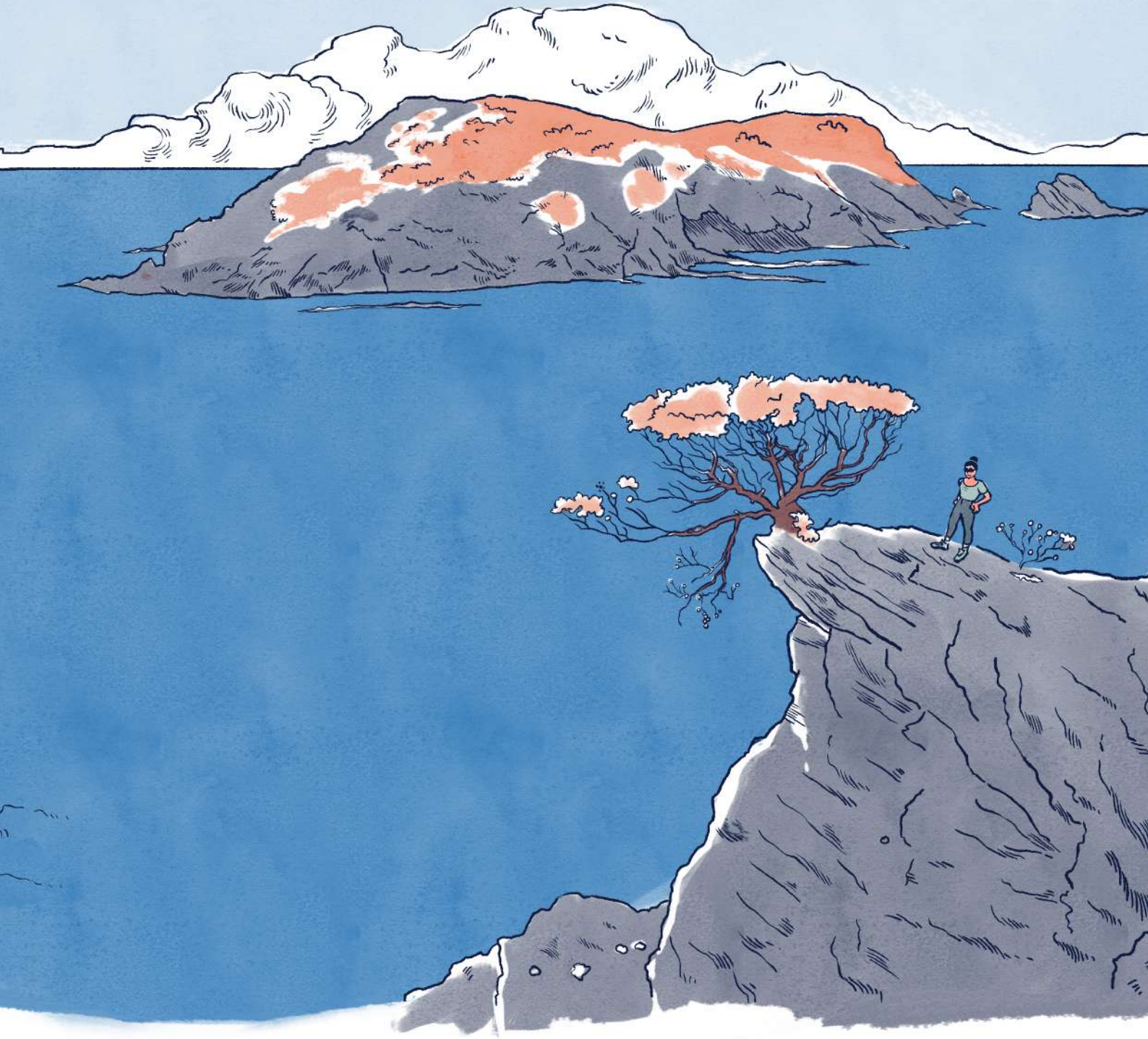
Conservatoire du littoral

INTERNATIONAL NGO FOR MEDITERRANEAN SMALL ISLANDS

Mediterranean Islands

Management and conservation experiences



RÉPUBLIQUE FRANÇAISE
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FFEM FONDS FRANÇAIS POUR L'ENVIRONNEMENT MONDIAL

COGITO project

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Conselleria d'Agricultura, Pesca i Medi Natural

QUOTATION OF THE WORK

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DRAFTING OF THE WORK

This methodological guide was elaborated under the coordination of the Europe and International Delegation of the Conservatoire du littoral (Ms Céline DAMERY and Mr Fabrice BERNARD), and the association «Initiative for the Small Islands of the Mediterranean» (Ms Eva TANKOVIC, Ms Sevahnee PYNEEANDY, Mr Mathieu THEVENET and Mr Joan MAYOL), in partnership with the International Association of Soldiers of Peace (Mr André MARTINEZ-HUMAYOU), and the conservation actors of the Mediterranean Islands Collective (MIC), and with the support of the company AGIR Écologique (Mr Vincent RIVIERE).

AGIR écologique is a company at the interface between development and biodiversity preservation, both a design office and works company. Specialised in ecological engineering operations, the structure's ecologists have been involved, since its creation in 2013, in all forms of expertise and work related to biodiversity. A dual skill that allows the ecologists to benefit from valuable feedback, both in studies (monitoring, fauna and flora assessments, regulatory studies), as well as in the concrete implementation of actions adapted to the ecological requirements of the targeted species (ecological audits, application of ERC measures, restoration of natural habitats, creation of species habitats, etc.).

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This document has been prepared with the support of french Water Agency for Rhône Mediterranean and Corsica, the City of Marseille, the MAVA Foundation, the French Facility for Global Environment (FFEM) and the Department of Agriculture, Fisheries and Natural Environment (Government of Balearic Islands)..

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Responsible for the Publication

The Conservatoire du littoral
French Coastal Protection Agency

Recognising the ecological, social, economic and cultural value of its coastline, France has opted to preserve a substantial portion of its natural coastal areas while still making them accessible to all. In 1975, the French government established the Conservatoire du littoral (the French Coastal Protection Agency), a public establishment now under the jurisdiction of the French Ministry of Ecological Transition which operates a land policy aimed at the lasting preservation of natural areas and landscapes on the country's shores. The Conservatoire du littoral operates throughout the coastal cantons in mainland France and in its overseas territories, as well as in municipalities that border estuaries, deltas and lakes with an area of over 1,000 hectares.

Its Objectives

The preservation of natural environments and landscapes that are both noteworthy and threatened, preserving sites and raising awareness of environmental conservation while also ensuring their accessibility to the public, the implementation of sustainable development practices across all activities carried out on the sites (agriculture, asset management, etc.), as well as coastline preservation while taking climate change into account through reasoned management with its local partners. The Conservatoire du littoral owns the sites it acquires and entrusts their management to other public or private entities (regions, departments, local authorities, public-private entities, associations, etc.) which employ 'coastline rangers' responsible for maintaining the sites, enhancing their value, and welcoming the public.

In addition, the Conservatoire du Littoral develops international partnership-based initiatives that reflect the values and management principles that it promotes and implements throughout France. The European and International Delegation of the Conservatoire du Littoral therefore works to share the practices undertaken in France in terms of coastal preservation, primarily along the coastlines of the regional seas in which France is located (in particular the bordering Mediterranean countries). The strength and unique nature of the Conservatoire du Littoral's international action is that it supports its partners' development through the implementation of tangible projects on its pilot sites, at both institutional and technical levels. As coastal issues are extremely diverse, the Conservatoire primarily assists its partner countries in implementing regional policies and strategies on the basis of integrated coastal zone management (ICZM). It also works to implement initiatives for the promotion and enhancement of ecosystems and natural environments, in particular wetlands and small islands. The intervention strategy for the Conservatoire's European and international initiatives can be summarised through a single approach:

Working together to develop integrated coastal zone management policies and taking action in favour of better management of protected coastal areas.

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Conservatoire du littoral
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PIM Initiative
Preserving Small Mediterranean Islands Initiative

Launched in 2005 by the Conservatoire du Littoral, in 2017 the PIM Initiative became, after twelve years of operation, an independent international NGO that continues to promote and assist in the management of Mediterranean island regions. Its aim is to preserve these micro-spaces by taking concrete action in the field and encouraging the exchange of knowledge and expertise between conservationists and experts in the Mediterranean region. The organisation is strengthened by its international governance and is composed of experts from a wide range of international backgrounds. Its approach gives priority to straightforward and pragmatic solutions. The Initiative's work is structured around organising meetings and encouraging exchanges between those involved in environmental conservation, as well as capitalising on and disseminating knowledge and expertise.

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Initiative PIM pour
les Petites Iles de Méditerranée

Contributing Partners

SPIA
Soldiers of Peace International Association

"Because peacekeeping is only possible on a healthy planet which is respected by its inhabitants and remains protected" is the philosophy of SPIA — an association that was founded in 1988 that works to ensure that environmental factors are integrated into peacekeeping operations. SPIA's mission is to expand, on humanitarian and diplomatic fronts, the actions led by the Blue Helmets on the ground, as well as helping former Blue Helmets return to their lives after their military service, helping them fight for their rights, and contributing to keeping the memory of their actions alive. In terms of environmental protection, SPIA focuses on three main areas: training, expertise and advocacy. Furthermore, under the partnership between SPIA and the Conservatoire du littoral, from 2016 onwards, several initiatives have been carried out, including training workshops for rangers and environmental authorities, workshops on how to create walking trails, and providing specialist knowledge on how to accommodate the public in natural areas.

www.aisp.fr

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MIC
Mediterranean Islands Collective Project

MIC Strategy & Action Plan

The Mediterranean Islands Collective (MIC) Project, coordinated by PIM Initiative, brings together the teams from the Conservatoire du Littoral, IUCN Mediterranean, MedPAN, Marilles Foundation, Conservation Collective and WWF Greece.

The aim of this partnership is to develop a common strategy and an action plan to be implemented after 2022 for the preservation of biodiversity on Mediterranean islands. Identifying common threats and challenges including priorities, were the stepping-stone to drafting the strategy. As for the action plan, it is made of priority areas of interventions aimed at identifying actions that can be done simultaneously in different Mediterranean islands and which will enable scaling-up, networking, capacity-building, sharing of good practices and solutions between different islands.

MIC pilot projects

Additionally, the MIC project is supporting several pilot projects across the Mediterranean that are small, innovative, replicable, and scalable. These projects are carried out by MPA managers, academics, local Non-Governmental Organisations and municipalities, independent researchers, experts on Mediterranean small islands and ecological engineers. All the projects fall under four categories namely actions to mitigate invasive species impact, actions addressing ultra-endangered endemic species, landscape restoration and island economical sustainability. The outcome of some of them are included in this methodological guide in order to share conservation experiences that can inspire others.

This initiative, which started in May 2021 and ended in September 2022, benefitted from the financial support of the MAVA foundation.

Financial Partners

FFEM
French Facility for Global Environment

As part of the French cooperation and development policy for the protection of the global environment, the French Facility for Global Environment subsidises sustainable development initiatives that are in line with the multilateral environmental agreements signed by France, with the aim of preserving biodiversity, the climate, international waters, land, and the ozone layer, and combating chemical pollution. The FFEM draws from these pilot projects so that the most effective solutions can be applied in other locations or on a larger scale.

FONDS FRANÇAIS POUR L'ENVIRONNEMENT MONDIAL

www.ffem.fr

The FFEM has supported the Conservatoire du littoral for several years now, notably in its support for site management operations and capacity-building initiatives for managers and actors involved in the protection of natural coastal and island areas in developing countries by funding several cooperation projects (COGITO, SMILO, WACA…). Since 2016, and every year thereafter, classroom and on-site training sessions have been organised for Mediterranean and African partner-countries

Agence de l'Eau Rhône-Méditerranée Corse
French Rhone-Mediterranean and Corsica Water Agency

The Agence de l'Eau Rhône Méditerranée Corse, French Rhone-Mediterranean and Corsica Water Agency, is a public organisation under the French Ministry of Ecological Transition that is dedicated to water conservation. The agency collects water taxes which are paid by all consumers. Each euro collected is reinvested in local authorities, as well as economic and agricultural actors, to fight against pollution and improve the use of available water, through a long-term intervention programme. Furthermore, the agency organises consultations with local actors and also produces and disseminates information on the subject of water.

The Agence de l'Eau Rhône Méditerranée Corse is a major partner of the Conservatoire du littoral, both on French and international levels. The agency supports both institutional and technical cooperative projects addressing issues related to the conservation of wetlands and small islands.

www.eaurmc.fr

Ville de Marseille
City of Marseille

With a long tradition of hospitality and openness towards the rest of the world, Marseille has become a leading European and Mediterranean city through the international development of both its image and areas of excellence. This appeal also stems from its increasing number of overseas projects with the aim of sharing its experience across a wide range of topics, including the sustainable development of its territory. For over 10 years, the City of Marseille has supported the Conservatoire du littoral and its actions in favour of the conservation, management and development of small Mediterranean islands. Within this scope, various initiatives have been conducted, including the organisation of technical workshops on the management of small islands, the production of communication materials and the organisation of international events (Celebrate Islands, etc.), as well as international training courses on multiple subjects involving a variety of actors (project design and management, preparation of policy documents, land-sea ecological engineering, etc.), all of which have led to the sharing of knowledge and expertise among actors involved in conservation. The making of this document is in line with these information-sharing and capacity-building approaches.

VILLE DE MARSEILLE

www.marseille.fr

MAVA Foundation

The MAVA Foundation was born of the passion, vision and adventure of the founder, Luc Hoffmann. It was created in 1994 to support the conservation of iconic places like the Camargue and Doñana, it has since grown into a professional foundation, becoming a key funder of global conservation.

The MAVA Foundation supports conservation that benefits people and nature through four formal Programmes in the Mediterranean, Coastal West Africa, Switzerland and Sustainable Economy – as well as through a small number of Global Projects. Its work is founded on trust and collaboration, as well as respect for local culture and the close involvement of local people and communities. Protecting emblematic species and tackling threats, responding rapidly and applying sound science, encouraging collaboration and staying the course are its trademark.

As the Foundation moves toward ending its grant-making in 2022, it is putting greater emphasis on funding project portfolios – delivered by groups of partners working together, and collaboratively funded by donor consortia.

www.mava-foundation.org

Government of the Balearic Islands

The General Directorate of Natural Environment, part of the Department of Agriculture, Fisheries and Natural Environment of the Government of the Balearic Islands, has the responsibility, among others, of regulating, planning and managing the protected natural areas of the archipelago: the Cabrera National Park. , seven natural parks, two natural reserves and the Paratge Natural Serra de Tramuntana, which in total represent 76,076 terrestrial hectares and 108,716 marine hectares. Likewise, it administers the Natura 2000 system: 169 sites, covering 143,932 terrestrial hectares - 29% of the territory - and 109,182 marine hectares, partly coinciding with those of protected natural areas. Considering the 149 small islands within the archipelago, 66 are part of parks and reserves and 51 are part of the Natura 2000 system outside protected areas.

The General Directorate also ensures the conservation of wild fauna and flora, forest management as well as the organization of the Service of Environmental Agents.

Govern de les Illes Balears
Conselleria d'Agricultura, Pesca i Medi Natural

www.caib.es

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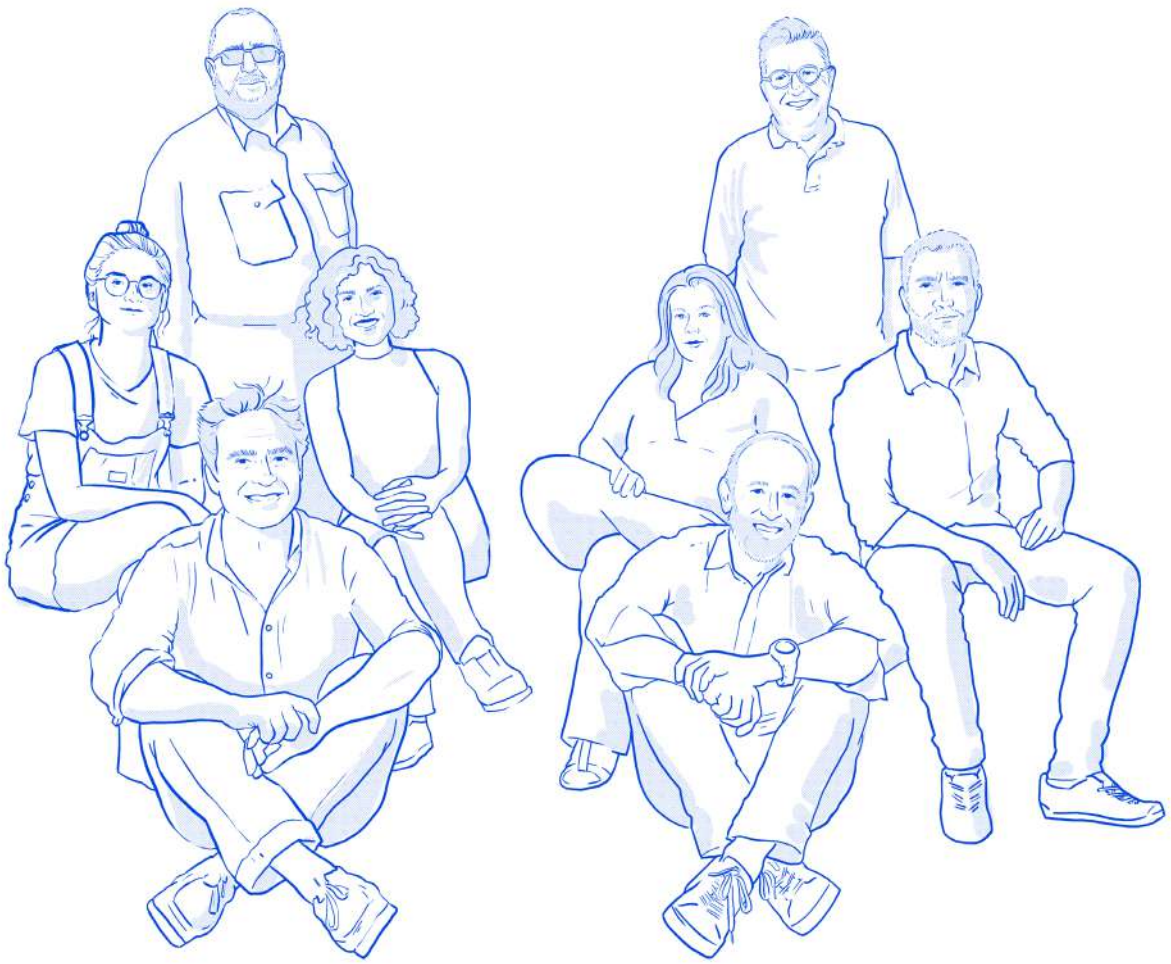

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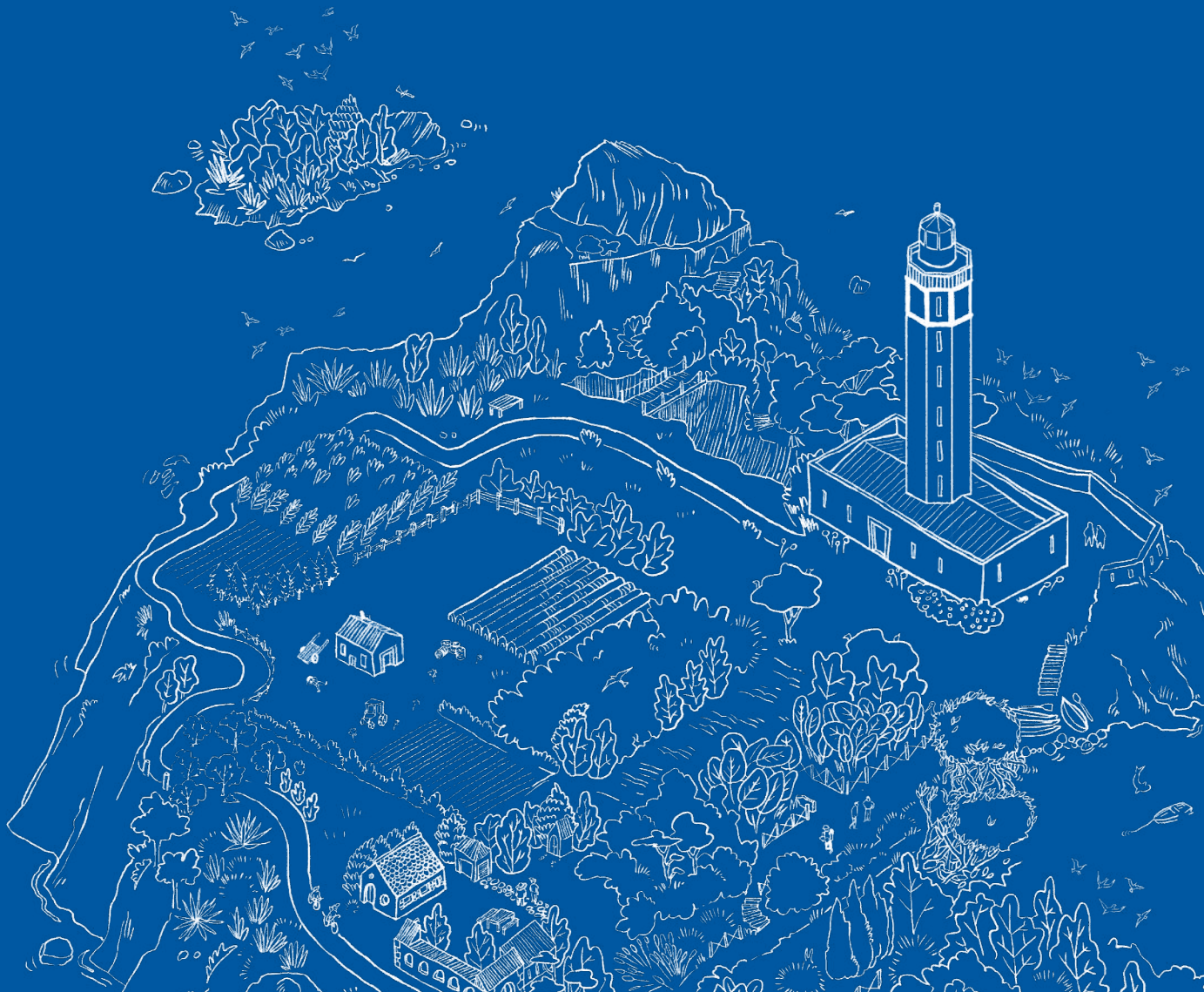
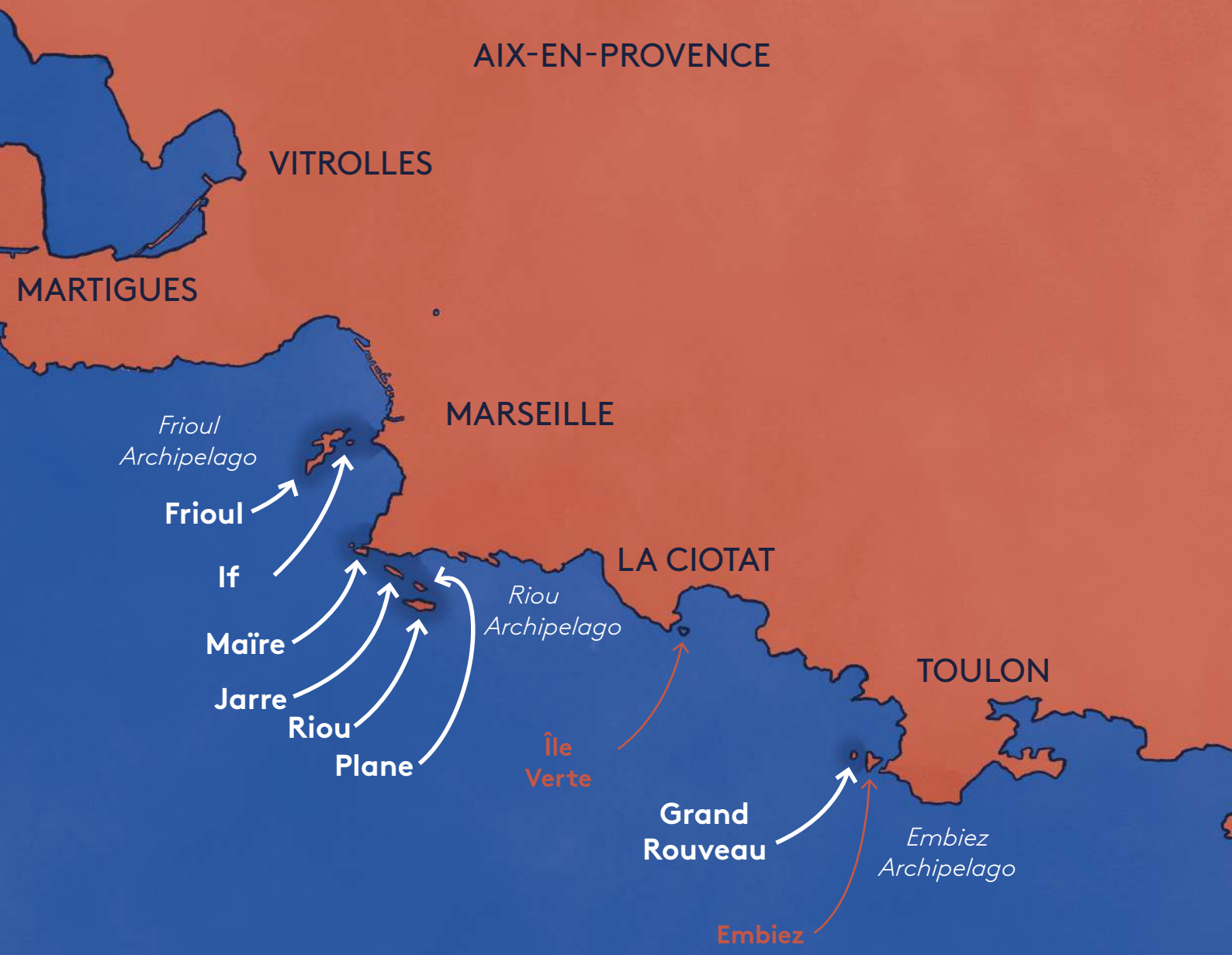
Introduction: The importance of small islands



The islands shown in white have been the subject of the management and conservation actions described in this document


CROATIA
Zlarin
BOSNIA
HERZEGOVINA
MONTENEGRO
ITALY
ALBANIA
Strombolicchio
GREECE
Paros
Gavdos
MALTA
100 km
LIBYA
LIBYA

Map of the Small Islands of Provence, France



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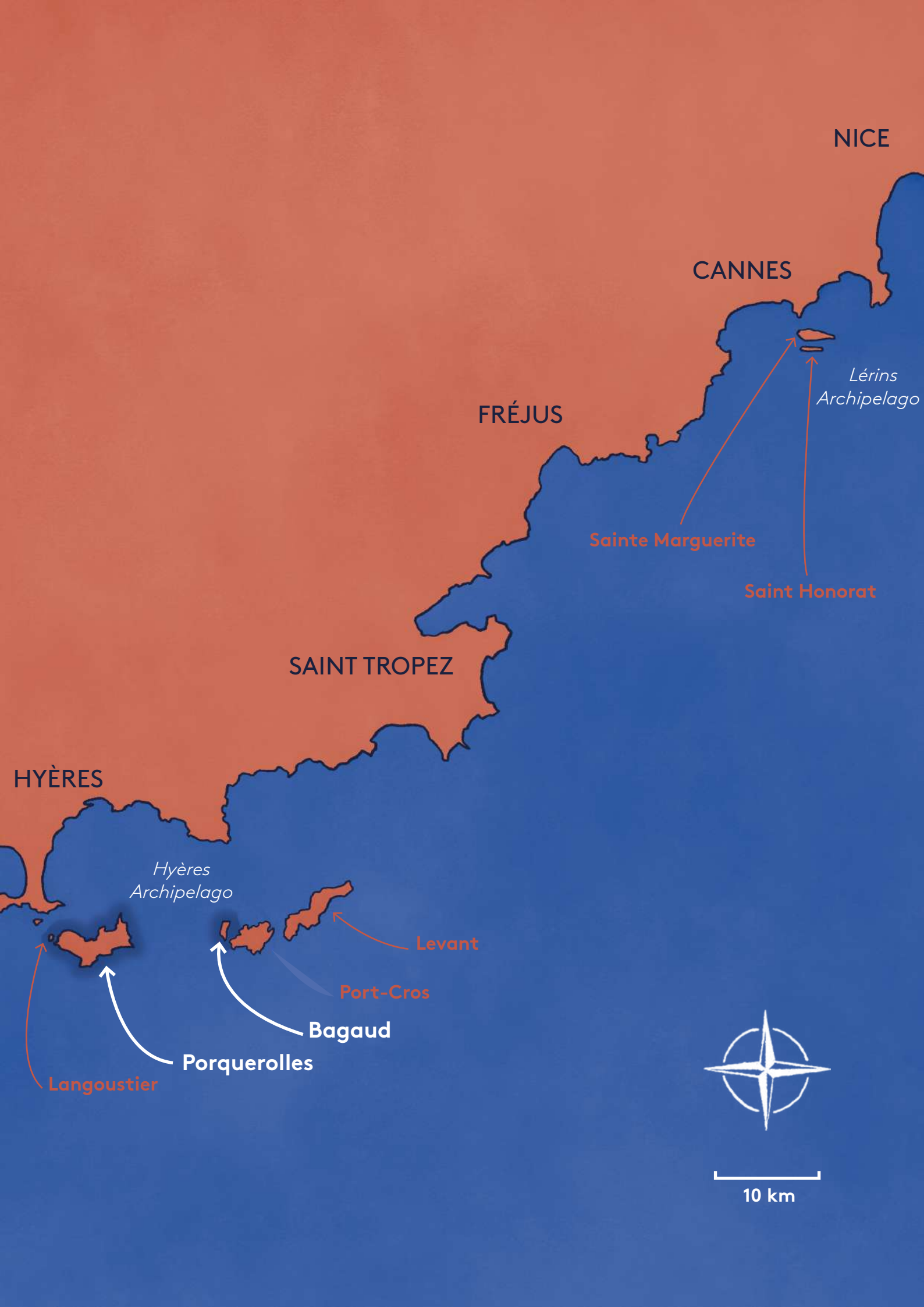

NICE
CANNES
Lérins
Archipelago
FRÉJUS
Sainte Marguerite
Saint Honorat
SAINT TROPEZ
HYÈRES
Hyères
Archipelago
Levant
Port-Cros
Bagaud
Porquerolles
Langoustier
10 km

The importance of small islands

What is an island?

The United Nations Convention on the Law of the Sea defines an island as "a naturally formed area of land, surrounded by water, and which is above water at high tide" (UNITED NATIONS, 1982). The definition of a small island, however, involves a tweaking of several parameters, which are at the same time physical, biological and socio-economic, and yet which are also very sensitive. It is within these parameters that the Research and Management Committee of the PIM Initiative adopted the following definition in 2013:

"An island is a land mass that supports at least one vascular plant (or other species of importance in terms of terrestrial or marine heritage), is clearly distinguished and separated from another exposed area of land (more than 5 metres away and at least 50 cm in depth within the water, or remaining disconnected at low tide), including the surrounding coastal fringe (up to a bathymetry level of -50 metres and within one nautical mile of the island). In the context of the PIM Initiative, an island is defined as "small" if it covers less than 1000 hectares of land, which corresponds to the size at which the majority of islets start to become inhabited and experience more complex forms of human impact, whose influence on biodiversity and landscapes is significant."

Small islands around the world: exceptional territories facing diverse challenges

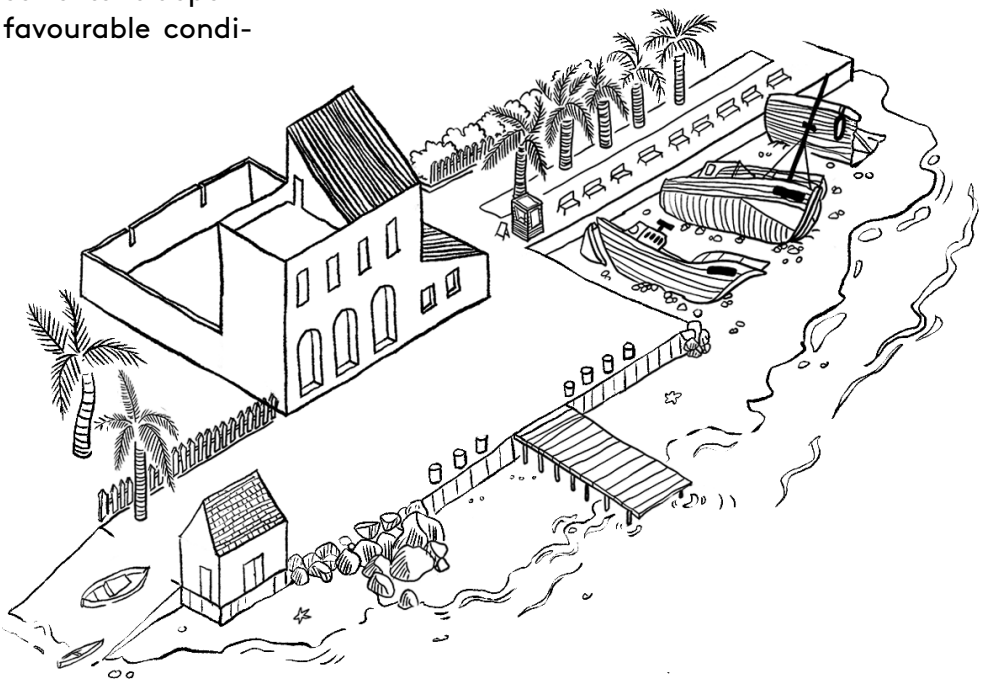
There are many different types of islands including volcanic islands resulting from volcanic eruption, coral and river islands resulting from sedimentary accretion, and islands formed through tectonic accretion. Overall, islands account for 5% of the earth's surface area (KEITT et al., 2011) with over 180,000 islands worldwide (BELLARD et al., 2013), and up to one million islands if islets and rock formations are also taken into account (WEIGELT et AL., 2013). The Mediterranean Basin alone is estimated to contain nearly 15,000 islands.

Island environments are fragile and unique spaces (GROS-DÉSORMEAUX, 2012), and several threats, resulting from global changes, endanger their natural, cultural, economic and social heritage (ORUETA, 2009):

- Habitat destruction: construction is increasingly impacting on islands, particularly with the increase in mass tourism during the summer months (WEIGELT et al., 2013);
- Invasive species: recognised as the second largest cause of biodiversity loss worldwide, invasive species pose a greater threat to islands due to the absence of predators for certain species, the reduction in the size and distribution of some species, and the low biological connectivity with neighbouring ecosystems (IRD, 2009);
- Overexploitation of resources: waters surrounding the islands can be adversely affected by the strain on fisheries resources caused by uncontrolled or poorly regulated fishing practices;
- Climate change: as ice melts and sea levels rise, some small islands may disappear in part (BELLARD et al., 2013);
- Pollution: waste management is more difficult on an island due to its isolated nature, and water is a precious and scarce commodity, as well as a subject of debate within micro-territories.

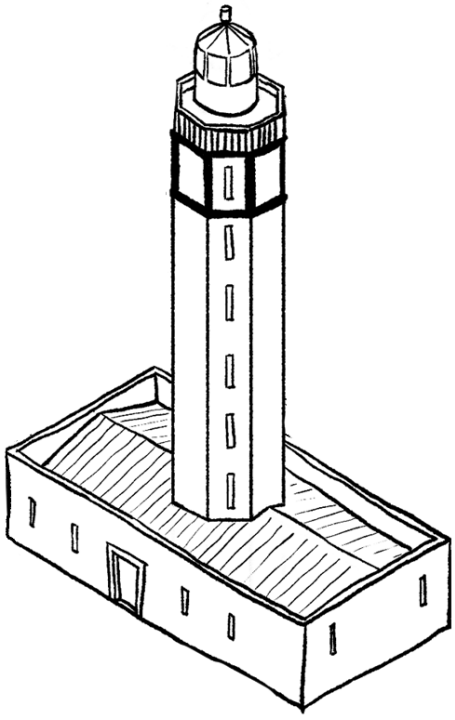
Islands are important locations for biodiversity conservation as they are home to nearly 20% of terrestrial plant and vertebrate species, while also accounting for 64% of species extinctions (IUCN) and around 45% of critically endangered species (KEITT et al., 2011). Many "hotspots" (biogeographical areas with high wealth of biodiversity that are particularly threatened by human activity) are composed mainly or entirely of islands (MYERS et AL., 2000). The biodiversity of islands is also unique in that they are areas with low levels of predation and disruption which makes them a haven for breeding, feeding and migration for many species (ROBERTSON etal., 2011). Furthermore, 600 million people are dependent on island ecosystem services for water, food, shelter, medicines and resources for their day-to-day lives (Convention on Biological Diversity, 2010). However, resource management issues (water, energy, waste, etc.) are at the heart of the challenges faced by the islands, since the nature of an island reduces the range of solutions available (Secrétariat d'état de l'outre-mer, 2007).

Islands are also witness to the history of human activity: humankind has left its mark, to a greater or lesser extent depending on whether it had favourable conditions for the permanent establishment of a settlement (freshwater resources, space, advantageous coastal topography, proximity to the mainland, etc.) or the temporary exploitation of its resources. Including military conquests, agricultural activity, and craftsmanship, the historic presence of humankind has led to the transformation of the original state of an island, and current structural and archaeological heritage can be the subject of restoration, preservation, and development projects. Finally, island landscapes are also the physical expression of an often very rich, intangible cultural heritage that represents practices, beliefs and customs that must be preserved (ISOS, 2019).



Whether by the diversity of their heritage (natural, historical, cultural, etc.), by their mysterious nature, or the essence of adventure that they portray, islands attract many visitors looking for a preserved natural environment and a change of scenery compared to the mainland (beaches, walking, diving, sailing, etc.) (BRIGAND et al., 2003). However, unregulated or poorly managed visitor traffic often has an impact on the landscape, fauna and flora (trampling, disturbance, destruction of habitats, displacement of populations) and the functioning of ecosystems (soil compaction, erosion, etc.) (DESFOSSEZ and VANDERBECKEN, 1994). Thus, island management teams are responsible for preserving the environment and landscape by maintaining public access through the provision of appropriate facilities (L'Hospitalier, 2000). Any development work on a small island therefore requires prior consideration of the inevitable wide-ranging consequences that will affect the land as a whole.

Island environments are thus large-scale laboratories for experimenting and implementing practices that are in line with the philosophy of sustainable development. Although the issues of sustainable resource management (drinking water supply and wastewater treatment, access to renewable energy sources, waste management, protection of local bio- and agro-biodiversity) and the enhancement of heritage (natural, landscape and cultural) are not specific to islands, they become particularly acute there due to their isolation, scarcity of resources, limited space and lack of locally available technologies - in other words their "insularity" which reduces the range of solutions a priori (SMILO, 2017). As many island biota are still understudied, improving and regularly updating and sharing knowledge is necessary to ensure their proper protection. Small islands share a certain number of challenges and therefore, inevitably, common solutions, which should be publicised and shared, on both a regional and international scale. It is in this context that the international SMILO (Small Islands Organisation) Program was launched, with the aim of responding to the need for exchanging information and providing support to the management teams of these regions, in order to initiate, encourage and enhance the preservation and sustainable management of natural resources on small islands, with a view to strengthening cooperation and solidarity between islands.



Capitalising on good practices and feedback: a major challenge for small islands

For several years, the Conservatoire du littoral and PIM Initiative have been actively working on the conservation and management of small islands, as well as on broad reflections regarding island issues, whether they be:

- In the case of the Conservatoire, the acquisition of island land in France to guarantee the long-term protection of these areas, and the implementation of management and conservation projects in partnership with various management bodies (public authorities, associations, national parks, etc.);
- Within the framework of international cooperation programmes in which they support pilot sites in the creation of multi-stakeholder «island committees» - governance bodies that enable the construction of land projects based on a common and shared vision;
- The establishment of networks of «islanders» (public and private actors involved in the management and conservation of island territories) aiming to develop a common information base and work collectively in the implementation of strategies and concrete initiatives at the scale of Mediterranean sub-regions;
- The preservation of small Mediterranean insular areas through the implementation of concrete actions in the field, by promoting the exchange of know-how and knowledge between conservationists and specialists of the Mediterranean basin;
- In institutional and technical partnerships with international networks (SMILO Small Islands Organisation, GLISPA Global Island Partnership, etc.)..

Thus, with the aim of sharing practices and knowledge, this document aims to capitalise on and promote the experience of conservation and management initiatives carried out in recent years on small Mediterranean islands.

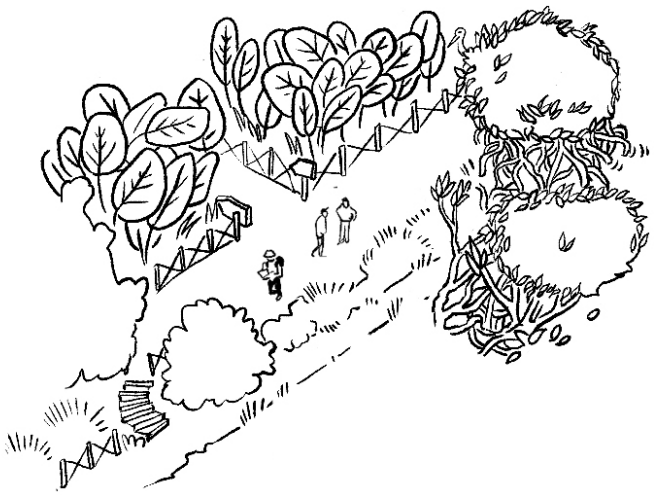
It is primarily aimed at organisations that are responsible for the management of island environments and that wish to undertake ecological engineering projects on their sites or to introduce simple, robust and often inexpensive facilities aimed at providing appropriate conditions for receiving the public and for good biodiversity management.

The feedback gathered by the authors, experts and partners associated with this project is not intended to address all the situations that management teams may face, but rather to present various practical case studies, the specific constraints of the sites, and the responses provided in each case.

Running an initiative on an island is similar to any other initiative in terms of defining its objectives. However, unlike on mainland sites, resources will be fully adapted to consider the typical constraints of an assignment in a natural environment, which are particularly exacerbated in an island environment - site access, weather conditions, the need to be self-sufficient on site, safety conditions, the very high stakes of biological heritage conservation, the diversity of the actors involved, etc. Each of these parameters will determine the very nature of the initiative, as well as its timeframe.

But these constraints, rather than being obstacles to the process, imply increased deliberation and analysis on the measures to be implemented, as well as being sources of creativity, of which the authors provide only a few examples herein.

We hope that the distribution of this document will facilitate the implementation of similar management initiatives and inspire other efforts to capitalise on shared lessons learned, so that we can mutually benefit from each other's experiences on small islands around the world.



2

Combating invasive alien species

Introduction

Biological invasion constitutes one of the components of global ecological change, and represents one of the major anthropogenic threats involved in the current biodiversity erosion crisis. On the global scale, around 27% of mammal, bird, reptile and amphibian species are currently threatened by invasive species, which constitute one of the primary causes of species extinction, especially within island ecosystems (SAX et al. 2008). Oceanic islands (such as the neighbouring islands of Corsica and Sardinia), due to their low alpha diversity and simplified food chains (DRAKE et al. 2002), are particularly sensitive to biological invasion (BERGLUND et al. 2009). A study of the causes behind the extinction of species on the IUCN's Red list shows that 86% of extinctions driven by the presence of invasive species occurred on islands (BELLARD et al., 2016).

While every island is unique in terms of its origins, climate, geography, remoteness, size and history, island ecosystems taken as a whole share certain common traits. Islands serve as refuges for native species, a role which is becoming all the more crucial given the extreme pressure on coastal zones, which results in the disappearance of species diversity due to demographics, urbanisation and pollution. Compared to mainland ecosystems, islands tend to be home to lesser-diversified plant communities. Their simplified ecosystems, natural seclusion and the ability to control the flow of new entrants make islands ideal spaces for implementing restoration programmes. Precisely because of the extreme sensitivity of island ecosystems to anthropogenic disruptions, the results of restoration efforts are generally more immediate and easy to interpret than in mainland environments. Islands make perfect, geographically contained laboratories for testing concepts, methods and techniques for wildlife management in general, and for restoration in particular (CHAPUIS et al. 1995).

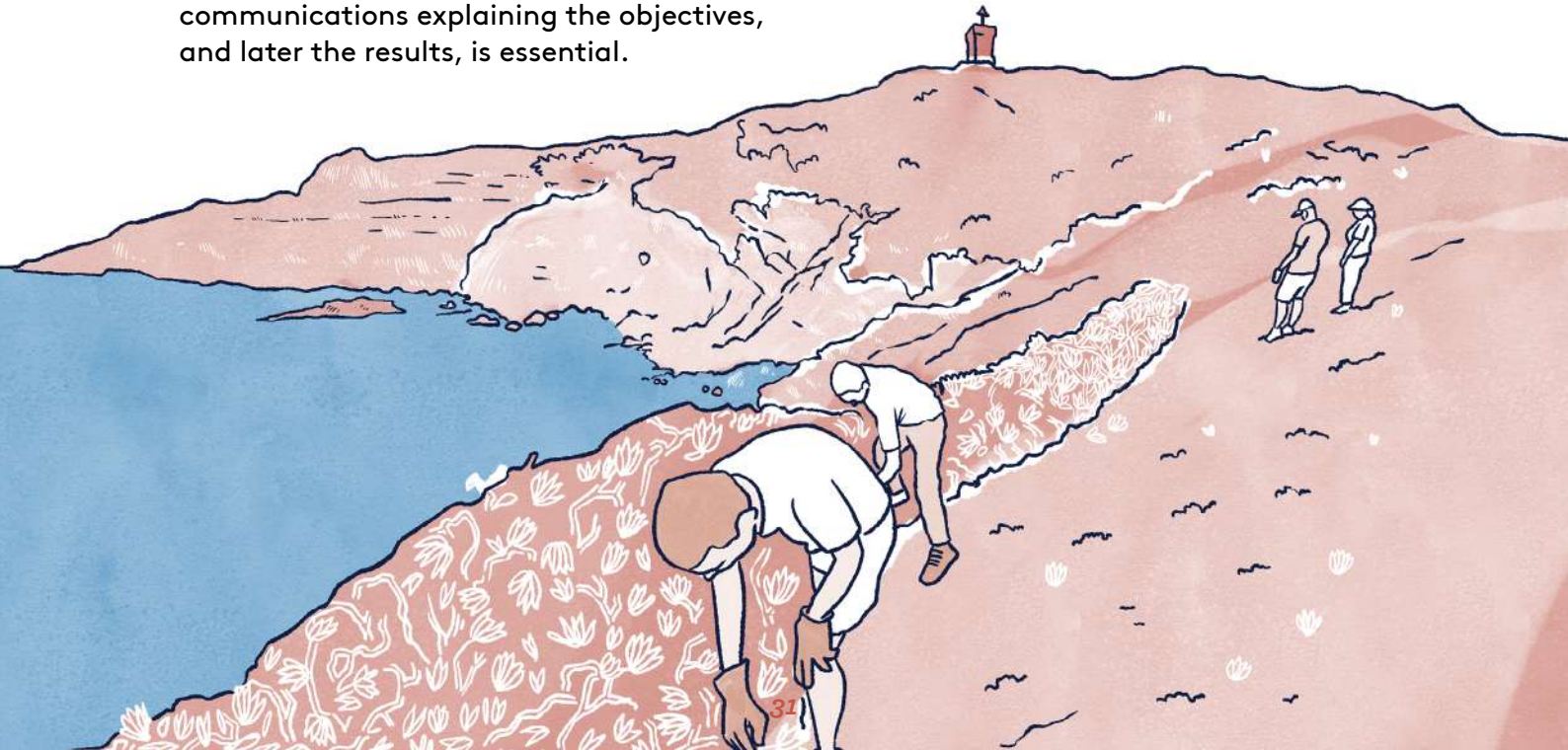
However, scientific consensus is not always easy to ascertain with regard to eradication initiatives, due to the biological impact that the removal of a given species (which may have been established for some time) will have upon a simplified community. There is a major risk of drastically modifying biological interactions and balances, which consequently requires opposing viewpoints to be discussed in order to establish a fully thought-out project. The process of scientific validation for these projects is a long one, requiring several years of maturation, during which various supplementary stakeholders may be included in the thought process: institutional stakeholders, political groups, or island users and inhabitants. Given that approval must come from multiple sources, any visible

action on an island must satisfy the diverse range of stakeholders who stand to be directly impacted, to one extent or another, by the deep-rooted changes to the island's landscape and environment that eradication will bring about. To this end, the publication, dissemination and sharing of feedback and experience (scientific monitoring and photographic surveillance) can contribute significantly to the social and political acceptability of a project – all the more so when the messages are clear, simple and accurate.

In addition, stakeholders' emotional perception of the species to be eradicated can constitute a major roadblock, and one that should not be ignored. More generally, the concept of an invasive species is itself not universally accepted, and the difficulty is further heightened when the species being targeted carries strong social attachment, bringing with it the growing concern of animal rights; this aspect must therefore be integrated into the project. Evidently, a plan to eradicate Black Rats will not face the same level of opposition as a plan to eradicate free-roaming cats, even though both species have a similarly significant impact on island biodiversity.

Finally, one of the key factors for the success of this type of action is that resource planning for an eradication programme must be projected into the long term. Follow-up and monitoring of the effectiveness of the project are absolutely essential, without which the significant efforts made during the initial phases of the operation might quickly be rendered null and void. In general, a 10-year surveillance period is considered necessary in order to validate the success of an operation, notably with regard to invasive alien plant species. The soil seed bank, having been enriched by invasive species, constitutes a major source of risk that species will return, rendering the project a failure if this regrowth is not also eradicated on a frequent basis before it can produce new fruit.

Consequently, due to the significant changes that will be brought about by any project involving the eradication of invasive species in an island area, projects must be planned out in a way that takes all angles into account: this of course includes the scientific aspect, which such projects generally stem from, but also the social aspect (so as to ensure understanding and acceptance of the project), and finally the temporal aspect in order to ensure the project's success is sustainable. Such projects rarely receive unanimous approval, especially when they involve highly visible and visited spaces, but the recovery of the environment is generally one of the key factors in generating more general acceptance down the line. As such, pre-emptive and wide-reaching communications explaining the objectives,
and later the results, is essential.



Eradication of sour fig plants

Grand Rouveau Island
Six-Fours-Les-Plages
Var
FRANCE

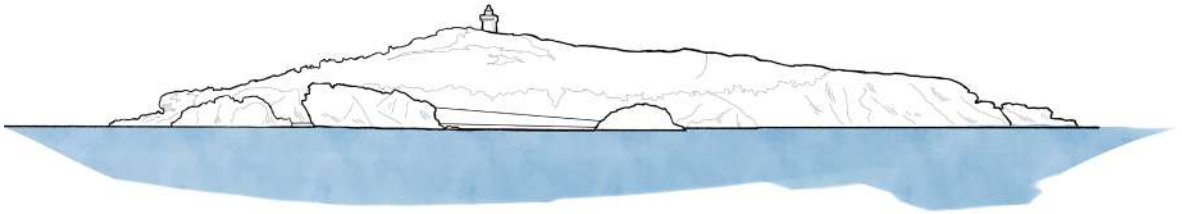
Photography by Louis Marie Préau
Conservatoire du littoral/ PIM (small Mediterranean islands)

Grand Rouveau island

Embiez archipelago

Var

FRANCE



Surface area: 6.45 ha
Altitude: 31 m

X Coord:43.080268
Y Coord:5.767686

Protected status: Property of the Conservatoire du Littoral; SPAMI (Special Protected Area of Mediterranean Importance), Natura 2000 site
Uninhabited island
Landing permitted

Biological challenges and sensitivity

SPECIES OF INTEREST

Presence of 7 local plant species and 5 protected species, of which 2 are perennial and visible year-round.

Presence of an endemic nocturnal gecko: the European leaf-toed gecko, *Euleptes europaea*.

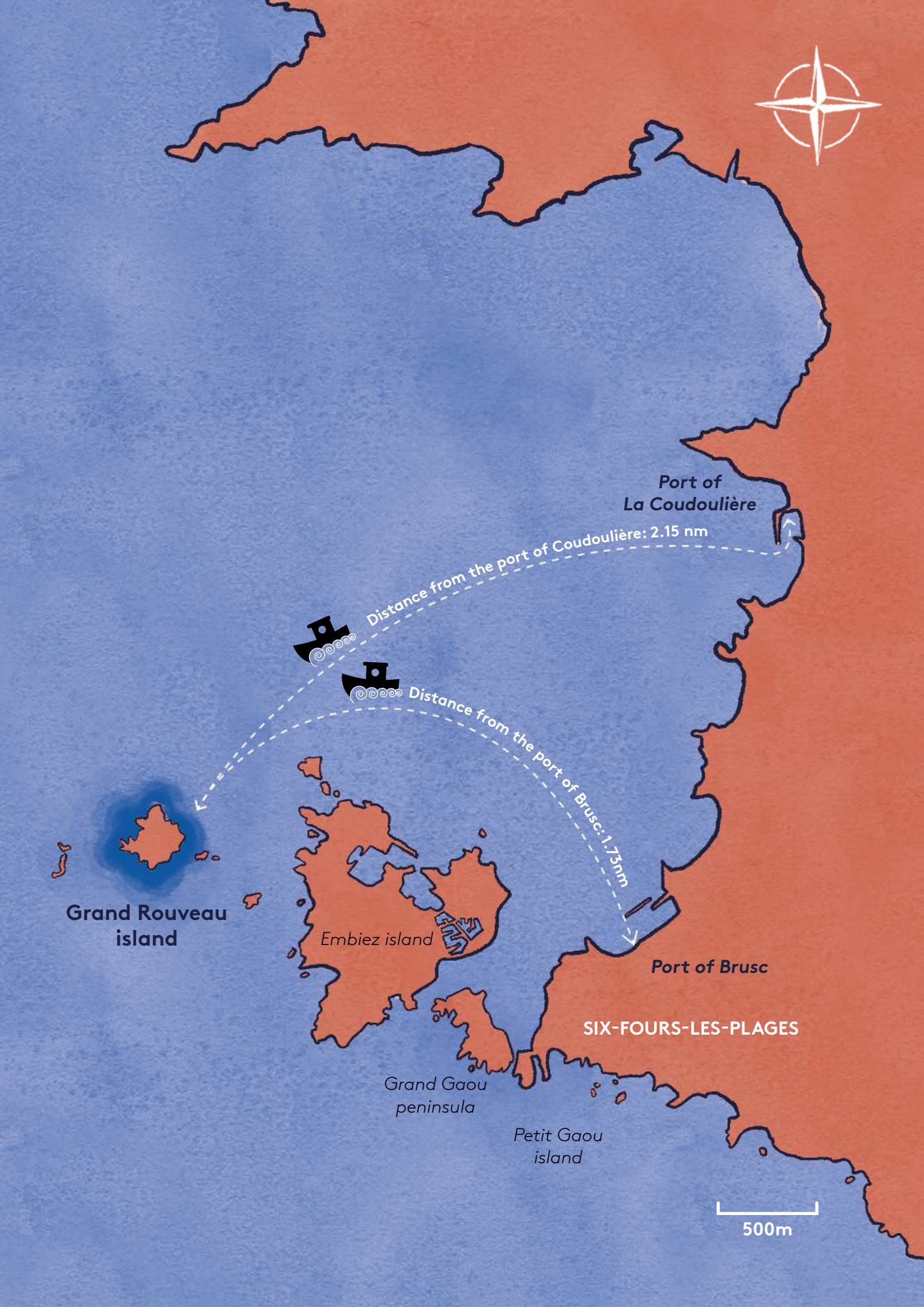
INVASIVE SPECIES

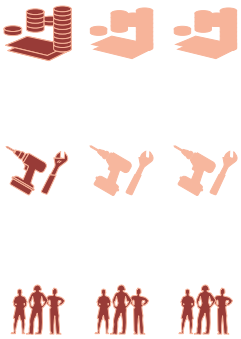
One invasive alien plant species: Sour fig, *Carpobrotus edulis*, eradicated in 2016 and currently under observation. Colony of Yellow-legged Gulls, *Larus michahellis*.

Population of Black Rats, *Rattus rattus*: eradicated in 2018, currently under observation.

Characteristics of project working conditions

- Landing stage available
- No fresh water source on the island
- No electricity
- Absence of sanitary facilities
- Presence of gas-fuelled accommodation capable of hosting a team for several days


Port of
La Coudoulière
Distance from the port of Coudoulière: 2.15 nm
Distance from the port of Brusc: 1.73nm
Grand Rouveau
island
Embiez island
Port of Brusc
SIX-FOURS-LES-PLAGES
Grand Gaou
peninsula
Petit Gaou
island
500m



Project Description

Project involving the eradication of invasive alien plant species (French: EVEE) jointly led by the Conservatoire du littoral and the town of Six-Fours-Les-Plages, which is responsible for the area in question, with technical and scientific assistance from the PIM initiative for Small Mediterranean Islands. The operation also covered the island of Petit Rouveau

The island also acts as an educational site for international training, thanks to funding from the French Global Environment Fund (French: FFEM) and the Agence de l'Eau Rhône Méditerranée-Corse.

July 2012
Initial removal campaign

→

July 2016
End of removal campaigns, including in cliff-side areas

Since July 2013
until zero regrowth occurs
Annual inspection of recovery levels in areas treated

Main parameters considered for the implementation of the project

PROXIMITY TO THE MAINLAND

2.15 nm from the port of La Coudoulière, Six-Fours-Les-Plages. This makes it possible to transfer equipment and personnel without any major difficulty.

LANDING STAGE AVAILABLE

Unloading of personnel and equipment: not possible to unload heavy or permanent equipment.

ON-SITE ACCOMMODATION

Autonomous operations possible over the course of several consecutive days (current max. capacity is 12 people).

OPEN TO THE PUBLIC

Potential risk of re-introduction of invasive species following completion of the operation

ISLAND ACCESSIBLE ON FOOT

Some fixtures required in order to enable access (ropes, lifelines) in particularly steep areas, following the opening of tracks through the vegetation.

SMALL LANDING STAGE

Not possible to leave boats docked on a quay.

TWO TYPES OF ZONES INVADED BY CARPOBROTUS EDULIS

- Cliff-side areas over 474 linear metres. Operations require personnel trained to perform rope access work.
- Sectors in accessible zones (around 3.71 ha), some of which were mono-species. No major access difficulties.

STORAGE

Plant debris was stored on site in windrows, simultaneously helping to limit soil erosion and facilitate plant recovery, with the added advantage of not requiring export to the mainland and processing in a specialist waste management facility.

"LOW-COST" APPROACH

Enables the operation to potentially be replicated on other island sites with limited budgets, and via the mobilisation of a network of volunteers.

LONG-TERM PERSPECTIVE

Uprooting operations followed by inspections to be undertaken each year, in order to avoid any regrowth of Sour Fig plants from the soil seed bank. The plant can reproduce fruit (and therefore seeds) in 2 years. Resources are required to monitor the site over the long term (over 10 years).

Operators:

Municipality of Six-Fours-Les-Plages – Conservatoire du littoral – PIM Initiative - AGIR Ecologique – volunteers

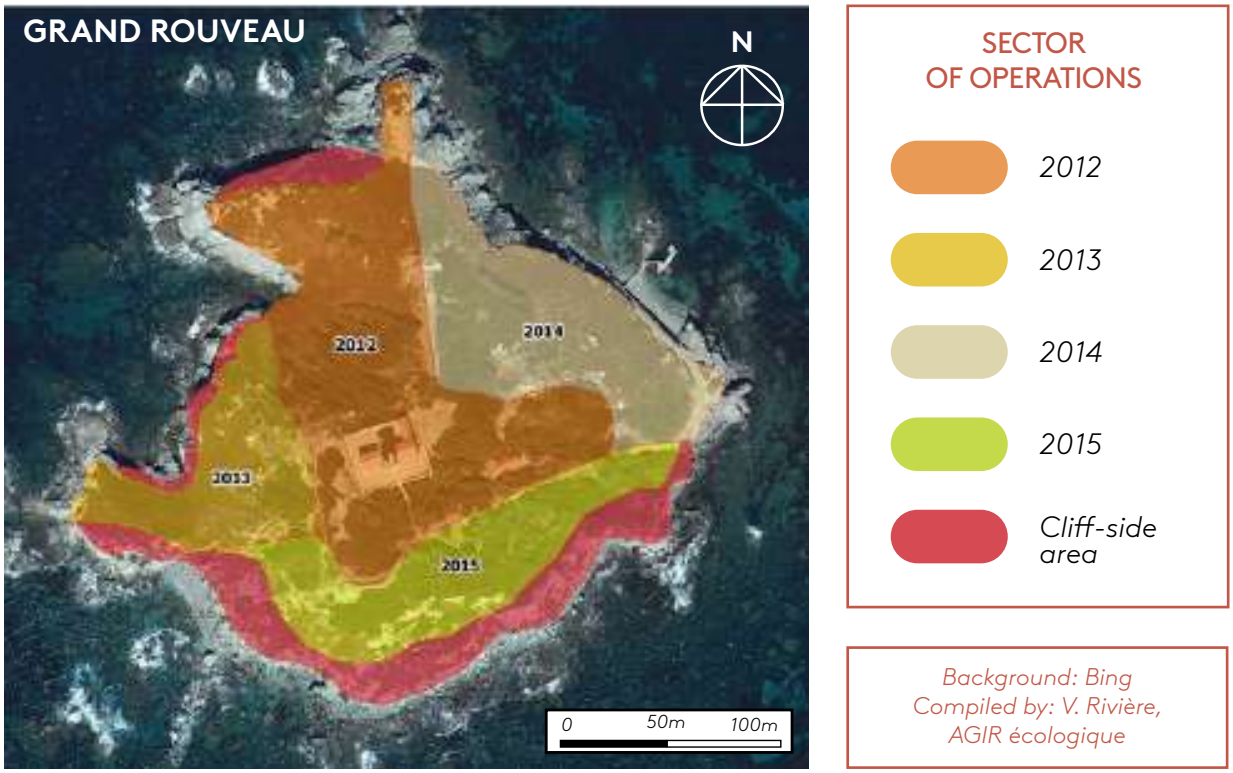
Selecting the appropriate intervention method

Given the layout of the area and the economic and ecological considerations at play, it was decided not to export any plant debris to the mainland to be processed in specialist waste management facilities. In order to limit erosion and encourage plant recovery, uprooted sour fig plants were used to lay out windrows. In addition, the perpendicular arrangement of these windrows relative to the slopes enables the accumulation of organic and mineral matter when water flows over the ground, supplementing the botanical debris formed by the decomposition of uprooted sour fig plants and forming rows above the windrows. The layer that forms serves as a mulch bed, which can then be used by native plant species during their recolonisation of the area.

In accessible zones, the method of laying windrows was a major factor in enabling the operation to go ahead, and allowing the mobilization of volunteers with no previous training in this type of work. The mobilisation of volunteers was one of the principles implemented throughout the operational phase, in order to limit the cost of this sizeable operation, while also raising awareness and involving partners.

In addition, the operation was planned to take place over a period of several years in order to limit the visual impact it would cause. Initially, the island was divided into 3 sectors in order to carry out the uprooting of sour fig plants over the course of three years. However, given the pace of the operation's progress and the time available, this schedule was revised to cover 5 sectors - 4 accessible and one on a cliff. These various sectors were mapped out in order to be generally equivalent in size, and in such a way that would enable them to be delineated using naturally visible borders (paths, slopes and crests) rather than man-made markers. Within each sector, the surfaces requiring attention were variable in nature.

It was decided to carry out the operation during the summer, as this season is a less ecologically sensitive period, and with the goal of a) facilitating the mobilisation of volunteers and b) taking advantage of the drier weather to perform the work involved (being less engorged with water, the sour fig plants would be drier, lighter and easier to uproot). The uprooting and monitoring operations were thus systematically carried out every July from 2012 to 2020.



Phasing of areas covered on the island

The uprooting phase itself consisted of two distinct types of operation:

- Operations along cliff edges or steep slopes. These operations required the involvement of staff trained to perform rope access work. Because these operations did not involve the carrying of heavy loads, they were able to be completed in just 10 working days: the uprooted debris was thrown down to the base of the cliffs. However, this operation did require careful phasing in order to ensure that no-one else was working beneath the cliffs during the uprooting. The remnants were then gathered up into windrows at the base of the cliff.

- Operations in flat or less hilly zones, with a new sector being covered each year between 2012 and 2015. The work was undertaken using a simple operating method (c.f. diagram below):

UPHILL PHASE

• Workers proceed to identify the lower limit of the operational zone, considering that each person would be responsible for a 2m-wide row;

• The volunteers uproot a row perpendicular to the slope at the lower limit of the operational zone (around 1.5 metres wide); the stalks are pulled up by hand and thrown to the upper part, above the line cleared.

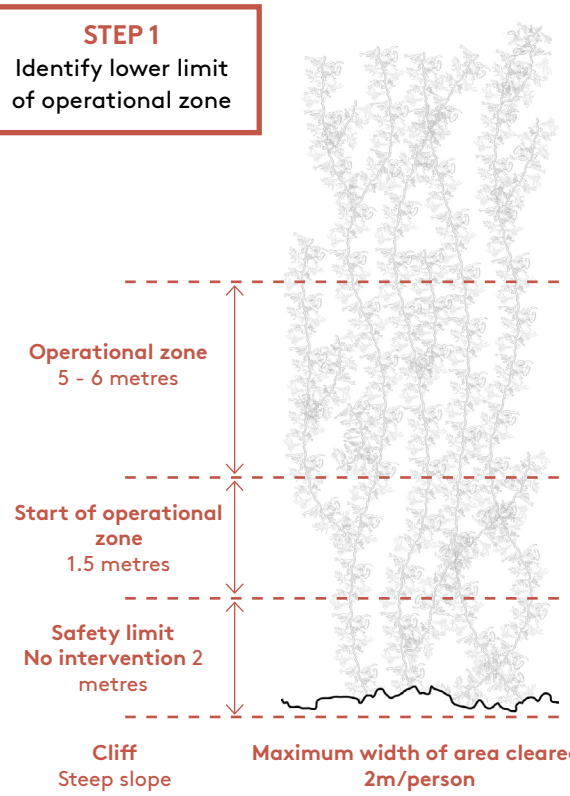
DOWNHILL PHASE

• The volunteers move about 5m or so up the slope in a line formation, in order to gradually move downhill pulling up the Carpobrotus as they go, perpendicular to the slope and rolling up the sour fig plants into mats; with the sour fig plants piled on top of one another, these mats form a thicker and thicker roll.

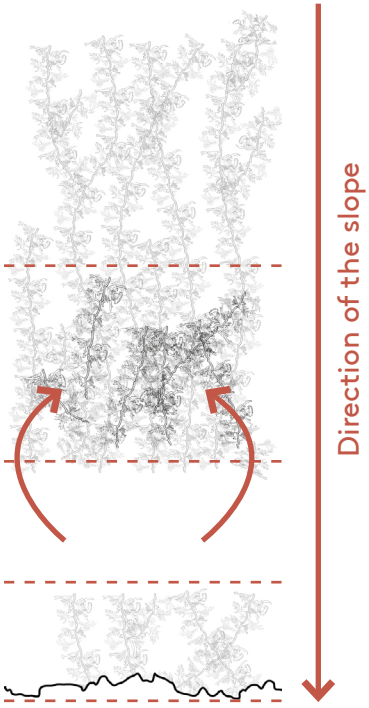
• The roll is deposited in the area that was previously cleared, ensuring that no stalks remain there that have not been uprooted; this enables the windrows to be laid out.

Over the course of these steps, the presence of any indigenous species (perennial or annual) is identified so that the root stalks can be preserved throughout the operation.

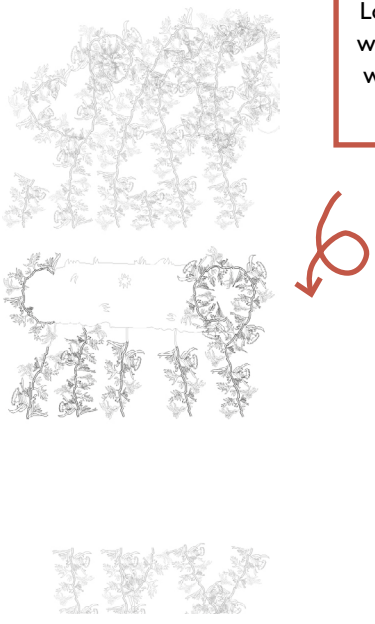
STEP 1
Identify lower limit of operational zone



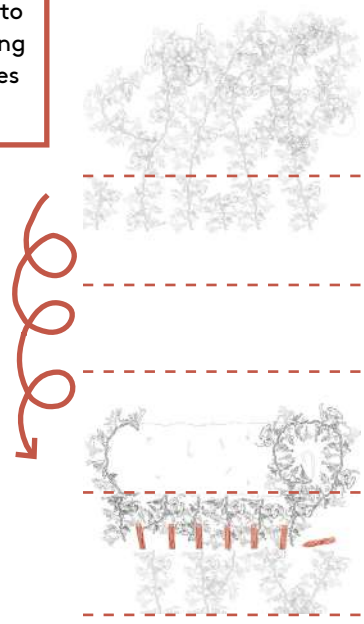
STEP 2
Clear a row about 1.5m in width, throwing the uprooted stems onto the upper mat. Ensure that no rooted stalks remain within the cleared row



STEP 3
Move 5 - 7 metres up the area to be cleared. Start rolling the sour figs up in a mat, moving toward the bottom



STEP 4
Lay out the rolls into windrows, stabilising with wooden stakes if necessary.



Method for uprooting sour fig plants on the island
Bird's eye view

Since 2012 when the first section was cleared, each section uprooted has been subject to a follow-up inspection, called a "repasse" in French. This is an annual operation carried out in sections that were cleared in previous years, which involves uprooting any sour fig seedlings having sprouted since the soil bed was cleared. Between 2012 and 2015, the inspection was carried out at the same time as uprooting operations (most often during the beginning/middle of the afternoon, as this work is less tiring during hot weather).

The results are only collected from accessible sectors, as volumes cannot easily be calculated in cliff areas. The volumes are calculated by collecting new seedlings in 50L plastic buckets.

Results

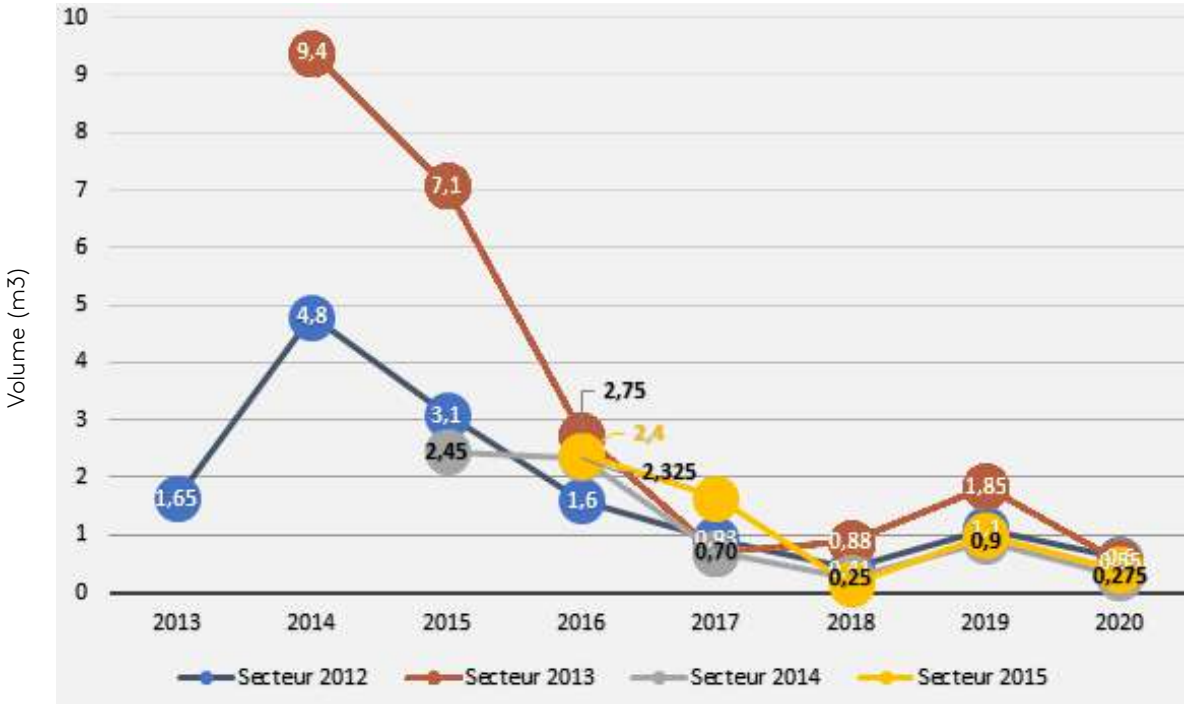
Period of operations	*16/07/2012 - 09/07/2020*
Total working hours	**740 hours** *uprooting from 2012 - 2016, cliffs included* **342 hours** *inspections/second passes from 2013 - 2020, cliffs included*
Total area of Carpobrotus cleared not including cliffs (estimate)	*1.23 ha*
Rate of uprooting (m²/pers/h) calculated over 4 sections between 2012 and 2015	*from 15.4 - 32 m²/pers/h*
Effectiveness of follow-up inspections, from 2012 - 2020 (including cliffs)	see table
Number of man-days mobilised between 2012 and 2015	*178*

Surfaces cleared and effectiveness of uprooting campaign

Sector	*2012*	*2013*	*2014*	*2015*
Surface area of sectors (ha)	*1.63*	*0.54*	*0.83*	*0.71*
Dates of operation (July)	*16 - 19*	*8 - 12*	*28 - 31*	*7 - 10*
Average no. of personnel mobilised (days)	13	11.3	14.5	8.6
Actual duration of the campaign (days)	3.5	5	3.5	3
Surface area cleared (m^3estimate)	2966	4043	3696	1419
Uprooting work* (h)	193h30	210h20	167h40	53h40
Efficiency rate*** (m2/pers/h)	15.4	32.0	22.0	26.4

Effectiveness of follow-up inspections

Years of intervention	Surfaces inspected (m2)	Total working time for follow-up inspections (h)	Follow-up efficiency rate (m2.h.pers)
2012			
2013	3195	26	122.9
2014	7238	40	181.0
2015	10,934	60.6	180.5
2016	12,353	55.4	223.0
2017	12,353 + cliffs	48	257.4
2018	12,353 + cliffs	50	247.1
2019	12,353 + cliffs	32.5	380.1
2020	12,353 + cliffs	30.4	406.3



Monitoring of volumes of Carpobrotus uprooted (m3)
per sector in the year following the first clearance, since 2013

Critique of the method

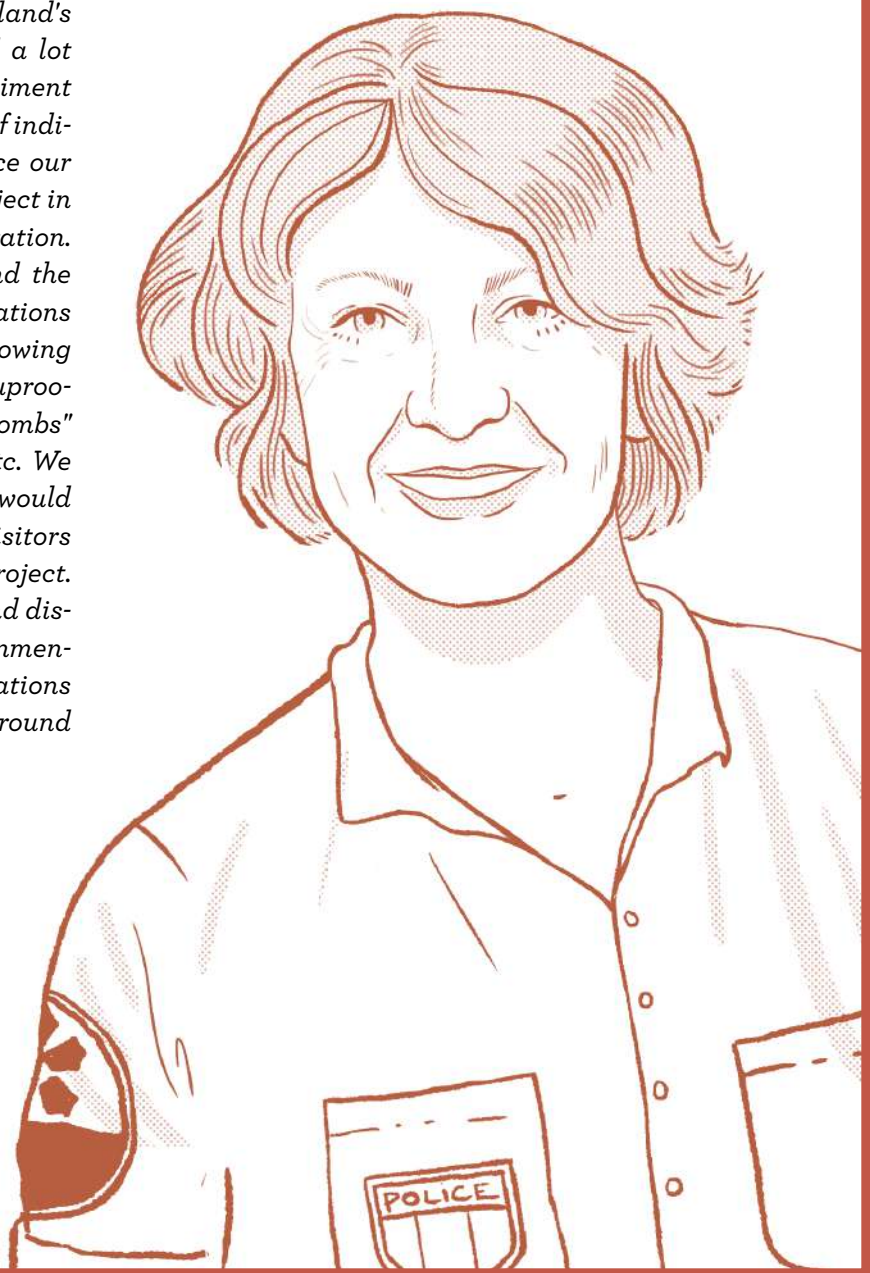
Depending on the layout of the sectors (exposure to wind, spray, slopes), windrows cannot always remain in place on their own, and need to be stabilised (using wooden pegs) and brought closer together. As such, the windrows in part of the 2012 sections were partially washed away. In order to address this problem, ecological restoration efforts (sowing seeds, local plantations developed from cuttings taken and grown on the island, the creation of windrows using driftwood found on site, the use of fascines made with coconut fibres surrounding the sour figs pulled up during second passes) were applied until 2019, after which point the operations were brought to a close given the success of natural and enhanced regrowth.
Inspections must still be carried out every year, although the amount of time involved is gradually diminishing. The total volumes involved are non-negligible: in 2020, 1.8m^3 worth of plants were still being pulled up across all sectors. These inspections are planned to continue for 10 years, but it is likely that the duration will be extended until the sour fig has been fully eradicated.

TESTIMONIAL

Paule Zucconi

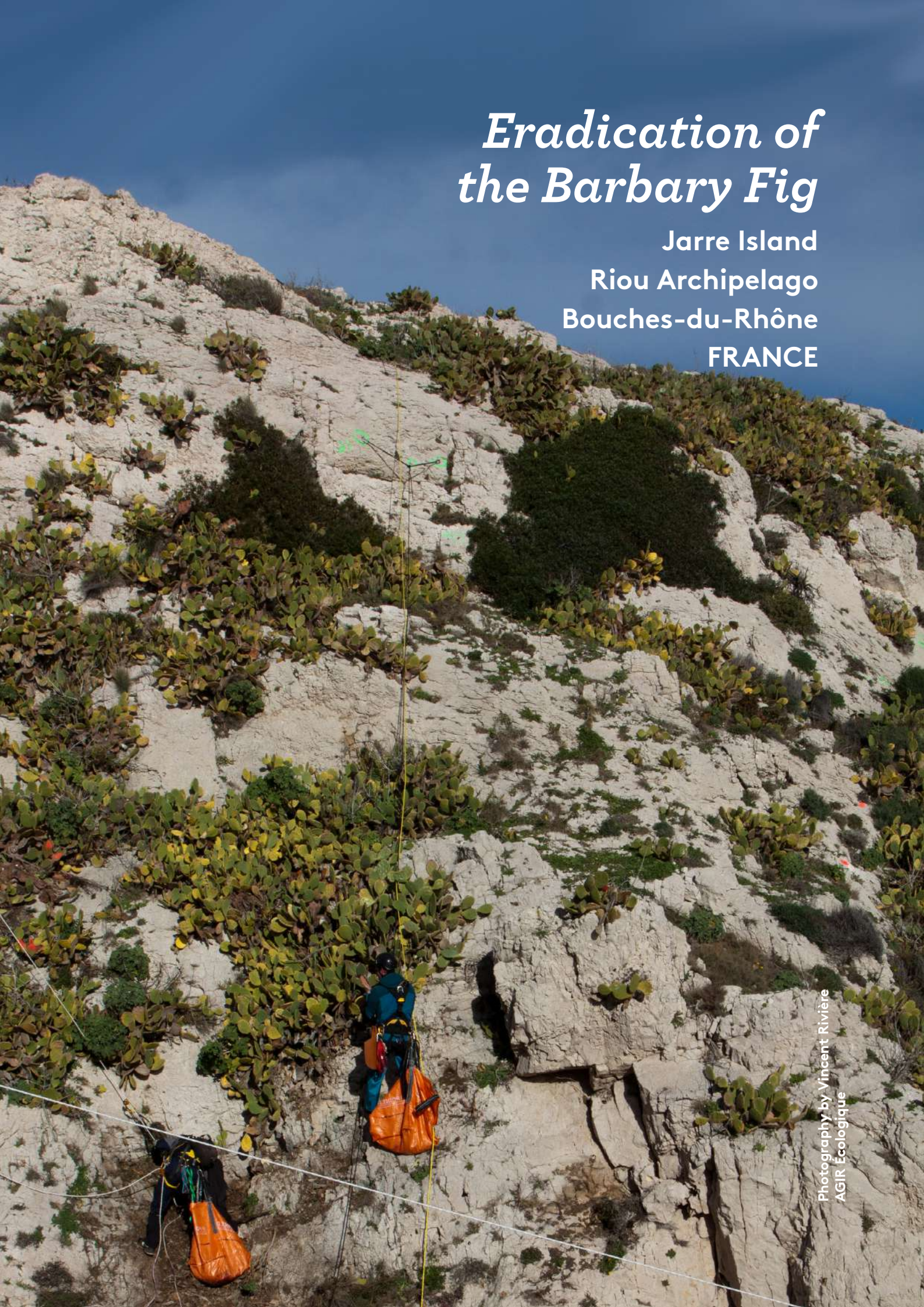
Ranger for the Grand Rouveau island,
City of Six-Fours-les-Plages

Launching an operation of this sort must always go hand in hand with a successful communications campaign. During the first year of operations, the landscape went from a lush green layer of sour fig plants to a vast slope of bare soil, with no visible plant life. The visual impact, whether from the esplanade around the light house or from the sea (with many pleasure boaters used to mooring just opposite this first sector to enjoy a view of the island's landscapes) was significant, and raised a lot of questions. This led us firstly to experiment with methods to encourage the regrowth of indigenous plant species, but also to enhance our wider communications regarding the project in order to explain the benefits of the operation. This included information panels around the site, articles in the local press, conversations with visitors while work was underway, allowing local young people to participate in the uprooting operations and the launch of "seed bombs" in areas to be replanted, short videos, etc. We embraced all available methods that would enable us to raise awareness among visitors to the area, and win them over to the project. These efforts continue in the form of island discovery days for students following environmental courses, as well as welcoming associations of pleasure boaters and showing them around the island.



Eradication of the Barbary Fig

Jarre Island
Riou Archipelago
Bouches-du-Rhône
FRANCE



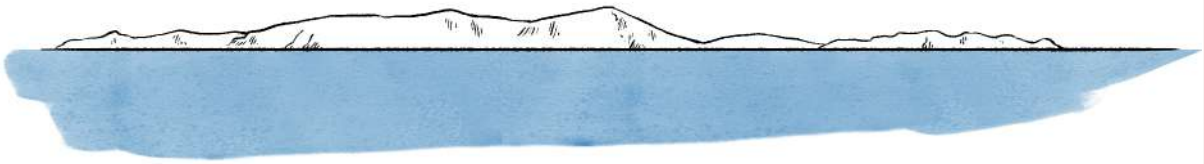
Photography by Vincent Rivière
AGIR Écologique

Jarre island

Riou Archipelago

Bouches-du-Rhône

FRANCE



Surface area: 18.61 ha
Altitude: 56 m
X Coord:43.19718
Y Coord:5.365064

Protected status: Core area of Calanques National Park
Uninhabited island
Landing prohibited

Biological challenges and sensitivity

SPECIES OF INTEREST

Presence of 7 protected plant species: *Thymelea hirsuta, Silene sedoides, Senecio leucanthemifolius subsp. Crassifolius, Sedum litoreum, Plantago subulata, Limonium pseudominutum, Astragalus tragacantha,* four of which are perennial and one of which is endemic.

Presence of 3 protected species of nesting birds: the Peregrine Falcon, *Falco peregrinus*, Scopoli's Shearwater *Calonectris diomedea*, and the Storm Petrel, *Hydrobates pelagicus*.

Presence of an endemic nocturnal gecko: the European Leaf-toed Gecko, *Euleptes europaeus*.

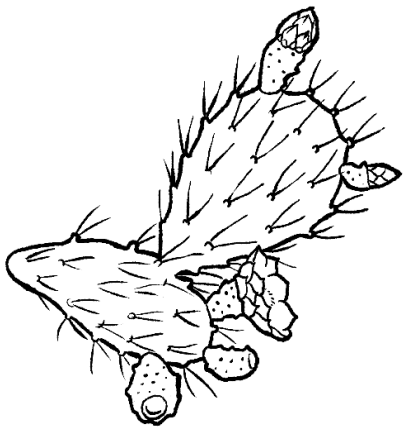
INVASIVE SPECIES

One invasive plant species: *Opuntia sp.*

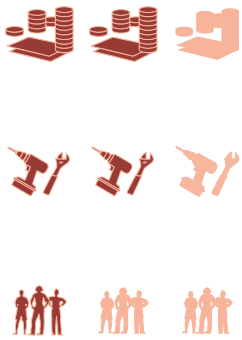
Colony of Yellow-legged Gulls, *Larus michahellis*, potentially responsible for dispersing Opuntia fruits.

Characteristics of project working conditions

- Absence of landing stage
  No mooring
- No fresh water source on the island
- No electricity
- No buildings
- No natural anchor point




MARSEILLE
Les Goudes
Port of Les Goudes
Callelongue
Port of Callelongue
Calanques
Distance : 0.9 nm
Jarron island
Jarre island
Calseraigne island
Riou island
500 m



Project Description

Project to Eradicate Invasive Alien Plant Species led by the Calanques National Park and the Provence-Alpes-Côte d'Azur Regional Agency for Biodiversity and the Environment (ARBE), as part of the LIFE Habitats Calanques programme.
The programme identified several target sites, with Jarre island presenting a particular level of complexity. Only one invasive alien species present: the Barbary Fig, *Opuntia sp.*

27 January 2020 → **12 March 2020** → **From March 2020 to March 2030**

Start of operation | End of uprooting | Monitoring

Main parameters considered for the implementation of the project

PROXIMITY TO THE MAINLAND

Island located less than one nautical mile from the nearest port, making it possible to transport materials and personnel without major difficulty.

NO LANDING STAGE

Landing only possible for personnel and light equipment, and only during favourable weather conditions. No way of evacuating heavy equipment or plant debris. Shallow draught, i.e. access using a rigid inflatable - boat.

PUBLIC ACCESS PROHIBITED

Low chance of re-introduction of invasive species following the intervention.

NO ON-SITE ACCOMMODATION

No options for on-site accommodation, and no freshwater source. Interventions can be carried out autonomously, depending on weather conditions.

TWO TYPES OF ZONES INVADED BY OPTUNIA PLANTS:

- Cliff areas (around 950 m²), where Opuntia growth is highly concentrated. This requires the intervention of personnel trained to perform rope access work; handling issues are limited if plant debris is thrown down to the cliff base.
- Sectors in flatter but also scattered areas This requires plant debris to be carried manually to the storage zone.

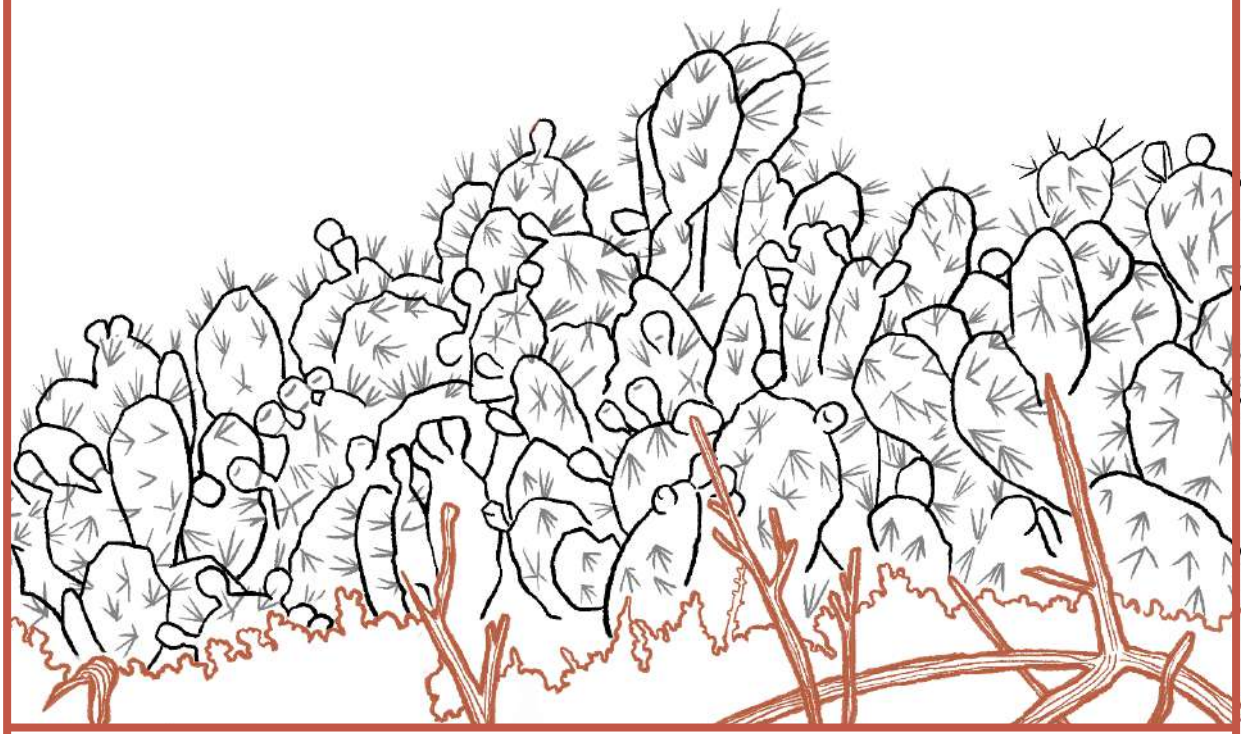
STORAGE

The intervention requires that all plant debris be processed, as even a single 'prickly pear' can produce new fruit when left on the ground.
In the absence of evacuation solutions, it is therefore necessary to identify a storage area for plant debris that will preclude any possible regeneration.
Locating this area within reach of ocean spray can help speed up the natural decay of plant debris.

PROTECTIVE GEAR

Opuntia are covered with small needles known as glochids, which are highly irritating and likely to cause injury:

- The operators therefore need to wear as much protective covering as possible (overalls or jumpsuits to avoid exposing the skin, as well as shin guards, protective socks, and thick gloves):
- The uprooting must be performed with a minimum of handling, using hoes and machetes;
- Tweezers are an essential piece of kit for all workers.



Operators:

La Compagnie des Forestiers - AGIR écologique

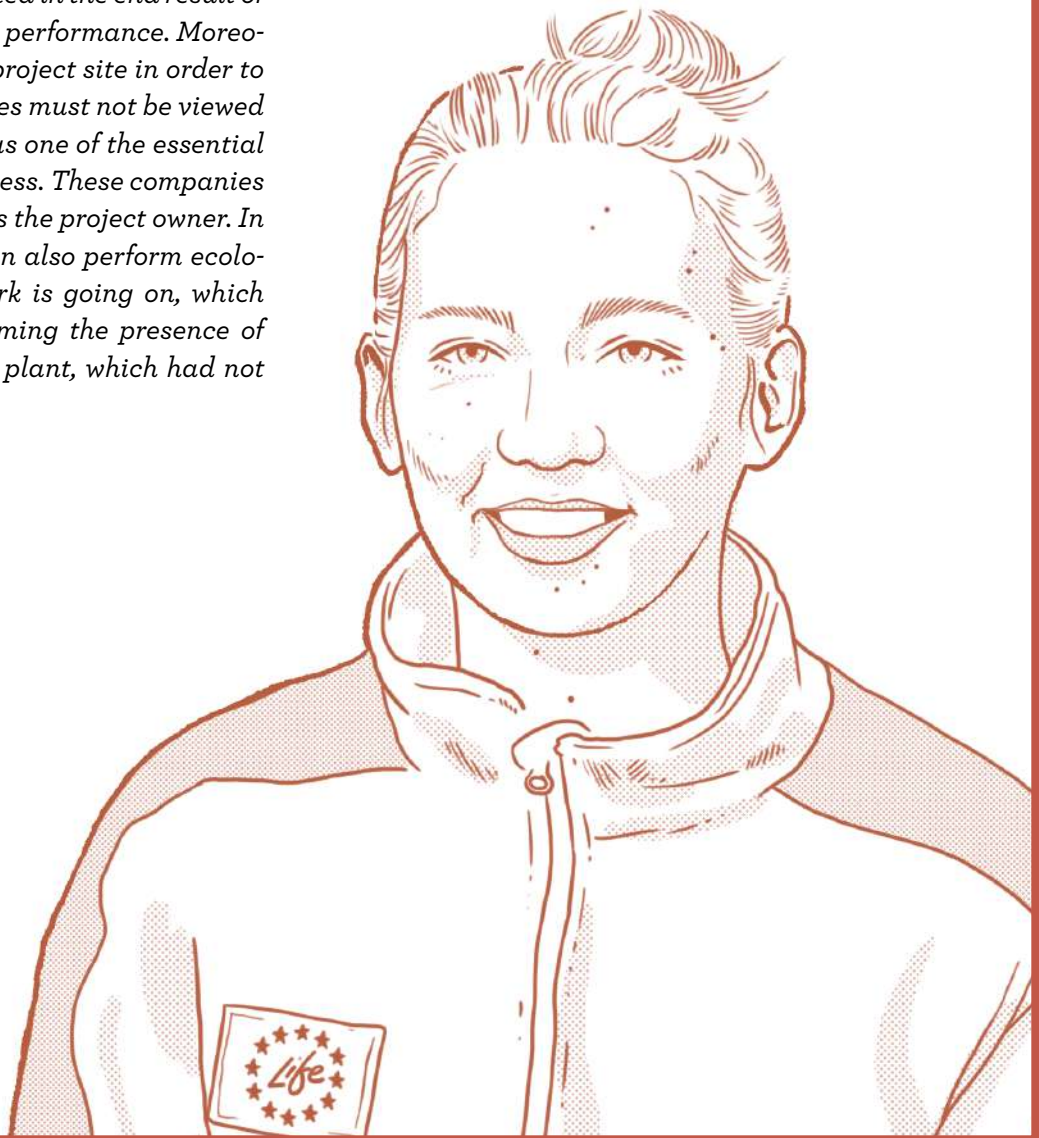
TESTIMONIAL

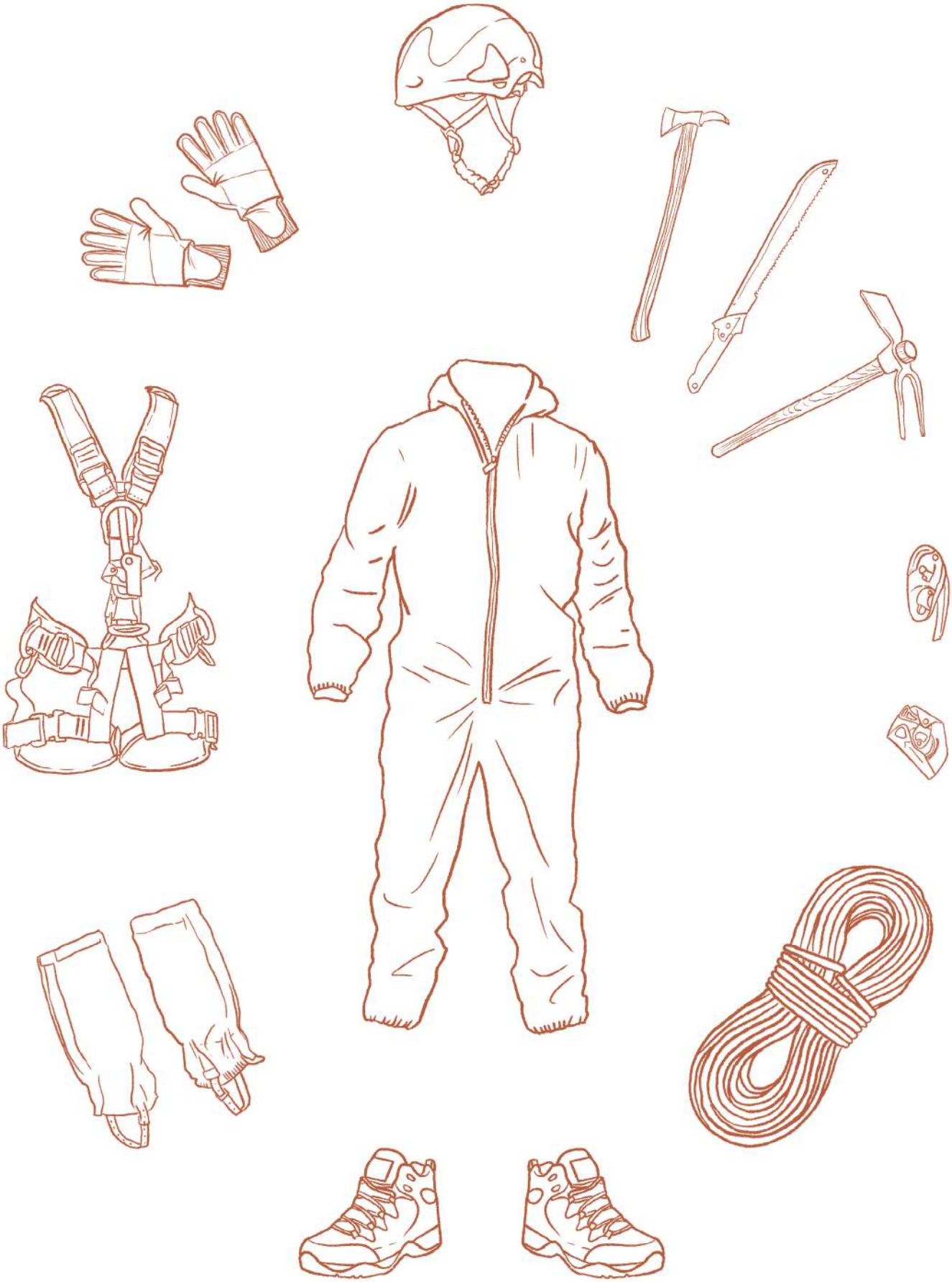
Laureen Keller

LIFE Project Coordinator
for the Calanques National Park

While the management of Invasive Alien Plant Species is in many cases a highly complex affair and difficult to achieve, undertaking these kinds of initiatives on the islands offers multiple benefits: firstly, the chances of success are high, and secondly the local or endemic species that stand to benefit from the operation are often those with a highly sensitive conservation status.

Calling in the services of teams who specialise in ecological engineering projects is another key factor in ensuring the project's success. These companies are just as invested in the end result of the project as they are in its performance. Moreover, the need to adapt the project site in order to account for protected species must not be viewed as a limitation, but rather as one of the essential aspects of the project's success. These companies speak the same language as the project owner. In addition, the companies can also perform ecological surveys while the work is going on, which notably led to them confirming the presence of the Astragale de Marseille plant, which had not been observed since 2003.





Equipment required to set up the project site

Selecting the appropriate intervention method

Given the multiple constraints presented by the site's sensitive nature and specific characteristics, the intervention was scheduled and organised in such a way as to limit any harm to biodiversity, with solutions being implemented to assist operators with handling and transport. The schedule for the intervention was aligned to reflect the site's ecological sensitivity: the optimum window for operations fell during the autumn-winter period, which also coincided with the most complex maritime conditions limiting access to the site by sea.

Given the layout of the site and the access issues it presented, **the decision was made not to export plant debris to the mainland: given how difficult it is to access the island by sea, the only viable way to do so would require the use of a barge and a helicopter, which would not only be cost-prohibitive but also highly disruptive to local bird populations (notably the peregrine falcon)**. A storage area was therefore laid out on the lower part of the island. All logistics for the operation were therefore organised around the transport of plant debris toward this storage area, and the implementation of adapted solutions in order to limit manual carrying. A 150-metre long zipline was installed, starting at a high point that could be accessed on foot from all points of the island, allowing uprooted plant debris to be transported to the storage area.

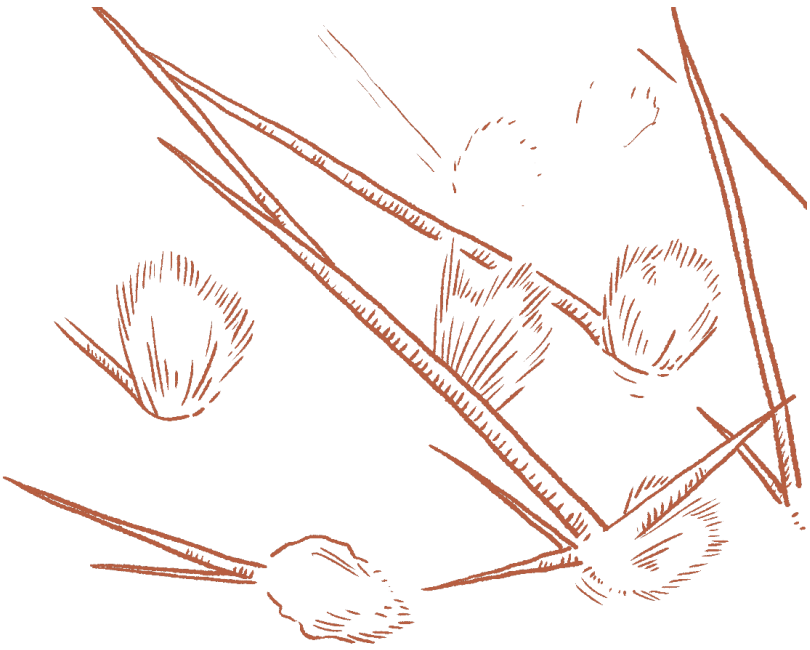
The plant debris accumulated in the storage area was broken up using a machete (fragmented leaves pose a lower risk of potential regrowth, and accelerate the decomposition process), in order to limit individual plants' ability to respawn. These fragments were then piled into a shallow pit in order to increase the build-up of covering layers, thereby encouraging natural decomposition. It was not necessary to cover the plant debris with a tarp. The natural process of decomposition was accelerated by the influx of sea spray.

THE UPROOTING WORK ITSELF INVOLVED TWO DISTINCT TYPES OF OPERATION

- Interventions in low-risk areas, which were spread out all across the island and generally concentrated around a high point. The uprooting work carried out required plant debris to be carried manually up to the zip line. This type of operation occupied the teams for around half of the project's duration.
- Operations along cliff edges or steep slopes. These operations, requiring the involvement of personnel trained to perform rope access work, took a relatively short time to complete despite covering a significant area. This was due to the fact that work on cliff faces required very little handling of debris, with uprooted plants being thrown down to the foot of the cliff. However, this operation did require careful phasing in order to ensure that no-one else was working beneath the cliffs during the uprooting. Once thrown to the ground, the fragments were then gathered into bulk bags to be transferred to the storage zone.

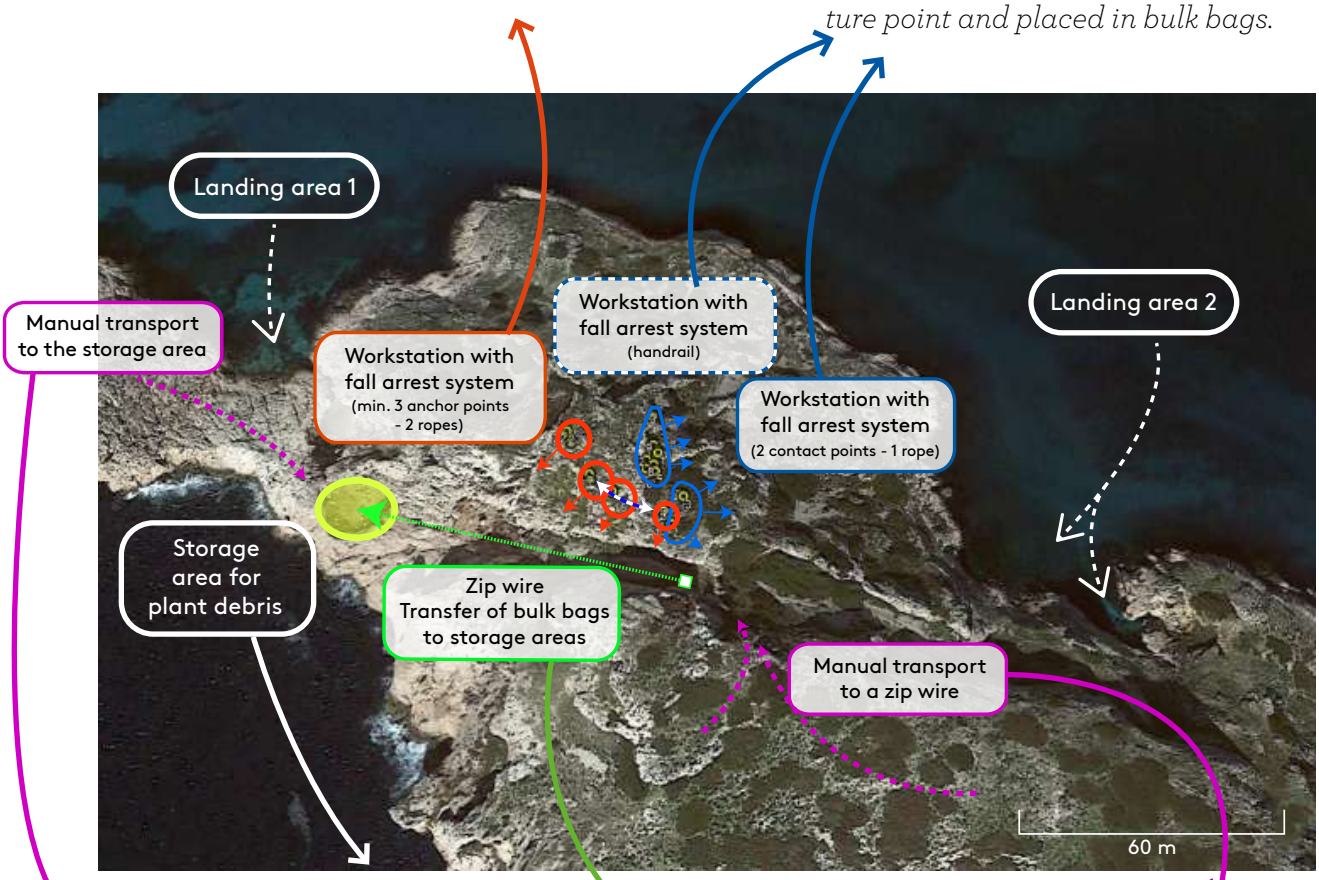
AS SUCH, SEVERAL WORK STATIONS WERE SET UP

- **An ecology project site supervisor post:**
  Transport of operators and equipment, checking to ensure compliance with ecological requirements, reminder of issues at stake for each new operator, monitoring of cleared areas, exploration expeditions, task organisation, log book;
- **Uprooting base stations in accessible sectors (not requiring rope access):**
  Uprooting and transport of plant debris in mini bulk bags (250L capacity, holding around thirty kilos) toward the zipline transfer area. Use of specific Personal Protective Equipment (PPE): jumpsuits, thick gloves, shin covers, machetes and hoes, mini bulk bags and frame backpacks for carrying loads to the zipline;
- **Uprooting workstations with fall arrest system:**
  Use of a rope and safety harness in addition to plant-handling PPE
- **Uprooting workstations on cliffs:**
  Requiring operators authorised to perform rope access work using specific PPE (helmet, harness, 2 ropes - a work rope and a backup safety rope), in addition to the PPE used for plant uprooting.
- **A zipwire transfer workstation:**
  Loading of bulk bags and transfer to the storage area;
- **Area for receiving and storage:**
  Bulk bags are received and the plant debris is gathered up and cut into fragments with a machete at the storage area.



In this area with very steep slopes, the uprooted Opuntia were discarded and gathered up using a large tarp positioned below. They were then transported to the storage area.

Given the geographical relief, fall arrest systems were installed at these two workstations in order to create safe working conditions. The uprooted Opuntia are manually removed to the zipline departure point and placed in bulk bags.



The uprooted Opuntia are manually removed and carried to the storage area

The Opuntia debris is stored here.

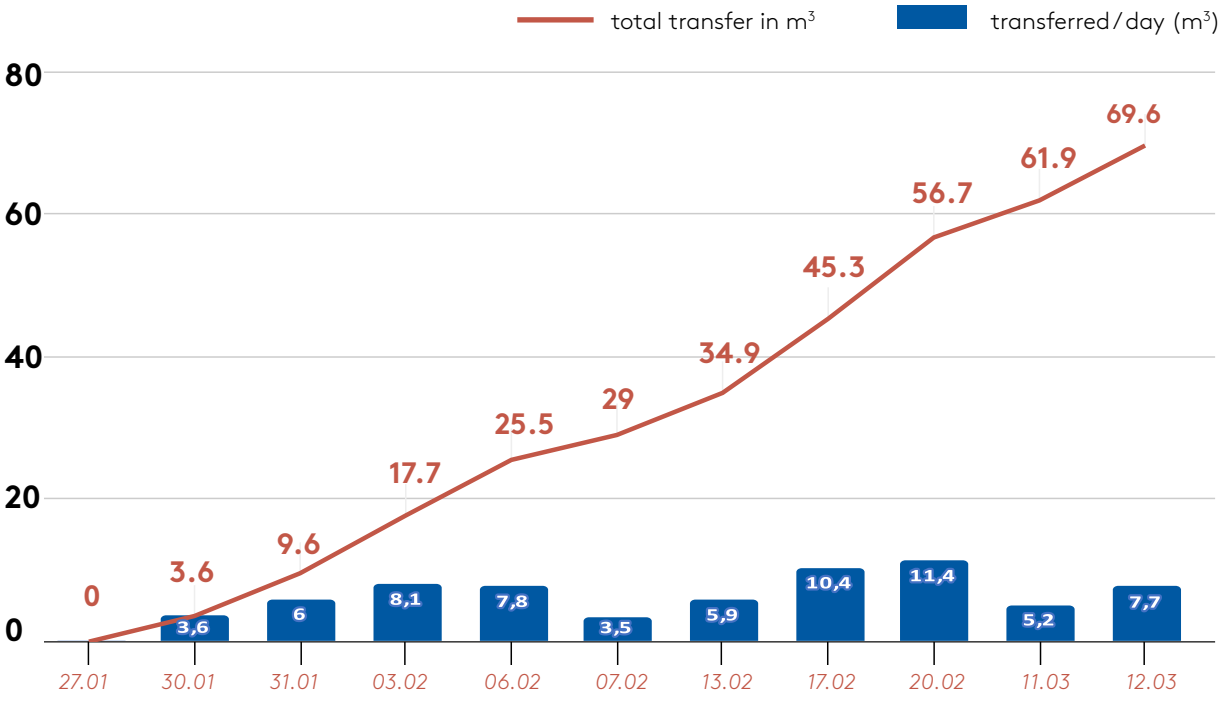
The Opuntia debris is loaded into bulk bags at the zipline departure point, to be transferred and then unloaded at the storage area.

The uprooted Opuntia are manually removed to the zipline departure point and placed in bulk bags.

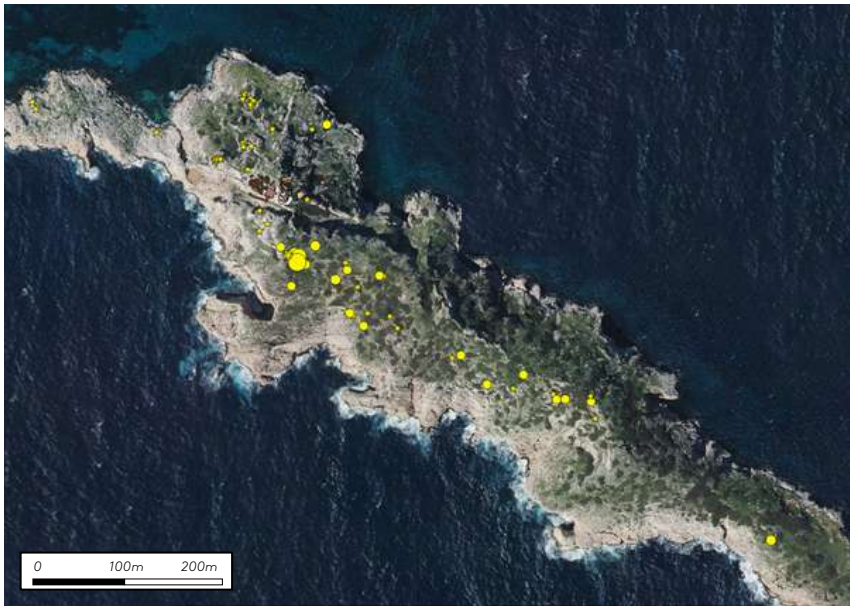
Workflow on Jarre island

Results

Period of operations	from 27/01/2020 - 12/03/2020
Number of permanently installed anchor points	25
Volume uprooted and stored (estimation)	69.6 m^3
Number of bulk bags transported	696
Total weight uprooted and removed to storage area (estimate)	20.8 t
Surface area covered (estimate)	942 m^2 on cliffs + 46m^2 scattered individuals, i.e. 988m^2
Number of man-days required (counting only operations on the island)	108.5 man-days divided over 13 calendar days. Half of all working time was spent handling and transporting plant debris
Distance travelled in rigid inflatable boat for the operation	165.6 nautical miles
Cost of the operation	€66,740 incl. tax (provision of a rigid inflatable boat, rental of apartments near the port of Callelongue, payment of work teams, rope climbing equipment and other items, bulkbags)



Fluctuation of volumes transferred to the storage areas (unit: m^3)



SPORADIC TASKS

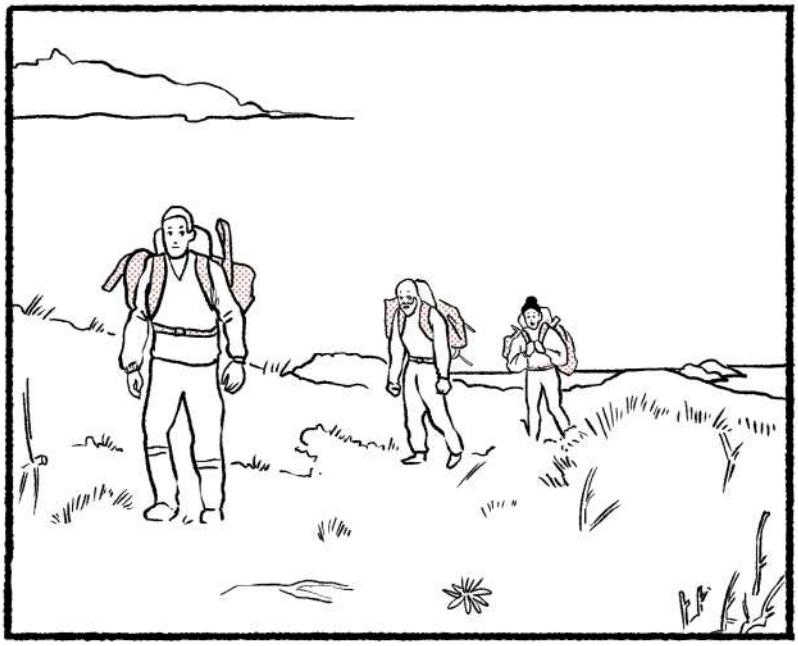
- <1
- 1 m²
- 2
- 3
- 4
- 5
- 6

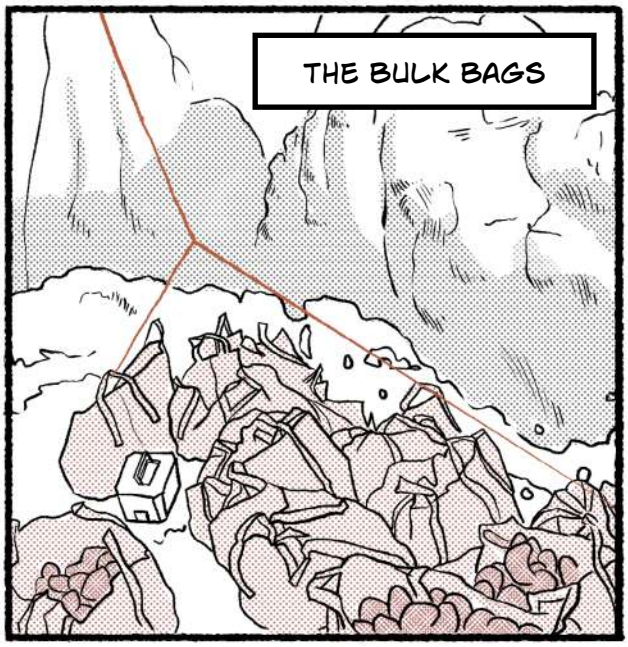
Background:
Bing IGN BD Ortho
Compiled by:
AGIR écologique
Source:
AGIR écologique,
Compagnie forestièrs,
Matières

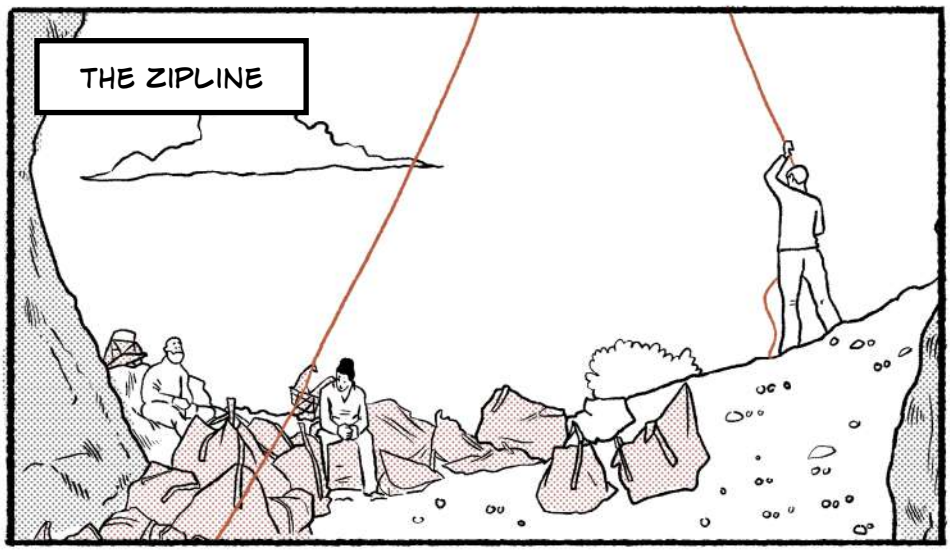
DATE OF OPERATIONS BY SECTOR

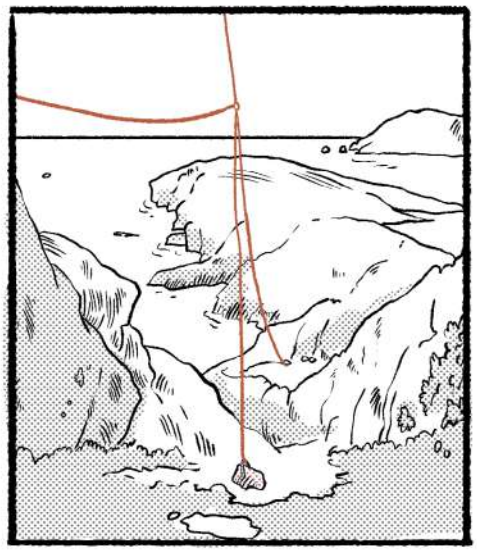
- *27.01.2020*
- *30.01.2020*
- *31.01.2020*
- *03.02.2020*
- *06.02.2020*
- *from 07.02 to 17.02.2020*
- *from 13.02 to 12.02.2020*

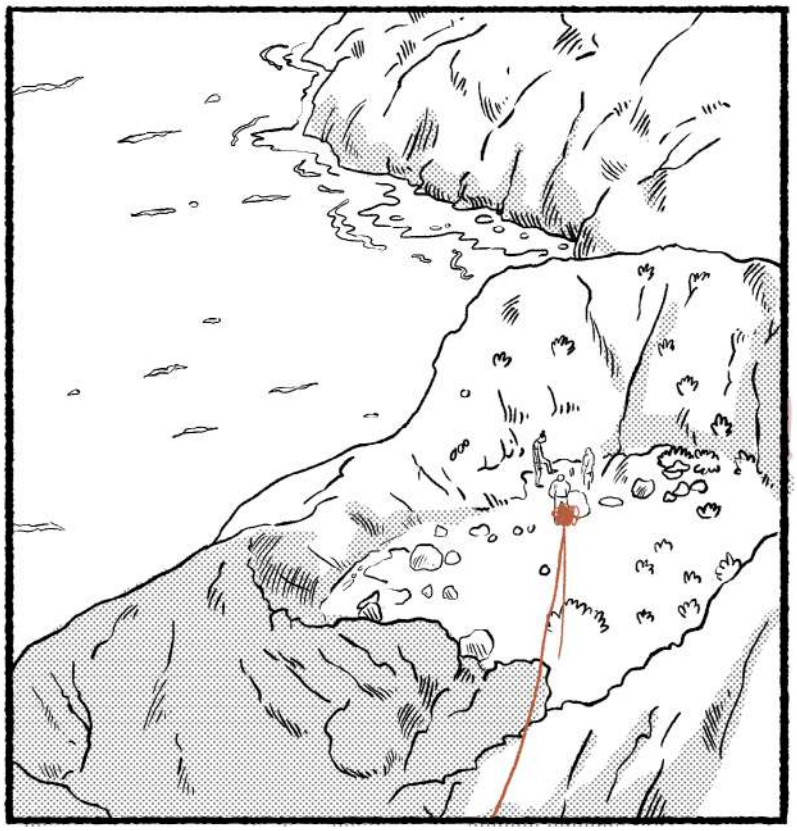
Background:
Bing IGN BD Ortho
Compiled by:
AGIR écologique
Source:
AGIR écologique,
Compagnie forestièrs,
Matières




THE BULK BAGS


THE ZIPLINE






STORAGE AREA
THE END

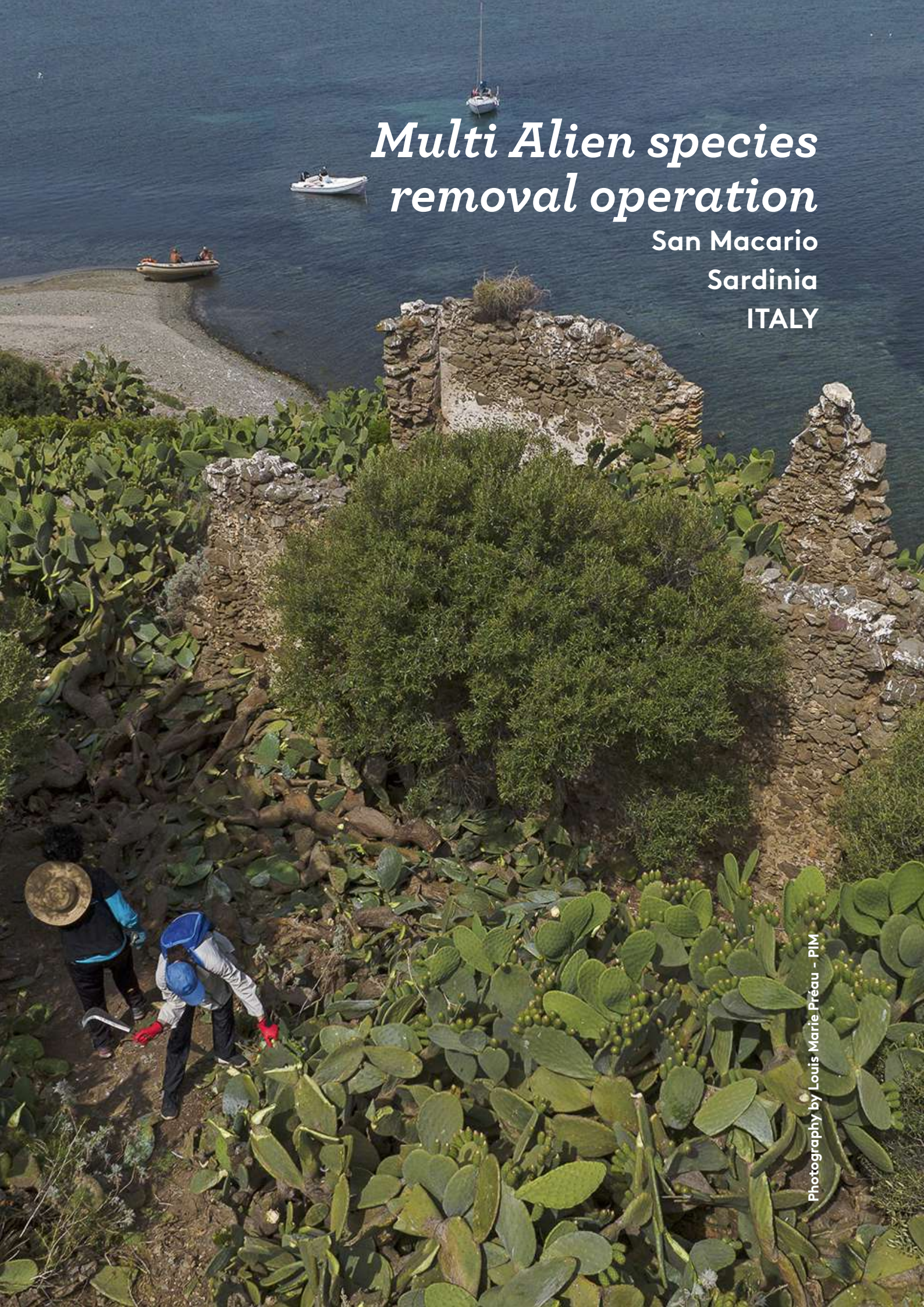
Critique of the method

- Despite the production of a detailed map for the use of the Project Owner, with each anchoring pin numbered and overlaid, the permanent anchor points will remain difficult to locate during future monitoring operations. Particular attention must be paid to this topic.

- The highly sensitive nature of this site, notably in terms of bird life, did not allow plant debris to be exported from the island (impossible to mobilise a helicopter, and with no loading dock there was no way to export plant matter by sea). As such, the approach adopted sought to store plant debris in an area with little plant life, with exposure to ocean spray which would encourage decomposition of the debris. Only the monitoring operations carried out by the National Park will be able to confirm whether this approach is effective in the long term.

- The repeated movements of the workers led to paths being formed along the landscape; these are not extremely harmful on an island closed to visitors, but they remain visible when necessary visits are made to the pistachio bush patches. These tracks should become overgrown in the medium term. We may also note that when bulk bags loaded with plant debris were set down temporarily while waiting to be loaded onto the zip line, and subsequently moved during transport, this caused partial damage to the upper layer of the soil. However, these operations did not harm any perennial protected species. Only annual species (*Senecio lecanthemifolius*) might have been partially damaged. Nonetheless, it remains highly probable that the damage will be rapidly absorbed, given that the species is known for its ability to colonise spaces during the post-eradication phase.

- While the act of discarding plant debris toward the foot of the cliff saves a great deal of time for the people working on the ropes, this technique nevertheless leads to a net increase in working time since these fragments then need to be gathered up from the base of the cliff. A time-consuming process of sorting and picking became necessary when fragments became mingled with the soil bed and unstable rocky patches. In addition, this technique risks possible dispersion of fragments and seeds. While a seed-clearing operation has not been planned due to high levels of concentration and dispersion, inspections of working areas were carried out throughout the course of the operation in order to avoid the possibility of any fragments being left behind.



Multi Alien species removal operation

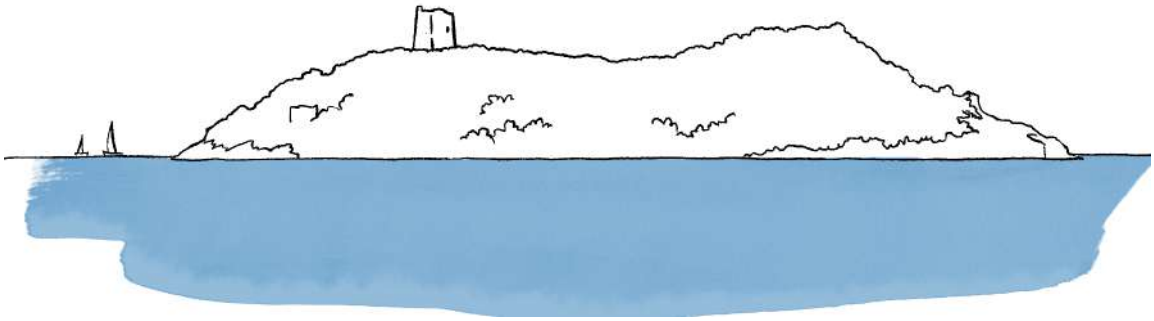
San Macario
Sardinia
ITALY

Photography by Louis Marie Préau - PIM

San Macario

Sardinia

ITALY



Surface area: 3.2 ha
Altitude: 0 - 15 m asl

Protection status: Special Area of Conservation (SAC) - ITB042216 «Capo di Pula»

Biological challenges and sensitivity

SPECIES OF INTEREST

Brassica insularis (Annex II 92/43/CEE and Bern Convention)
Breeding seabirds: *Gulosus aristotelis desmarestii*, *Falco peregrinus*, *Larus audouinii* (in the past)

INVASIVE SPECIES

Opuntia ficus-indica

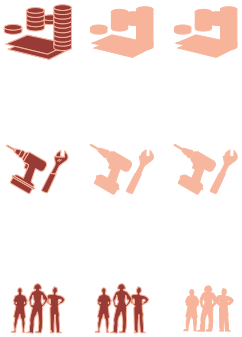
Characteristics of project working conditions

- No landing
- No sanitary facilities
- Long process for authorizations

Human and financial resources

- 5 workers (30 working days)
- 5 volunteers (5 working days)
- 4 scientists/coordinators (20 working days)
- 1 boatman (30 working days)


PULA
San Macario
NORA
Laguna di Nora
Coltellazzo
500 m



September 2021 → October 2021
October 2022

Feasability study

22 June → Octobre
2 August 2022 → Novembre 2022

Uprooting actions

Project Description

S. Macario is a small island off the coast of Pula, a town in southwestern Sardinia. The island is also about 2 km from the islet of Coltellazzo and the Lagoon of Nora, two other important areas for breeding birds and for the presence of other species of conservation interest, besides being a tourist-educational attraction center.

According to literature and comparison of historical images, S. Macario is undergoing a major invasion of *Opuntia ficus-indica*, a species that was probably introduced in historical times (17th century) but has recently been encroaching on the entire islet due to abandonment by humans, who previously used the area for sustainable recreational purposes, creating a vegetation mosaic that ensured a greater biodiversity.

This has thus turned out to be a clear threat to *Brassica insularis* and may be a reason why even bird species, such as Audouin's Gulls, are not nesting in recent years. In particular, *B. insularis,* an endemic plant that used to be present all over the island, is now facing a significant population reduction due to the occupation of its habitat by the invasive *O. ficus-indica*. Due to the same loss of natural habitats, other species, such as birds, may also not find suitable breeding conditions.

This project involves :

- seabird and plant monitoring,
- ex situ germplasm conservation and in situ reintroduction of *Brassica insularis*
- and control of *Opuntia ficus-indica*.
  Wastes, such as plastic and abandoned bottles, were also collected and removed from the island.

Main parameters considered for the implementation of the project

ACCESSIBILITY ON-SITE

No pathway, no lifeline, difficult to walk safely, especially due to the high concentration of O. ficus indica and its thorns and volatile glochids.
Accessing the site on land and eradicating O. ficus-indica were done in complex conditions.

NO LANDING/ACCOMODATION

Apart from the small beach, the islet is almost inaccessible. Landing is only possible for people and light equipment. No on-site accommodations or fresh water are available. A boat must be always present for sanitary safety.

LOCAL WORKFORCE

Logistic costs were high (transport of personnel and equipment by boat).
To optimise costs/effectiveness, the Municipality of Pula has made available the personnel from the Cooperative Omnia Service. They were local people from Pula and very motivated even if they had little experience in natural restoration projects. Help was also obtained from two tunisians NGO's.

OPUNTIA REMOVAL

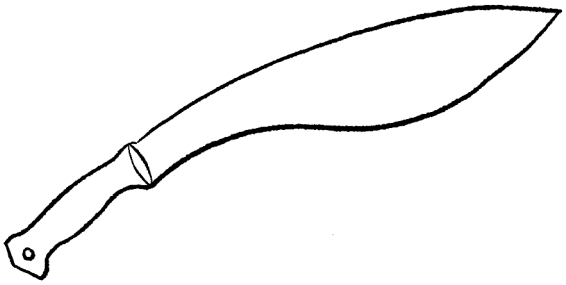
There was no possibility to remove the cuttings of O. ficus indica from the islet, so they were accumulated in some individuated sites. The removal of the approximately 5,000 m3 of cut material could only be possible with a helicopter, a solution that is not feasible as things stand.

Operators:

Financial management and coordination with local partners: Laguna di Nora Association
Local Authority and co-funding: Municipality of Pula
Monitoring plants and eradication and reference with MIC's partners: Unica-CCB
Monitoring seabirds: Anthus Association
Personnel of eradication: Cooperative Omnia Service
Volunteers (NGOs): Méditerranée Action Nature, Notre Grand Bleu

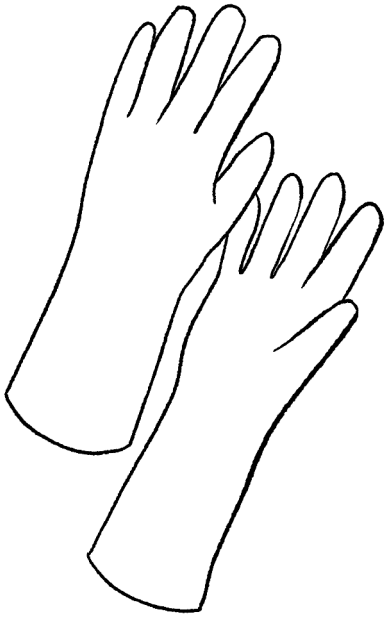
Selecting the appropriate intervention method

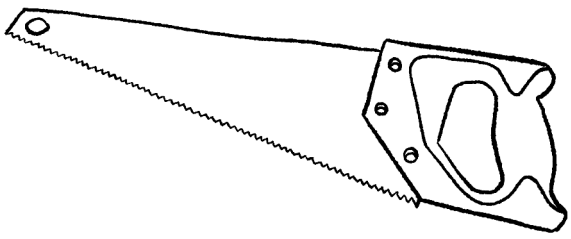
Necessary equipment

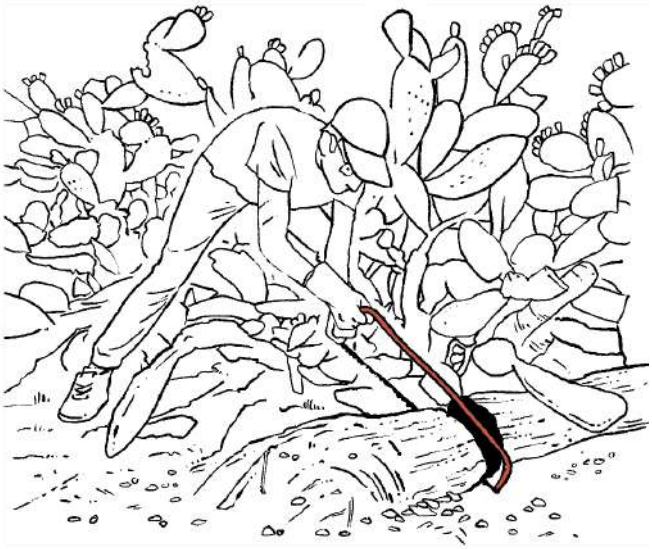


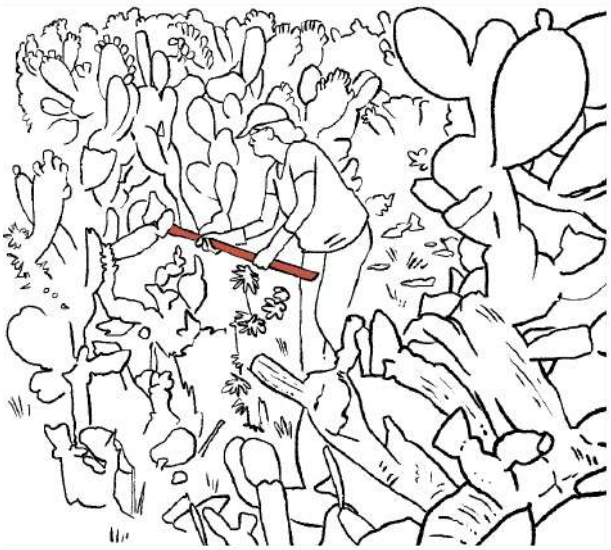
The removal of *O. ficus-indica* was manual and required very simple tools, such as

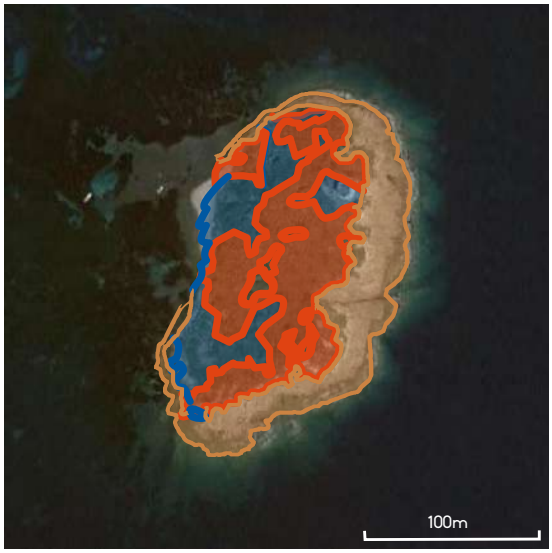
- hatchets
- saws
- gloves
- glasses
  for volatile glochids protection
- binoculars
  The monitoring was visual and required only binoculars for seabird identification and counting.











Opuntia, **0.9 ha (37%)**

Oleo-Ceratonion (H5330), **0.6 ha (25%)**
Sultable for *B. insularis, Audouin's gull*

Sea Cliffs (H1240), **0.8 ha (33%)**
Suitable for the European shag, Peregrine falcon

Map of the main habitats in S. Macario before the beginning of the project

Eradicated *O.ficus-idica*

Quantification of the eradicated O. ficus-indica

In situ conservation:

12% of total cost

- **80 individuals of** *Brassica insularis*

Ex situ conservation:

15% of total cost

- *Brassica insularis*
- *Magydaris pastinacea*
- *Charybdis purpurascens*
- *Senecio crassifolius*

Monitoring program and coordination:

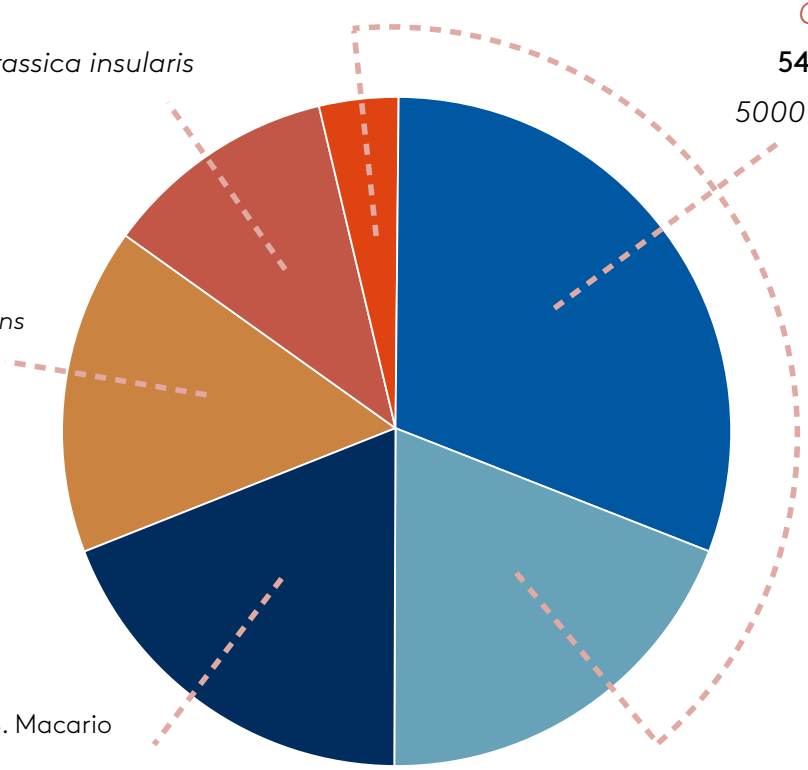
19% of total cost

- Authorizations
- Floristic inventory of S. Macario and Coltellazzo
- Seabird monitoring
- Quantification of eradicated O. ficus-indica
- Pre- and post-eradication vegetation monitoring

Eradication of *O. ficus-indica:*

54% of total cost

5000 m^3 (33m^3 /day)



- 5 workers (30 working days)
- 1 boatman (30 working days)
- 4 scientists (20 working days)
- long-term ex situ conservation
- plant production and reinforcement
- 5 volunteers (5 working days)

Labour-time mobilised

The main costs are for boat transportation and personnel.
The high interest of the islet made it possible to find co-funding (50% of total costs).

Critique of the method

Authorisations: the islet is public domain but the authorisations to proceed with the project had to come from the national authorities (State Property Office or "Demanio") to the local authorities (Municipality). This process took about six months of meetings, reports, and official administrative processes. Small islands can have other interests such as national security or navigation, and authorisations can be denied. Fortunately, this was not the case.

Logistical costs: concerned transport to the islet. A small boat can cost at least EUR 300 per day. A larger boat, to transport heavier tools and to remove the cuttings, would be more expensive or even impractical due to the absence of mooring facilities. Only waste such as plastic and empty bottles was removed, while the cuttings were stored in small piles. **Some of the plant material will resprout, others will rot, causing bad smells until next summer. As the islet is uninhabited, this was considered an acceptable downside risk.**

Continuous monitoring: the control of the O. ficus-indica population on S. Macario, as on most remote islands, is a difficult and costly task. This project has supported an important first step, but continuous monitoring and future actions are needed to ensure, at least, today's conditions. **To this end, S. Macario has the advantage of hosting several infrastructures of historical interest (1 Spanish tower from the 16th century; 1 Byzantine monastery; and 1 tuna fishery from the 18th century), which can be used to promote sustainable tourism activities that will allow for additional funding in the future.**

Testimonial

In the past, the island was used by fishermen and other people for recreational activities. Only older people (around 70-80 years old) were able to tell stories about it, while most young locals never visited it. This was due to the abandonment of traditional activities and the invasion of O. ficus-indica, which made the area almost inaccessible. Once the operation began, the villagers told various tales, such as the presence of springs and buried treasures or ghosts. Many began to come, even by swimming, to finally visit the islet. In summary, the islands are lands of pirates and fantastic stories and arousing an interest in them is relatively easy. This has to be managed to ensure that the activities to be conducted are sustainable but at the same time useful for an improvement of the current situation. To this end, the involvement of local authorities is useful, even if it might initially prolong the authorisation process.

Mauro Fois

Centre for the Conservation of Biodiversity of Cagliari

Controlling flora introduced in Cabrera

With the contribution of Eva Moragues Botey, PhD in Biology, invasive flora specialist, Head of biological conservation in Cabrera National Park from 2020 to 2022

Cabrera

Cabrera archipelago
Mallorca, Autonomous Community of the Balearic Islands

X Coord: 39,1451
Y Coord: 2,94391

Surface area : 1,569 ha
Distance from the main island: approx. 10 km (Mallorca)
Protection status: Maritime-Terrestrial National Park

Biological data

The National Park includes nearly 1,300 hectares of land covered in Mediterranean vegetation.
This flora includes one noteworthy endemic species, *Rubia balearica* subsp. *caespitosa*, exclusive to the island of Cabrera, with an occupation area under 1 km2 (350-400 specimens approx.). It is worth noting the recent discovery of 59 individuals of *Cistus Heterophyllus*. This species is listed as Critically Endangered.

Invasive plant species

The discontinuation of cultivation in the 1970s dampened the spread of adventitious and ruderal plants. The list of introduced flora includes only 26 species, 20 of which are considered invasive or potentially invasive.

Many alien flora species can colonise a site either naturally or by induction, but few represent a real threat. The vegetation of Cabrera has fluctuated with various degrees of natural cover depending on the intensity of human uses. Exotic species settle in the most disturbed areas (inhabited areas and some islets where seagulls nitrify the soil).

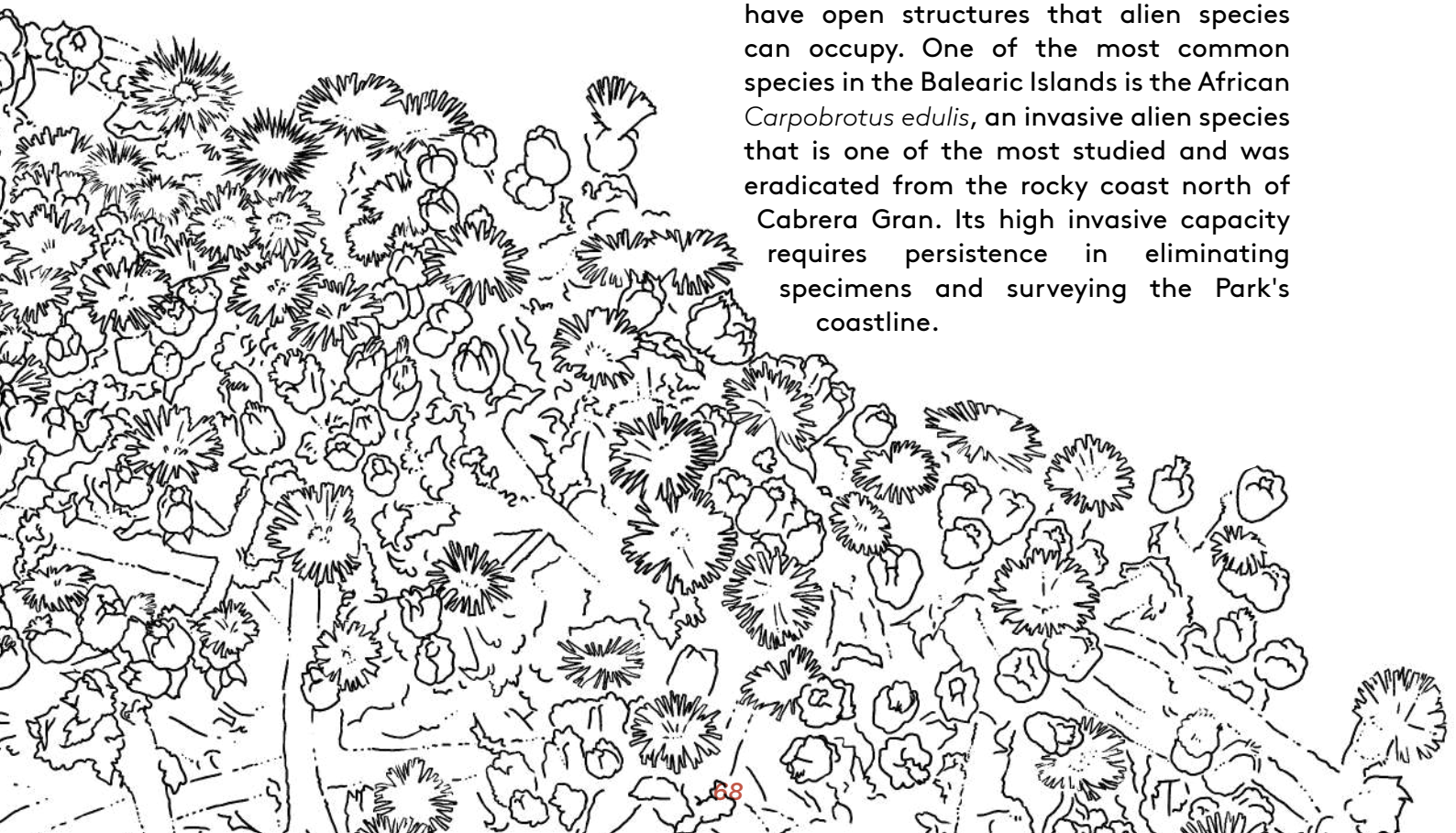
Twenty-eight alien species were identified: *Agave americana, Aloe vera, A. maculata, Amaranthus albus, A. deflexus, Aptenia cordifolia, Artemisia arborescens, Bryonia dioica, Carpobrotus edulis, Conyza bonariensis, Cyperus rotundus, Datura inoxia, D. stramonium, Disphyma crassifolium, Ecbalium elaterium, Echinochloa colona, Heliotropium curassavicum, H. europaeum, Ipomoea imperati, Iris x germanica, Mesembryanthemum crystallinum, Nicotiana glauca, Opuntia ammophila, O. maxima, Oxalis pes-caprae i Xanthium orientale ssp. italicum y X. spinosum.*

The most controversial species is the African *Oxalis Pes-caprae*, which represents a conservation problem and a management challenge. It can be found in the former farming areas of Cabrera Gran and the small villages of Na Redona and Conills. Its time of introduction is unknown. It was mapped in 2006/2007.

The company Tragsa launched an eradication campaign from 2007-2008 until 2010. Three treatments were used: glyphosate herbicide, ploughing and weeding. Herbicide was used in the islets of Na Redona and Els Conills, and the area in question was then covered with an opaque black plastic tarp. Except for Na Redona, the species was not eradicated due to a lack of consistency in operations. The operation's results were very successful, with significant reductions in the number and biomass of the bulbs.

Regarding this invasive species, the abandonment of cultivation and the advance of the Mediterranean scrub slowed its expansion. However, with the abandonment of control measures (2010), Oxalis Pes-caprae has colonised new garrigue spots, and it has been spotted between the stones of masonry walls, always close to the former farming area. It hasn't colonised other environments on Cabrera Gran and cannot enter the more structured areas of pine forest and Mediterranean vegetation.

Rocky shores are one of the most vulnerable environments to invasions. They are rich in endemic and endangered species and often have open structures that alien species can occupy. One of the most common species in the Balearic Islands is the African *Carpobrotus edulis*, an invasive alien species that is one of the most studied and was eradicated from the rocky coast north of Cabrera Gran. Its high invasive capacity requires persistence in eliminating specimens and surveying the Park's coastline.



Mesembryanthemum crystallinum, commonly known as the crystalline ice plant, is another example of an invasive species that has been controlled but not eradicated on the island of Conills. It is a lovely plant with succulent leaves covered with large crystalline papillae, giving it a frosted appearance. It has been found on some islets, such as the island of Conills, and its introduction is believed to be due to birdlife. It produces a potent seed bank (around 15,000 seeds per plant) that can survive up to two years. In Illa des Conills, it has been controlled manually and using herbicides. This location is checked annually.

Between 2006 and 2012, Tragsa made significant and intense efforts to eradicate the exotic flora in the Park. Apart from the aforementioned invasive species, the remaining exotic species had smaller, circumscribed populations, typically located in the inhabited areas of Cabrera Gran.

Subsequently, depending on available resources, the Park's staff pursued control and eradication work.

Main examples of eradication from 2008 to 2021 by Tragsa

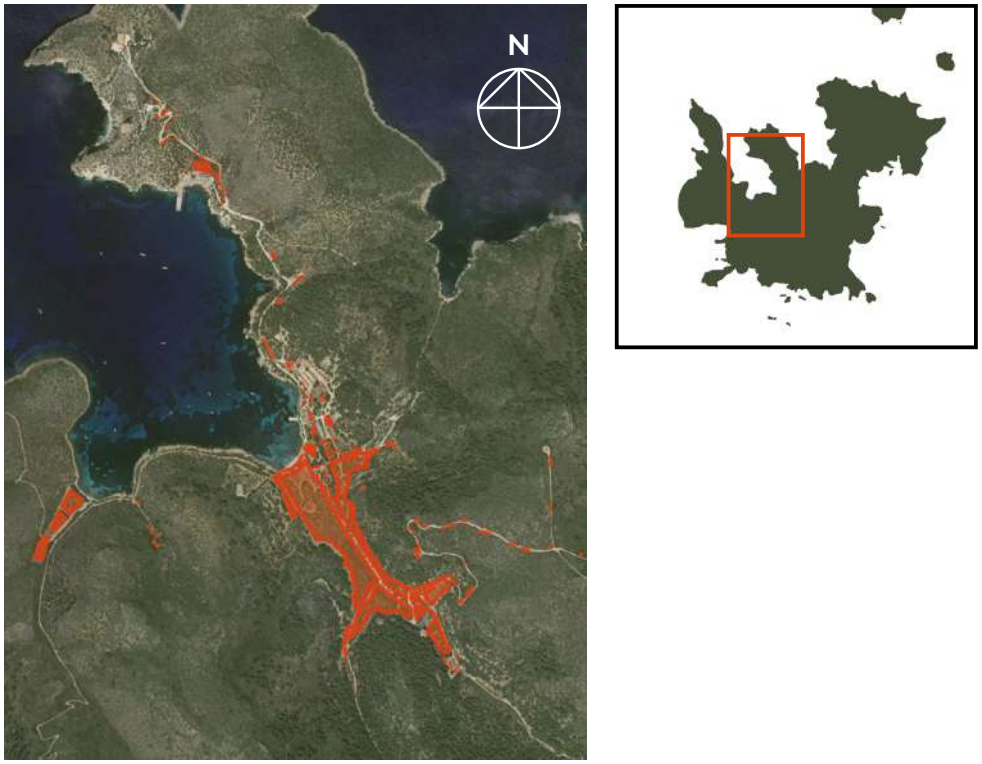
Species	Individuals eradicated	Controlling method	Area
Agave Americana	1,721 small individuals	Manual	Harbour and camping site
Nicotiana glauca	100	Manual and herbicide	Camping site and Guardia civil headquarters
Opuntia Maxima	898 small individuals	Manual	Harbour, camping site, Ensiola lighthouse, Guardia civil headquarters and Na Miranda. 1 individual in the islet Des Conills
Mesembryanthemum crystallinum	Countless	Manual continuous and herbicide	Illa des Conills
Carpobrotus edulis	47	Manual	Scattered locations along the coast of Cabrera. w/ focus on the coast between Sa Creueta and Cape Xoriguer, 1 individual in Conills and another in the Ses Rates island

Although the invasion rate of some species such as *Opuntia spp. or Agave spp.* might not be considered worrying, one should not forget that there are cases with a high risk of spreading to cliffs or rocky areas where control tasks are risky and costly. Therefore, even a single individual's escape may generate undesirable populations.

There are currently three invasive alien species with relatively large extensions that have not been eradicated in Cabrera National Park:

- *Oxalis pes- caprae* in former farming areas. No measures have been taken since 2012.
- *Mesembryanthemum crystallinum* in Illa des Conills. It is controlled every year.
- *Heliotropium curassavicum* in the harbour and beach area. It is controlled every year.

Six other less abundant invasive species, which occur sporadically and are monitored annually, are: *Nicotiana glauca, Opuntia sp., Conyza bonariensis, Datura inoxia, Ecbalium elaterium and Xantium spinosum.*



Cobertura Oxalis pes_caprae. December 2010
Illa de Cabrera

References:

BERRY, C., 1999. ATELK. ***Conservation Advisory Science*** *Notes No. 268, Department of Conservation, Wellington.*

Conservation of autochthonous flora in the National Park of the Archipelago of Cabrera from 2007 to 2012. *Tragsa*

GRAU, A.M., J.J. FORNÓS, G.MATEU, P.A.OLIVER I B.TERRASA (EDS). ***Arxipèlag de Cabrera. Històrtia Natural.*** *Mon. Soc. Hist. Nat. Balears, 30. 736 pp. Palma*

JONES,C., G. NORBURY AND T. BELL 2013***Impacts of introduced European hedgehogs on endemic skinks and weta in tussock grassland.*** *Wildlife Research.* http://dx.doi.org/10.1071/WR12164

TESTIMONIAL

Eva Moragues Botey

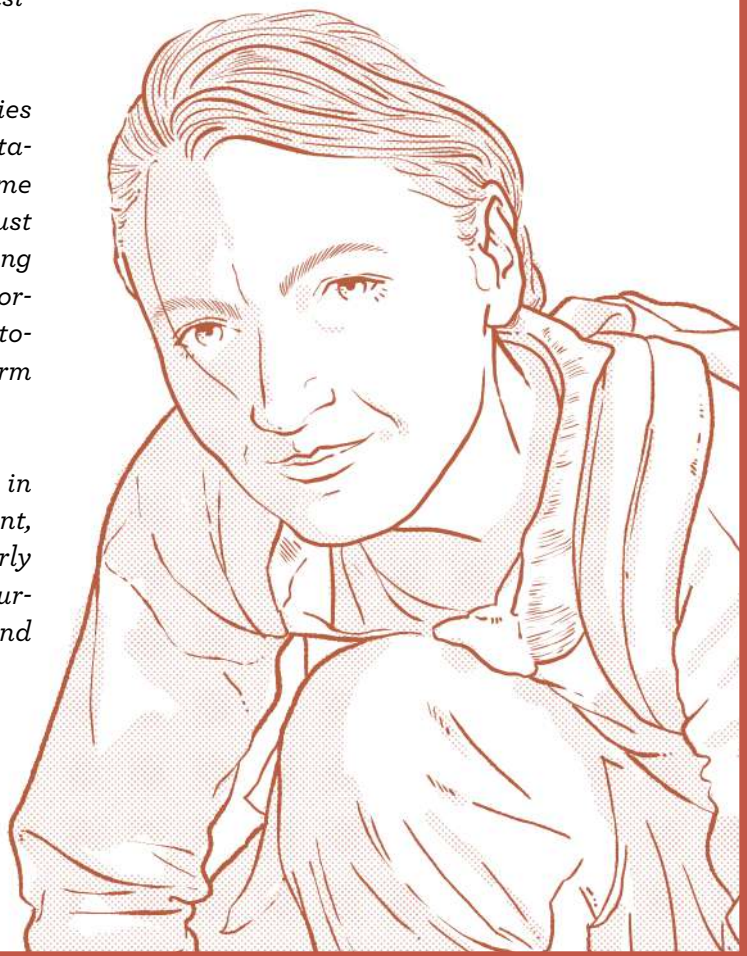
PhD in Biology, invasive flora specialist,
Head of biology conservation
in Cabrera National Park from 2020 to 2022

The isolation of the Cabrera archipelago and the stability of its plant communities means that the entry and establishment of invasive alien species are relatively low. Only one species is of particular concern, the Bermuda buttercup Oxalis pes caprae, which has succeeded in naturalising in the former cultivation areas of Cabrera Gran. The remaining invasive plants identified have settled in small, spontaneous populations in the few existing inhabited areas and some coastal areas.

Since the archipelago was classified as a National Park in 1991, different campaigns to control terrestrial invasive species have been carried out, fluctuating in intensity and frequency. Fortunately, Cabrera's intrinsic characteristics prevent the island's ecosystem from being particularly vulnerable to invasive plants despite the large number of visitors to the Park each year (with an average of approximately 55,843 visitors in 2021).

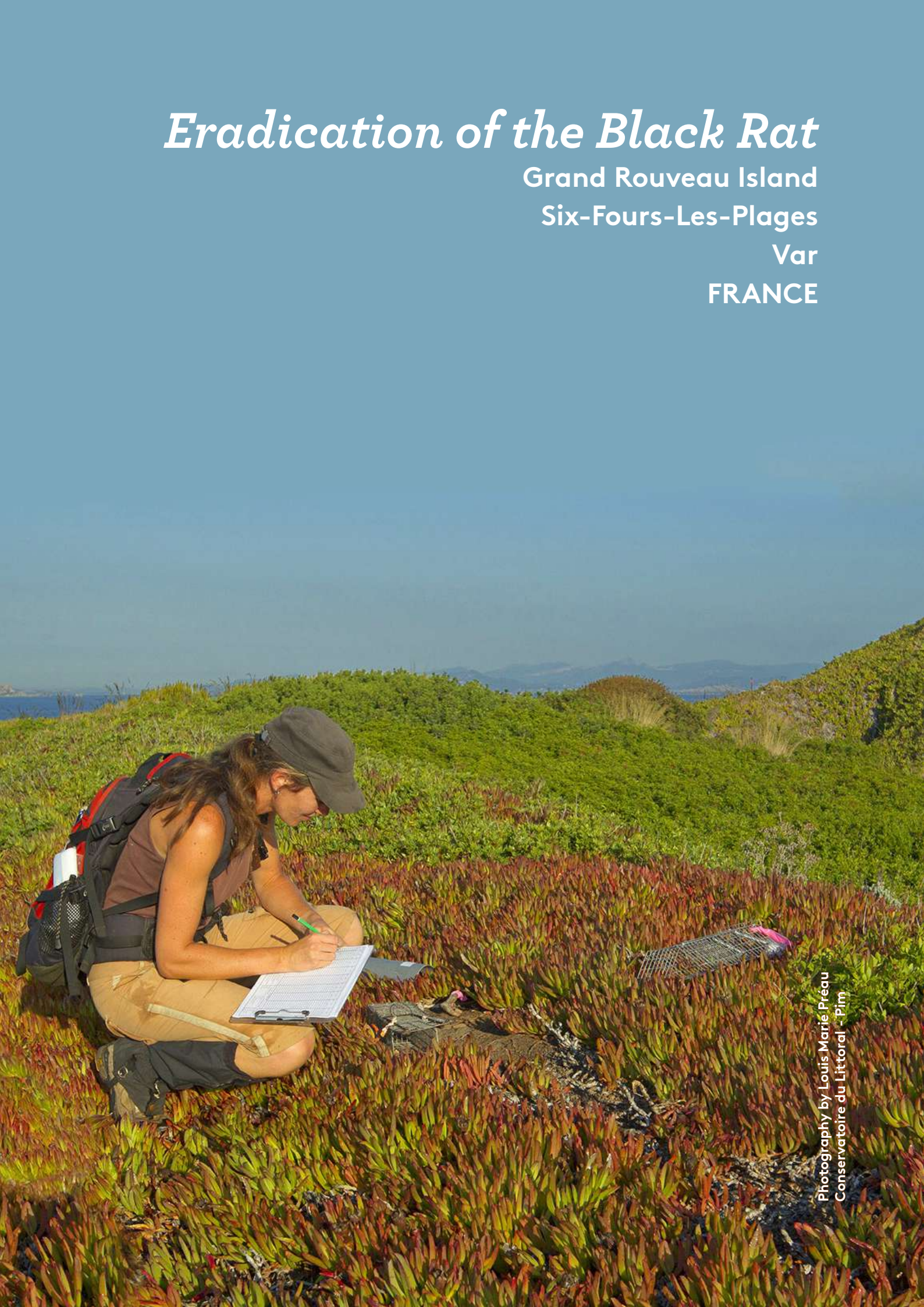
To achieve continuity in the control of invasive species and successful eradication, a technical implementation protocol that is easily reproducible over time is necessary. The biology of the alien species must be known beforehand, and an appropriate working method must be established. The methodology, working hours, and field staff must be planned, and up-to-date mapping must be carried out, backed by a firm implementation budget.

The arrival of new alien plants or propagules in Cabrera National Park is a one-off and isolated event, but it is also probable and challenging to avoid. Early detection should be reinforced through annual surveys of the most vulnerable areas and outreach and training of park staff.



Eradication of the Black Rat

Grand Rouveau Island
Six-Fours-Les-Plages
Var
FRANCE

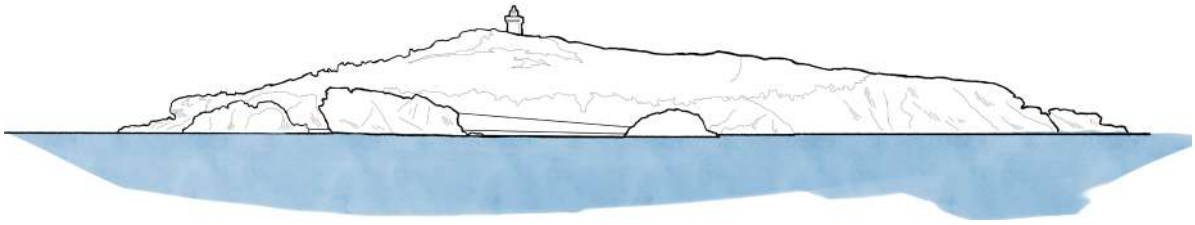


Photography by Louis Marie Préau
Conservatoire du Littoral - Pim

Grand Rouveau island

Embiez archipelago

Six-Fours-Les-Plages, FRANCE



Surface area: 6.45 ha
Altitude: 31 m

X Coord:43.080268
Y Coord:5.767686

Protected status: Property of the Conservatoire du Littoral; SPAMI (Special Protected Area of Mediterranean Importance), Natura 2000 site
Uninhabited island
Landing permitted

Biological challenges and sensitivity

SPECIES OF INTEREST

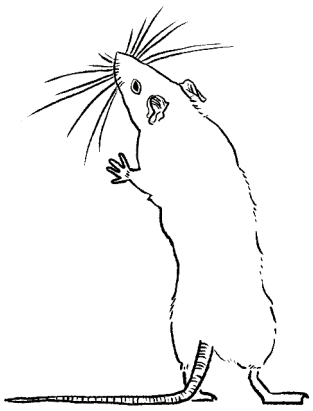
Presence of 7 local plant species and 5 protected species, of which 2 are perennial and visible year-round. Presence of an endemic nocturnal gecko: the European leaf-toed gecko, *Euleptes europaeus*.

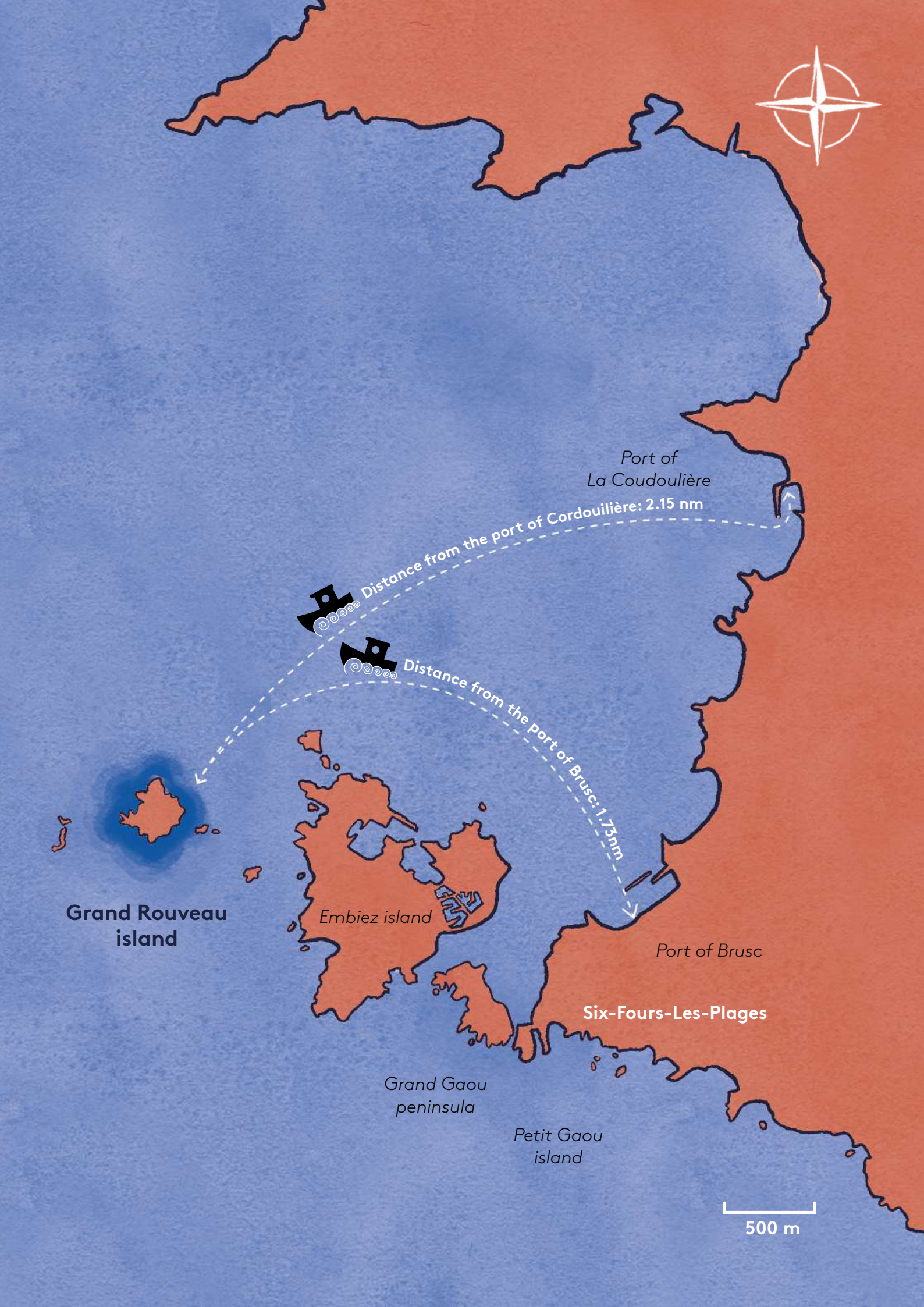
INVASIVE SPECIES

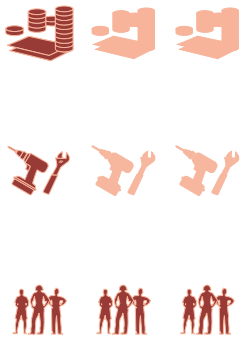
One invasive alien plant species:
Sour fig, *Carpobrotus edulis*, eradicated in 2016 and currently under observation.
Colony of Yellow-legged Gulls, *Larus michahellis*. Population of Black Rats, *Rattus rattus*: eradicated in 2018, currently under observation.

Characteristics of project working conditions

- Landing stage available
- No fresh water source on the island
- No electricity
- Absence of sanitary facilities
- Presence of gas-fuelled accommodation capable of hosting a team for several days




Port of
La Coudoulière
Distance from the port of Cordouilière: 2.15 nm
Distance from the port of Brusc: 1.73nm
Grand Rouveau
island
Embiez island
Port of Brusc
Six-Fours-Les-Plages
Grand Gaou
peninsula
Petit Gaou
island
500 m



Project Description

Project for the eradication of Invasive Alien Plant Species jointly led by the Conservatoire du Littoral and the site's owner, the town of Six-Fours-Les-Plages, with the technical and scientific support of the PIM Initiative for small Mediterranean islands and a company specialising in ecological engineering work (*AGIR écologique*). The operation covered the island of Petit Rouveau. The island also acts as an educational site for international training, thanks to funding from the French Global Environment Fund (French: *FFEM*) and the Agence de l'Eau Rhône Méditerranée-Corse.

10 July 2017 → **August 2018** → **August 2018 - 2028**

Start of trapping | End of chemical trapping | Monitoring

Main parameters considered for the implementation of the project

PROXIMITY TO THE MAINLAND

2.15 nm from the port of La Coudoulière, Six-Fours-Les-Plages. This makes it possible to transfer equipment and personnel without any major difficulty.

LANDING STAGE AVAILABLE

Unloading of personnel and equipment; possible to unload small machinery (mini-digger < 1.5t, motorised wheelbarrow)

OPEN TO THE PUBLIC

Potential risk of re-introduction of invasive species following completion of the operation

ACCOMMODATION AVAILABLE ON SITE

Autonomous operations possible over the course of several consecutive days (current max. capacity is 12 people).

ISLAND CAN BE TRAVERSED ON FOOT

Some fixtures required in order to enable access (ropes, lifelines) in particularly steep areas, following the opening of tracks through the vegetation.

"LOW-COST" APPROACH

Enables the operation to potentially be replicated on other island sites with limited budgets.

Operators:

City of Six-Fours-Les-Plages – Conservatoire du Littoral – AGIR écologique – PIM Initiative – Volunteers. Remote scientific assistance from the National Institute for Agricultural Research (INRA) in Rennes and A. Abiadh.

Selecting the appropriate intervention method

The methodology applied was the INRA protocol (National Institute for Agronomic Research, Rennes, France), which had already been used in several programs for the eradication of invasive species (on islands in Brittany and around Marseille, on the Lavezzi isles, island of Gabnière, island of Bagaud, etc.), and involves the combination of an initial phase of physical trapping followed by a chemical phase, poisonous baits enclosed in secrured boxes.

146

146 numbered stations were spread evenly across the entire island, containing rat traps with blocks of Bromadiolone (0.005%) and lengths of 20cm x D63mm PVC tubing, designed to serve as physical traps and containers for toxic bait, in a foldable model from Manufrance during the chemical eradication phase, laid out every 20 metres and in all directions (density = 24 traps / ha).

32

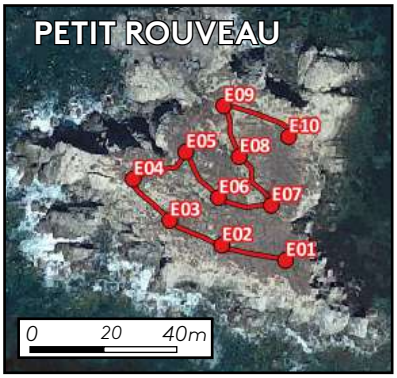
32 anti-reinfestation boxes were then spread out across strategic sectors (tips of the island, high-infestation zones and areas with dense vegetation) in order to avoid any re-emergence or the establishment of new breeding areas. These posts are intended to remain in place permanently.

4

These traps were spread out along 4 routes of around 1km each, thereby facilitating tracking, dividing the work into teams, and limiting the travel time between each station during inspections.

10

10 traps were installed on the island of Petit Rouveau (15 traps/ha). Compilation of a theoretical preliminary grid, with traps positioned according to possible access points for the terrain.
Traps identified using barrier tape.

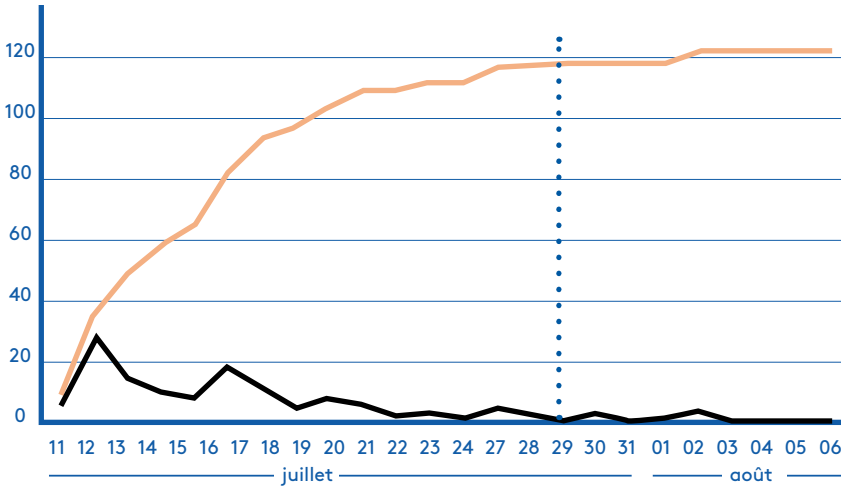


TRAPPING ROUTES

- *Route A*
- *Route B*
- *Route C*
- *Route D*
- *Route E*

Sources: AGIR écologique
Background: Bing
Compiled by: R. Grauer, AGIR écologique

Location of traps and routes
Islands of Grand Rouveau and Petit Rouveau



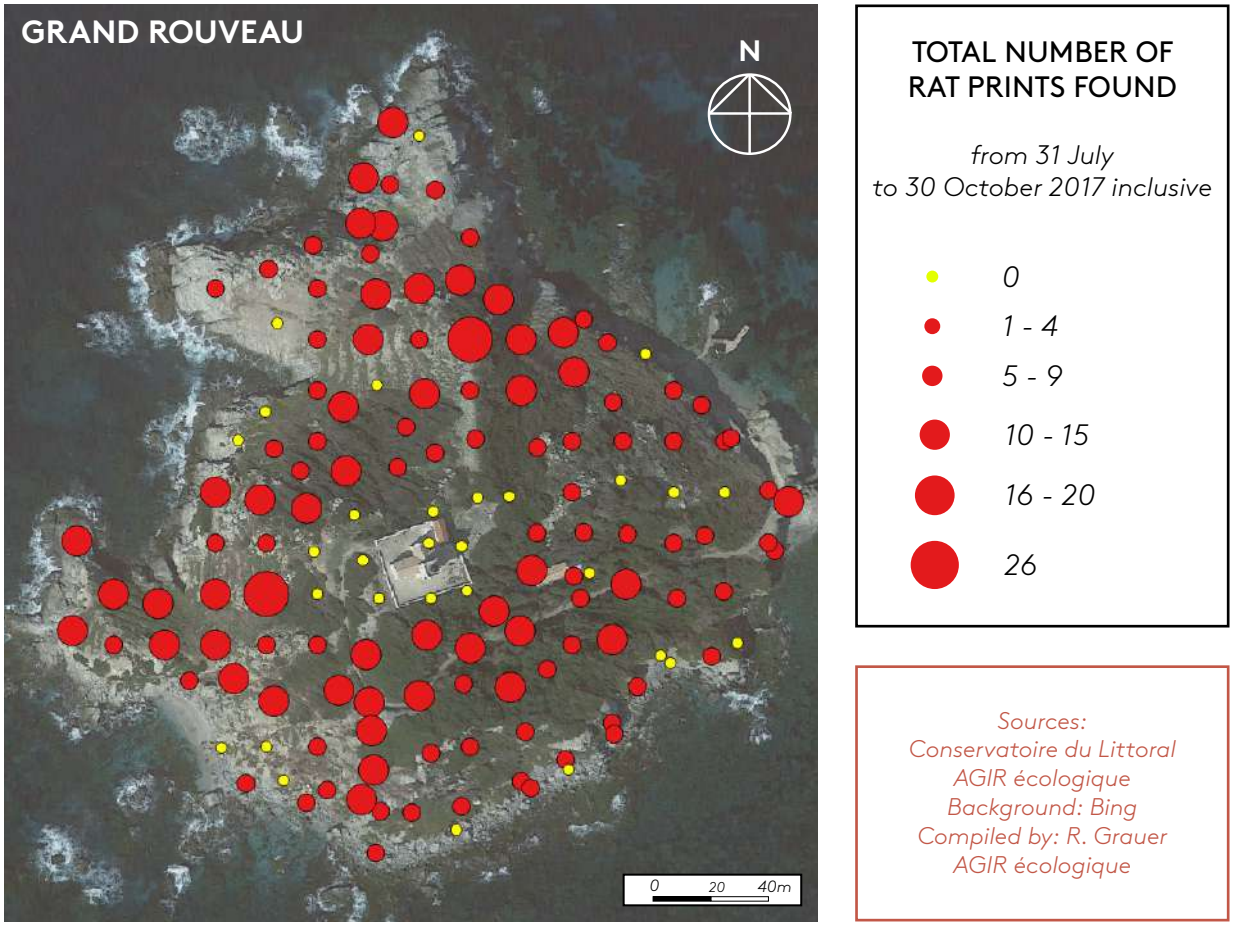
Number of captures

Number of captures (combined total)

Start of chemical phase

Once the trapping threshold has been met, the traps are removed and replaced by chemical bait.

Monitoring using mechanical traps



Distribution of evidence of rats found on toxic baits

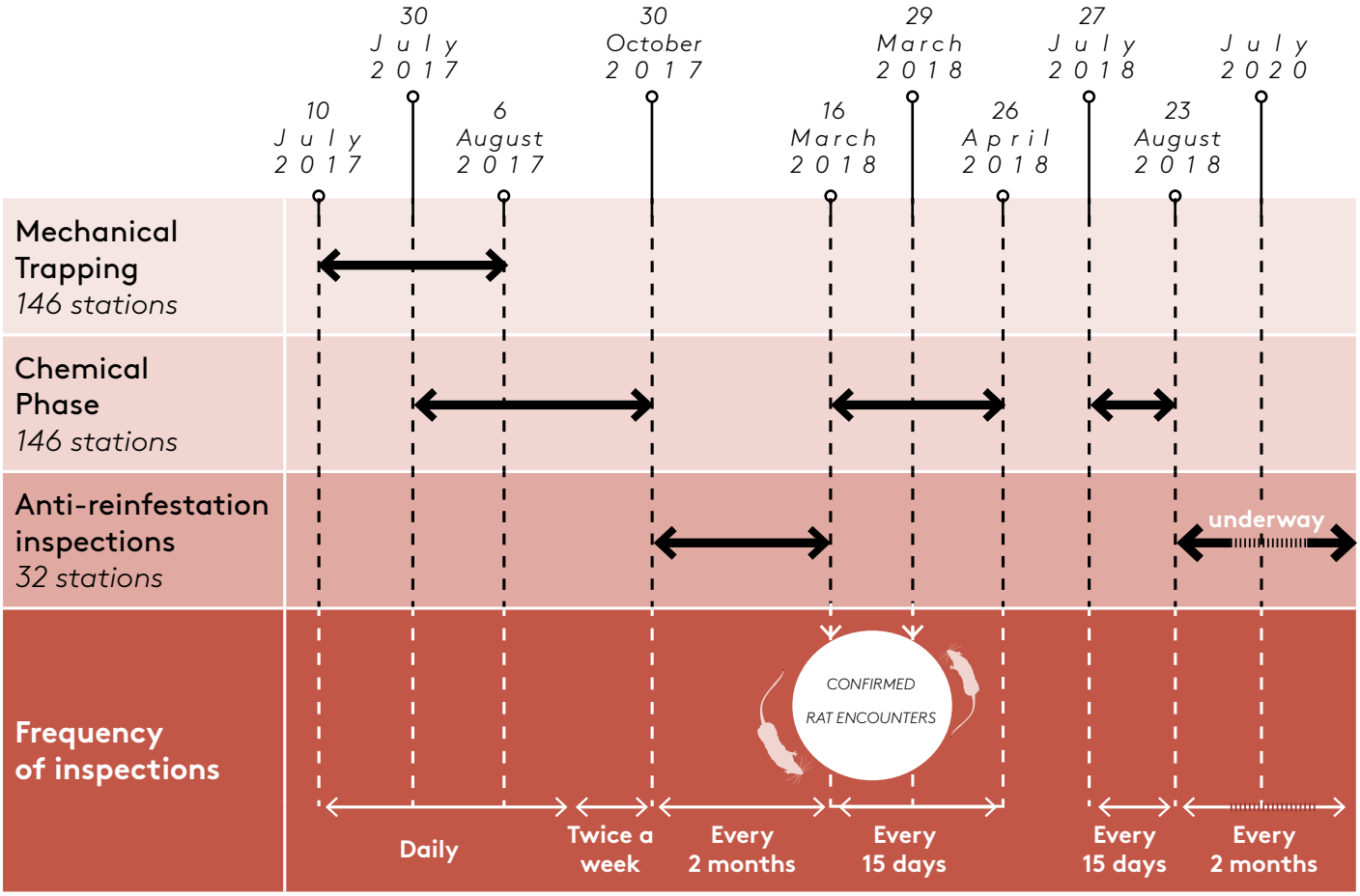
Duration of operation

The eradication process took place over 2 years, from 2017 - 2018, over several phases due to confirmed Black Rat contact in 2018. As of the time of writing (July 2020), the operation constituted 30 stations, likely extended to 60 stations using anti-reinfestation boxes to be monitored on a regular basis.

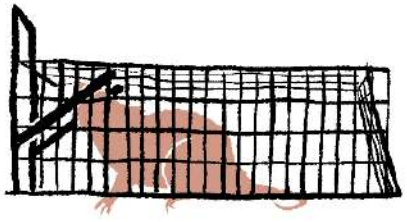
Specific characteristics of the project

Traps were inspected on a daily basis by alternating the mobilisation of ecologists from a service provider company (40% of man hours) and the mobilisation of agents of the Conservatoire du Littoral and the PIM initiative, accompanied by volunteers (60% of man hours) in order to limit labour costs.

A project to clear away sour fig plants was carried out prior to the rat eradication program, thereby severely limiting the availability of food and water resources for the rats during the summer period.



Mechanical trapping
Manufrance rat traps

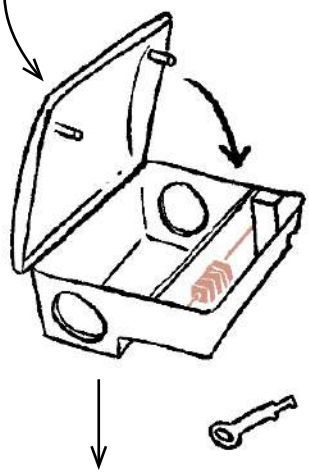


Bait:
peanut butter
+ oats
+ sardine oil

Chemical Phase
PVC tube

Bait:
Bromadiolone

Anti-reinfestation inspections
Beta-box



Bait:
Bromadiolone

Results

Success of the rat eradication operation on Petit Rouveau island	*29 July 2017*
Success of the rat eradication operation on Grand Rouveau island	*13 September 2018*
Black Rats captured and euthanised	*123*
Number of stations installed	*146 (Grand Rouveau island)* *+ 10 (Petit Rouveau island)*
Duration of installations	*26 days of mechanical trapping* *164 days (accumulated) of chemical trapping*
No. of people mobilised during the trapping phase	*44 (including 10 volunteers)*
Distance travelled over the island when setting up trap routes	*144 km*
Number of return journeys by sea between the port of La Coudoulière and Grand Rouveau	*55*
Distance travelled by sea	*235.5 nm travelled by boat*
Cost of labour	*€31,315 excl. tax divided across 79 man-days from service provider* *119 man-days (agents of organisations involved + volunteers)*
Cost of materials	*2017 costs:* *PVC tubing = €304.10 incl. tax* *Bromadiolone blocks = €677.55 incl. tax* *Beta box (40) = €373.50 incl. tax*

Critique of the method

Several difficulties were encountered during the implementation of this protocol:

- Mobilising the teams responsible for the inspection of traps over the long term can be complex, notably when these inspections no longer require workers to stay on the island for several consecutive days.
- Despite the feedback provided, it has not been possible to precisely adjust the man-hours needed to carry out an operation of this sort. Whenever significant amounts of bait are consumed during a session, it is necessary to bring the sessions closer together in order to replace them.
- Vegetation can offer rats an alternative food source, making the bait less attractive – especially in sectors where the vegetation is dense.

The mobilisation of volunteers is largely facilitated by several factors:

- Working time of one morning per person once two people are mobilised (the volunteer may use the rest of the day as they please).
- Taking advantage of the summer period makes it possible to solicit volunteers when they are more available.

However, while this solution offers a number of advantages, it also requires a significant logistical and transport framework.

TESTIMONIAL

Awatef Abiadh

Expert specialising in Invasive Species, employed by the Bird Protection League, Member of the Regional team for CEPF projects in North Africa

While the eradication of Black Rats on islands is becoming more and more straightforward to implement, its success remains dependent on several climate and operational factors. The island of Grand Rouveau benefitted from a campaign to eradicate the Black Rat in 2017, but monthly checks showed that rats were still present in 2018. In theory, a single pregnant female could repopulate the island.

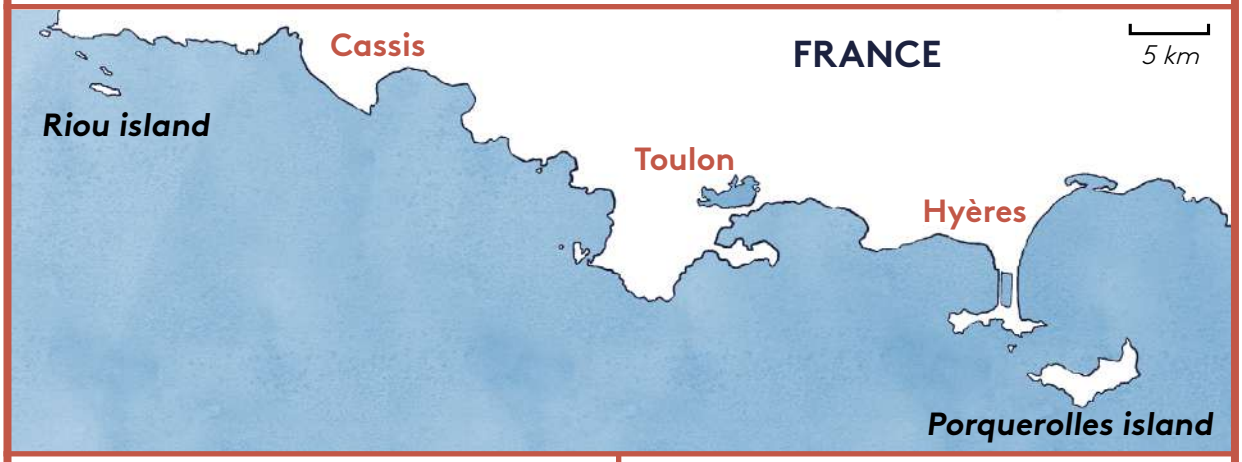
This was due either to a failure of eradication, or a reintroduction of the species via boat or from another infested site. Analyses of the genetic pool is the only effective method for determining the cause of a recolonization. The implementation of eradication campaigns using the combined method usually occurs during the season in which the rats face food shortages, which coincides with a drop in birth rates. On the island of Grand Rouveau and elsewhere in the Mediterranean basin, summer is the ideal season for this. Nevertheless, in certain areas on Grand Rouveau one can find bushes providing an additional source of food year-round.

I believe this is a limiting factor in terms of directing the rats toward the bait kept in both mechanical and chemical traps. It is likely that the chemical phase should have been extended over a longer period, in order to counterbalance the attractiveness of the food resources offered by the island's shrubs.

Regulation of Black Rat populations

Case studies on the islands of Porquerolles and Riou

With contributions from Peggy Fournial (Port-Cros National Park) and Jean-Patrick Durand (Calanques National Park)



Porquerolles

Archipelago of Hyères islands
Var

X Coord: 43,00095
Y Coord: 6,21304
Surface area: 1278ha
Distance from main island:
5.15 nm (Port-Cros)
Distance from mainland: 1.46 nm

Riou

Riou Archipelago
Bouches-du-Rhône

X Coord: 43,17638
Y Coord: 5.385431
Surface area: 89.85 ha
Distance from main island:
2.26 nm (Maïre)
Distance from mainland: 1.71 nm

Biological issues

SPECIES OF INTEREST

Presence of colonies of Scopoli's Shearwater (between 26 and 89 couples), and Yelkouan Shearwater (36 - 79 couples)

INVASIVE SPECIES IN HYÈRES

Presence of the Black Rat and feral cat

INVASIVE SPECIES IN RIOU

Presence of the Black Rat and European rabbit

The islands of Riou (Riou archipelago, Marseille, lying within the Calanques National Park) and Porquerolles (îles d'Or archipelago, Hyères, lying within the Port-Cros National Park), play a major role in the conservation of Procellariidae species, as these islands are home to large colonies of Scopoli's Shearwaters and Yelkouan Shearwaters. The Calanques and Port-Cros national parks therefore have a major responsibility in terms of local conservation of nesting sites for marine bird populations.
The presence of Black Rats (*Rattus rattus*) on these islands has a negative effect on the reproductive success of Shearwater colonies. For various reasons, however, efforts to eradicate the Black Rat on Riou and Porquerolloes have been difficult to implement (c.f. explanations in the table below), and in order to mitigate the rats' negative impact, population control campaigns have been undertaken during the Shearwater mating season (from February to the end of August).

What does rat population control involve?

In cases where full eradication of rats is not possible, trapping operations performed around protected bird colonies helps limit predation by Black Rats during the reproductive cycle. Mechanical trapping requires daily checking of the traps, and is therefore very costly in terms of man-hours. Chemical traps may be set around the colonies, in which case the bait must be changed regularly (once every week or 15 days depending on the time available and/or other missions underway). With chemical trapping, however, it is impossible to estimate the number of rats dispatched via this technique.

Installation of automatic traps on Porquerolles

When should inspections be carried out?

Population control should be carried out mainly during the Shearwater mating period, which runs from March - September. On Riou, trapping was halted in mid-August, by which time the Shearwaters had grown big enough to defend themselves from rat attacks. Regular trapping operations performed throughout the duration of the mating season would be ideal, but in order to alleviate the pressure of trapping and avoid excess human presence around mating sites, specific periods could be selected (such as the search for nesting sites, followed by the periods of laying, hatching, brooding and feeding of chicks).

How is trapping carried out?

- Lay at least twenty traps per colony, for at least 4-5 nights (ideally this action should be carried out across several colonies)
  Set traps at a reasonable distance from the Shearwater burrow, neither too close nor too far from their landing areas.
- Attempt to standardise the trapping protocol on an annual basis (maintaining the same stations, same number of traps and same type of bait) in order to enable data modelling.
- Lay the traps with bait, and switch out the bait regularly (in order to ensure they remain attractive).
- Check the traps every day if using mechanical traps Re-lay and re-bait the traps preferably in the late afternoon, in order to avoid capturing undesired diurnal prey.

N.B.
Never leave rat corpses in the area, as they will attract other predators (cats, rats, hedgehogs)

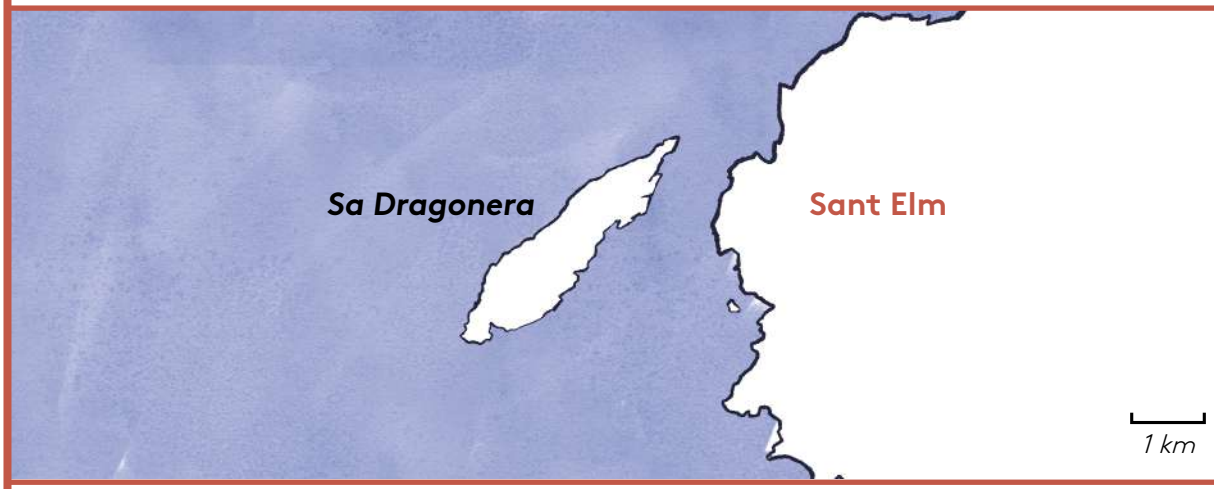
	Porquerolles	Riou
Why not attempt full eradication?	Large surface area, significant human population, presence of feral cats, high levels of maritime traffic.	Large island surface area + escarpments The possibility of eradication by helicopter was studied by the Calanques National Park, following on from rat eradication programs on several small islands in the archipelago between 1995 and 2012.
Trapping period for population control	Up until 2019, mechanical trapping every day from March - September	Mechanical trapping since 2004 Today, chemical trapping only is used around colonies of the two Shearwater species, from February to the end of August.
Number of traps	20 traps/colony	Between 1 and 6 boxes per colony. 60 in total across the island
Total number of colonies monitored	4	21
Results	No positive impact indicated on the rate of Shearwater reproduction (numbers monitored every year)	Shearwater reproduction rates have increased since the onset of efforts to control the rat population. **Start of trapping in 2004:** reproduction rates rose from 0.25 young per couple in 2003 to 0.65 young per couple in 2004 and 0.75 young per couple in 2005. Reproduction rates on Riou are now comparable to those on islands where rats have been eradicated. (Between 0.8 and 0.9 y/cple on average for Scopoli's Shearwaters. Around 0.5 on average for Yelkouan Shearwaters).
Man hours	Highly costly in man-hours	Around 40 man-days per year for experienced agents Around 80 man-days per year for inexperienced agents

What about other islands?

Control of rat populations using mechanical traps positioned around the colonies was carried out during the mating season (around a hundred traps) on the islands of Pomègues and Ratonneau (Frioul archipelago, Marseille). Rat populations appear to be fairly sparse on these islands, and given the low rates of capture achieved by mechanical traps on these islands and the man-hours required to set them, it could be beneficial to install independently functioning traps like the ones tested on Porquerolles, for example. Once laid, these traps can function automatically up to 24 times, and do not contain any poison.

Aerial rat extermination in Sa Dragonera

With the contribution of Joan Mayol, Biologist, Head of technical nature conservation in the Balearic Islands from 1981 to 2019, and president of the PIM initiative



Sa Dragonera

Mallorca

Autonomous Community of the Balearic Islands

Coord X: 39,5844

Coord Y: 1,19726

Surface area: 288 ha

Distance from the main island: 0.8 km (Mallorca)

Protection status: Natural Park

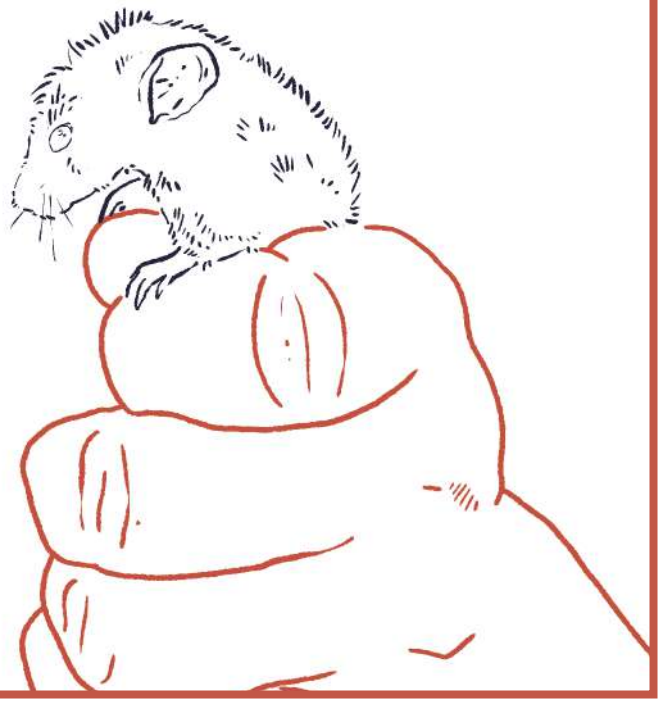
Biological data

Sa Dragonera has not undergone significant transformations over time, which were limited to farming a small part of the island, the adaptation of one of the coves in the 19th century to accommodate a harbour with several small buildings, the construction of three lighthouses (one of which has been abandoned), and forestry exploitation in the past. The island flora includes 361 species, 23 endemic to the Balearic Islands. It is home to important colonies of seabirds (Yellow-legged Gull, Audouin's Gull, Balearic shearwater, Cory's Shearwater, Tufted Cormorant, Eleonora's falcon and, in the past, European Storm Petrel, a species incompatible with the presence of rats). Pantaleu (neighbouring island) is home to a significant colony of Cory's shearwater.

Invasive species

Sa Dragonera was used for livestock farming of bighorn goats—which were exterminated by promoters to improve wild vegetation—and pigs—until they were purchased by the Consell (1987)—which preyed on the seabird nests they could reach (mainly seagulls). The invasive species with the most significant impact are black rats (*Rattus rattus*), house mice (*Mus musculus*) and rabbits (*Oryctolagus cunniculus*). Black rats have an overall impact on plants and fauna, which is less significant for mice, and rabbits have an occasional erosive effect on their environment.

The presence of invasive flora is limited. Some alien species grow near the harbour and farming areas, but most have not extended beyond the inhabited areas. Only a few species (see measures) have been deemed hazardous, and measures were taken to contain or eradicate them.



Purpose of the intervention

Sa Dragonera had a dense population of black rats (*Rattus rattus*), resulting, among other impacts, in the annual loss of all the Balearic shearwater (*Puffinus mauretanicus*) clutches on the islet. No specific information exists on the species' introduction period to Sa Dragonera. However, evidence suggests a relatively recent population: in the 14th century, a lease agreement was concluded to harvest palm hearts (more than 5,600 kg in 1373). This species is now abundant on the immediate Mallorcan coast but very rare on Sa Dragonera, where only a few trees have been found on the cliffs. As a result of rat extermination measures, the fan palm is again thriving throughout the island. Rat predation caused the palm's recent scarcity (it should be noted that rodents on small islands without mammalian predators proliferate in high density). Since the area was declared a National Park, rat density (except in the months following control campaigns) was so high that they seriously impacted the vegetation. They even ate tree barks and bushes and were seen scurrying around the reception centre in broad daylight, with all the health hazards this entails.

Since the area was declared a National Park, six conventional rat extermination campaigns have been carried out, using baits designed to keep lizards from accessing the rodenticide. However, the results were short-lived, and whenever the campaigns were interrupted, rat density rapidly increased within a few months, up to 50 rats per ha. Difenacoum and Bromadiolone and campaigns with five bait replenishments were used. Even before the area became a National Park, the company that planned the island's urban development carried out a massive rat extermination operation using poison without baits. The operation was unsuccessful (B. Trobat, c.p.).

Given Sa Dragonera's size and relief, the only alternative was to resort to aerial rodenticide dispersion. Such campaigns had been successfully carried out on many Pacific islands and, in 2008, on the Sardinian island of Molara (Tavolara Marine Protected Area), whose managers provided us with the helicopter-borne diffuser and their own technical experience during a PIM meeting.

Regulatory framework

Sa Dragonera Natural Park Management Plan 2008/2013. The project of extermination by free dispersion of rodenticide was submitted to the governing board (management advisory body), which accepted it unanimously (minutes 28.04.09).

Particularities and challenges

As this was the first rat extermination operation using free aerial dispersion of rodenticide, there was some resistance, unfortunately not only on a technical level: a bureaucratic boycott was attempted, and the action was politicised through specific actions in the **Parliament of the Balearic Islands** and a complaint to the Environmental Prosecutor's Office, which fortunately was unsuccessful. Counselor Vicens (a biologist by education) gave the project a definitive boost.

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Determinant factors

The project was feasible thanks to the availability of the dispersion tank. The operation had to be carried out with one of the Regional Ministry's fire helicopters, which had no GPS. Hence, a team of staff members marked the paths with flags as they moved between previously designated points on the land, defining 40-meter-wide bands. A technical team on the ground completed the dispersion operation inside buildings or in areas that were unreachable by air.

Brodifacoum pellets were used as the selected toxicant at a concentration of 0.005%, with 14.02 kg/ha doses, to achieve at least one lethal dose per 100 m2. The company that had successfully prepared the pellets in Italy was commissioned to manufacture pellets of a size and consistency suitable for aerial dispersion.

Before application, hangar and outdoor tests were conducted at the airfield to verify dispersion accuracy.The ground team (signallers, persons in charge of the hopper loaders, coordinators, etc.) was prepared and trained. General and group protocols and dispersion verification protocols were drafted. The rodenticide (9 MT) was transported to the island beforehand to facilitate the successive loading manoeuvres.

Temporary enclosures had been planned to keep groups of 200 lizards safe from the application, but this was deemed unnecessary, as specimens had previously been kept for several months in terrariums with samples of rat pellets, which neither attracted the reptiles nor had any effect on them if they licked them or ingested small quantities.

The helicopter and bait disperser in Sa Dragonera

Operation progress

The first application was conducted on 13 January 2011 under optimal weather conditions (no wind, no rain forecast for the following days). The helicopter dispersed its first load at 9 AM and finished (with 16 loads) shortly after 12h30 PM.

A second, similar application was carried out on February 8, reversing the direction of the flights for optimal coverage.

Verifications were done to ensure that the rodenticide reached 96% of the surface. The gaps were subsequently filled using manual dispersion.

- All in all, the operation used seven helicopter hours. Other operation costs included:
- Rodenticide: €15,515
- Technical assistance: €6,000
- Miscellaneous equipment: €4,000

It is worth noting that the operation staff was from the administration (Conselleria de Medi Ambient, Consell de Mallorca, Consorci per a la Recuperació de Fauna de les Illes Balears—COFIB) with the support of the company Skua. These specialised consultants oversaw the operation's preparation and development (technical assistance). In addition, two Italian technicians with experience from the Molara case supported the field operation. Overall, 30 field days were invested for the preparatory phase and 33 people/days for application (including the helicopter crew). Office preparation work was not quantified but was significant.

Subsequently, an operation was set up to remove yellow-legged gulls, which were indirect victims of the operation (400 to 700 birds out of a colony of 5,000 couples). The yellow-legged gull population at Sa Dragonera was considered excessive (in fact, it had been the subject of repeated culling campaigns in previous years), so this collateral damage was not regarded as relevant. Successive surveys in the field and the immediate marine area did not show any other species affected by the campaign.

Results

The results were optimal: rats, mice and rabbits disappeared from the island. The camera trap campaigns and trace detection devices indicated the presence of only one rabbit, which probably disappeared after being caught in a localised rabbit trap.

Spontaneous colonisation from Mallorca (800 metres separation, with high currents in the channel) is highly unlikely.
A biosecurity protocol was designed, but its implementation was partial: information to vessels using the harbour, baits maintained indefinitely at landing points, and field attention to possible signs of presence (no detection up to now).

In 2010 (before the extermination campaign), less than ten identified Balearic Shearwater nests were outside the cliffs of Sa Dragonera, and every year, rats killed all their clutches or chicks. In 2022, 22 occupied nests were identified in various control areas, and mating productivity was usual for the species. This suggests there may be as many as 200 nests in the non-cliff area of the island.

Monitoring of the endemic lizard showed a slight decrease in the year following the rat extermination operation, followed by a significant increase in the number of individuals in the following seasons. (L.Santamaria, c.p.). An increase in invertebrates has also been detected: endemic molluscs that were hardly visible before the project are now observed more often.

Information poster concerning the operation,
which stayed up for several months on the island

Description of the monitoring system

In the case of Sa Dragonera, it was vital to check in the weeks following the extermination operation for possible survivors, as these could represent a recolonisation. Two systems were used to this end: camera traps placed in specific locations and a more extensive network of small tracking 'tunnels' consisting of 50 cm long weather-resistant quadrangular tubes, with a strip of ink-impregnated paper on the lower inner side, to record the traces of any animal passing through, with small portions of odorant food to attract the animals. In addition to three camera traps, one hundred tracking traps were set out. Only the first of these devices was successful, and a rabbit was detected; the area was then fenced to eliminate it, which was apparently successful.

References:

MAYOL, M. ET AL. SA***Dragonera, la mayor isla mediterránea (probablemente) libre de ratas.*** *Quercus 314: 26-33*

MAYOL, J. ET AL , 2012 ***Aerial broadcast of rodenticide on the island of Sa Dragonera (Balearic islands, Spain). A promising rodent eradication experience on a Mediterranean island.*** *Aliens, 32: 29-32*

ORDINAS, G. I A.REYNÉS (COORD) 1996. ***Sa Dragonera Parc Natural.*** *Consell Insular de Mallorca. 139 pp.*

TRAVESSET, A. ET AL. 2009 ***A review on the effects of alien rodents in the Balearic (Western Mediterranean Sea) and Canary (Eastern Atlantic Ocean).*** *Biological invasions 11(7) 1653-1670.*

TESTIMONIAL

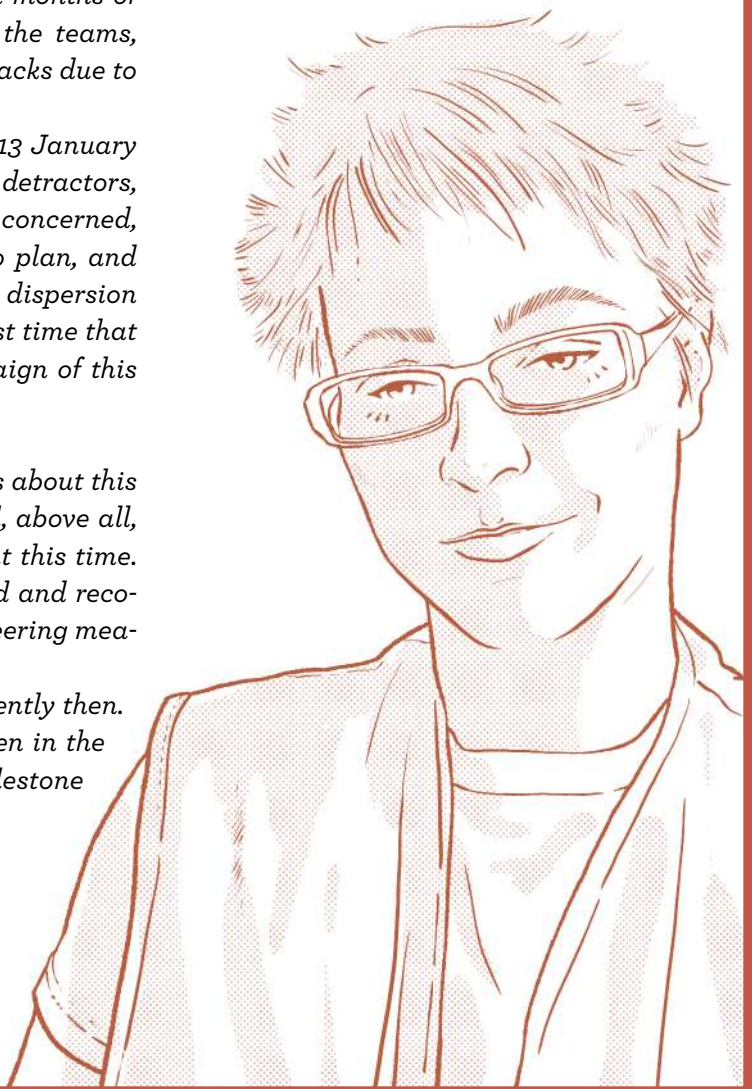
Ana Rodríguez

Biologist involved in the project and its preparation at SKUA, SL, Environmental Studies Bureau

The successful operation at Sa Dragonera marked the culmination of years of work, study, and conviction that rat extermination was possible. It was a rocky road, first with costly and ineffective baiting campaigns. The leap to using rodenticides in the environment yielded magnificent results on the islands and islets of Mallorca and the Cabrera archipelago. However, the challenge was still the larger islands; for this, land-based means alone were not enough.

Thanks to a trip to New Zealand, a world reference in island rat extermination, my friend and partner at Skua, Miguel McMinn, laid the foundations for what would become the rat extermination project in the Natural Park of Sa Dragonera using aerial dispersion. The project involved months of preparation and training, coordination between the teams, including international teams, hard work and setbacks due to last-minute issues with the dispersion tank.
Finally, the day came. We were pretty nervous on 13 January 2011; it was a significant campaign with several detractors, but there was also confidence and, as far as I am concerned, a lot of excitement. Everything went according to plan, and two hours later, we had achieved a homogenous dispersion of rodenticide throughout the island. It was the first time that Spain had carried out a rat extermination campaign of this kind.

It has been 11 years, and now I have mixed feelings about this campaign. I am delighted with the work done and, above all, with the results obtained and achieved throughout this time. Yet, I feel that the operation was not disseminated and recognised as it deserved, although it had been a pioneering measure in the Balearic Islands and Spain.
Many things could have been done better or differently then. Still, it was time to take risks, and I hope that, even in the future, this campaign will be remembered as a milestone in conserving the Balearic Islands' biodiversity.



Evolution of deratisation methods in the french islands

With the collaboration of Louis Dutouquet
HELP Sarl - Histoire, Environnement, Littoral Patrmoine

Accidentally introduced mammals, including rats, have a significant impact on native animal species, particularly land and sea birds, reptiles and small mammals. They are considered to be the second cause of biodiversity loss after habitat destruction. The 3 rat species (Black Rat, Pacific rat and Norway rat) are considered to be the introduced species with the greatest impact on island ecosystems.

Indeed, due to their geographical isolation and their generally limited surface area, they are home to a low diversity of animal and plant species. They are characterised by a short food chain, generally lacking in predators, and have a high rate of endemism. They are therefore particularly vulnerable to the introduction of exogenous species.

In addition to its significant impact on native fauna, the Black Rat can also represent a health risk as it is a reservoir and vector of diseases (viral lymphocytic chorio-meningitis (VLMC), Sodoku), which can be transmitted by bite but also by excrement and urine. Finally, on inhabited islands, the rat causes damage to property, infrastructure and food items, the cost of which is sometimes not negligible for the community (power supplies, pipes, woodwork, etc.).

The first eradication on the French islands

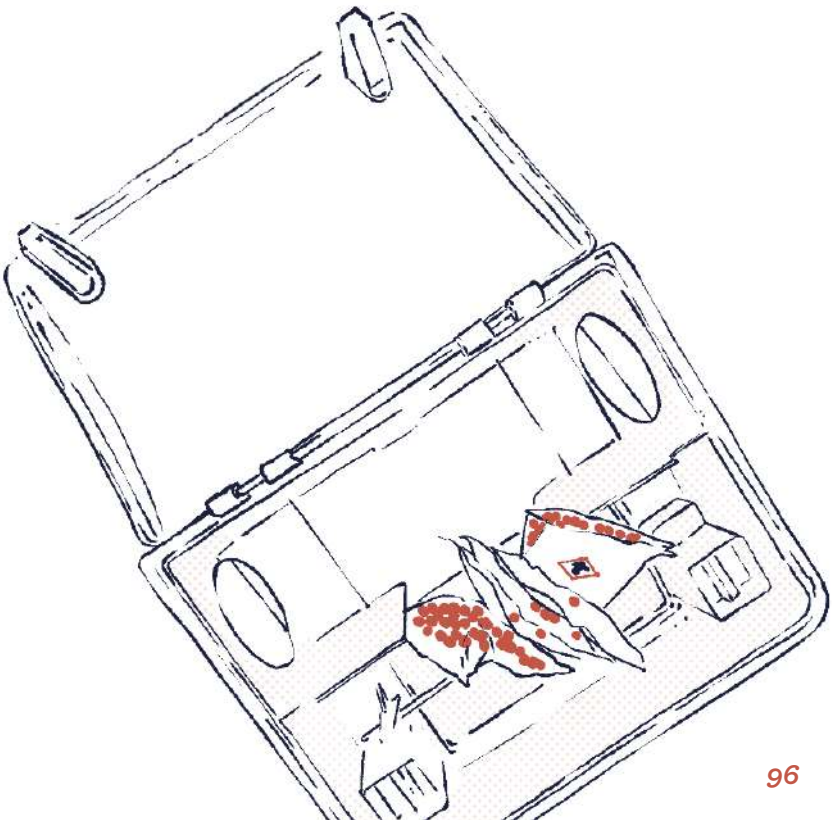
This is why in France, from the 1990s onwards, eradications of Muridae were attempted mainly on uninhabited islets with the declared aim of protecting island biodiversity. Thus, two significant operations were carried out on the Sept-Iles (Perros-Guirec, Côtes d'Armor) in 1994 and on the Trielen and Chrétiens islands (Molène Island, Finistère) in 1996. These operations were conducted under a protocol initiated by the SCRIBE station (Station Commune de Recherches en Ichtyophysiologie, Biodiversité et Environnement) of the Institut National de Recherches Agronomiques (INRA) in Rennes, which has now become the Institut National de Recherche pour l'Agriculture, l'Alimentation et l'Environnement (INRAE), UMR ESE (Écologie et Santé des Écosystèmes de la source à l'océan), team EPIX (Écologie évolutive des perturbations liées aux invasions biologiques et aux xénobiotiques). This protocol successively combines mechanical trapping, carried out using non-vulnerable mechanical dobbies, and chemical control, carried out using anti-coagulant baits placed in the middle of PVC tubes. In the years 2000-2010, this protocol was successfully applied on many Brittany islands under the aegis of the Conservatoire du Littoral in partnership with INRAE in Rennes (Tomé Island, Ile aux chevaux, Trébéron Island, Ile des Morts, Herpin Rock, etc.) and also on two Tunisian islets (Zembretta and Zembrettina).

Adaptation of the protocol in inhabited islands

More recently, eradication projects have been initiated on inhabited Britanny islands. The permanent human occupation of these territories required the adaptation of the eradication protocol used until then. **Indeed, the presence of children, elderly people and domestic animals on these sites did not allow the use of mechanical traps for obvious safety reasons of the inhabitants and to limit the risks of accidents.**

This is why in 2017, an adaptation of the protocol was proposed by HELP Sarl under the cover of scientific expertise of INRAE in Rennes. In 2018, it was successfully tested in Brittany on the island of Molène and its lédénez (120 permanent inhabitants, 90 hectares, 1220 baiting stations) then in 2019 on the island of Hoëdic (100 permanent inhabitants, 230 hectares, 3400 baiting stations). Since then, it has been successfully reproduced on numerous island sites along the Channel-Atlantic coast (Banc de Bilho, Vierge Island, Archipelago of Chausey) and overseas (Chancel islet in Martinique).

This protocol uses exclusively chemical control. The anti-coagulant baits are no longer placed in PVC tubes but in secure (because locked) baiting stations with a 55 mm diameter hole at each end allowing the passage of a rat but not larger animals. The use of secured bait stations greatly reduces the risk of toxic release into the environment and the consumption of bait by non-target species. For added safety, the bait is skewered inside the bait station, forcing the rodent to consume the bait inside the station, thus limiting its release into the surrounding natural environment. The island is gridded with baiting stations in a 20/25 metre grid. Each station is numbered, and its geographical position is recorded using a metric precision GPS. The posts are then checked every day by experienced agents who hold the trapper's licence and the certibiocide, a certificate required for the use of anti-coagulants in a professional environment. During each control, the agent records the bait consumption for each station. These daily data are then recorded in an Excel spreadsheet and processed by a Geographic Information System to produce a map showing the distribution of bait consumption for each control. This set of maps allows the evolution of bait consumption to be monitored diachronically as the operation proceeds, and thus the presence and relative abundance of the rodent on the treated site are monitored indirectly.

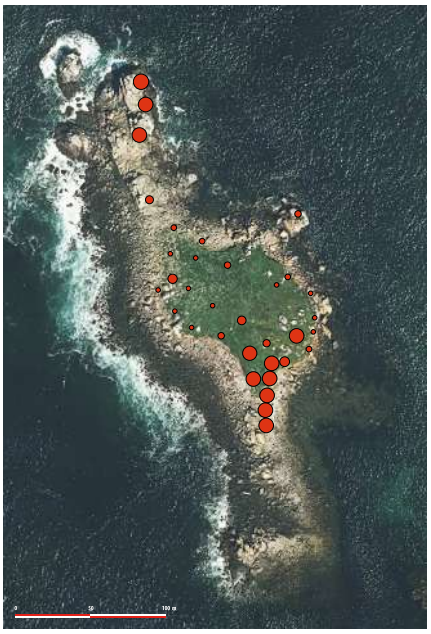


View of the inside of a bait station stocked with bait skewers

11/02/2019

12/02/2019

13/02/2019



14/02/2019

CONSUMPTION

- *5*
- *10*
- *15*

Source:
BD Ortho IGN (29)
Data source:
HELP Sarl
Cartography :
I. Delacourte
LittoMatique

Diachronic evolution of bait consumption by the Norway rat on Vierge Island Plouguerneau, Finistère

In addition to monitoring consumption, the presence/absence of rodents is also assessed using a set of infrared cameras deployed at various strategic locations on the site to be treated. This device helps to:

- Validate the presence/absence of the target species on the entire site.
- Identify whether the bait is being consumed by the target species.
- Discover possible non-target species unknown on the site.
- Gain information, often unprecedented, about the rate and type of rodent activity.
- Evaluate the interaction between non-target species and the baiting device.

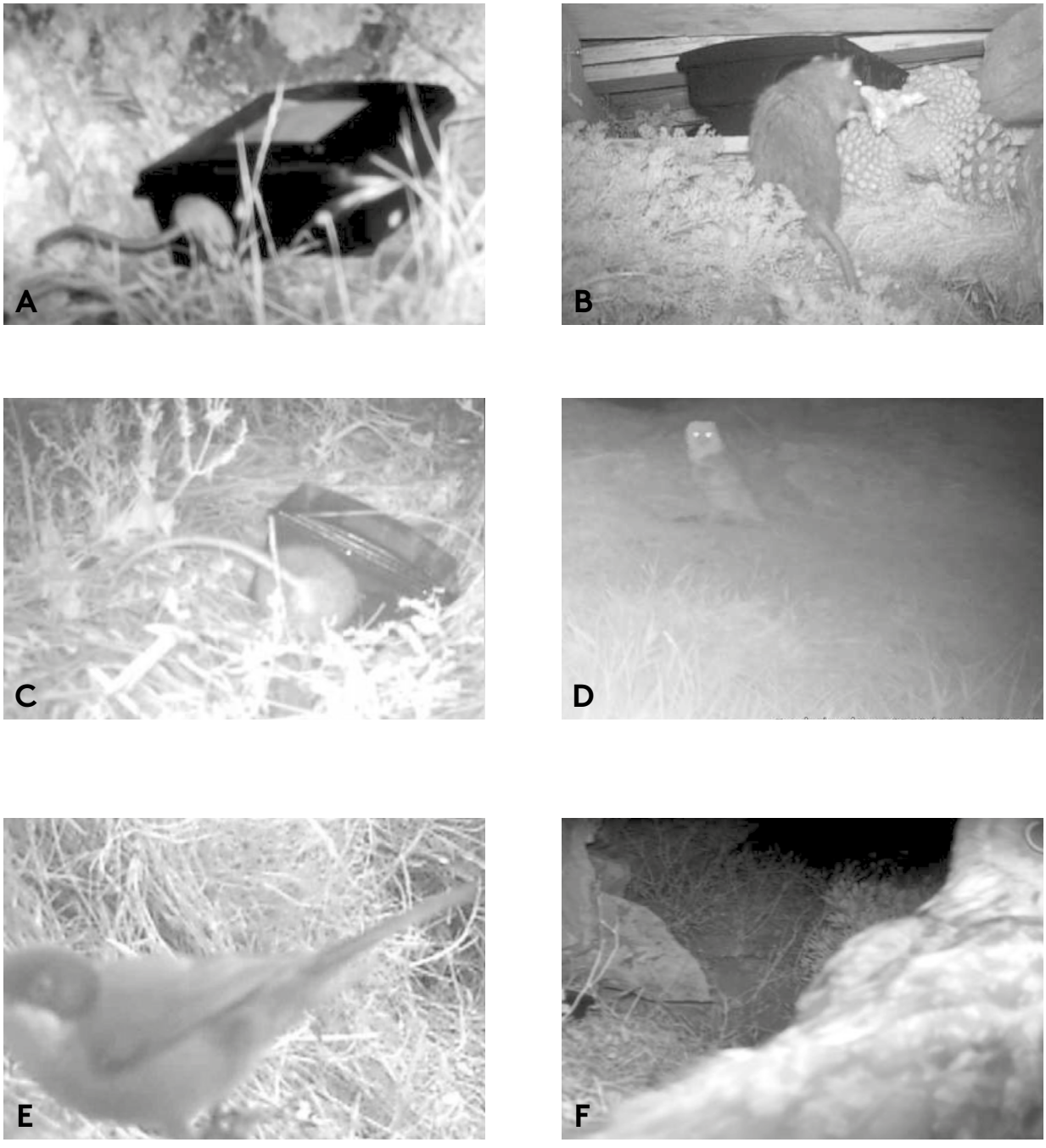


Photo credits: HELP Sarl

Monitoring of deratting by infrared camera

A	Black Rat consuming bait in a baiting station installed on Gargalo Island (western Corsica).
B	Norway rat prospecting near a baiting station (Ile Vierge, Finistère).
C	Norway rat consuming bait in a baiting station installed on the Bilho bank (Saint-Brévin les Pins, Loire-Atlantique).
D	Barn Owl (Banc de Bilho, Loire-Atlantique).
E	*Melanocephalous* warbler on the islet Portixoll (Spain).
F	*Ubo.sp* owl on the islet Portixoll (Spain).

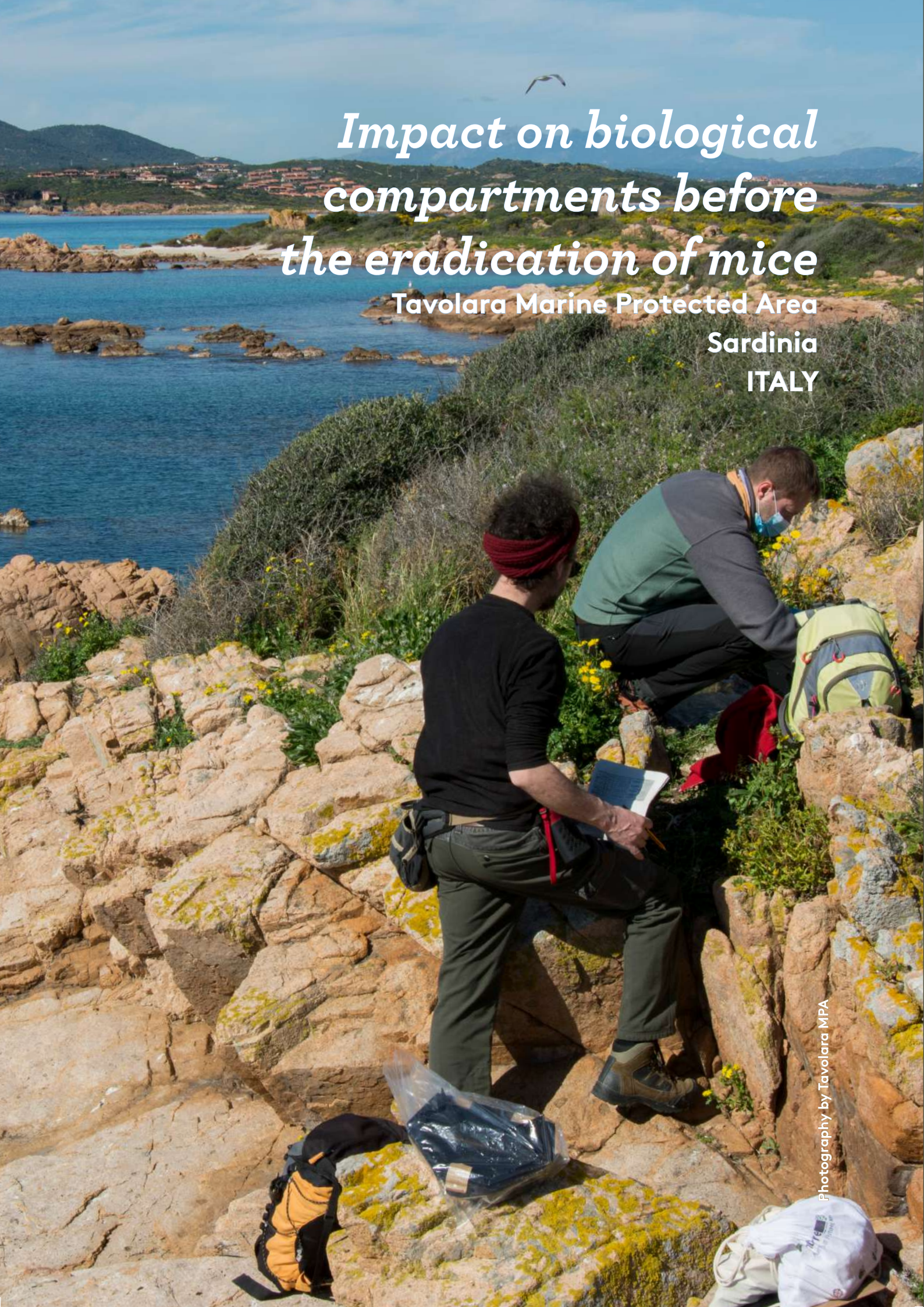
Benefits and advantages of this new method

These various operations also made it possible to estimate the impact of the method on non-target species, as the daily monitoring of baiting stations also makes it possible to collect any vertebrate corpses that may have been killed by the bait. **It appears that collateral damage at the beginning and middle of the operation is rare or non-existent.** It is only at the end of the operation, when the rats have almost all been eliminated, that certain indigenous birds and micro-mammals colonise the bait stations. In the case of birds, these are a few individuals of opportunistic species (herring gulls, magpies, carrion crows) that specialise in eating rat corpses or that try to extract the bait from the bait stations. Some insectivorous passerines (robin, flycatcher) may also be secondarily affected by the consumption of insects (woodlice, snails, slugs, forficula) that have themselves consumed bait. These secondary intoxications concern a few individuals, the maximum number of which was always less than 10 individuals.

With regard to the diffusion of the active substance in the soil and surrounding water, a study was carried out by an independent consultancy firm on the Chausey archipelago in 2020 and 2021. This consisted of deploying a set of ultra-sensitive sensors in the marine environment before, during and after the deratting operation in order to detect the molecule used in the marine environment. **It turned out that no trace of the substance could be detected in the environment despite the deployment of 2,525 bait stations on 65 islets and more than 11,000 baits consumed by the Norway rat.**

This new method, which uses exclusively chemical control, is the result of a long experience in rodent control on the island. It has several advantages over the protocol using mechanical trapping and chemical control in succession: it requires 2 to 3 times fewer human resources and 2 times less logistical resources. In fact, its cost is significantly lower than that of the mechanical trapping + chemical control method. In terms of efficiency, about 80% of baiting stations are subject to at least one consumption of bait by the rat.

The geolocation of the baiting device, its regular control by experienced agents coupled with the installation of infrared cameras allows for fine monitoring of the operation, the main objective of which is to limit its impact on island biodiversity as much as possible.



Impact on biological compartments before the eradication of mice

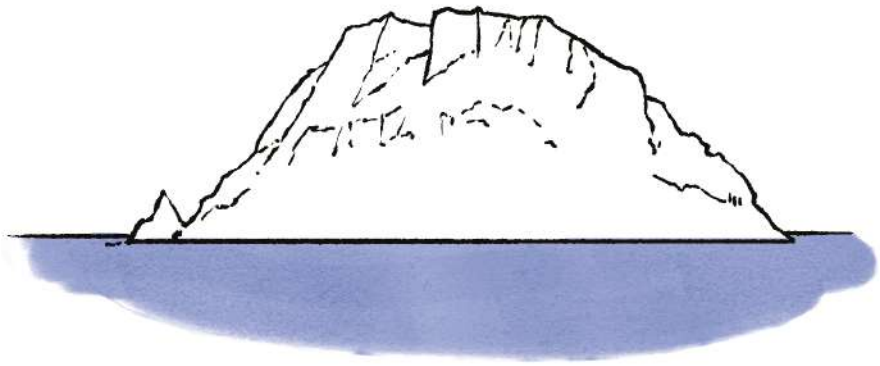
Tavolara Marine Protected Area
Sardinia
ITALY

Photography by Tavolara MPA

Tavolara Marine Protected Area

Sardinia

Italy



Surface area concerned

2,2 ha Isola Cavalli

13,6 ha Isola Piana

2,2 ha Isola Reulino

15 ha Spalmatore di terra (Isola Tavolara)

Distance from continent

Piana island: 660 m

Reulino: 970 m

Tavolara Spalmatore: around 2 Km.

Inhabited/Uninhabited

- Cavalli, Piana and Reulino islands: uninhabited
- Tavolara – Spalmatore: about 40 people from mid-June to mid-September, none during the winter

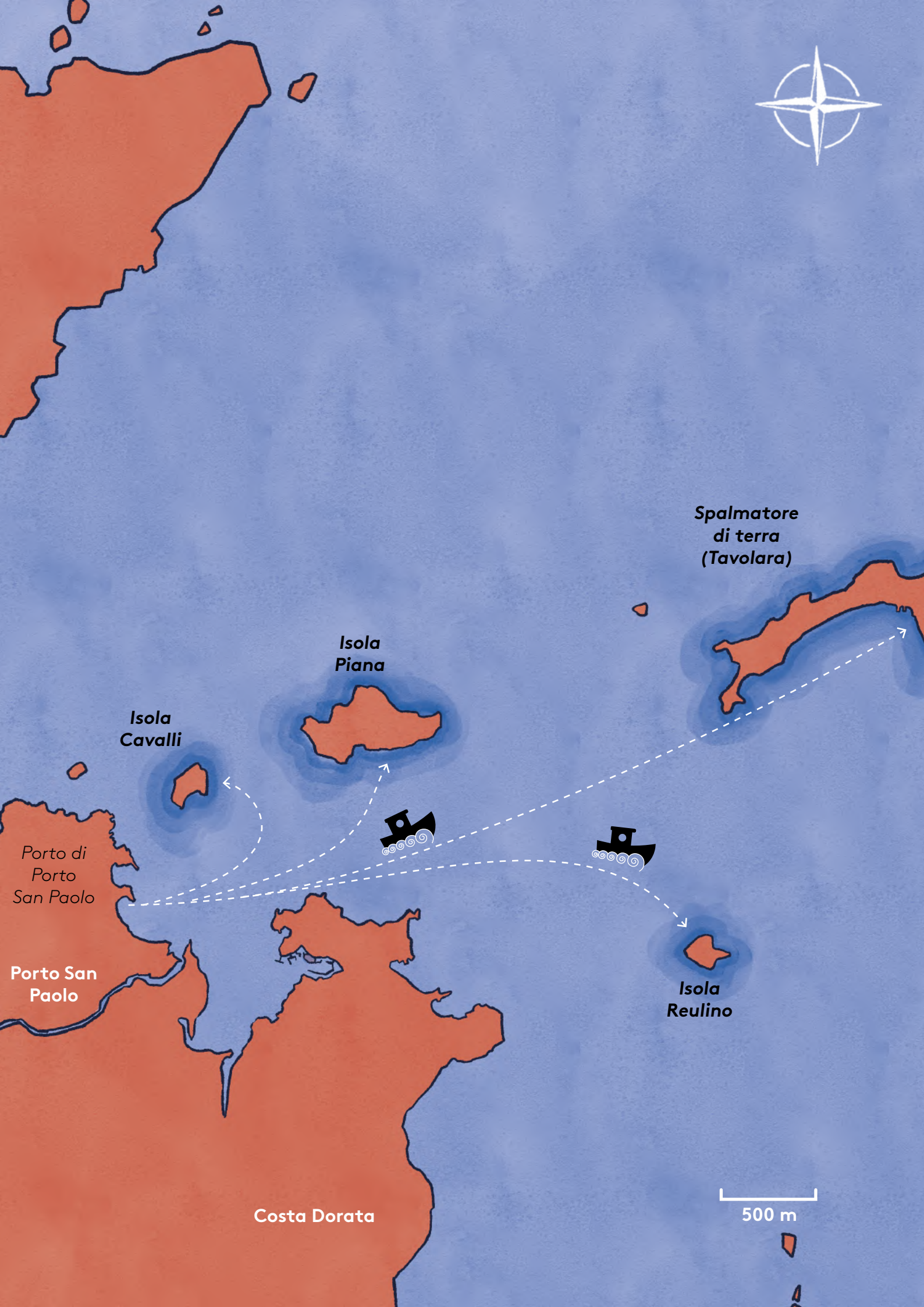
Protection status MPA

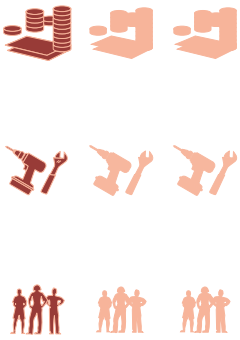
Focus Invasive species

Characteristics of project working conditions

On Cavalli, Piana and Reulino: no landing facilities

On Tavolara (Spalmatore): presence of a pier


Spalmatore
di terra
(Tavolara)
Isola
Piana
Isola
Cavalli
Porto di
Porto
San Paolo
Porto San
Paolo
Isola
Reulino
Costa Dorata
500 m



Main parameters considered for the implementation of the project

WEATHER CONDITION AND SEASONALITY

Need to carefully evaluate weather conditions to reach the islands and to consider seasonality of the presence and detectability of both reptiles and invertebrates.

ACCESSIBILITY

- Access on islands is authorised
- Piana and Reulino: only with private/MPA boat
- Tavolara: with ferries from June to October, private or MPA boat during winter/spring months
- No accommodation on site available
- Euleptes europaea being a nocturnal species, work at night was possible

Biological challenges and sensitivity

SPECIES OF INTEREST

Cavalli, Piana and Reulino: *Phalacrocorax aristotelis desmarestii* and *Larus michahellis*, Endemic lizard *Podarcis tiliguerta* and endemic gecko *Euleptes europaea*, Soil invertebrates

Tavolara: Nesting colonies of *Puffinus yelkouan* and *Calonectris diomedea*

INVASIVE SPECIES

Mus domesticus

Human and financial resources

- Total budget: 20 000€
- Logistic & organisational support from MPA Tavolara (boat, operators)
- Experts with background knowledge and experience of island ecology

02/2022 → Online meetings

04/2022 → Field work for invertebrates (Pit fall-traps positioning & recollection of the samples)

05/2022 → Field work for Reptiles (By night for *Euleptes europaea*)

06/2022 Second session of Field work on islands for Reptiles

Project description

On 3 islets near Tavolara, the eradication of the House mouse is planned for autumn 2022, with the aim of improving the efficiency of biosecurity activities against the Black Rat (successfully eradicated in Tavolara in 2017 via a Life project) and increasing the naturalness of the islets themselves.

Before this intervention, we want to carry out a monitoring of ecosystem effects based on the analysis of Reptiles populations and of terrestrial invertebrates' communities. Two species of Reptiles common to each island, will be used as indicators to evaluate the effect of eradication. It is planned to monitor the Reptiles populations both in the year before the eradication and after, to verify the effects of eradication on the abundance and population structure of the two species. The monitoring is carried out with linear transect for *Podarcis tiliguerta* and the demographics and spatial behaviour of *Euleptes europaea* was analysed.

Invasive alien rodents (*Rattus spp., Mus domesticus*) deeply impact terrestrial invertebrate communities, either directly or indirectly. Ground invertebrates proved to be suitable indicators of the impact of alien rodents on islands, as demonstrated by several studies on oceanic islands as well as, in recent times, on the Pontine archipelago.

Although piece of evidence exists demonstrating the impact, both direct and indirect, of domestic mouse *Mus domesticus* on invaded island's invertebrate communities few studies have been carried out to quantify the magnitude of the effects, none of which are available in the scientific literature for Mediterranean islands. Pit-fall trapping is an effective and cheap sampling method which allows to study the ground invertebrate community, more prone to the impact of mice predation. The effect of mice eradication will be investigated by following a BACI (Before-After/Control-Impact) experimental design.

Operators

Sistema Museale Università di Firenze , Nemo s.r.l., Nesos, Mpa Tavolara Punta Coda Cavallo operators

Selecting the appropriate intervention method

Euleptes europaea

The field activities for *Euleptes europaea* have been conducted on Isola Piana and Reulino; Spalmatore (Tavolara) was excluded because the habitat wasn't suitable and there is the presence of two other species of geckos as well. Sampling sites were chosen during the day, but sampling began two hours after sunset.

For each detected animal the following data were collected:

1. animal uncovered or covered (e.g., under the vegetation),
2. distance from soil;
3. age (juveniles or adult),
4. sex if possible.

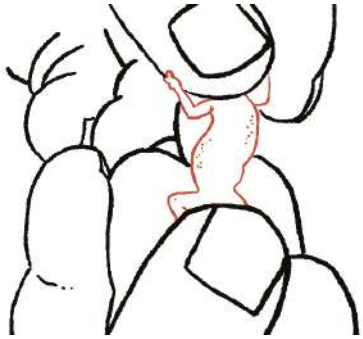
For each collected animal was measured:

1. SVL - from the tip of an animal's nose to the opening of the cloaca at the tail base with a calliper,
2. the weight with an electronic scale.

Then, was recorded:

1. the back pattern,
2. the presence of injuries of the tail or of the limbs,
3. the presence of ectoparasites,
4. for males – the presence and shape of cloacal spines,
5. for females – the presence of eggs, their stage of development and presence of neck glands.

On both islands, Reulino and Piana, feces were collected too.



Podarcis tiliguerta

Data were collected using VES (Visual Encounter Survey) and linear transect.

Ground invertebrates

Samples of ground invertebrates were collected on islands Piana and Reulino where the eradication of *Mus musculus* will take place; Tavolara is considered as control site (no eradication expected).
Communities of invertebrates of the three islands were studied by means of pit-fall trapping, an effective and cheap sampling method which allows to study the community composition of surface terrestrial invertebrates.

Pitfall traps = plastic cups (95 mm diameter and 125 mm depth) buried in the soil and filled to approximately 2 cm depth with a 50/50 mix of glycol and water, with a drop of detergent.

- Piana and Spalmatore: 8 samples were collected for two different areas.
- Reulino: 2 areas were trapped with 5 pitfall traps per area.
  After 10 days, samples were collected and preserved in 70% ethanol.
  Sampling was repeated 3 times.

Field methods

- Experimental design:
  Before/After-Control/Impact (BACI)

  IMPACT / CONTROL - BEFORE / AFTER
  Reulino, Piana / Spalmatore / 2022 / 2023, (2024...)

- 8 pitfall traps x 2 areas x island
- 10 days x 2 temporal replicates (April 2022)

Data analysis and parameters

- Community diversity abundance (Shannon H', Species Richness, N)
- Multivariate statistical analysis of the invertebrate community change after the eradication of *Mus muculus*

Monitoring of ground invertebrates : methods

In the laboratory, invertebrates were sorted and identified to Class or Order except for Aranea and Coleoptera, which were identified to family or to genus and species when possible. We chose to investigate these two groups at higher taxonomic resolution since, among the taxa found in the traps, they were those known to represent possible prey items for *Mus domesticus*.

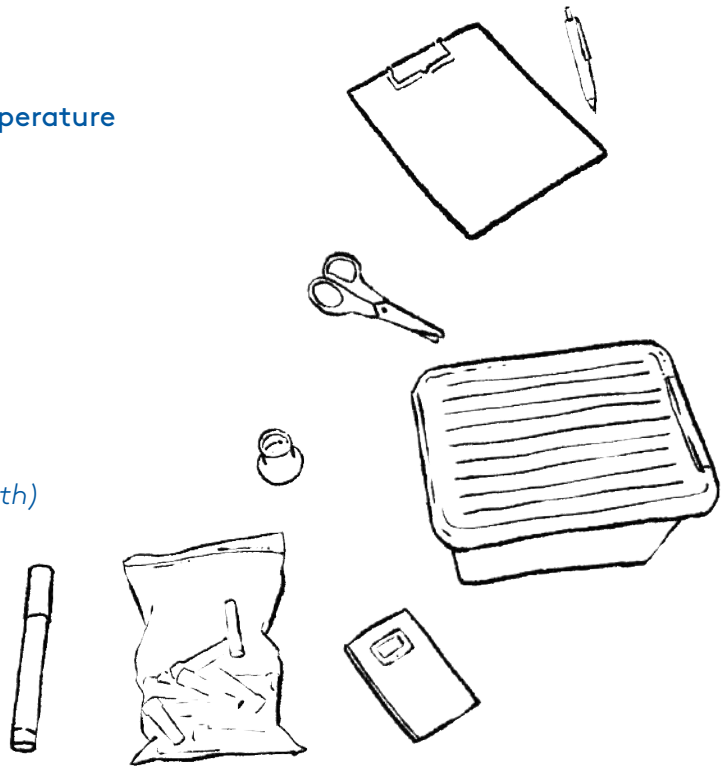
Necessary equipment

For Reptiles

- Headlamp
- Calliper
- Electronic scale
- Notebook and pencil
- Thermometer for air and soil temperature
- Portable hygrometer
- Tweezers
- Centrifuge tube
- Magnifier

For invertebrates

- Plastic cups
  (95 mm diameter and 125 mm depth)
- Glycol
- Tweezers
- Gloves
- Stainless strainer
- Sample container
- Binocular microscope



Results

The results of the study are a partial view of the outcome of the project and will be completed after the eradication of the House mouse. For now, they are interesting and represent a good starting point for improving the knowledge of the island systems of the marine protected area of Tavolara. **The comparison between these data and those that will emerge after the eradication will give management indications or, at least, will serve to identify the aspects to be explored when planning an eradication of House mouse on islands.**

Invertebrates

2055 specimens processed belonging to 115 taxonomic unit distributed in 7 classes, Insect, Entognath, Chilopod, Diplopoda, Arachnida, Malacostraca, Gastropod and 19 orders/ suborders.

Reptiles

Euleptes europaea:
Isola Piana: 21 and 23 individuals collected respectively in May and June
Reulino: 24 individuals collected in June

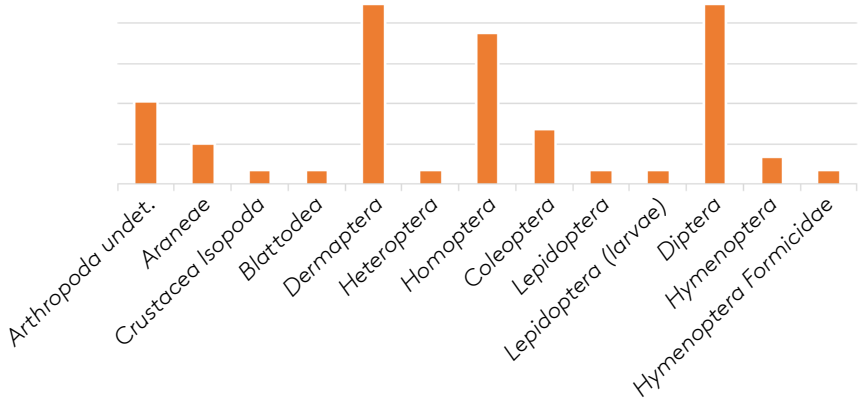
SIZE OF INDIVIDUALS

Comparing the size of individuals of Reulino and Piana islands with the data from other population from Sardinia and Corsica already analysed, we see that both belong to the group of those characterized by small individuals (northern Sardinia). This applies to both males and females. **The size of geckos could be linked, directly or indirectly, to the presence of mice. Further studies will be needed after the eradication to better understand these aspects.**

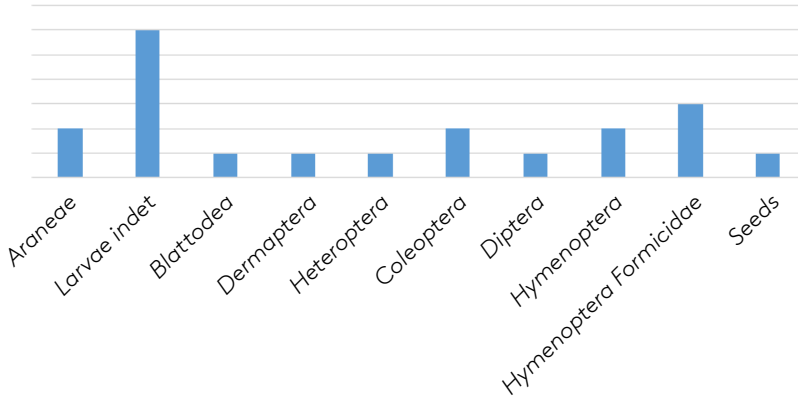
FAECAL SAMPLES

We also collected and examined faecal samples containing remains of prey. On Isola Piana, faecal samples examined (36) contained the remains of 58 identifiable prey; the most represented taxa are the Dermaptera (22.4%), the Diptera (22.4%) and the Homopter (18.9%).

On Reulino samples examined (8) contained the remains of 19 prey; the most represented identifiable taxa are the Formicidae (15%), but the sample includes a high percentage of undetermined insect larvae (30%); a seed was also found, probably belonging to an undetermined species of the Amaranthaceae family.



Prey remains for Euleptes faecal samples on Isola Piana



Prey remains for Euleptes faecal samples on Reulino

Labour-time mobilised

INVERTEBRATES = 40 MAN-DAYS

- fieldwork: three sampling campaigns with three operators for three days to put in place the traps and two operators for two days to collect the samples (repeated twice).
- laboratory work: include identification of sample.

REPTILES = 35 MAN-DAYS

- fieldwork: 4 nights for *Euleptes europaea* & during the day for *Podarcis tiliguerta*.
- laboratory work: include data analysis.

Critique of the method

The goal of the project is the monitoring of the effects of *Mus domesticus* eradication on two different components of the ecosystem on Isola Piana and Reulino, Reptiles and soil invertebrates. **It is important to begin considering these components too while working on islands and removing alien species, instead of concentrating the whole monitoring effort on the species we aim to protect (marine birds)**. The project has simple sampling activities, and no complex tools are needed, but good expertise is fundamental to collect good data. It is important to complete the work with a thorough analysis of field data and to be able to collect data for several years. So, expertise coming from outside the MPA Tavolara is needed and the project benefitted from competent people who have been working on islands for years.

Moreover, logistics are important, speaking about islands you have to cope with weather conditions, facilities and accessibilities that can make the difference. We could recommend a preliminary inspection with the experts to evaluate all the choices made at the time of designing the project: for example, sampling area on Tavolara (Spalmatore) did not turn out to be adequate for Euleptes, but we only realized this during the first sampling night.

Testimonial

This project has been an opportunity to investigate some aspects usually not considered when planning eradication activities. We had the chance to gather data on Reptiles and Invertebrates, not the first choice when you speak of charismatic animals!
The driving force of the project has been teamwork: we have different opinions on the impacts of alien species on the islands and on the active conservation measures to be adopted, but we were all able to question our ideas to better understand how the island systems work and to plan better interventions in the future. Little camping stove and shared coffee on the working nights offered us important moments of discussion and improvement. The Mediterranean small islands are confirmed as great meeting places!

Giovanna Spano

Rodent detection , a simplified protocol

With the contribution of Rafel Mas Ferrer, Biologist at the Species Protection Department of the Government of the Balearic Islands

The presence of rodents (mainly black rats *Rattus rattus)* on small islands is incompatible with colonies of European storm petrels (*Hydrobates pelagicus*). It severely reduces productivity and colonies of Cory's shearwater (*Calonectris diomedea*). Moreover, Balearic shearwater colonies (*Puffinus mauretanicus*) are affected in the short term, resulting in the species' sharp decline or disappearance. It also affects the productivity of other species, such as Audouin's gulls (*Larus audouinii*), European shags (*Phalacrocorax aristotelis*) and Eleonora's falcons (*Falco eleonorae*). Moreover, it has other adverse effects on biodiversity (flora, reptiles, and invertebrate fauna).
Several management plans for protected areas and the Balearic seabird conservation plan (Lilford Plan) include predator control measures and the elimination of rodents in breeding colonies. Rodent control measures are as important as monitoring actions to detect possible recolonisation, enabling early elimination measures.

Regulatory framework

The islets were declared Natural Areas of Special Interest (ANEI) by the 1991 Law *Llei d'espais naturals i de règim urbanístic de les àrees d'especial protecció de les illes Balears* (LEN). Previously, most islets had been included in the Natura 2000 network and declared Special Area of Protection for Birds (SPA) and Site of Community Importance (SCI). Most of them are part of natural parks or reserves.

Measures

In June and July 2016, a pilot experiment was carried out to detect the presence of rodents in the islets. Eight islets in Mallorca, five in Menorca, and seven in Eivissa were chosen to check for the presence of rodents using a simple data collection method. The method was designed by technicians from the COFIB (Consorci per la Recuperació de la Fauna Illes Balears - Balearic Islands Wildlife Recovery Consortium), which subsequently compiled a record of the presence of rats on the archipelago's different islands and islets.

Methodology

The method in question involved using 2 types of attractant baits:

- 15 x 3 x 1 cm or 15 x 3 x 0.5 cm pine wood slats impregnated with waste oil by frying the wood in the liquid in question. These strips were intended primarily for the possible detection of mice (M.musculus).
- Fragments of common reed (Arundo donax) about 15-20 cm long, and cut between knots. The resulting tube was filled with a mixture of peanut butter and a mixture of seeds and poultry feed. One of the ends of the tube was left open, yet plugged with paper to prevent ants from extracting the content, and a hole was made on the side of the knot to release the smell.

Both bait types were secured to rocks or vegetation with galvanised steel wire to prevent the rodents from moving them. Each bait was identified with a number and geolocated through GPS, with a complete data sheet. The baits had to be checked after a minimum period of 48 hours.

When checking the baits, each was photographed to record their condition and document their corresponding data sheet.

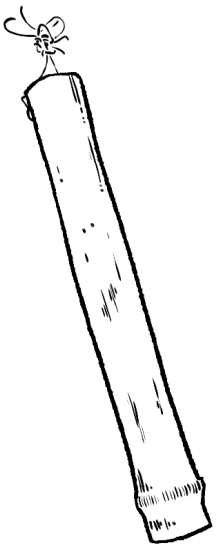
Before placing the baits, the islets were checked for signs of rodent predation on seabird eggs and chicks (especially in the case of rats), gnawing traces on vegetation woody branches (especially indicative of rats sharpening their teeth), and the presence of olive pits and wild olive fruits. Gulls feeding in olive groves and regurgitating on the islets may consume large quantities of these stones, possibly indicating the presence/absence of rodents. Observing whether these stones appear gnawed (rats search for the seeds embedded in the stone) or intact may indicate whether or not rodents are present.

Results

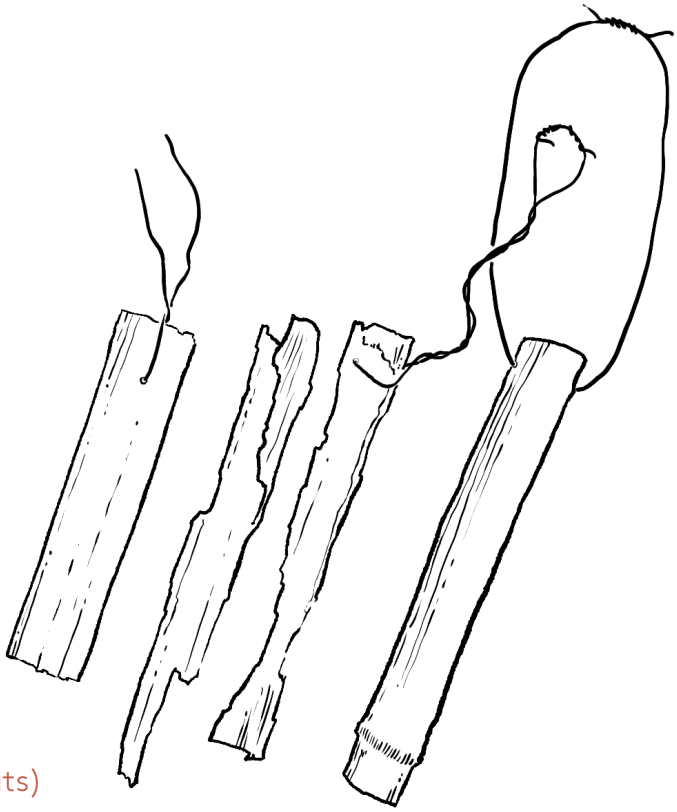
The results of the experiment show that rats prefer the tubes filled with peanut butter and seeds. Rat teething marks were also observed on the oil-impregnated wooden slats but are less apparent. Because of the hardship of life on the islets and probably the lack of food, the tubes filled with peanut butter disappeared in the presence of rats or were severely gnawed and practically destroyed.

The mice's preference complied with expectations, and they would usually leave small gnawing incisions in the peanut-filled tubes or the oil-soaked slats.

Presence of rodents	18
Possible presence (to be confirmed)	2
Absence of rodents	9
Rodents eradicated in previous campaigns	4
Insufficient data	19
Number of islets surveyed in total	**52**
Presence of rats (Rattus rattus and/or R. norvegicus)	**13**
Presence of mice (Apodemus sylvaticus and/or Mus musculus)	**12**



Cane tube filled with bait, secured to vegetation



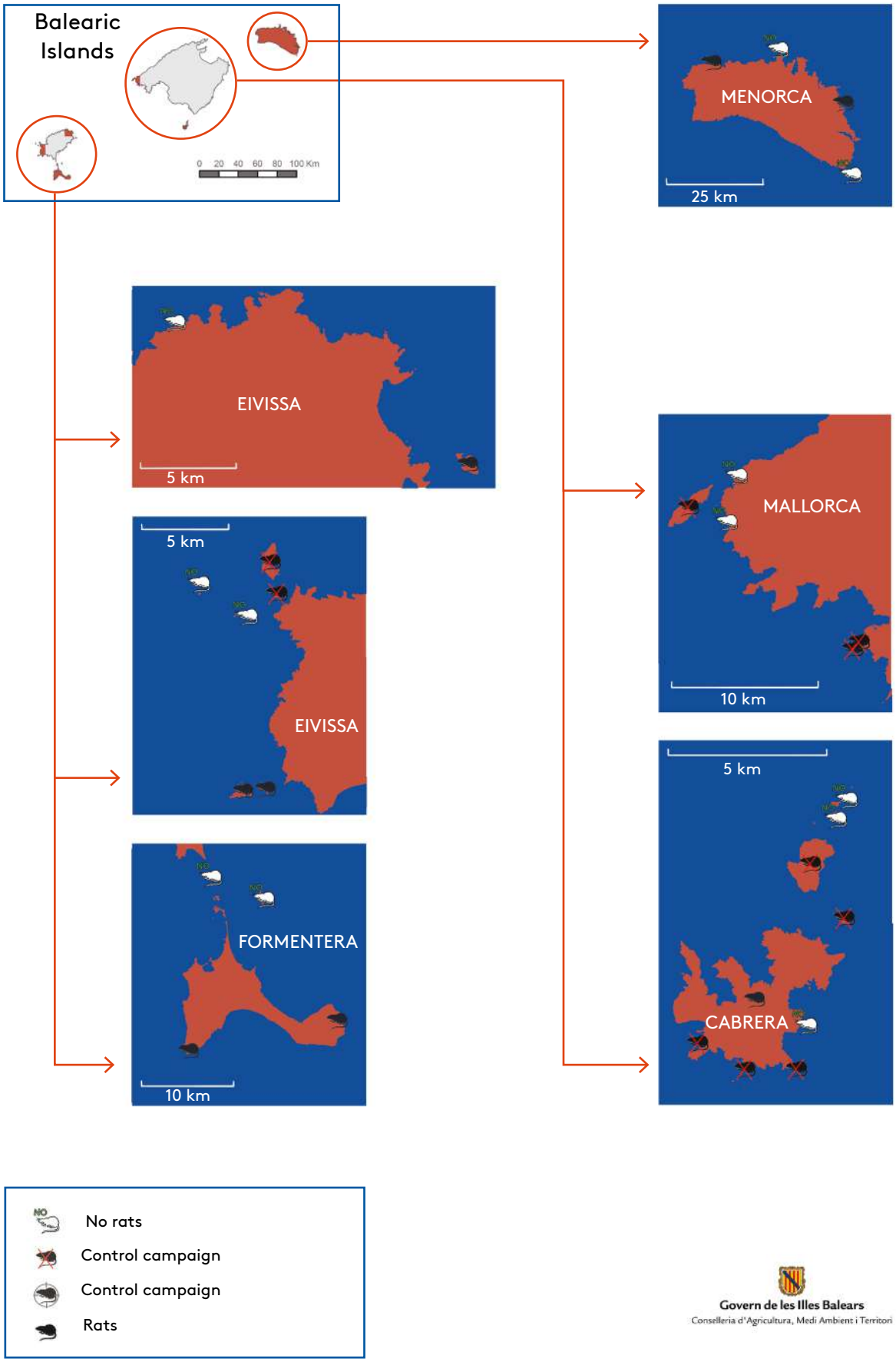
Edges intact (there are no rats)

Tube eaten and slat with mice tooth marks

In conclusion, the detection method showed that most islets surveyed remained rodent-free. The key strength of this methodology is its simplicity in making, placing, and checking the baits. Above all, it is a very economical method.

Islands	Years	Methods	Result
Malgrats (2)	1988-2005	5 campaigns with feedlots. Sylimarin, Diphenadione, Chlorophacinone or Bromadolione.	Not eliminated
Malgrats (2)	2006-2007	3 Bromadiolone free dispersions	Exterminated
Sa Dragonera	1993-2008	6 campaigns with 15 replenishments, in feedlots. Difenacoum or Bromadolione	Not eliminated
Sa Dragonera	2011	Aerial dispersion of Brodifacoum	Exterminated
Formentor	1999	1 campaign with Clorophacinone feedlots	Not eliminated
Guardis	2017	1 campaign with feedlots. Brodifacoum	Not eliminated
Cabrera gran	1994-2021	Feedlots with Bromadiolone and other substances	Not eliminated
Conills	2002-2005	3 campaigns with feedlots. Bromadiolone	Not eliminated
Conills	2006	Free dispersion, Bromadiolone	Exterminated
Cabrera islands	1994-2006	5 or more campaigns with feedlots. Bromadiolone	Exterminated on 6 islets
Conillera y Bosc (Eivissa)	1999	Feedlot, Bromadiolone and Chlorophacinone	Not eliminated
Vedrà y Vedranell	1999	Feedlot, Bromadolione and Chlorophacinone	Not eliminated
Tagomago	1999 & 2017	Feedlot, Bromadolione, Chlorophacinone and Brodifacoum	Not eliminated
Ponent islets	2004 & 2008	Feedlots. No product data	No result data
Espalmador	2004	Feedlots. No product data	Not eliminated
Colom	1999	Feedlots. Bromadiolone and Chlorophacinone	Not eliminated

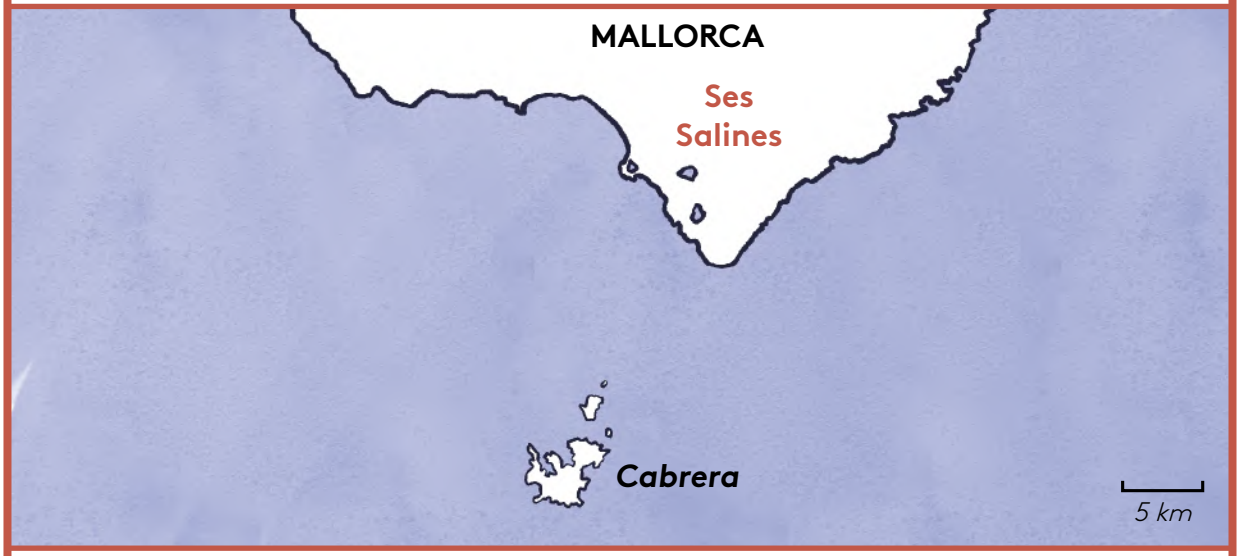
(De McMinn & Rodriguez, 2010, modified)



Rat control in seabird colonies
in the Balearic Islands

Elimination of allochtonous mammals in the Cabrera archipelago

With the contribution of Eva Moragues Botey, PhD in Biology, invasive flora specialist, Head of biological conservation in Cabrera National Park from 2020 to 2022



Cabrera

Cabrera archipelago
Mallorca, Autonomous Community of the Balearic Islands

X Coord: 39,1451
Y Coord: 2,94391

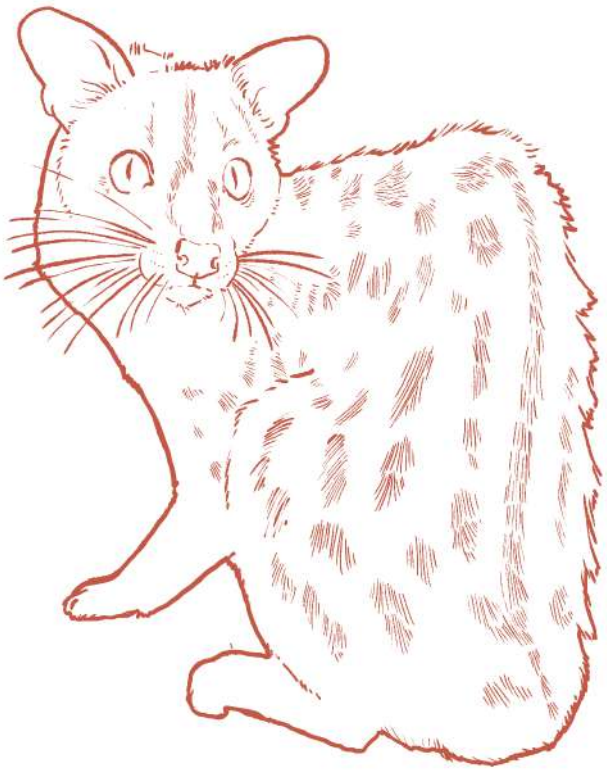
Surface area : 1569 ha
Distance from the main island: approx. 7 km (Mallorca)
Protection status: Maritime-Terrestrial National Park

Biological data

The terrestrial biota includes colonies of seabirds, nesting birds of prey (the density of ospreys has become the highest in the Mediterranean, with seven pairs in 2017), Balearic lizards (10 subspecies) and endemic invertebrates.

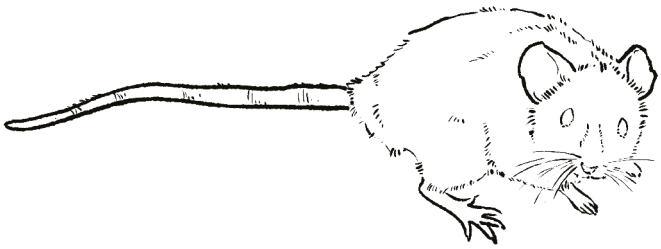
Invasive animal species

The goats, after which the archipelago was named in Roman (or earlier?) times, were eliminated in the 1950s. The presence of rats and rabbits on several islands and islets is very ancient. They have been eliminated from all the islands except the largest, where the genet was introduced at the beginning of the 20th century to control the rabbit populations that attacked the vineyards planted at that time and hedgehogs that were introduced at an unknown time. Domestic cats have existed on the island until recent years. These three species significantly impact the terrestrial biota, with an exceptionally high incidence on the Balearic Shearwater, which nests in some areas of the main island where it used to be more abundant.



Since Cabrera was listed as a National Park in 1991, various studies have been conducted on invasive species and measures taken to control and eradicate multiple alien species.

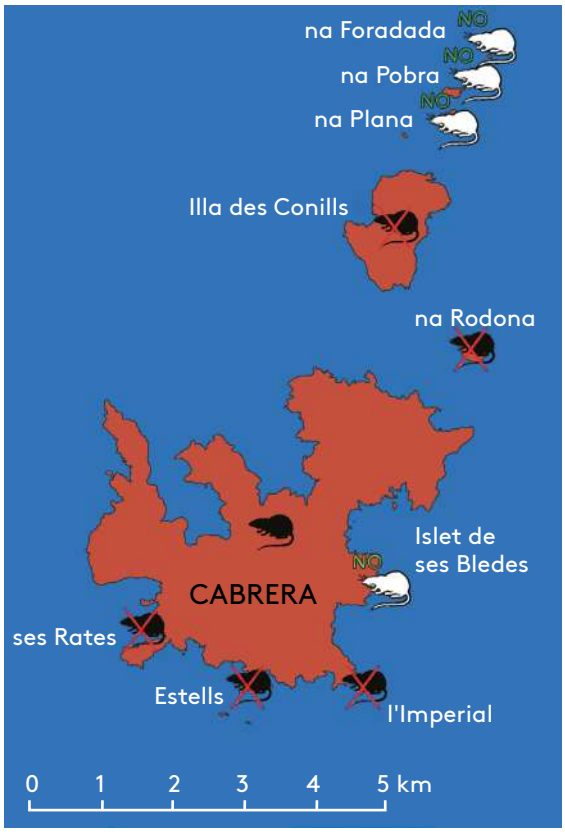
Since 1995, the National Park's management has prioritised eradicating the populations of bighorn cat *Felis catus, Genetta genetta*, and black rat *Rattus rattus*. The three species are incompatible with the existence of breeding colonies of Procellariiformes—European Storm-petrel, Balearic Shearwater and Cory's Shearwater.



Rodents

Alien rodents have been shown to have devastating effects on insular ecosystems. They prey on nesting seabirds and consume plant species (shoots and reproductive parts), reptiles, and invertebrates.

The black rat probably colonised the archipelago in historical times. Yet, an abundance of Balearic Shearwater in some caves on the main island suggests that the rat's arrival is not very old. The presence of the house mouse *Mus musculus* in the inhabited areas of Cabrera Gran was detected in 2004.



The first control measures for introduced mammals were carried out in 1995. As a result, some islets (Estell Xapat, Estell de s'Esclatassang, Na Redona, Illes des Fonoll, L'Olló, Ses Rates, Illa des Conills) were disinfested entirely. The larger islands were controlled, although successive recolonisations were detected on some islets in certain years due to the rodents' ability to swim from Cabrera Gran.

In 2004, a project named 'Control of problematic species' was launched in Cabrera National Park. The project's main objectives were the control and eradication of rodents in the inhabited areas of Cabrera Gran and the maintenance of the previous actions carried out on the archipelago's islets. Control and eradication actions were pursued until 2011/2012. The project also included eliminating feral cats and genets in Cabrera Gran.

MAIN RESULTS

Illa des Conills: Measures began in 2000 by placing baits with rodenticide. Total eradication was not achieved until 2006 through free rodenticide dispersion without baiting. The orography of the island prevented placing baits all over, and areas were thus left without rodenticide. Free dispersion was maintained for several consecutive years with no further detection of rodents. In 2010, two infrared cameras were installed, but no rodents were detected. Currently, the island is free of rodents.

Other islets Between 2000 and 2011/2012, eradication campaigns were carried out using baits with rodenticide. Except for a few recolonisation episodes, the islets have remained rodent-free except for De Ses Rates, an islet whose proximity to Cabrera Gran makes it very vulnerable to recolonisation.

Inhabited areas of Cabrera Gran The harbour and campsite areas require continuous control of black rat and house mouse populations by installing (lizard-protected) anticoagulant bait nets and closed traps, as well as monitoring waste collection points to prevent rats from visiting. The measures began in 2000 and were pursued until 2021, when a genet was found dead from rodenticide and the control measures were cancelled.

Ensiola peninsula A pilot eradication project using baiting and free dispersal of rodenticide was initiated in 2004/2005. Within a few months, the catches ceased (successful measure), yet the project was not pursued.

There are no historical data on black rat and house mouse densities in the National Park. In 2013, the Balearic Islands Wildlife Recovery Consortium (COFIB) conducted a population assessment campaign in pine forests, scrubland and coastal areas by placing baits (rags soaked in oil and tuna). Fifty-eight rats were captured in total through an effort of 2,700 trap days, leading the study to conclude that the species' abundance was low. The study was repeated every year until 2015 included. Of particular note are the low densities detected concerning intensive carnivore control.

Genets and cats in Cabrera

Cats and genets prevent the recolonisation of sites historically populated by shearwaters. Cats are probably the introduced species that has had the most harmful impact on autochthonous fauna, mainly birds.

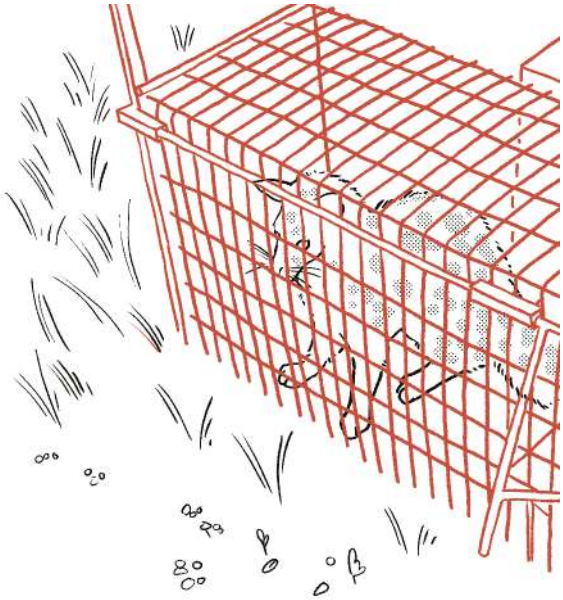
It is not known when the cat was introduced. Genets were introduced in the late 19th century to control the rabbit population when vines were planted on the islands.

In 2003-2004, a study on the presence of genets and cats was conducted (Skua. Gabinete de estudios ambientales S.L.), following which the first control campaigns were initiated in Cabrera Gran. Captures were performed using cage traps, a bloodless, effective and widely accepted method. The captured genets were moved to Mallorca and, after undergoing a period of quarantine, released into the wild by Skua SL and COFIB (Balearic Islands Wildlife Recovery Consortium), which has pursued the operation.

	2004	2005	2006	2007	2008	2012	2013	2014	2017	2018	2019	2020	2021	Total
Cats	1	3	4	5	3	3	1	0*	0*	1	0	0	0	21
Genets	6	13	5	8	3	7	14	4	6	7	9	11	4	97
Hedgehogs	36	12		41	131	20	47				3	9	8	307
Weasels							1							1
Total	43	28	9	54	137	30	63	4	6	8	12	20	12	

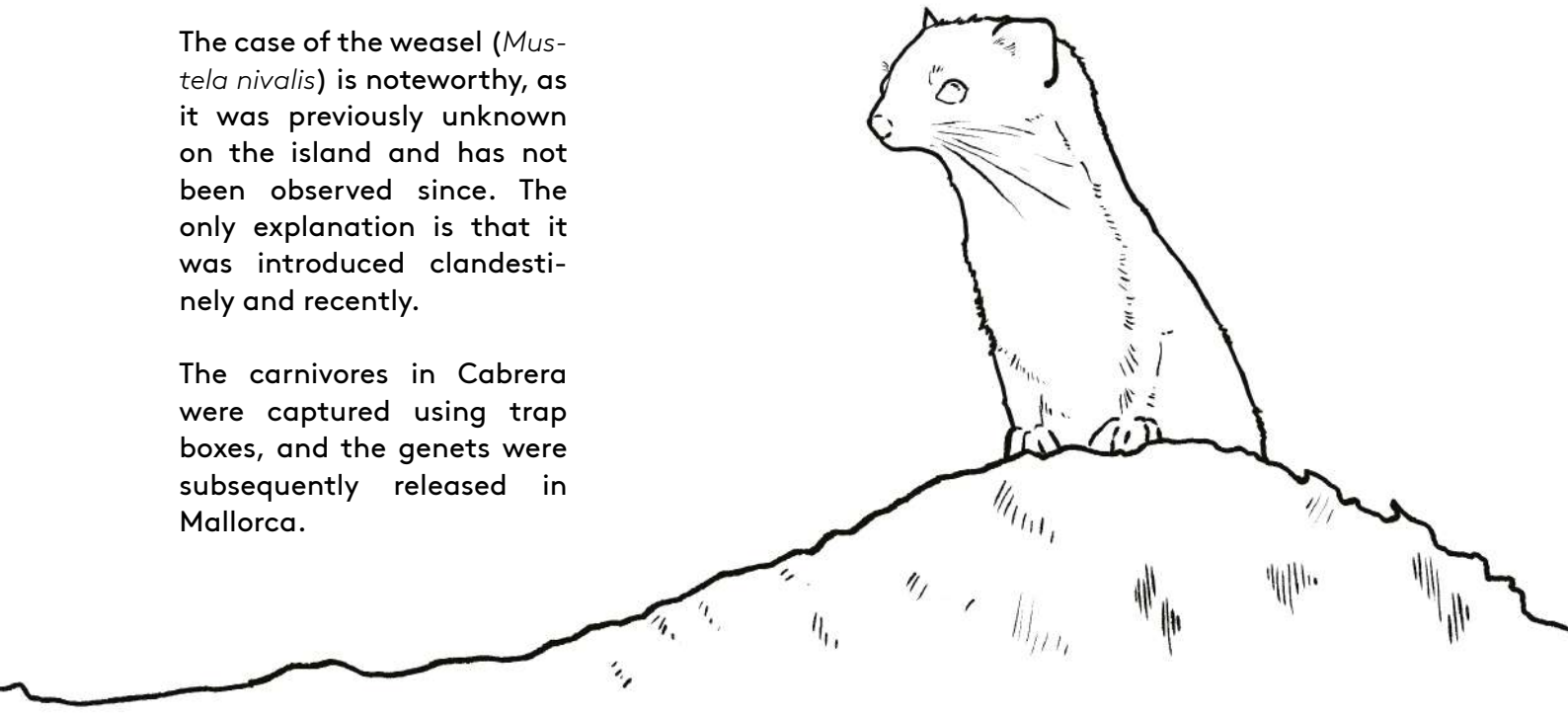
Captures

No control campaigns were carried out in 2010 and 2011.
**Presence detected but not individual captured.*



The case of the weasel (*Mustela nivalis*) is noteworthy, as it was previously unknown on the island and has not been observed since. The only explanation is that it was introduced clandestinely and recently.

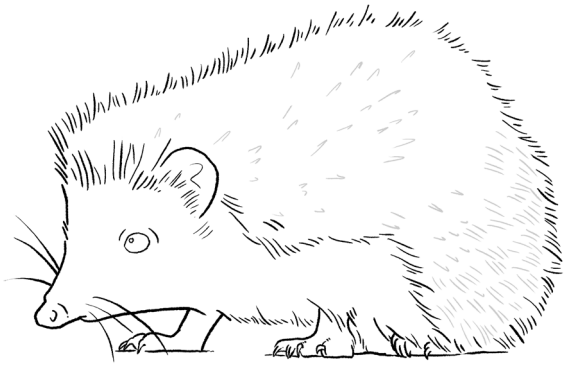
The carnivores in Cabrera were captured using trap boxes, and the genets were subsequently released in Mallorca.



A pending business: the North African hedgehog

The North African hedgehog (*Athelerix algirus*) is a species introduced in the Balearic islands probably during the Almohad period (circa 1200, Alcover 2010). Despite this, it is included in the List of Specially Protected Species, yet its presence in an island park should be reconsidered. The predatory capacity of this insectivore on invertebrates and small vertebrates is well known. It has been shown that the European species introduced in New Zealand has had a considerable impact on endemic reptiles and invertebrates (Jones et al. 2013) and could also affect Kiwis (Berry, C. 1999) . In Cabrera, hedgehogs reach high densities despite the aridity of the terrestrial ecosystems, as demonstrated by the numerous captures in carnivore traps. This could be a limiting factor for endemic invertebrates, Balearic lizards, and even some seabirds on land (Balearic shearwater). The Rector Plan envisages the elimination of invasive species as one of its primary objectives for maintaining natural processes and improving the habitats of present and potential populations and communities. This measure has not yet been applied to this species, whose specimens should be translocated to Mallorca.

Currently, the Park does not have a specific action programme for rat extermination or invasive alien fauna control. Monitoring the presence of rats, especially on the islets, must be continued. Capture efforts have fluctuated over the years. Among the factors that have affected the capture effort are the variety of campaigns with different personnel, varying numbers of traps and their distribution, and modification of the bait used. A long-term, planned campaign is lacking; such measures require time, dedication and patience for complete eradication.



References:

ALCOVER, J.A. 2010 ***Introduccions de mamífers a les Balears. L'establiment d'un nou ordre. In*** ALVAREZ POLA, C. 2010. ***Seminari sobre espècies introduïdes i invasores a les illes Balears.*** *Govern de les illes Balears. Conselleria de medi ambient i mobilitat. 175-186*

BERRY, C., 1999. ***Atelk.*** *Conservation Advisory Science Notes No. 268, Department of Conservation, Wellington.*

Campaña de control de especies problemáticas en el PN de Cabrera. Control gato y gineta 2004-2005 y rata negra . *Skua Gabinet d'estudis ambientals S.L.* Dirección técnica Miguel mcMinn y Ana Rodríguez. Manuscrito.

Control de Rattus rattus Rata negra en el Parque Nacional de Cabrera. De 2007 a 2010 Tragsa. Dirección técnica Miguel McMinn y Ana Rodríguez. Manuscritos.

Control especies problemáticas en el PN Cabrera. campaña 2011-12. Tragsa. Manuscrito.

GRAU, A.M., J.J. FORNÓS, G.MATEU, P.A.OLIVER I B.TERRASA (EDS). ***Arxipèlag de Cabrera. Històrtia Natural.*** *Mon. Soc. Hist. Nat. Balears, 30. 736 pp. Palma*

JONES,C., G. NORBURY AND T. BELL 2013 ***Impacts of introduced European hedgehogs on endemic skinks and weta in tussock grassland. Wildlife Research.*** *http://dx.doi.org/10.1071/WR12164*

Plan de control de especies problemáticas en el PN de Cabrera 2004-2005. Manuscrito.

Nota : los manuscritos reseñados se encuentran en los archivos del Parque Nacional.

TESTIMONIAL

Miguel McMinn

**Biologist involved through SKUA,
Environmental Studies Bureau SL
in invasive fauna control or elimination projects
on small islands in the Balearic Islands**

Mallorca's civil society's protracted environmental demand culminated in 1991 with the declaration of the Cabrera National Park. Although many believed Cabrera to be a pristine island that only required monitoring actions, from a biologist's point of view, the island was suffering from accelerated loss of biodiversity and ecosystem. The black rat, the quintessential invasive species, as defined by David Towns, threatened the last Balearic shearwater colonies. It caused the attrition of all Cory's shearwater clutches in two of the main colonies and devastatingly affected invertebrates and vegetation, as was becoming apparent. Moreover, it was not the only invasive species on the island: house mice, rabbits, hedgehogs, cats, and genets had also been identified. The presence of small carnivores was one of the main limiting factors for seabirds. The absence of nesting Yellow-legged Gulls on the main island can be attributed to the presence of cats and genets and not, as previously believed, to the human population (military, park managers and visitors).

My experience studying the fossil island faunas of the Balearic and Canary Islands, which became extinct with the arrival of humans, motivated me to work on the conservation of endangered island fauna. The ecological restoration of Cabrera's island ecosystems became a vital target to preserve the colonies of seabirds nesting on the archipelago's islets and, consequently, all its biodiversity: invertebrates, reptiles, and plants.

Early work on rodent control in Cabrera had failed, and total eradication was considered infeasible. What could be done? Using rodenticide was the best system, but a proper methodology was lacking.

We started using GIS to design the application protocol in detail on small islands, and portable GPS was used to ensure the even distribution of rodenticides. Using manual baiting and dispersal, rats were eradicated one island at a time, from the smallest island to Conills (140 ha).

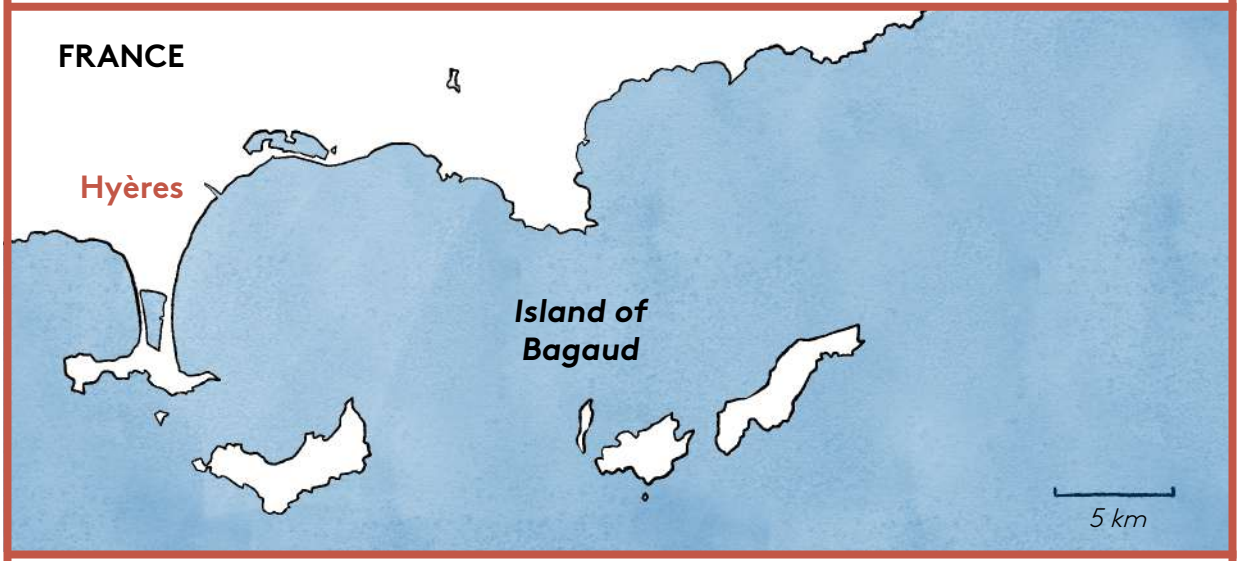
That left the island of Cabrera, which, owing to its size (1,770 ha), would require aerial dispersion of rodenticide and subsequent campaigns to eradicate small carnivores. Once black rats had been eradicated from the island of sa Dragonera, it seemed the time had finally come for Cabrera. Dragonera was a preliminary test to demonstrate that the ecological restoration of Cabrera was possible, but the moment isn't right yet, although we hope it is near because the chances of recovering the Balearic shearwater population with the small surviving groups on the island are high.

Surely, there is much that could have been handled better. If I had to do it over again, I would document and publish the whole process, mentioning what went well and what didn't.

It is unfortunate that the restoration of island ecosystems may not seem to be driven by a sense of a new normal, which includes invasive species. Some people think that if there are rats in Mallorca, it is expected that there should be rats in Cabrera. This is what is called the Shifting Baseline phenomenon. The lack of adequately documented information about what was lost leads people to believe that Cabrera is a pristine island. Nobody can imagine the sight of shearwaters flying over the castle of Cabrera at night to reach their colonies in Penyal Blanc.

Hopefully, we will be able to see it again!

Ten-year program of ecological restoration on the island of Bagaud



Bagaud

Archipelago of islands of Hyères
Var

X Coord: 43.013872
Y Coord: 6.36295

Surface area: 58ha
Distance from main island:1km (Port-Cros)
Distance from mainland:1.46 nm

Biological issues

SPECIES OF INTEREST

Armadillidium quinquepustulatum; Cis quadridentulus; Euleptes europaea; Fumaria bicolor; Galium minutulum; Genista linifolia; Limonium pseudominutum; Orobanche sanguinea; Pancratium maritimum; Patella ferruginea; Puffinus yelkouan; Romulea florentii; Urticicola suberinus, and others.

INVASIVE SPECIES

Carpobrotus spp.; Rattus rattus

The island of Bagaud is a satellite of the island of Port-Cros, and is shielded from anthropogenic influence via its status as a National Park "full-coverage nature reserve" and its land tenure status (the island is owned by the Conservatoire du Littoral). From 2009 - 2019, a ten-year ecological restoration programme was established, led by the Port-Cros National Park (*PNPC*) in collaboration with the Mediterranean Institute for Biodiversity and Marine and Terrestrial Ecology (*IMBE*) and the National Mediterranean Botanical Conservatory (*CBNMed*). The objective was to carry out a scientific study and management operation over the long term, integrating the joint eradication of sour fig plants, *Carpobrotus spp.* and the Black Rat, *Rattus rattus*, in order to improve the conservation of native species identified on the site.

Key dates

Mid 2009 - mid 2011:
Start of programme, baseline data, start of ecological survey (flora, entomofauna, avifauna, squamata)
2011-2012:
Initial Eradications of *Carpobrotus* and Black Rats
2012:
Eradication of *Carpobrotus* on cliff faces
2012-2019:
Post-eradication monitoring of indigenous taxons and biosecurity (Carpobrotus: 2012 - 2015, 2017 - 2019: Black Rat: several missions per year, checks stepped up in 2013, 2014, and 2018)

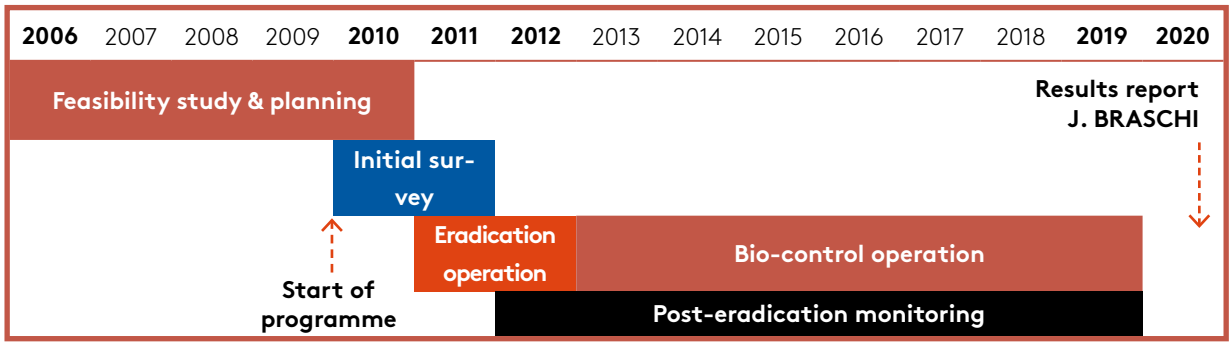


Diagram of the Ten-year programme on Bagaud, 2010-2019

What were the methods used?

Eradication of Black Rats

With the support of the Rennes INRA, a mechanical trapping campaign (lasting 22 nights) was carried out all across the surface of Bagaud (2011), followed by a chemical pest control phase. 886 bait trap posts were installed across the island using a 20x25m grid, and 29 additional bait posts were positioned on vegetation-covered cliffs accessible via sea. Given the density of ground-level vegetation (maquis) on the island, the installation of these devices required 21km of pathways to be opened up all over the island. The operation was deemed a success in 2014, after over 2049 night traps. (KREBS etal., 2014 ; LORVELEC and LE QUILLIEC, 2014).

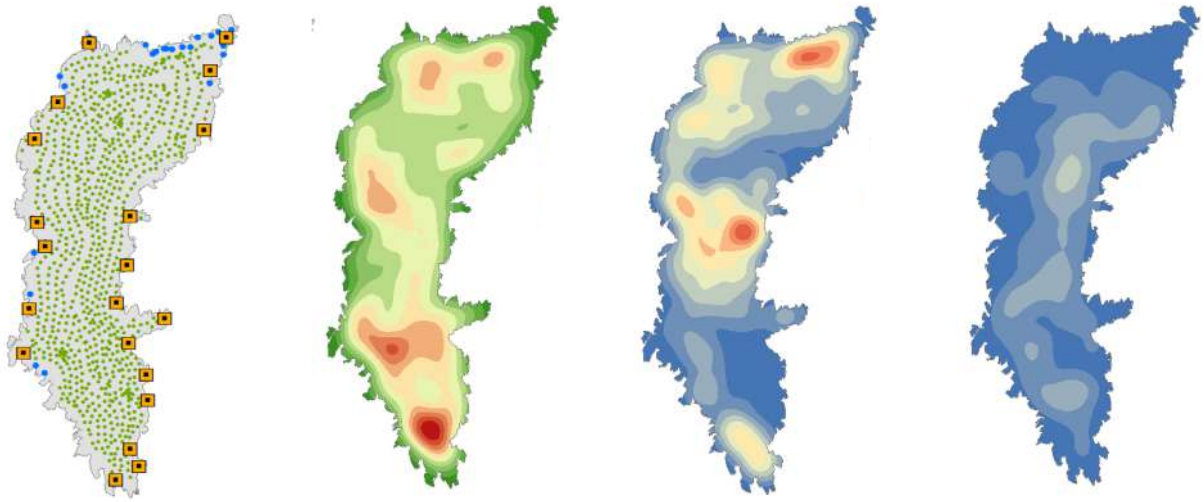
In 2015, following the implementation of a biosecurity monitoring procedure, the species was again detected in the north of Bagaud (KREBS, 2015). Following numerous biocontrol efforts and a trapping campaign implemented in 2018, the species was still present on the island in 2019. The attempted eradication having been unsuccessful, the question now is whether or not the current population are descended from survivors of the eradication or from rats originating outside the island. In 2018 the INRA carried out a spatio-temporal genetic analysis of the rat populations on small islands around Port-Cros, comparing them to nearby island and mainland populations.

Map of the 886 trap and bait posts, the 29 additional posts in cliff areas, and the 20 permanent posts around the periphery

Density of Black Rat captured in September 2011

Number of blocks of toxic bait eaten into in September 2011

Number of blocks of toxic bait eaten into from October 2011 - June 2012



Attempt to eradicate the Black Rat, *Rattus rattus*, on the island of Bagaud in 2011 (based on RUFFINO etal. 2015; cartography by D. Fourcy).

A separate genetic analysis of the populations of the islands around Port-Cros shows that Black Rat populations are relatively isolated from one another. We can confirm, based on the results of genetic analysis using samples taken during the initial eradication campaign, that at present there is little interaction between the islands. A fresh attempt could therefore be made at eradication.

Eradication of Carpobrotus spp.

Forty tonnes of Carpobrotus spp. were manually cleared from an area spanning 18,000 m2 between 2011 and 2012, including cliff areas. The initial operation was followed by numerous inspection operations. Temporal changes in plant communities were analysed within permanent plots (100 m^2 and 16 m^2) before (2010-2011) and after eradication of the Carpobrotus (2013-2019).

The regrowth of indigenous flora has increased considerably since 2013. The recovery of halo-tolerant indigenous species in the coastal zones seems to have occurred more rapidly than that of the halophilic grasses and subshrubs on the island's interior.

Eradication	Accessible sites	Cliff areas
Cleared surfaces (m2)	11,000	8000
Human resources (man-days) / financial resources (€)	54 m.d / €11,302	162 m.d / €100,703

The eradication of sour figs has been a success: low levels of regrowth, increasingly sparse in areas that were once heavily invaded and have now been recolonised by indigenous flora. The number of seedlings pulled up annually continues to diminish over time, thereby exhausting the soil seed bank. In flat areas where sour fig plants were uprooted, the dynamic of recolonisation by plant communities seems to be forming a blend of vegetation classified as "halo-nitrophile meadows." The cliff areas where sour figs were pulled up appear to be shifting toward a standard blend of coastal vegetation. As such, after 10 years the operations to eradicate sour fig plants have resulted in success, along with the simultaneous recovery of indigenous vegetation.

Monitoring by ecologists

Four biological sectors were monitored over a ten-year period (vascular flora, nesting and marine avifauna, entomofauna and herpetofauna) in order to monitor the areas' levels of ecological resilience, and were the subject of numerous publications.

	Positive results	Negative results	Conclusions
Yelkouan Shearwater	Increase in reproduction levels in 2012, 2013, 2017 and 2019. Discovery of new burrows in 2019. No visible signs of predation.	Drop in reproduction rates in 2014. Reproductive success rates low. No sign of reproduction among Scopoli's Shearwater or Cory's Shearwater.	Only species of Procellariiformes for which nesting is certain. No clear trend. Headcounts low but rising slightly (9-11 couples). Low reproductive success: 2 chicks in 2019
Terrestrial birds	Headcounts generally positive (though fluctuating) for five species, including the Sardinian warbler and the common nightingale. Rise in species diversity. Three new nesting species	Low number of sightings of blue rock thrush and the European nightjar. Weak population dynamic for carrion crows and peregrine falcons. Highly variable for the European shag.	Positive effect on the community. 3 new nesting species: blackbirds, Eurasian scops owl and common wood pigeon. Situation generally favourable for the pallid swift, common shelduck, Sardinian warbler, common nightingale and common chaffinch.
Common Wall Lizard	Increase in numbers of young sighted, but this cannot be attributed with certainty to the eradication programmes.	No increase in the number of sightings.	No significant trend. Results difficult to interpret.
Montpelier Snake	Likely diversification in diet; no radical slump in numbers which is proof of effective reproduction.	Protocol sub-optimal. No significant trend.	Only individuals sighted (outside protocol). The specific conditions on Bagaud (dense vegetation) did not allow for the implementation of an adequate protocol (distance sampling). Colonisation of the southern tip following removal of Black Rats
European Leaf-toed Gecko	Increase in number of young sighted. Very positive population dynamic, with solid population density by the end of the programme (2019).		Positive results; densities among the highest in Mediterranean island populations. Adaptation of behaviour among young, who could be observed outside cracks when Black Rats were absent, before retreating inside when they returned. Survival rate of young is positive.
Arthropods	Increase in abundance of arthropods. Increase in abundance of saprophytes, phytophages and detrivores.	Decrease in abundance of predators and parasites.	Results are generally positive, but should be treated with caution as they are difficult to accurately interpret. Awaiting results of the specific study by J. Braschi.
Vascular flora	Increase in coverage and species diversity of indigenous vegetation.		Rapid resilience of coastal plant communities; less so for plant communities further inland. Conservation of heritage species stations

Overview of results of indigenous taxon monitoring during the Bagaud ten-year programme

Human and financial resources

The ten-year programme has involved almost 355 people over the course of a decade, and has required significant financial input: an estimated €1,585,000 in total, i.e. €2,733/ha/year (sourced notably from EU financing, the Total Foundation, and FEDER (for Europe), the Port-Cros National Park, the regional government of Sud Provence-Alpes-Côte d'Azur, the TLV company, and others). Eradication efforts carried out on cliff faces were notably costly.

What were the difficulties encountered?

Arrival of the wild boar (2015)
The issue here is the impact of this species on rare and endangered species, such as the Romulée de Florent flower, the conservation of which is a region-wide concern. According to the scientific council of the PNPC: the specific status of the island of Bagaud, as a full-coverage nature reserve, requires specific consideration [regarding the wild boar issue] for an area in which non-interventionism is the norm." Given that the arrival of wild boar on Bagaud could potentially disturb the interpretation of the results of studies that have been underway for over half a decade, it was decided that their impact on the site should be quantified.

Issues linked to the island's remoteness
(including access being dependent on weather conditions)
Weather, too few staff trained to drive boats, transport of heavy loads, steep terrain, etc.: these obstacles have impacted the regularity of checks (notably rat trapping stations which can only be accessed by sea, as well as monitoring of flora and fauna, etc.). Moreover, as often occurs with long-term programmes, it has been difficult to weather the exhaustion of financial resources, the management of material resources and the waning motivation levels of the teams involved.

Oil spill (2018)
70m² of coastline was contaminated by an oil spill. Given that the areas affected on Bagaud were mostly bare rock, and that the measures applied to clean the rocks and beaches can be destructive to the environment, no anti-pollution operations were carried out, so as to avoid any overly-intrusive cleaning operations in a nature reserve where there is no need to accommodate tourism-related concerns. Plans have been made to monitor the effects of this pollution in the medium term.

What results were seen ten years later?

- Successful eradication of the sour fig plant, return of indigenous flora, improved knowledge base (species distribution, etc.), discovery of new species, various additional inventories taken (lichens, heteroptera, chiroptera, inventory of historic structures, etc.).
- Difficulties in monitoring Black Rat numbers, usefulness of biosecurity, discovery of new colonies of yelkouan Shearwaters, positive population dynamics for certain nesting passerines,
- New disruptions: pollution by hydrocarbons, arrival of wild boars on the island, etc.
- Showcasing the value of the ten-year programme via over 70 published studies and articles, reporting seminars, and various communications within research symposiums (REVER network, Life Calanques, etc.).

Future Prospects

A ten-year monitoring plan for 2020-29 is currently being drawn up based on the lessons learned over the previous decade; meanwhile, new issues are now being faced by authorities responsible for island management, notably including:

- Continuing to combat the proliferation of the two invasive alien species (continued biosecurity efforts)
- Ongoing monitoring surveys by ecologists (which protocols should be used to study overall change?)
- Management of wild boar populations
- The implementation of marine protective measures (non-removal areas around Bagaud, creation of mooring and light equipment zones, etc.)

Bibliographic references

ABOUCAYA A. & KREBS E., 2015. ***Le programme décennal de restauration écologique de la réserve intégrale de l'îlot de Bagaud (Parc national de Port-Cros). Quelle résilience peuvent présenter des milieux insulaires méditerranéens suite à l'éradication d'espèces exotiques envahissantes?*** *Scientific convention held by the organisation of French national parks: "Des espaces protégés pour interroger, accueillir et accompagner la recherche." 23-24 November 2015, Montpellier (France)*

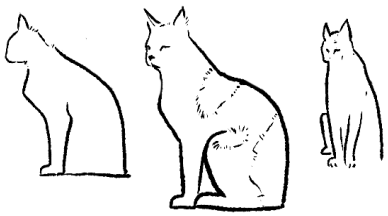
COTTAZ C., ABOUCAYA A., KREBS E., PASSETTI A. & BUISSON E. (coord.), 2020.***Programme de restauration écologique de la réserve intégrale de l'île de Bagaud, Parc national de Port-Cros. Overview of activities and results of the ten-year programme - 2010-2019 phase.****Report by the Port-Cros National Park and the Porquerolles national Mediterranean Botanical Conservatory, 118 p + annexes.*

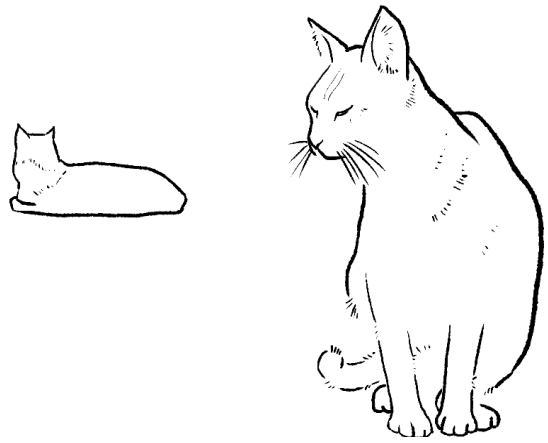
KREBS E., ABOUCAYA A. & PASSETTI A. (coord.), 2014. ***Programme de restauration écologique de l'île de Bagaud: synthèse des activités. Phase: 2010-2014.*** *Report by the Mediterranean Institute of Biodiversity and Ecology, and the Port-Cros National Park, 53 pages + appendices*

KREBS E., PAVON D., PONEL P. & AUDEMARD K., 2014. ***Restauration écologique de l'île de Bagaud. State of affairs [poster presentation].*** *Presentation seminar for the ecological restoration programme for the Bagaud nature reserve. Port-Cros national park. 16 December 2014, Aix-en-Provence (France)*

LORVELEC O., LE QUILLIEC P., FOURCY D., PASCAL M. et al., 2014. ***L'éradication du Rat noir d'îles méditerranéennes : une méthode intégrant piégeage et lutte chimique.*** *Presentation seminar for the ecological restoration programme for the Bagaud nature reserve. Port-Cros national park. 16 December 2014, Aix-en-Provence (France)*

Cats and islands





The subject of "Cats and Biodiversity" is an emerging topic in conservation biology, both in continental France and on a more general, global scale (in Australia, New Zealand, Great Britain and the USA, for example). In France, the National Museum of Natural History has been leading a participatory survey into feline predation since 2015, and at the same time is studying the impact cats have on garden bird populations (PAVISSE et al., 2019).

The statistics being published outside France paint a clear picture (MEDINA et al., 2011): American publications in this field indicate that around 3.6 million birds a day are killed by domestic and feral cats (the latter being once-domestic cats that have been returned to the wild). In Great Britain, the figure reported was 55 million birds killed per year. Although widespread, the idea that cats which are fed (as pets) no longer hunt is a misconception. In Australia, it is estimated that feral cats prey on 750 animals per year, compared to 74 for roaming domesticated cats. In total, some 2 billion animals are killed by cats each year on the island continent.

As such, their impact on ecosystems is particularly significant, but every initiative to try and regulate roaming and feral cats runs into the same issue: the sense of attachment associated with these domesticated species. Indeed, the earliest evidence of domestication stretches back almost 9,000 years (OTTONI et al., 2017). This long history of reciprocal benefits generates real difficulty in the implementation of initiatives aiming to regulate or even eradicate cat populations. As such, in France, more flexible actions have been put in place, albeit with limited effectiveness: these include both sterilisation and the transfer of captured individuals to specialist centres (Society for the Protection of Animals).

Their impact on continental ecosystems is significant, and drastic on island ecosystems. In Australia, the impact of this species on the endemic biodiversity of the island-continent led to widespread awareness of the issue, followed by efforts to create sanctuaries spanning almost 10,000 hectares, as well as a plan to eradicate almost 2 million cats by 2020.

Given that cats are generalist predators, their diet of prey varies from island to island, ranging from large birds to small insects, as well as mid-sized mammals (BONNAUD et al., 2010). Their impact on island species is particularly disruptive because these species have not developed any defensive strategy to help them deal with a predator they have never encountered before. As such, on the islands, it is estimated that felines are responsible for the disappearance of 14% of native bird, reptile and mammal populations (MEDINA etal., 2011).

Moreover, the impact of cats on island biodiversity is made more significant when other "prey species" are also introduced to the ecosystem in question (MEDINA etal. 2011). Indeed, feral cats are rarely the only species to be introduced to the islands. When other "prey species" are also present (such as the European rabbit), rather than reducing the impact of cat predation on island vertebrates, the vulnerability of endemic species tends to increase due to the combined impact of the two species. However, in such situations, eradicating cats does not systematically reduce this vulnerability.

Once several species have been introduced to an island along with cats, the impact of any eradication campaign must necessarily be assessed in a way that includes the indirect effects of their disappearance on their prey species, and their consequences for native species. Indeed, the behaviour of generalist predators entails the regulation of prey species, whose numbers and impact on the ecosystem will then increase once the predator is no longer present.

As such, considering the vast numbers of endemic and vulnerable species on the islands, programs for the eradication of cats should target these ecosystems as a priority (NOGALES etal. 2013). To date, less than 100 initiatives for the eradication of cats on the islands have been recorded, despite their dramatic impact on island vertebrate populations on at least 5% of the world's small and medium islands.

Any plan for the eradication of cats within an island ecosystem must therefore take all these aspects into account. Population regulation or stepping up localised captures around marine bird colonies may be the most suitable solution, notably in cases where the cat population is historically established, and even more so in the context of inhabited islands. In cases where the population has been recently introduced and numbers remain limited, eradication may have a real chance of success if carried out rapidly, thereby limiting the rising impact on native species. These initiatives have an even greater chance of success on islands where the land surface is smaller, numbers of individual animals remain low, or the chances of re-invasion are limited. However, and particularly on inhabited islands, the chances of success require that social acceptance and public perceptions be taken into account for any initiatives seeking to manage cat populations, as currently these aspects remain under-researched (DEAK et al., 2019).

Bibliographic references

BONNAUD E., MEDINA F.M., VIDAL E., NOGALES M., TERSHY B., ZAVATELA E., DONLOAN C.J., KEITT B., LE CORRE M. & HORWATH S.V., 2010. ***The diet of feral cats on islands: a review and a call for more studies.*** *Biological invasions.DOI 10.1007/s10530-010-9851-3.*

DEAK B.P., OSTENDORF B., TAGGART D.A., PEACOCL D.E. & BARDSLEY D.K., 2019. ***The significance of Social Perceptions in Implementing Successful Feral Cat Management Strategies: A global Review.*** *Animals 2019, 9, 617; doi :10.3390/ani9090617*

MEDINA F. M., BONNAUD E., VIDAL E., TERSHY B. R., ZAVALETA E. S., JOSH DONLAN C., KEITT B. S., LE CORRE M., HORWATH S. V. AND NOGALES M., 2011. ***A global review of the impacts of invasive cats on island endangered vertebrates***. *Glob Change Biol, 17: 3503–3510.*

MEDINA F.M., NOGALES M., 2008. ***A review on the impacts of feral cats (Felis silvestris catus) in the Canary Islands: implication for the conservation of its endangered fauna.*** *Biodiersity Conservation (2009) : 18 :829-846.*

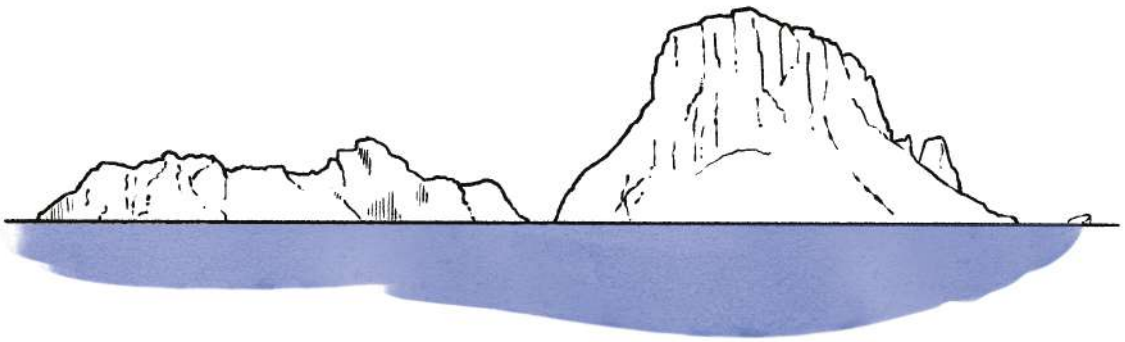
NOGALÈS M., VIDAL E., BONNAUD E., TERSHY B.R., CAMPBELL K.J. & ZAVALETA E.S., 2013. ***Feral Cats And Biodiversity Conservation : The Urgent Prioritization Of Island Management.*** *BioScience 63 :804-810.*

OTTONI, C., VAN NEER, W., DE CUPERE, B. et AL. ***The palaeogenetics of cat dispersal in the ancient world.*** *Nat Ecol Evol 1, 0139 (2017). https://doi.org/10.1038/s41559-017-0139*

PAVISSE R., VANGELUWE D. & CLERGEAU P., 2019. ***Domestic Cat Predation on Garden Birds: An Analysis from European Ringing Programmes.*** *Ardea, E. J. Brill, 2019, 107 (1), pp.103.0.5253/arde.v107i1.a6. hal-02188701*

The goats of Vedrà

With the contribution of Joan Mayol,
biologist, Head of technical nature conservation
in the Balearic Islands from 1981 to 2019, and president of the PIM initiative



Es Vedrà
Ibiza
Autonomous Community of the Balearic Islands

Coord X: 38,8668
Coord Y: 1,19726

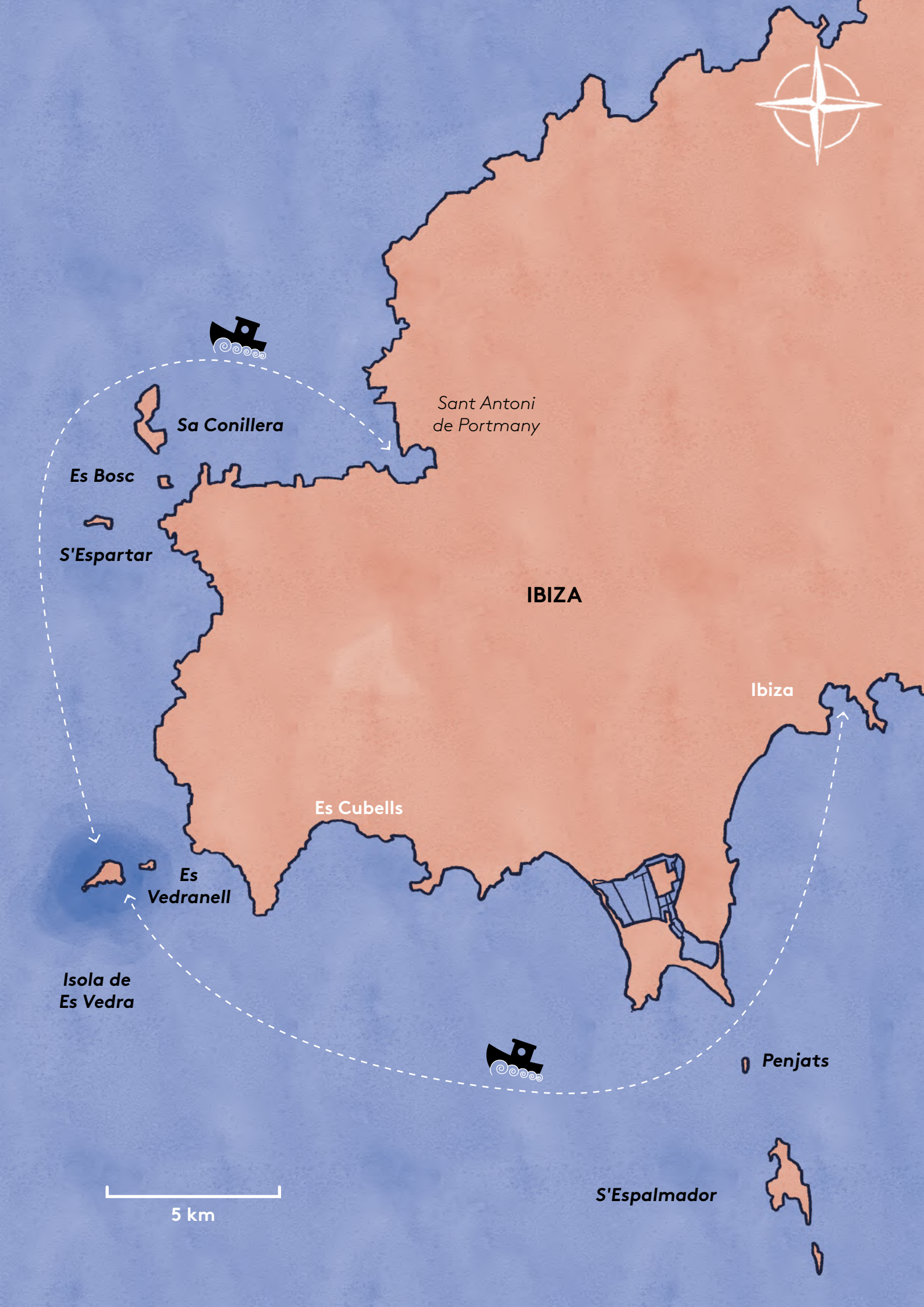
Superficie: 62 ha
Distance from the main island: 0.3 km (Ibiza)
Protection status: Natural Reserve of the Illots de Ponent

Biological data

The area shows the largest differentiation in Pitiusas lizards, with very differentiated forms, some of which are melanic. The seabird colonies are remarkable; among them are the largest of the Paiño seabirds in the western Mediterranean (S'Espartar). Remarkable endemic and relict plant species. High biodiversity and well-preserved seabed.

Invasive species

In the past, goats (one of the 100 worst invasive species in the world, according to IUCN) were present on the islands of des Bosc, Conillera, and Vedrà, as well as rabbits and black rats, which were also present on Es Vedranell. Conversely, there is almost no trace of invasive flora. Of specific concern is the possible recent introduction of ophidians (*Hemorrhois Hippocrepis*) in Ibiza.


Sant Antoni
de Portmany
Sa Conillera
Es Bosc
S'Espartar
IBIZA
Ibiza
Es Cubells
Es
Vedranell
Isola de
Es Vedra
Penjats
S'Espalmador
5 km

The use of islets as corrals for herbivores is an ancient practice. For millennia, seafarers have used islets to easily supply meat. This practice has existed since times immemorial in the Mediterranean (one only has to consider the toponyms referring to goats and pigs on many small islands). Many small islands were used by nearby farms as temporary corrals. These practices were very widespread until the first half of the 20th century. They are documented on more than 20 small islands in the Balearic Islands and have had variably severe impacts on their vegetation.

Es Vedrà is the undivided private property of fourteen families. For the last two hundred years, they have kept a flock of semi-wild goats on the island and 'harvested' the kids at Easter and Christmas, a risky operation due to the rugged terrain (over 380 m high). This practice was abandoned in the second half of the 20th century, and the flock disappeared. The flora (172 taxa, including 21 endemic, micro-areal or precious species) is the most valuable of the Pitiusas and has recovered spectacularly.

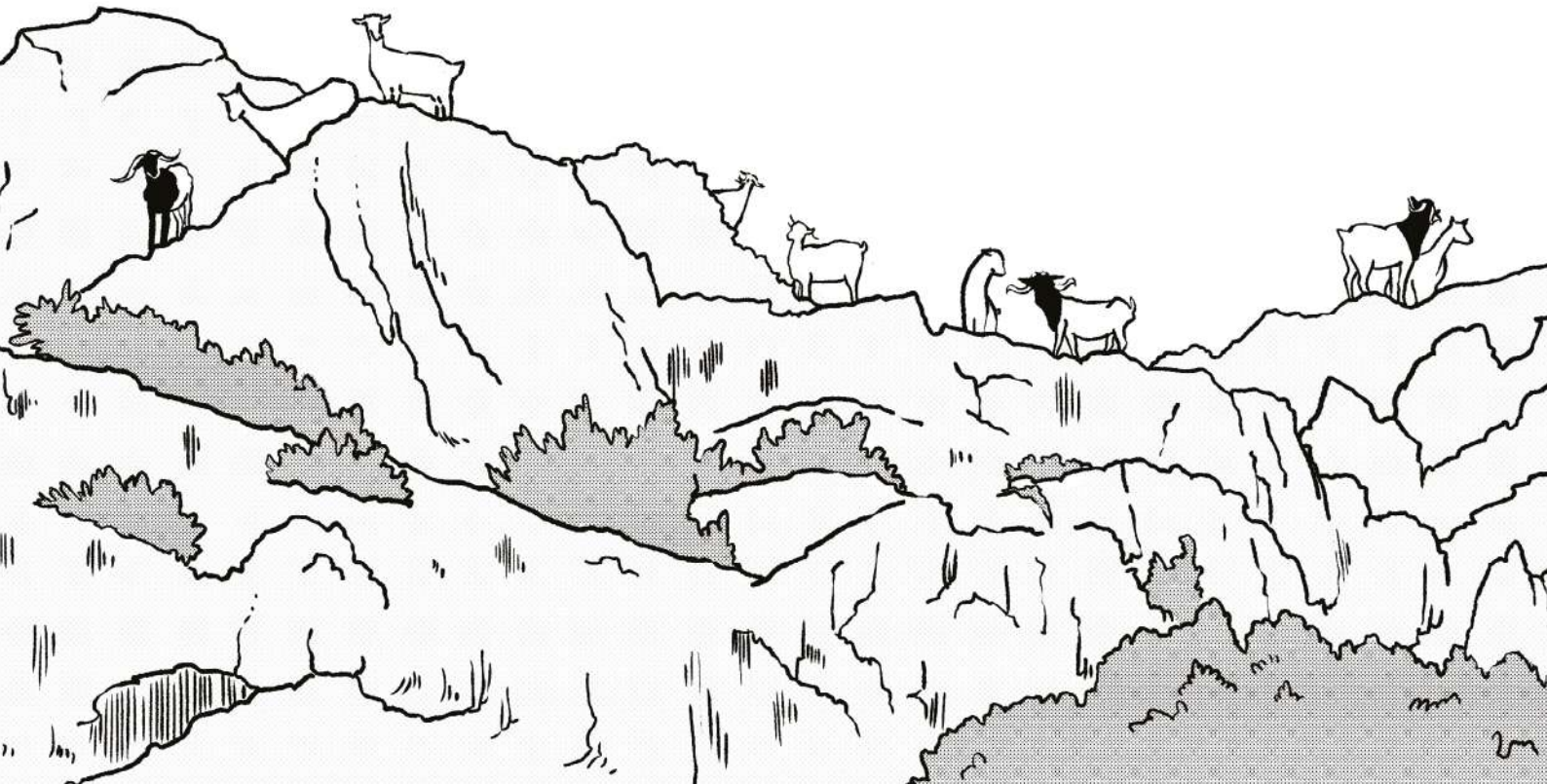
In 1995, goats were once again released on the island to revive the tradition, but control was deficient, captures were sporadic, and the flock numbered more than 100. This caused a severe impact on the vegetation and triggered erosive processes in some places.

When the area was declared a nature reserve in 2002, livestock farming was banned, but the presence of goats was nevertheless maintained. Several attempts to engineer a solution with the landowners' agreement failed, and political reasons complicated the controversy. Botanical studies demonstrated the dramatic degradation of the vegetation and the near disappearance of some endemic plant species.
Finally, in 2015, a removal procedure was initiated by formally informing the owners of the flock's illegality, the absence of mandatory health management, and the ownership requirement. None of the owners acknowledged this information. As a result, the goats were categorised as animals with no owners, and the Director General of Natural Areas decided to remove them immediately. The animals' and the island's nature made live capture impossible, so a professional team of experts in controlling and eliminating invasive fauna shot 55 animals in three days. Other alternatives (corraling or snaring the animals, use of an anaesthetic rifle) had been previously examined but were considered unfeasible or risky for the operating personnel.

Animal rights groups, some island newspapers, the political opposition, and social sectors associated with esotericism (remember that es Vedrà is in Ibiza) reacted virulently, with various demonstrations and threats to those responsible for the decision. They succeeded in getting a judge to suspend the operation for several years. The administration fortunately stood firm, and the eradication was completed as soon as the case was judicially filed. Two politicians involved in the process eventually resigned from their posts due to pressure.

Five animals survived the 2016 operation, but in 2019, there were already 19. When it was judicially possible, all but one was shot down. It should be noted that on hundreds of islands around the world, goats have been eradicated using the quickest, most effective and most humane slaughtering method: slaughter by firearm.

The process was flawless from a legal and administrative point of view: the presence of goats had been expressly forbidden since the area had become a nature reserve, and the decision to intervene was made once the owners had been notified in due time and form. The scientific and conservation reasons were amply documented in the dossier. Several legal complaints filed by opponents were closed, although they had remained open for many months. Perhaps a prior information strategy might have lessened the intensity of the social protest. Still, it could also have led to a further postponement of the removal of the animals (as had been the case for 20 years). In any case, it is advisable to work with sociologists and communication specialists in such cases because, very often, the issues are not only biological but also social, and it is often the latter aspect that is the most complex and challenging to solve.



Photos Joan Rita UIB

Results of the goat eradication. A year later, the quasi-bare hillside was covered in a dense plant population dominated by the endemic *Diplotaxis ibicensis*.

TESTIMONIAL

Victor Colomar

Veterinarian
Head of the fauna control team of COFIB (Balearic Islands Wildlife Recovery Consortium).

The case of Es Vedra has become a classic in debates on controlling invasive species in the Balearic Islands and beyond. It highlights the importance of conserving specific animal and plant species in protected areas. Above all, it has confronted different visions (owners, animal rights activists, ecologists) in the debate on nature management, especially in Ibiza and Formentera. Ultimately, conservation and the law prevailed over immobilist and animalist positions.

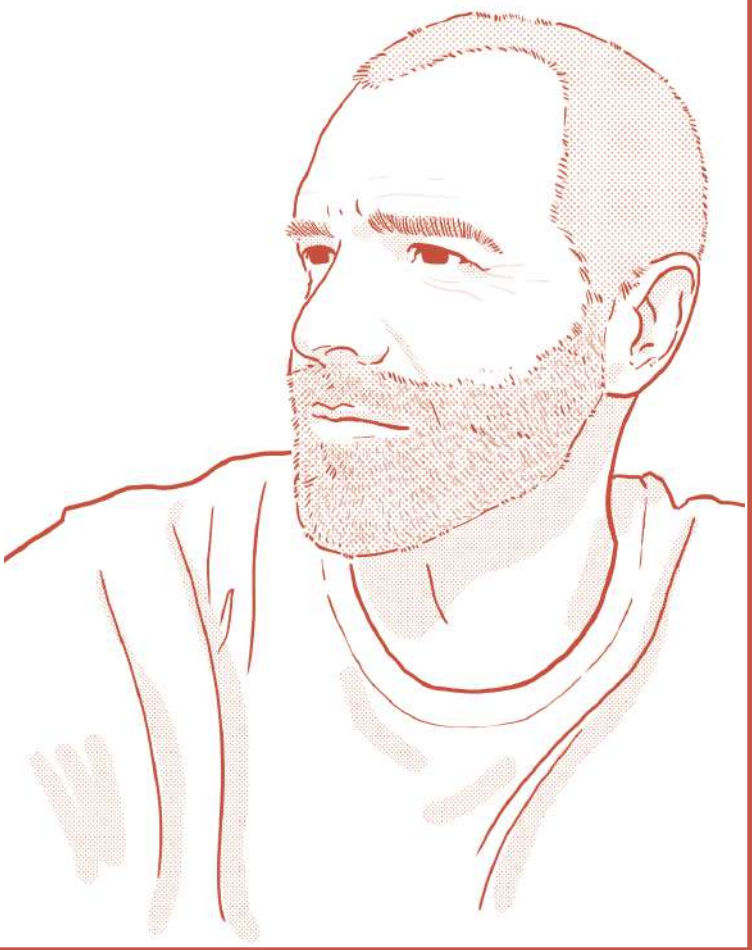
To free the islet of feral domestic ungulates entailed overcoming numerous hurdles and listening to opinions and proposals, some of which border on the ridiculous. It would be laughable were it not because the action involved great stress and even suffering for some managers.

Our team is grateful that the political and administrative decision-makers merely set the goal and allowed us to determine the how and when of our experiment, especially in such a complex field and regarding such a highly scrutinised operation.

Once non-cruel possibilities had been ruled out and the decision had been taken, discretion and efficiency had to be exercised. The use of firearms was precisely the goat control method employed in the Balearic Islands for decades. It was the one recommended by many goat management postulates and the only one that guaranteed to reach the objectives set without putting anybody at personal risk.

The goat eradication operation began uneventfully, discreetly and efficiently. However, an unfortunate leak sparked a huge media uproar, alerted many opinion makers and managed to bring the process to trial and paralyse it for months, which increased the number of individuals to be shot. Ultimately, the court ruled in favour of the interests of nature and thus guaranteed this type of action in the future.

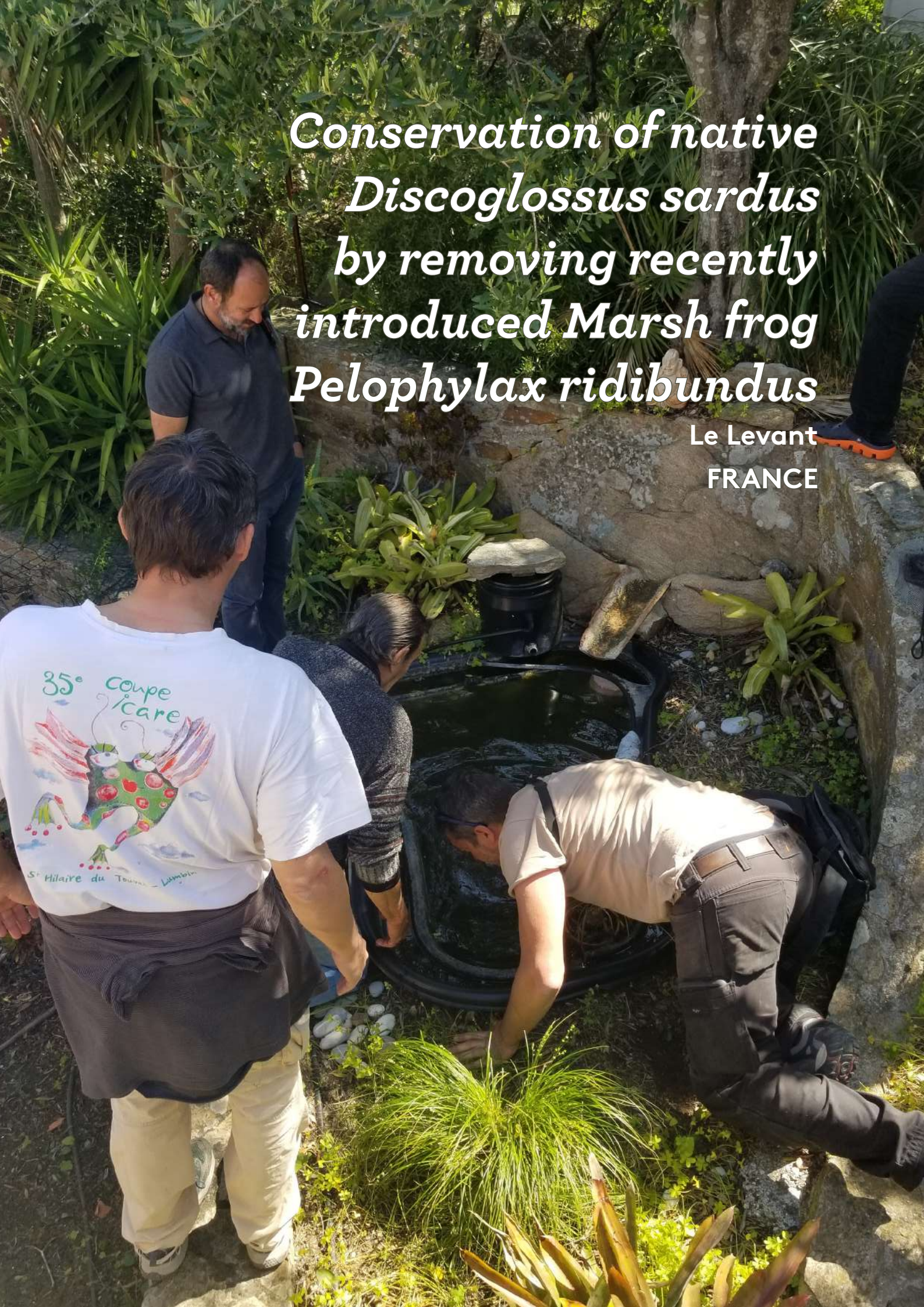
Today, notwithstanding all the difficulties, the islet's plant regeneration has turned it into a symbol of flora and fauna conservation on the islands of Ibiza and Formentera.



Conservation of native Discoglossus sardus by removing recently introduced Marsh frog Pelophylax ridibundus

Le Levant

FRANCE



Le Levant

France

Surface area concerned : 31 ha
Altitude : 138 m (highest peak)
Inhabited : on a small surface area, the island is mostly a military zone

Protection status : National Park of Port-Cros – Adhesion area
Focus : Invasive species

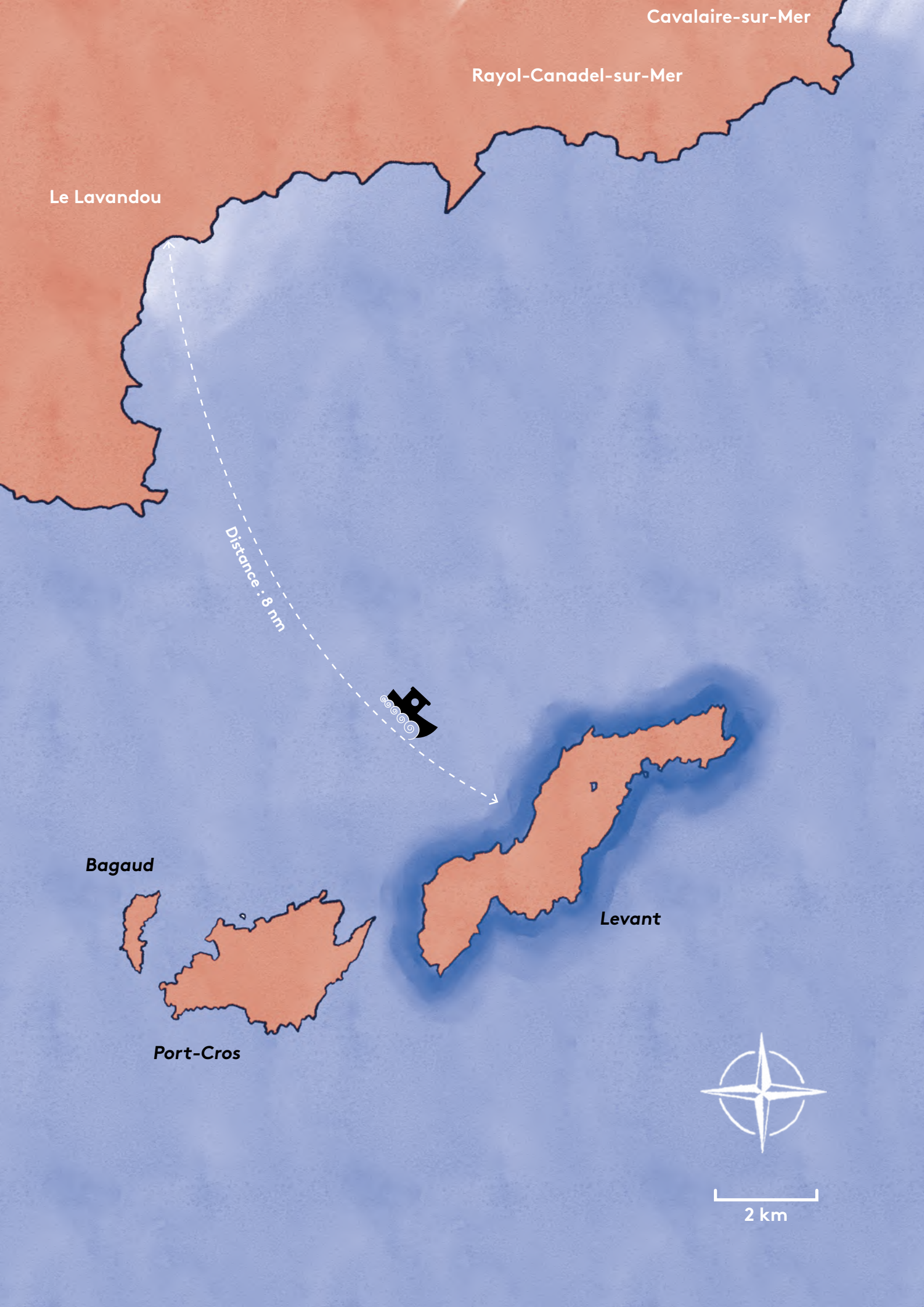
Biological challenges and sensitivity

Species of interest:
Discoglossus sardus

Invasive/Introduced species:
Pelophylax ridibundus

Characteristics of project working conditions

Only one native species of amphibians: *Discoglossus sardus*. Little information is available on the conservation status of the population, but it is, a priori, worrying because of **relatively low number and very localized breeding sites.**


Cavalaire-sur-Mer
Rayol-Canadel-sur-Mer
Le Lavandou
Distance : 8 nm
Bagaud
Levant
Port-Cros
2 km

May 2021	→	June 2021	→	May 2022
visit of the sites supposedly occupied and identification in fact, only 2 ponds occupied (with supposedly 12 or 13 individuals)		capture and removal of 12 *Pelophylax* individuals from the 2 ponds (conserved in the EPHE Collection)		Control session No *Pelophylax* founded

Project Description

The operation is part of a scientific partnership between PIM Initiative, AGIR Ecologique and the National Park of Port Cros. The team also benefits from the scientific supervision and advice of the members of the Scientific Committee of PIM as well as the voluntary support of Frédéric Capoulade, special deputy of Le Levant of the City of Hyères. **It aims at the eradication of individuals of *Pelophylax ridibundus* from the island of Levant (Var), located in the area of the Port-Cros National Park.**

Individuals of *Pelophylax ridibundus* were intentionally introduced on the island of Le Levant where it was not naturally present. It constitutes a risk for the population of *Discoglossus sardus*, the only native amphibian on the island. The area of natural presence of this species is limited to the islands of Hyères in France. **The presence of a non-native species and potential competitor of a local species requires urgent action.** Considering the small surface of the area of presence, the population of *Discoglossus sardus* are particularly fragile and the National Park has a strong responsibility towards its conservation.

Methodology

The private owners of the ponds located on the private part of the island were contacted in advance to allow intervention on their land.

Pelophylax ridibundus is also a protected species in France (only native in the Eastern part of France and introduced in the South) so, a request for exemption was issued by the Var DDTM for the capture and removal of individuals.

The methodology used was the manual capture of individuals in artificial ponds during the day. Spawning and tadpoles were also searched. A nocturnal control was carried out. **Once the individuals are captured, the simplest method is to consider euthanizing the individuals. Any translocation of the target individuals towards the continent is to be excluded considering the invasive character of the species.**

A control mission has been carried out in May 2022 to control the absence of individuals of *Pelophylax ridibundus*.

Main parameters considered for the implementation of the project

DISTANCE FROM CONTINENT

The island of Levant is located about 11 km from the coast of Le Lavandou and 7 km from the island of Port Cros.

ACCESSIBILITY

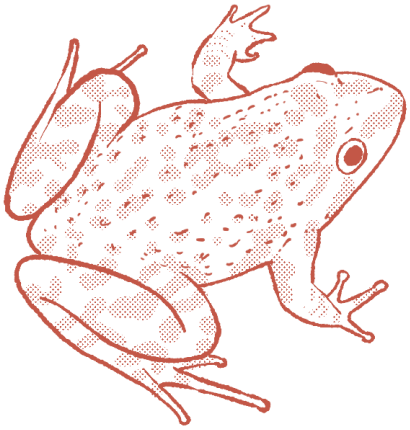
The private part of the island is accessible by sea shuttle. Over 75 % of the island is military and is not accessible. This part was not prospected on the project.

LOW-COST APPROACH

The operation consisted of manual capture and euthanasia *on site by an authorized person.*

LONG TERM CONSIDERATION

The major challenge in the long term is to avoid any reintroduction.
Particular attention will have to be paid to raising the awareness of the inhabitants in the coming years to avoid any reintroduction of individuals.



Operators

Vincent Rivière - AGIR Ecologique – In charge of the technical realization of the operation,
PIM Initiative – Coordination of the operation,
National Park of Port-Cros: Scientific and logistic support,
Frédéric Capoulade (Hyères Municipality): Support for the contact with the private owners of the artificial ponds, and awareness of the inhabitants,
Pierre-André Crochet (Centre d'Ecologie Fonctionnelle et Evolutive) : Scientific support, **Fabrice Bernard (Conservatoire du littoral)**: engaged in consultation processes with the island's inhabitants within the framework of the island actions of the NGO SMILO also supports the project.

Human and financial ressources

	Labour-time (days)
Elaboration of technical note and Protocol	3
Preparation of the field operation	3
Capture - Eradication	
Evaluation size population	2
Eradication	4
Control	2
Drafting report/Scientific note	1,5
Total labour-time	15,5
Total financial cost (including travel expenses and material)	**6580€**

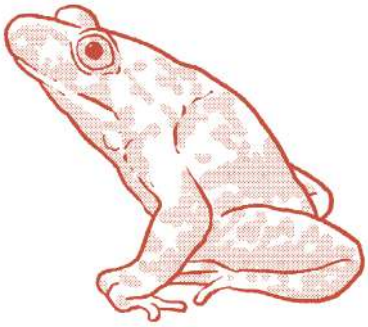
Selecting the appropriate intervention method

Installations/Facilities/Devices

The **first record of the *Pelophylax ridibundus*** by Deso was **in 2018** – 3 sites were occupied in the civilian part of the island. This increases pressure on the population of *Discoglossus sardus*: **rapid intervention is needed.**

The eradication by euthanasia and conservation of individuals was preferred to the translocation of the individuals, since *Pelophylax ridibundus* also has the status of an introduced species on the continent.

Results



Labour-time mobilised

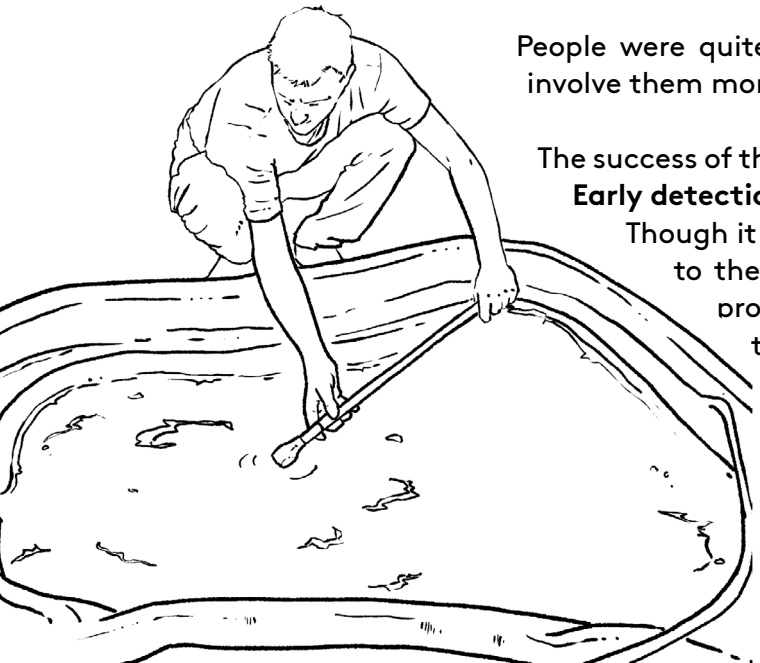
- 16 human days
- A Summary assessment of the size of the population mission, and eradication mission is given below:

Site	Villa Sandy	Villa Cassiopée	Vallon de l'Ayguade
Time of prospection (h)	*1h during the day + 30 min at night*	*1h during the day + 30 min at night*	*30 min*
Number of Pelophylax observed	*5*	*8*	*0*
Number of Pelophylax eradicated	*5*	*7*	*0*

Critique of the method

The operation is a success: no individual was found 1 year after the eradication, and inhabitants confirmed that they don't hear the marsh frog anymore.

Reasons for the introduction: lack of knowledge of the sensitivity of island ecological balances, even in a National Park



People were quite receptive, but **more education is needed** to involve them more in these conservation issues.

The success of this type of intervention is based on the principle: **Early detection / Rapid intervention.**
Though it took 3 years to get permission to intervene due to the inertia of the authorisation and consultation procedures (Validation by the Park and PIM scientific councils, etc)

TESTIMONIAL

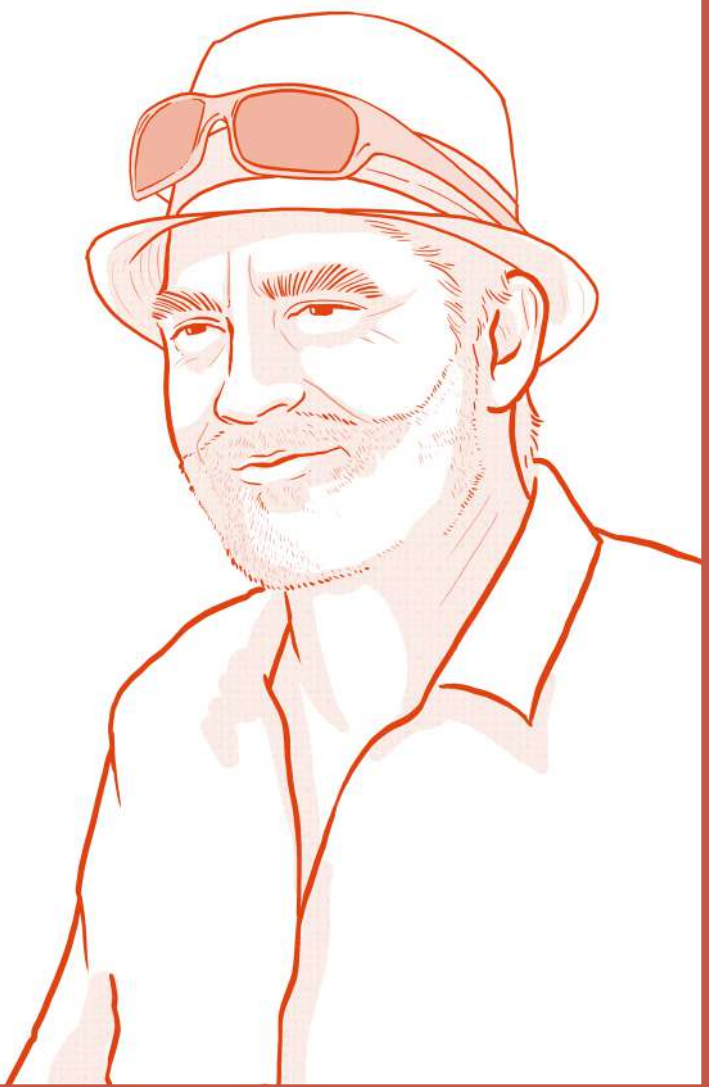
Vincent Rivière

AGIR Ecologique

In general, when it comes to intervening in the eradication of an invasive species, we face several obstacles. Technical feasibility is far to be the only one. It is also necessary to justify the action on a scientific level regarding the stakeholders, but also to show pedagogy. However, ethical questions very quickly arise in the debate, and scientific arguments cannot face them alone. Specifically for animal species, the emotional perception aroused by the species, linked to the cultural construction of the inhabitants, should be considered. The subject is often delicate and divisive, as illustrated by the example of cats in France.

It is important to take into account that invasive species actions absolutely need to be thorough in the mid-term. The operation success also depends obviously both on the technical feasibility, and once again on the acceptance of the inhabitants. The latter depends on their appropriation of the species into the local landscape. Thus, the longer a species is introduced, the more it occupies large areas and the more its presence is considered as native by the population.

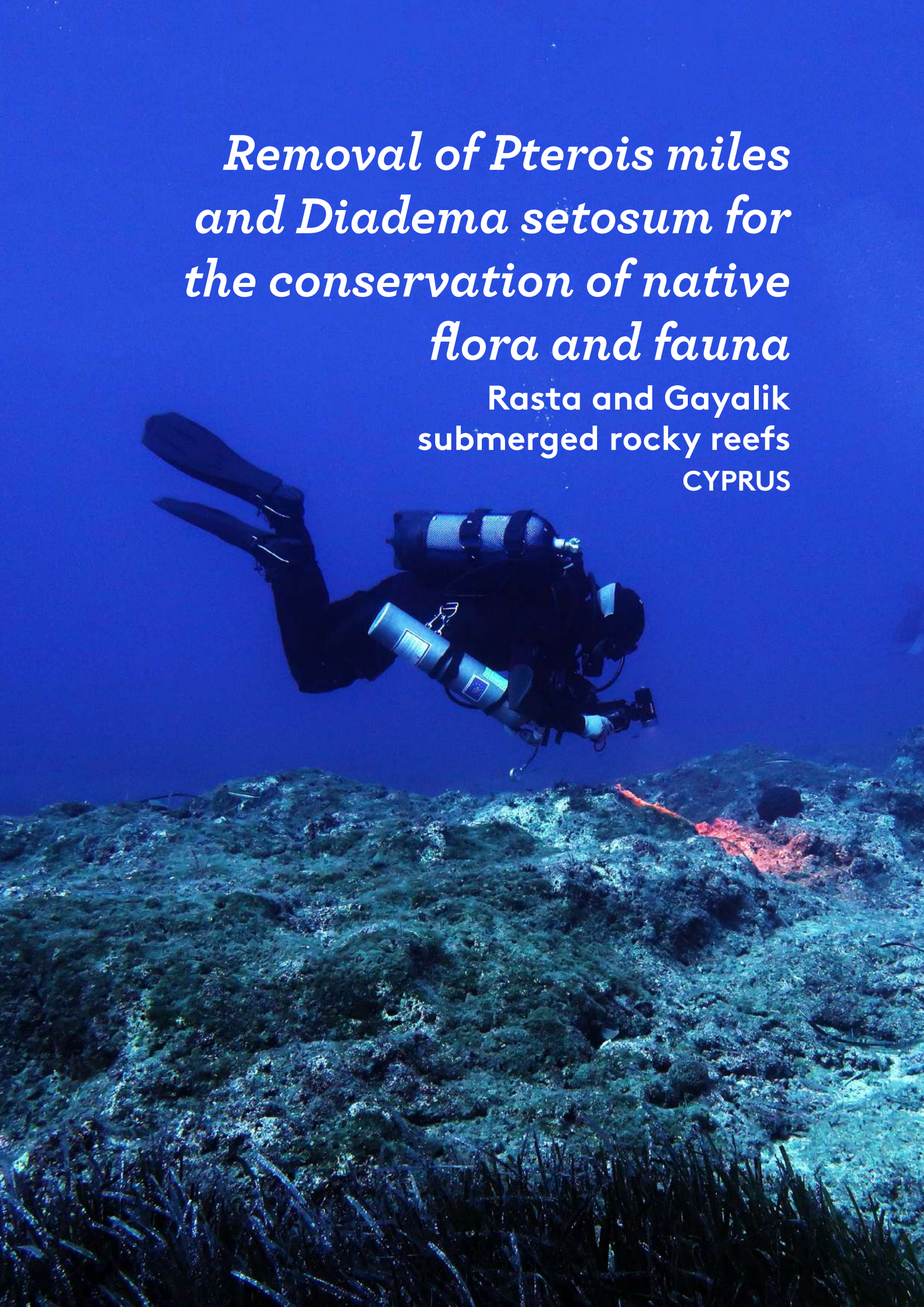
In our case, the conditions for success were met, fairly recent introduction (although dating back more than 10 years), few invaded environments, and very little appropriation of the species by the population, who, moreover, was already very concerned by island biodiversity conservation. Moreover, the mobilization around our intervention has permitted a dialogue with the inhabitants, who will tomorrow be the first rampart against a species reintroduction.



Removal of Pterois miles and Diadema setosum for the conservation of native flora and fauna

Rasta and Gayalik submerged rocky reefs

CYPRUS



Rasta and Gayalik submerged rocky reefs

Cyprus

Type of habitat & site: Submerged rocky reefs.
The two rocky reefs are part of a series of low relief outcrops on sandy bottom and discontinuous patches of the seagrass *Posidonia oceanica*. The monitoring activities were conducted along transects laid along the scarpe.
Depth: Rasta reef - 28m (Kyrenia),
Gayalik reef - 22m (Famagusta)

Protection status:
No official status of protection

Biological challenges and sensitivity

SPECIES OF INTEREST

Native groupers, *Epinephelus marginatus*, *E. costae*, *Mycteroperca rubra*; Occasional *Dentex dentex*, *Dasyatis marmorata* and *D. pastinaca*; Sea turtles - *Chelonia mydas* and *Caretta caretta*

INVASIVE SPECIES

Torquigener flavimaculosus, *Parupeneus forsskali*, *Sargocentron rubrum*, *Siganus rivulatus*, *Siganus luridus*. Focus on *Pterois miles* (lionfish) and *Diadema setosum* (long-spined sea urchin)

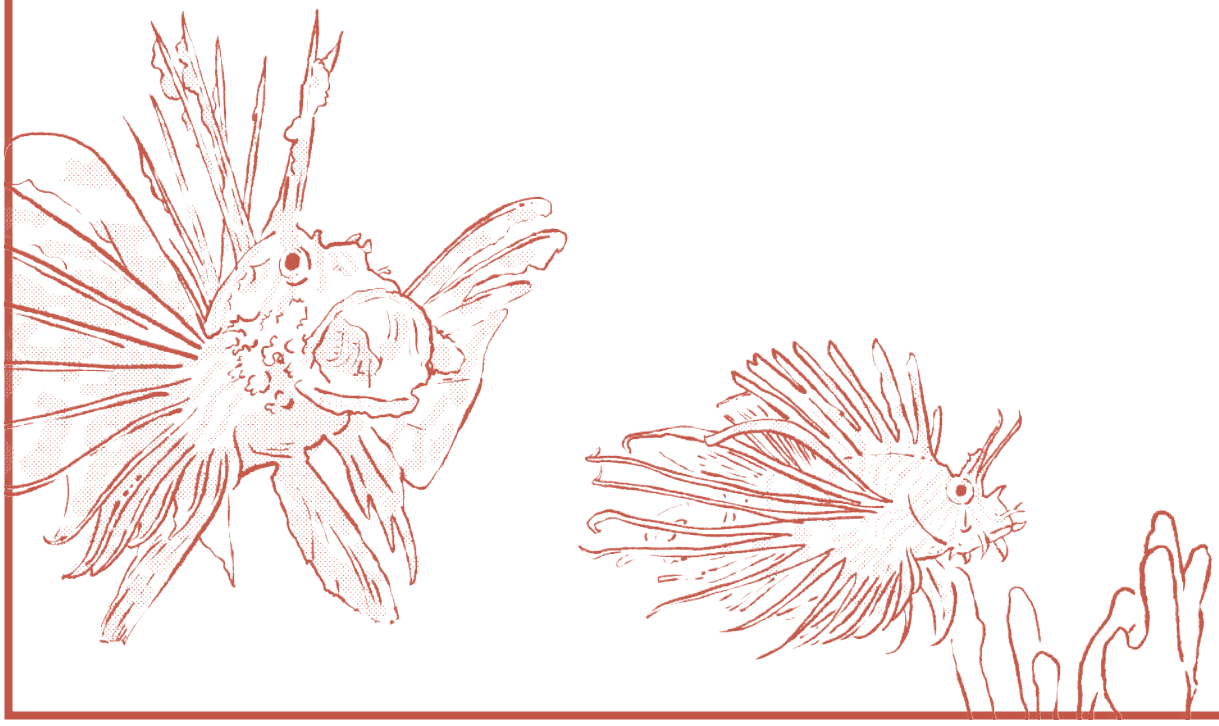

TÜRKIYE
Mersin
Alanya
Silifke
Anamur
Famagusta
Reef
CYPRUS
Rasta Reef
20 km

Characteristics of project working conditions

- The access to the sites is only possible by boat
- Fully exposed to heavy swells during unsettled weather and windstorms
- Visited by divers, spearfishers and fishers
- Unofficial protection due to being diving site

Project description

Research revealed that Cyprus island stands as a gate to the rest of the Mediterranean from East to West, for the Lessepsian invasive alien species (IAS). **Although many efforts to control several IAS have been carried out, knowledge on the effectiveness of removal activities is not sufficient.** In this project, we experimentally removed lionfish and long-spined sea urchins, two established IAS, from selected areas in Cyprus. A monitoring program (visual census along bottom transects) was launched at the beginning of the project in order to characterize the fish communities of the study sites, before and after the removal of the IAS. Removal of the IAS and a final assessment will demonstrate the recolonization potential of both the native species filling similar niches but also the IAS. With the successful completion of the project, monitoring will be continued with a voluntary approach by the trained diving professionals and the partners in this study.



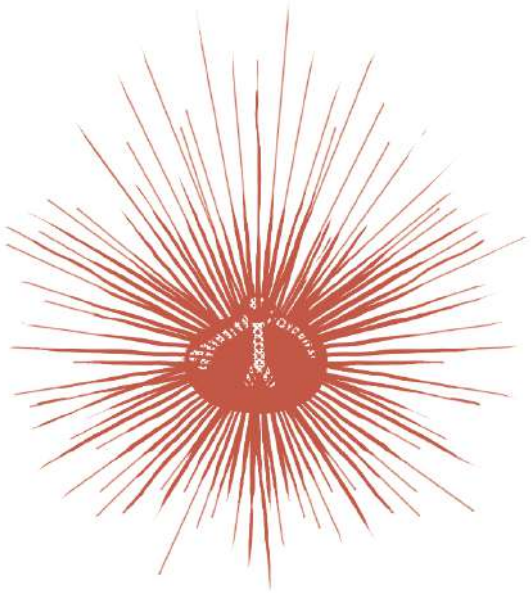
Main parameters considered for the implementation of the project

LOCATION

Rasta and Gayalik reefs are about 1 km and 0,8 km from the coast, respectively. In consequence, the monitoring activities are infrequently affected by human activities.

LOW-COST APPROACH

With the exception of the essential scuba diving gear, the materials used in the implementation of the monitoring and culling activities were few and of low cost: measuring tape to lay the transect, slingshots and polypropylene containers for IAS removal.



WEATHER

Due to their offshore location, the two study sites are exposed to the swells. Fieldwork had to be accommodated often to the sea conditions.

SCUBA DIVING REQUIREMENTS

Since the monitoring and culling activities require experienced divers familiar with decompression procedures, technical diving skills and gear are highly recommended for this type of project at offshore, submerged rocky reefs.

SEASONALITY

Monitoring activities need to include more than one seasonal cycle in order to measure change and identify trends according to IAS removal.

Operators

Main partners in the project were SPOT and ENALIA. Other participants contributed officially and unofficially to many activities related to the project.

Human and financial resources

During the project, several students and volunteers participated in the activities: one undergraduate student and one PhD candidate learned about the monitoring and culling methods by taking part in the visual census and subsequent cullings. Other university students and volunteers (e.g., scuba divers) assisted occasionally.

CO-FUNDING = 11 000 €

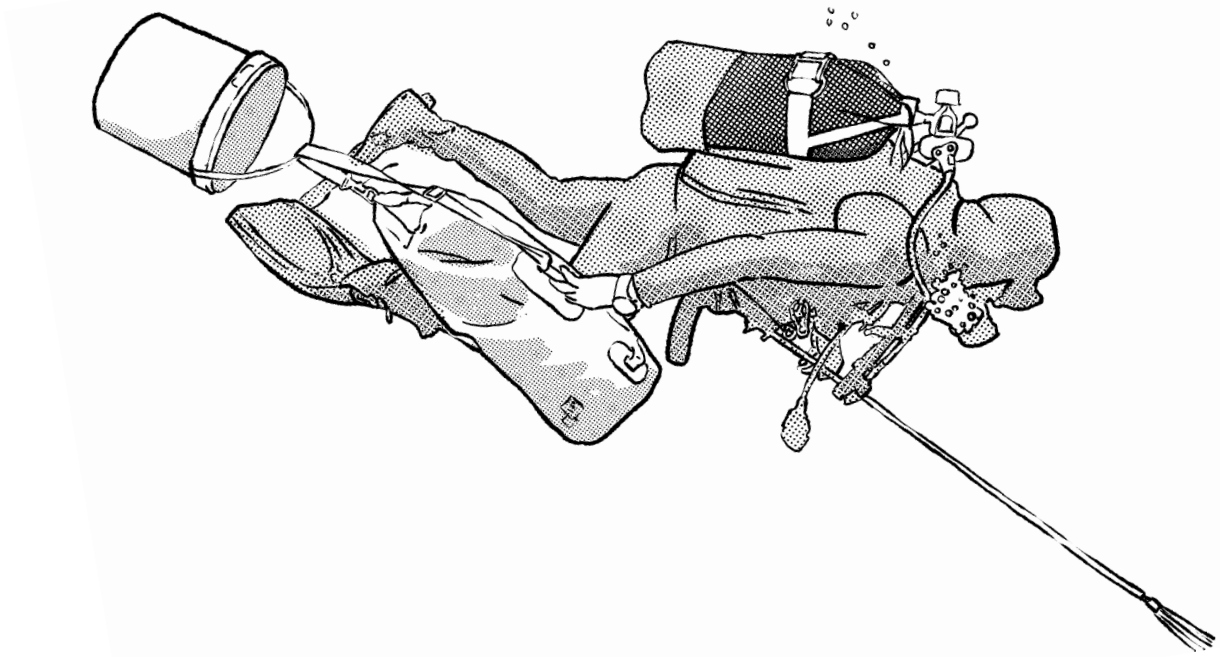
This includes four technical diving gears, vehicles to transport embarkations, participants and gear, salaries of the main researchers and administrative costs of the project.

Selecting the appropriate intervention method

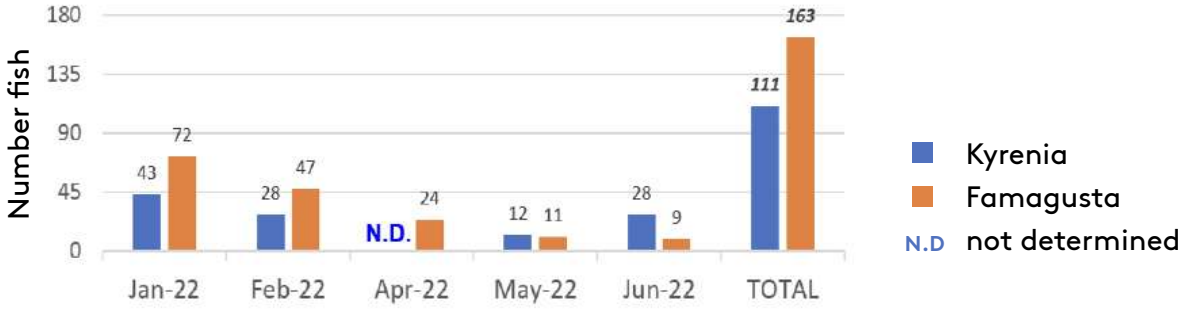
Necessary equipment

- Slingshots
  Hawaiian slings
- Polypropylene containers
- Scuba gear
- Embarkation
- Measuring tape
  to lay the transect along the rocky reek

This method was selected in order to standardize the surveyed area for the visual censuses and IAS removals.

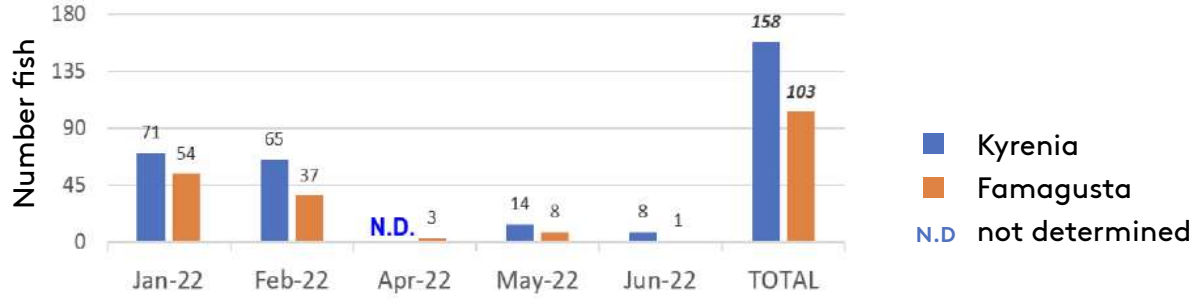


Results



Removal *Pterois miles* (lionsish)

A total of 111 and 163 lionfish were culled at the Kyrenia and Famagusta rocky reefs, respectively, during five months in 2022 (Fig.1). In general, more lionfishes were culled at the Famagusta rocky reef than in Kyrenia, except for June 2022, and the numbers at each reef decreased with time. Due to bad weather conditions in April, the removal in Kyrenia was suspended.



Removal *Diadema setosum* (long-spined sea urchin)

During the same time period, a total of 158 and 103 long-spined sea urchins were removed at the Kyrenia and Famagusta rocky reefs, respectively. Kyrenia in this case had the highest numbers of sea urchins. As in the lionfish cullings, there was a trend in the numbers to decrease with time. April's removal was not possible due to bad weather.

- **Total weight eradicated**: 300 kg
- 3 meetings held with general public after culling events
- **Total surface area eradicated**: 1650 m²

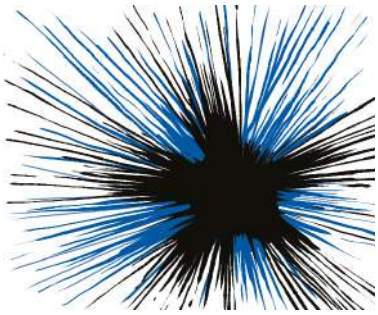
LABOUR-TIME MOBILISED

For 1 person fully involved in the project over 1 month:

- time spent on fieldwork = 16h
- time spent on logistics, meetings and administrative purposes = 8h

Critique of the method

The method is sound and widely used to characterize fish communities and evaluate recolonization of removed species. However, **the monitoring needs to include seasonal cycles in order to better detect change**. The same can be said for the removal efforts. In order to be effective, that is, to keep low the IAS abundance, removal efforts need to be frequent and, in many places simultaneously. Punctual removals like in our case, have limited capacity to effectively lower IAS abundance in the long-term. This is due to a combination of factors, such as distance with rocky reefs without removals and the ability of the species to disperse and recolonize. These untouched reefs act as sources of larvae and adults of the removed IAS that will eventually recolonize the study area.



The sea urchin *Diadema setosum*, a beautiful animal with mildly venomous long spines, have established populations in most of the rocky habitats of Cyprus.

Testimonial

This project was eventful and involved a lot of contributors through its various actions: academic through the University of Kyrenia, tourism stakeholders through a tasting event of the IAS and even fishermen on the study site.

- We had the opportunity to involve international MSc students from University of Kyrenia who volunteered with logistics, navigation and diving operations as a part of two graduate courses, Marine Ecology and Marine Biology.
- One unexpected event occurred on one of the field studies. As we approached the reef to tie to thte buoy, there was already a fishing boat on top of it pouring hundreds of meters of nets. When we approached and talked, he assured that he didn't drop it right on our transects, despite being very close.
- Nothing left to waste! The culled lionfish have all been consumed by project personnel, volunteers, neighbours and friends. Far eastern delicacy, sea urchin gonads and all remaining soft tissues have been consumed by project personnel and the fish in the vicinity within minutes.

Yaprak Arda
IUCN

3

Fostering indigenous species and ecological resilience

Introduction

Given their highly specific biological makeup and the role they play as refuges for endangered biodiversity, efforts to preserve islands' biological heritage tend to follow on naturally and rapidly from the environmental management plans drawn up for these spaces. Conservation efforts generally aim to maintain certain species and habitats, with a priority focus on heritage species, then to increase their numbers or improve their conservation status. It is in this way that two main types of initiatives have emerged: those focusing on the habitats of target species, involving the creation of artificial habitats, and actions to increase their numbers using subjects originating on the island.

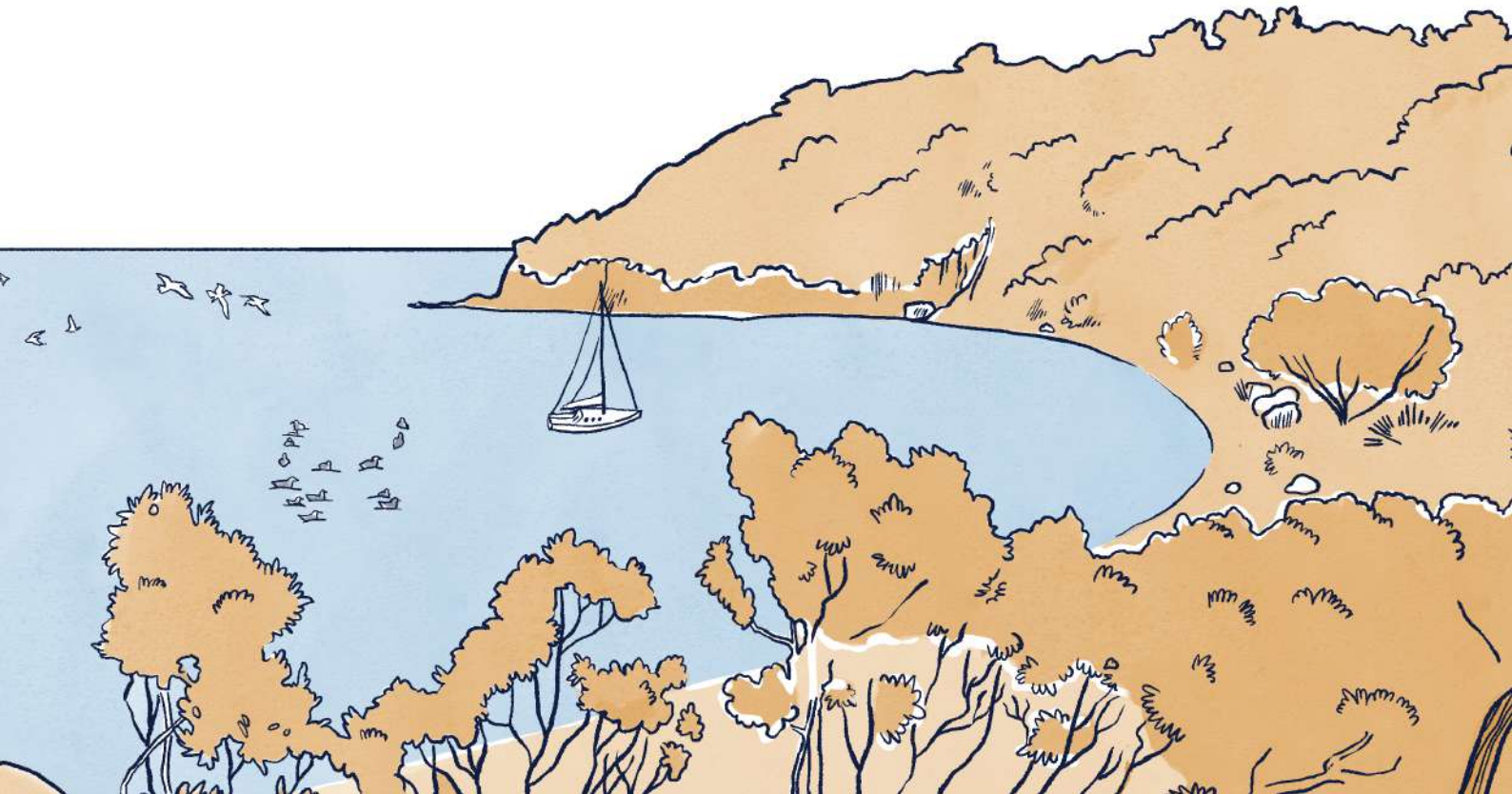
Habitat restoration efforts may be undertaken when damage is observed, such as the gradual disappearance of a habitat due to natural developments or especially due to human intervention. Regardless of the cause, no environmental restoration initiative can be undertaken unless the pressure or source of habitat destruction is removed before any reclamation operations begin.

However, it is clear that for species which use the islands to complete only one part of their biological cycle (notably marine birds), creating a habitat provides only a partial response to the needs of the target population. That said, habitat engineering is also a fast and sometimes simple response to supplement more broad-spectrum initiatives, which should be undertaken to address other types of threats putting pressure on species living outside the island, but whose implementation falls within the scope of much more global public policy.

Regarding efforts to strengthen populations, we need only consider the example of endangered plant species to see that these organisms form a part of the island's unique genetic makeup. Indeed, as the result of a long history of adaptation within these simplified ecosystems, the plants present on the islands have developed their own unique adaptations, forming ecotypes which differ even from plants of the same species growing on the nearby mainland. As such, projects aiming to increase population numbers must take this aspect into account, favouring organisms originating on the island to the detriment of those coming from the mainland, even excluding those grown in horticultural productions.

What all these ecological restoration efforts have in common is that they rely upon an intrinsic characteristic of plant and animal communities found on islands: their resilience and ability to adapt to ecosystemic change, and by consequence their ability to colonise new habitats which are created for them.

Finally, the question of the legitimacy of such actions must be considered. Of course, combating a natural or global phenomenon on such a small geographic scale can seem insignificant in terms of the effort invested for a relatively small number of organisms. However, the benefits of these actions, however partial they may be, are still worthwhile given the high number of threats faced by island species and ecosystems. Any action that can help endangered species deserves to be undertaken, especially if it entails only minor consequences for other island populations.



Habitats favouring marine birds Cory's Shearwater and Yelkouan Shearwater

Grand Congloué island
Riou Archipelago
Marseille
FRANCE

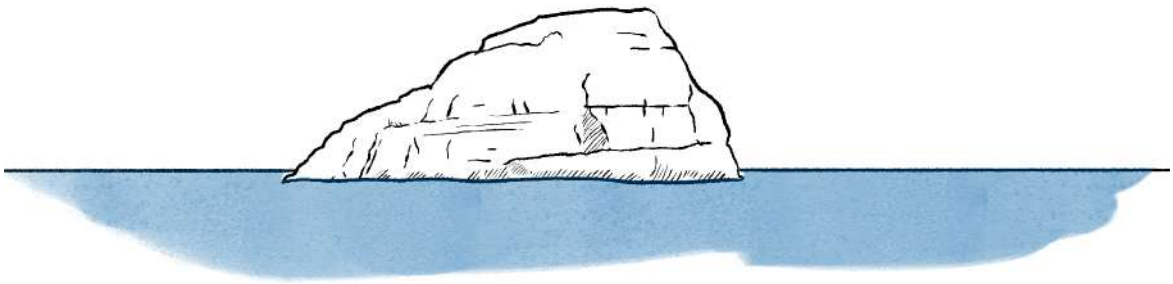
Photography by Louis Marie Préau
Conservatoire du littoral - PIM initiative

Grand Congloué Island

Riou Archipelago

Calanques National Park

FRANCE



Surface area: 1.99 ha
Altitude:47 m
X Coord:43,17596
Y Coord:5,41273

Protected status: Property of the Conservatoire du Littoral "Heartland area" of the Calanques National Park
Uninhabited island
Landing prohibited

Biological challenges and sensitivity

SPECIES OF INTEREST

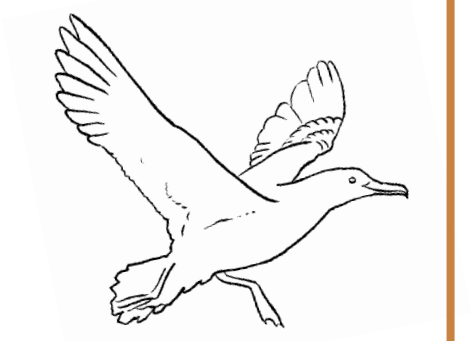
Presence of nesting marine birds: Scopoli's Shearwater, *Calonectris diomedea*, Yelkouan Shearwater, *Puffinus yelkouan*

INVASIVE SPECIES

Colony of Yellow-legged Gulls *Larus michahellis*

Characteristics of project working conditions

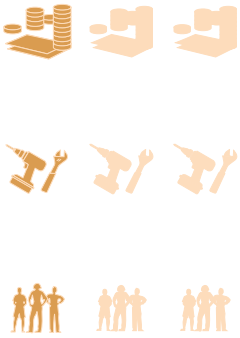
- No landing stage
- No sanitary facilities



February - June 2004 → **Every year until present day**

Installation of nests → Population monitoring


Pointe-Rouge
Port of Pointe-Rouge
MARSEILLE
Tiboulen island
Les Goudes
Port of Les Goudes
Callelongue
Port of Callelongue
Maïre island
Jarron island
Jarre island
Plane Island
Distance from the port of Pointe Rouge: 7nm
Petit Congloué
Grand Congloué
Riou island
500m



Project Description

Following on from a rat eradication program on the island on of Grand Congloué, undertaken as part of the LIFE Nature project entitled "Conservation of marine bird populations on the islands of Marseille" (2003-2007), and as part of efforts aiming to restore the area's natural island habitats, the Research Conservatory for the Ecosystems of Provence (owner of the Riou Archipelago nature reserve and the nature areas of the Frioul islands marine park) proceeded to install artificial nesting boxes with the aim of encouraging new Shearwater couples to settle on the island.

The *Procellariidae*, a family of marine birds which notably includes Shearwaters, generally nest in rocky outcrops around island coastlines. Spending most of their lives out at sea, the return to land allows them to mate and reproduce. As this reproductive process has been threatened by the destruction of natural island habitats and the presence of invasive mammal species, it was deemed useful to increase the number of viable habitats available in order to foster the species' survival. It should also be noted that threats faced at sea are also largely responsible for the reduction in numbers of this species.

Main parameters considered for the implementation of the project

DISTANCE FROM MAINLAND

Islands are relatively remote from the mainland, and public access is prohibited. There is a slight chance of post-operational reintroduction of invasive species (black rat).

NO ON-SITE ACCOMMODATION

No options for on-site accommodation, and no freshwater source Operations are day-long and autonomous.

NO LANDING STAGE

Only personnel and light equipment may be unloaded.

ACCESS

No path / no lifeline; progress is difficult, requiring personnel to secure themselves as they go. Transport and installation of the nesting boxes on site is achieved in challenging conditions.

Operators

Research Conservatory of the Ecosystems of Provence.

Monitoring is currently performed by the rangers of the Calanques national park.

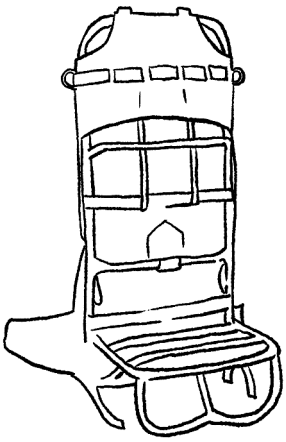
Selecting the appropriate intervention method

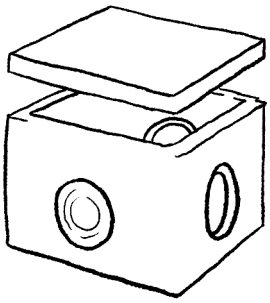
These types of installations are recommended when the substrate is loose or eroded (due to high footfall or the presence of rabbits). These may include damaged habitats and burrows which have collapsed.

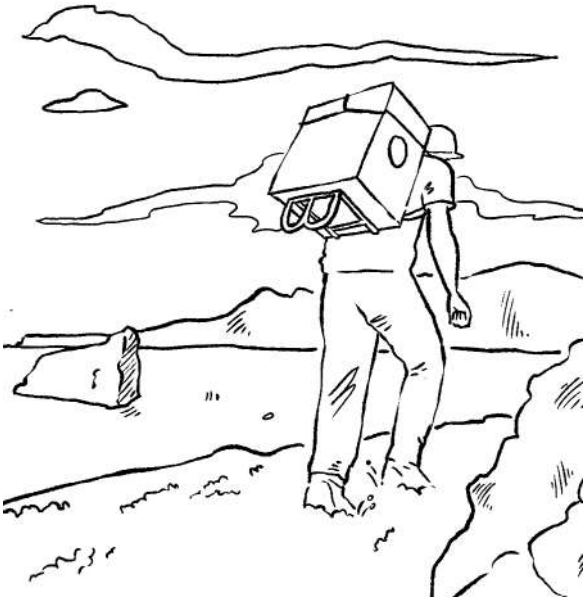
In order to optimise this operation's chances of success, it was necessary to eradicate invasive mammal species on the site, and to plan to install the nesting boxes near existing Shearwater colonies in the area, or in places where there has been a historic Shearwater presence.

Necessary equipment

- **Concrete catch basins**
  The dimensions used are adapted to suit the species; the recommended sizes are 40x40cm for Cory's Shearwater and 30x3cm for Yelkouan Shearwaters (Mediterranean species).
- **Frame backpack**
- **Rope**
  For hoisting the nesting boxes to the installation areas.







Installing the nesting boxes

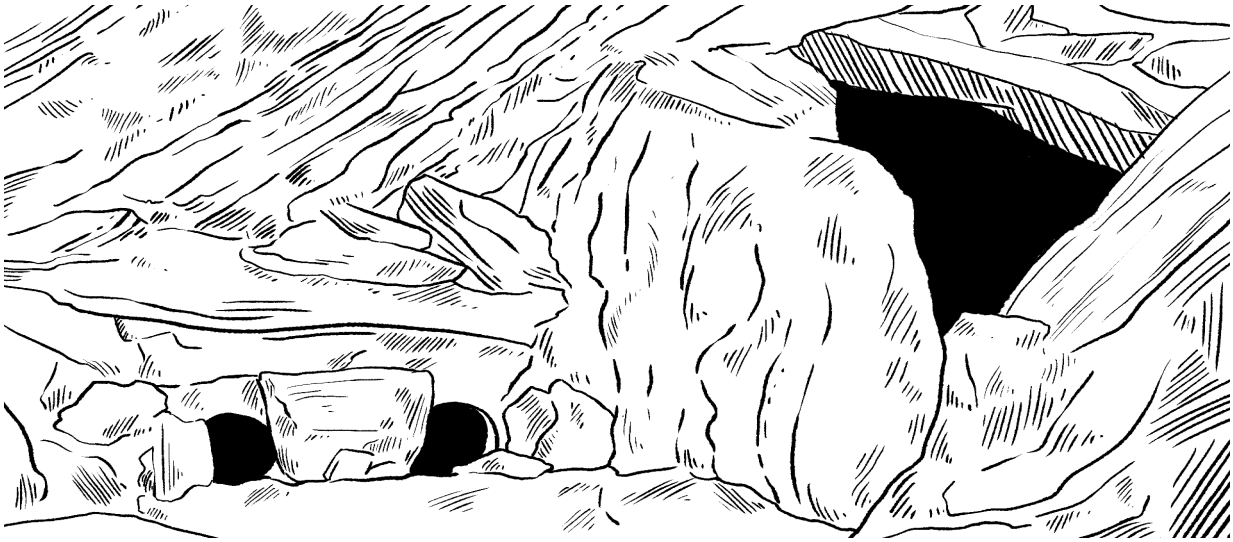
The catch basin is laid down on its side, and one of the lateral grates must be opened. The nesting box can then be camouflaged with local stones. It is also advisable to use these same stones to form a small tunnel, around twenty centimetres long, in front of the opening. For larger species of shearwater, the diameter of the entrance hole should be around 15cm.

The nesting box should be set up (notably in terms of the orientation of the catch basin and the tunnel) in such a way as to ensure the interior is shielded from rough winds, sea spray, sunlight and rain.

Additional installations - follow-up

In order to optimise the efficiency of the artificial nesting boxes, automated bird call broadcasting systems may be installed, playing the mating calls of the target species we aim to attract.

This device is made up of a battery, an MP3 player (loaded with various male and female mating calls for the species in question) and a speaker. All the components must be sufficiently durable and waterproof in order to remain effective over time.



Results

Around twenty nesting boxes were set up on the island of Grand Congloué.

As part of the LIFE project, a similar method was applied on other islands in the archipelago (Riou, Pomègues, and others). In total, some 112 nesting boxes for Scopoli's shearwater and 15 nesting boxes for Yelkouan shearwaters were unloaded and installed across the Riou Archipelago.

The tables below quantify the success of this type of operation for the islands of Riou and Pomègues.

As regards the small island of Grand Congloué, the operation is considered to have been particularly effective given that an average of 15 nesting boxes (out of a total of twenty installed in 2004) were still occupied in 2019, whereas only a single natural nest had been found in the area prior to the LIFE project.

	Nesting box occupancy rates	Reproductive success in occupied nesting boxes
2004	11.76%	1 chick / couple
2005	21.05%	1 chick / couple
2006	19.05%	1 chick / couple
2007	19.05%	1 chick / couple
Average	17.73%	1 chick / couple

Rates of occupancy and reproductive success for Scopoli's Shearwater in nesting boxes on Pomègues since 2004.

	Scopoli's Shearwater		Yelkouan Shearwater	
	Nesting box occupancy rates	*Reproductive success in occupied nesting boxes*	*Nesting box occupancy rates*	*Reproductive success in occupied nesting boxes*
2004	3%	1 chick / couple	27%	0.75 chick / couple
2005	4%	1 chick / couple	33%	1 chick / couple
2006	11%	0.73 chick / couple	53%	0.33 chick / couple
2007	11%	0.73 chick / couple	47%	0.67 chick / couple
Average	7.25%	0.87 chick / couple	40%	0.69 chick / couple

Rates of occupancy and reproductive success for Shearwaters in nesting boxes on Riou since 2004

Bibliographic references

CEEP MARSEILLE, 2007. ***Guide to the management of marine bird populations.*** *Life Oiseaux Marin Îles de Marseille.*

Habitats favouring the European Leaf-toed Gecko

Château d'If
Frioul archipelago
Marseille
FRANCE

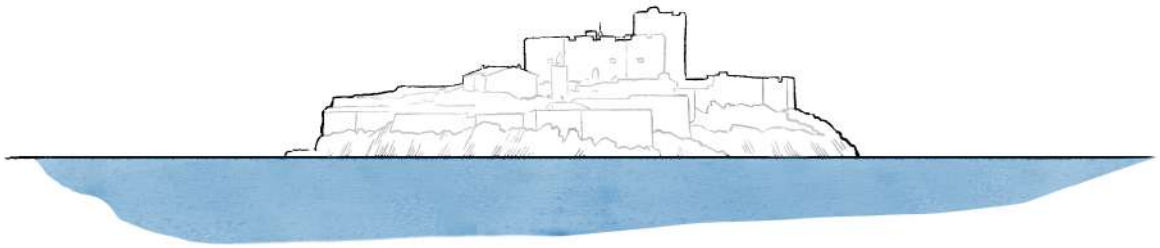
Photography by Vincent Rivière
AGIR Écologique

Chateau d'If island

Frioul archipelago

Marseille

FRANCE



Surface area:
3.25 ha
Altitude:23 m
X Coord:
43,17596
Y Coord:
43,17596

Protected status: lies within the Calanques National Park, Natura 2000 site (listed as a Special Protection Area under EU policy)
Monument listed on the French registry of historical monuments
Uninhabited island
Landing requires government authorisation (from Monuments Nationaux)
Several ferry shuttles landing daily during tourist season
100,000 visitors / year

Biological challenges and sensitivity

SPECIES OF INTEREST

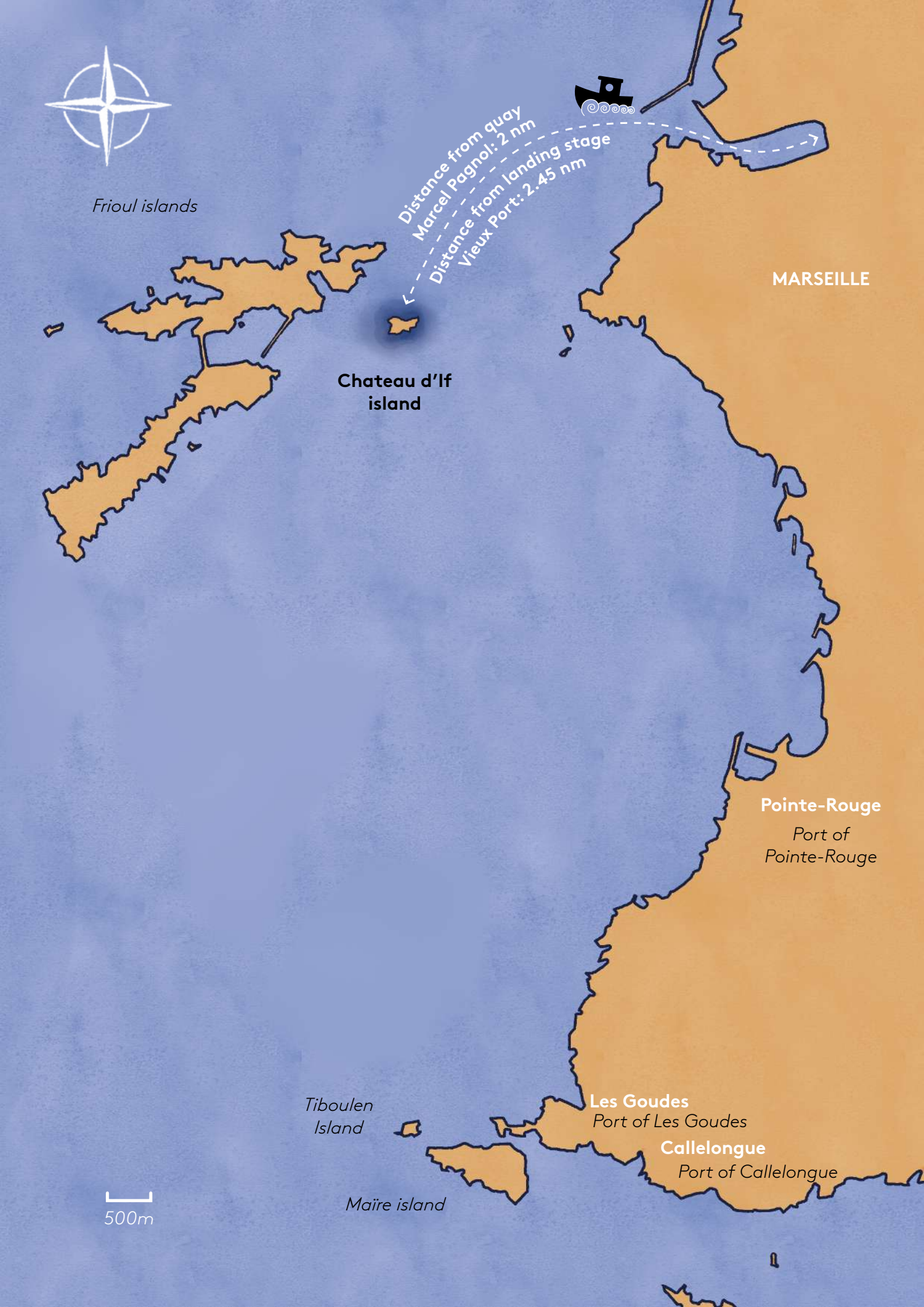
Presence of 4 protected plant species: *Anthemis secundiramea, Limonium pseudominutum, Silene sedoides, Senecio leucanthemifolius subsp. crassifolius,* Presence of an indigenous, nocturnal gecko, the European Leaf-toed Gecko *(Euleptes europaeus)*, One of the rare French habitats of the Italian Wall Lizard, *Podarcis siculus*. Presence of the Pallid Swift, *Apus pallidus*.

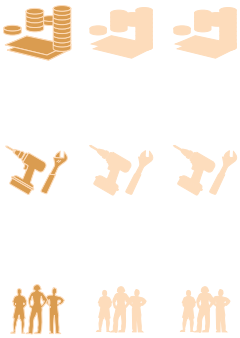
INVASIVE SPECIES

4 invasive alien plant species *Carpobrotus sp., Atriplex halimus, Opuntia sp., Agava americana*, Colony of Yellow-legged Gulls, *Larus michahellis*.

Characteristics of project working conditions

- Landing stage available
- Freshwater piped from the mainland
- Presence of buildings (accommodation possible) with running water
- Electricity available


Frioul islands
Distance from quay
Marcel Pagnol: 2 nm
Distance from landing stage
Vieux Port: 2.45 nm
MARSEILLE
Chateau d'If
island
Pointe-Rouge
Port of
Pointe-Rouge
Tiboulen
Island
Les Goudes
Port of Les Goudes
Callelongue
Port of Callelongue
Maïre island
500m



Project Description

In order to preserve the historic monument of the Château d'If, the building's ramparts required essential repairs. However, this restoration meant that the grouting in the stone walls was to be repaired (to prevent the erosion of joints), thereby destroying the habitat of the European Leaf-toed Gecko, a reptile with a limited range of distribution which is endemic to the Mediterranean, and which seeks shelter in cracks in the building's walls.

The restoration project was undertaken by the site's owner, the National Monuments Centre, under the supervision of an architect from that organisation, with the Calanques National Park monitoring the project's accommodation of protected species. The renovation project began in 2019, following validation from the Calanques National Park and the Higher Regional Council for Nature and Conservation in 2018.

15/04/2019
Beginning of capture campaigns

→

Mid-2021
End of capture campaigns

→

Mid-2021 to 2041
Population monitoring

Main parameters considered for the implementation of the project

ACCOMMODATION

On-site accommodation available, making it possible for operations to be carried out over several consecutive days.

ACCESS

Access to the project site is well-developed: possible to bring in equipment by sea (landing stage and winch) or by helicopter.

BUILT HERITAGE

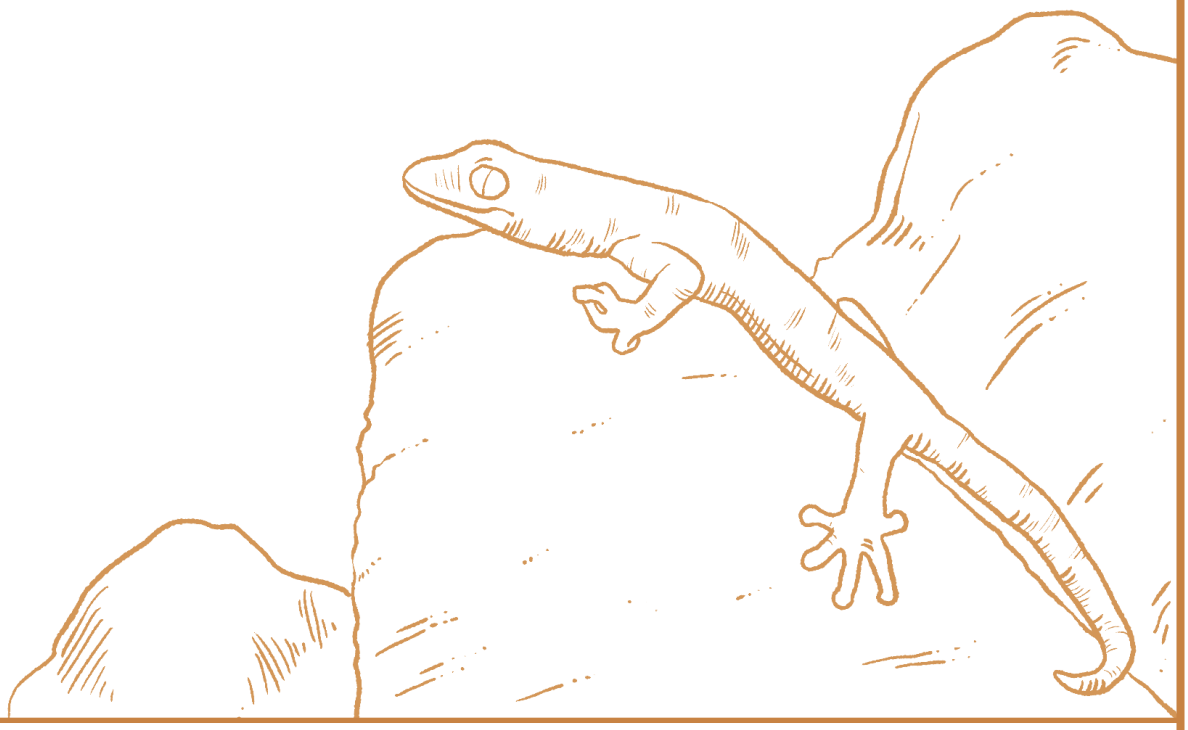
Necessity of preserving the solidity of the construction and its historical recognisability No preservation of deep cracks, no specific creations impacting the visual aspect.

ETHOLOGY

The European Leaf-toed Gecko is light-averse (the use of lighting in an area prevents colonisation) and is not active year-round (capturing and removal operations must be carried out between mid-March and the end of September). By the same token, even during their active periods not all individuals are active at the same time of night. It is therefore necessary to repeat capture operations several times per night.

RISKS

Significant amounts of equipment being brought in from the mainland. Potential risk of the re-introduction of invasive species.



Operators

Girard (a company from the Vinci group)
AGIR Ecologique (assistance with ecological project management).

Selecting the appropriate intervention method

Methodology applied

Incorporation of artificial dens suitable for the Leaf-toed Gecko within the parapet (interior portion of the rampart), without upsetting the visual aspect of the renovation. Operation carried out progressively and per sector (12 in total)

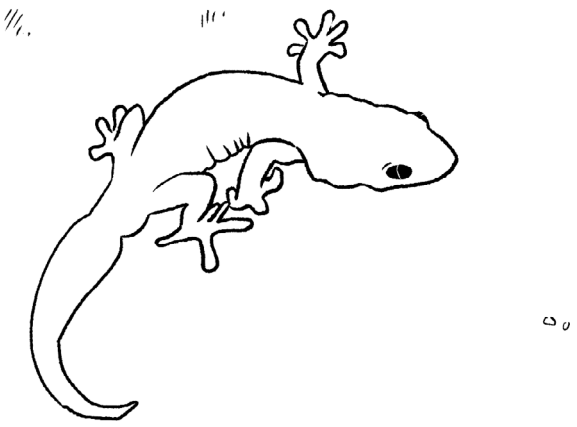
For each sector

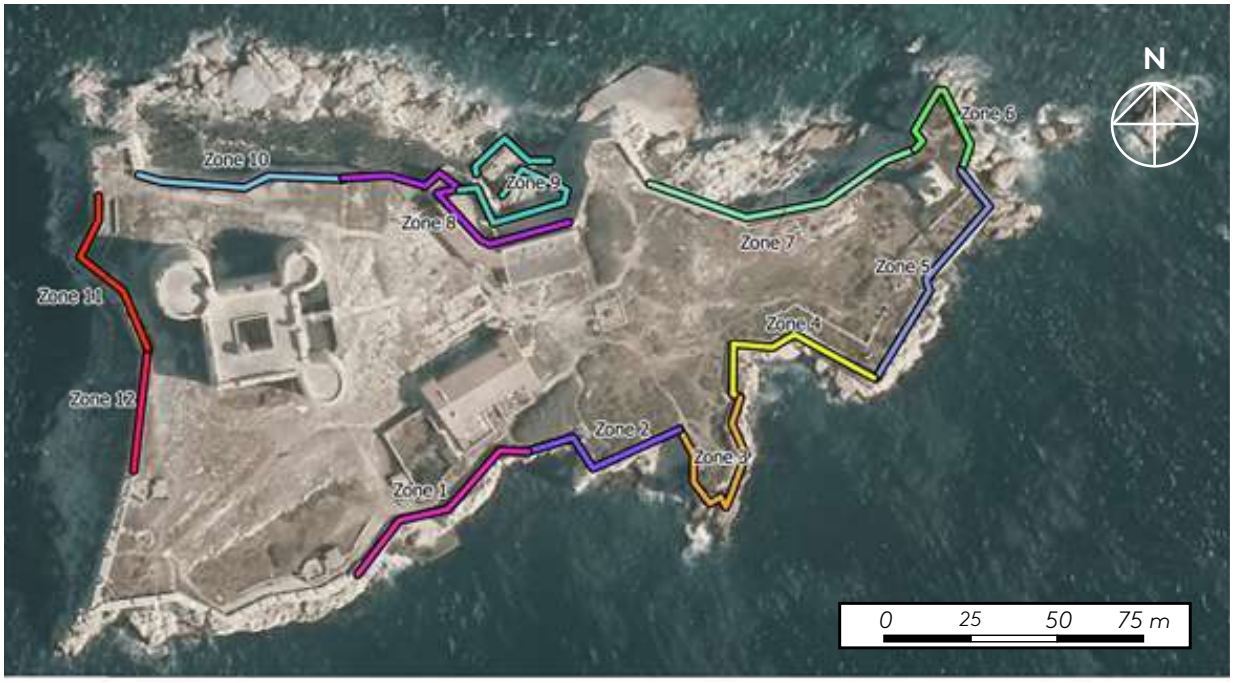
STEP 1
Active individuals captured over 1-3 consecutive nights during 1-hour sessions (in order to limit the destruction of individuals remaining within the cracks).

STEP 2
Individuals held in captivity for 3 weeks in temporary facilities located at a distance from building work, during the time that work was being performed on the inner part of the ramparts (incorporation of permanent dens, re-grouting of walls, nocturnal lighting on parapets to avoid any recolonisation of the construction site while work is ongoing). During this 3-week period, the parapet where building work would be carried out was illuminated all night as a method of aversion, in order to prevent Leaf-toed Geckos from returning to the area.

STEP 3
Quality control of the permanent dens + captured individuals set free during the night.

STEP 4
Monitoring of species activity on the parapets during the post-construction phase, once a year during the animals' active period (from mid-April to end of September) for 20 years. All these measures have been granted an exceptional exemption from the law prohibiting the destruction of protected species, obtained in 2018 after a year of studies and consultation.



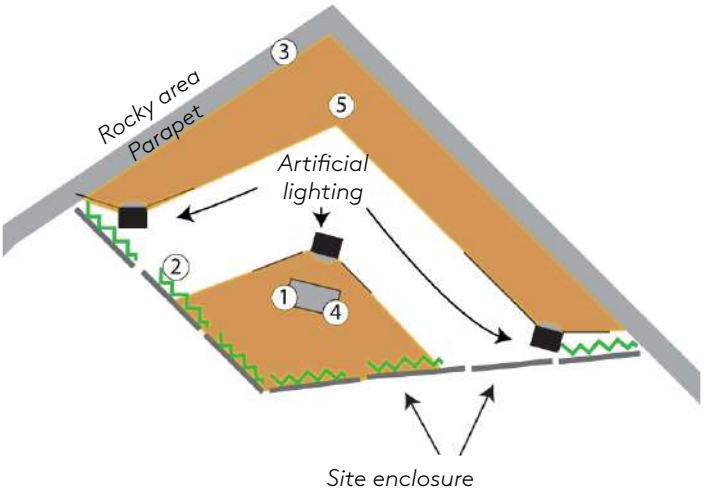


WORK ZONING

Zone 1	Zone 4	Zone 7	Zone 10
Zone 2	Zone 5	Zone 8	Zone 11
Zone 3	Zone 6	Zone 9	Zone 12

Background: IGN
Compiled by: Vincent Rivière AGIR écologique

Zoning for construction, 2019-2021



1. *Creation of artificial dens*

2. *Installation of light-blocking geotextiles around the construction site enclosure*

3. *Capture of European Leaf-toed Geckoes within the construction zone over the course of one full night*

4. *Transfer to the artificial den; den is illuminated*

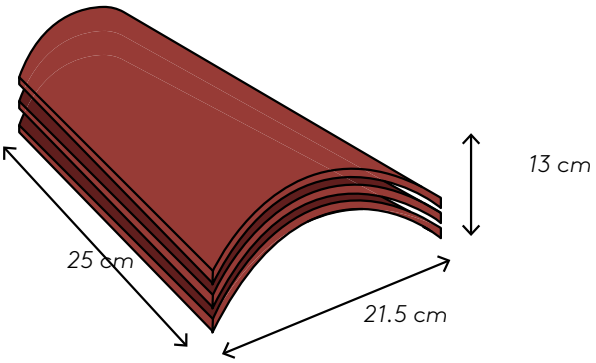
5. *Parapet is illuminated following the final capture session until the end of construction*

Compiled by: AGIR écologique

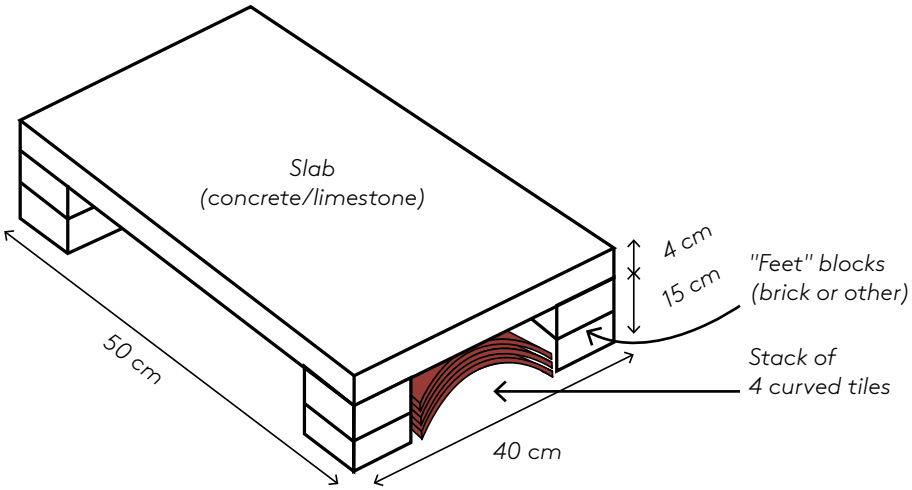
Implementation of live traps and post-capture lighting in order to avoid any recolonisation

Apparatus

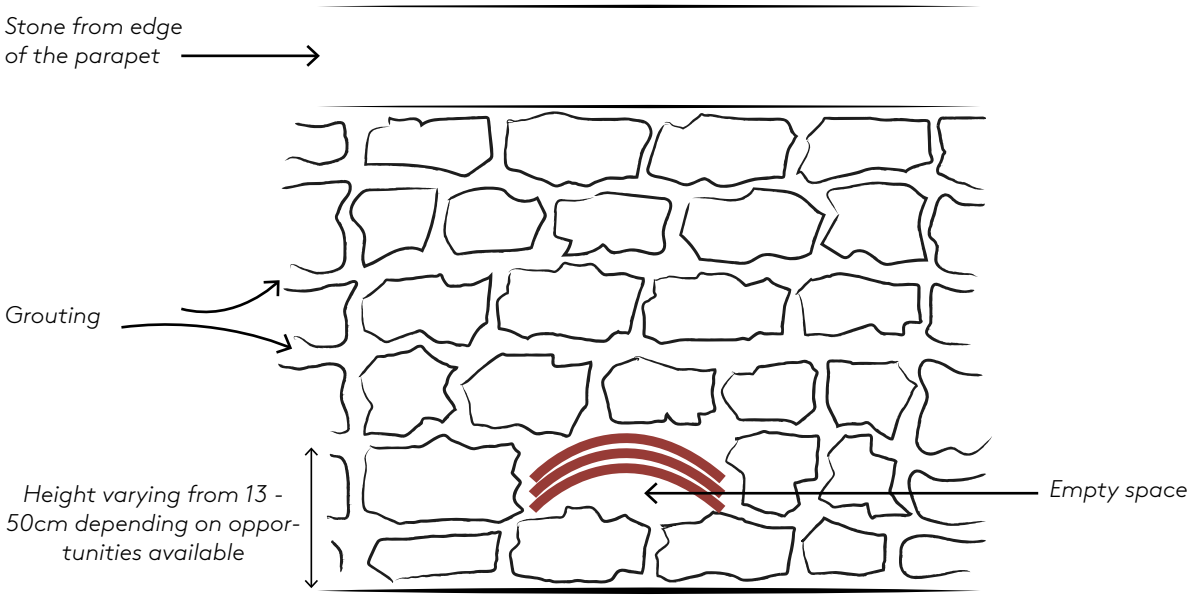
Each permanent den is made up of 4 curved roman tiles stacked on top of one another, less than 50 cm above the ground.
These dens are then set permanently into the wall, at a distance of every 5 meters.



Dimensions of artificial dens to be inserted into the wall



Temporary facility for keeping captured individuals during construction; illuminated during the construction period



Apparatus once achieved

Duration of operation

The duration of the operation is tied to that of the overall construction project. Moreover, capture operations have to be carried out during the European Leaf-toed Gecko's period of activity. For each phase of the construction work, renovation of the parapets can occur separately from work carried out on the exterior ramparts, which are used only marginally by the Leaf-toed Gecko. As such, work on the parapets would last a maximum of three weeks, but could be performed in several sectors simultaneously. In August 2020, since the outset of construction, capture and removal operations were carried out in 5 of the 12 sectors.

Specific characteristics of the project

Inserting special dens for Leaf-toed Geckoes into the castle's parapet required validation by the Custodian and the head architect from the Historical Monuments agency, in order to limit their visual impact. This long-term feature will remain a permanent part of the monument.

Results

Total length of parapets to be restored	*726 metres*
Number of gecko-friendly dens to be created	*145*
Number of individuals captured (4 sectors/12)	*271*
Number of capture sessions performed	*44 sessions*
Cost of labour (specialist company used for trapping)	*€5,000 excl. tax*
Cost of monitoring over 20 years (by specialist company)	*€24,000 excl. tax*
Cost of materials (tiles, lighting)	*included in the global renovation budget*

TESTIMONIAL

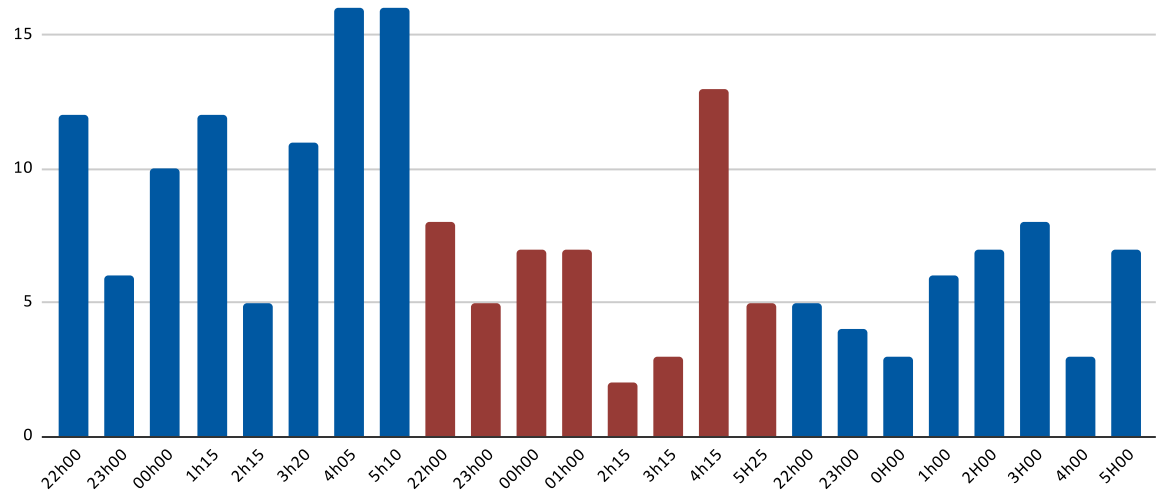
Armelle Baduel

Custodian of the Château d'If

Natural and architectural heritage are intimately linked at many of the sites managed by the National Monuments Centre, but especially here on the island of the chateau d'If. Without this exceptional natural environment the château d'If would never have been built, and by the same token*, without the presence of the castle, its occupants and its ramparts, the flora and fauna seen on the island today would not be the same. Without the castle's walls and ramparts, unique species would not be able to survive on the island. The château d'If does not only watch over the kingdom of France, but also its flora and fauna - protecting them from storms, the mistral winds, the cold and the heat; and of course, certain species are found there precisely because they were brought by humans. That is why restoration work on the ramparts that encircle the 3 hectares of the island involves a real challenge: walking the tightrope between protecting the architectural heritage and the natural species that dwell there. The solutions identified, such as the creation of refuges for Leaf-toed Geckoes and pallid swifts, will help make these species more visible to visitors and spread awareness of the need for conservation. Visitors will understand the reasons why the If island was listed as a "heartland area" in 2012 during the creation of the Calanques National Park. These programs to showcase and enhance the Château d'If's dual heritage reflects one of the fundamental missions of the National Monuments Centre: awareness and education.*

Critique of the method

During the upstream phase, the capturing operation aimed to capture the majority of active individuals found on the same portion of the parapet, with each portion being demarcated using light barriers. Following the capturing operations, which were carried out every hour, the number of animals captured should trend toward 0. However, while this hypothesis did prove accurate in early spring and autumn, the same was not true of the summer period. Individuals are also capable of escaping from crevices into nearby vegetation, leading to ongoing colonisation of the parapets. To date, we have been unable to demonstrate that these captures were exhaustive.
The three-week period during which the Leaf-toed Geckoes are kept in captivity on site must not coincide with the gestation period, in order to avoid any eggs being laid or lost in the artificial capture den.



Numbers captured per session in sectors 2 & 3:
the number of individuals captured remained high during the final session

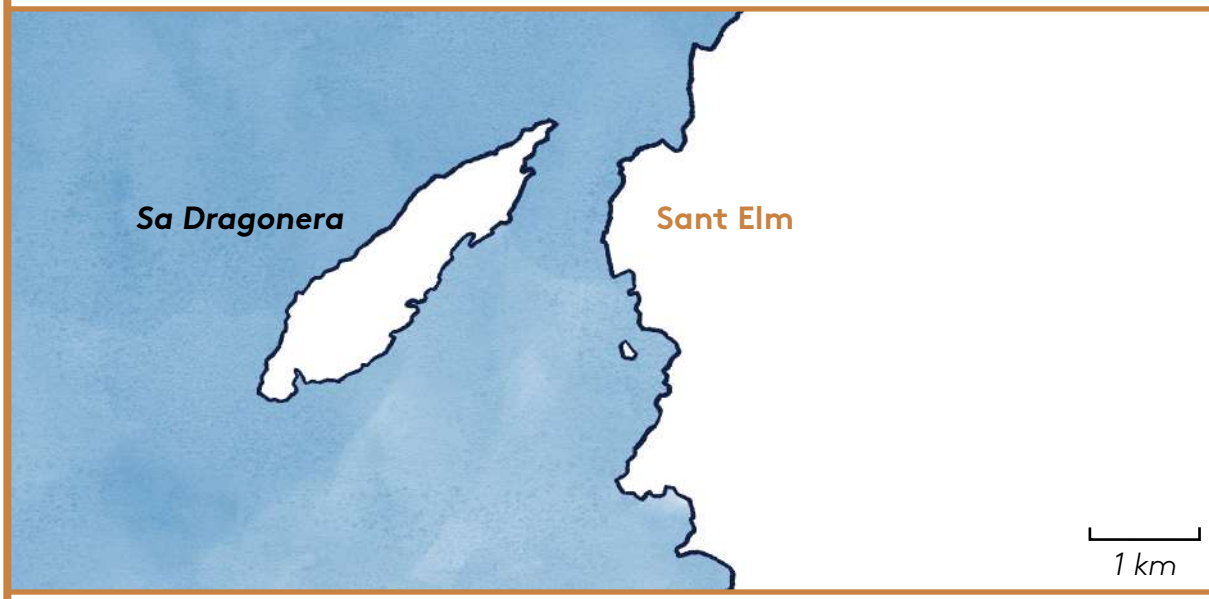
Installation of lighting
at sufficient height and distance
from the parapet

Grouting almost complete

Permanent den prior to
restoration of wall grout

Heritage restoration: Llebeig Tower in Sa Dragonera

With the contribution of Martí Mayol,
Geographer, Head of Sa Dragonera Natural Park from 2000 to 2019



Sa Dragonera,
Mallorca, Autonomous Community of the Balearic Islands

X Coord: 39,5844
Y Coord: 2,31983

Surface area: 288 ha
Protection status: Natural Park
Distance from the main island: 0.8 km (Mallorca)

Project description

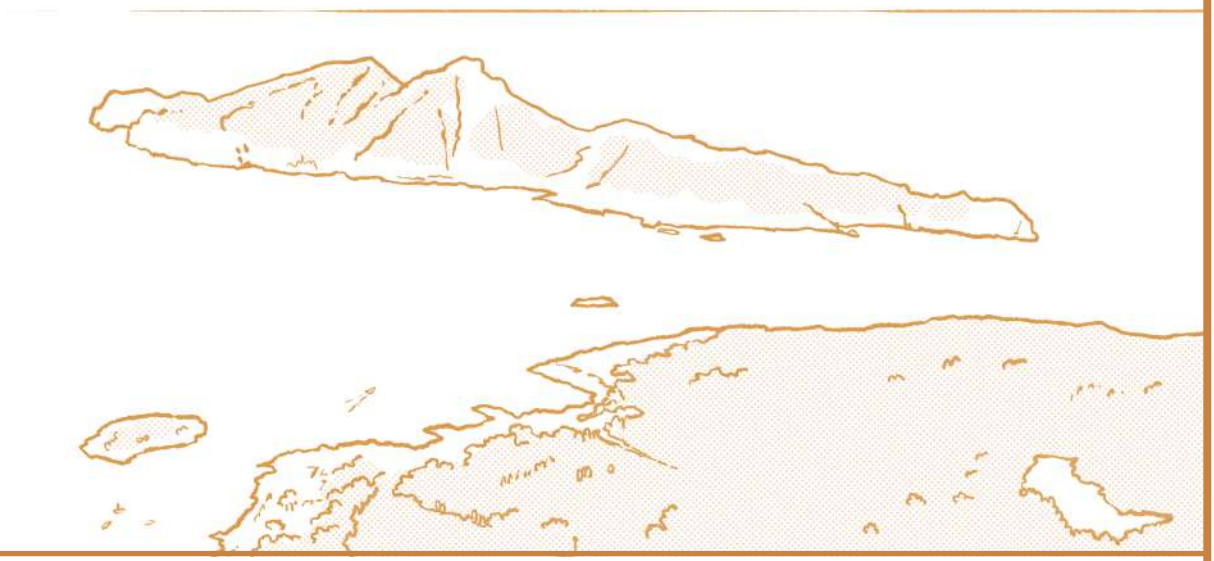
Restoration of a 16th-century watch tower (1585) using traditional materials and techniques, adapting it for visitors using Corten steel access stairs to the room and terrace (different material than the original stairs, possibly rope stairs).
Restoration of a large gun carriage, with customised plans adapted to the size and calibre of the artillery piece.
The tower is the oldest building on the island, predating the construction of the lighthouses and the road connecting both ends of the park.

Schedule

From July 2003 to June 2004	→	To restore the tower
August 2007 to April 2008	→	To build and transport the gun carriage

Main challenges

- Lack of visual documentation on the original state of the tower.
- Isolated site and difficulty accessing and transporting building materials and water for masonry work.
- Obtaining permits from the Island Heritage Commission was difficult due to the lack of original plans, which meant that only the consolidation of the existing building, not its full restoration, could be carried out.
- The tower is located near one of the park's three itineraries, which makes it easily accessible to visitors.
- The building was in danger of being degraded due to unrestricted visiting.
- The working agenda was conditioned by the bird nesting period (Audouin's Gull and mainly Eleonora's Falcon).
- There was no presence of bats, and it was irrelevant as regards the Sa Dragonera lizard.



Operators

The tower of Sa Dragonera was restored by the Consell de Mallorca's staff with the support of the Government's Directorate General of Protected Spaces for the transport of materials by helicopter. No private company was involved.

Historical overview

Since the Catalan conquest in the 13th century, the Mallorcan coast has been guarded by men placed in strategic locations. At the end of the 16th century, when raids by Saracen pirates and corsairs became more frequent, partially fortified watchtowers were built, which were more effective and habitable for the lookouts.
These towers were located in places where they were visible from one another, forming a surveillance ring that completely covered the coastline of the island of Mallorca.

Two towers were built in Sa Dragonera: the Na Pòpia Tower (1580), which was destroyed in 1850 when the lighthouse of the same name was built, and the Llebeig Tower (1585), which was abandoned in 1867 but is still standing.
Na Pòpia Tower served to communicate to the northeast with the tower of Es Grau (in Estellencs) and to the east with the tower of Cape Andritxol in the direction of Palma.
The Llebeig tower, located near the cape of the same name, provided strategic cover for the nearby cove, which could become a dangerous landing point, hidden from the top of na Pòpia. The Llebeig Tower was equipped with two pieces of heavy artillery that could deal with alien ships approaching the coast.

This site was chosen because it is located where the peak of na Pòpia is visible, so the two watchtowers could communicate visually. Furthermore, the bottom of the neighbouring cove—a hypothetical landing spot—is visible from the top part of the tower.
The tower is surrounded by a series of small buildings used as pens for domestic animals. There was probably a small garden attached. The nearby cove shows the remains of a dry dock where the watchtower guards could shelter their boats from storms.
In addition, most towers had a small vegetable garden that provided a few vegetables for food.

These towers were operational from 1580 to 1867. The watchers' lives were hard, with numerous captures by enemy ships, some deaths, and desertions.

Water, a scarce resource

Water supply was one of the most critical challenges in the continuous habitation of the towers. With the current rainfall in Sa Dragonera (350 mm) and a collection surface of 20 m2, 7 MT of water could be collected per year, a very modest amount.
Among the remains surrounding the tower, you can still see an ingenious system formed by two walls that concentrated the rainwater. This water was channelled to a set of eight water jars and a cistern, with a total volume of just over 10 tons. The water was used to meet physiological and hygienic needs, water the animals, and irrigate the small vegetable garden.

Undoubtedly, the watchmen had to fetch water from the nearby springs, both from Mallorca and from the island itself (Cueva des Moro and the Puig spring).

The Joan Binimells warning system (16TH c.)

During the 16th century, a series of Turkish assaults and plundering of coastal towns (Sóller 1542, Valldemossa 1545, Pollença 1550, Andratx 1558, etc.) prompted an improvement in coastal surveillance on the island of Mallorca. Joan Binimells, a doctor, mathematician, astronomer and historian, designed a system based on communication by fire and smoke between coastal towers strategically located along the Mallorcan coast.

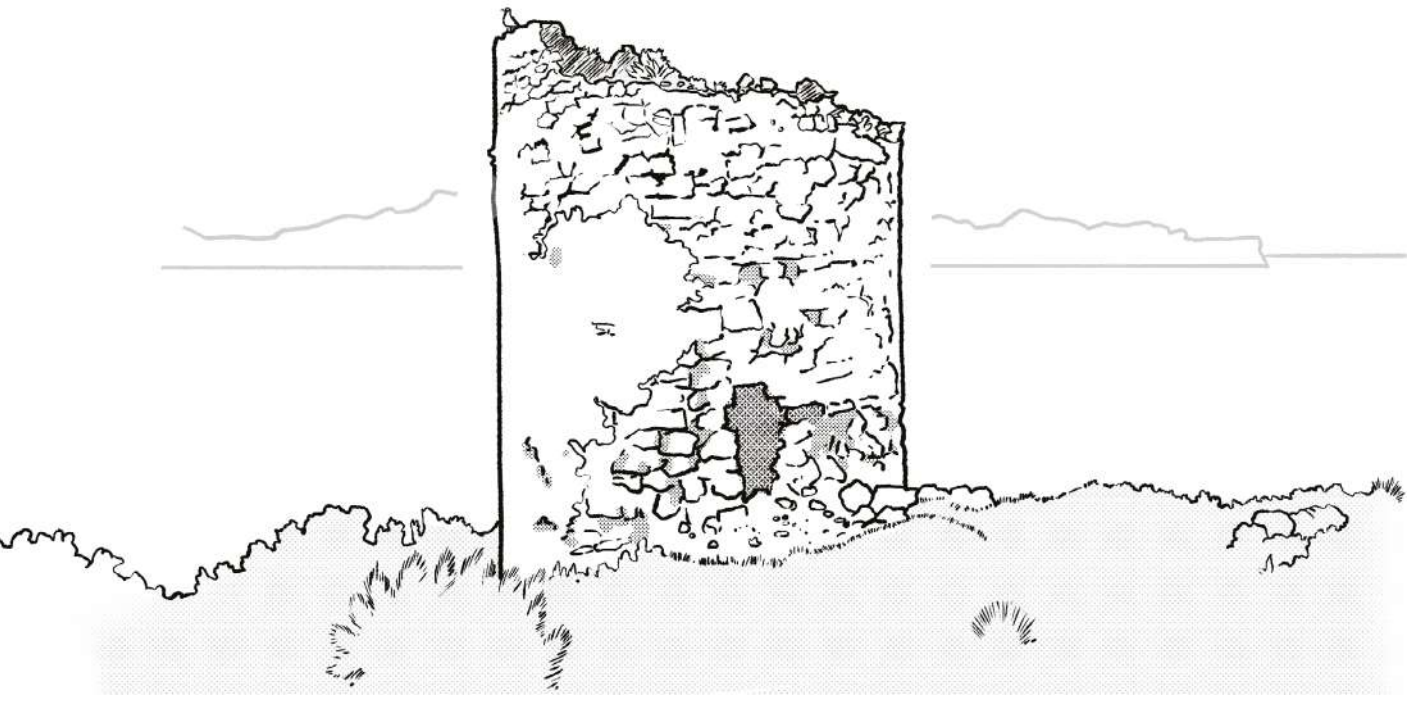
Daily communication began at the tower of Na Pópia and ended in Palma; Sa Dragonera, which had until then been a pirate and corsair hideout, became one of the mainstays of the surveillance system for the entire island of Mallorca.
Access to the Moor's cave, where many pirate ships used to moor, was closed off with large stones.
The watchtowers of Es Grau in Banyalbufar and Cap Andritxol, between the municipalities of Andratx and Calvià, received the signals directly from Pópia.

This system remained active until the mid-19th century, after which the watchtowers were abandoned, and most of them underwent a progressive degradation process.

The tower's cannon

Because it watched over a possible landing point in the cove of the same name, Llebeig Tower was equipped with light weapons for the lookouts and two cannons, one of them large, similar to those typically placed in fortifications and other isolated watchtowers located in strategic places.
This cannon, initially placed on a swivelling cart, was also restored in 2008, as it was located directly on the floor of the tower roof.

A gun carriage was explicitly designed to support it, with dimensions calculated according to the calibre (weight) of the projectiles, to withstand the recoil when firing.



Restoration of Llebeig Tower

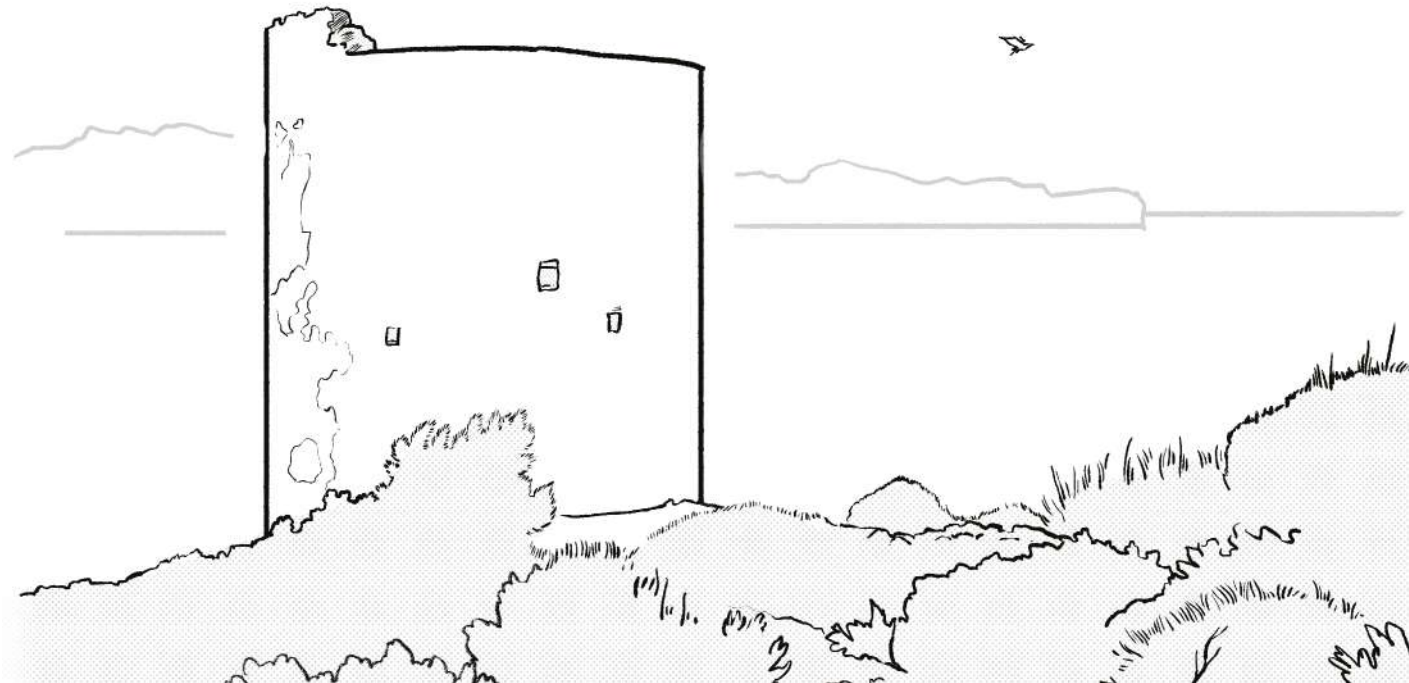
By the end of the 20th century, the tower, abandoned in 1867, was in an advanced state of dilapidation. The upper part of the building, the partially tiled roof, the sill, and the exterior and interior plastering of the living quarters were severely deteriorated. Furthermore, workers who had built the nearby lighthouse had cut a large hole in the northern part of the wall to gain access and inhabit it. The probability of the tower's collapse due to water penetration into the wall itself and a large crack in the south face of the building prompted rehabilitation measures; this is detailed in the PRUG—Plan Rector de Uso y Gestión—of the natural park in 1999.

The restoration was carried out with the utmost rigour, in line with the available written and visual documentation, and using the original building materials. The mortars were made with lime, sandstone, and tile dust, following the recommendations of heritage restoration specialists.

The Insular Commission of Historical Heritage approved the project on 31 March 1999. The main challenges the workers had to face were hauling the materials, the water supply, the journey to the work site itself—subject to inclement weather and the sea—and the harsh environment. The restoration was carried out from July 2003 through June 2004, with 454 working days, 14,500 euros in transport costs and 6,500 euros in equipment and miscellaneous supplies.

The involvement of the Environment Department of the Balearic Islands Government was essential for the aerial transport of the materials (helicopter), given the difficulty of accessing the tower by sea and land.

We should also mention the collaboration of the volunteers participating in the La Trapa—sa Dragonera work camp in July 2003, which cleared a path leading to the tower from Llebeig road.



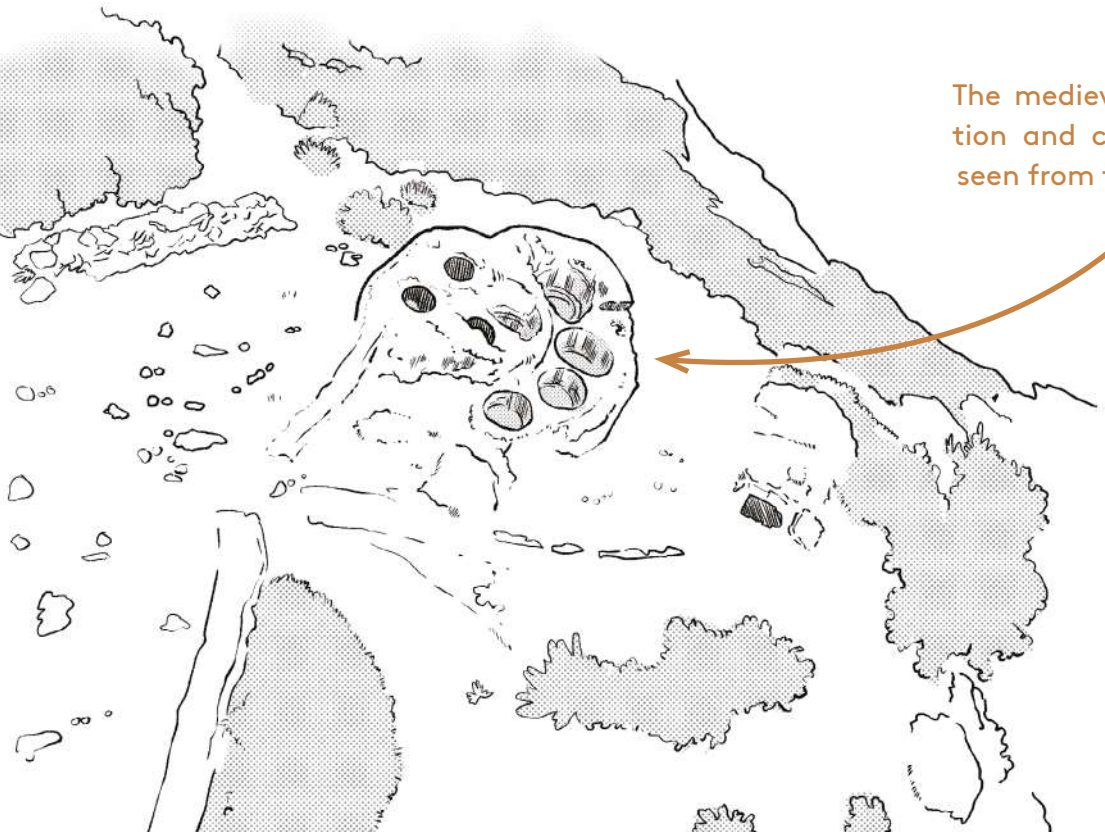
Activities carried out include:

- Rebuilding the stone wall
- Repairing the large hole that had been opened in the wall
- Replacing the outside plaster (lime mortar, sandstone dust and tile dust)
- Restoring the roof and its protective wall
- Restoring damage to interior vaulting
- Restoring the floor in the living quarters
- Installing access stairs made of Corten steel and doors to the living quarters and the upper floor

	2003	2004
Manpower	*11,675*	*29,103*
Travel and transport	*2,500*	*12,000*
Materials	*2,400*	*4,100*
Total	*16,575*	*45,203*

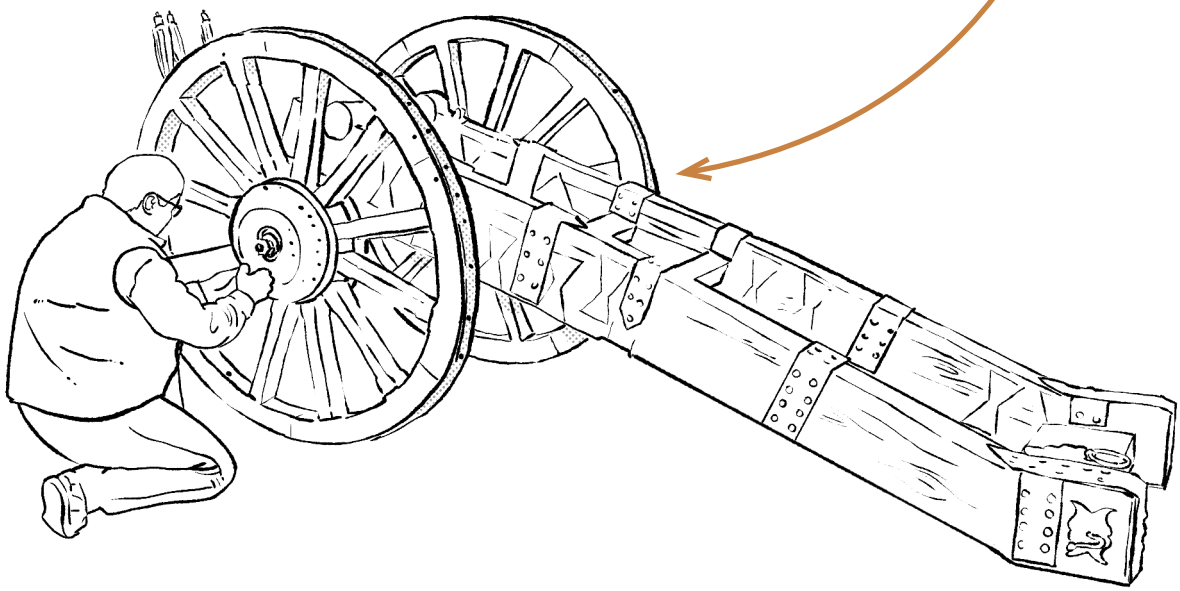
Note: does not include the costs of officials and institutional resources involved in the action.

Restoration of Llebeig Tower — Costs



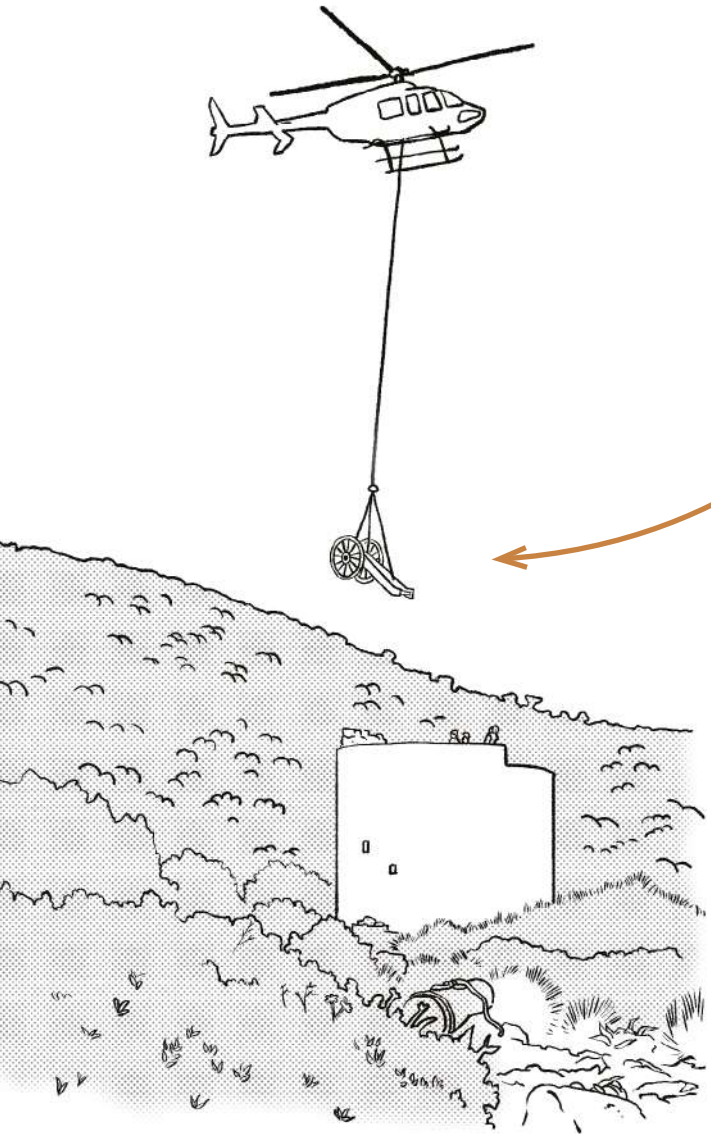
The medieval rainwater collection and conservation system, seen from the top of the tower.

The gun carriage recreated using historical documentation.



Llebeig Tower, before restoration

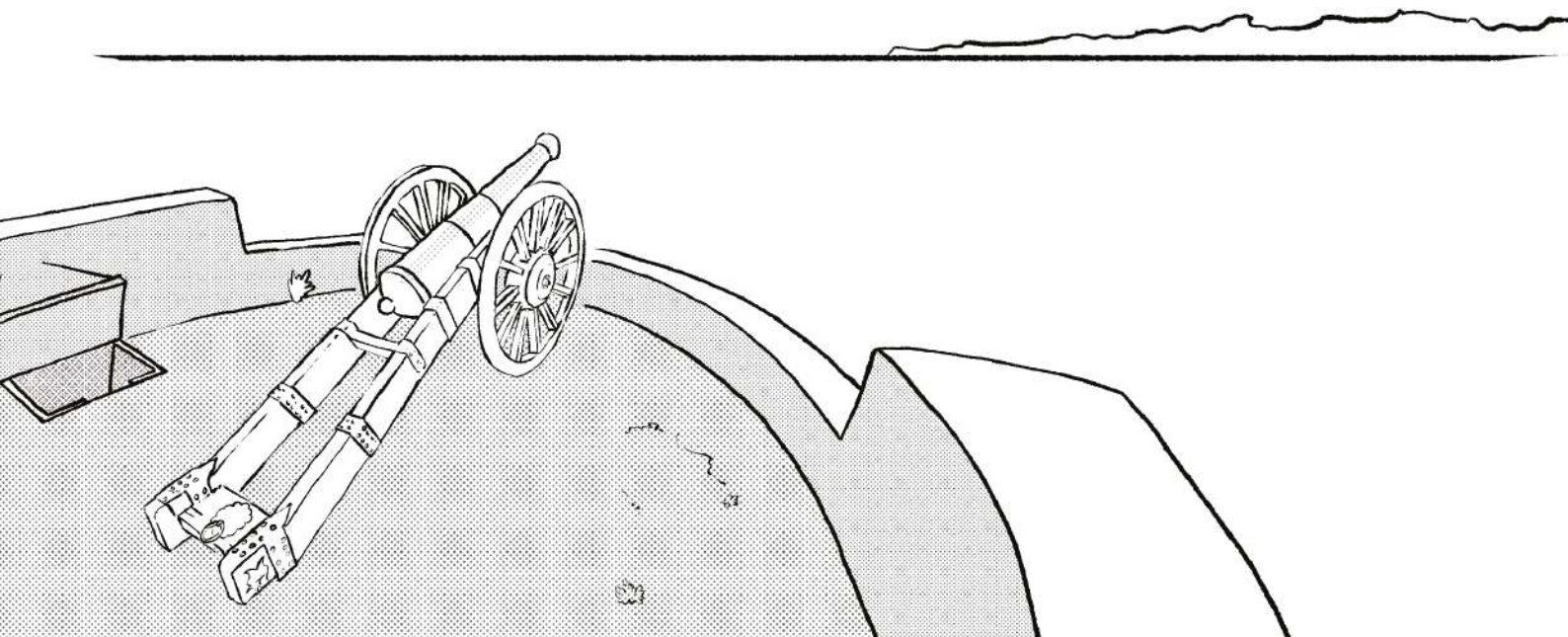
and after restoration



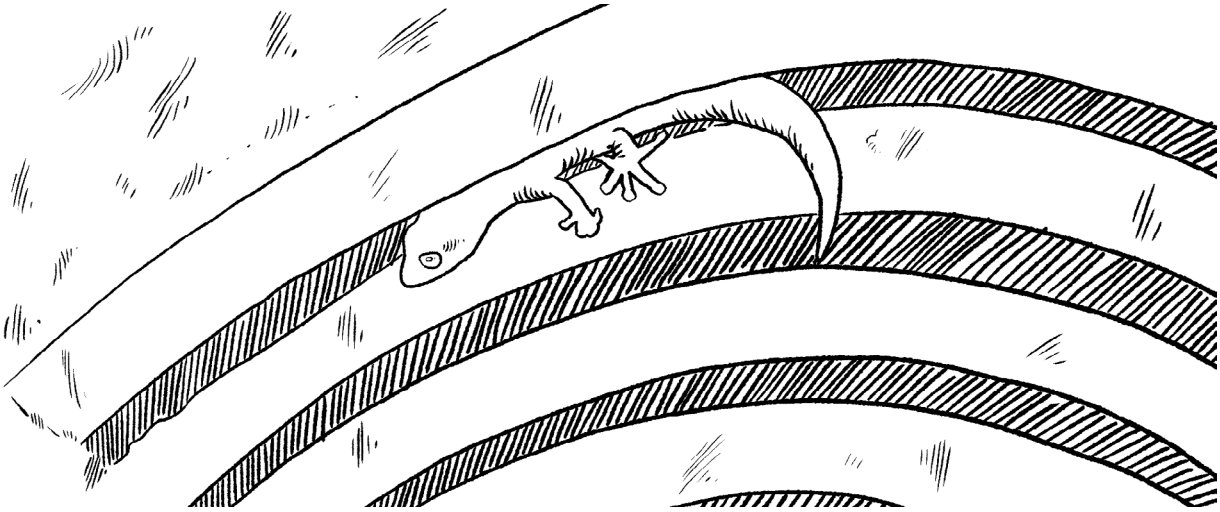
Transporting the gun carriage. The cannon on the ground, ready for loading.

Critique of the method

The restoration work could not be completed, as permission could not be obtained to erect a roofed porch that covered part of the tower's terrace. Traces of building material and fragments of roof tiles had been found on this terrace. Yet, heritage officials demanded concrete evidence that was impossible to obtain. However, the watch guards' task clearly required a structure that would protect them from the sun and rain.



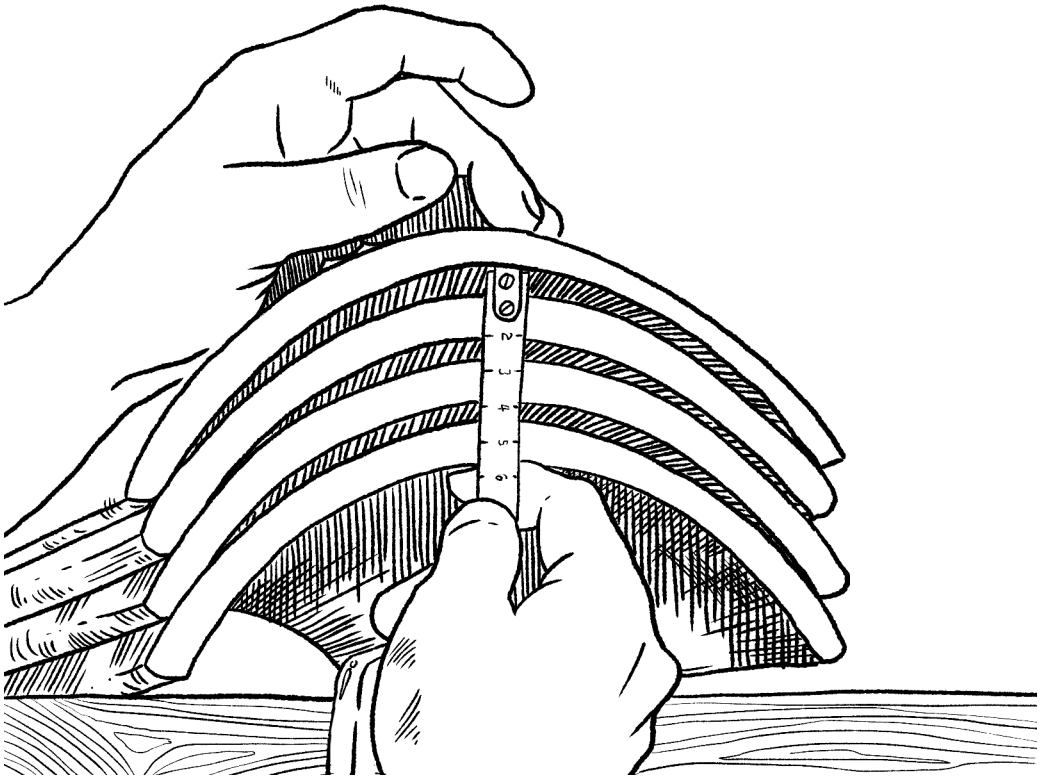
The creation of permanent dens for the European Leaf-toed Gecko: a bridge between the islands of Grand Rouveau and Chateau d'If



In order to keep pace with demographic trends within the population, it is necessary to have access to robust methods that can be easily reproduced over time. This observation applies even more urgently to islands, where access is highly dependent on more complex logistics and favourable weather conditions.

Taking these elements into account, and with the goal of establishing long-term monitoring of the European Leaf-toed Gecko (*Euleptes europaea*), the use of artificial dens was trialled on the island of Grand Rouveau in 2013 (Embiez archipelago, Six-Fours-Les Plages, France). Other sheltering initiatives had already been undertaken for this species – in the hills around Genoa in Liguria, (SALVIDIO & DELAUGERRE, 2003), on the island of Port-Cros in Provence (DELAUGERRE, 2009 ; MERCIER et al., 2017) and on the island of Roscana off Corsica (DELAUGERRE PERS. COM.) – but the methods used have delivered results which are difficult to interpret.

A good number of reptiles do use the dens to satisfy their eco-physiological needs (BULOVA, 2002; BECK & JENNINGS, 2003; GRILLET et al., 2010). These dens serve as both nocturnal and diurnal shelters, hibernation spaces, temperature regulators, a refuge from predators and, in some cases, areas for nesting and reproduction (INEICH, 2010). While some species dig burrows, most use natural dens which may or may not have been created by other species such as mammals, birds, other reptiles, or even spiders (EBRAHIMI & BULL, 2012). More than any other species, the European Leaf-toed Gecko requires access to rocky crevices to hide in during the day, but also to hibernate and lay eggs in (DELAUGERRE, 1981). Setting up shelters adapted to these needs can therefore be a good way of monitoring population size, at least in certain conditions, and even of increasing population numbers.



Two types of dens were tested: one using bricks with holes in them and another in which curved Roman roof tiles were stacked on top of one another (these tiles were sourced from the island, as debris from the renovation of an outbuilding). After just one month of installing these artificial dens, the results were beyond doubt: the system using the roman tiles proved to be extremely effective, and the dens were rapidly occupied by European Leaf-toed Geckos. On the contrary, the system using honey-combed bricks was found to be less attractive and less practical to use.

Based on this empirical discovery of a system that, while artificial, was also functional and attractive, the installation of these artificial shelters was extended across the entire island: from 2014 onwards, over thirty dens were installed and visited twice a year for monitoring purposes.
The Leaf-toed Geckoes use the spaces in between the tiles to flatten as much of their body surface as they can against the clay, thereby gaining as much heat as possible via thermal inertia. As such, the space left between the tiles is an essential parameter in terms of maintaining the effectiveness of the system. It appears that a space of between 5mm and 1 cm at the centre of the tile's curve is the optimum measurement to ensure colonisation by the species.

Building on this success, the system of artificial dens was replicated on the île du Château d'If beginning in 2017, demonstrating the same level of effectiveness. It is for this reason that, by extension, the tiles were considered to be favourable artificial habitats and inserted directly and permanently into the parapet of the ramparts of the Château d'If, in order to counterbalance the filling in of cracks used by the species during renovation of the stonework. The effectiveness of this solution will be evaluated in two different ways once construction is completed: replicating the monitoring of selected areas during the same periods along the restored parapets, and post-construction monitoring of the artificial dens. In this way, the two intersectional methods allow us to evaluate, and even to quantify, the differences in activities and demographics before and after the construction work.

Bibliographic references

This text draws heavily from the article byCheylan M., Rivière V. & Cheylan A., 2018, ***Evaluation d'une méthode de suivi à long terme du gecko Euleptes europaea sur l'île du Grand Rouveau (Archipel des Embiez, Var, France).*** Revue d'écologie (Terre et Vie), Vol. 73 (4), 2018: 526-536.

Beck, D.D., Jennings, R.D. 2003 - ***Habitat use by Gila monsters: the importance of shelters.*** Herpetol. Monogr., 17:111–129.

Bulova, S.J. (2002).***How temperature, humidity, and burrow selection affect evaporative water loss in desert tortoises.*** J. Therm. Biol. 27 :175–189.

Delaugerre, M., 1981 - ***Sur l'histoire naturelle de Phyllodactylus europaeus Gené, 1838 (Gekkonidae Sauria Reptiles).***Port-Cros : étude d'une population naturelle. Trav. sci. parc nation. Port-Cros 6: 147–175.

Delaugerre, M. 2009.-***Protocole de suivi géographique du Phyllodactyle d'Europe (Euleptes europaea) sur l'île de Port-Cros.*** Parc National de Port-Cros, 34 p.

Ebrahimi, M., & Bull, M. C. 2012, ***Lycosid spiders are friends and enemies of the endangered Pygmy Bluetongue lizard (Tiliqua adelaidensis).*** Transactions of the Royal Society of South Australia, 136(1), 45-49.

Grillet, P., Cheylan, M., Thirion, J.M., Doré, F., Bonnet, X., Dauge, C., Chollet, S. & Marchand, M.A.,2010, ***Rabbit burrows or artificial refuges are a critical habitat component for the threatened lizard Timon lepidus (Sauria, Lacertidae).*** Biodiversity and Conservation, 19 (7): 2039-2051.

Ineich, I., 2010, ***How habitat disturbance benefits geckos: conservation implications.*** Comptes Rendus Biologies, 333(2010), 76-82.

Mercier O., Bernard G., Bruhat L. ... & Millon A., 2017, ***Etude pilote pour la mise en place d'un protocole de suivi du Phyllodactyle d'Europe (Euleptes europaea) sur l'île de Port-Cros (Var, France).*** Sci. Rep. Port-Cros National Park, 31: pp. 189-211.

Salvidio S., & Delaugerre, M., 2003, ***Population dynamics of the European Leaf-toed Gecko (Euleptes europaea) in NW Italy: implications for conservation.*** Herpetological journal, 13(2), 81-88.

Save The Aeolian Lizard

a conservation project for the most threatened island endemic species of the Mediterranean herpetofauna

Aeolian Island

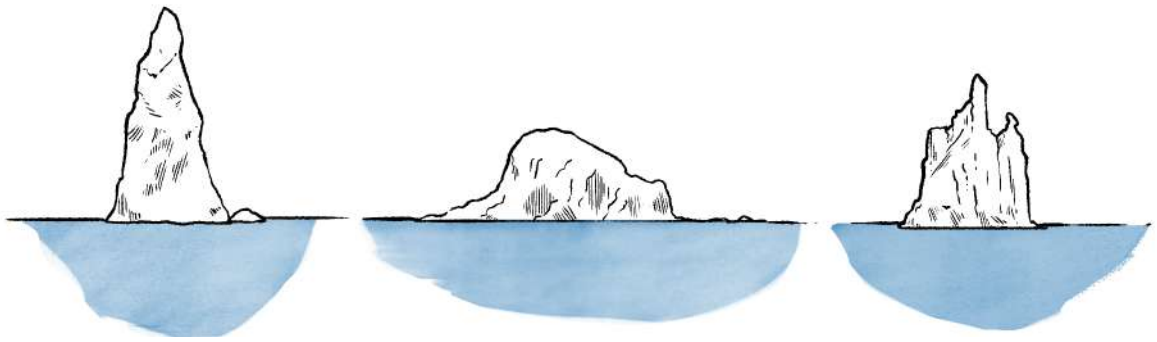
ITALY

Photo of Nesos Association

Aeolian Islands

Sicily

Italy



Surface : Area currently occupied by species is 0,02 km2, shared in three different sites. The islets where reintroduction is planned have a comparable surface.

Altitude : small islets with < 100 m above sea level

Protection statut the islets where reintroduction is planned lies in the Nature 2000 Site SPA ITA030044

Uninhabited

Focus Ultra-threatened species assessed by IUCN as Critically Endangered with the criteria B1ab(v)+2ab(v)

Biological challenges and sensitivity

SPECIES OF INTEREST

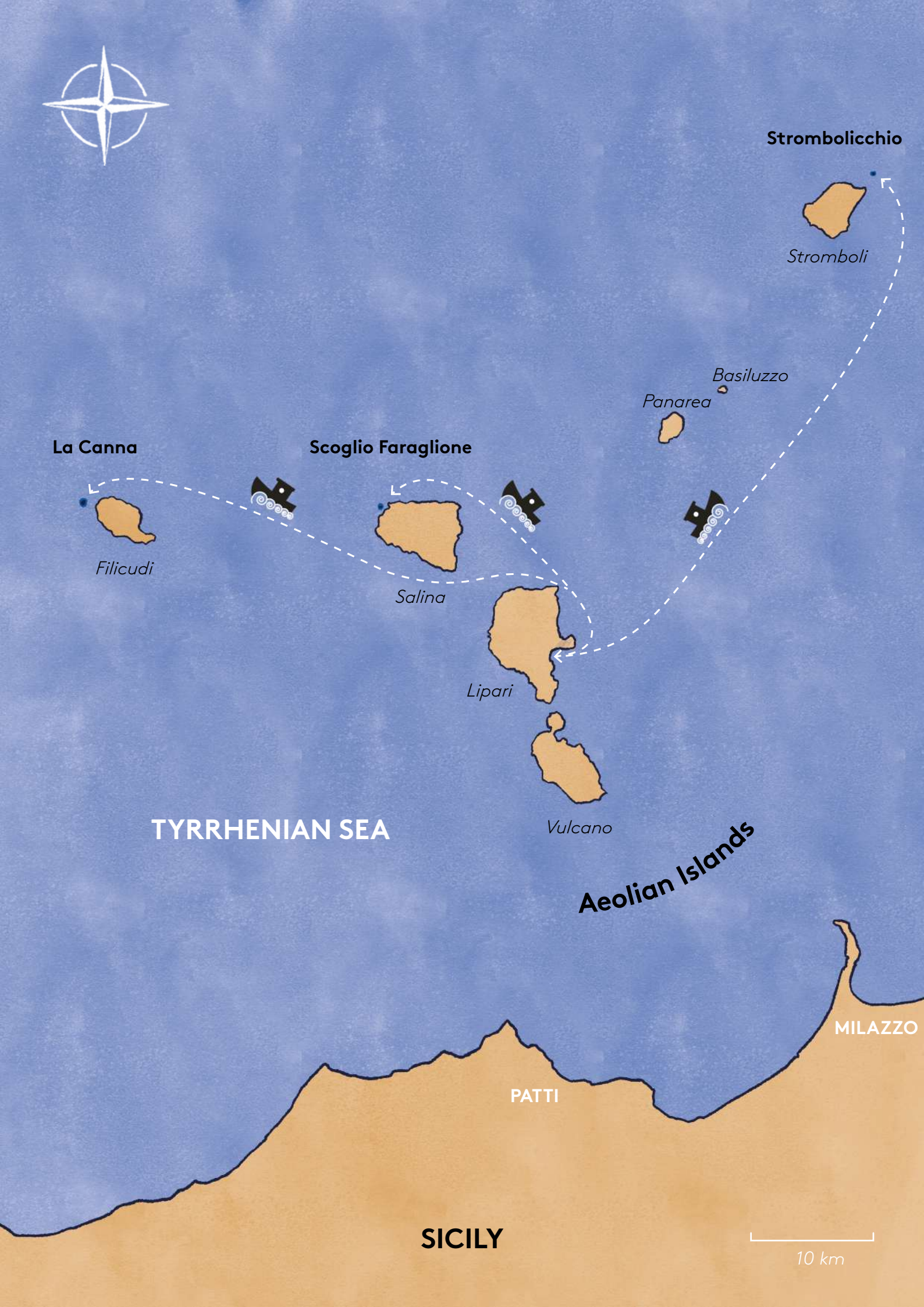
Podarcis raffonei

INVASIVE SPECIES

Podarcis siculus

Characteristics of project working conditions

- There is no pathway in 2 out of 3 islets and access is really difficult. Pietra del Bagno is less steep, and access is relatively easier.
- Although disembarkation is not forbidden, there are no visitors on the islets due to their low accessibility and rough morphology.


Strombolicchio
Stromboli
Basiluzzo
Panarea
La Canna
Scoglio Faraglione
Filicudi
Salina
Lipari
Vulcano
TYRRHENIAN SEA
Aeolian Islands
MILAZZO
PATTI
SICILY
10 km

May 2022
Build terraria
Installation of incubator
Preparation of space

June - July 2022
Sample first individuals from source-population
Arrangement of breeding captive program

Septembre 2022
Other samples from source-populations
Breeding captive program

October 2022 - April 2023
Breeding captive program according to natural cycles

May 2023 - June 2024
Reintroductions / other samples

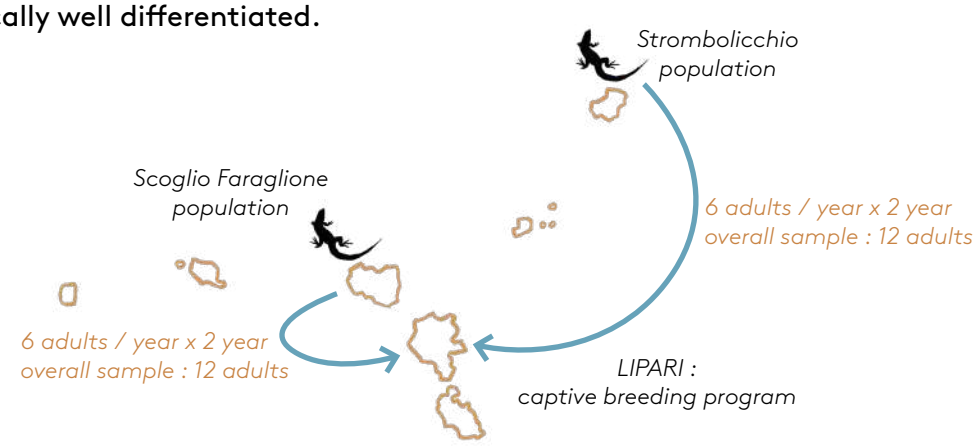
August 2022 - 2024
Communication / dissemination activity
Raising awareness campaign

Project description

Podarcis raffonei is endemic o f the Aeolian Archipelago, where it currently occurs on three tiny islets (Strombolicchio, Scoglio Faraglione and La Canna) with a whole population estimated as < 1,000 individuals. A residual population on Vulcano Island shows a strong decline during the last decades and it may be actually considered extinct. **The general decline of this species seems to be due to anthropogenic disturbance and to exclusive competition process with *Podarcis siculus* that has replaced the endemic lizard in most part of its original geographical range.** The survival populations occur on small, isolated areas and are highly exposed to the risk of stochastic events that could quickly lead to extinction.

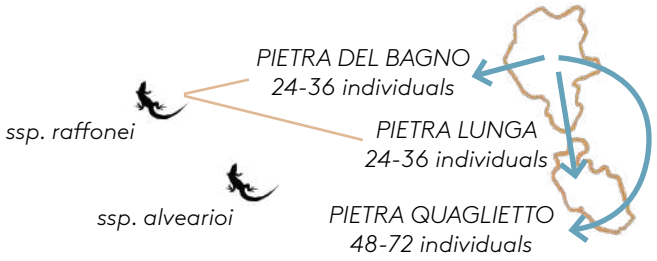
The cause of decline of the Aeolian lizard suggests excluding the possibility of reintroducing this species on areas inhabited by other lizard species (such as *Podarcis siculus*), as well as in those subject to anthropogenic disturbance. For this reason, we have identified suitable sites to host new populations where competitors or predators are absent. After a long-term program of biological assessment of their characteristics, we selected three islets of the Aeolian Archipelago (Pietra Quaglietto, Pietra del Bagno and Pietra Lunga) where the local ecosystem is comparable with that occupied by the survival populations.

However, the small size of these latters lead to exclude their use for a direct reintroduction through specimens translocation; thus, we prefer to plan and develop a captive breeding program using only a small number of founder individuals from the two largest population (Strombolicchio and Scoglio Faraglione), taking also in consideration that they belong respectively to two distinct subspecies, morphologically and genetically well differentiated.



Planned sampling from
the "donor" populations

During the 3-years captive breeding program, all the new-born individuals will be released on the selected islets in order to increase the existing populations of the species.



Expected results after the 3-years
captive breeding program

One of the aims of the project is also to improve awareness of the importance of the target-species in the whole context of the biodiversity at local, regional and wider level. For this reason, the outdoor space and the lab will be opened to the visits from students, scholars and visitors, when the project will be fully operative (after the 1st cycle of reproduction in captivity). Another aim is to assess a model useful for the replicability of this project in other places with comparable conditions and conservation problems.

The project has obtained the patronage from Societas Herpetologica Italica, Federparchi, Municipality of Lipari, Municipality of Malfa.

Main parameters considered for the implementation of the project

DISTANCE FROM CONTINENT

The selected islets for the new populations are relatively close to the main islands of Lipari and Vulcano, that are located 17.7 and 32.2 km respectively from the coast of Sicily

TYPE OF HABITATS

The islets host simplified examples of coastal vegetation mostly dominated by nitro-halophile plants, typical of the rocky shores influenced by the sea nearness

SEASONALITY

Seasonal factors represent one of the main constrain to the development of the project steps; the natural cycle of lizards' reproduction, and therefore eggs/juveniles availability, is limited to some months between April and September and each female lays eggs 1-2 time per year.

Human and financial resources

- 6 volunteers are involved in these activities
- The project benefits from several co-funding (MAVA, Nesos and FPA2) for an approximate of 70 000€

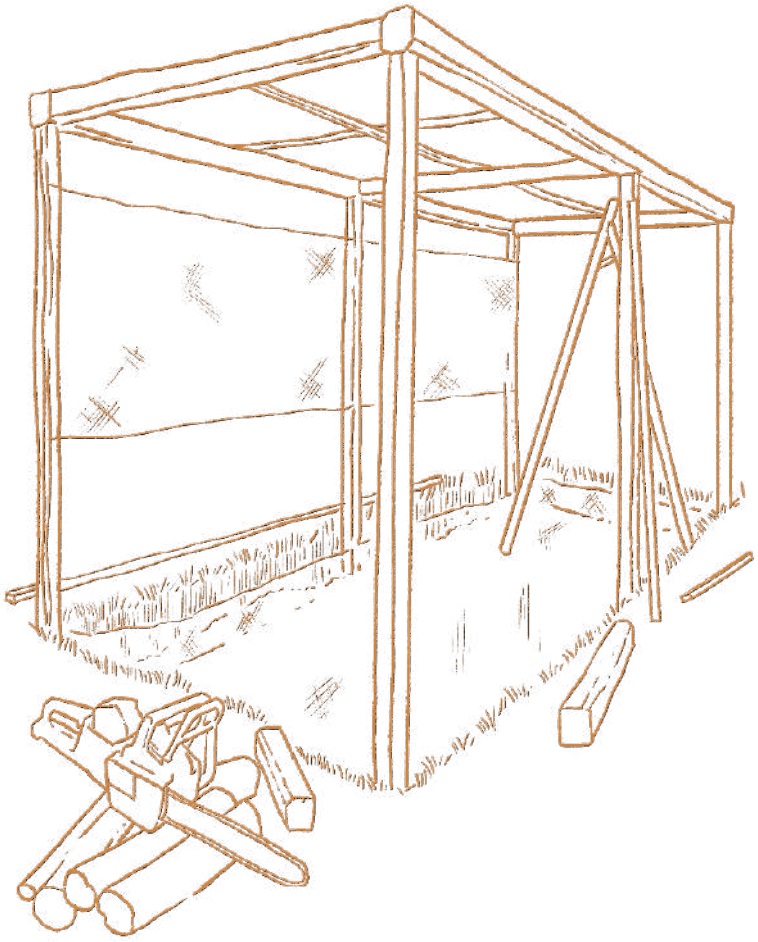
Operators

Local association involved in conservation and research programs: Kurma
Support in boat availability: Blue Marine Foundation
Veterinary assistance: Veterinary Department of Messina University
Supervisor: Zoological Section "La Specola" of the Natural History Museum of Florence University

Selecting the appropriate intervention method

Necessary equipment

- Terraria
  1 outdoor terrarium with 4 separated spaces, 4 indoor terraria for temporarily breeding adults and juveniles first stages development.
- Incubator FIEMM professional
- Fauna boxes for meal insects
- Fauna boxes for lizard translocation
- Fridge
- Field equipment for lizard monitoring
- Boat for field activities and related costs
  gasoline, insurance, maintenance, etc...



Results

Labour-time mobilised

- Arrangement of the internal and external spaces for the project activities: ~ 1 month
- Realisation of the outdoor terrarium: 5 days
- Monitoring activities (at the populations of Strombolicchio and Scoglio Faraglione): in order to verify if the demo ecological parameters allowed to sample a small number of individuals to start the captive breeding program, 2 sessions per islet for 4 overall working days.
- Breeding program: the first samples were taken from the islets occupied by the species and consequently the breeding program started.
  Daily monitoring of terrariums where individuals are temporarily housed
  At least 2 hours a day to feed the captive individuals and check their physiological status
  3-4 times a week to check and feed meal insects

Cost of materials

Total cost of equipment	*4 200€*
Total cost of building materials and spaces maintenance	*13 600€*
Total cost of meal for captive breeding	*10 700€*
Total cost of boat maintenance	*3 500€*
Total cost of gasoline for field activities	*2 500€*
Miscellaneous expenses	*1 200€*

Captive Breeding program

As of end of September have been sampled 4 females + 2 males from Strombolicchio and just 4 females from Scoglio Faraglione; in the next weeks 2 males from this latter population will be sampled. All the individuals are temporarily placed in indoor terraria, waiting to refine the surface drainage system of rainwater in the outdoor terrarium. By spring 2023, all the individuals will be definitively hosted in this latter, while their eggs will be removed and developed in the incubator; after the eggs hatch, new-born individuals will be temporarily placed in indoor terraria before their reintroduction on the islets.

Awareness campaign

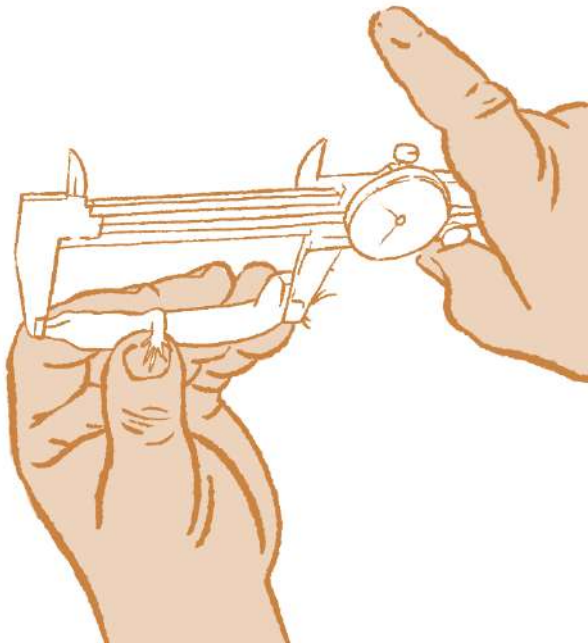
The first step of the awareness campaign was the realization of a project's logo and a website (http://www.nesos.org/aeolianlizardproject/index.html#). A first public presentation event was held in August 2022 with a conference on the island of Salina (where an islet hosts one of the populations of the species). We have in plan further similar events at short term in order to disseminate the importance of the target species and the related conservation actions at local and regional level. Next year we will participate to national and international scientific meetings to discuss the first results of the project. Further objectives are the creation of informative material, the opening of the laboratory and the breeding space to the public, encouraging the presence of schools, local stakeholders and visitors, and a regular updating about the project steps given through the main social network of Nesos and all the partners.

Critique of the method

The 3-years captive breeding program should provide an adequate stock of individuals to constitute three small new populations; these latter will double the actual number of the Aeolian lizard populations. The main weakness of the project consists of the expected low genetic variability of the new populations although the current populations of the species are affected by the same problem. It should be noted, however, that lizards seem to be usually more resilient than other animals to the low genetic variability, as revealed by the long-term persistence of some very small populations on tiny islets and rocks, for instance, of Balearic Islands where viable surface is extremely reduced. Apparently, this problem cannot be resolved in this case.

Testimonial

Among the project staff, a key person is undoubtedly Francesco Allegrino. Born in Lipari, he is completing a degree in Environmental Sciences at the University of Messina. Francesco has a great passion and expertise for reptile breeding, an activity he has been doing since he was a child. He has immediately understood the importance of the conservation of the species and the scientific approach on which is based the project. His collaboration became really significant for the success of the captive breeding program because lizards are extremely fragile and exposed to several constraints (humidity, food, proper temperature, etc.) that play an important role in their reproductive performance.



Arrangement and lighting of small indoor terraria

A fauna box for meal insects

A volunteer painting the different spaces inside the outdoor terrarium with images of the islets. In addition to the aesthetic value, this will facilitate the ability to understand the difference between the lizards subspecies and their provenance to the visitors.

Creation of an island plant nursery to foster heritage species

Frioul Island
Frioul archipelago
Marseille
FRANCE

With contributions from Julien Ugo of the Porquerolles National Botanical Conservatory

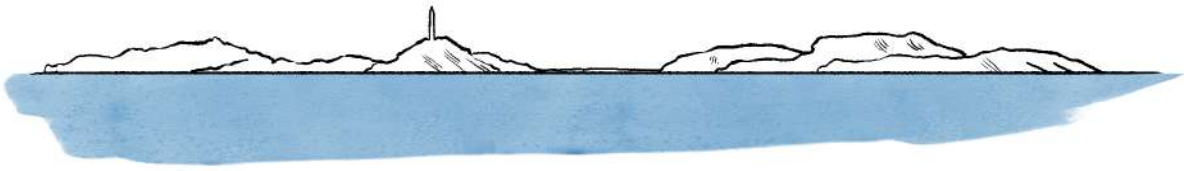
Photography by Julien Ugo
Porquerolle National Botanical Conservatory

Frioul island

Frioul archipelago

Marseille

FRANCE



Pomègues

Surface area: 90.37 ha
Altitude:84 m
X Coord: : 43.26955
Y Coord:5.297718

Ratonneau

Surface area: 98.35 ha
Altitude:74 m
X Coord: : 43.2826
Y Coord:5.308323

Protected status: "Heartland zone" of the Calanques National Park
Inhabited island
Regular boat landings
Daily ferry shuttles several times per day

Biological challenges and sensitivity

SPECIES OF INTEREST

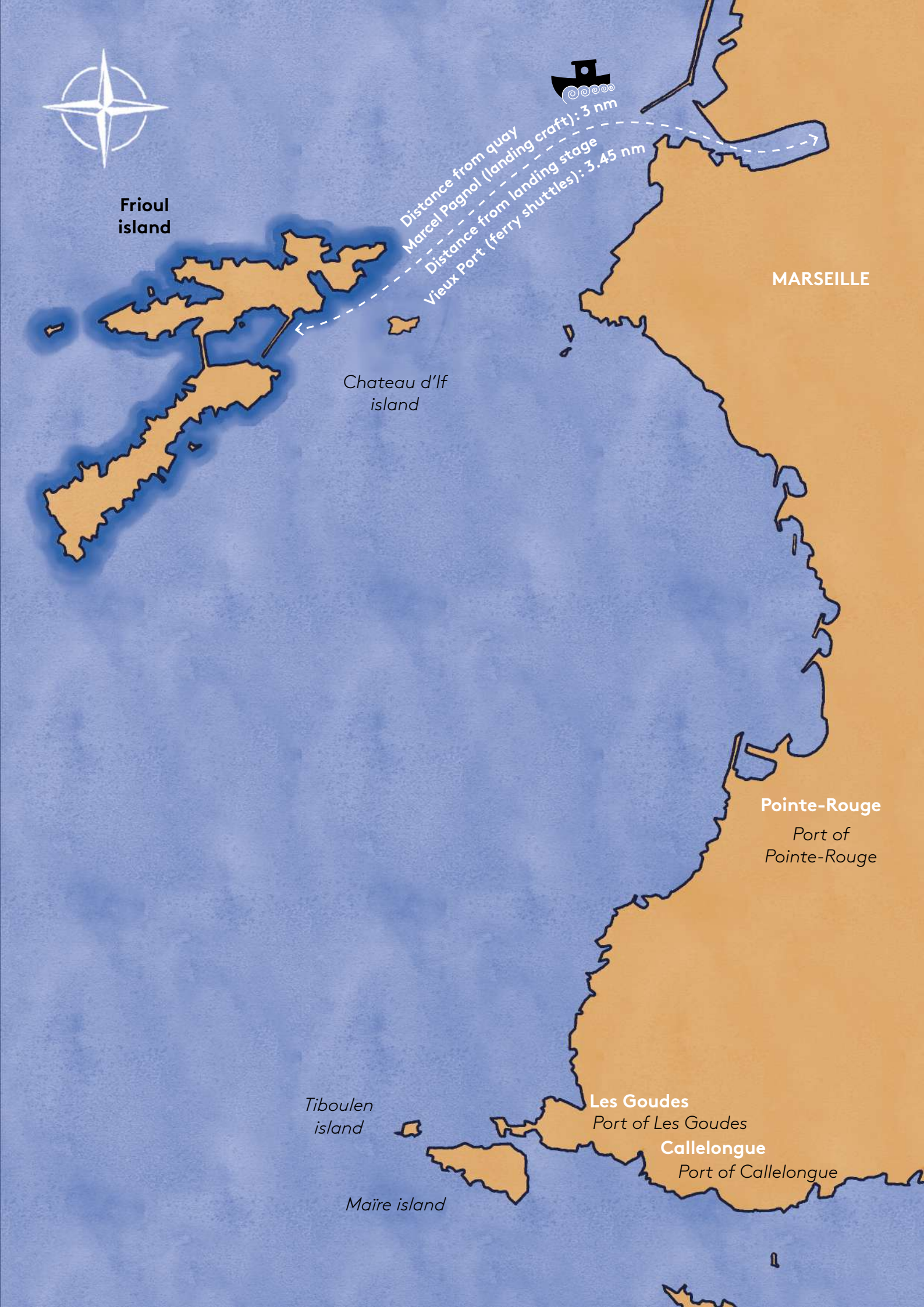
Array of protected plant species (15 species) and heritage species (15 species)
Presence of an endemic nocturnal gecko
Protected and heritage insect species
Marine birds and birds of prey

INVASIVE SPECIES

Array of invasive alien species *Carpobrotus sp., Atriplex halimus, Opuntia sp., Agava americana, Medicago arborea*
Black rat *Rattus rattus*
Pet cats
Colony of Yellow-legged Gulls *Larus michahellis*

Characteristics of project working conditions

- No difficulty in unloading personnel (ferry shuttles) and equipment (landing craft)
- Proximity to road network (possible to transport equipment by lorry)
- No running water or electricty at the site of the plant nursery


Frioul
island
Distance from quay
Marcel Pagnol (landing craft): 3 nm
Distance from landing stage
Vieux Port (ferry shuttles): 3.45 nm
MARSEILLE
Chateau d'If
island
Pointe-Rouge
Port of
Pointe-Rouge
Tiboulen
island
Les Goudes
Port of Les Goudes
Callelongue
Port of Callelongue
Maïre island

Project Description

Undertaken in September 2018, this project to create an *in situ* plant nursery supplements the efforts to boost the natural populations of plantain, *Plantago subulata* , which is a rare and protected endangered species that grows on the coast and on the island of Frioul. The objective is create a pool of individuals adapted to highly local and extremely restrictive conditions, and to use the seeds they produce to strengthen the populations at ecological restoration stations.

The Porquerolles National Botanical Mediterranean Conservatory (CBNMed) is in charge of the restoration project, which falls within the Calanques LIFE Habitats programme, in which the Calanques National Mark, the Provence-Alpes-Côte d'Azur Regional Agency for Biodiversity and the Environment, and the city of Marseille are all involved. For this specific project, the CBNMed has partnered with the Lycée des Calanques high school.

September 2018
Start of initiative

→

Until end of 2022
Maintenance and monitoring

Main parameters considered for the implementation of the project

ACCESS
Site offers significant accessibility: possible to bring in personnel and equipment by sea (ferry shuttles and landing craft), with connection to the local road and vehicle network.

WATER
Running water available on the island but at a distance from the nursery.

ACCOMMODATION
Accommodation available on site, enabling operations to be carried out over several consecutive days

RESTORATION
Necessary to recreate the edaphic conditions found at the site where ecological restoration will take place

Operators

Porquerolles National Botanical Conservatory, Lycée des Calanques.

Selecting the appropriate intervention method

Implementation steps

STEP 1
Identification of an ideal site for the creation of the plant nursery (near an access road but at a safe enough distance to avoid any accidental damage)

STEP 2
Development of the site in order to recreate the mineral composition of natural stations:

- Removal of any remaining invasive alien species
- Transfer of sensitive species outside the area being developed
- Removing top layer of soil
- Provision of coarse materials gathered from around the island in order to recreate the soil layer and limit subsequent competition.

STEP 3
Transplanting individuals grown from Plantago subulata seeds (collected on the island of Frioul) and raised in the CBNMed's nursery on the island of Porquerolles (located in the Var department of France).

STEP 4
No watering for 2 years in order to encourage the root stock to adapt to natural conditions on the island.

Apparatus

Two plant beds with a total surface of 30m2, cleared of grass and weeds, in which 95 individuals were planted.

Duration of operation

A high school class were e (16 students and 2 teachers) were enlisted to help create the nursery, along with two agents from the CBNMed over a two-day period. Maintenance (which mostly involves weeding) is carried out once a year by agents of the CBNMed and the Calanques national park.

Specific characteristics of the project

This initiative included a significant pedagogical aspect, mobilising a class from a local agricultural high school and creating a win-win partnership between the high school and the CBNMed: the Conservatory provides the scientific expertise and authorisation required to implement the initiative, while the high school benefits from pedagogical support for its students and provides the working materials (van and tools). This helps the initiative fit within the principles of the Calanques LIFE habitats program, owing to the reduced cost of implementation. In addition, the nursery was specificially designed to host a single species, Plantago subulata, a desert plant that does not require regular watering.

Results

Number of root stocks transplanted to the nursery	*95*
Survival rate after one year	*60% (vs. 2% for individuals transplanted into natural environments)*
Recruitment of 6 subjects grown from spontaneous germination	*271*
Cost of labour in setting up the nursery *No external service provided, only man-hours used*	*40 man-days*
Cost of materials *transport by van, cost of return journeys by ferry shuttle, meals). Van and materials provided free of charge by the high school*	*less than €1000*

TESTIMONIAL

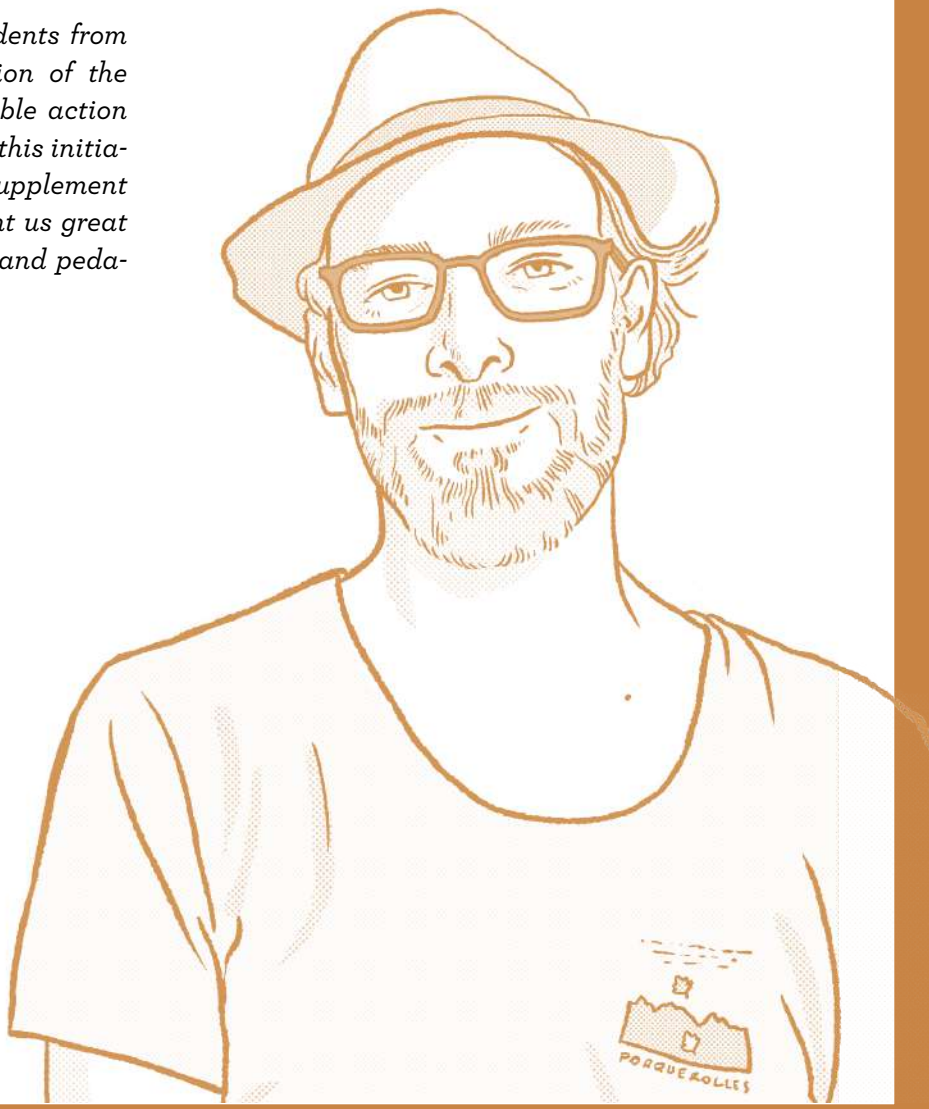
Julien Ugo

Project Leader
Porquerolles National Botanical Conservatory

The population status of the Plantago subulata species required human intervention.

This project to strengthen the population was above all an experiment, which we went into with no guarantee of success. That is why we planned out this nursery project as a plan B, in the event that the in natura plantations were unsuccessful. The fact that we have a solid understanding of the species' ecology enabled us to create a substitute habitat without any major difficulty, and the fact that the plant requires very little water in order to develop made success a possibility.

Thanks to the involvement of the students from the Lycée des Calanques, the creation of the nursery was an opportunity for tangible action and to communicate the goals behind this initiative. The initiative, which served to supplement the transplantation campaign, brought us great satisfaction on a scientific, techncial and pedagogical level.



Critique of the method

The plants used to populate the nursery were exclusively made up of young plants grown from seeds harvested from wild populations on the island of Frioul – a population which is suspected to be suffering from interbreeding leading to lower survival rates (reflected by the drop in numbers in the natural environment in recent years). However, in the absence of genetic analysis this hypothesis cannot be proven, and the possibility of constituting a stock of composite plants issuing from varying populations (using genetic amalgamation) has not received scientific consensus. A genetic study of the various populations of this species could improve the approach used.
It is difficult to showcase the value of the nursery to the general public. The nursery was only designed to host this particular species, and further development would be required in order to grow a wider diversity of species (especially where the issue of watering comes into play).

Initial site

Preparing the terrain: weeding

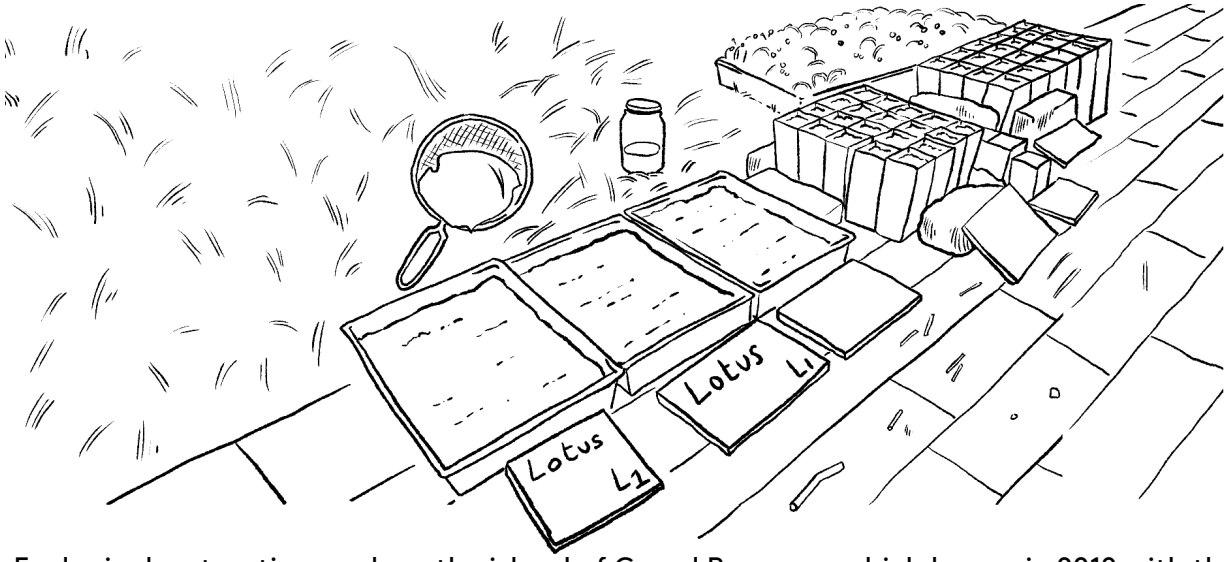
Preparing the terrain:
creating the mineral layer

Plantation

Condition after
18 months

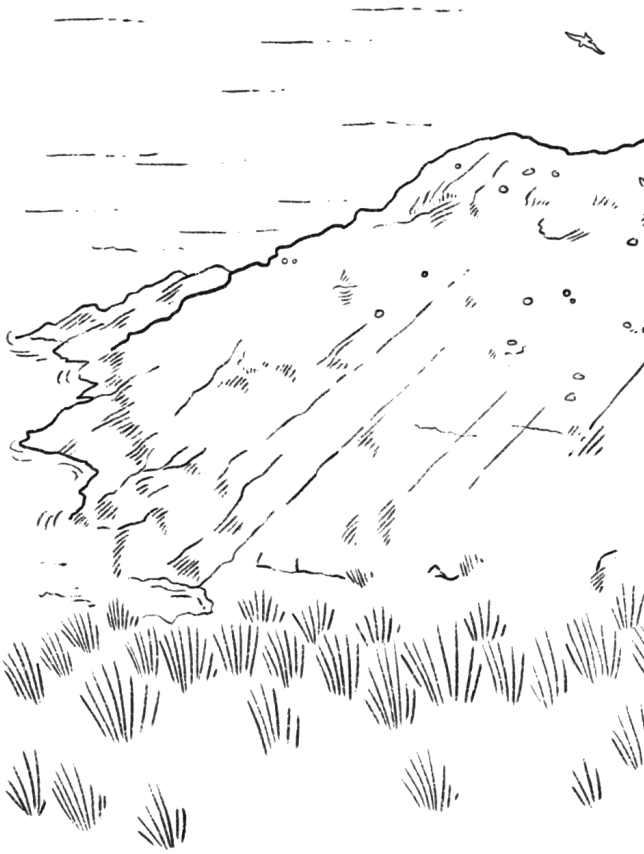
Photograph by J.Ugo and M. Robichon

The plant nursery on Grand Rouveau island



Ecological restoration work on the island of Grand Rouveau, which began in 2012 with the removal of the main invasive alien species found on the island, the sour fig (*Carpobrotus edulis*), required technical adjustments as early as the spring of 2013.

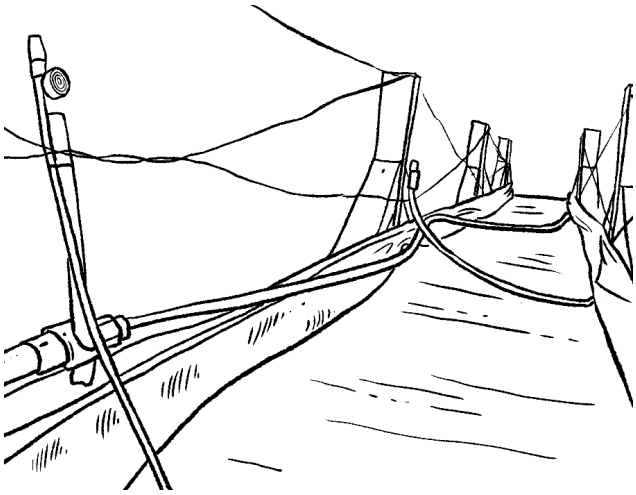
In effect, while the windrows created using the sour fig debris did show a certain level of effectiveness in terms of combating soil leaching, in certain highly localised circumstances they did not function as intended. This was notably observed on one of the slopes covered by the operation: the slope was known to be highly exposed to rain and sea spray, and consequently the windrows could not maintain their position on the hillside. Following this observation, the windrows were moved closer together and stabilised with wooden stakes.

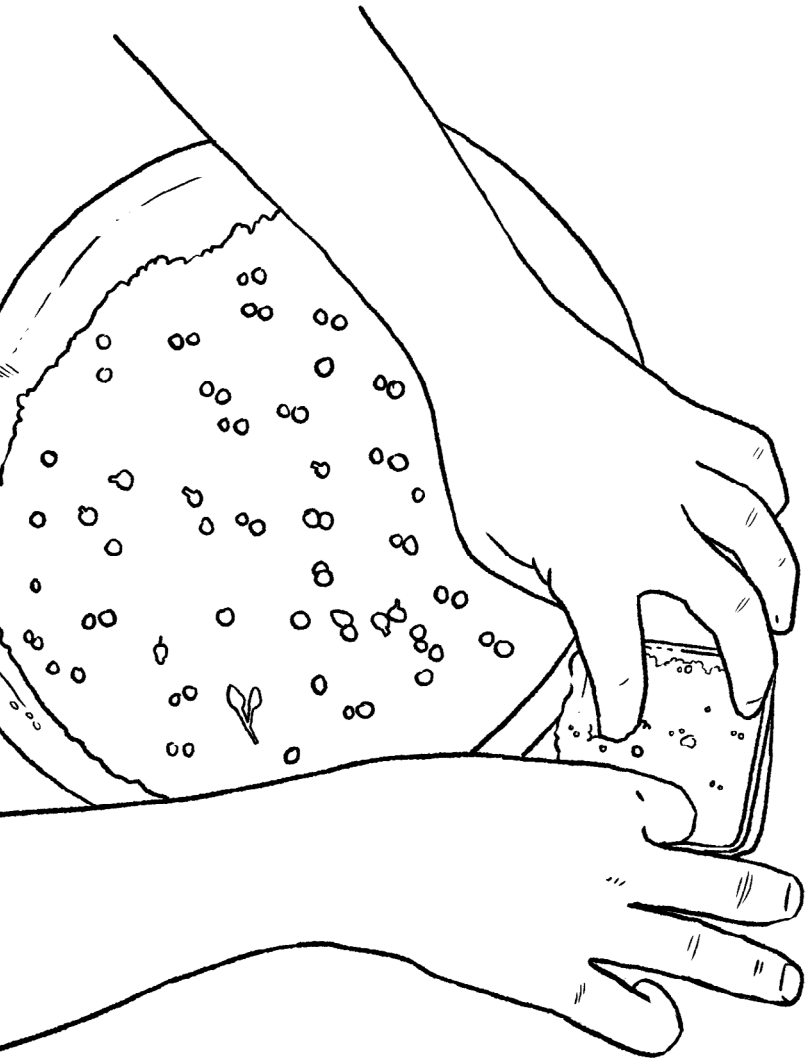


The preferred method of recolonisation in the sectors cleared of sour fig plants was almost exclusively to let nature take its course. However, in certain specific sectors this strategy could not be maintained due to the risk of allowing the thin layer of soil, so crucial to vegetation recolonisation, to disappear completely. Ecological engineering work to limit soil leaching was rapidly carried out. At the same time, a self-sufficient island nursery was set up.

This nursery was designed to meet a strictly local goal: the plants would be sourced exclusively from the island (by gathering seeds and cuttings), and had to be grown in the island's own soil in order to avoid any introduction of other species or genetic contamination. However, this nursery also had to overcome a certain number of technical constraints, notably including the lack of either running water, electricity or regular monitoring.

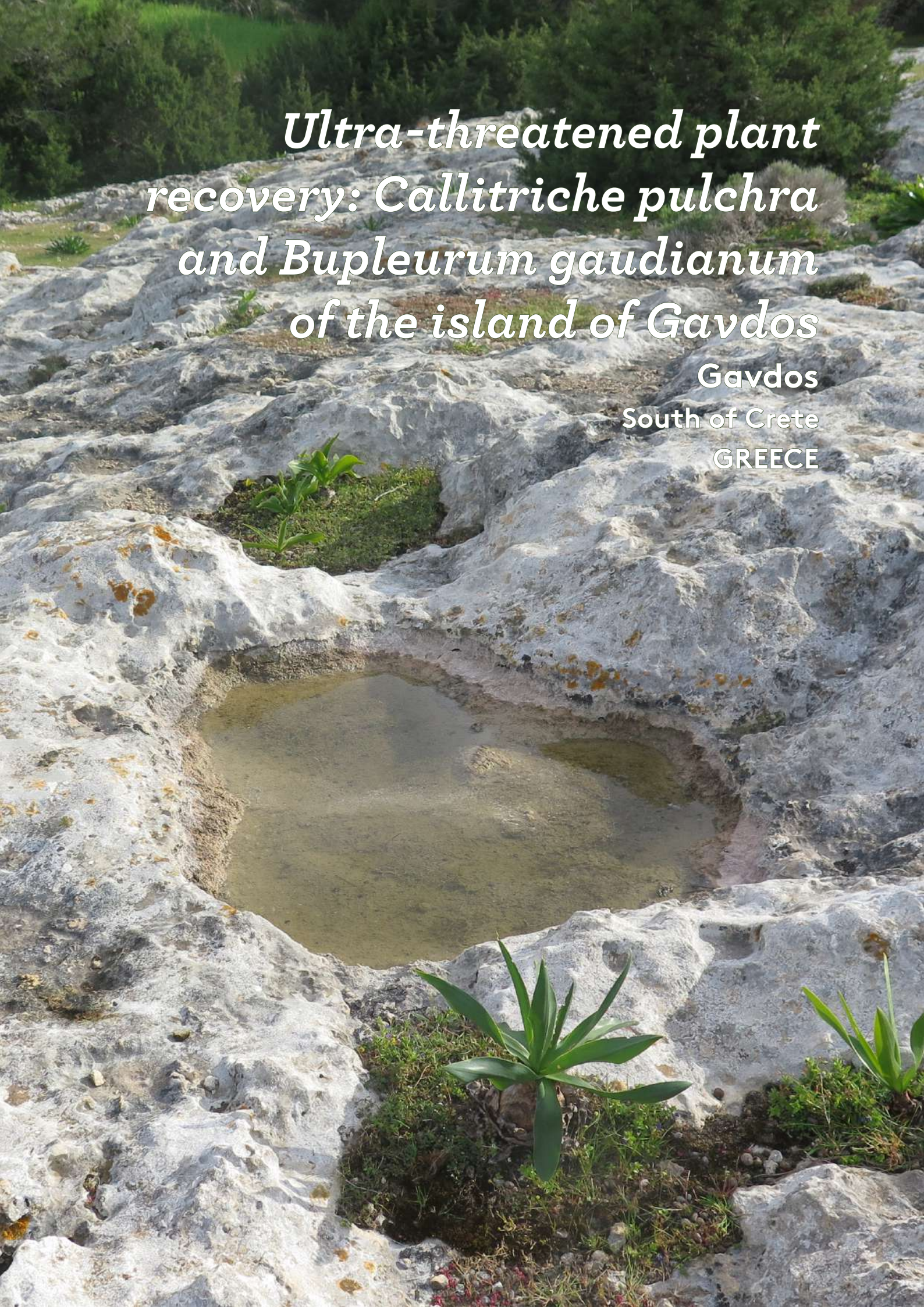
As such, from 2013 to 2018, the skills of several specialists were called in to address these various issues: nursery managers, ecologists, and the plant watering department of the town of Six-Fours-les-Plages. Each year, the nursery was able to benefit from additional input and experience garnered from previous attempts and failures: selecting species presenting the best recovery or germination rate, adjusting the watering schedule using an automatic timer, watering with a sprinkler system, etc.





Despite all this, very few plants were able to be transferred to the restoration site after a year of growth in the nursery. In fact, the water reserve used to irrigate the nursery dried up over various lengths of time during the summer period, causing the vast majority of root stocks to dry out. We should specify that this water reserve was filled up from a cistern located beneath the island's lighthouse; this cistern could only be accessed from inside the lighthouse, which was opened on an exceptional basis when the owner was present (there were no option of installing gutters on outbuildings in order to collect rainwater).

As such, given these difficulties and coupled with the resilience demonstrated by the target sector, the nursery was dismantled in late 2018. The project is not unachievable, but its objectives would need to be adjusted to the limitations of the site. In this context, it would have been necessary to increase monitoring and upkeep of the nursery; something that did not align with the self-sufficiency being sought.



Ultra-threatened plant recovery: Callitriche pulchra and Bupleurum gaudianum of the island of Gavdos

Gavdos

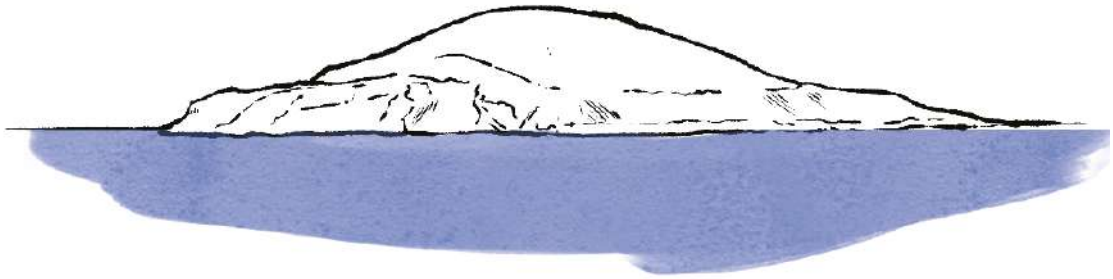
South of Crete

GREECE

Gavdos

South of Crete

Greece



Surface area concerned: 2958 ha
Altitude: 0-362m
Inhabited :
< 100 people live on the island permanently throughout the year. In summer, the population can reach 3,500 due to tourists with most of them being campers.
The inhabitants are mainly engaged in livestock farming and tourism.

Protection status:
Natura 2000 (GR4340013 – NISOI GAVDOS KAI GAVDOPOULA)

Biological challenges and sensitivity

Species of interest:
Callitriche pulchra - Schotsman and Bupleurum gaudianum - Snogerup

Characteristics on site:

Remote island, only accessible by boat.
Easy to get stranded due to bad weather conditions


CRETE
Chora Sfakion)
Port of Chora Sfakion)
Distance from the port : 21.5 nm
Gavdos
5 km

October 2021 → **January 2022** → **Mars 2022** → **April 2022**

Site visits to select best sites to implement actions campaigns

Preparation of action plan for *Callitriche pulchra* & *Bupleurum gaudianum*

Mapping of subpopulation of *B. gaudianum*

Dissemination Event in Gavdos & Production of t-shirts

May 2022 → **September 2022** → **End 2022**

Collection of seeds & monitoring of plant populations

Creation of Information booklet (English & Greek)

An Action Plan for long-term conservation of *Callitriche pulchra*. Report of the reintroduction protocol for *B. gaudianum* and long-term monitoring

Project description

Gavdos is a Mediterranean island: host of some of the most threatened plant species, and its one hundred inhabitants are multiplied by 20 during summer.
This phenomenon provokes an obviously important impact on natural habitat and especially on two of the most endangered plant species. To monitor this impact and raise awareness on the necessity to preserve Gavdos' threatened biodiversity, an action plan has been designed through various activities:

Activity 1
An Action Plan for long term conservation of *Callitriche pulchra*

Activity 2
Creation of a reintroduction protocol for *Bupleurum gaudianum*

Activity 3
Creation of Information booklets in English and Greek

Activity 4
Production of t-shirts

Activity 5
Dissemination Event in Gavdos

Main parameters considered for the implementation of the project

SEASONALITY
The monitoring of these threatened plants should be carried out in March and in April

ACCESSIBILITY
33.8 km of the southwest Cretan coast and accessible only by boat from Sfakia or Paleochora with ferries.

TYPE OF HABITATS
Fragile wetland habitat named «Mediterranean Temporary ponds», priority for conservation according to the Habitats Directive.

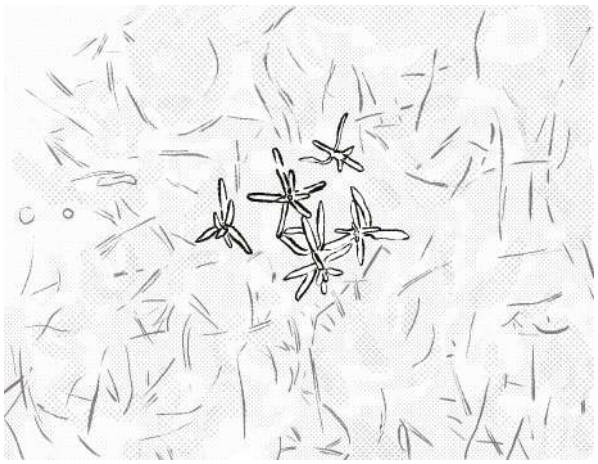
Operators

MIPSG (IUCN/SSC/Mediterranean Island Plant Specialist Group) and Mediterranean Agronomic Institute of Chania (CIHEAM-MAICh) Local Partners: Gavdos Municipality

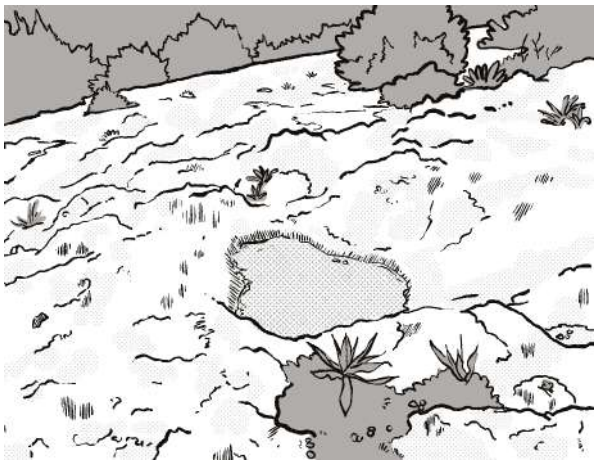
The activities in detail

ACTIVITY 1 : AN ACTION PLAN FOR LONG TERM CONSERVATION OF *CALLITRICHE PULCHRA*

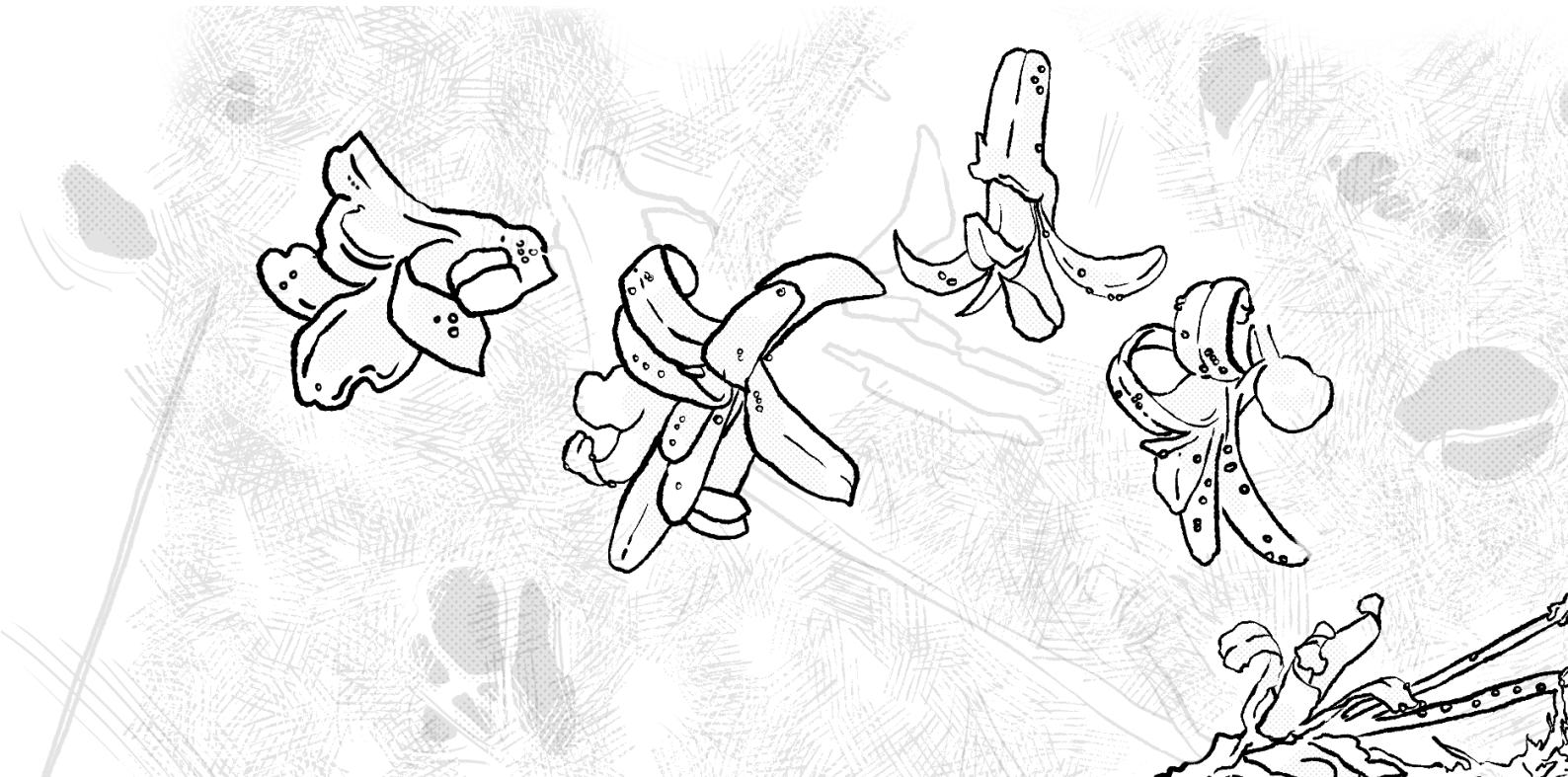
A detailed Action Plan is formulated for the conservation of *Callitriche pulchra*, through the protection of its fragile wetland habitat named «Mediterranean Temporary ponds», priority for conservation according to the Habitats Directive. The Mediterranean temporary ponds of Gavdos are peculiar and have been recorded during the LIFE – MEDPONDS program in order to maintain their ecological function. During the project MEDPONDS, the temporary ponds on the island were mapped in detail and the flora they host was recorded. The temporary ponds contribute significantly to the support of migratory birds, while they also host the critically endangered plant species Callitriche pulchra. Detailed mapping of the species took place on Gavdos in 2015, and the species was recorded in 101 locations. The Mediterranean Plant Conservation Unit of MAICh participated in the action, which mainly contributed to the ex-situ conservation of the species. An Action plan for the long-term monitoring will be created as well as management actions will be proposed in order to maintain the ecological functions that the temporary ponds performed.



Callitriche pulchra

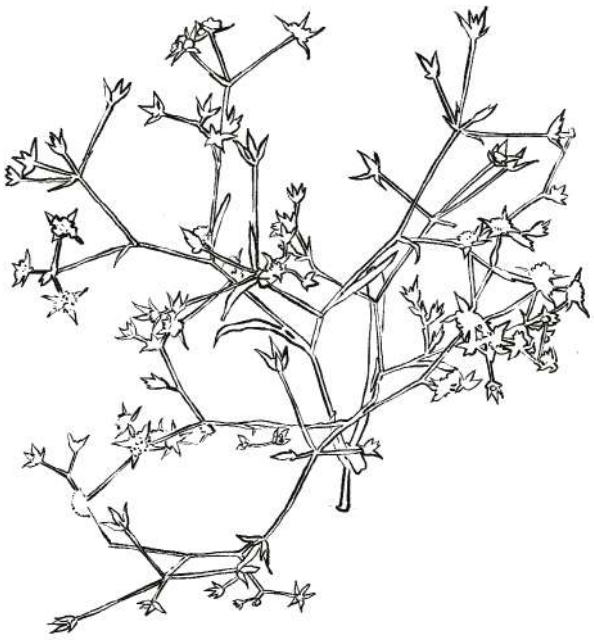


Karstic rock pools at Agios Pandeleimon of Gavdos – habitat of *Callitriche pulchra*



ACTIVITY 2 : CREATION OF A RE- INTRODUCTION PROTOCOL FOR *BUPLEURUM GAUDIANUM*

Bupleurum gaudianum is a steno-endemic and threatened plant occurring only on the small island of Gavdos. A germination protocol of the plant was created. An Action plan will be created for the long-term monitoring of its populations and a reintroduction protocol will be created based on germination protocol of the species.



Bupleurum gaudianum in flowering

ACTIVITY 3 : CREATION OF INFORMATION BOOKLETS IN ENGLISH AND GREEK

On the island of Gavdos, 10 plant taxa have been recorded as threatened in the Red Data Book of Threatened plants of Greece. A booklet will be produced to inform visitors about the significant flora of the island and the above threatened species. The booklet will be published in Greek and English and will be available on the Municipality's website.

ACTIVITY 4 : PRODUCTION OF T-SHIRTS

For the two most threatened plants of Gavdos, 500 T-shirts are to be produced. The T-shirts will be designed with plant sketches and information related to their conservation. The T-shirts will be distributed to inhabitants and visitors.

ACTIVITY 5 : DISSEMINATION EVENT IN GAVDOS

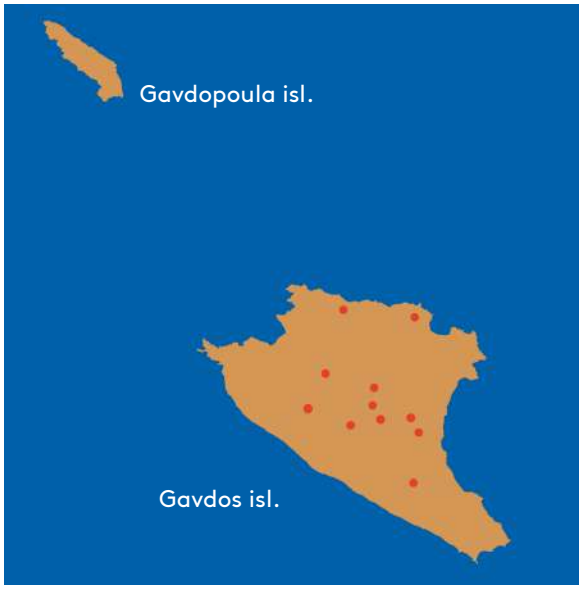
In collaboration with the Municipality, a mini symposium on "The environment and cultural heritage of Gavdos" will be organized. An opportunity to present the work being carried out on plant conservation in Gavdos and to distribute booklets and T-shirts to raise awareness.

Human and financial resources

15 months of labour time by MAICh - the project is implemented by the staff of CIHEAM - MAICh in cooperation with the IUCN/SSC/Mediterranean Plant Specialist Group and the Municipality of Gavdos. Additionally, the interest of the residents of Gavdos in the promotion and protection of biodiversity has contributed significantly to the successful implementation of the project and they expressed their interest to contribute to long-term monitoring of threatened plants. Also, specialist flora researchers such as orchid specialists helped to compile the guide.

In addition, cooperation with the competent management bodies: Forest Directorate of Chania and Management Unit of Samaria National Park and the Protected Areas of Western Crete-N.E.C.C.A. is essential for the completion and exploitation of project results.
40 000 € - the project's budget is funded 50% by the MAVA Foundation and 50% by CIHEAM-MAICh.

Results



Distribution map of *Callitriche*

ACTIVITY 1 : AN ACTION PLAN FOR LONG TERM CONSERVATION OF *CALLITRICHE PULCHRA*

In 2015, 47 pools with *C. pulchra* were located in 5 localities. In a monitoring action carried out by MAICh in 2022, at the same localities much fewer pools were located (9) with *C. pulchra*. This could be due to the abandonment of traditional livestock practices that kept the ponds free of organic materials which lead to eutrophication. It could, also be due to the seasonality of this annual plant or the climate. This pends to be determined and a thorough long-term monitoring plan is being designed. It will be based on the detailed mapping of Medponds of Gavdos provided by the LIFE 2004, Medponds Programme.
Using this mapping, a modern monitoring technique will be suggested based on citizen science and smart phone application.

ACTIVITY 2 : CREATION OF A RE- INTRODUCTION PROTOCOL FOR *BUPLEURUM GAUDIANUM*

In March 2022 a monitoring action was carried out by MAICh for *Bupleurum gaudianum*. Most of its subpopulations were located and mapped. 3 permanent plots (10 m2 each) were established whereas during the first-year monitoring, 1170 plants were located.

Distribution map of the plant *Bupleurum gaudianum* on Gavdos

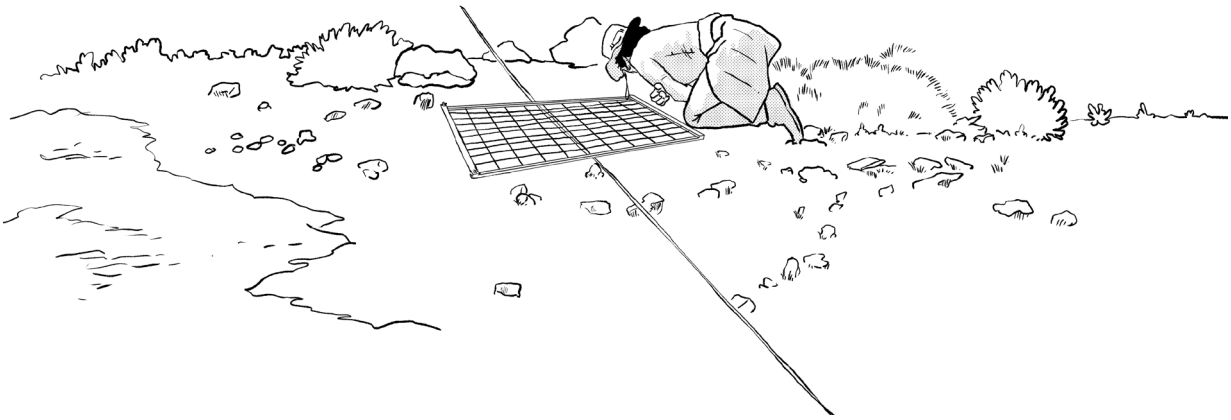
ACTIVITY 3 : CREATION OF INFORMATION BOOKLETS IN ENGLISH AND GREEK

An Information booklet (40-50 pages) will soon be published both in English and Greek and will also be available on the Municipality's website. It informs and raises awareness among the residents and visitors of Gavdos and Gavdopoula about the important biodiversity of the islands, and specifically about the rare threatened and protected plants that are found in the area. The selection of the species was made from the plant lists of the two islands known to date.

The most important plants were evaluated, i.e.

- plants which are included in the Red Data Books of Rare and Threatened Plants of Greece and in the Red Lists of threatened species of the International Union for Conservation of Nature (IUCN),
- plants with a restricted distribution (e.g., endemic plants),
- plants protected by the Greek legislation or international conventions,
- and other important plants of the two islands.

The protected habitats where several of the important plants are found as well as the pressures and threats that they face mainly due to human activities are also presented.



Field work for monitoring of the plant population of *Bupleurum gaudianum* in the area Ai Stratigos of Gavdos Distribution map of the plant *Bupleurum gaudianum* on Gavdos

ACTIVITY 4 : PRODUCTION OF T-SHIRTS

A total of 440 t-shirts and an additional 140 cloth bags were made and distributed by the Municipality of Gavdos to inhabitants and visitors of the island.

Information material, canvas bags and T-shirts depicting the rare and endangered plants of Gavdos, *Bupleurum gaudianum* and *Callitriche pulchra*

ACTIVITY 5 : DISSEMINATION EVENT IN GAVDOS

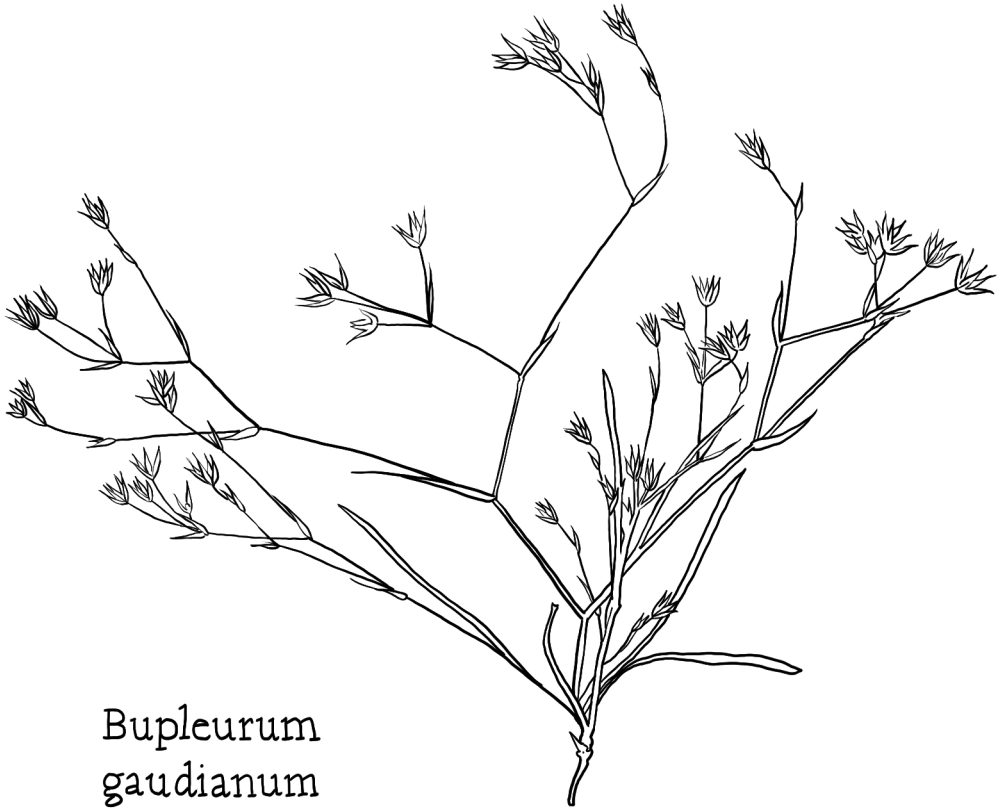
An informative event, open to the public, was held in April 2022 on 'The environmental and cultural heritage of Gavdos' and was co-organized by the Mediterranean Agronomic Institute of Chania (CIHEAM-MAICh), the Municipality of Gavdos and the International Union for Conservation of Nature (IUCN), in collaboration with the Administration Unit of the Samaria National Park and Protected Areas of Western Crete (OFYPEKA) and the Forestry Directorate of Chania in the Decentralized Administration of Crete.

In the discussion-consultation that followed the presentations from key speakers, all the participants agreed that the special environmental and cultural heritage of Gavdos should be protected and preserved, and the old terraces scattered on the island should be gradually restored. The need for the dissemination of scientific knowledge, which concerns the island, to the residents and visitors through web tools as well as the organization of summer schools by the Municipality, the Universities or other bodies, was also stressed. The need for fire prevention measures was mentioned, such as pine forest management measures and informing holidaymakers about the risk of forest fires through leaflets or other information material. In addition, the need to manage the large number of visitors was pointed out so as not to destroy the important habitats of the island. Finally, several residents expressed their interest in participating voluntarily in environmental protection actions under the guidance of expert scientists.

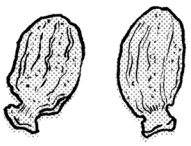
During the event, illustrated information material was shared about two important endangered plants of Gavdos: the small annual endemic *Bupleurum gaudianum*, which grows in Gavdos and nowhere else in the world, and *Callitriche pulchra*, another annual plant regarded as 'Extremely Endangered' according to the Red Data Book of Greece, as it is found in the country only in the 'aroliths' (seasonal lakes) of Gavdos.

Critique of the method

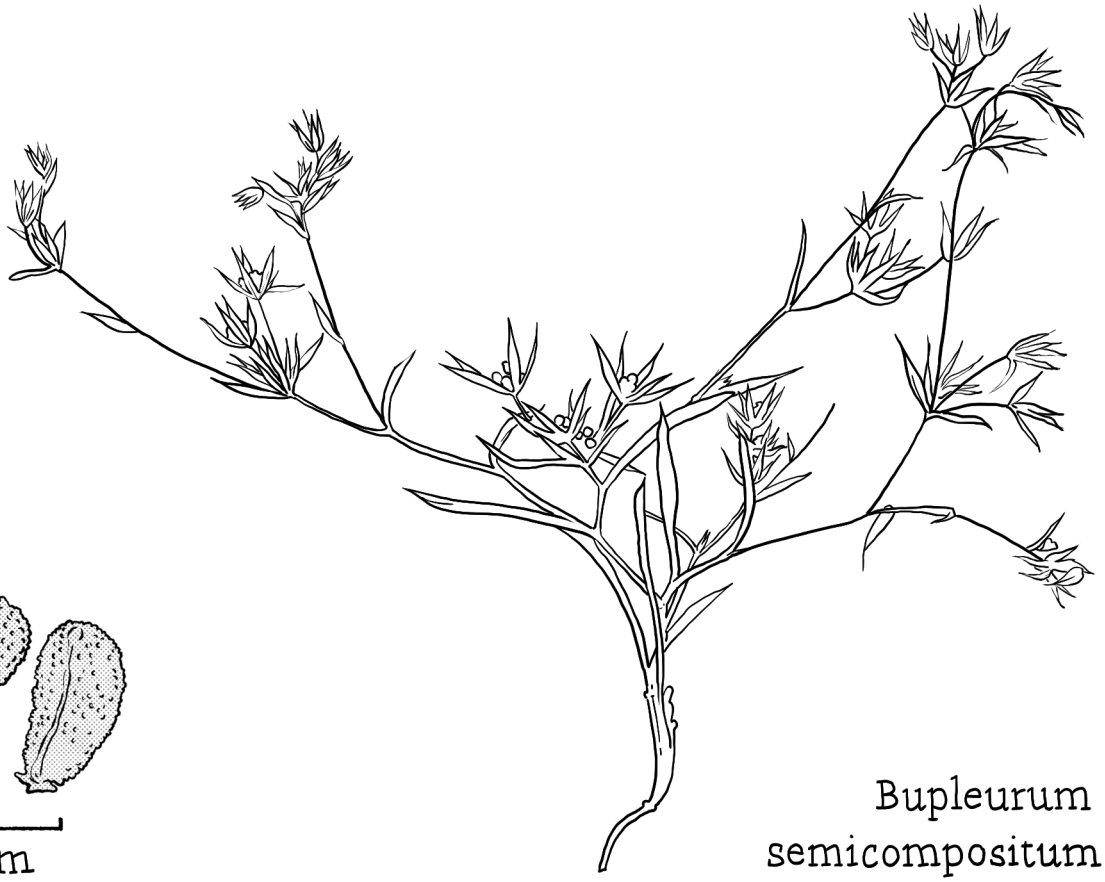
It is known that monitoring biodiversity data on small remote islands is difficult as it depends on the mobility of researchers. Apart from the possible lack of resources, weather conditions are often a limiting factor. In this program we try to find solutions so that long-term monitoring can be easily carried out by permanent residents / volunteers. For the aquatic species *Callitriche pulchra*, we are trying to find a solution through modern technology so that the residents can easily and accurately record the seasonal ponds where the plant is found. Of course, the participation of residents for monitoring plant species is not always possible as is the case with the other endangered plant *Bupleurum gaudianum*.



Bupleurum
gaudianum



1 mm



1 mm

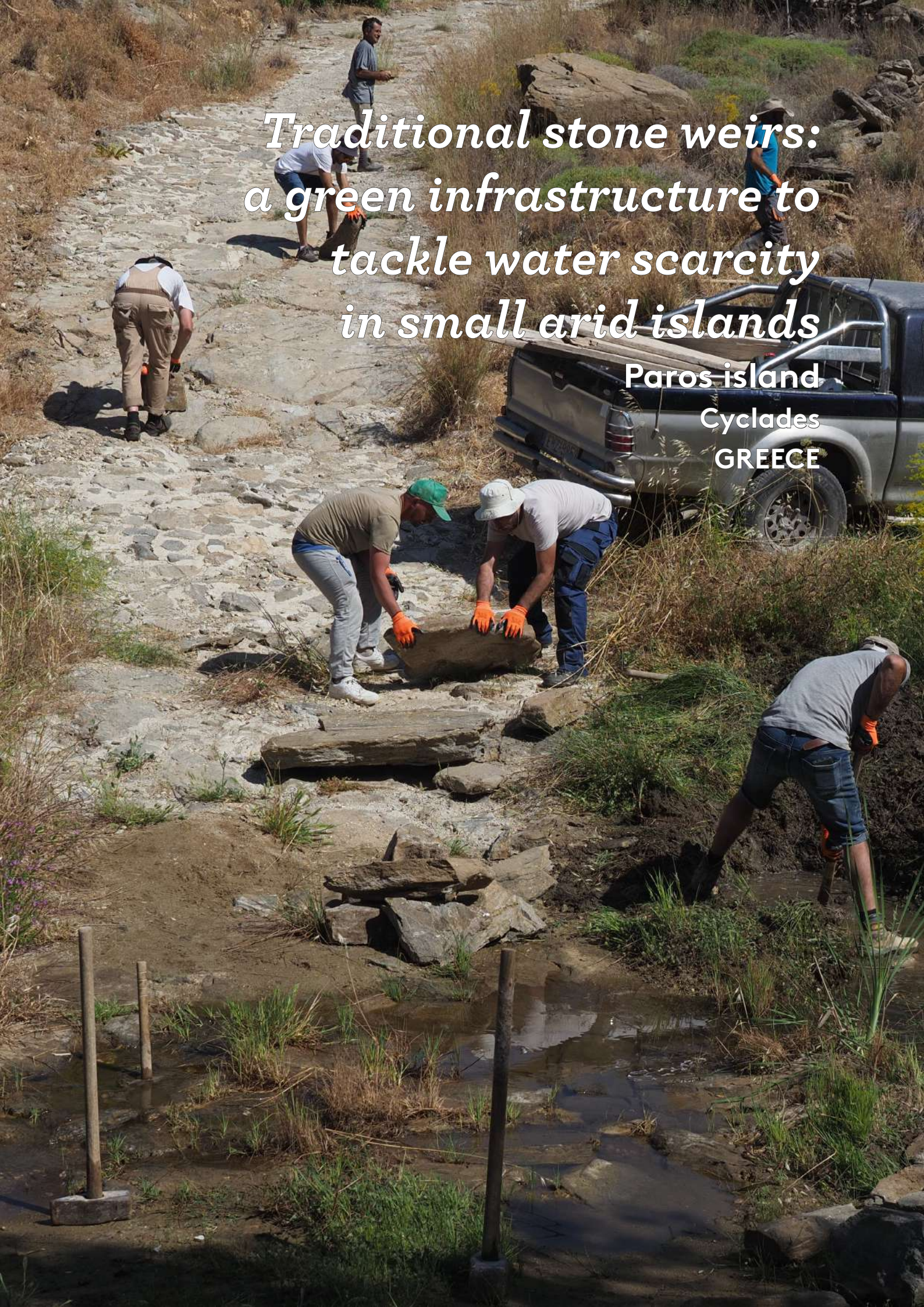
Bupleurum
semicompositum

TESTIMONIAL

Christini Fournaraki

Mediterranean Agronomic Institute of Chania (MAICh)

Bupleurum gaudianum is a small annual tiny herbaceous plant, 2-7 cm tall often confused with another annual species of the same genus, Bupleurum semicompositum. It is difficult to distinguish the two species because of their small size. In the field one must have very good practical experience to separate them on appearance as their differences are not visible. Therefore, it is difficult to record the plant by non-specialists especially in the areas where the two species coexist. their fruits (~1 mm long) differ in size, shape and outer appearance. The fruits of B. semicompositum are larger, lighter in colour and are covered with small whitish papillae, while the fruits of B. gaudianum are smaller, dark brown, wrinkled, and without papillae. They can also be distinguished from the number of bracts (small leaves that surround the inflorescence), which are usually 4 for B. gaudianum and 5 for B. semicompositum. Because the two species can be confused, it is possible that sites in the literature for B. gaudianum refer to B. semicompositum.



Traditional stone weirs: a green infrastructure to tackle water scarcity in small arid islands

Paros island

Cyclades

GREECE

Paros island

Cyclades

Greece

Surface area concerned:
Water basin of river: 5.9 km2
34 small retention ponds:
constructed in ~1.300 meters length
within the ephemeral stream of ~5.000 meters
Altitude: 100m – 210m

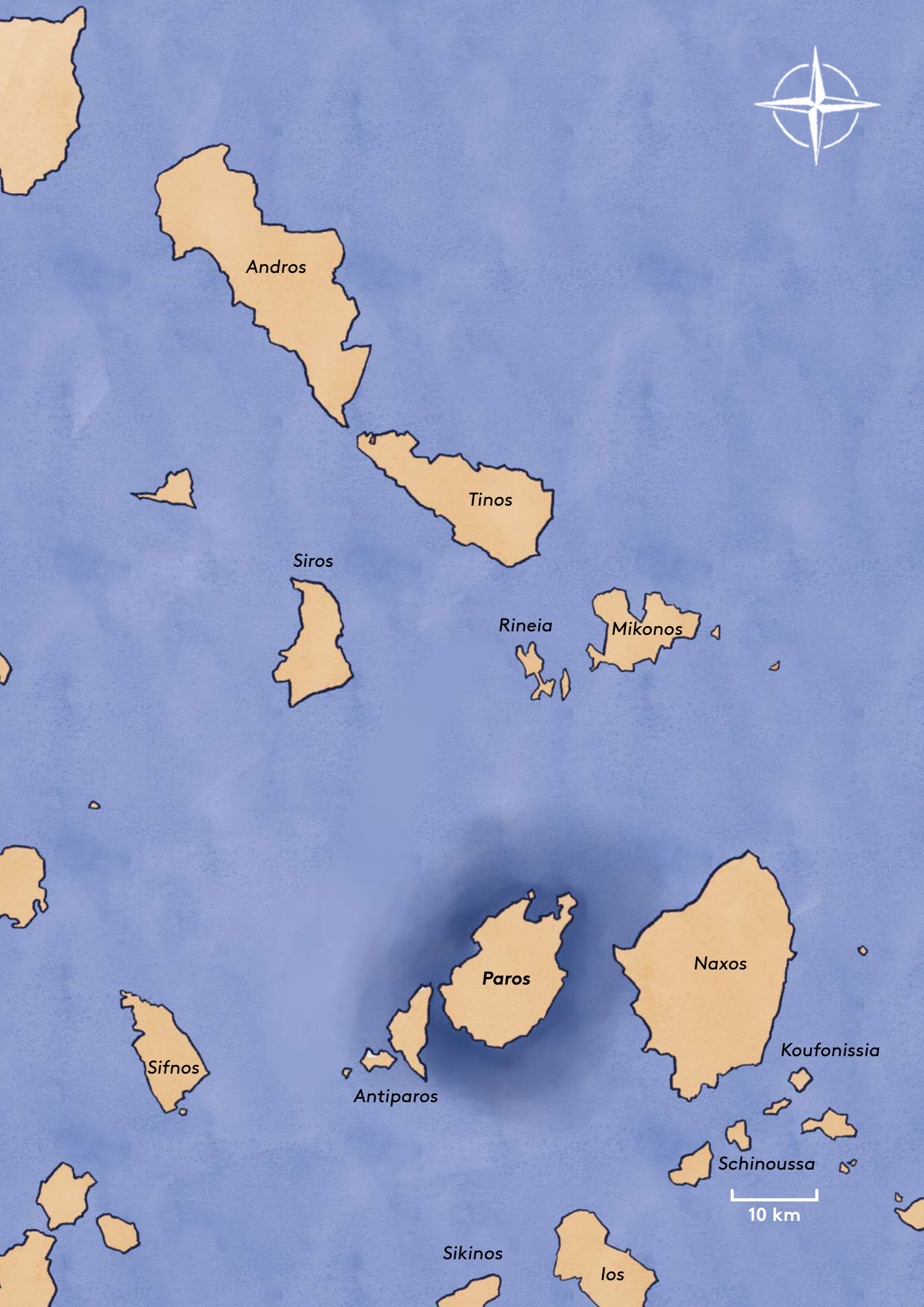
Latitude : 37.016298°,
Longitude : 25.202709°
Inhabited: ~250 inhabitants live within the water basin
Focus: Landscape restoration

Biological challenges and sensitivity

Species of interest: *Potamon hippocrate*, *Pelophylax kurtmuelleri*

Characteristics of project working conditions

- Local material for the construction nearby the stream
- The area of intervention has few farmers that will directly benefit from the project. However, during summertime, the population of the area increases due to tourism.


Andros
Tinos
Siros
Rineia
Mikonos
Paros
Naxos
Sifnos
Antiparos
Koufonissia
Schinoussa
10 km
Sikinos
Ios

June 2021
Launch of the project, define the areas of the weirs, launch of the pre-construction monitoring period

→

November 2021
Issue environmental permits for the implementation of the project of t-shirts

June 2022
Construction of the 34 weirs, workshop for the volunteers

→

June 2023
End of the post-construction monitoring period

Project description

Water has always been in demand on small islands. Traditionally, island communities have used a variety of approaches to address their water shortage like small reservoirs, wells, cisterns, etc. Among the various technics, the construction of stone weirs along the riverbeds of seasonal streams was of common practice.

A number of small weirs were constructed in 1300 meters of Kavouropotamos stream (Paros Island), based on existing knowledge and experience from Naxos and Kythera islands. **These green infrastructures increase water percolation and enrich the aquifer and at the same time provide water for the adjacent farmlands, while also help maintain water during the dry summer period, thus creating small biodiversity oases for flora and fauna.** The significance of stone weirs for biodiversity and the aquifers will be shown through a monitoring process.

Main parameters considered for the implementation of the project

CRITERIA FOR THE SELECTION OF THE AREA

Choose the area based on the following criteria: Seasonality of water flow, geological data, ground inclination, proximity to existing roads, adjacent agricultural land, ability to cooperate with local citizen groups, and ability to secure data collection for the monitoring of the project.

REPLICATION TO OTHER AREAS

Replication of the approach in other islands was taken in account when setting up the project.

MONITORING OF RESULT

Organizing and implementing the monitoring actions are among the most significant challenges.

Operators

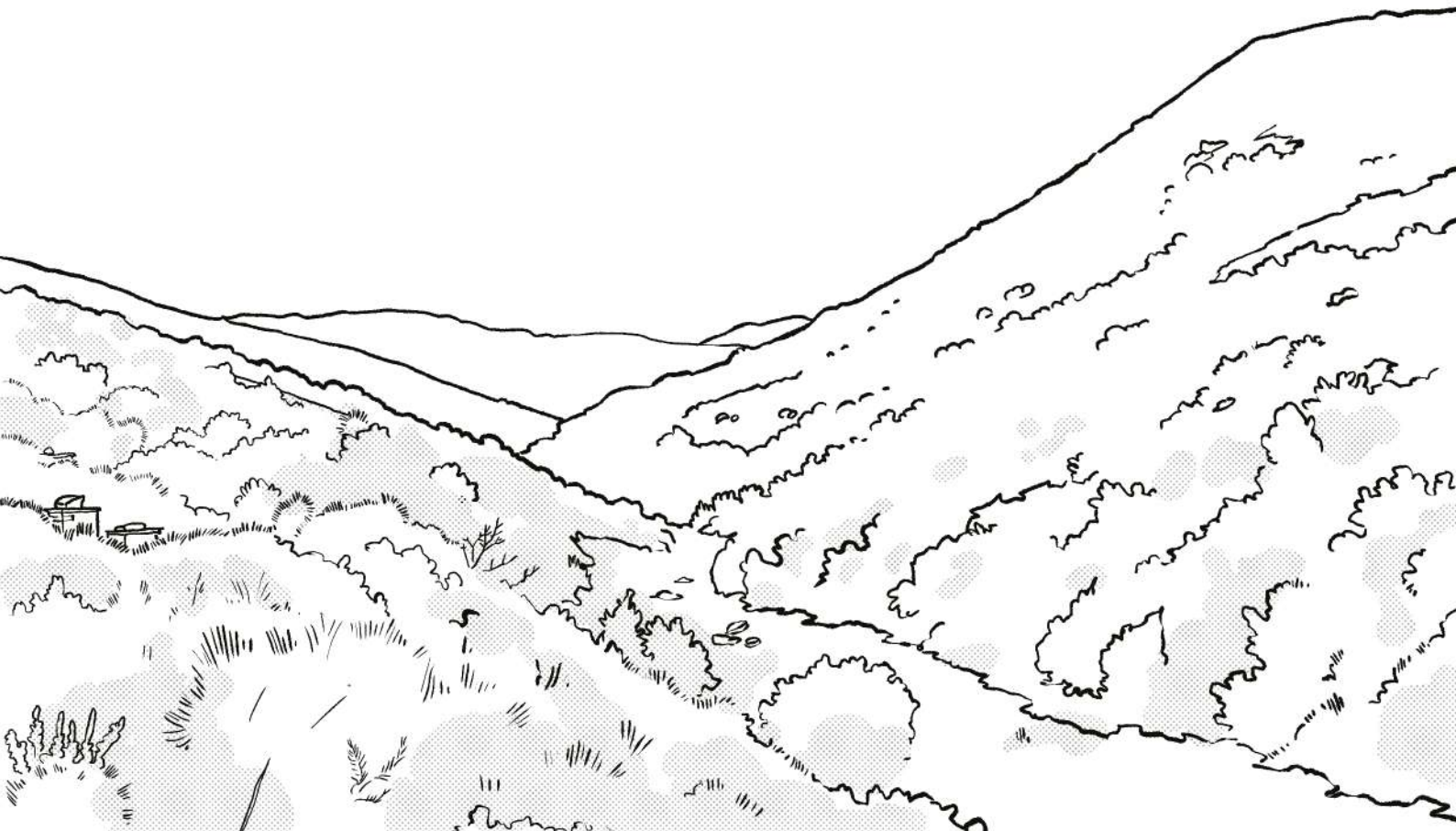
Interdisciplinary research collaborative "Boulouki", Paros Festival, Local NGO "Archilochos"

Selection of the site

Catchment area
of Kavouropotamos stream

Dark blue and yellow line is the stream (5,9km).
Only yellow line is the length of interventions.

Kavouropotamos stream (i.e., the stream of the crabs) in Paros Island was selected for the construction of the weirs based on the specific criteria. Initially, the specific locations of the weirs were selected, and a technical study was prepared and promoted to the relevant authorities in order to acquire all necessary permits.

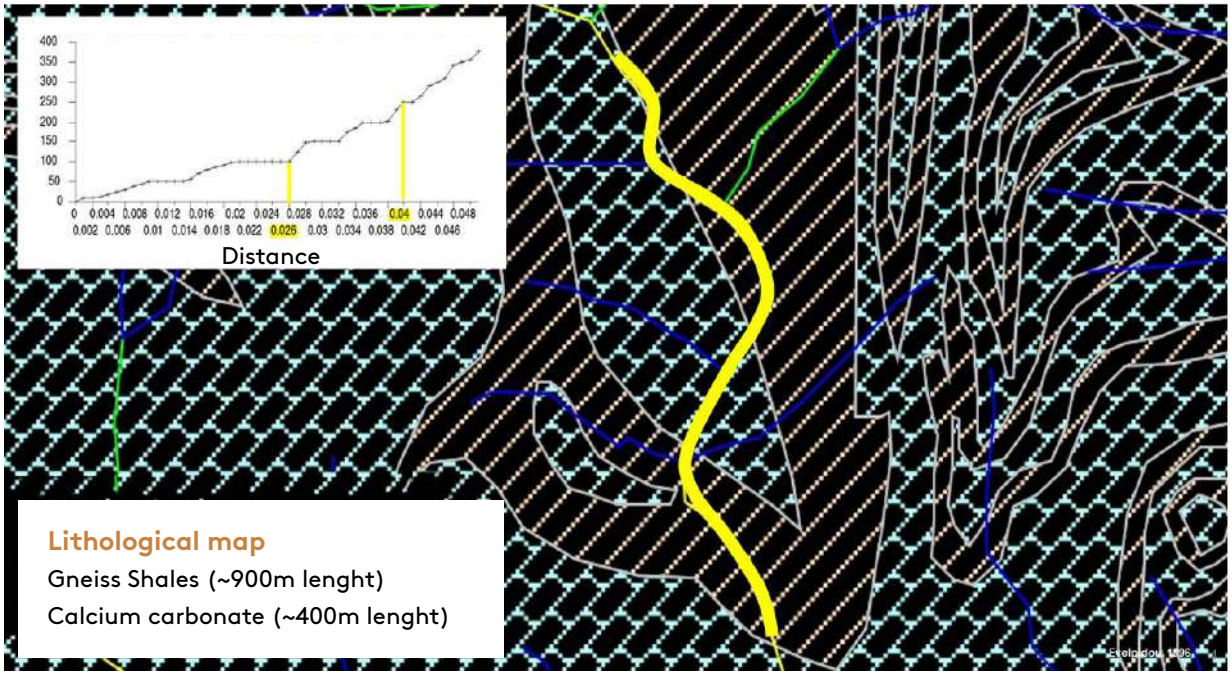


Following, three local stone masons along with their crews were selected based on their fine ability to use traditional techniques in their stonework. On early June 2022, a ten-day construction phase was started at the beginning of which a four-day workshop was organised. During the workshop 16 people from all over Greece were trained on stone construction by the masons and the relevant engineers and architects of the project team.

The project is implemented by WWF Greece, the Mediterranean Institute for Nature and Anthropos (MedINA), the Hellenic Institute of Speleological Research (HISR), the Municipality of Paros and the Paros Water Supply and Sewerage Company.

Location of the 34 weirs

In total, 34 weirs were built on a total length of 1300 meters of the stream. For the construction local materials were used while the height of the weirs never exceeded 0,5m.



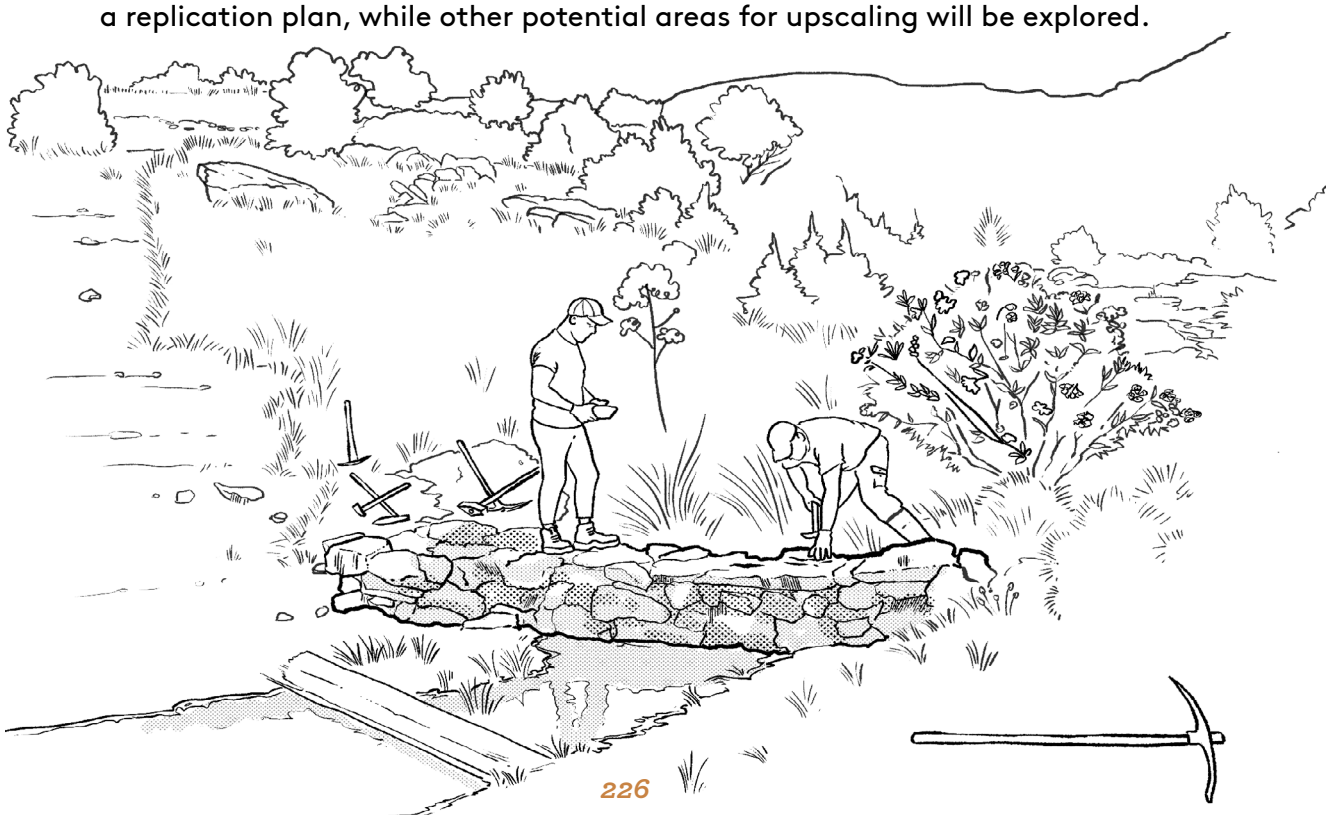
Human and financial resources

6 researchers were mobilised in the pre monitoring phase. 4 masons and 6 workers were occupied during the construction phase along with 16 volunteers from all over Greece who were participated in the initial phase of the construction via a relevant workshop, which had been organized by the "Boulouki" in close cooperation with the project team. The volunteers along with the local masons constructed the 14 out of the total 34 weirs.

Selecting the appropriate intervention method

For the implementation of the project, the following activities have been planned and their implementation is ongoing:

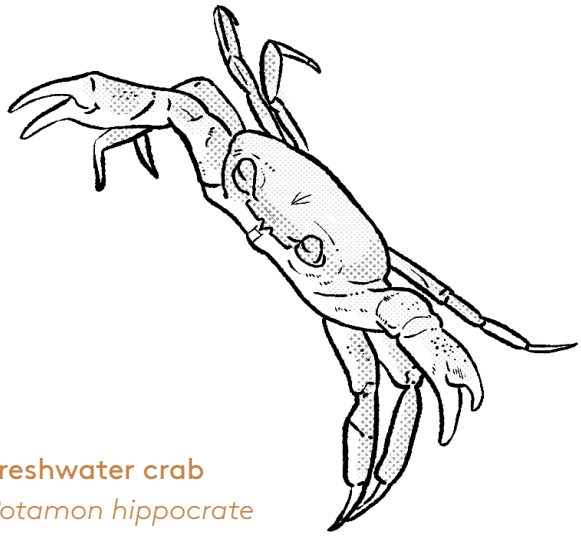
1. Mapping of stakeholders and making first contacts for expression of interest.
2. Study and licensing of the project, according to the procedure that has already been applied in Kythera.
3. Pre and post construction monitoring system: Impact of the weirs on 1) the water balance of the area (monitoring the water level of wells, water flow of spring supplies, etc.), 2) the ecosystems and biodiversity (flora and fauna diversity and abundance) and 3) other socio-economic parameters (agriculture, tourism, etc.).
4. Construction and supervision of the project
5. Actions of information and mobilization of local actors so that there will be a full acceptance of the value and usefulness of the project as well as mass participation of the local community in the construction phase. Local stakeholder engagement (citizens, local NGOs, etc.) will be achieved through presentation and other awareness activities.
6. All the phases and results of the project will be documented and published creating a replication plan, while other potential areas for upscaling will be explored.



Results

Regarding the **biotic parameters**, three field visits have already been made (Oct 2021, April & June 2022), **focusing on qualitative and quantitative information for flora species and habitat types, bats, herpetofauna, and invertebrates (both terrestrial and freshwater)**. Information acquired from this first monitoring stage will be compared with the data collected during the three post construction field visits (Oct 2022, April & June 2023).
A significant population increase of the freshwater crab *Potamon hippocrate* which is almost extinct in the area and the preservation of the Balkan Water Frog *Pelophylax kurtmuelleri* will be considered a success if achieved.

Balkan Water Frog
Pelophylax kurtmuelleri



Freshwater crab
Potamon hippocrate

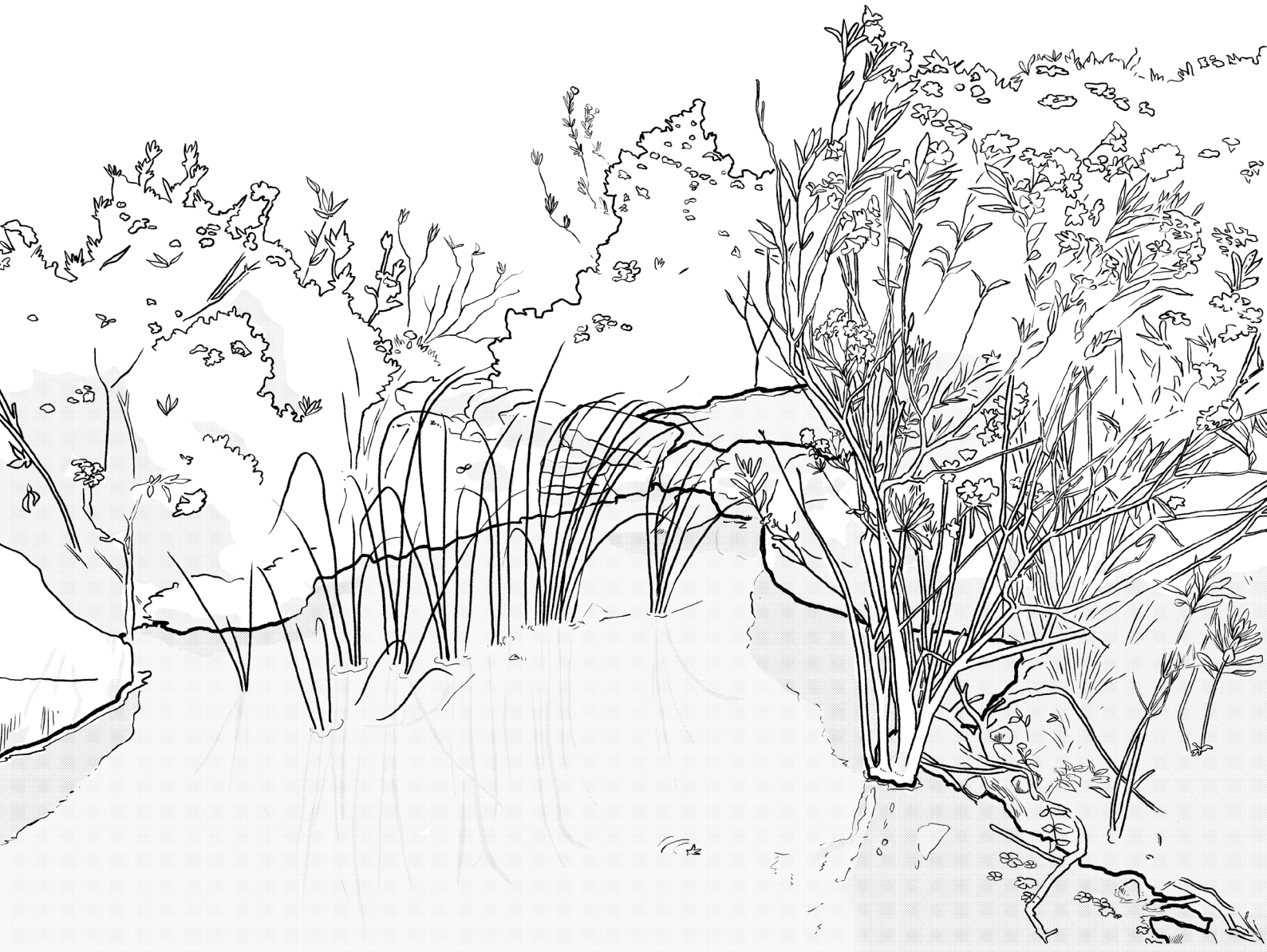
Changes in aquifer level are measured in a borehole at the boundaries of the Kavouropotamos watershed by the Water Supply and Sewerage Company of Paros. Water level measurements are also taken monthly from a private well located in close proximity to Kavouropotamos stream.

Critique of the method

Since the construction of the 34 weirs in Kavouropotamos stream (Paros) and the dissemination of the actions, 5 more islands (Sifnos, Sikinos, Ios, Ikaria & Karpathos) have shown interest to replicate the approach. The project team has already visited two of them (Sifnos and Ios) and the project has been presented to the respective mayors and local stakeholders while both of them have committed to dedicate some funds to initiate the process.

Testimonial

Traditional stone weirs are interventions that are best fit in the small arid islands of the Mediterranean Sea as a way to provide solutions for both water scarcity and biodiversity loss. This combination of structural engineering with natural features (hybrid NbS) is based on knowledge and experience of past ages while in the threat of climate change, it can significantly contribute to mitigate societal challenges such as water security (availability of water, salinization), disaster risks (floods) and biodiversity loss. We aspire that this project will be the start for replicating the approach in other arid Mediterrenean islands thus reducing the need for the promotion of large-scale grey infrastructure.



One of the 34 weirs in Kavouropotamos stream (Paros)

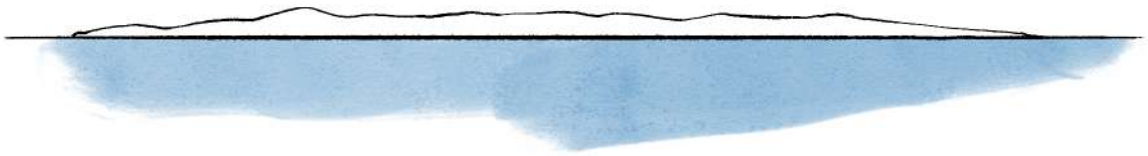
Zlarin landscape restoration
Lokvica washbasin
cultural landscape

Zlarin
Šibenik
CROATIA

Zlarin

Šibenik

Croatia



Surface area concerned: ~ 1400 m2
Altitude: ~ 55 m
Uninhabited part of an inhabited island

Protection status: none
Focus: Landscape restoration

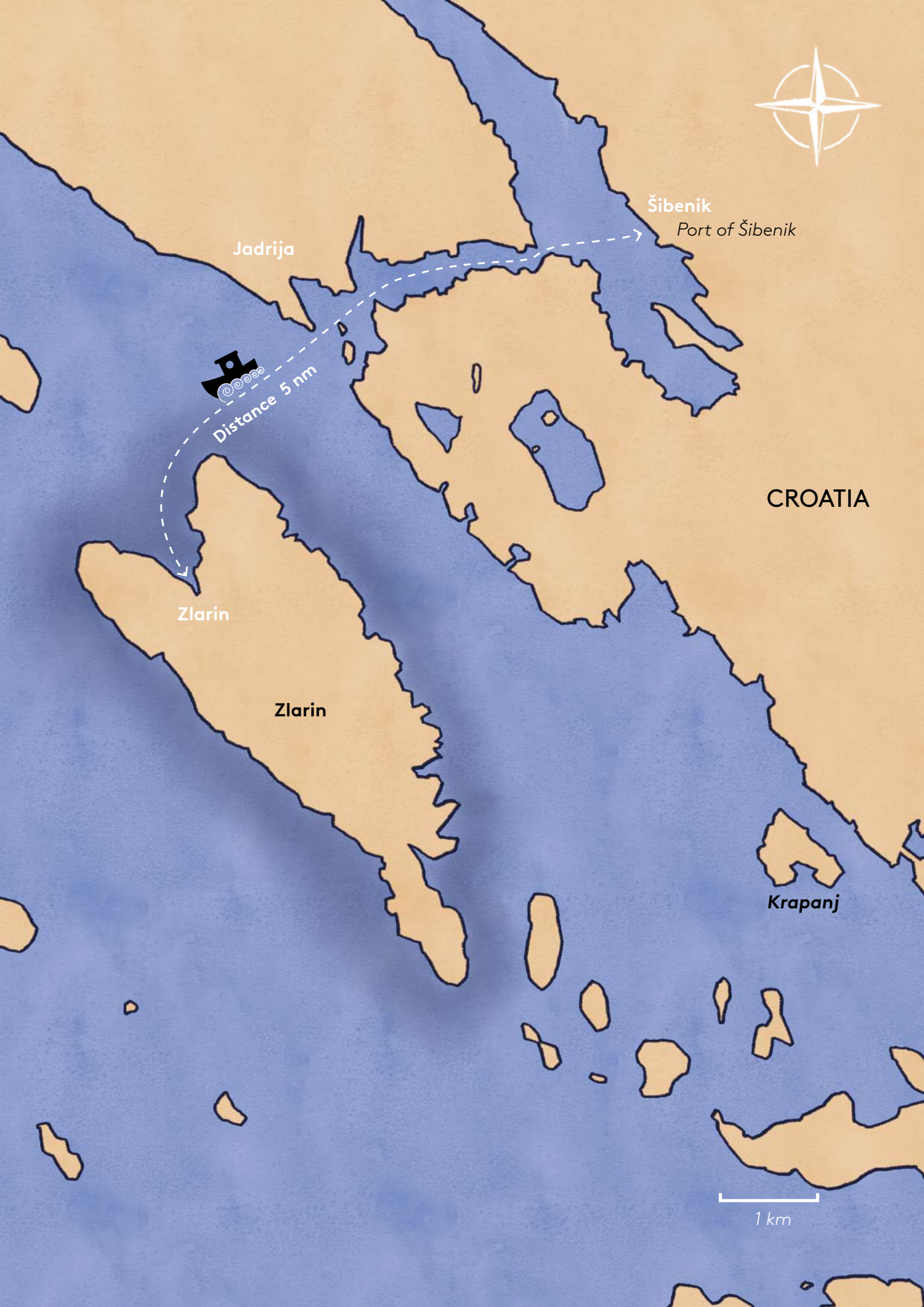
Biological challenges and sensitivity

Species of interest
13 species of orchids like *Ophrys bertolonii*

Invasive species
Agave americana, Opuntia stricta, Ailantus altissima

Characteristics of project working conditions

- Easily accessible from the village but has no sanitary blocks on site
- Lack of shade
- Presence of a road nearby to easily bring materials on site
- Surrounding olive grove sites are mostly abandoned and hard to access in part


Šibenik
Port of Šibenik
Jadrija
Distance 5 nm
CROATIA
Zlarin
Zlarin
Krapanj
1 km

May/June 2022 → **April 2022** → **March/April 2022**

Analysis, programming, landscape planning and design workshop

Education, meetings, discussions

Preparations and pre-production

April 2022 → **2023**

SMILO site survey
Ecological report on site Lokvica

Further work by the team in education about cultural landscape and restoration of pathways and drywalls near the site.

Project description

Lokvica is a natural washbasin that is a cultural landscape landmark and is considered to be the island's centre of biodiversity. The project aims to

- raise awareness of the local community on the importance of washbasins, methods of regulation of rainwater and possibilities of agricultural use of rainwater.
- create a new public zone on the island with year-round activities interesting to tourists and the local community so that the washbasin "Lokvica" space becomes a gathering place that strengthens the community.
- renovate the ecosystem in the project zone through reintroduction of indigenous species.
- communicate with owners and users of the surrounding agricultural fields with possibility of agricultural revitalization in a participatory and inclusive manner, using as much local (on the island) materials as possible.
- develop a maintenance and management plan with year-round activities.

Main parameters considered for the implementation of the project

DISTANCE FROM CONTINENT

Zlarin is a Croatian island with an area of 8,19 km2 located on the eastern shore of the Adriatic Sea, off the town of Šibenik and under its administration.

ACCESSIBILITY

Zlarin is easily accessible by a ferry boat and the washbasin Lokvica is located 15 minutes by foot from the island centre.

LOW-COST APPROACH

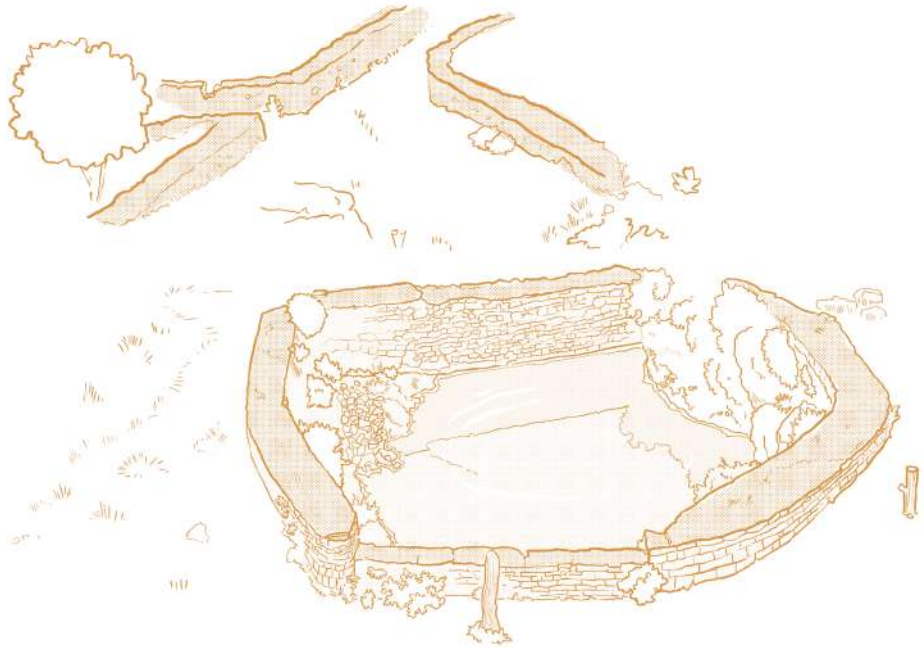
In order to reduce cost, local craftsmen were encouraged to use as much local materials as possible and selected trees for planting were originally found on the island itself.

Human and financial resources

The core project team coordinated the project with the locals and the stakeholders and organised the phases of work. **The core project team consists of :**

- the coordinator from the Tourist board of Zlarin
- a freelance architect
- agronomist
- an architect
- a landscape architect from Šibenik

The local community was immensely involved, helping and participating in every aspect of project. Zlarin has an active local community which is frequently interested in the improvement of community spaces. The local NGO Tatavaka that is focused on projects on the island helped with the organisation, as well as the NGO Dragodid that specialises in restoration of drywalls. Every workshop (listed below) involves around 10-15 volunteers providing their expertise and opinions. The Croatian water institute is an important stakeholder as it is the main owner of the site. The institute helped with work on site and provided free workforce.



Operators

SMILO
Mjesni odbor Zlarin
City of Šibenik
NGO Tatavaka
NGO Bodulići
NGO Dragodid
Public institution Nature of Šibenik-Knin County
Hrvatske vode (national water system management)

Selecting the appropriate intervention method

A database has been created about the location. It includes historical maps of Zlarin, urban plans, photos and stories related to the location. A detailed survey of the abandoned agricultural terraces (olive groves) and pathways surrounding the washbasin "Lokvica" was made.

The first workshop with the local community consisted of an onsite lecture and talk about the cultural importance of the washbasin "Lokvica" and the biodiversity of the island wetland. It also consisted of a meeting with everyone from the local community interested in the project and a lot of information and inputs about the site were gathered from them. It was important to involve everyone from the local community, as well as the owners and users of the surrounding agricultural fields. A series of meetings and talks with the latter were held during the month of May 2022.

Ten participants that consisted of young architects and designers, with the help of locals, held an architectural workshop at the end of May. During this workshop, participants talked about proposals for the site and made sketches and detailed plans. Within three days a detailed site analysis was made; mock-ups on site that showed how the site will be designed as a new public zone on the island with year-round activities interesting to tourists and to the local community. There was an organized clean-up of the surrounding agricultural fields with the help of the local community. The drywall of the path that goes through to Lokvica was also mended during those workshops.

At the end of June and beginning of July, meetings were organised with the Croatian water institute to start work on the site following the vision shared for the space. Their contributions to the Lokvica washbasin consisted of cutting grass and levelling parts of the terrain, providing a more accessible path to the bay of Lokvica. They opened a new pathway that was an old canal so that Lokvica can have an exploration loop offering the possibility of diversifying the educational content.

Workshop at the end of September 2022 consists of restoration and renovation of dry stonewalls in the area with the help of the NGO Dragodid, specialised in such reparations and community work. At that same time, parts of the design will be implemented on site (with supervision, mentoring and site management) consisting of equipment and furniture inspired by the local know-how. The benches and areas for the community will be put on site with the help of volunteers and locals.

In the first part of October 2022, the site will be prepared for a tree planting workshop. Trees that were beforehand found on the island will be replanted on site under the supervision of a local forestry engineer from Zlarin who will plant them with the help of volunteers and local children. That workshop will mark the end of the project.

Installations/ Facilities/ Devices

The site plan shows the ideas for the project that came out of the workshops with the community and volunteers. Firstly, the restoration of two drywalls that were demolished over time, the walls will have small openings for the nesting of species such as snakes. The site now lacks shade, and this will be restored by planting trees found on Zlarin itself. The selected trees originally found on the island will support the biodiversity on the site. Benches and smaller seating areas will be placed on the site.

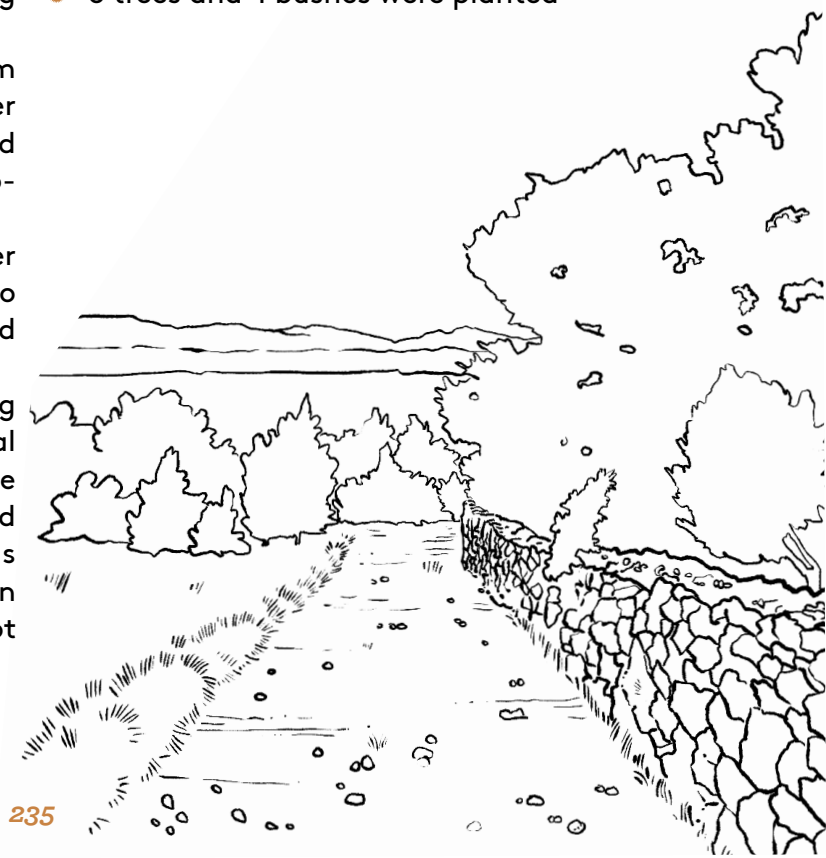
Labour-time mobilised

- Duration of the project: **6 months**
- **1 long meeting** for the coordinating team **every month** to plan future workshops
- **4 workshops with a duration of 3 days each** were organised with volunteers and the community
  o **Objective:** implement the plans drawn by the coordinating team
  o **Execution**:
- local craftsmen were found to make the materials for the benches and seating area.
- A big part of the project benefitted from the help and work of the Croatian water institute and their resources that lasted a week and were supervised by the project coordinators.
- An agronomist and a forestry engineer took a week to have a few hours walks to find the trees that were to be replanted on site.

  Except for the workshops, implementing the project consisted of a lot of informal meetings and arrangements since the project coordinators are all connected to the island and the important aim was the development of a long-term plan of management and maintenance, not only the results.

End results

- The full surface surrounding Lokvica, which is around 1400m2, was cleaned and restored.
- A drywall 12 m long erected
- 3 surrounding olive fields were cleaned, and the olives cut
- A new 10-minute-long pathway was opened from the site to the cove below the washbasin
- Four stone benches were made and put on site
- 8 trees and 4 bushes were planted



Budget-wise

MATERIALS: ~ 3000 €
for the core materials placed on site, for the benches, concrete that we needed and specially crafted stone, compost and fixtures for the plants as well as materials that were needed to work on site (hammers, shovels, etc.).

HUMAN RESOURCE: ~ 1000 €
for local craftsmen that were contracted. They were asked to use as much local materials as they could. One example is the use of pine wood for benches which was harvested in Dalmatia.

MOST OF THE COST:
for **travel expenses**, especially the drywall professionals from Dragodid that held the drywall workshop and providing **food and materials for workshops**, as well as some of **accommodation expenses**, although most of the accommodation was provided by the locals involved.

About a third of the budget of 12 000 € went on fees for the experts and coordinators involved, for leading the lectures, educational walks and programming the design workshops.

Critique of the method

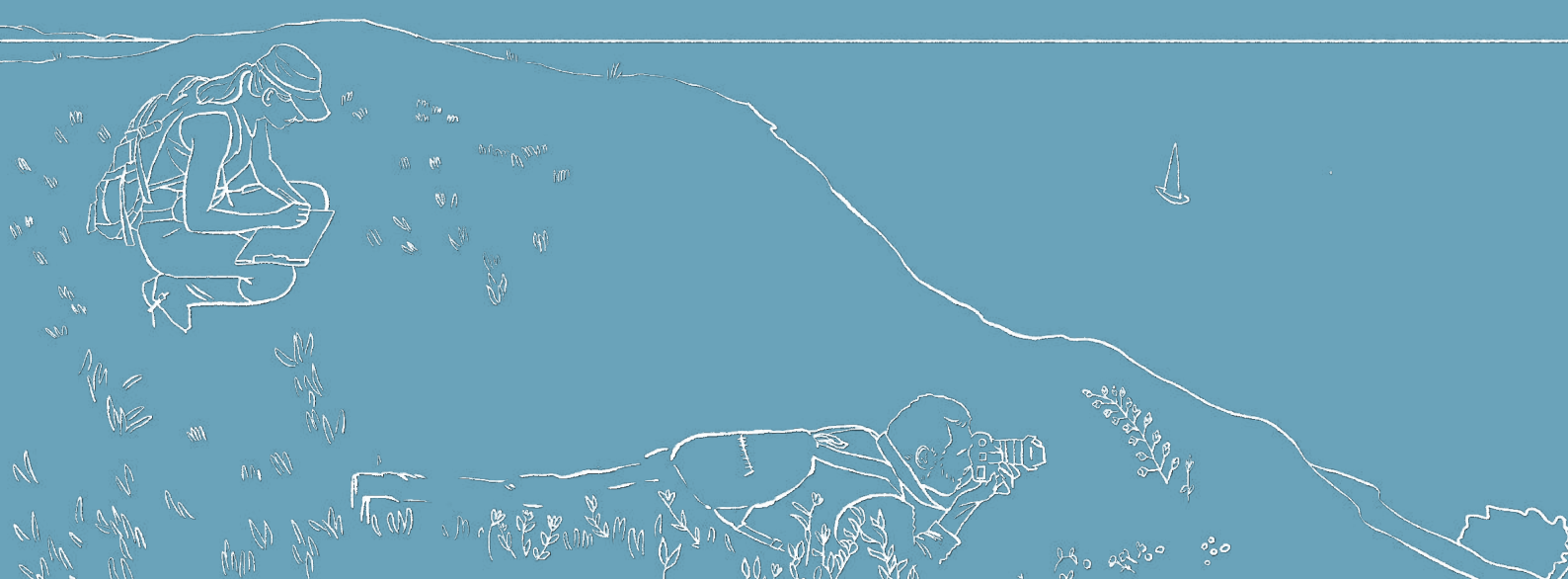
The basis of the methodology is the involvement of the local community and strengthening the community through participation in all phases of the project which is sometimes challenging and quite hard to manage. In the other instances of the project, we will tend to involve younger children more since they are one of the best motivators for the rest to get involved. We believe that the combination of working with the community and at the same time doing lectures and educational walks is the best way to involve them and to get them to appreciate a space and its biodiversity. This kind of process needs a lot of communicating with different stakeholders and a good basis of understanding and research of the possibilities and specialities of people in the community. So, organising and producing the workshops take a lot of time in order to be effective.

Testimonial

One of the results of the involvement of the community was the formation of a team of younger women on the island that are all family connected to the island and have known each other for a while but have never worked or knew each other's work and specialities. Hana Truta as an agronomist, Mare Vukov as a forestry engineer, Bruna Alfier and Tea Truta as architects interested in environmental causes, Maja Jandrić who is a product designer and Maja Flajsig who is the coordinator of the NGO Tatavaka while coordinating and volunteering, became a team interested in further implementing new projects in Zlarin with Lokvica and beyond. Their specific professional knowledge made new results in the way a space like Lokvica can be observed and become interdisciplinary.

4

Conducting long-term monitoring on an island



Introduction

To a management team, monitoring is generally a means of checking the effectiveness or benefit of a management project or initiative. An initiative carried out on a given site must therefore be accompanied by a follow-up, which will enable the management team to approve their initiative, adapt it, and communicate with institutional actors, the general public, and donors.

Any kind of monitoring is defined by three main parameters:

Its aim

WHAT is the purpose of this monitoring, what should it verify, and to whom are the results directed? The methods to be employed will therefore vary and be adapted according to the target audience and the management team's capacity to implement this monitoring.

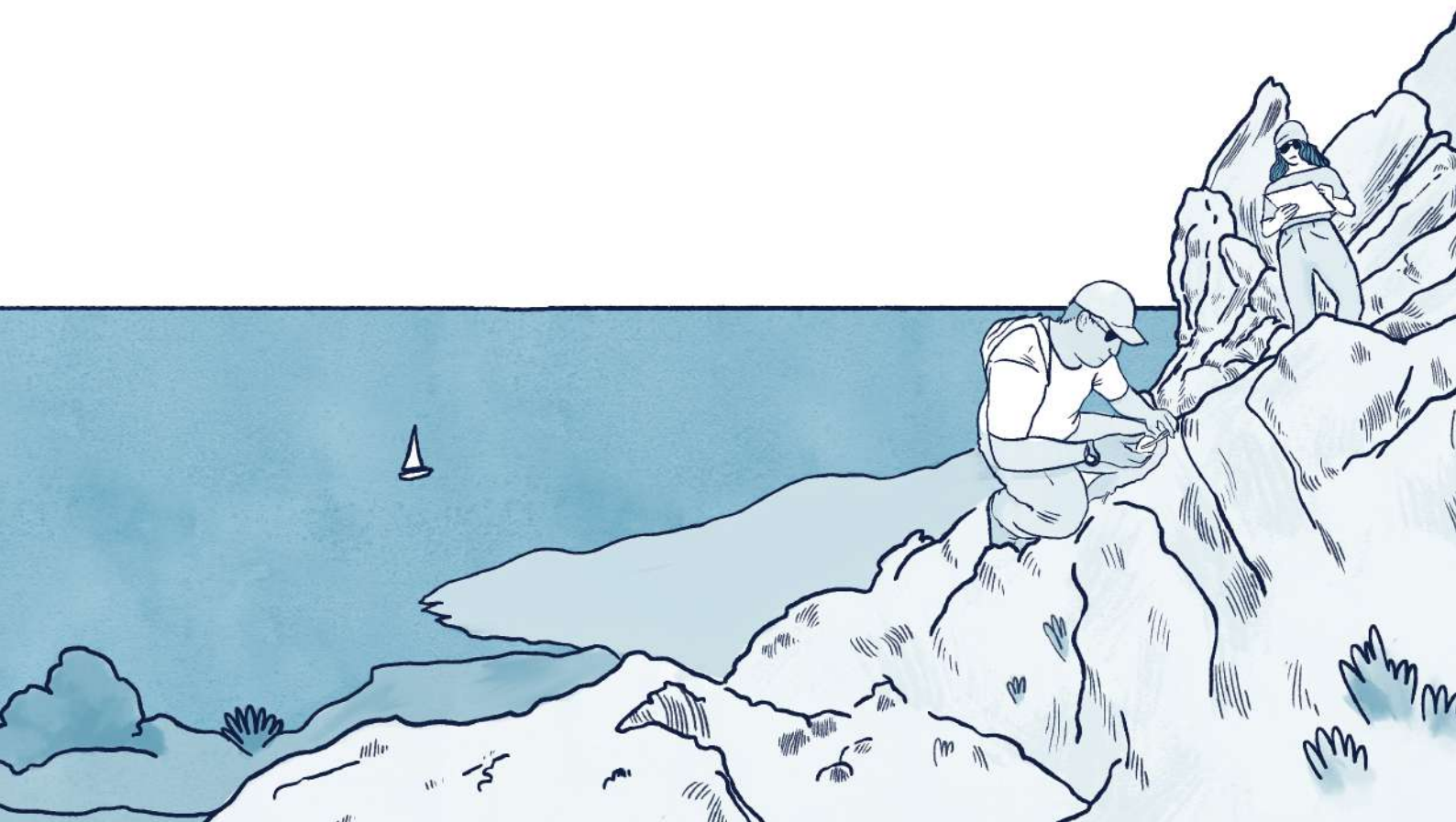
The protocol itself

Because of the logistical constraints that come with any activity of this sort on islands, particularly uninhabited islands and islets, any protocol must be as simple as possible, with minimal constraint when carrying out replica work. The simpler a protocol is, and the less expensive it is (in terms of time and resources), the more likely it is to be reproduced over time. However, this pursuit of simplicity is countered by the need for objectivity in the results obtained. These results must be scientifically robust and free from any bias related to the observation, the observer, the weather conditions, etc. Thus, the protocol is an adjustment of these two parameters: the simplicity of implementation and the robustness of its results. It is also important to have benchmarks to assess the success of the project. Where possible, the protocol should also include a number of 'control' areas, which will not be subject to the management initiative.

Its duration

Monitoring takes place over a period of time, in order to demonstrate a change linked to the management initiative that has been implemented and may take several years to become noticeable. Thus, it is necessary to have a baseline before any action occurs. This baseline condition, i.e. the condition of the site before the initiative is put into place, can also be monitored for several years before the implementation of the project, in order to take into account environmental variations that are not directly linked to the project. It is therefore necessary not only to plan ahead, but also to incorporate implementation over a number of years into the budgetary and management documents.

Taking these three parameters into account therefore directly influences the action taken. The latter must be planned for, it must be possible to assess, and finally, it is necessary to observe any impact over several years. Funding associated with monitoring is generally more difficult to obtain than funding associated with initiatives. For this reason, it is important that the overall budget for a project includes the budget for monitoring before any discussion with donors.



Photographic monitoring of the landscape - photomonitoring

Objective

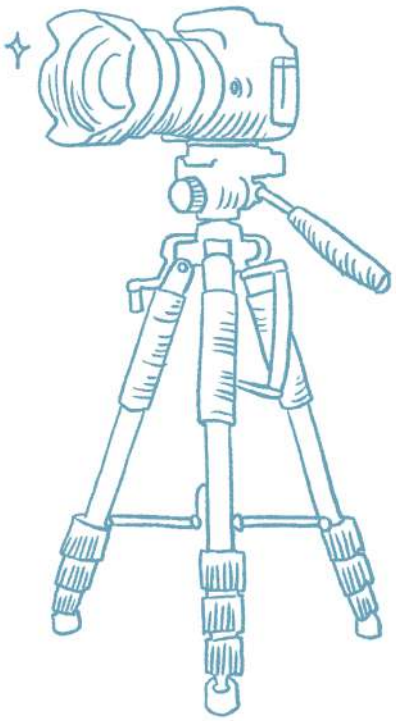
Photographic monitoring, or photomonitoring, of an area makes it possible to follow the evolution of a particular location over time, be it negative or positive.

Firstly, it consists of determining a series of photography stations, marked on the site, which will enable a photographic baseline to be set prior to the project taking place. Then, once this project has been carried out, photos should be taken again at a set time interval and in a standardised manner (same angle, same height and, as far as possible, the same light conditions), in order to observe changes in the landscape.

It offers the advantage of being a simple and reproducible method, requiring few technical skills, while also being an excellent tool for communicating your project to a wide audience (decision-makers, local residents, visitors, etc.). This process must, however, be carried out rigorously by personnel who can see and anticipate the changes in the sites they manage.

Necessary equipment

- 1 camera
  The same camera or a camera with the same focal length should be used over a period of potentially several years
- 1 tripod
- Stakes and sledgehammer
  To establish the point of the shot in an unalterable way
- 1 GPS for precise noting of the photo location
  Allowing the physical realisation of this point to be completed



Method

The essential prerequisite, from which technical adjustments arise, is first and foremost that the landscape to be photographed will change as a result of the management initiative being implemented. Moreover, while some of the consequences of the management initiative can be anticipated, others can be surprising, by indirectly modifying elements of the landscape. It is therefore important, in monitoring, to include peripheral stations not directly affected by the initiative.

Another difficulty is that photomonitoring, the frequency of which must be determined beforehand (monthly, annually, etc.), will sometimes have to be carried out by different observers. To find the same photo point, in a changed landscape, with a different observer, requires a certain amount of technique and precision to guarantee the success of this initiative, though it may seem simple to carry out.
Follow-ups should be carried out over several years, keeping a more or less identical photographic axis and the same focal length.

In order to find the same angles over several years, it is advisable to mark the point of the shot with an easily visible and unchanging marker (stake, stone, etc.) and to note the date, time and season of the shot. The purpose of such monitoring is to keep an iconographic record of a natural site or landscape.
Here are some recommendations on how to find a photo station that will last for several years on a changing landscape:

- Take a GPS reading of the location of the photo station
- Locate the point precisely using a marker if possible (stake, stone, etc.).
- Take a picture of the target point, with the marker to help you position yourself in the same place the next time you take a picture.
- During the next photo monitoring session in this area, a map of the location (with the GPS points of the stations) should be brought along, as well as the photographic records of the station taken during the previous session.

Next, some tips on how to get the same frame every year:

- Frame the image according to fixed landmarks in the landscape: peaks, rocks, buildings. All natural heritage features are inherently changeable, so using them can cause real difficulty in the long run.
- For each photograph, note the orientation of the image. This information can be associated in the attribute table of the file containing the GPS points.
- Take notes and use the same type of camera and, above all, the same focal length of lens from one year to the next.
- Also, record the height from the natural terrain. The use of a tripod can be particularly useful for this.
- For greater simplicity, record the station code, orientation, date and time of capture in the title of your digital file for each image.

Example:

FRIST11a_20191030_104056.jpg gives the following information:

- *Station: "FRI" for Frioul, "ST11" for "Station 11"*
- *Orientation: a (if several photos with different orientations are taken from the same photo location)*
- *Date: "2019" year, "10" month, "30" day*
- *Time: 10 hours 40 minutes and 56 seconds*

During subsequent monitoring sessions, bring the photographic records of the previous session to facilitate this same process.

Sources: AGIR écologique
Background: IGN BD ORTHO

Created by V. Riviere, AGIR écologique

Map of the location of the photographic monitoring stations in the framework of an invasive non-native plant species eradication operation
Frioul island, France

NAME	X	Y	HEIGHT	EQUIPMENT	OBJECTIVE	FOCAL LENGTH	ORIENTATION
Photo01	888226.555	6245444.223	1.8 m	Canon EOS 50D	CANON ZOOM LENS EF 24-70 mm	24 mm	North-West
Photo02a	888269.231	6245415.095	1.8 m	Canon EOS 50D	CANON ZOOM LENS EF 24-70 mm	24 mm	West
Photo02b	888270.133	6245415.234	1.8 m	Canon EOS 50D	CANON ZOOM LENS EF 24-70 mm	24 mm	South-East
Photo03	888287.705	6245407.872	1.8 m	Canon EOS 50D	CANON ZOOM LENS EF 24-70 mm	24 mm	West
Photo04a	888287.950	6245393.331	1.8 m	Canon EOS 50D	CANON ZOOM LENS EF 24-70 mm	24 mm	West
Photo04b	888287.950	6245393.331	1.8 m	Canon EOS 50D	CANON ZOOM LENS EF 24-70 mm	24 mm	East
Photo05a	888335.058	6245404.155	1.8 m	Canon EOS 50D	CANON ZOOM LENS EF 24-70 mm	24 mm	West
Photo05b	888335.058	6245404.155	1.8 m	Canon EOS 50D	CANON ZOOM LENS EF 24-70 mm	24 mm	South-East
Photo06a	888335.517	6245392.680	1.8 m	Canon EOS 50D	CANON ZOOM LENS EF 24-70 mm	24 mm	West
Photo06b	888335.517	6245392.680	1.8 m	Canon EOS 50D	CANON ZOOM LENS EF 24-70 mm	24 mm	South
Photo06c	888335.517	6245392.680	1.8 m	Canon EOS 50D	CANON ZOOM LENS EF 24-70 mm	24 mm	South-East
Photo07a	888382.036	6245408.038	1.8 m	Canon EOS 50D	CANON ZOOM LENS EF 24-70 mm	24 mm	South-West
Photo07b	888382.036	6245408.038	1.8 m	Canon EOS 50D	CANON ZOOM LENS EF 24-70 mm	24 mm	North-East
Photo08a	888418.268	6245431.479	1.8 m	Canon EOS 50D	CANON ZOOM LENS EF 24-70 mm	24 mm	South-West
Photo08b	888418.268	6245431.479	1.8 m	Canon EOS 50D	CANON ZOOM LENS EF 24-70 mm	24 mm	North-East
Photo09a	888429.936	6245453.275	1.8 m	Canon EOS 50D	CANON ZOOM LENS EF 24-70 mm	24 mm	North-West
Photo09b	888429.936	6245453.275	1.8 m	Canon EOS 50D	CANON ZOOM LENS EF 24-70 mm	24 mm	North-East

Attribute table of photo files

Example of before/after shots of a management initiative that has significantly altered the landscape

Frioul island, France

Example of before/after shots of a management initiative that has significantly altered the landscape
Island of the Grand Rouveau, France

Station 11 N
2013

Station 11 N
2014

Station 11 N
2018

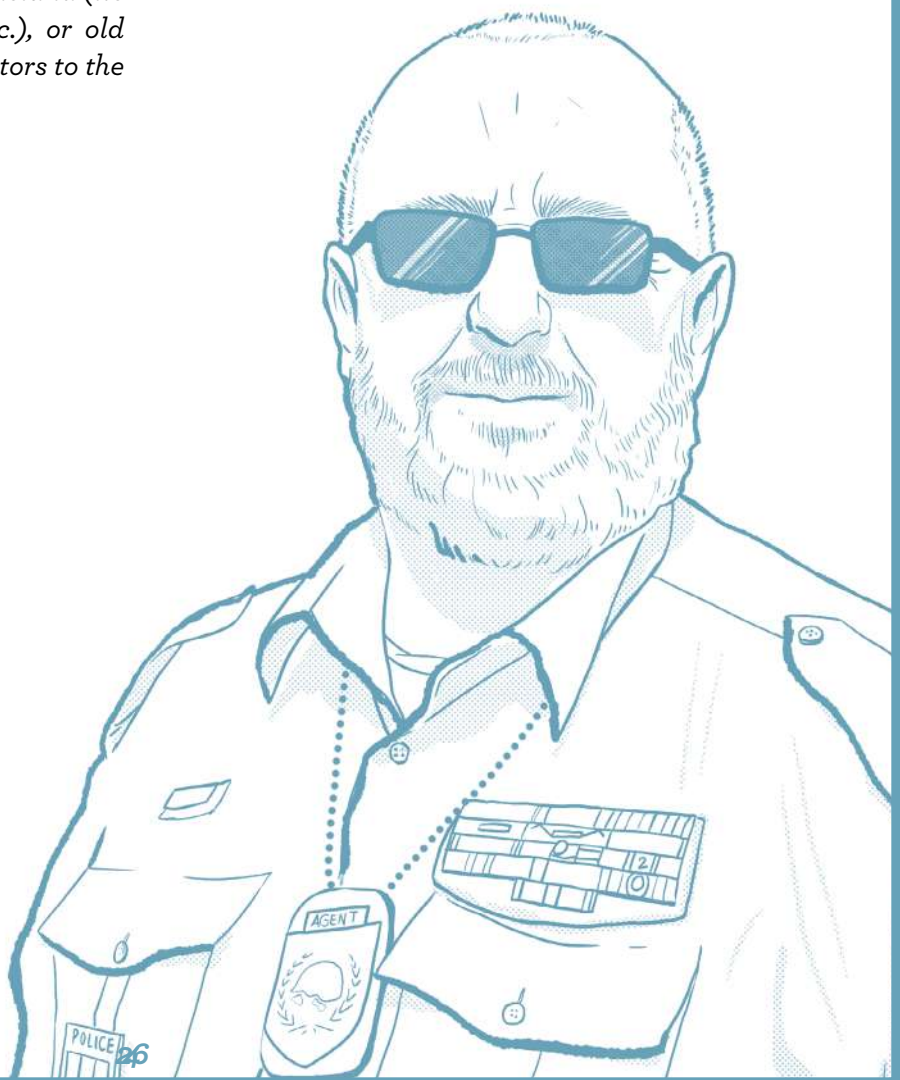
TESTIMONIAL

André Martinez-Humayou

Soldiers of Peace International Association (SPIA)
Ranger for the Cap Taillat site on behalf of the Conservatoire des Espaces in the region of Provence-Alpes Côte d'Azur (CEN PACA)

For the purpose of "positive" reporting, I recommend taking photos before the work is carried out in unfavourable weather conditions (winter) and after the work is completed in favourable conditions (good weather, flourishing vegetation, etc.). ". This is not a scientific monitoring process, but a communication initiative that is supplementary.

It is interesting to be able to carry out research in the archives to find old photos of the island (its landscapes, buildings, the visitors etc.), or old texts. Also consider asking regular visitors to the site, especially the older generations!



Monitoring of anti-reinfestation posts

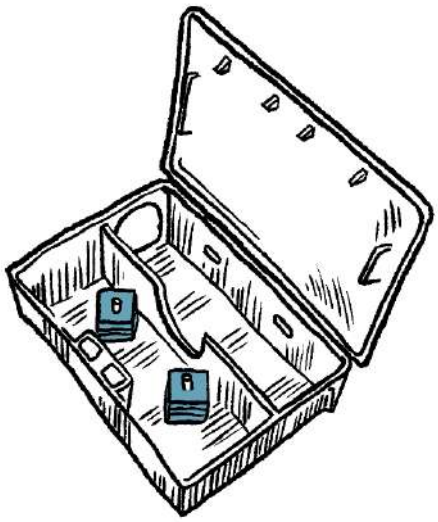
Eradication is a costly and time-consuming operation. To ensure its continued success, a permanent system must be put in place to quickly identify any new infestation and to prevent any risk of reinfestation.

Why implement a monitoring system?

The purpose of implementing a monitoring system is to optimise the chances of successful eradication in the long term. The system avoids any recolonisation via the sea and also compensates for the possible omission of a few individual rats during eradication by covering the most favourable areas for the rats.

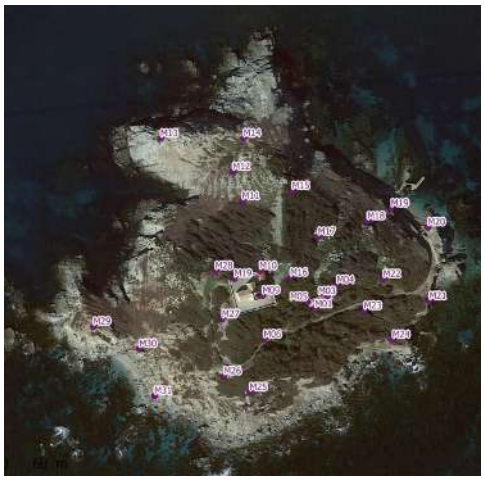
Which method should be used?

How do you check for Black Rats? Monitoring stations are closed boxes containing toxic bait blocks with a hole that limits access to rats only. The baits are those used during the chemical phase of eradication, i.e. an anticoagulant of the Bromadiolone or Brodifacoum type (it is essential to refer to the legislation for the use of these products prior to use). At each monitoring, the observer must check for the absence or presence of rats (bite marks on the poison blocks, signs of passage, droppings, etc.).
At each monitoring, it should be checked that no bait has been consumed. All poison blocks should be replaced with new bait to maintain maximum palatability and effectiveness.



If evidence of consumption by rats is observed, a mechanical trapping system should be set up around the station where evidence is found. If rats are caught during the trapping campaign, it will be possible to determine whether they belong to the island's population (indicating a failure of the operation) or to the populations of the surrounding islands or coastlines. This analysis is made possible by comparing the DNA of these rats with the collection of DNA samples taken from rats captured during the initial eradication campaign, and thus allows the management team to target its response strategy in the event of reinfestation.

How should the monitoring stations be positioned?

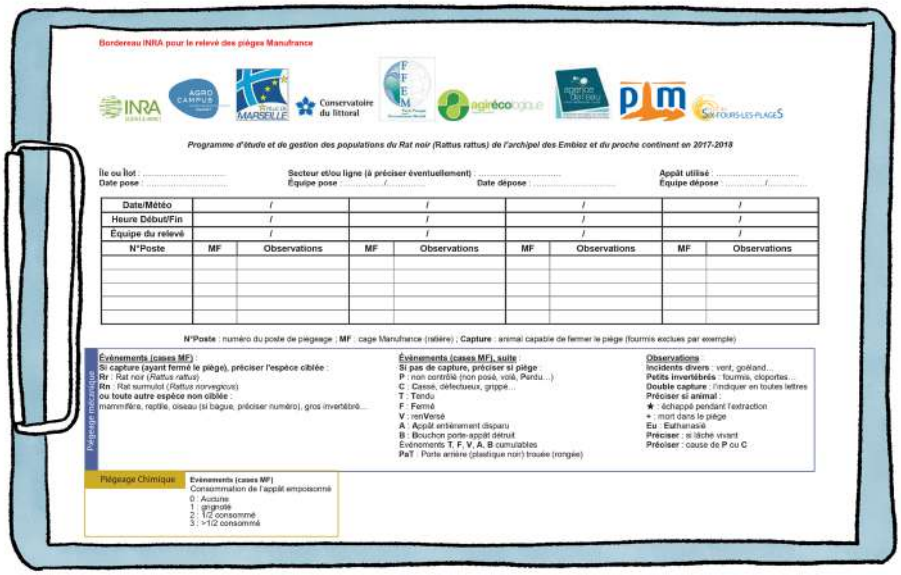


Following the eradication of the Black Rat in the Grand Rouveau (Six-Four-Les-Plages, 83), 44 permanent poison stations, corresponding to 30% of the total number of traps set during the eradication campaign (146 traps in total) were set up. The stations are located in the areas where the catches were the most significant within the potential sites of re-invasion of the island (ship anchorage area, disembarking area, deposits of seaweed, etc.). On the Island of the Grand Rouveau, possible reinfestation zones are located near the quay, near the lighthouse, and the South-Western Beach, which is forbidden to dock but is used by visitors with boat access.

How often should monitoring be carried out?

Several monitoring phases were implemented following the eradication project:

- During the year following eradication: Regular monitoring of the anti-infestation stations should be carried out. A first check should be carried out one month after the end of the eradication campaign. Then a second check one month later, then a check every two months for the first year.
- Approximately one year after the eradication project, a light mechanical trapping system (about 10% of the number of traps used in the main project) should be set up and monitored for 5 nights to confirm the absence of rats (ABIADH et al. 2010)
- The permanent stations can then be checked every 3 to 6 months, in order to be able to react quickly in case of a possible change.


Bordereau INRA pour le relevé des pièges Manufrance

Programme d'étude et de gestion des populations du Rat noir (Rattus rattus) de l'archipel des Embiez et du proche continent en 2017-2018

Date/Météo								
Heure Début/Fin								
Équipe du relevé								
N°Poste	MF	Observations	MF	Observations	MF	Observations	MF	Observations

N°Poste : numéro du poste de piégeage ; MF : cage Manufrance (ratière) ; Capture : animal capable de fermer le piège (fourmis exclues par exemple)

Piégeage mécanique

Évènements (cases MF) :
Si capture (ayant fermé le piège), préciser l'espèce ciblée :
Rr : Rat noir (*Rattus rattus*)
Rn : Rat surmulot (*Rattus norvegicus*)
ou toute autre espèce non ciblée :
mammifère, reptile, oiseau (si bague, préciser numéro), gros invertébré...

Évènements (cases MF), suite :
Si pas de capture, préciser si piège :
P : non contrôlé (non posé, volé, Perdu...)
C : Cassé, défectueux, grippé...
T : Tendu
F : Fermé
V : renVersé
A : Appât entièrement disparu
B : Bouchon porte-appât détruit
Évènements T, F, V, A, B cumulables
PaT : Porte arrière (plastique noir) trouée (rongée)

Observations :
Incidents divers : vent, goéland...
Petits invertébrés : fourmis, cloportes...
Double capture : l'indiquer en toutes lettres
Préciser si animal :
★ : échappé pendant l'extraction
+ : mort dans le piège
Eu : Euthanasié
Préciser : si lâché vivant
Préciser : cause de P ou C

Piégeage Chimique

Évènements (cases MF)
Consommation de l'appât empoisonné
0 : Aucune
1 : grignoté
2 : 1/2 consommé
3 : >1/2 consommé

Bibliographic reference

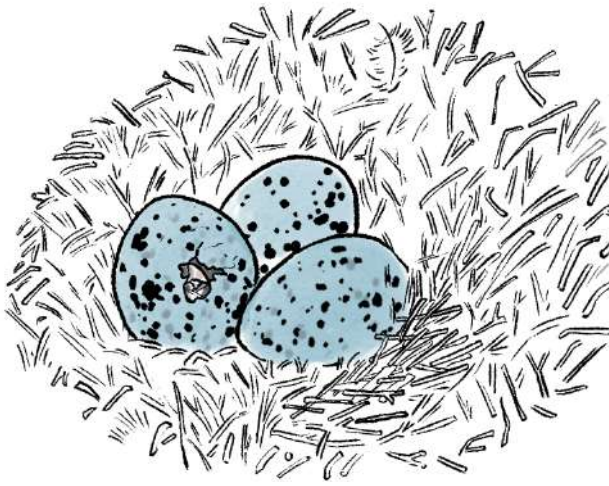
ABIADH A., 2011. ***Etude de faisabilité de l'éradication des rats noirs sur les îles Habibas – Algérie.*** PIM Initiative p. 12

Population census of the Yellow-legged Gull in the Riou Archipelago, France

The Yellow-legged Gull, *larus michahellis*, **is one of the most common species of gull in the Mediterranean in terms of numbers. Easily identifiable, it is usually found near islands and in peri-urban areas.**
An opportunistic species, it has a great capacity to adapt to its environment, and is thus closely linked to human activities. The birds originally nested on islands, feeding on small crustaceans and fish from the surface of the sea, but over time they have adapted to urban environments. The increase in numbers is often linked to the presence of accessible waste from harbours or households where they can feed (open dumps, etc.).

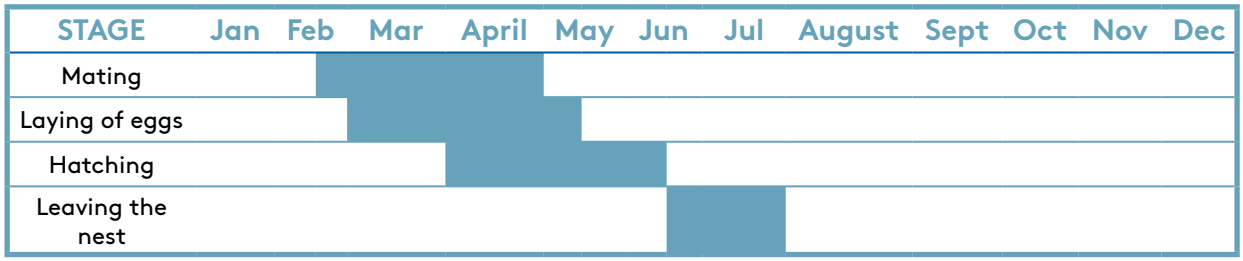
Why monitor the Yellow-legged Gull?

- It is an emblematic species of the islands and are a constant presence in the Mediterranean, and the health of its colonies is often representative of the health of the site in which it lives;
- The often rapid increase in its numbers on the islands can have an impact on the nature of the soil, and therefore, indirectly, on plant life (nitrate soil which favours nitrophilous plant species). It is therefore important to monitor their numbers to understand the distribution and nature of various plant life;
- Linked to human activities, it is a good indicator of good or bad waste management in neighbouring towns.



When should a survey of breeding populations be carried out?

The phenology of the Yellow-legged Gull is as follows:



The best time to count the year's egg production is when the maximum number of eggs have been laid, and when the chicks are still not very mobile, i.e. around mid-April.

Which method should be used?

The protocol explained below is part of the national census of breeding seabirds in France set up by GISOM (Groupement d'intérêt scientifique oiseaux marins / Scientific Interest Group for Sea Birds). It has been used on the Riou Archipelago in Marseille for several years, notably by the staff of the Calanques National Park.

This protocol requires relatively little ornithological knowledge. The management team can call on volunteers who are new to the species, and can thus combine participation in a concrete management initiative with awareness-raising on the biology and conservation of the species. If human resources are readily available, the aim will be to carry out as exhaustive a count as possible. If few human resources are available, a census of active nests using binoculars is possible (although less reliable, it nevertheless has the advantage of limiting the impact of the observer).
Before carrying out the census, it is important to have a map of the island, divided into sectors, which can be easily identified using visual markers (peaks, valleys, etc.). It may also be useful to mark the sector boundaries on the ground beforehand with markers, or by taking their GPS coordinates.

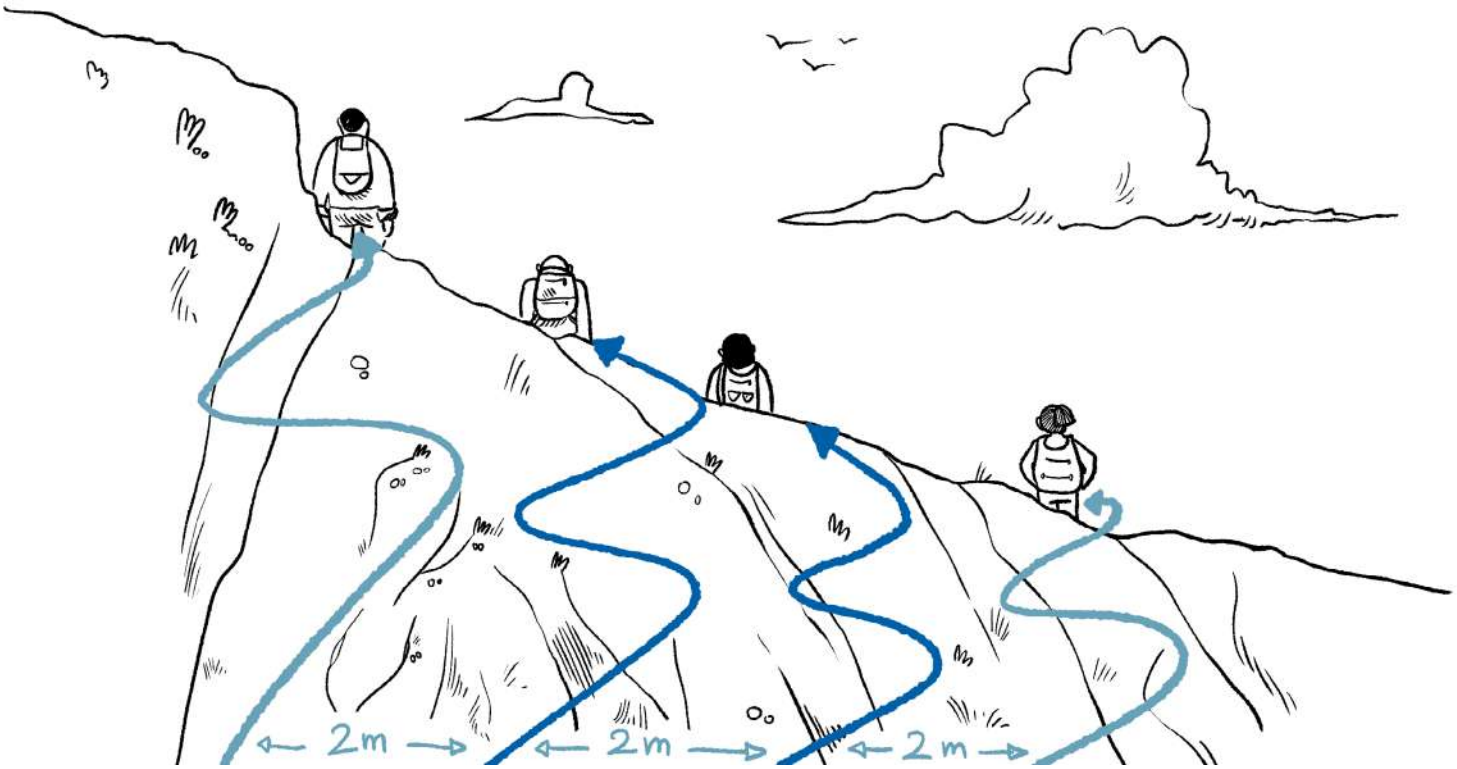
The census is conducted in several phases:

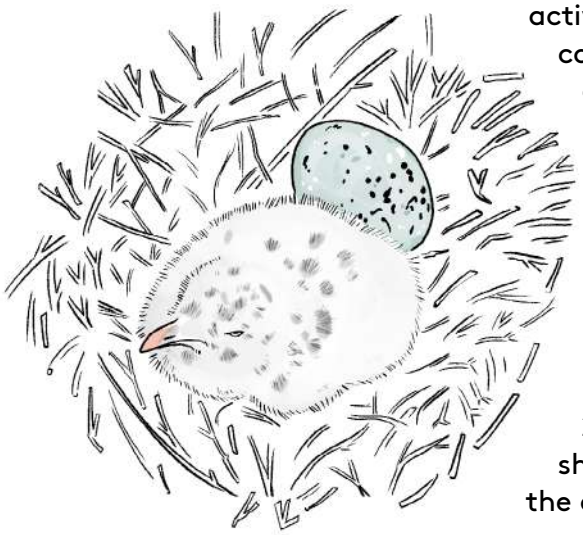
PHASE 1: DISTRIBUTION OF OBSERVERS OVER A LONGITUDINAL AREA

The participating observers (up to ten) position themselves at the start of a sector, keeping a distance of 2 metres between each person. Two leaders will be positioned at the sides of the group and will be in charge of enforcing the alignment and keeping the group on track.

PHASE 2: COUNTING NESTS ON THE FIRST PASS PRIMARY OBSERVERS

The "primary observers" (1st line) are in charge of proceeding through the sector in a zig-zag fashion, counting the active nests: these are the nests containing signs of reproduction for the year. (This consists of a bowl-shaped nest with some material brought in by the adults, droppings, or with the presence of feathers or simply an egg or chick).





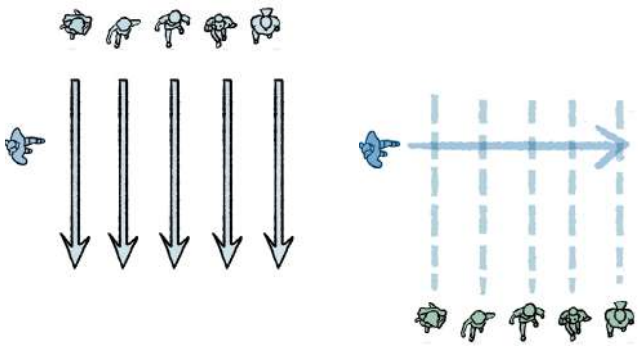
The line of observers progress through the area, counting the active nests they see on their way. In order to avoid double counting of the same nest, it is recommended to use a biodegradable substance to mark the nests already counted (for example, with an individual piece of pasta).

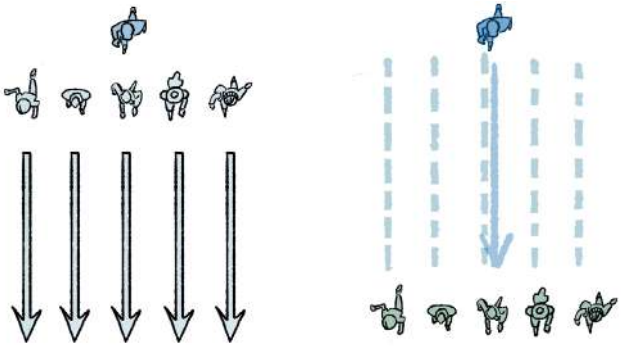
It is beneficial to record the precise contents of the nests during the survey of the colony, either systematically in all the sectors surveyed or only in part of them, in order to have an overall idea of the progress of the eggs. Each observer then counts the number of empty active nests (with 1 egg/chick, 2 eggs/chick, etc.) and records it on an observation sheet. After this first pass, the total number of nests in the area is calculated (N1).

PHASE 3: CORRECTION OF THE OBSERVER EFFECT BY SIMULTANEOUS DOUBLE COUNTING BY SECONDARY OBSERVERS

This technique, like any other, can be subject to counting bias: vegetation covering the nests, observer's lack of concentration, etc. To correct this bias for large colonies, it is advisable to carry out a double count: one person immediately makes a second pass over the sector to count the proportion of active nests that were marked by the observers during the first pass (N2r) or those that were not counted (N2nr), checking for the absence of marks for those nests not seen the first time.
This double counting can be done simultaneously, with the secondary observer following the primary observer at a short distance.
For this second pass, there are 3 options:

Either count the nests on a random transect that runs perpendicular to the previous ones, without distinguishing between primary observers

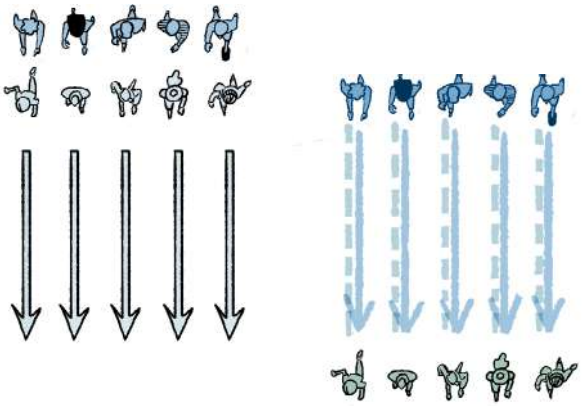




Or count on the same transect as one or more primary observers

Or count on all the same transects of the first count. `

It is recommended that primary and secondary observers alternate their roles during counts in different sectors.



PHASE 4: CALCULATING THE TOTAL POPULATION

The estimate of the number of birds in each sector will be made on the basis of the information recorded in the observation sheets of the primary and secondary observers, using the following formula:

$$NP = N1 * (N2r + N2nr) / N2r$$

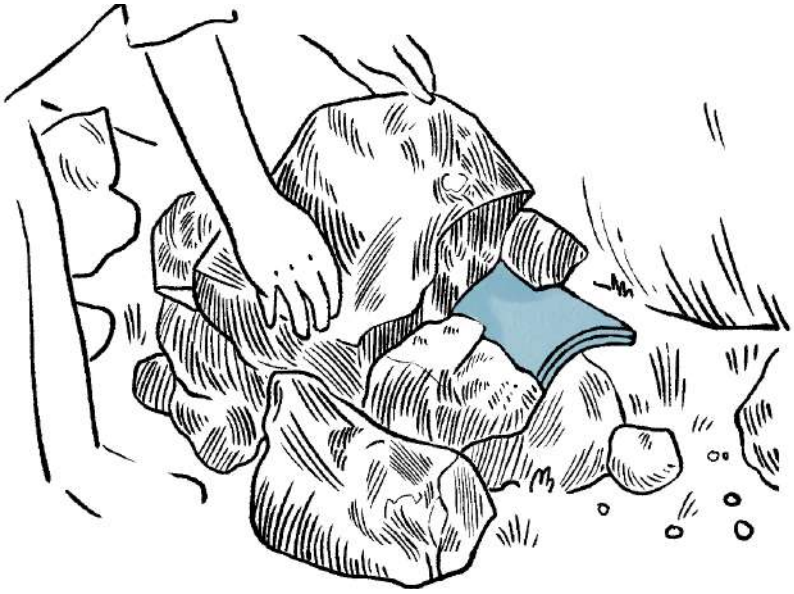
Long-term monitoring of the European Leaf-toed Gecko on the Island of the Grand Rouveau, France

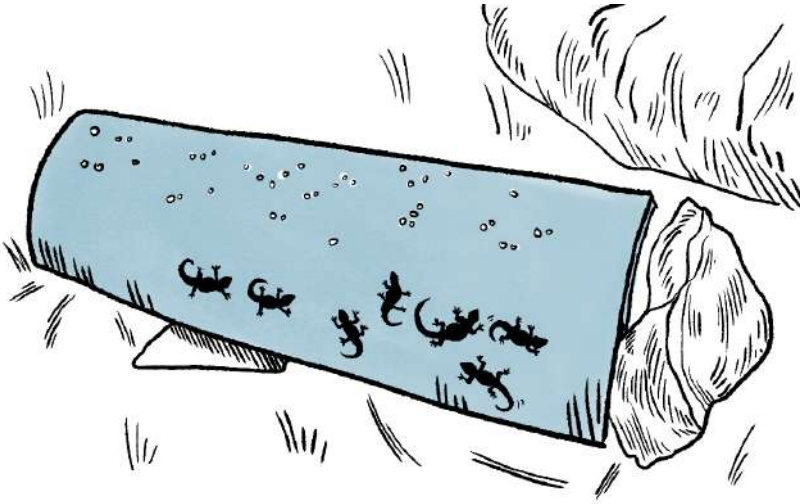
Long-term monitoring of species or habitats is particularly important to assess demographic changes in populations in response to management initiatives or global changes. Carried out over several consecutive years, such monitoring requires the implementation of scientifically rigorous protocols that are easily reproducible over time, so that the interpretation of results is robust.

In the case of the European Leaf-toed Gecko, *euleptes europaea*, there are many obstacles to the implementation of such monitoring, not least of which is the ecology of the species. The gecko is both nocturnal and secretive: it lives in crevices in which it remains throughout the day and all of winter. Only 'active' individuals (mainly visible outside the crevices) are usually counted. However, the activity of the latter is seasonal and highly dependent on weather conditions. Furthermore, within the same population, the activity of individuals is asynchronous: individual geckoes are therefore not active at the same time in the evening. The individual geckoes counted therefore represent only a fraction of the population actually present in the area. In order to get around this point, so-called capture-mark-recapture techniques are generally used, which are difficult to apply to the European Leaf-toed Gecko due to the difficulties of long-term marking in this species. Work on individual identification by photographing individual geckoes is, however, underway (RENET, pers. comm.). However, the main constraint of this method is its cumbersome implementation (several days of marking are required) and therefore its poor repeatability over time. The line transect technique also has its limitations, for example the effect of the season and weather, the observer effect and the difficulty of rigorously following the same route over the years while being carried out by different observers.

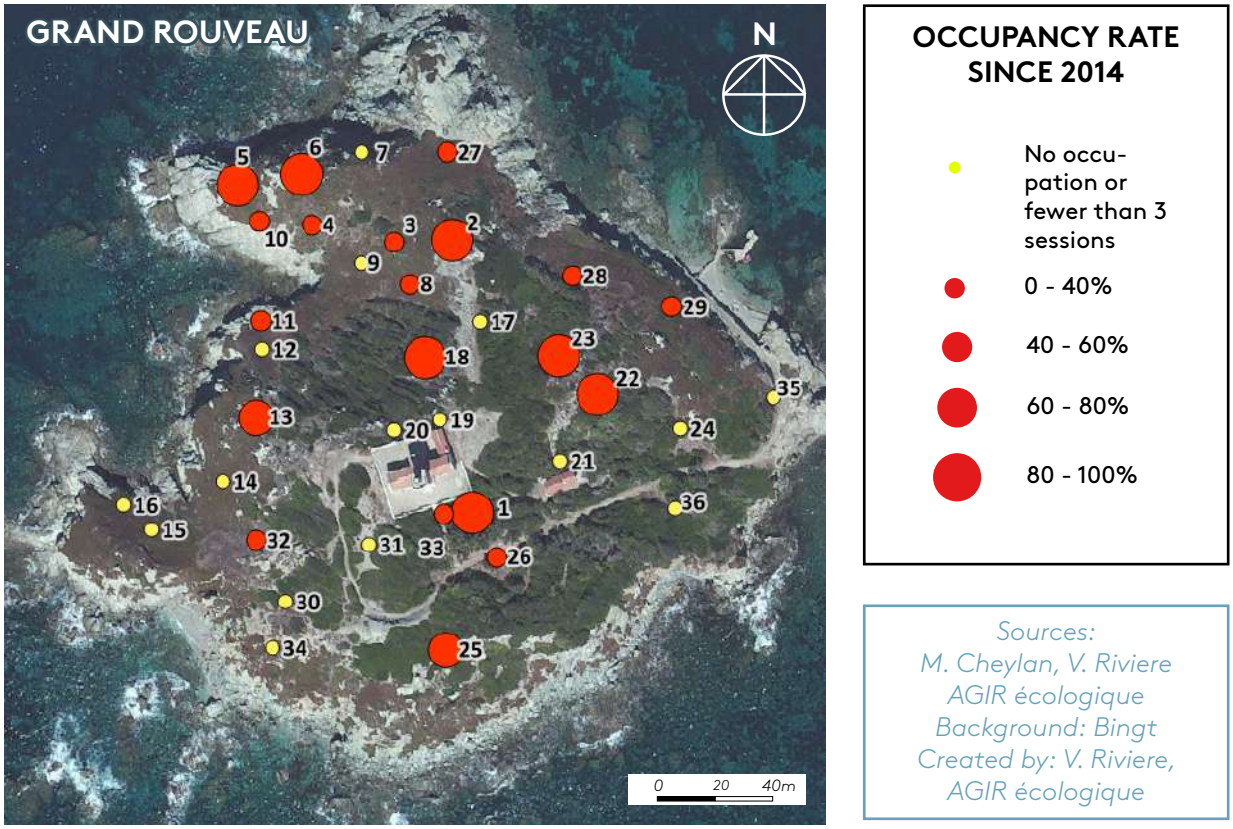
Finally, the implementation of such a protocol on the islands implies a strong technical constraint - due to the nocturnal activity of the species, the logistics of the initiatives require a more complex organisation than when monitoring is carried out during the day or on the mainland. As is the rule for any study in an island environment, these projects are inevitably subject to the vagaries of the weather.

Despite all these difficulties, different protocols have been implemented for this species: monitoring via transect techniques based on daytime presence clues (MERCIER et al., 2017) and monitoring via artificial habitats, allowing individual geckoes to be identified outside the activity period. These can be made up of piles of stones taken from the site (DELAUGERRE, 2009), or, as was put in place on the Island of the Grand Rouveau, of round tiles superimposed and covered with stones (CHEYLAN et al., 2018). This system of superimposed tiles has the advantage of providing an identical surface in each habitat, which is not the case with piles of stones, whose gaps, to which the species is particularly sensitive, are variable.





The superimposed tiles were rapidly occupied by the European Leaf-toed Geckoes (see section on gecko habitats p. 95) and have several advantages: monitoring can be carried out during the day, there is no particular difficulty in observing, therefore no observer bias, little or no weather-related bias, and all individual geckoes present in the habitat are counted, not just the active ones.



Distribution of evidence of rats found on toxic baits
Occupancy rate per habitat over the period 2014-2017

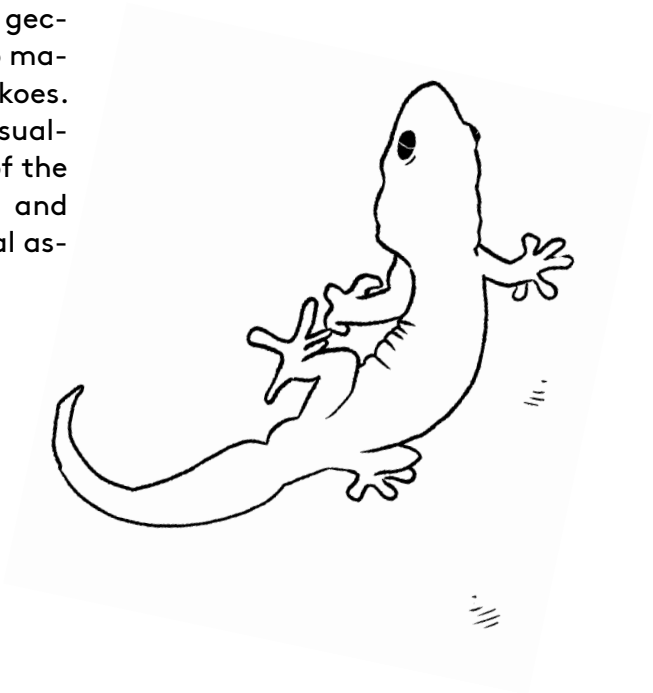
This is the method that was chosen in 2014 for long-term monitoring on the Island of the Grand Rouveau, in anticipation of the rat eradication initiative implemented in 2017-2018. The objective of this monitoring is above all to identify, and even quantify, whether the disappearance of the Black Rat has had a positive effect on the European Leaf-toed Gecko in addition to observing changes in behaviour and in the number of juveniles as evidenced or recorded on the Bagaud island - Port-Cros National Park (KREBS et al., 2015). Similarly, in view of the restoration of the ramparts of the Château d'If (whose cracks are inhabited by the geckoes), this type of monitoring was also set up on the island in 2016.

On the Island of the Grand Rouveau, thirty-two artificial habitats were installed and distributed evenly over the island in order to incorporate the widest possible range of conditions (stationary, exposure to the sun, vegetation, etc.). These habitats are monitored twice a year, once in spring and again in autumn, which is when the juveniles from the eggs laid in summer are present. The monitoring of habitats is relatively simple and quick. They can be monitored in one day by one or two observers. However, it requires special care when dismantling the tiles, so as not to injure geckoes when handling them.

The results of the monitoring carried out from 2014 to 2017, prior to the eradication of the Black Rat, are quite encouraging for future assessments. Three indicators can be monitored and evaluated later:

- The occupancy rate of the habitats, i.e. the number of habitats in which at least one individual gecko is observed during the session. The latter is stable (around 38%), which indicates that the geckoes have rapidly occupied the sites that were favourable to them;
- The number of individual geckoes, which fluctuates more, with significant variations between sessions. Thereafter, monitoring will be carried out three times a year, in order to even out this variation in numbers;
- The demographic structure of the geckoes is difficult to establish since no manipulation is carried out on the geckoes. The age classes are only recorded visually, distinguishing juveniles (young of the year) from other geckoes (adults and pre-adults). Subsequently, individual assessments may be required.

The three years of surveys (2014-2017) prior to the rat eradication operation (2017-2018) will be compared with the results of the following three years (2018-2020). The implementation of this method has already been published in the ecology journal 'Revue d'écologie' (CHEYLAN et al., 2018). The results of the comparisons between these two periods (before and after eradication) will also be published.



Bibliographic reference

All references in this section can be found in the following article:

CHEYLAN M., RIVIÈRE V. & CHEYLAN A., 2018, ***Evaluation d'une méthode de suivi à long terme du gecko Euleptes europaea sur l'île du Grand Rouveau (Embiez Archipelago, Var, France).*** Revue d'écologie (Terre et Vie), Vol. 73 (4), 2018: pp. 526-536

Other citations:
DELAUGERRE, M. 2009, ***Protocole de suivi géographique du Phyllodactyle d'Europe (Euleptes europaea) sur l'île de Port-Cros,*** Parc National de Port-Cros: p. 34

KREBS, E., ABBA, A., GILLET, P., EUDELINE, R., GAUTHIER, J., LE QUILLIEC, P., LORVELEC, O., MARTINIERIE, G., VIDAL, E., BUISSON, E., (2015). ***Réponses des populations de reptiles à l'éradication du Rat noir (Rattus rattus) sur l'île de Bagaud (Parc National de Port-Cros, Var, France).*** Revue d'Ecologie (Terre et Vie), Vol. 70 (supp XII «Espèces invasives»), 2015: pp. 99-109.

MERCIER O., BERNARD G., BRUHAT L. ... & MILLON A. (2017). ***Etude pilote pour la mise en place d'un protocole de suivi du Phyllodactyle d'Europe (Euleptes europaea) sur l'île de Port-Cros (Var, France).*** Sci. Rep. Port-Cros National Park, 31: pp. 189-211.

5

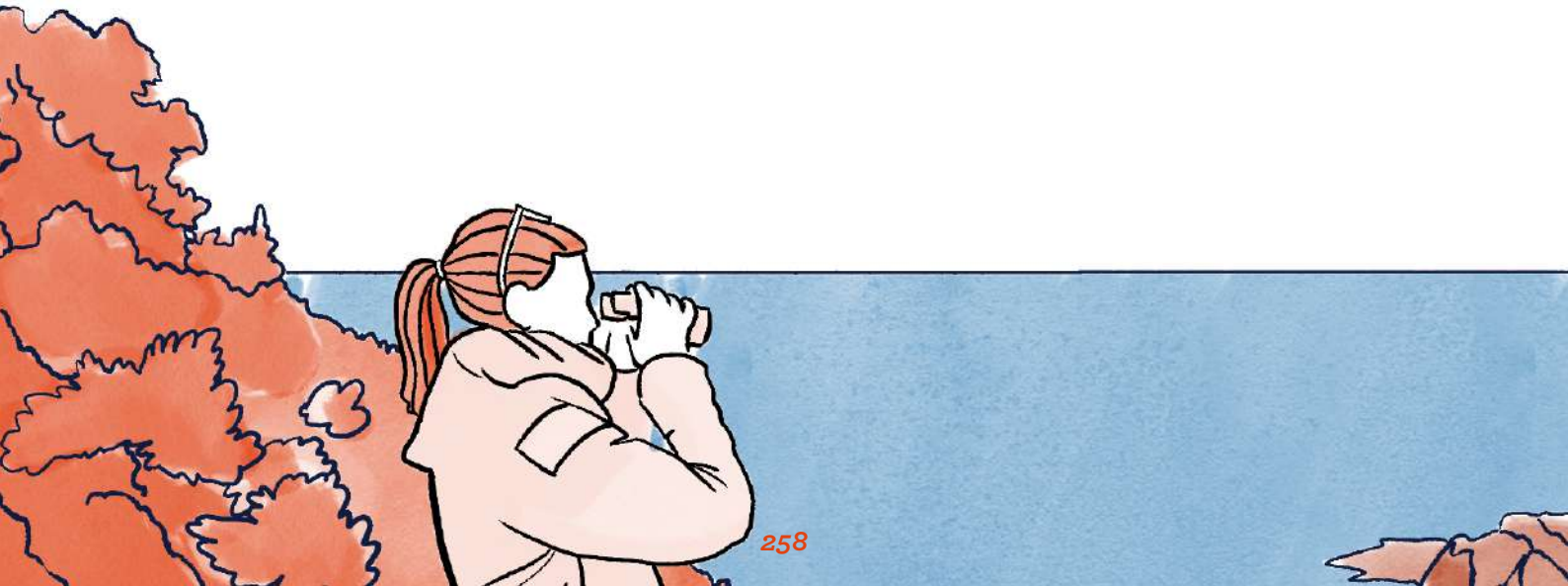
Managing and directing visitors

Introduction

Those who manage protected natural areas are responsible for preserving environments and landscapes while also maintaining public access, unless otherwise regulated. Managing the flow of visitors is the basis for the adaptive management of a natural environment.

In general, visitors consider natural sites to be areas of freedom, without regulations. However, it is thanks to these rules and the regulatory statutes that a vulnerable natural site can support both its biodiversity and a landscape of character. Visitor numbers have an impact on the landscape, vegetation (trampling), fauna (disturbance, destruction of habitats, displacement of populations) and the functioning of ecosystems (soil compaction, erosion, etc.) (*Desfossez and Vanderbecken, 1994a*).

Thus, the construction of infrastructure makes it possible to channel visitor flows, limit the impact of overcrowding, improve traffic flow, make sites easier to find, and control development. These infrastructures must be integrated into the landscape in order to maintain the "wild" nature of the area and also to avoid them being perceived as a constraint on the public (risk of damage or non-use) (*L'Hospitalier, 2000*).
Some structures orient and guide visitors to limit their impact on the site (preventive measures), while others help restore deteriorated sites (curative measures) (*L'Hospitalier, 2000*). The installation of infrastructures such as benches, picnic tables and toilets should be carefully considered alongside an analysis of their advantages and disadvantages in relation to the site. Indeed, they can be justified in places with a high frequency of use, whereas in other cases, trails are designed to explore protected areas. Therefore, the presence of infrastructures can be unnecessary and 'denaturing' (*Desfossez and Vandrebecken, 1989*), especially on islands. We will therefore not go into detail about this type of construction.



Many natural sites now limit litter bins to the edges of car parks or parking areas to avoid creating unsanitary conditions in the middle of a natural area and to avoid creating collection difficulties in areas that are not easily accessible.
Furthermore, this type of "facility" tends to increase the concentration of waste in a given area when it is at its most saturated (generating both health and landscape impacts).
Before any development, a reflection and a study of the site must be carried out in order to select the appropriate development and location (*André Martinez-Humayou, pers. comm., SPIA; Desfossez and Vanderbecken , 1994b*).

Therefore, it is important to:

- consider photomonitoring from the same angle and studying old photos, drawings, and inventories
- analyse the features of the environment (vegetation, soil type, topography, climate, etc.)
- study the frequentation, circulation and use of the site by the public, as well as the causes of disturbance and patterns of behaviour.

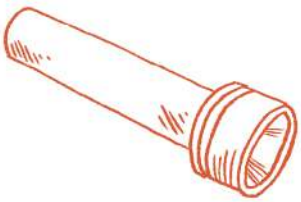
Indeed, the presence of facilities and physical boundaries on a site are perceived in different ways by different individuals. The management team must therefore assess the suitability of any equipment in terms of environmental preservation and public attitudes (*Desfossez and Vandrebecken, 1989*). The best time for said work is when visitor levels are at their lowest. Wherever possible, a reduction in the number of visitors can be implemented (closing parts of the site, etc.).
Finally, following any developments, an annual follow-up must be carried out in order to evaluate any needs in terms of maintenance and legal responsibility (insurance, etc.) (*Desfossez and Vanderbecken, 1994b*).

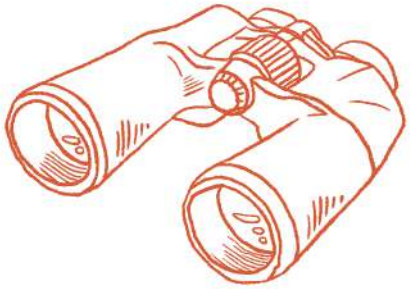
The following pages aim to present some examples of facilities that can be implemented on small islands, with inexpensive techniques that can be carried out directly by a field team, the rangers or the management team.

The daily life of a ranger

The ranger's patrol

The regular monitoring patrol is one of the pillars of routine management.
Ideally, a regular monitoring patrol takes place on a daily basis, every morning. It can be done alone or in pairs (for daytime patrols in uneven areas with a risk of falling and for nighttime patrols).



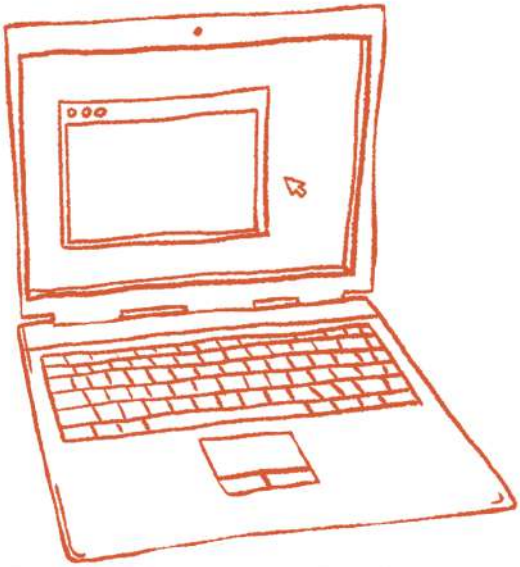


The essential tools

Staff members who carry out a daily surveillance patrol must carry a minimum amount of equipment with them at the outset:

At the outset

- A badge showing their role,
  Their professional ID card
- A modern means of communication
  (radio, mobile phone)
- A motorised vehicle suitable for
  the specific morphology of the area
- A digital camera
- A notebook and pen
- A pair of binoculars
- A wristwatch
- A torch (night patrol)



Upon return

- A computer
- Specialised naturalist literature (botany, herpetology, ornithology, etc.) or regulatory literature (e.g., practical guide to interventions in natural environments)
- Internet access (data and photo sharing)

Objective

The aim of the regular monitoring patrol is to assess the site on a day-to-day basis, in order to adapt current management by making quick adjustments to a specific project, without modifying the axis defined by the management plan (adaptive management).
Example: *if on patrol you notice that an information board is slightly damaged by graffiti, it is important to remove the graffiti before visitors arrive. This shows that the site is monitored and maintained. It is equally important to record the offence by writing a report and taking photographs of the damage or deterioration. This can later be used to identify the perpetrator through internet searches or other similar offences.*

Note

A ranger can also go on an extra surveillance patrol. This is
in addition to the regular patrols and focuses on initiatives that might alter management or even call into question the management plan. These extra patrols are done on an emergency basis, right after a significant event occurs at the site.
The cause of the aforementioned event is usually natural (fire caused by a dry summer storm, winter storm, heavy rain, etc.) but these events can also be of malicious or accidental origin (fire, pollution, etc.). In any case, rangers should take note of all the evidence in order to take the appropriate emergency measures.

TESTIMONIAL

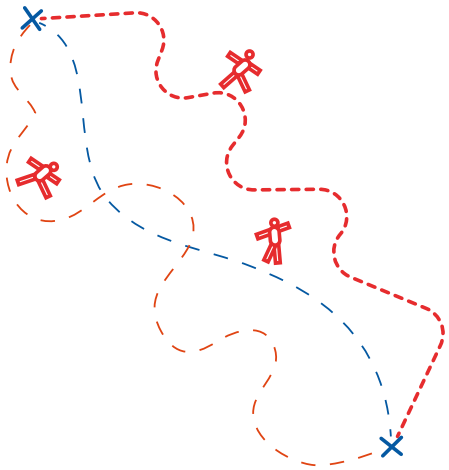
André Martinez-Humayou

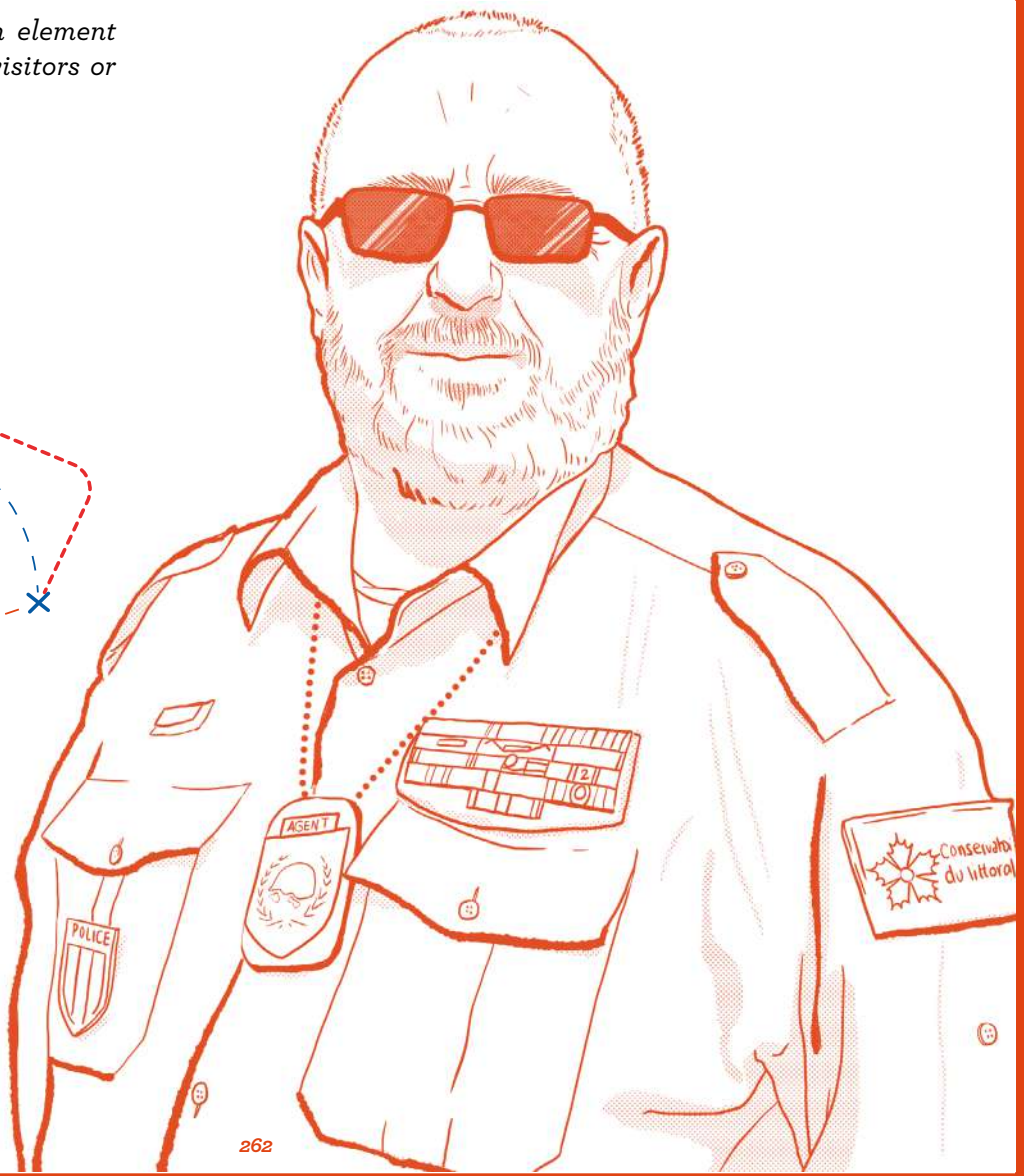
Soldiers of Peace International Association (SPIA)
Ranger for the Cap Taillat site on behalf of
the Conservatoire des Espaces in the region
of Provence-Alpes Côte d'Azur (CEN PACA)

Don't choose one route over another!

The regularity of patrols is essential, but the timetable, the direction, and areas must be irregular. A potential offender will quickly remember your route, the time of patrol, and how often you go by.

It is up to you to create an element of surprise when you meet visitors or possible offenders.





Patrol report

Objective

The patrol report is essential in order to anticipate any measures to be taken on a daily basis (adaptive management), or in the near future, for the proper management of a natural area.

Method

During their rounds, rangers may be in radio or telephone contact with administration (their direct supervisor) or the judicial authorities (police) to report minor damages, an accident, or another incident. The fact that rangers notify said authority by telephone or radio does not exempt them, on their return from their patrol, from writing a simple report in a book with numbered pages, on pre-printed sheets, or even on a spreadsheet. This report provides an accurate and concise account of the patrol. For sworn officers, they can draw up an official report depending on the offence(s) observed during the patrol. In French law, three types of records are available to officers:

STATEMENT REPORTS	STATEMENT OF INFORMATION	STATEMENT OF OFFENCE
are requested by an authority in order to know the exact details of a situation in a specific place and the possible criminal or administrative proceedings relating to that situation. This report will not be sent to the public prosecutor, it is internal to the administration of the natural site and is sent to a recognised entity.	is drawn up by the agent in question in order to quickly alert the public prosecutor's office or the police to situations or infractions for which they are not administratively or legally competent.	is the observation by the agent of a infraction or an offence for which they are administratively or legally competent; they alert the public prosecutor - the authority on which they are dependent - as soon as possible.

WORDS FROM A RANGER

The term 'procès-verbal' (statement or record) comes from the fact that Napoleon's gendarmes did not, as a rule, read or write. Also, when they returned from their patrols, which were always done in pairs, they gave a 'processus verbal' (spoken account) of their patrol to an officer, who would then question them to obtain more information and as precise an account of the patrol as possible. Over time, this 'processus verbal' has become 'procès-verbal', although today it is in the form of a written document.

Interrogation

The questioning of an individual or a group in a natural area is a regular occurrence in the working life of a ranger. This intervention is not trivial and it generally involves police intervention.

Method

This action is taken to stop a wrongdoing. It can be tricky because depending on the offence found, it will be classified (under law) as a felony, misdemeanour or infraction. When approaching an individual or a group, you will be obliged to introduce yourself by giving your name(s) and role(s), even if the signs of your role are visible (uniform, badge etc.). You must take a psychological lead over the situation from the very first exchanges, you must maintain control (direct the dialogue) and positioning in the space.

EXAMPLE ON THE BEACHFRONT

If the incident is taking place on the beach, hold the upper end of the beach and move towards the person(s), maintaining a firm but courteous dialogue. They will instinctively back away and then come into contact with the wet sand or surf, this will be uncomfortable and will distract the person(s). You will gain the upper hand and be able to carry out your intervention in a calm and respectful manner and catch out the offender(s).

If you are working in pairs or more, you should divide the responsibility between you:

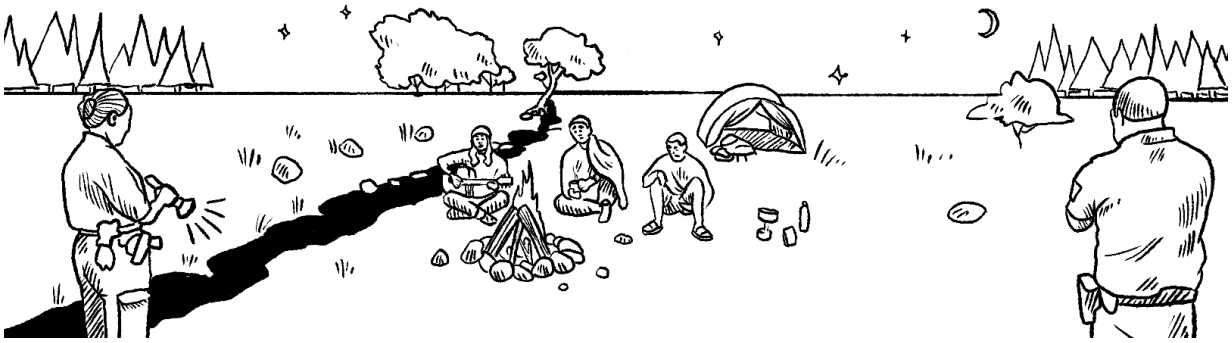
- One ranger leads the intervention, keeps talking, and directs the intervention
- The other agents are involved in destabilising the individual or the group

EXAMPLE IN TEMPORARY CAMPSITE

At a temporary campsite (tent) with a campfire, while a ranger talks to the offender(s), one of the rangers takes photographs of the camp and the remains of the fire, another ranger positions themself behind the group or the isolated individual, and with their eyes tries to make contact with the officer who is conducting the intervention. After agreement, they enter the intervention to complete the destabilisation of the group or the individual. During the intervention, rangers should look for the weakest person(s) in the group or those who disagree with the group leader: whether the group is family or friends, there is always a leader in a group.

EXAMPLE AT NIGHT

At night, the same logic applies! You see people camping on the beach around a campfire (prohibited by French regulations). You must be identified at the time by the offending individual(s). If the visual does not work, the campfire, candles, flashlights, and other sources of light should be turned off or extinguished. Only rangers should have a light source, this situation allows you to have a quick advantage over a group or an isolated individual.



It is important to divide the roles:

- Only one ranger is involved in the direct intervention.
- The other rangers remain in the background to ensure adequate protection of the intervention, to take photos with flash, to have an overview of the situation and to not forget anything when drawing up minutes, to perfect the destabilisation of the group or the isolated individual by tightening the group and having one of the rangers pass several times through the camp or the picnic area.

WORDS FROM A RANGER

This must be done without hatred or fear - never act in anger or fear, the act of confrontation must remain within a legal framework. If you act in anger, the offender(s) will use that anger against you as a weapon and turn the original situation on its head. If you are afraid of confronting an offender, ask for help (police) and do not intervene alone.
Remember that rangers are observation personnel, not intervention personnel, like the national police.

Installation of stairs

Aim of the development

In a natural area, paths, whether earthy or sandy, can be built on sometimes fragile and unstable ground. The installation of a structure (stairs, footbridge) must be done with a view to managing visitor flows and with a concern for its integration into the landscape and the total reversibility of the structure if there is a change in management (DESFOSSEZ AND VANDERBECKEN, 1989; L'HOSPITALIER, 2000).

Steps and staircases should be installed where a slope may destabilise the path. In effect, the structure will slow the speed of any water flow and sustain the ground. The gradient depends on the nature of the soil, the surface of the path, wind and water erosion conditions, and the level of use. Construction must follow the topography of the site, improve user comfort, and allow for the routing of visitors. Stairs are common and very popular with the public.

Thus, consideration should be given to ensuring that their installation does not increase the number of visitors or damage preserved areas. A few principles make it possible to adapt the design in the best possible way (AGATE, 1983):

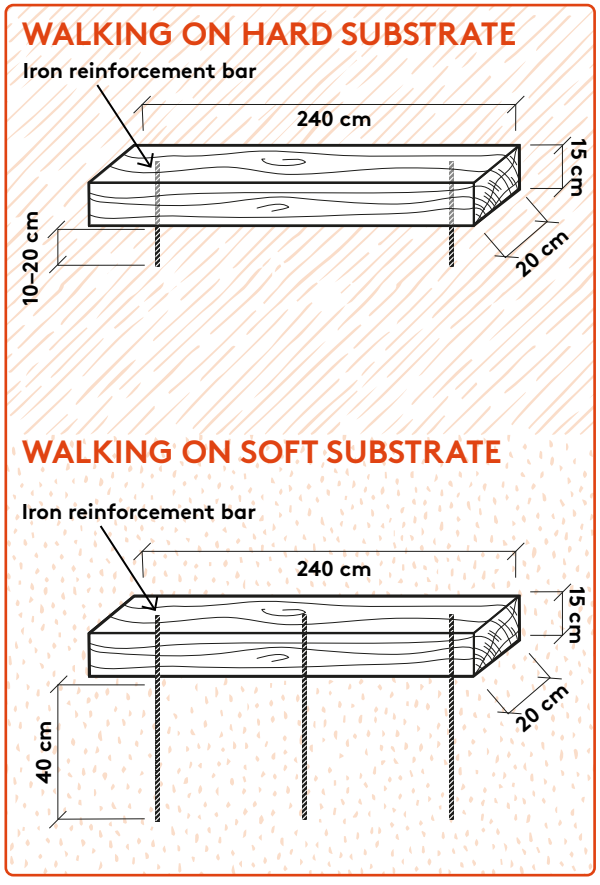
- Avoid straight lines (more difficult to drain, and intimidating to walkers);
- In downhill stretches, walkers may be tempted to take shortcuts, particularly on either side of a staircase; it is therefore important to conceal these stretches so as to encourage visitors to take the staircase and thus avoid possible deterioration or erosion in its vicinity;

- Avoid hillside staircases, which are difficult to build;
- Wider steps are more attractive (at least 1.20 metres wide for wooden steps, to allow 2 people to pass);
- A staircase should never have fewer than 3 steps (*Ausseur-Dolleans, 1993*).

To summarise, installing a staircase serves 3 purposes:

- Making footpaths accessible and safe;
- Establishing pathways that avoid at-risk areas or the trampling of plant life;
- Preventing erosion.

The technique described here has the advantage of being adaptable to the site, simple and inexpensive, and feasible for three employees to undertake with a minimal amount of equipment.
It can be used on rocky, earthy or sandy soil (embryo or stabilised dune belts in grey and black dunes) with the same ease of installation.

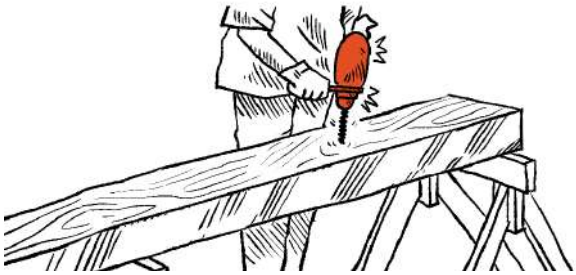


Necessary equipment

- Workwear
  Safety trousers, Safety shoes or boots, Gloves
- Wooden crossbar
  Usually made of oak with a length of 2.40 m, a width of 50 cm, and a thickness of 30 cm.
- Concrete reinforcement bars adapted to the nature of the soil
  Generally 14 mm thick and 1 m in length
- Shovel
- Rake
- Drill with 14 mm diameter and 20 cm long concrete bit
- Stakes
- Grinder
- Spirit level

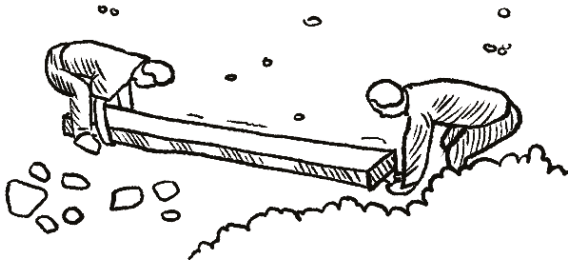
Implementation steps

STEP 1: Shape the ground where the first wooden step is to be placed (to ensure the stability of the installation, it is advisable to remove any stones and level the ground, in order to have a stable substrate).
Note: *this first step must be the length of the crossbar*



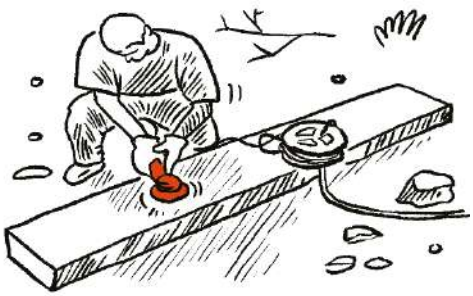
STEP 2: Drill a hole in the step with the concrete drill bit 20-30 cm from the edge (2 holes for a 2.40 metre length step or 3 holes for installation on loose substrate)

STEP 3: Place the first wooden step so that it is stable on its base;
Words from a ranger:
"Don't be afraid to take your time, because this stage is essential for the durability of the work! "



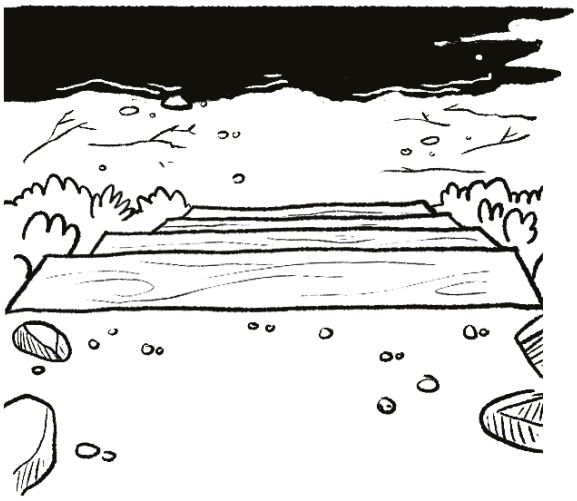
STEP 4: Fix the step to the ground by hammering in the reinforcement bars (10 cm on hard substrate; 40 cm on soft substrate and up to 1 m in sand).
Words from a ranger:
"Watch out! As soon as the stake bounces back, the metal rod is at the bottom of the hole or has hit an obstruction. Stop hitting it! If you continue, the rod will lift the crossbar, so you risk destabilising the step and having to start all over again".

STEP 5: Using the grinder, level the bars



STEP 6: A final hit with the sledgehammer is required to drive in the remaining concrete rod.

STEP 7: Repeat the process by installing the second and subsequent steps. Depending on the configuration of the path, the installation of the steps can be done either at the edge of the previous path or with a gap (at least 20 cm). Always ensure that the excavated soil from the foundation is deposited upwind and that the steps have a recessed foundation. The stair nosing should be slightly higher than the bottom of the stair, so that the person walking down the stairs does not slip (either because it is steep or because of dampness or rain).



WORDS FROM A RANGER

To avoid overheating the drill bit when drilling the crossbars, and to ensure that they are not affected by the drilling process and the insertion of metal pegs (risk of splintering), the crossbars must be soft (wet). This humidity is artificial and must be maintained during storage. They should be stored flat to avoid twisting or bending the crossbars.

The installation of a micro-gabion perpendicularly on each side of the steps of this new staircase will finish the work and stabilise it. Within a few months, the micro-gabion will revegetate and integrate the stairs into the surrounding environment.

Bibliographic references

Agate, E., 1983. ***Footpaths – A practical conservation handbook point***. British trust for conservation volunteers. Great Britain

Ausseur–Dolleans, C., 1993. ***Aménager des sentiers de promenade***. Ministère du Tourisme, Ministère de l'Environnement, Atelier technique des Espaces naturels

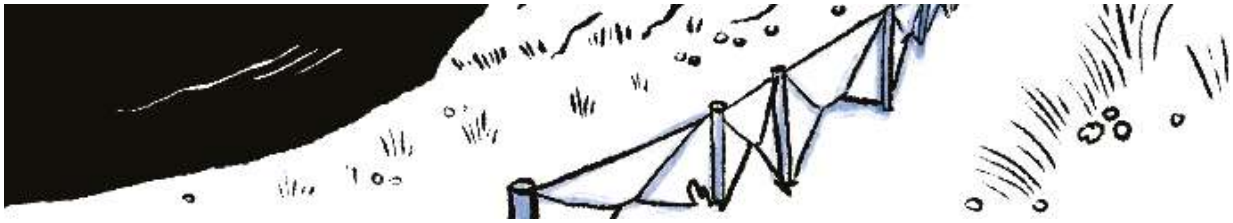
Desfossez, P. and Vanderbecken, A., 1994a - Chapter 7: Accueil de public. ***Manuel technique de l'agent de terrain des espaces naturels. Montpellier: Atelier technique des espaces naturels***, Conservatoire du littoral.

Desfossez, P. and Vanderbecken, A., 1994b - Chapter 6: Technique pour l'agent. ***Manuel technique de l'agent de terrain des espaces naturels***. ***Montpellier: Atelier technique des espaces naturels,*** Conservatoire du littoral.

Desfossez, P. and Vanderbecken, A., 1989 - ***Dialivre technique sur les sentiers. European Economic Community. Matériaux de formation destinés aux agents techniques chargés de la gestion d'espaces naturels***. France: Association ALFA, Conservatoire de l'espace littoral et des rivages lacustres.

Fencing

Installation of wooden stakes with crossed wire



Aim of the development

It is sometimes necessary to erect barriers or fences along paths - for fencing, to protect vegetation, nesting areas, a rare plant site (DESFOSSEZ AND VANDERBECKEN,1989), and also to limit the emergence of other unauthorised paths (L'HOSPITALIER, *2000*), and to manage the flow of visitors by directing them. The footpaths that serve the site are easily subdivided into sub-trails (which are only used by a few people to get to a secluded cove or other area). If visitor flows are not taken into account from the start of the project, it can take years to restore the sites of unauthorised paths and this can have an impact on the budgets of the natural site.

Certain principles help to better direct the public (DESFOSSEZ AND VANDERBECKEN,1994):

- The stability and safety of a path is more attractive than unstable ground;
- A winding path with many twists and turns, varying shady and wide-open areas, and the possibility of free movement in certain places can limit a walker's desire to explore;
- When pathways are dangerous, it is better to widen them more than necessary (or close them) until they reach a more stable and flatter area; the width of the pathway depends on the type of user and the intensity of use (lightly used area: 45–60 cm / heavily used: 1 m / disabled users: 1.5–2 m) (AUSSEUR-DOLLEANS, 1993).

The installation of a fence should not be a destructive or irreversible action. The fixing of fence posts with concrete or other unsightly anchors should be avoided. The installation of wooden posts with crossed wire has the advantage of being simple, inexpensive and achievable by two people with a minimal amount of equipment, being reversible, and limiting the impact on the landscape. It is also largely replicable on hard (stone, wood) and soft (sand) substrates with a few modifications; several variants are possible depending on the state of progress of the site management. The preparation for the construction (cutting the posts to size, drilling, etc.) can be carried out in a workshop, but the final adjustments will inevitably need to be made on site.

Before installing the stakes, it is important to assess the length of the path: the entire path does not necessarily need a cross-wire fence. On a seaside path, the downstream side is more often an invitation for visitors to wander in search of the water, the beach, or the creek. Crossed wires will be of paramount importance here to limit the creation of uncontrolled paths that quickly destabilise the soil.
Work should be carried out at times when there is less foot traffic, ideally in the autumn and spring. In rainy seasons, the soil is soft (while boring), and installation in soft and fresh soil will favour natural adhesion (suction cup effect) between the soil and the wooden post.

If a large crest line is to be fenced off, the fence should never be placed on the crest line, but rather a few metres downstream. There are two reasons for this - the first is aesthetic and the second is for the benefit of the birds (thrushes, hoopoes, blackbirds, partridges, birds of prey, etc.) that might hit the fence.

Necessary equipment

- Workwear
  Safety trousers,
  Safety shoes or boots,
  Gloves
- Concrete reinforcement bar
  14 mm in diametre
- Wooden stakes (chestnut or acacia)
  8–10 cm in diametre
  and 1.75–2 m high
- Drill with wood bit
  and concrete bit,
  both 14 mm
  in diametre and 20cm long
- Crossed wire
  2–4 mm thick (beyond that, it is too rigid and difficult to handle)
- Galvanised staples
  5 mm in diametre and 50 mm long
- Hammer

If the substrate is soft:
- Auger drill
- Stakes

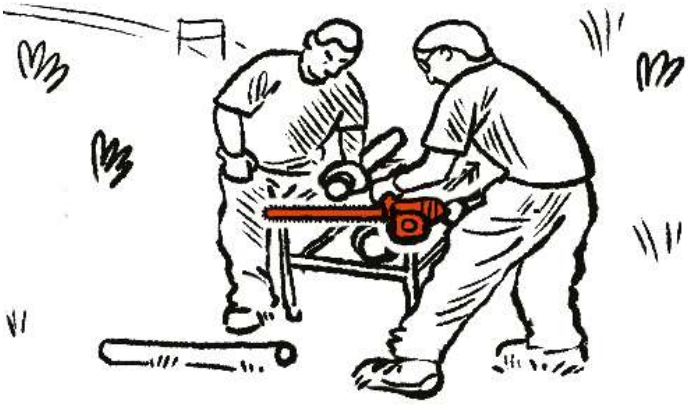
WORDS FROM A RANGER

After estimating the number of stakes and the number of metres of wire you will need for your work, always allow for a margin of error (2 extra stakes per 100 metres; 1 extra roll of wire) in case of unexpected problems! Standard rolls of wire are 103 m long at most suppliers in Europe. Don't forget to always bring a spare drill bit in case the first one breaks!

Implementation steps

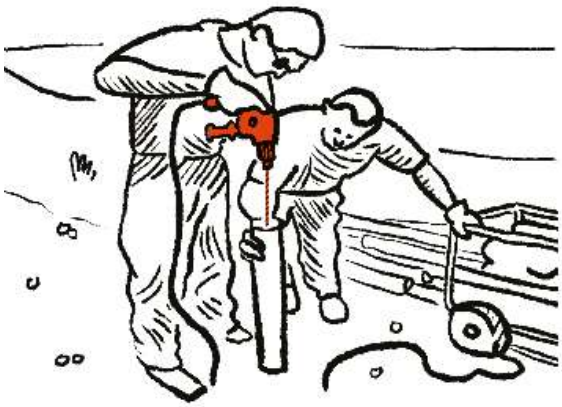
PHASE 1: Installing the wooden stakes

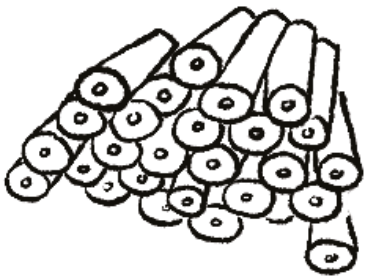
Step 1: Cut the reinforcing bar to a length of 40 cm



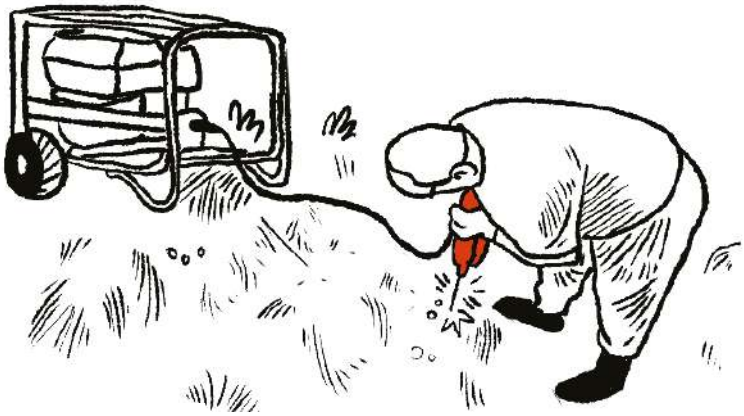
Step 2: Cut the wooden post into 2 sections of about 70–80 cm in height (the pointed part of the post will not be used)
Note: *for soft substrate, keep the 1.75/2 m stake in its original state*

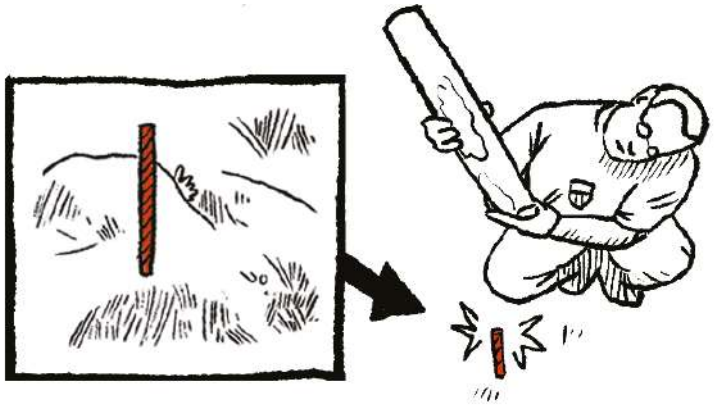
Step 3: With the wood bit, drill a hole in the centre of the post to a depth of 20 cm





Step 4: Drill the hard substrate (stone, wood) with the concrete drill bit to a depth of 20cm

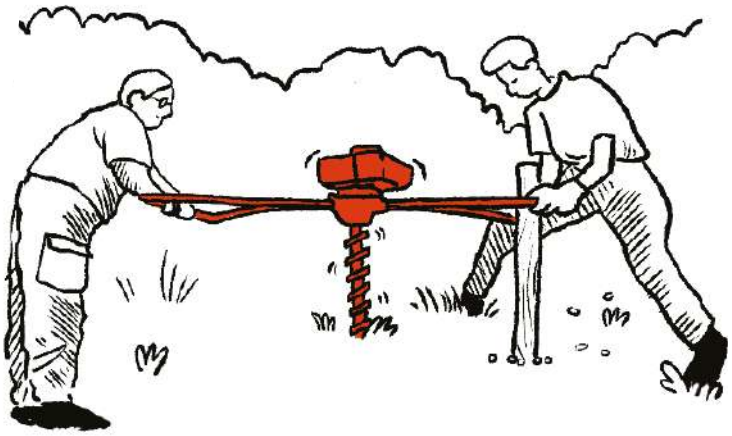




Step 5: Insert the metal peg about 20 cm and install the wooden stake

Note: *for soft substrate, use an auger and sledgehammer to drive the stake to a depth of about 1 m*

Step 6: Repeat the process, keeping a spacing of 1.50–2m between the stakes



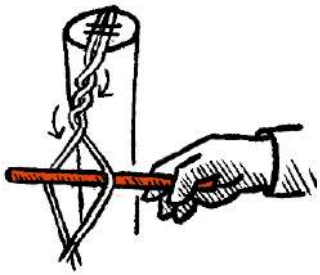
WORDS FROM A RANGER

«To avoid overheating the drill bit when drilling the posts, and to make them resistant to being cut and to the insertion of metal pins (risk of splintering), the posts must be soft and damp.
This humidity is artificial and must be maintained during storage.
Tap the wooden post on the hard substrate: the mark left by the sawdust deposit will allow you to drill in the right place».

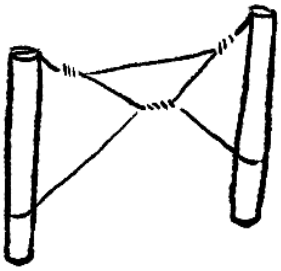
Implementation steps

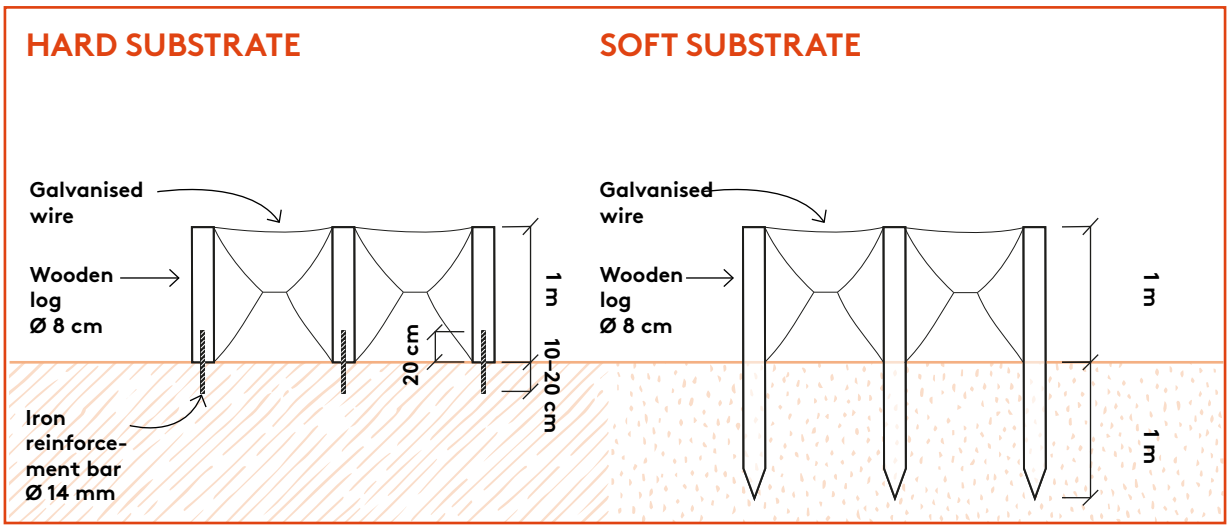
PHASE 2: Installing the crossed wires

Step 1: Fix the wires in place with the staples using the hammer



Step 2: Wrap the wire around the top 2 corners and the middle to reinforce the structure





WORDS FROM A RANGER

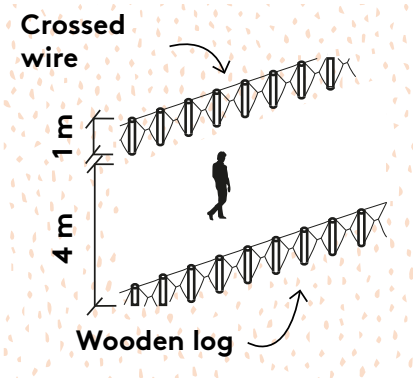
The public often has the impression that barriers or fences spoil the landscape. It has a «park-like» feel to it, while the islands carry a feeling of freedom without people or amenities. When fencing a path or a wilderness trail with this system (wooden posts and crossed wires), we recommend greasing (in a neutral colour) the posts and wires so that no one touches the fence or steps over it without getting covered in grease. Rebellious visiters will quickly overlook this path for their next visits!

In sloping areas where this has been installed, it may be worthwhile to place gabions perpendicular to the construction at its entrance, middle and exit. During rainy periods, these will catch loose soil and seeds (carried by the water flowing over the path) and thus reduce erosion and encourage revegetation around the structure.

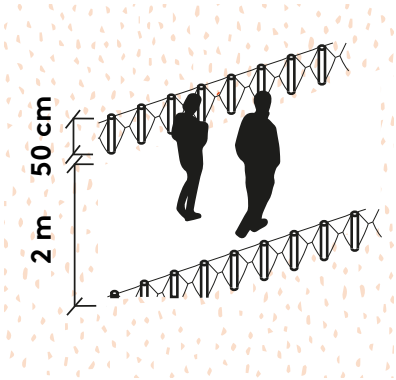
An evolving design!

As the management of the site progresses, it will become possible to modify the initial design to achieve a more minimalist fence.

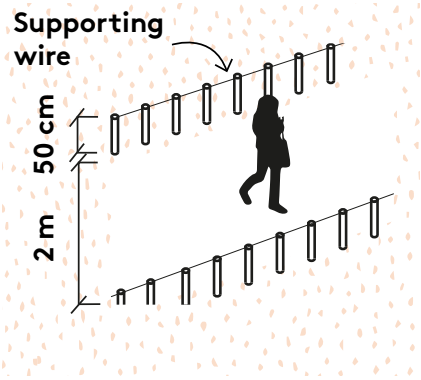
1. At the very beginning, it is necessary to set up a 4-metre wide path, with stakes reinforced with crossed wires protruding 1 m from the ground, in order to delimit, as much as possible, the path to be taken



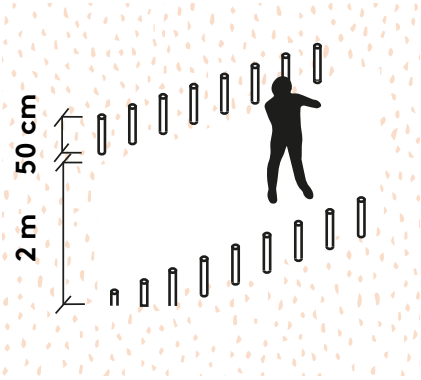
2. Three to four years later, the path can be reduced to 2 metres, the posts reduced to 50 cm, and the wires kept crossed



3. The third management phase consists in replacing the crossed wires with a single supporting wire.



4. The last step is to remove the supporting wire; the delimitation is then discreet but sufficient since the public is now aware of it.



Bibliographic references

Ausseur-Dolleans, C., 1993. ***Aménager des sentiers de promenade***. Ministère du Tourisme, Ministère de l'Environnement, Atelier technique des Espaces naturels

Conservatoire Etudes des Ecosystèmes de Provence/ Alpes du Sud, 2014. ***La protection des espèces et des milieux***. http://www.ilesdemarseille.fr/html/gestion_frequentation.html

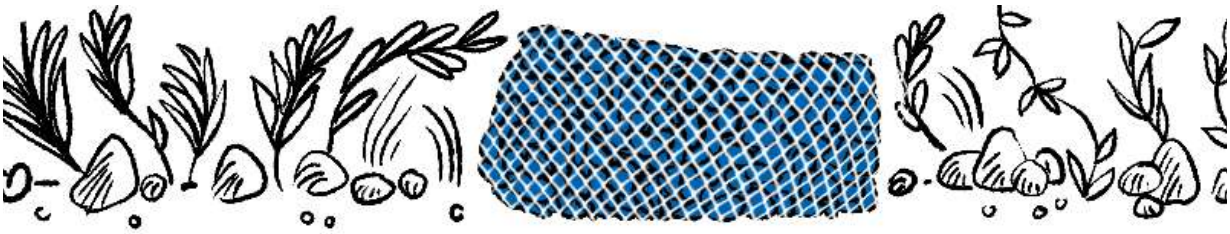
Desfossez, P. and Vanderbecken, A., 1994a - ***Chapter 7 : Accueil de public. Manuel technique de l'agent de terrain des espaces naturels. Montpellier: Atelier technique des espaces naturels***, Conservatoire du littoral.

Desfossez, P. and Vanderbecken, A., 1989 - ***Dialivre technique sur les sentiers. European Economic Community. Matériaux de formation destinés aux agents techniques chargés de la gestion d'espaces naturels***. France: Association ALFA, Conservatoire de l'espace littoral et des rivages lacustres.

Grimes, S., 2012. ***Rapport de comité de pilotage du site des îles Habibas – Aménagement des îles Habibas.*** Algiers: Conservatoire du littoral, PIM Initiative, Ministère de l'Aménagement du Territoire et de l'Environnement, People's Democratic Republic of Algeria.

L'Hospitalier, J.P., 2000. ***Catalogue des équipements (zones de compétences du Parc National de Port-Cros)***. France: Parc National de Port-Cros, Ministère de l'agriculture et de la pêche.

Gabions



Aim of the development

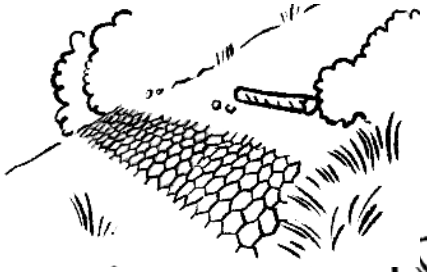
The placement of gabions is carried out to stabilise slopes (Agate, E., 1983). This installation is used to repair small areas of erosion caused by run-off water (rill erosion) or degradation prior to maintenance. This method of repair consists of laying a wire mesh, without any prior work on the ground (digging, levelling, etc.), shaped like a cushion, which is filled with stones, rubble or dirt, all taken from the area to be repaired. It is easy to install, can be installed by a single worker and is inexpensive.

The gabion is a remarkable method of combating slope erosion, as it slows down run-off water, captures seeds and fine soil, and can thus re-vegetate and blend in with the surrounding greenery within a few months.

Necessary equipment

- Workwear: *Safety trousers, Safety shoes or boots, Gloves*
- Galvanised steel chicken wire
- Metal staples
- Stakes
- Shovel
- Bucket
- Hessian (if using soil to fill the gabion)

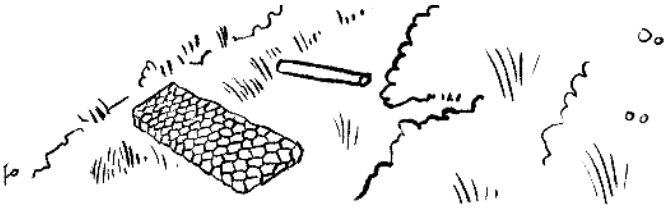
Implementation steps



STEP 1: Lay the mesh along the section to be protected

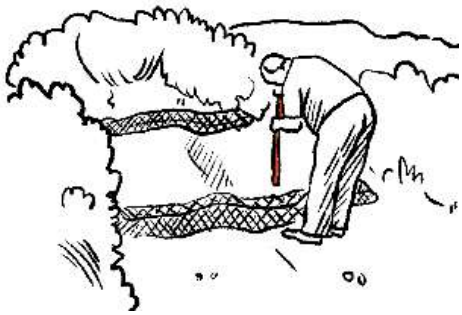
STEP 2: Fill with stones/ gravel/soil found on site

STEP 3: Close the edges together to create a sausage-shape



STEP 4: Fold the outer edges under the 'sausage' after securing them with staples and fix the folded edges to the 'sausage' with metal staples

STEP 5: Hammer the 'sausage' into the shape of the ground with a 5 kg sledgehammer to flatten it and stabilise it.
Note: On very steep slopes, where there is a lot of runoff, consider securing the gabion with reinforcing pegs made of iron.



STEP 6: Covering the gabions with soil so that they blend into the landscape

WORDS FROM A RANGER

«In an isolated area, you can also use strips of seagrass to fill the gabion. Seagrass can take a long time to degrade, which makes it a suitable material for this type of project». Between each gabion, scratch the soil horizontally to prevent compaction and to encourage the establishment of seeds that fall naturally in this area, or those that may be thrown in by the ranger. This will accelerate plant recovery

Bibliographic references

*Agate, E., 1983. Footpaths – **A practical conservation handbook point.** British trust for conservation volunteers. Great Britain*

Signage

Installing a sign without using concrete

Aim of the development

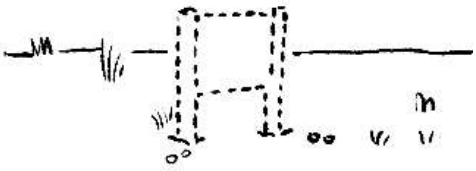
The use of signs is often intended to raise awareness and inform the public. The aim of the method described here is to reduce the use of polluting substances in the natural environment. In this case, the installation of signs does not require any fixing with concrete. This will allow the sign to be removed or replaced at a later date while avoiding the retention of a foreign material in the soil.

Necessary equipment

- Workwear
  - *Safety trousers,*
  - *Safety shoes or boots,*
  - *Gloves*
- Signage
  - *Here is an example of a 1 metre long sign*
- 4 wooden planks
  - *Two 1.20 metres long*
  - *and two 0.70 meters long*
- Hammer
- Nails
- Crossed wire
- Cutting pliers
- Shovel
- Pickaxe
- Spirit level
- Bucket

Implementation steps

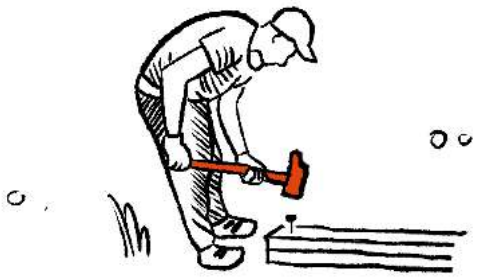
To install a typical Conservatoire du littoral sign measuring 100 cm long by 60 cm high



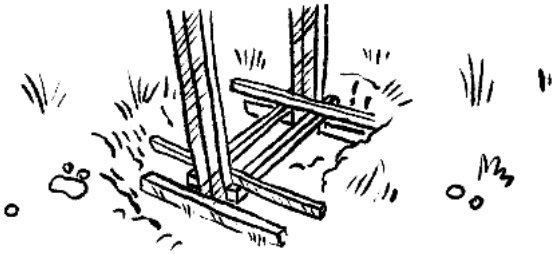
STEP 1: Position the future sign so as to offer the least resistance to strong winds

STEP 2: Dig a rectangular hole 0.80 metres deep x 1.20 metres long x 0.70 metres wide

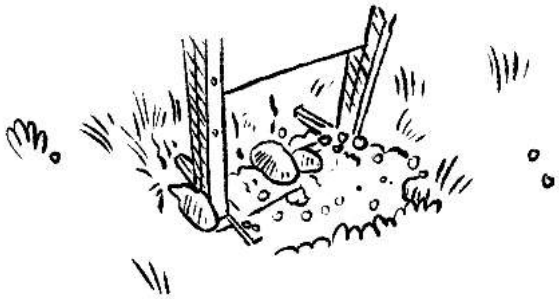
STEP 3: With the hammer and nails, fix the planks to the sign posts, having 2 planks lengthways and 2 planks breadthways
Note: *if the wood of the sign posts is too hard, use wire to secure it*



STEP 4: Place the base of the sign posts at the bottom of the hole



STEP 5: Place large flat stones or, failing that, miniature gabions (small wire meshes filled with stone, rubble or dirt) on the planks



STEP 6: Check that the sign is properly supported (the sign should stand upright on its own) and that it is balanced with the spirit level; if necessary, make adjustments

STEP 7: Fill the hole with the excess soil and, ideally, water the excexcavated soil (1 or 2 buckets of sea water) to encourage the infiltration of the soil into the gaps and thus compact it

WORDS FROM A RANGER

For a larger sign, use support brackets on the back of it

It is the weight at the foot of the sign that holds it in place, not the concrete; a square-edged hole is more resistant to lifting than a round hole (ball joint effect)

Consider placing your signs at the entrance to a pathway, or in such a way as to close off certain unauthorised areas. The sign will thus help to channel visitors

Instead of planks, you can also use pieces of driftwood, collected locally. In this case, use wire and a wire cutter to attach them to the sign posts

Building a dry stone wall

Aim of the development

The use of dry stone walls dates back to prehistoric times, and they were mainly used for agricultural and pastoral purposes as crop terraces, to enclose land, and to protect it from bad weather and the movement of livestock. It is an eco-friendly technique: it uses materials taken only from the ground, and does not use any form of binder (cement). In this way, run-off water flows freely, and the weight, bulk and cohesion of the materials help to combat erosion. They are also valuable spaces for biodiversity (ferns, gastropods, insects, reptiles and amphibians) which find refuge in the shady and humid cracks in the wall (Association pour la participation et l'action régionale, 2014). This sustainable project, which is integrated into the environment, is therefore appropriate for natural areas. It is used to restore existing walls, to build on sloping ground, and to support paths or trails. Its implementation involves real consideration of the landscape, safety, crafts-manship and biodiversity concerns (construction of habitats - recesses - for some reptiles to find shelter). The strength of a wall depends on the placement of the largest stones at the base, an appropriate slope for the type of terrain, good assembly, and adequate infilling. The maximum height of this type of structure should not exceed 1.50 metres and the width of its base should be one third of its height (50cm).

Necessary equipment

- Workwear
  Safety trousers, Safety shoes or boots, Gloves
- Sledgehammer
- Shovel
- Pickaxe
- Tape measure
- Buckets
- A nice pile of rocks!

IMPLEMENTATION STEPS (Consell de Mallorca, 2009)

STEP 1: CLEARING THE AREA

This task consists in removing and sorting the crumbled material (soil, infill and stones). It is often necessary to start by clearing the work site. Beware of the risk of the soil sinking when it is saturated with water.

STEP 2: THE BASE

Depending on the height of the wall and the slope of the land, dig down to a relatively hard area to create the trench where the first stones will be placed. The trench should be slightly sloped at the back so that the wall has a good footing and does not slide sideways. In clay-based soils, it may be necessary to double the width of the trench in order to add more filling material (increase drainage).

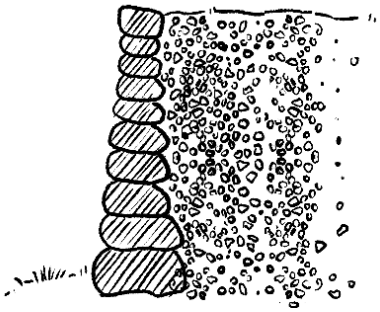
STEP 3: FOUNDATIONS

The foundation stones of the wall mark the beginning of the banking (building up the embankment). In general, the largest stones are chosen to reinforce the strength of the wall. The first stones are placed at each end of the foundation. The rest of the foundation stones are then laid and set in place with cord, so that they are angled inwards to match the desired slope. The space between the facing and the body of the wall should be carefully infilled as the wall is being built.

STEP 4: FACING

The arrangement of the stones is an essential factor in ensuring the strength of a wall and enhancing its stability. Here are some recommendations to ensure the stability of your wall:

- Arrange the stones in an organised manner, with the larger stones at the bottom (base)
- Place the stones together with a maximum surface area of contact between them;
- Set the stones in place on the back of the wall, never on the front, where there would be no resistance in the event of expansion due to run-off water;
- Vertical "stone columns" should be avoided at all costs, as they could render the parts of the wall where they are placed unstable, and eventually lead to the wall's collapse. The larger the stones used, the more stable the wall will be.



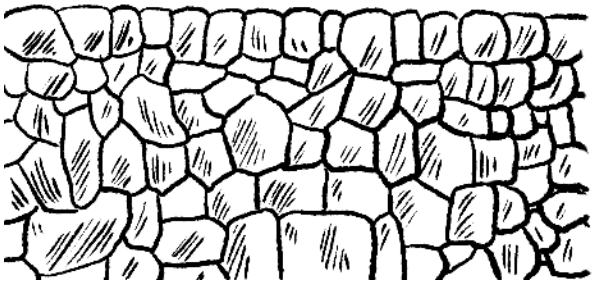
STEP 5: INFILLING

Filling in gaps behind the facing with small stones (or fragments of brickwork or broken tiles) will allow water to drain away and thus ensure the strength and stability of the wall. The infill should be carefully placed in the correct position, ensuring that there is no shifting caused by the infilling process. The density of the infill should be as great as possible and it should be easily 'drainable'.

STEP 6: COPING STONES

It is the correct positioning of the final row of stones that will help prevent the wall from deteriorating. Therefore, large stones are needed to stabilise the wall (never thin, jutting flat stones). There are two ways to place coping stones:

- Flat: the final row is levelled at the top, with stones of varying sizes (flat or oblong).
- Arrayed: a line of stones of the same size (same height and more or less rectangular facing) placed directly after the flat row.



FLAT-LAYING COPING STONES

ARRAY OF COPING STONES

WORDS FROM A RANGER

How to find the right stone: take a mental picture of your stone pile (saves on handling). There is always a temptation to take a stone that is too big and insert it between others that have already been placed - a rounded stone can't be used!

General

Consell De Mallorca, Office De l'Environnement De La Corse, Communita Montana Suol d'Aleramo, 2009. ***La construction en pierres sèches – fiches techniques – mur de soutènement, pavage, toiture en lauze***. Transfert de compétences acquises et de savoirs techniques pour le programme européen Grundtvig projet multilatéral.

Association pour la Participation et l'Action Régionale, 2014. ***Valeur écologique : la pierre sèche, une leçon d'écologie pour gérer les sites ruraux d'aujourd'hui***. PACA region, Vaucluse department, SMAEMV.

Consell De Mallorca, 2009. ***Les ouvrages de la pierre sèche à Mallorca***. Programme pour l'éducation et la formation tout au long de la vie.

Grimes, S., 2012. ***Rapport de comité de pilotage du site des îles Habibas – Aménagement des îles Habibas.*** Algiers: Conservatoire du littoral, PIM Initiative, Ministère de l'Aménagement du Territoire et de l'Environnement, People's Democratic Republic of Algeria.

Wintz, T., 2013. ***Pierre sèche – techniques – À L'ETAT BRUT (06)***

Tree felling

With contributions from Lisa Bertrand and Jean Michel Battin,
Des Racines et des Graines

Objective

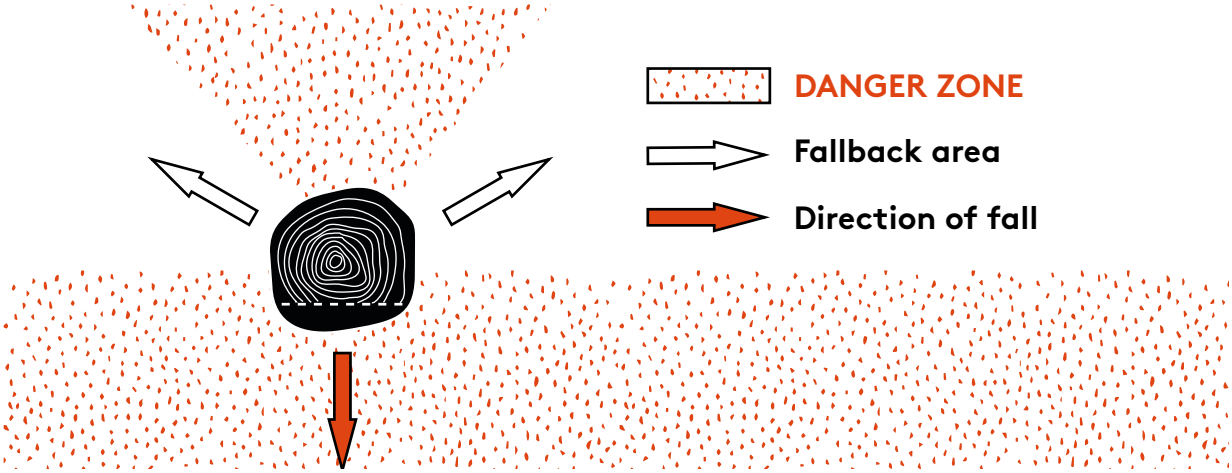
The felling of one or more trees is part of the sustainable management of a protected natural area. This should not be done in the interest of removing an ailing or unsafe plant, but rather in the interest of good management. Sometimes it is necessary to cut down a healthy, but mature plant in order to allow several promising plants to grow and develop. It is also common practice to leave a dead plant in the ground to support a specific species of flora or fauna, but in this case the plant must be far from any path or trail and in the middle of an open space to avoid any problems in the event of a fall.

Equipment

- Workwear
  Safety trousers, Safety shoes or boots, Gloves
- Helmet
- Earplugs
- Protective glasses or visor
- Billhook or any other type of impact cutting tool (axe, hatchet, etc.) to clear the vegetation around the felling area
- Felling chainsaw (and if possible pruning chainsaw) in perfect working order (new or sharpened chain, fuel, oil, attachments included).

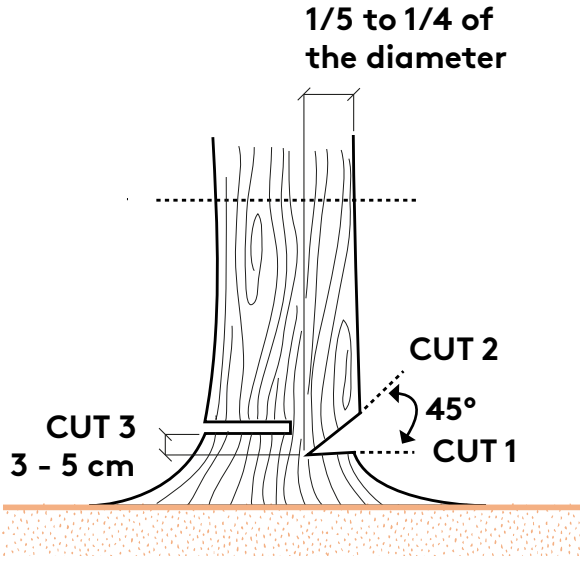
Implementation steps

Felling work must be done in a very safe manner, working at least in pairs. If felling is difficult (e.g. on very steep slopes, or near houses, buildings or roads, etc.), it is preferable to call in a company that specialises in this type of work.
If the operation is to be carried out in an area where there is a risk of people walking nearby, it is essential to demarcate the felling area and even temporarily prohibit visitors from entering the area.



STEP 1: First determine the direction of fall. Determining factors for the direction of fall are, among others, the wind direction, the shape, position or angle of the tree and the nature of the site (flat or sloping area, etc.).

STEP 2: Clean around the base of the tree and remove large branches at the base of the trunk (for better fall control), and if necessary the fall zone. Watch out: provide a fallback area in case the tree does not rest on the felling notch and rotates on its axis and changes direction of fall (e.g. sudden gust of wind).



STEP 3: Cut the felling notch exactly at a right angle to this direction. The felling notch should be made at about 1 metre from the ground and reach a depth of about 1/5 of the trunk diameter (up to a maximum of 1/4). First, cut the base (horizontal cut) of the felling notch and then the slant. The trunk should not be cut beyond the point of intersection of the slant and the base, so as not to damage the splitting point and hasten the tree's fall in an undefined direction.

STEP 4: After the tree has fallen, wait until it stabilises on the ground. When pruning branches, start from the base of the cut towards the peak. Cut the upper branches first, then clear these branches from the working area. Look for branches that are under stress due to their contact with the ground and the weight of the trunk. Before each new branch is cut, check that the worker's feet are not under the axis of the trunk, depending on the terrain. In sloping areas, stand uphill of the cutting in case the trunk rolls.

STEP 5: Finish the task by cutting up the trunk. While pruning, you can collect large branches, stakes, poles, etc. which can be used for further management of the site.

STEP 6: After felling and cutting, make a clean cut on the stump (a flat cut in dry conditions and a slightly sloping cut in wet conditions to prevent water from stagnating on the stump and causing it to rot). This last step is only relevant if a plant species, such as willow or eucalyptus, grows from the stump.

WORDS FROM A RANGER

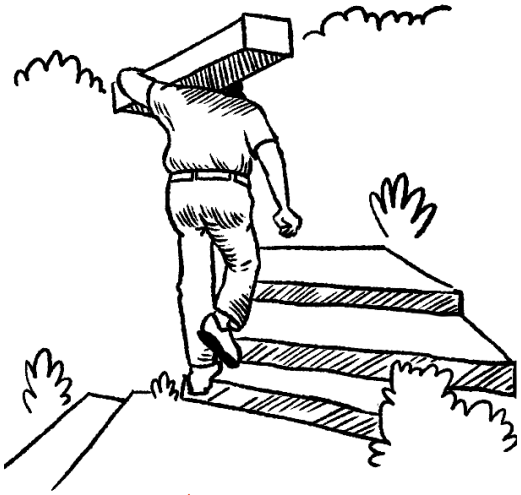
Forestry or forest management falls into two categories: nonprofitable and profit-making. Depending on your position, you will have a different attitude to the fate of trees that, in a profit-making operation, would be felled, and on the contrary saved in a non-profitable management operation.

Whenever you cut down one or more trees, you must do so in a safe manner. Never work on tree cutting at the end of the day, in strong winds, or in bad weather.

Transporting materials

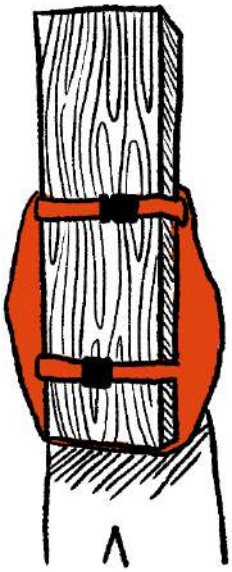
In a natural environment, it is sometimes difficult or even impossible to drive a vehicle due to steep areas, narrow paths, sloping paths, etc. Access to certain areas is not always possible by sea.

Also, in order to transport smaller equipment and materials, which will be used to carry out a development on the site (fencing, stairs, panels, etc.), the use of a backpack known as a "carrying frame" (used by the fire brigade, for example) may be a suitable solution for the ranger or management team.



BEFORE

This backpack will eliminate or limit the need to carry equipment on your arm or shoulder, which will be more tiring if a large volume of equipment has to be carried.

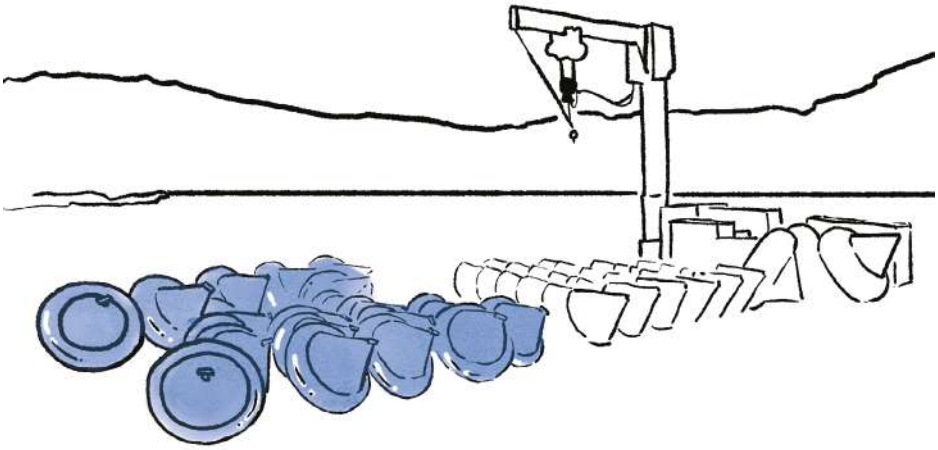


AFTER

"CARRYING FRAME"

Buoys and moorings: Managing private boats in Cabrera National Park

With the contribution of Jorge Moreno Pérez, biologist and Head of Cabrera National Park from its foundation in 1991 to 2016.



The National Park covers about 90,000 ha of marine area to a depth of less than 2,000 metres and has several integral reserve areas. The park features an extensive representation of all Mediterranean marine habitats except the low-lying coastal silt. Of particular note are the abundant Posidonia oceanica seagrass meadows. The flora, fauna and biocenosis have been updated in a recent publication (Grau et al. eds 2020).

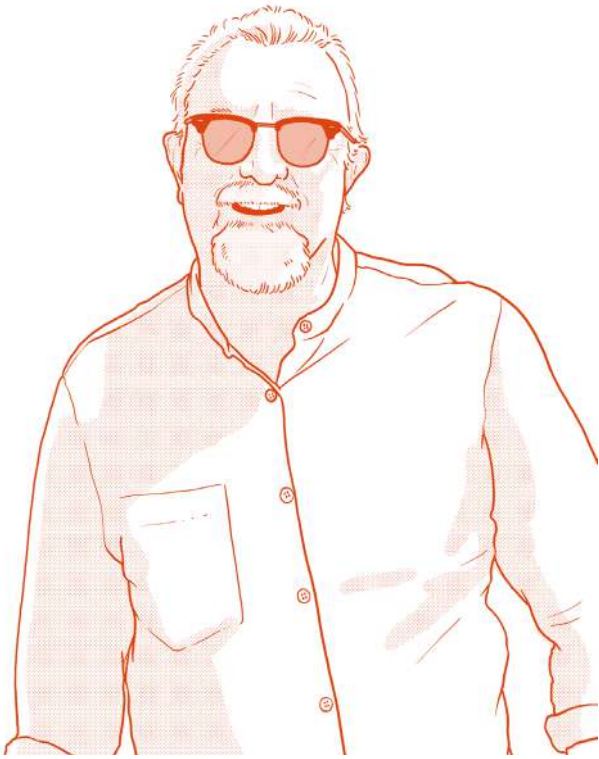
In 1993, two years after its status was declared, Cabrera National Park installed a field of ecological buoys (50) to limit the mooring of private boats and visitor access. This measure marked a milestone in terms of management and served as an example for many other areas, as it was the first of its kind implemented in the Mediterranean.

Ecologic buoy fields keep traction elements (nylon or polypropylene chains or stakes) from coming into contact with the sea bottom utilising intermediate buoys. They had only been used in moorings in some areas with coral bottoms in the United States, where anchor dropping is prohibited (bottom-friendly).

A system was designed using concrete blocks, connected to the surface buoy with a polypropylene stake (which years later was replaced with nylon) instead of a chain, with an intermediate buoy to ensure the stake remained floating and never touched the bottom. As a result, the only impact is the concrete blocks themselves, which are usually located on a sandy bottom.

Fifty buoys were installed, organised by colour indicating the the securing capacity in terms of submerged deadweight and maximum permissible length, based on demand in previous years:

- Twenty-six white buoys for lengths up to 12 metres.
- Fifteen yellow buoys for lengths between 12 and 15 metres.
- Six orange buoys for lengths between 15 and 20 metres.
- Three red buoys for lengths up to 35 metres.



The number of moorings was set based on average occupancy during summer months to exceed the expected demand except for weekends in August. Consequently, there was a certain margin for a possible increase, which was foreseeable due to the system's appeal and Cabrera's attraction as a national park. Moreover, the number was adequate for anchorage in a national park, as the harbour bay area is about 55 hectares, leaving approximately one hectare for each vessel.

The installation budget was around €180.000 in 1993. This amount may seem high for the time. Still, considering that all the equipment had to be transported from Mallorca and that ships with cranes capable of moving large, heavy concrete blocks had to be used, it was not excessive.

The decision to use concrete anchors instead of other more environmentally friendly systems (Helix or Manta Ray anchors) is due to the fact that these technologies were very recent at the time, complex at the industrial level, and did not provide sufficient safety guarantees. Moreover, almost all the blocks were installed on sandy bottom. Indeed, the distribution of the moorings had been designed with this criterion in mind, and they had no impact on the Posidonia meadow.

We attach great importance to these structures' safety and ease of maintenance compared with structures buried in the sand (e.g., Manta Ray), where hidden damage to the support structure is difficult to see, as opposed to concrete structures above ground. Maintenance and security costs are critical in public service facilities.

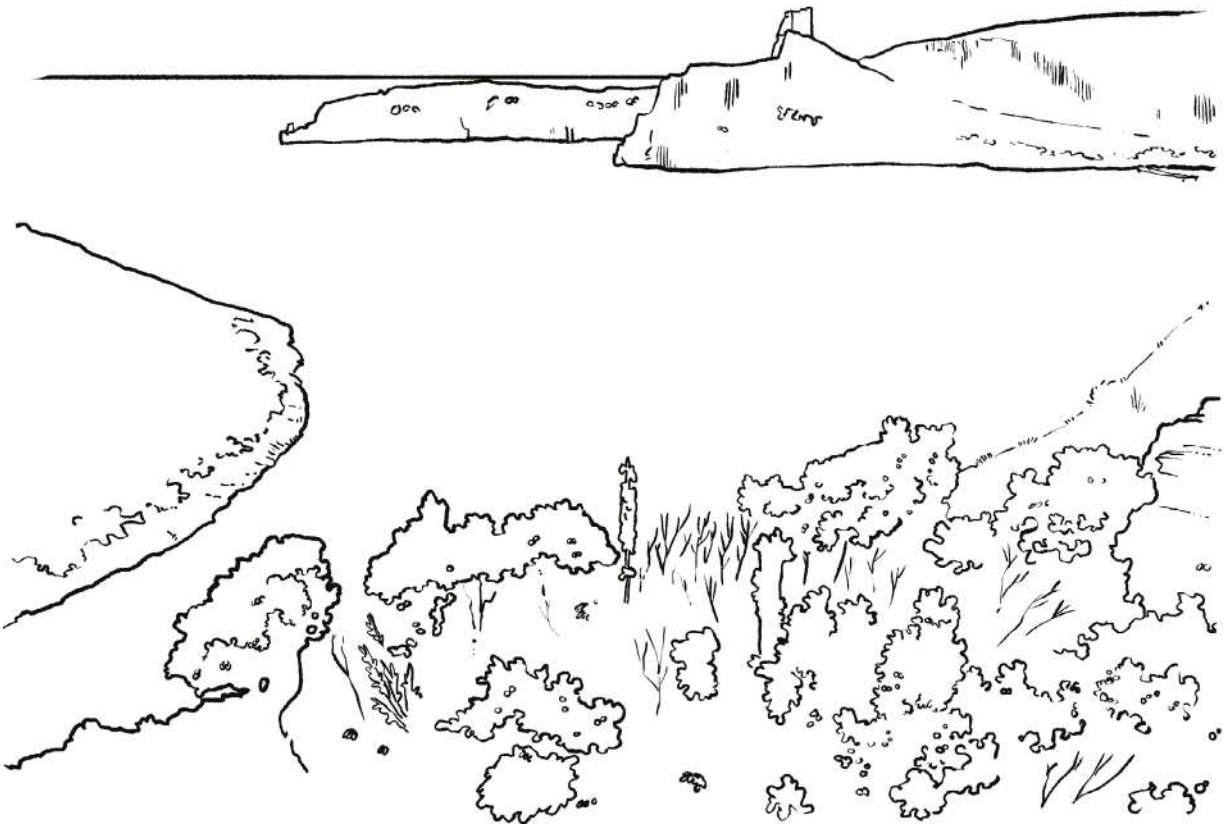
Beyond protecting the seabed and Posidonia, the buoys have gained recognition from users and paved the way for collaboration between the nautical sector and the National Park. They are safe, and all crew members can sleep peacefully. They also guarantee a certain distance between boats for peace of mind and privacy. This promotes high-quality visiting experiences, which is essential in a national park.

In addition, applying for prior authorisation guarantees visitors a mooring location. It should be noted that Cabrera is ten nautic miles away from the nearest port.
Mooring was free for the first 15 years of operation, and later, when the decision was taken to establish a usage fee based on vessel length, season and number of nights, prices were set at a low cost, which is a disincentive to apply if the visit is unsafe.

Installing such buoys was akin to "painting lines in the sea" or marking the parking spaces in a newly built car park so that users know where they can and cannot park without getting in the way or risking being towed away.

The project was designed to accommodate the boats' number, size, and position, following the same logic as the pontoons of a yacht club, with their numbered moorings and different separations according to lengths and beams. This was well understood and accepted by the boaters. The ecological and hostile bay (*Capraria, insidiosa naufragiis*, as Pliny wrote) thus became a safe and accessible anchorage for boaters. Thirty years later, it still is.

It is important to remember that these measures were taken 30 years ago. It was the first project of its kind to be carried out in the Mediterranean, and it entailed, for the first time, requesting a permit to access a natural area that had previously known no access limits.



References

Grau, A.M., J.J. Fornós, G.Mateu, P.A.Oliver i B.Terrasa (Eds). ***Arxipèlag de Cabrera. Històrtia Natural.*** Mon. Soc. Hist. Nat. Balears, 30. 736 pp. Palma

TESTIMONIAL

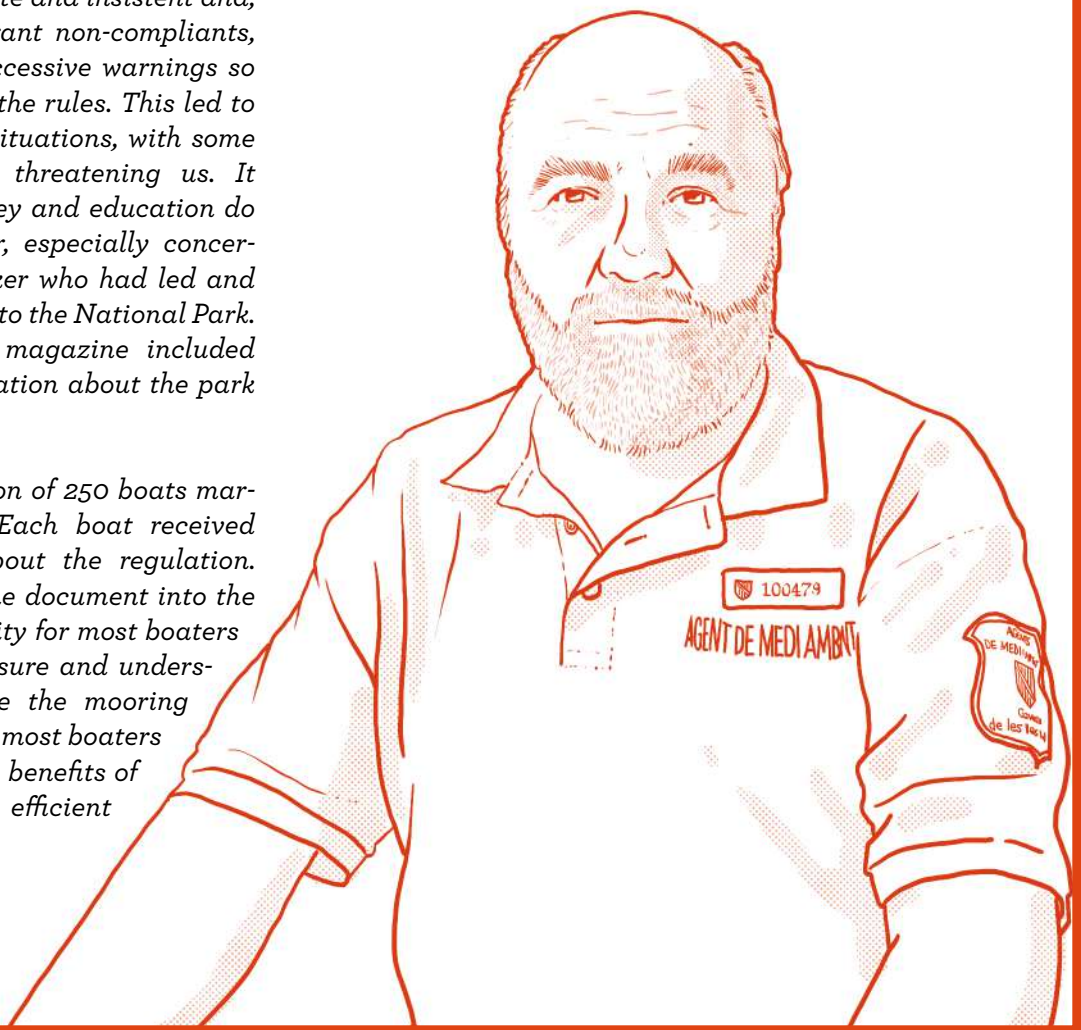
Francesc Aquareles

Environment Officer,
at Cabrera National Park
from 1991 to 2000

As one of the first persons responsible for the surveillance of Cabrera, I participated in the ecological buoy implementation project from the outset, collaborating in the search for sandy bottoms to bury the concrete blocks for the anchorages. This conditioned the layout, which could not be geometric, as it would have appeared artificial. We had to work in challenging conditions, as yacht owners would not accept having to request mooring authorisations, and the atmosphere was hostile.

The work with boaters had begun beforehand: checking authorisations and preventing anchoring in restricted areas. Our instructions were to be polite and insistent and, in the case of recalcitrant non-compliants, to pester them with successive warnings so that they would accept the rules. This led to some very unpleasant situations, with some boaters insulting and threatening us. It became clear that money and education do not always go together, especially concerning a well-known banker who had led and financed the opposition to the National Park. For years, a nautical magazine included some damaging information about the park in each of its issues.

A massive demonstration of 250 boats marked a turning point. Each boat received written information about the regulation. Although some threw the document into the sea, it was an opportunity for most boaters to learn about the measure and understand its benefits. Once the mooring buoys were operational, most boaters came to understand the benefits of a safe, organised, and efficient system.



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General bibliographic references

AGATE, E., 1983. ***Footpaths – A practical conservation handbook point.*** *British trust for conservation volunteers. Great-Britain*

BELLARD, C., GENOVESI, P. & JESCHKE, J. M., 2016 - ***Global patterns in threats to vertebrates by biological invasions.***

BELLARD, C., LECLERC, C., COURCHAMP, F., 2013. ***Impact of sea level rise on the 10 insular biodiversity hotspots . Global ecology and biogeography,*** *John Wiley & Sons Ltd edition*

BERGLUND, H., JÄREMO, J. & BENGTSSON, G., 2009.***Endemism Predicts Intrinsic Vulnerability to Nonindigenous Species on Islands.*** *Am. Nat. 174, 94–101 (2009).*

BRIGAND, L., RICHEZ, G., & RETHIERE, D., 2003.***Etude de la fréquentation touristique des îles de Port-cros et Porquerolles***

CHAPUIS J-L. & AL., 1995. ***L'éradication des espèces introduites, un préalable à la restauration des milieux insulaires. Cas des îles françaises.*** *Nature -Sciences -Société - Hors Série*

CONVENTION SUR LA DIVERSITE BIOLOGIQUE, 2010. ***La biodiversité insulaire. Canada:Programme des Nations Unies pour l'Environnement***

DESFOSSEZ, P. & VANDERBECKEN, A., 1989. ***Dialivre technique sur les sentiers. Commission économique européenne.*** *Matériaux de formation destinés aux agents techniques chargés de la gestion d'espaces naturels. France : Association ALFA, Conservatoire de l'espace littoral et des rivages lacustres.*

DESFOSSEZ, P. & VANDERBECKEN, A., 1994A. ***Chapitre 7 : Accueil de public. Manuel technique de l'agent de terrain des espaces naturels.*** *Montpellier:Atelier technique des espaces naturels, Conservatoire du littoral.*

DESFOSSEZ, P. & VANDERBECKEN, A., 1994B. ***Chapitre 6 : Technique pour l'agent. Manuel technique de l'agent de terrain des espaces naturels.*** *Montpellier : Atelier technique des espaces naturels, Conservatoire du littoral.*

DRAKE, D. R., MULDER, C. P. H., TOWNS, D. R. & DAUGHERTY, C. H. 2002.***The biology of insularity: An introduction.*** *J. Biogeogr. 29, 563–569 (2002).*

GROS-DESORMEAUX, J-R., 2012. ***La biodiversité dans des territoires insulaires, approche théorique et perspectives de développement.*** *Développement durable des territoires 3 (1):1-19*
IRD, 2009. ***Quand les espèces invasives s'invitent au Sud. Sciences au Sud,*** *Le Journal de l'IRD, N°51:4*

ISOS, 2019. ***Actes de l'Atelier technique « Protection et Valorisation des patrimoines insulaires».*** *Projet Interreg France – Italie Maritime 2014-2020.CUP n° : I46J17000050007).*

KEITT, B., CAMPBELL K.J., SAUNDERS, A., CLOUT, M.N., WANG, Y., HEINZ, R., NEWTON, K., & TERSHY, B., 2011.***The global islands invasive vertebrate eradication database : a tool to improve and facilitate restoration of island ecosystems.*** *Islands Invasive : eradication and management. Veitch C.R., Clout M.N. and Towns D.R. (eds) edition*

LHOSPITALIER, J.P., 2000. ***Catalogue des équipements (zones de compétences du Parc National de Port-Cros).****France:Parc National de Port-Cros, Ministère de l'agriculture et de la pêche.*

MYERS, N., MITTERMEIER, R.A., MITTERMEIER C.G., DA FONSECA, G.A.B., & KENT, J., 2000. ***Biodiversity hotspots for conservation priorities.****Nature 403 (24):853-858.*

NATIONS UNIES, 1982. ***Convention des Nations Unies sur le droit de la Mer.Montego Bay.***

ORUETA, J.F., 2009. ***International efforts to conserve biological diversity in islands.*** *Convention on the conservation of European wildlife and natural habitats. Strasbourg:European Council.*

ROBERTSON, P., BAINBRIDGE, I., & SOYE, Y., 2011. P***riorities for conserving biodiversity on european islands.*** *Convention on the conservation of European wildlife and natural habitats. Strasbourg:European Council.*

SAX, D. F. & GAINES, S. D., 2008 . ***Species invasions and extinction: The future of native biodiversity on islands.*** *Proc. Natl. Acad. Sci. 105, 11490–11497.*

SECRETARIAT D'ETAT D'OUTRE-MER, 2007. ***Vers un outre-mer exemplaire - Grenelle de l'Environnement -*** *Plan d'Action Outre-Mer. Paris, France : Direction des affaires économiques, sociales et culturelles de l'Outre-mer, Ministère de l'Intérieur de l'Outre-mer et des collectivités territoriales.*

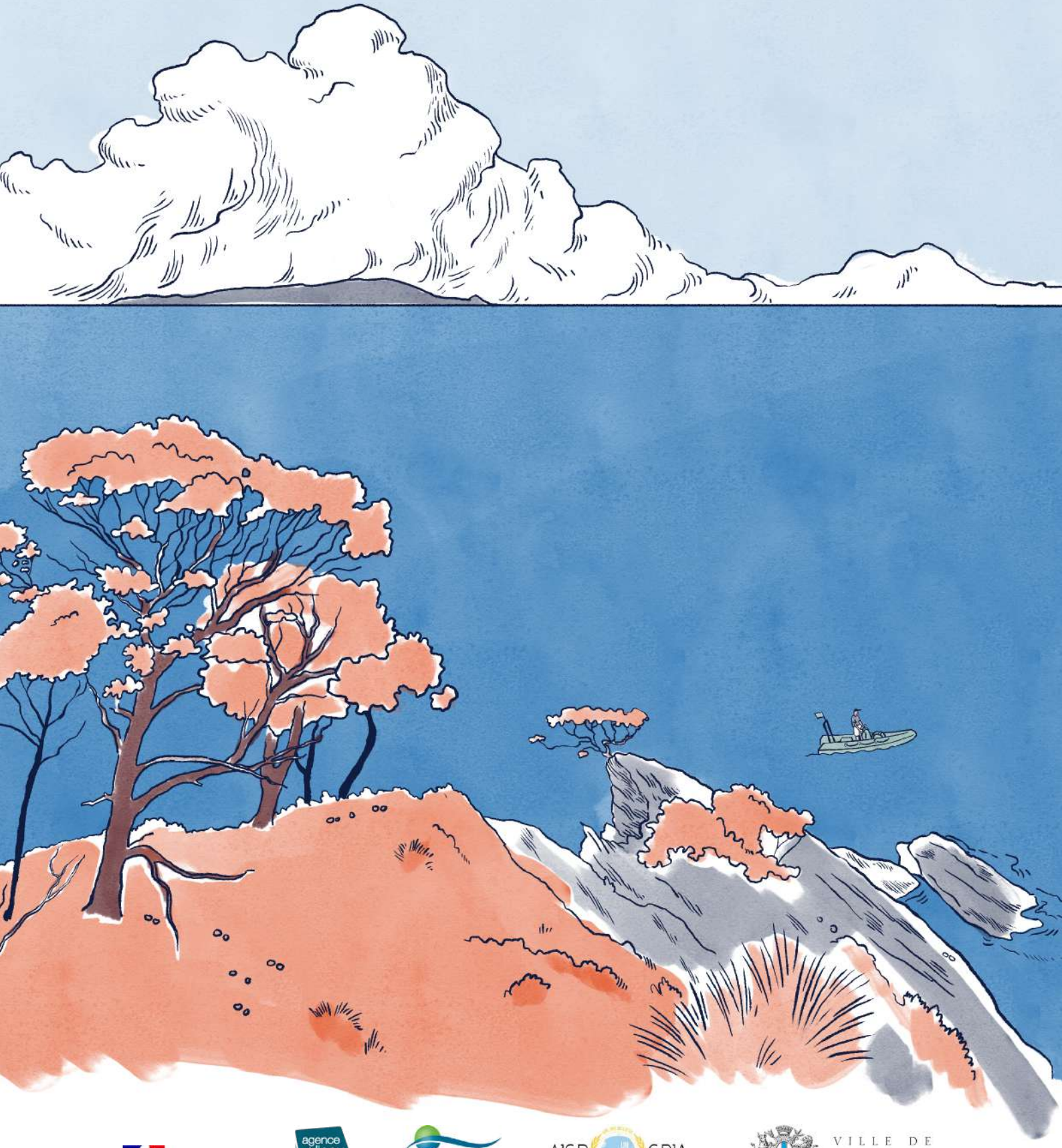
SOYE, Y., 2011.***Charte de la sauvegarde et de l'utilisation durable de la diversité biologique des îles d'Europe.*** *Comité permanent 31ème réunion. Convention relative à la conservation de la vie sauvage et du milieu naturel en Europe. Strasbourg : Conseil de l'Europe.*

SMILO, 2017.DOCUMENT DE RÉFÉRENCE 1 :***Principes stratégiques.***

WEIGELT, P., JETZ, W., KREFT, H., 2013. ***Bioclimatic and physical characterization of the world's islands. Proceedings of the national academy of sciences of the united states of America, 1-6.***

Conservatoire du littoral

INTERNATIONAL NGO FOR MEDITERRANEAN SMALL ISLANDS



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