficient to limit predation of sea-turtle nests by mongooses or whether the mongooses have learned how to avoid the traps.
- In 2018 at Anse Trabaud, the very low CPUE value was due to the massive arrival of sargassum seaweed and consequently a small number of turtle nests, making the area less attractive for mongooses.

■ Success rates of different baits tested in 2019

- Nine different types of bait were used and the bait was renewed 416 times. The capture success rate for each type of bait was calculated as (number of captured mongooses per bait x 100) / number of times the bait was used.
- Crab meat would appear to have the highest success rate. It should be noted, however, that this bait was used on only one site, Anse Trabaud, where a high density of mongooses had been observed. The success rate was not due exclusively to the use of crab meat as the bait, but to the high concentration of mongooses on the site.
- Beef-flavoured canned dog food and chicken sausage also produced acceptable results, with the latter being the most used because most practical.
- Chicken sausage was the easiest to use with good results and was therefore used most often.

Table 4. Success rates of different baits.

Bait	Peanut butter	Canned sardines	Chicken sausage	Mackerels	Crab meat	Salmon-flavoured canned cat food	Beef-flavoured canned dog food	Sausage
Success rate (%)	0	11	15.5	9	21	0	16.5	14

Financial aspects

- The five years of trapping work cost 108 219.63 €, i.e. 21 643.93 € per year.
- The project was funded by FEDER, the regional council, ONF and DEAL for the work in 2012-2014 (PNA 2010-2015 funding) and by MTES in the framework of general funding projects for biodiversity, DEAL and AFB (later OFB) in the framework of the "Overseas initiatives" call for projects for the period 2018-2020.

Table 5. Breakdown of costs.

	Payroll	Equipment and services	Internships	Total
2012-2014	42 859.00 €	7 541.92 €		50 400.92 €
2018-2019-2020	47 615.00 €	4 251.41 €	5 952.30 €	57 818.71 €
Total for the five years				108 219.63 €
Annual cost				21 643.93 €

Information on the project

- Very little information was made public or published on the social networks given the risk of opposition to the trapping campaigns.
- Posters to raise awareness were nonetheless created for the public visiting the beaches during the trapping campaigns.
- The informational caravan on sea turtles is operated by the non-profits in the network for sea turtles each year during various events (patron saint fiestas, science days, etc.) and it informs on the impact of mongooses on sea turtles.
- A page presenting the work may be found on the internet site of the network for sea turtles in Martinique (www.tortuesmarinesmartinique.org).

Outlook

■ Better assess the benefits of the operation

- The distance to sites makes it difficult to count all nesting sites and to estimate the level of predation. Predation monitoring several times per season will help to better assess the effectiveness of trapping in protecting the nests.
- Two methods to assess the predation pressure on nests by mongooses were tested in 2020, namely the installation of baited camera traps and the creation of false nests. Analysis of the data will tell us if these indicators are useful in measuring the predation pressure on sea-turtle nests by mongooses.
- Analysis of the stomach contents of mongooses will inform on the species consumed and make it possible to assess qualitatively the benefits of trapping of the other native species.

■ Improve the effectiveness of trapping

- Analysis of the cumulative capture data indicates that, in spite of the trapping effort, not all the capturable mongooses were in fact captured. Predation of sea-turtle nests has occasionally been observed during or after trapping periods.
- Other nesting sites are subject to intense predation pressures but were not included in the programme due to the excessive distance.
- The use of lethal traps such as the Goodnature E2A24 (a self-resetting trap using CO2 cartridges) and the DOC 250 (a spring-operated trap placed in a tunnel trap) could increase trapping effectiveness and make it possible to trap on more remote sites. These traps require less maintenance than non-harmful traps.

■ Raise public awareness

- Food scraps left by the public on beaches represent a significant food resource for mongooses and rats, a contributing factor for their reproduction. The posting of signs on the most important sites could help to limit the quantities of food left by people.
- Mongooses have a positive image with the public because they are part of the insular culture and are assumed to kill the poisonous Martinican pit viper (*Bothrops lanceolatus*) feared by the population on Martinique. Correcting this image could facilitate its management.



8 - Informational caravan for the conservation of sea turtles during an event in Sainte-Anne.
9 - Sign posted at beaches where trapping was under way to inform the public on the management work.
10 - A Goodnature A24 trap attached to a tree.

Regulations

- The introduction of the small Indian mongoose on Martinique is prohibited by the ministerial decree dated 8 February 2018 on preventing the introduction and propagation of animal IASs on Martinique.
- The species is also on the list in the decree dated 7 July 2020 prohibiting the detention, transport, use and/or trade of IASs on Martinique.
- The species is named in the prefectural order dated 8 July 2013 authorising the capture and killing of certain IASs, including mongooses, by certain competent organisations, including ONF.
- Finally, the species is listed in Appendix II-1 of the ministerial decree dated 14 February 2018 on preventing the introduction and propagation of animal IASs in continental France.

Authors: Clara Singh, IUCN French committee, Fabian Rateau, ONF Martinique, Julie Gresser (DEAL Martinique), Alicia Bonanno, ONF Martinique, for the IAS Resource Centre in conjunction with the Overseas IAS Initiative. April 2021. Editor: French Biodiversity Agency.

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For more information...

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This volume is part of the *Knowledge for action* series and can be downloaded from the technical portal of the French Biodiversity Agency (<https://professionnels.ofb.fr/fr/comprendre-pour-agir>).

Below is a list of the latest publications.

24. The cost of degradation in aquatic environments for water users. An assessment of compensatory expenses (2017, in French)
25. Scientific data and recommendations on creating planted discharge zones (2017, in French)
26. Ecological damage and ecological torts. How does society deal with and remediate damage to water and aquatic environments? (2017, English translation in 2018)
27. River restoration in France. Changes in definitions and methods over time and space. Outlook for the future (2017, in French)
28. Cumulative impact of water reservoirs on aquatic environments. A collective science-advice report (2017, in French)
29. Invasive alien species in aquatic environments, Practical information and management insights. Vol. 3, Management insights (2018, English translation in 2019)
30. Mid and long-term projections of demand for drinking water. An assessment of current methods and practices (2019, in French)
31. The benefits of preserving groundwater. Why assign a monetary value and how? (2018, in French)
32. Lessons from the human and social sciences on eliminating micropollutants in aquatic environments (2018, in French)
33. Synergies between agro-ecology and ecological networks (2019, in French)
34. Assessing the passage of obstacles by fish and macro-crustaceans in the French tropical islands of the Atlantic and Indian Oceans. Concepts and design (2019, English translation 2021)
35. Bresle - Oir - Scorff - Nivelle. Three decades of observation and research on migratory fish (2020, in French)
36. State of the art, available methods and current practices in determining ex ante compensation of damage to biodiversity (2020, in French)
37. The history and environmental impacts of gold washing in French Guiana. Keys to understanding the current tensions (2020, in French)
38. Assessment of the National Biodiversity Strategy 2011-2020 (condensed version) (2020, in French)
39. Techniques to prepare and implement dark ecological networks (2021, in French)
40. Prospective studies for biodiversity. Using the future to promote public biodiversity policies (2021, in French)
41. Treatment of household wastewater in the overseas departments (2021, in French)
42. Micropollutants produced by households and artisanal companies. Changing habits to better preserve water. Management reports and recommendations for local governments (2021, in French)
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45. Invasive alien species, Practical information and management insights. Volume 4 (2022, English translation 2023)



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Invasive alien species (IAS) and their impacts represent a growing concern for the managers of natural areas. In both continental France and the overseas territories, a large number of people and organisations have taken action to limit the damage. Recent public policies launched on both the EU and national levels facilitate the work, however significant new knowledge is needed before any real progress can be made in both continental France and the overseas territories.

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?

The first volume, published in the *Knowledge for action* series in 2015 and 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 actionable information while attempting to address the specific aspects of each situation.

The second volume, published the same year and titled Management insights, provides valuable examples of efforts to control IAS in the form of over 50 project management reports. Given the enthusiastic reception of the first two volumes and the momentum they provided, a third volume titled Management insights (bis) was published in 2018 and contained another 35 project management reports. This fourth volume continues the series with 25 new management reports concerning both terrestrial and aquatic environments, eight species of fauna and flora already presented in previous volumes and twelve new species, including eight in the overseas territories.

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