Autonomous Region of the Azores

Regional Secretariat for the Environment and Climate Change

LIFE IP Azores Natura (LIFE17 IPE/PT/000010)

Progress Report

covering the project activities of action C8.1

Reporting Date

31/12/2021

GOVERNO DOS AÇORES | Secretaria Regional do Ambiente e Alterações Climáticas

Life IP AZORES NATURA

NATURA 2000

Life

Table of Contents

List of Tables

List of Figures

List of key-words and abbreviations

DLR	Decreto Regulamentar Regional (Regional Regulatory Decree)
ha	Hectares
IAS	Invasive Alien Species
POBHL	Plano de Ordenamento das Bacias Hidrográficas das Lagoas (Lagoon Basin Management Plan)
SPA	Special Protection Area
SAC	Special Area of Conservation

1. Technical part

Action C8 of the LIFE IP Azores Natura project (Implementation of IAS control works in terrestrial restored habitats) includes the implementation of works to control invasive species of plants (sub-action C8.1) and animals (sub-action C8.2). This report presents the works carried out within sub-action C8.1 up to the end of Phase I.

Sub-action C8.1 – Control and eradication of IAS plant species in terrestrial restored habitats

This sub-action specifies a set of flora control methods in the project's target areas and focuses on the main IAS species encountered in each area. Planning of the specific tasks commenced in April 2020, after the Technical Assistant to the Project Manager was contracted. As a first step, all intervention areas were visited and an exhaustive list of the present flora species was compiled. Operational Plans were subsequently devised per island, establishing the concrete IAS control works to be implemented in each of the intervention areas. The present report will describe the activities carried out up until 31 December 2021, specified separately for each island, including mapping of all interventions.

An online database was created, where the Nature Wardens in charge of supervising the control works carried out by the Operational Assistants register all IAS control interventions:

Base de dados_remoção de invasoras_LIFE IP.xlsx

The following table provides an overview of the total area intervened on each island:

Table 1. Total intervened area (in hectares) per island.

Island	Intervened area (ha)
Corvo	10
Faial	0,31
Flores	0,68
Graciosa	1,88
Pico	8,5
Santa Maria	0,54
São Jorge	0,69
São Miguel	32,81
Terceira	36,9
Total:	**92,31**

Corvo

Operational Assistants on Corvo Island spent a total of 12 working days removing foci of invasive species. Priority was given to those species that are spreading across the island, but have not yet reached the Caldeirão of Corvo. In total, 110 individuals of *Solanum mauritianum* and 240 individuals of *Hedychium gardnerianum* were removed in a total area of 10 hectares (Figure 1). While *Solanum mauritianum* was removed mechanically including the root system (Figure 2), the cutting of *Hedychium gardnerianum* was followed by the application of herbicide to the rhizome (Figure 3).

Figure 1. Mapping of the control intervention of *Hedychium gardnerianum* and *Solanum mauritianum* on Corvo Island, August 2021.

Figure 2. Mechanical removal of *Solanum mauritianum* individuals, August 2021, Corvo Island.

Figure 3. Mechanical removal of *Hedychium gardnerianum*, August 2021, Corvo Island.

Flores

On Flores Island, 4 000 kg of *Hedychium gardnerianum* were manually removed in an area of 6000 m^2 in the Lagoa Branca intervention area in October 2021, with 5 Operational Assistants dedicating three weeks (15 working days) to this task (Figure 4 and 5). The removed biomass was buried and covered with soil, in order to avoid resprouting or contamination of other areas. Given that the Lagoa Branca intervention area is entirely within the lagoon's hydrographic basin (POBHL - Lagoon Basin Management Plan, DLR no. 6/2013/A), the use of chemicals in the control of invasive species is not permitted. This increases the difficulty of controlling the highly proliferate ginger lily *Hedychium gardnerianum*, requiring the removal of the whole root system, and continuous maintenance to control the regeneration that originates from the seed bank, rhizomes accidentally left behind or sections of roots that have broken off during the removal of individuals.

Please note that the nuclei of *Hedychium gardnerianum* outlined in Figures 4 and 5 are the areas covered by this species that are visible from the air. The species is, however, also widely distributed underneath the shrub canopy.

Figure 4. Aerial photo of the intervened area, indicating some of the ginger lily nuclei (light blue polygons), January 2022, Flores Island.

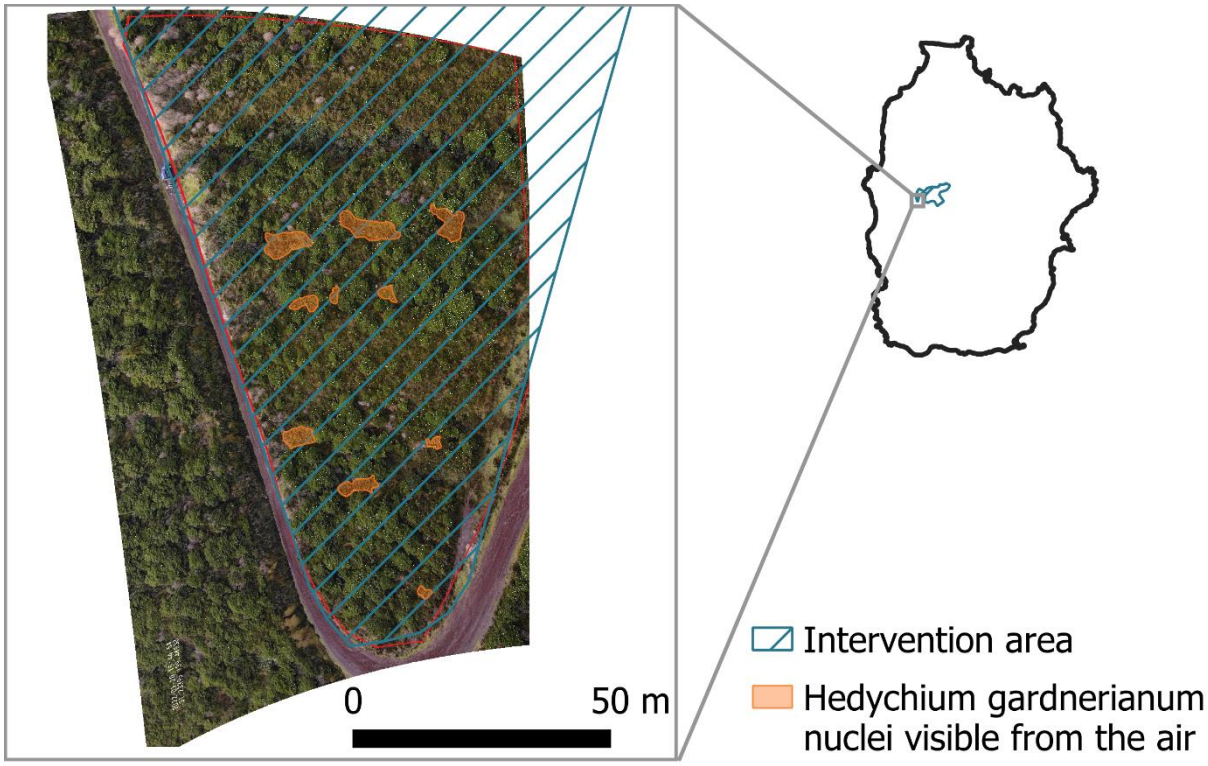

Figure 5. Mapping of the control intervention of ginger lily, October 2021, on Flores Island.

Graciosa

On Graciosa Island, Operational Assistants spent a total of 12 days between August and December 2021 removing *Tetragonia tetragonoides* from Baixo Islet, and *Arundo donax*, *Carpobrotus edulis*, *Hedychium gardnerianum*, *Rubus ulmifolius*, and *Tetragonia tetragonoides* from the intervention areas on the main island of Graciosa.

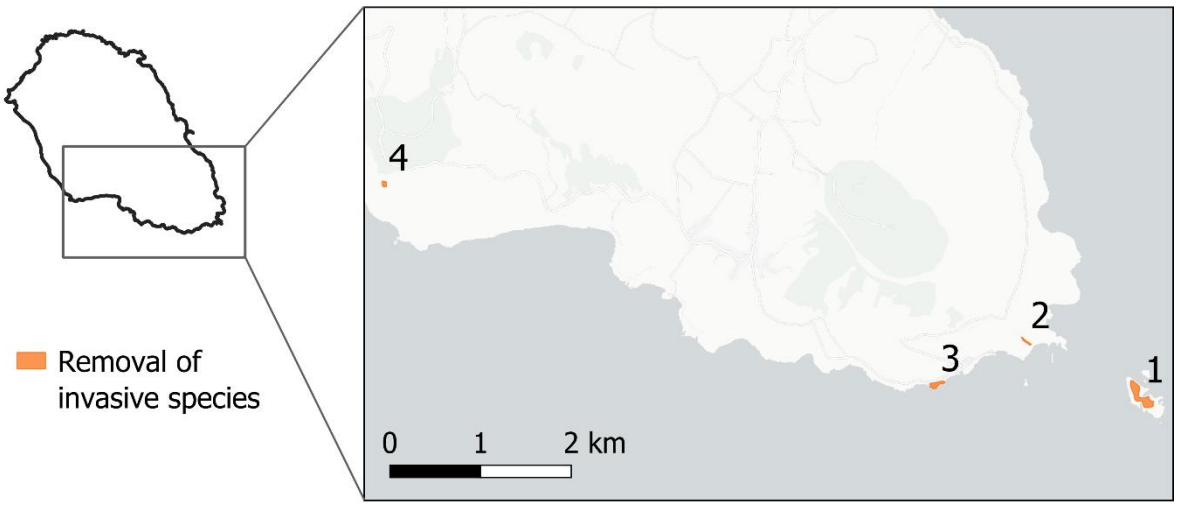

Figure 6. Mapping of the control interventions of invasive species on Graciosa Island in 2021.

On Baixo Islet (area 1 in Figure 6), 80 m^3 of *Tetragonia tetragonoides* were removed mechanically in an area of 3000 m^2, piling up the removed biomass. After a drying period of several weeks, and given the difficulty of transporting the biomass from the islet to the main island, the biomass was burned. Given the large volume of biomass removed in the Ponta da Restinga area (area 2 in Figure 6; Figures 8 and 9), namely 50 m^3 of *Carpobrotus edulis* and 1 m^3 of *Arundo donax* in an area of 1 696 m^2, the plant material was left on site to dry, given that its volume and difficult access to the area did not allow it to be moved and delivered to the waste centre. After a drying period, it will also be burned, thereby also destroying the seedbank.

Due to their difficult access, the same approach was applied in the two other mainland areas in which interventions occurred, namely the Carapacho area (area 3 in Figure 6, Figure 7), where 20 m^3 of *Carpobrotus edulis* and 2 m^3 of *Tetragonia tetragonoides* were removed in an area of 1 120 m^2, and the Serra Branca (area 4 in Figure 6), where 200 kg (approx. 10 m^3 in an area of 2 490 m^2) of *Hedychium gardnerianum* and *Rubus ulmifolius* were removed.

During the volunteer camp that was carried out on Graciosa Island in July 2020 within the frame of action E5, an additional 1.045 ha were intervened in various areas of the island, targeting *Carpobrotus edulis*, *Tetragonia tetragonoides*, *Arundo donax*, *Rubus ulmifolius*, and *Hedychium gardnerianum*.

In Ponta da Barca, Graciosa, tests were carried out on *Tamarix africana*, to see its response to drilling and injecting with glyphosate. Depending on the results of these tests, this method will be used on Praia Islet to eradicate *Tamarix africana*, which is expanding and limiting nesting habitats for seabirds.

Figure 7. Mechanical removal of *Carpobrotus edulis*, October 2021, Graciosa Island.

Figure 8. Mechanical removal of *Carpobrotus edulis*, Ponta da Restinga, Graciosa Island, September 2021.

Figure 9. Part of the removed *Carpobrotus edulis* biomass, Ponta da Restinga, Graciosa Island, September 2021.

São Jorge

On São Jorge Island, invasive species removal has been concentrated on the intervention area in Fajã dos Cubres. Figure 10 depicts the area around the Cubres lagoon where an area of 1 735 m^2 covered by *Rubus ulmifolius* and an area of 822 m^2 covered by *Arundo donax* were cleared by three operational assistants in July 2021. Furthermore, a continuous expansion of *Juncus acutus* was evidenced, given that the area covered by this species increased by 21%, from 1.2 ha in 2012 to 1.5 ha in 2020. This expansion was controlled by clearing am area of 4 381 m^2 of *Juncus acutus*, in order to open up clearings for endemic species such as *Solidago azorica*. A brush cutter was used for the intervention; however, care was taken to leave the widely dispersed individuals of endemic and autochthonous species intact (Figure 11).

Since the first intervention, several maintenance interventions have taken place, to control the regrowth of the invasive species.

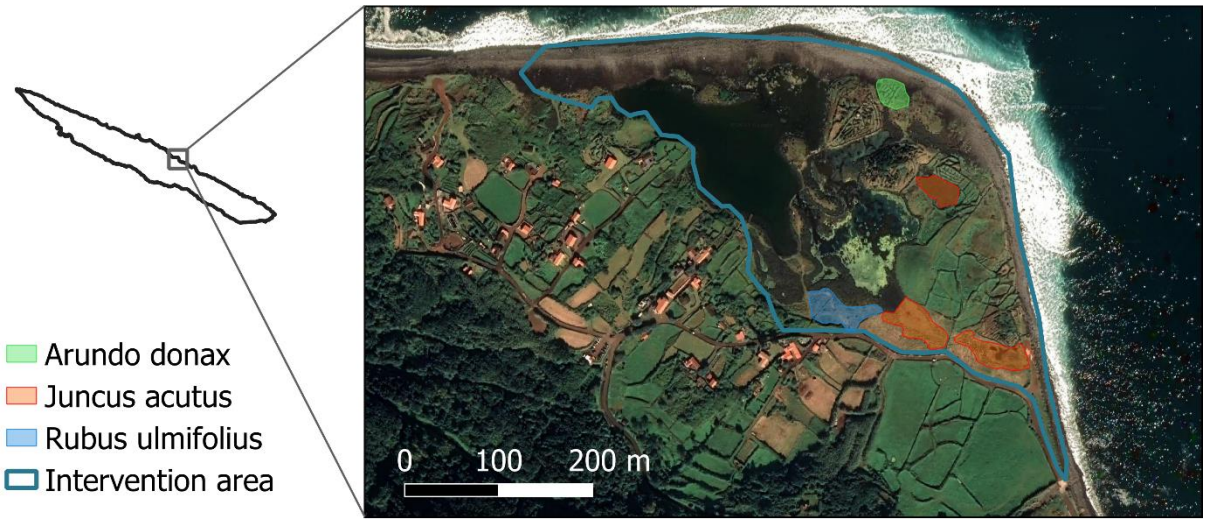

Figure 10. Mapping of the control interventions of invasive species in Fajã dos Cubres, São Jorge Island, in 2021.

Figure 11. Removal of *Juncus acutus* in the Fajã dos Cubres, in order to open space for *Solidago azorica* to reproduce.

Pico

Invasive species control on Pico Island began with the first volunteer camp (action E5) in September 2020, during which 750 kg of the exotic *Cryptomeria japonica* were removed (Figure 13). This intervention took place in a forest stand of 4.3 ha in the Caveiro intervention area and covered an area of 4 000 m^2 (Figure 12). The area was already target of drill & inject interventions in 2009, 2011 and 2012. However, some of the trees survived the treatment with glyphosate, wherefore more interventions will have to take place in order to remove the remaining seeding individuals and all of the natural regeneration.

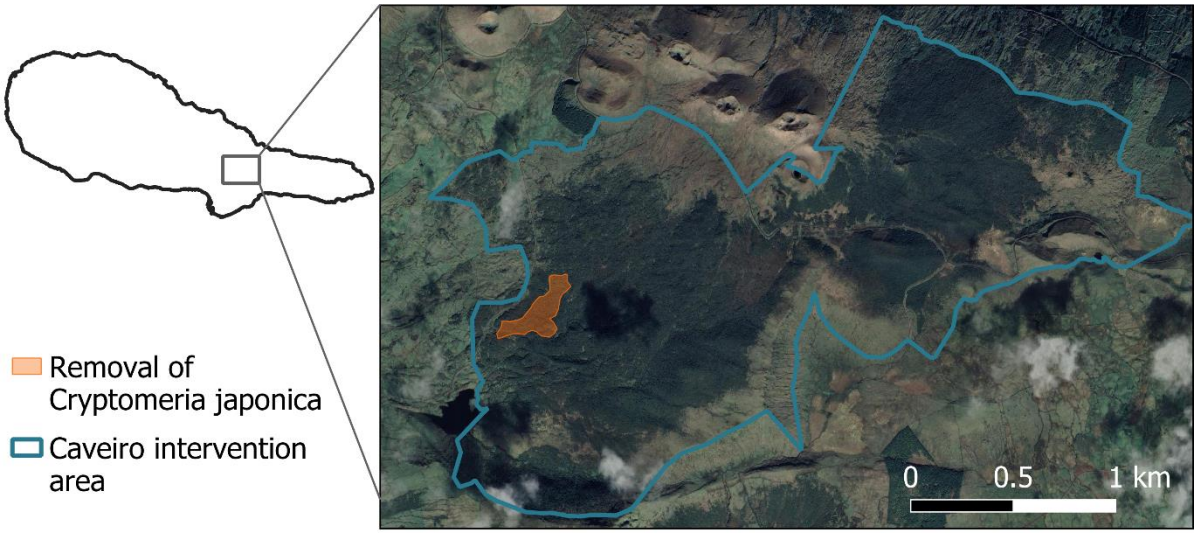

Figure 12. Mapping of the control interventions of *Cryptomeria japonica* on Pico Island in 2020.

Figure 13. Cut *Cryptomeria japonica* biomass ready for transport to the green waste collection centre, Pico Island, September 2020.

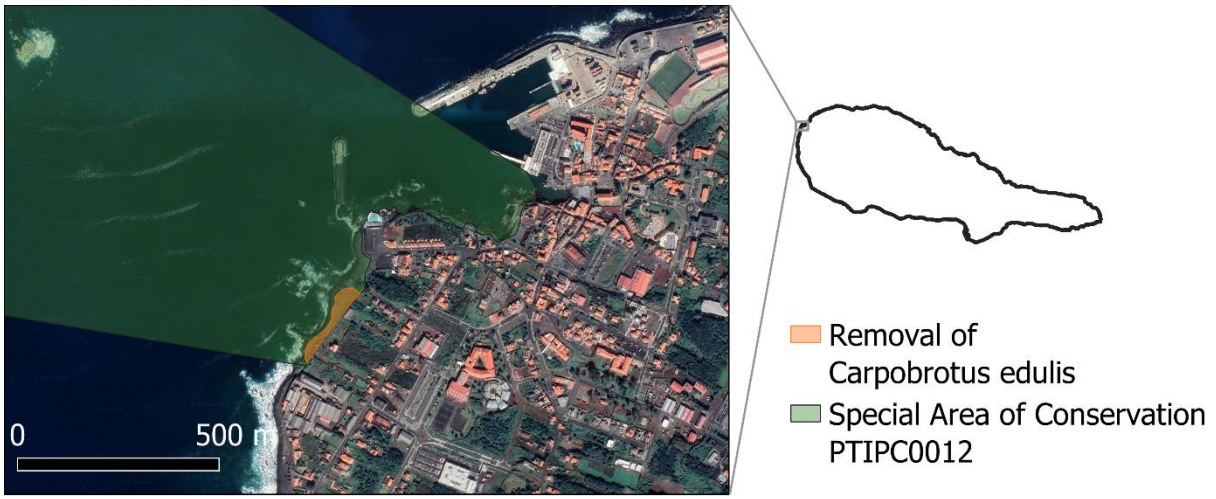

Figure 14. Mapping of the control interventions of *Carpobrotus edulis* in SAC PTPIC0012 on Pico Island in 2020.

During the same volunteer camp, an area of 1 000 m^2 within the SAC PTPIC0012 was cleared of *Carpobrotus edulis* and in an area of 150 m^2, *Tamarix africana* was pruned (Figures 14 and 15). The removal of invasive species was followed by planting 154 *Festuca petraea*, 148 *Erica azorica*, 12 *Solidago sempervirens*, 7 *Azorina vidalii* e 2 *Morella faya*, in order to reduce the area available for reinvasion by invasive species.

Figure 15. Removal of *Carpobrotus edulis* in the Special Area of Conservation PTPIC0012, Pico Island, September 2020.

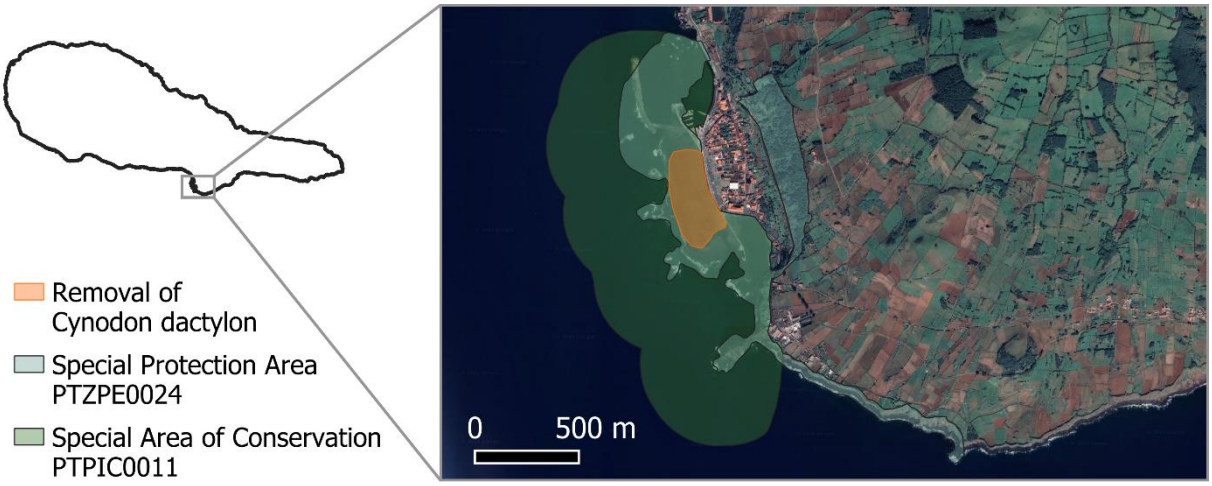

Figure 16. Mapping of control interventions of *Cynodon dactylon* in SPA PTZPE0024 and SAC PTPIC001 on Pico Island in 2020.

Within the Special Protection Area PTZPE0024 and the Special Area of Conservation PTPIC0011 in the township of Lajes do Pico, on Pico Island, the 15 volunteers removed 345 kg of the invasive grass *Cynodon dactylon* from an approximate total area of 8 hectares (Figures 16 and 17).

Figure 17. Manual removal of *Cynodon dactylon* in the Special Area of Conservation PTPIC0011, Pico Island, September 2020.

Faial

On Faial Island, invasive species control has been concentrated on the Ribeira da Lomba watercourse that crosses the intervention area south of the Caldeira (Figure 18). Between July and September 2021, 4 Operational Assistants spent a total of 31 days clearing 3 076 m^2 of 19 m^3 of *Hydrangea macrophylla* which had invaded and was obstructing the stream bed (Figure 19). Given the location of the intervention, all works were carried out mechanically with the help of machinery, but without chemicals.

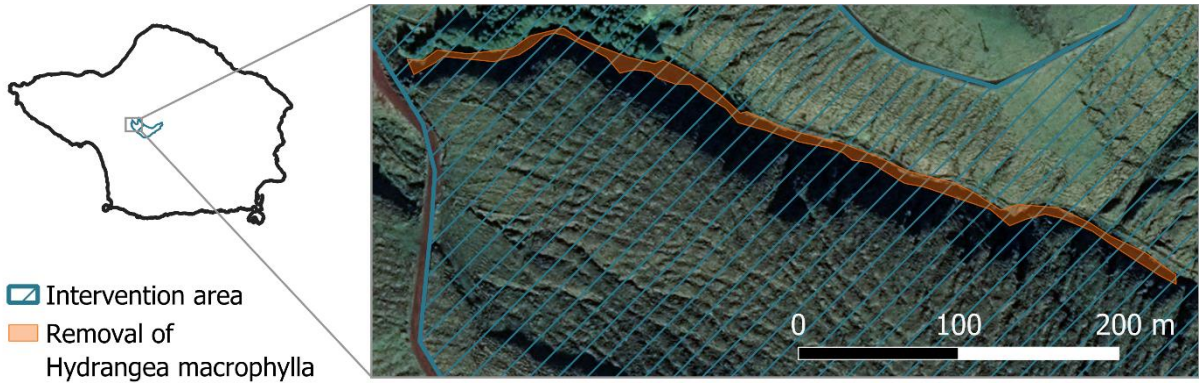

Figure 18. Mapping of control interventions of *Hydrangea macrophylla* on Faial Island in 2021.

Figure 19. Before (June 2020) and after (August 2021) hydrangea control interventions in Ribeira da Lomba, Faial Island.

Terceira

Terceira Island had by far the biggest investment into invasive species control in terms of area (36.9 hectares). More than 80 working days have been invested by teams of up to 11 Operational Assistants in exotic/invasive species control interventions in five of the project's intervention areas: Turfeira da Lomba, Lagoa do Negro, Vale da Vinagreira, Quinta da Madalena, and Pico Alto e Tamujal 3.

In Turfeira da Lomba, *Cryptomeria japonica* eradication started in October 2020 and is expected to be concluded during the winter of 2021/2022. Small and medium sized trees were felled and the exposed surface of the cut immediately brushed with a mix of phytopharmaceuticals and food colouring, in order to leave a visible mark on the stumps that had already been treated. Altogether, 18 627 *Cryptomeria japonica* trees were removed between October 2020 and January 2022, in a total area of 16.52 hectares (Figure 20). Larger individuals were killed using the drill and inject method (Figure 21). The accumulating biomass was removed from the area whenever possible, and smaller branches were shredded on site (Figure 22). The intervened area will be left to regenerate naturally. Only where removal of *Cryptomeria japonica* created clearings larger than 200 m^2, will plantings of native species be carried out, utilizing seeds collected in the area.

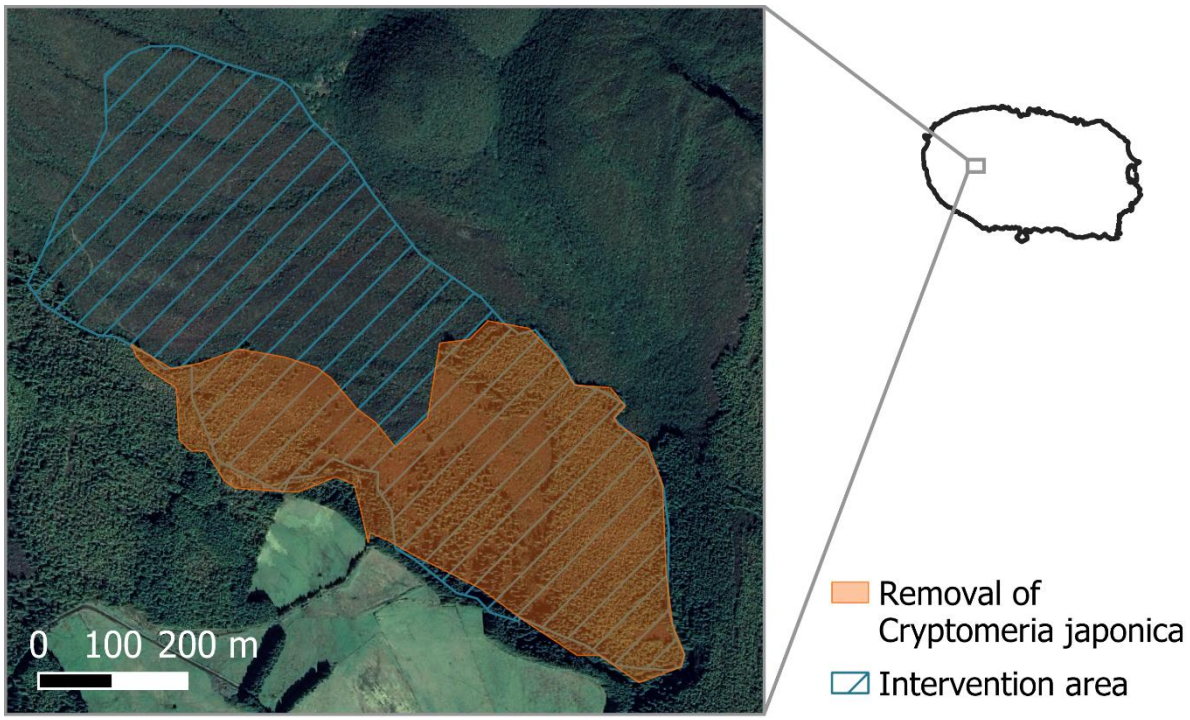

Figure 20. Areas of *Cryptomeria japonica* removal in the Turfeira da Lomba intervention area, Terceira Island, between October 2020 and January 2022.

Figure 21. *Cryptomeria* biomass collected for shredding, and larger trees killed using the drill & inject method in the background, Turfeira da Lomba, Terceira Island, July 2021.

Figure 22. On-site shredding of smaller branches of *Cryptomeria japonica*, Turfeira da Lomba, Terceira Island, September 2020.

In the Lagoa do Negro intervention area, a total of 9 439 *Cryptomeria japonica* trees has been cut or killed using the drill and inject method between March and September 2021 (Figure 25). Furthermore, 30 C*yathea cooperi* were cut, *Rubus ulmifolius* was controlled by spraying with herbicide (Figure 24), and *Hedychium gardnerianum* by cutting into the rhizomes and applying herbicide. The intervened area has a size of 9.1 hectares (Figure 23).

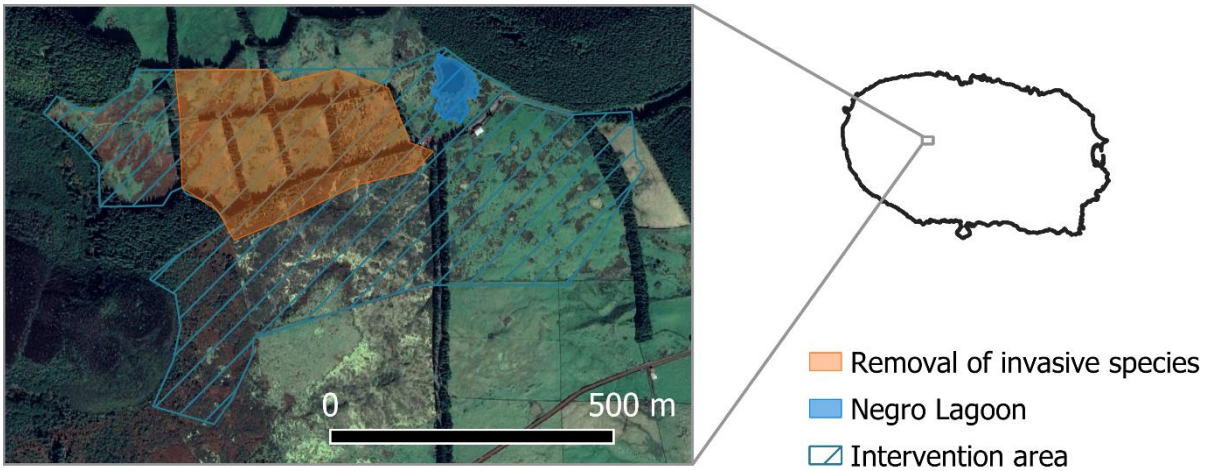

Figure 23. Mapping of control interventions in the Lagoa do Negro intervention area, Terceira Island, 2021.

Before: green areas of *Rubus ulmifolius*, May 2020

After: brown areas of cut/sprayed *Rubus ulmifolius*, September 2021

Before: green areas of *Rubus ulmifolius*, June 2020

After: brown areas of cut/sprayed *Rubus ulmifolius*, September 2021

Figure 24. Before (2020) and after (2021) the invasive species control interventions in Lagoa do Negro, Terceira Island.

Figure 25. Aerial photo of the area where *Cryptomeria japonica* was killed using the drill & inject method.

During the planting season of 2021/2022 (during the winter and spring months), *Prunus lusitanica* subsp. *azorica*, which has been propagated using in-vitro tissue cultures from Terceira's natural population, will be planted in the intervened area in Lagoa do Negro. The 300 plants are currently being transported from Faial to Terceira.

In the Vale da Vinagreira intervention area, 16 individuals of *Cryptomeria japonica* natural regeneration, and 14 individuals of *Acacia melanoxylon* were removed in March 2021. Large individuals were killed with the drill & inject method, whereas smaller individuals were cut and the stump sprayed with herbicide. The total intervened area in Vale da Vinagreira sums up to 3 208 m^2 (Figure 26).

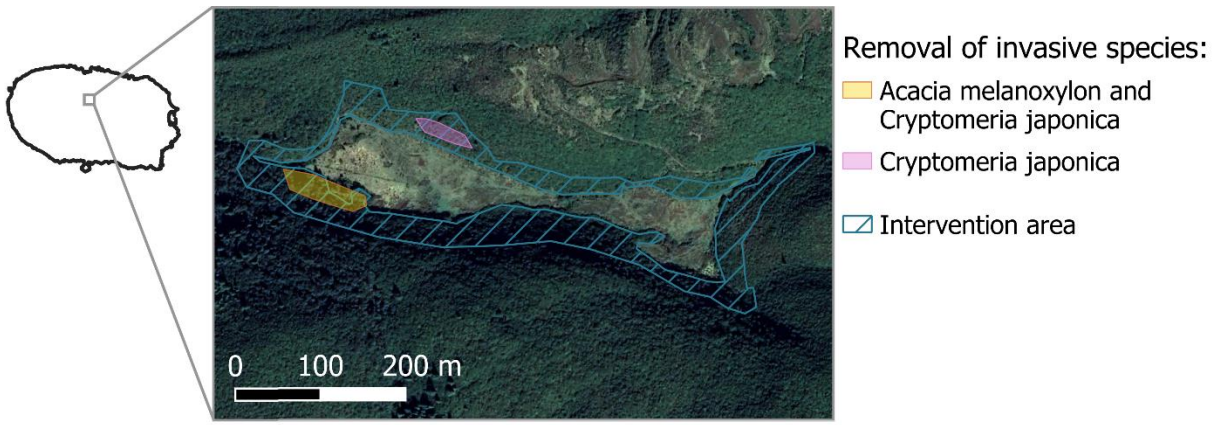

Figure 26. Mapping of control interventions in the Vale da Vinagreira intervention area, Terceira Island, 2021.

In the Quinta da Madalena area, a total of 335 *Cryptomeria japonica* trees (natural regeneration) were killed using the drill and inject method in October 2021. Currently, a hedge consisting of 133 *Cryptomeria japonica* trees remains in the area, for which the request to cut the trees has to be formally made to the Forestry Services of Terceira Island. Furthermore, 10 *Acacia melanoxylon*, 44 *Pittosporum undulatum*, and 1 *Metrosideros excelsa* were removed by cutting, spraying the stumps with herbicide, and removing their biomass. The total intervened area has a size of 1,75 hectares (Figure 27).

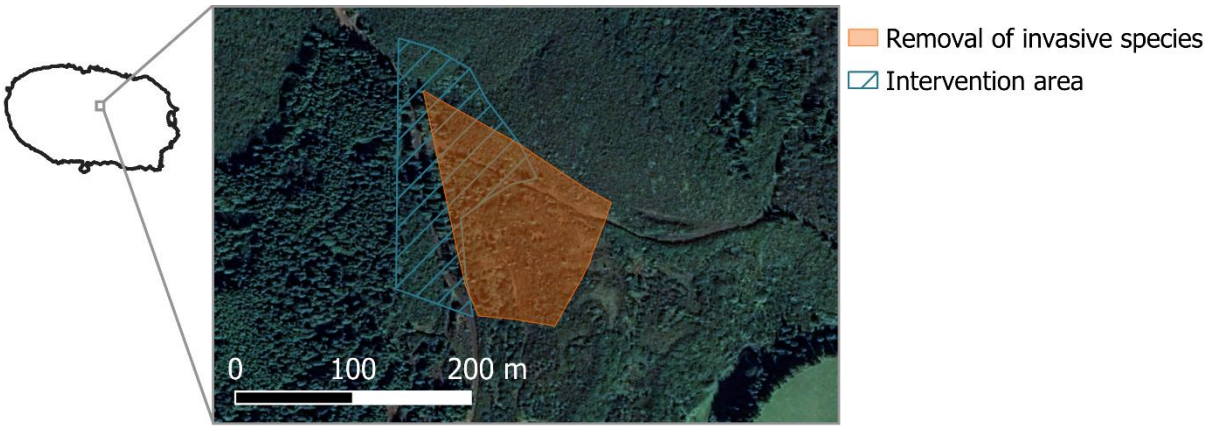

Figure 27. Mapping of control interventions in the Quinta da Madalena intervention area, Terceira Island, 2021.

In the intervention area "Pico Alto e Tamujal 3", some 500 *Eucalyptus nitens* trees have been cut in an area of 8,9 hectares (Figure 28). This required 17 working days with 8 Operational Assistants. Work in this area is ongoing. Given the existence of a thick undergrowth of native species (Figure 29), the removal of *Eucalyptus nitens* will be sufficient to restore the natural habitat of the area.

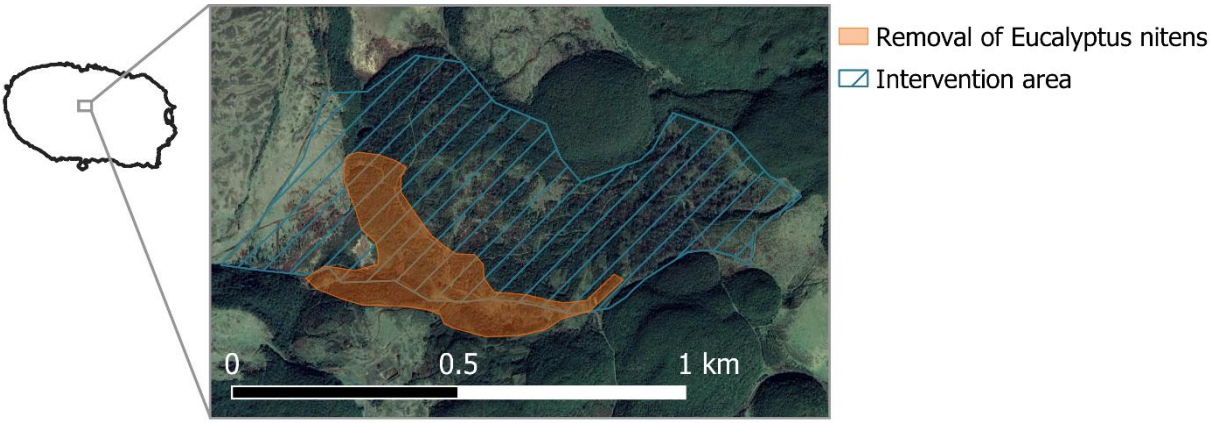

Figure 28. Mapping of control interventions in the Pico Alto e Tamujal 3 intervention area, Terceira Island, 2022.

Figure 29. View of the "Pico Alto e Tamujal 3" intervention area with *Eucalyptus nitens* in the upper canopy, and thick undergrowth of native species, Terceira Island, 2022.

São Miguel

The island of São Miguel features the second biggest investment into invasive species control, with a total of 67 days spent intervening in a total area of 3.51 hectares. Forty-six of those working days were devoted to the Lagoa do Fogo intervention area, where a team of 4-6 operational assistants removed *Rubus ulmifolius*, *Acacia melanoxylon*, *Hedychium gardnerianum*, *Dicksonia antarctica*, and *Cryptomeria japonica* in an area of 3.43 ha (Figure 30). The removed biomass remained onsite due to the remoteness of the area, and was arranged in lines (Figure 31). The planting of 16 000 woody plants (2 000 *Viburnum treleasei*, 5 000 *Erica azorica*, and 2 000 *Vaccinium cylindraceum*, 2 000 *Prunus lusitanica* subsp. *azorica*, and 5 000 *Frangula azorica*), which are ready to be provided by the island's Forestry Services, is planned to take place in spring 2022. Furthermore, 10 individuals of *Cortaderia selloana* were detected in the Lagoa do Fogo area (outside of the intervention area, Figure 30), with a total volume of 1.5 m^3. These have successfully been removed, thereby evading a massive expansion of this highly proliferous species. The area will be continued to be monitored in order to eradicate any individuals that might appear in the future.

Besides the control works carried out in the intervention area in Lagoa do Fogo, localized foci have also been removed. In September 2021, our networking partners from invasoras.pt (action E3) alerted us to the discovery of the highly invasive species *Pueraria lobata* in Furnas, São Miguel, a species that had not yet been recorded in the Azores archipelago. Within weeks, the invaded area of approximately 80 m^2 was cleared by the project's Operational Assistants, removing 7 m^3 of biomass. Nature Park staff are now sensitised to the detection of this species, and will be able to respond rapidly in future, should further foci be discovered.

Furthermore, 341 m^2 were cleared of *Osteospermum* sp. in the Fajã do Araújo, 395 m^2 of *Drosanthemum floribundum* and *Carpobrotus edulis* in the Ponta da Galera / Caloura area, and 59.4 m^2 of *Hedychium gardnerianum* in the Cumeeiras das Sete Cidades area, where the endemic *Chaerophyllum azorica* was planted after removing the invasive flora.

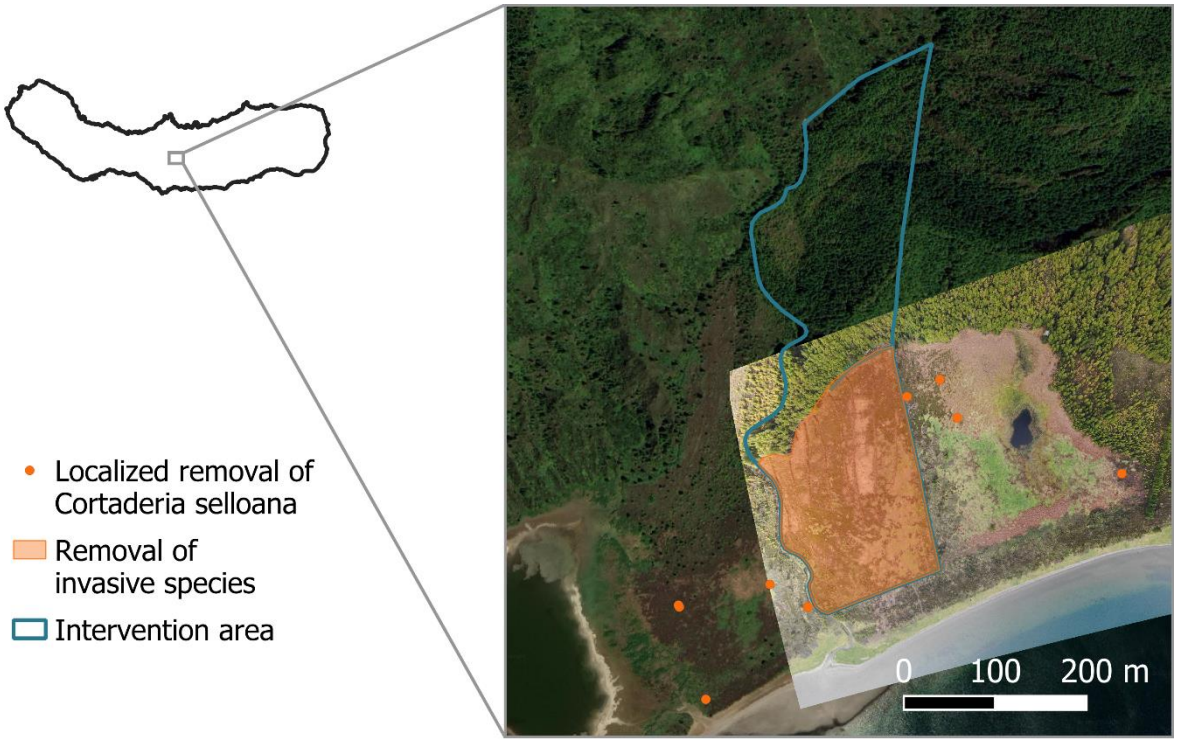

Figure 30. Mapping of control interventions of invasive species in Lagoa do Fogo, São Miguel Island, between July and December 2021.

Figure 31. Aerial photo of the area cleared of invasive species in Lagoa do Fogo, São Miguel, with the removed biomass piled up in lines.

Within the intervention areas coordinated by SPEA, IAS control was carried out in Mata dos Bispos prior to the restoration of the water streams and priority habitats (action C4.3). IAS control in this area started in July 2019. *Pittosporum undulatum* trees were controlled in the entire area (29.3 hectares), with a total of 1 909 trees killed by injection with glyphosate. Most trees remained standing in order to provide support for the soil during the establishment of the native species plantings. However, in the water lines and steeper areas, *P. undulatum* trees were logged and the wood was used to build natural engineering structures to improve soil retention and reduce erosion (Figure 32). The chemical control of *Hedychium gardnerianum* and *Clethra arborea* was conducted in an area of 11.5 hectares. In order to avoid water contamination, manual methods were applied in the waterlines and margins. Additionally, forest logging with heavy machinery was used to extract trees of *Acacia melanoxylon* and *Cryptomeria japonica* in an area of 3 hectares. The logged wood was either used *in-situ* for the building of natural engineering structures or removed and sent to a logging company to be processed and prepared for the construction of the walkways that will be built within the frame of sub-action C14.2. The remaining wood was destroyed with the help of a mechanical chipper, or through controlled burning. As of February 2022, 41 248 native woody plants have been planted in this area (6 482 *Picconia azorica*, 2 792 *Prunus azorica*, 4 475 *Laurus azorica*, 10 367 *Morella faya*, 6 072 *Erica azorica*, 1 040 *Juniperus brevifolia*, 2 400 *Viburnum treleasei*, 3 760 *Frangula azorica*, 3 050 *Myrsine retusa* and 810 *Ilex perado* subsp. *azorica*). A monitoring system, started in July 2019, is being carried out to evaluate the efficacy of IAS control and plant survival.

Figure 32. Intervention in a *P. undulatum*-dominated forest in four different stages 1: *P. undulatum* control with drill & inject method (above, left); 2: IAS control in the undercover and clear cut of *P. undulatum* (above, right); 3: Slope stabilization through natural engineering (below, left); 4: Area planted with native species (below, right).

On Vila Islet, interventions to control the proliferating New Zealand spinach *Tetragonia tetragonoides* began in July 2021, with the clearing of a small area of about 300 m^2 (Figure 33). However, it was quickly evidenced that the removal of New Zealand spinach caused elevated erosion rates, due to the loose substrate on the island. It was therefore decided that the removal would continue in strips along the contour lines of the islet, starting from the top, sowing fast growing native species and planting *Festuca petraea* in order to stabilize the soil. As sufficient seeds were not available at the time, works will continue with seed collection during the 2022 seeding season and propagation of the seeds collected during the previous year. Starting in September/October, invasive species control works will continue, followed by immediate sowing/planting in the cleared area. The size of the area in which IAS will be removed will be adapted to the quantity of plants and seeds available at the time.

It is worth noting that access to Vila Islet is highly restricted. First of all, it is dependent on the legal registration process of the vessel acquired within the frame of action C6.1, being completed, which will be in early 2022. Furthermore, the islet can only be accessed with this vessel in completely calm sea conditions, which hinders the continuous implementation of works on the islet.

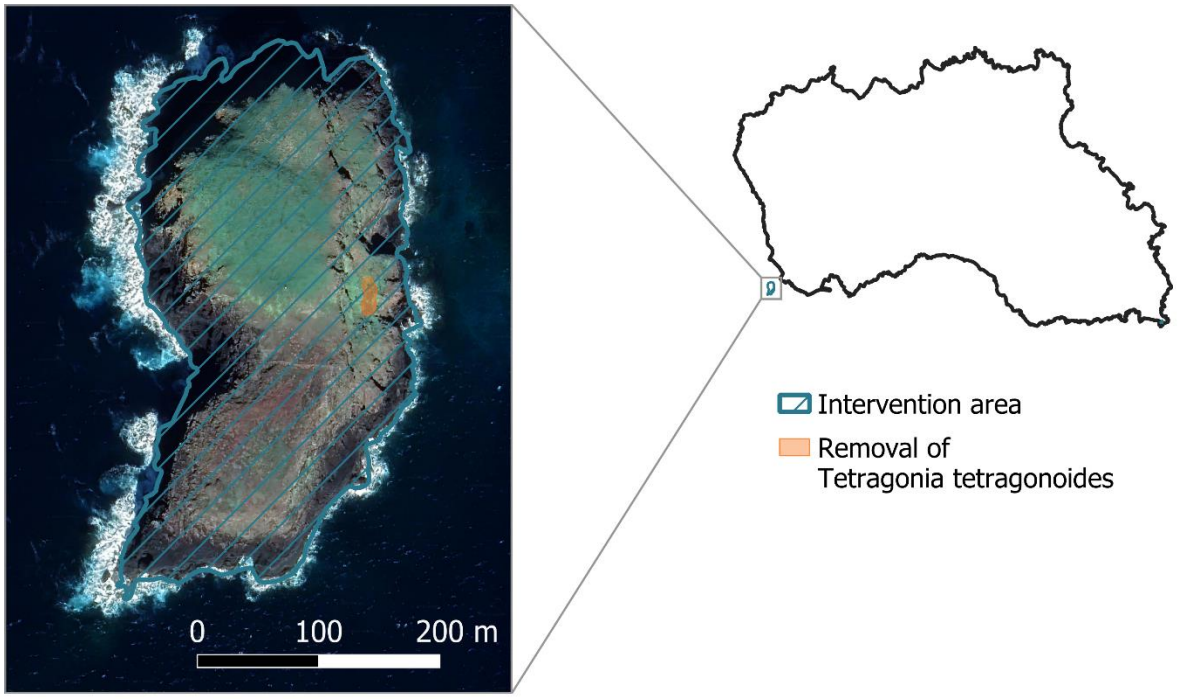

Figure 33. Mapping of control interventions of *Tetragonia tetragonoides* on Vila Islet, Santa Maria Island, in July 2021.

In the Ponta do Castelo area (Figure 34), two volunteer camps have taken place so far. During the first one, organized in April 2019 by the company *Desafio das Letras* within the frame of the LIFE IP Azores Natura project, volunteers spent 10 days removing *Agave americana* from an area of approximately 5 138 m^2.

In November 2020, the second volunteer camp took place, within the frame of action E5 of the LIFE IP Azores Natura project (Public engagement and volunteering program). Fourteen volunteers and several Operational Assistants of Santa Maria's Department for the Environment and Climate Change collaborated to remove the invasive *Agave americana* and *Carpobrotus edulis* from the same area as the first volunteer camp (5 138 m^2).

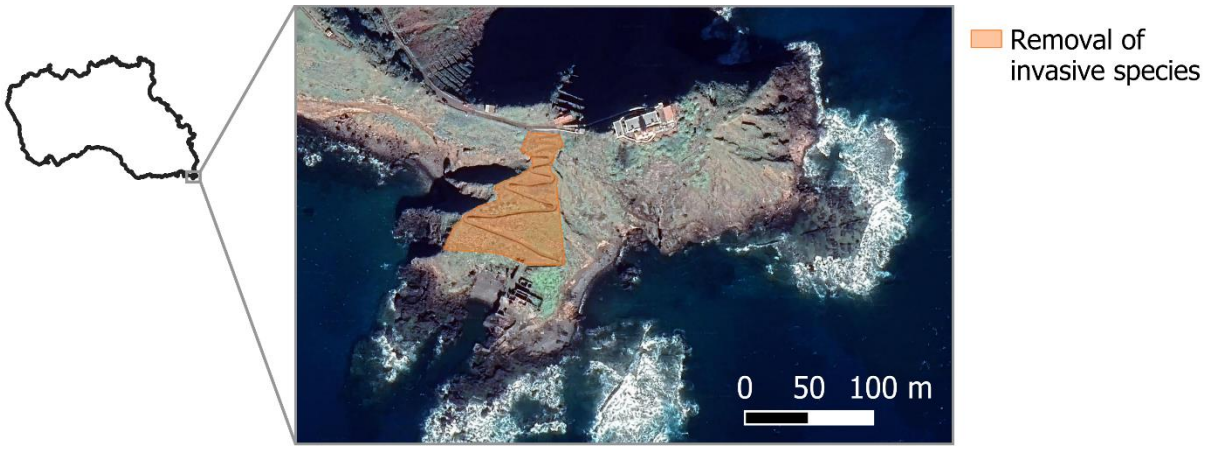

Figure 34. Mapping of control interventions in the Ponta do Castelo area, Santa Maria Island, between 2019 and 2021.

The intervention was continued in the same area by staff of Santa Maria's Department for the Environment and Climate Change in September 2021, during which approximately 12 000 kg (corresponding to about 32 m^3) of *Agave americana* were removed.

2. Overall progress

Overall progress of the implementation of sub-action C8.1 is well within the timeframe defined in the project, and so far, all due milestones and deliverables have been achieved (Table 2).

Table 2. Milestones and deliverables for sub-action C8.1.

Milestone	Due date	Achieved
1st control intervention	31/12/2020	✓
1st interventions in all areas accomplished	31/12/2021	✓
Reduction by 50% of the negative impact of IAS flora on bird and flora species, as well as in habitats on island intervention areas and islets	31/12/2022	
No adult/mature individuals of IAS flora present in intervened areas	31/12/2027	
Deliverable		
Photos and maps evidencing the different implemented control techniques	31/12/2020	✓
Sub-action report to be delivered together with Phase I report	31/12/2021	✓
Sub-action report to be delivered together with Phase II report	31/12/2023	
Sub-action report to be delivered together with Phase III report	31/12/2025	
Final report	31/12/2027	

The first milestone (1st control intervention) was achieved in September 2020, thus well ahead of target, with the start of the *Cryptomeria japonica* removal in the Caveiro intervention area on Pico Island. At the time of submission of the present report, 1st interventions were accomplished on all islands. The present report constitutes the first intermediate report describing the developments in the implementation of this sub-action and the associated results (deliverable D95), including photos and maps evidencing the different implemented control techniques (deliverable D31) up until December 2021.

Table 3 illustrates the actual progress of the implementation of sub-action C8.1 in relation to the proposed timeframe.

Table 3. Gantt-chart illustrating overall progress of sub-action C8.1.

Action		2020				2021				2022			
		1T	2T	3T	4T	1T	2T	3T	4T	1T	2T	3T	4T
C8.1	Foreseen												
	Executed												

Legend:

- Period defined in application
- According to plan
- Exceeding the targets