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Expedition Selvagens 50 Report and Long-Term Monitoring Programme



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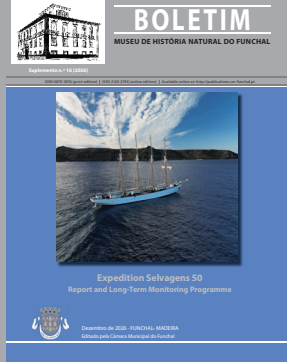
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Expedition Selvagens 50 Report and Long-Term Monitoring Programme for the Selvagens Islands Nature Reserve

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CONTENTS

1. SUMMARY

2. INTRODUCTION

2.1. Summary description of the study area

2.2. Objectives of The Selvagens Expedition 50

2.3. Partners and funding

3. RESULTS

3.1. Terrestrial environment

Inventorying and monitoring of bryoflora

CARLOS LOBO & SUSANA FONTINHA

Inventorying and monitoring of flora and vegetation

DÍLIA MENEZES, CRISTINA MEDEIROS, FRANCISCO FERNANDES, CARLOS LOBO, JUAN SILVA, LURDES COSTA & SUSANA FONTINHA

Inventorying and monitoring of the endemic terrestrial mollusc *Theba macandrewiana*

DINARTE TEIXEIRA & ISAMBERTO SILVA

Monitoring and assesment of terrestrial arthropods

DÍLIA MENEZES, MÁRIO BOIEIRO, YSABEL GONÇALVES & ISAMBERTO SILVA

Monitoring and population assement of the Selvagens gecko *Tarentola bischoffi*

RUI REBELO, RICARDO ROCHA, MANUEL NOGALES & FÉLIX M. MEDINA

Monitoring and population assesment of the Selvagens wall lizard *Teira dugesii selvagensis*

RUI REBELO, RICARDO ROCHA, MANUEL NOGALES & FÉLIX M. MEDINA

Monitoring the effective breeding population of cory's shearwater *Calonectris borealis*

JOSÉ PEDRO GRANADEIRO & PAULO CATRY

Monitoring the chronology and breeding success of the cory's shearwater *Calonectris borealis*

FRANCIS ZINO & MANUEL BISCOITO

Monitoring the breeding population of yellow-legged gull *Larus michahellis* at Selvagem Grande, Selvagem Pequena and Ilhéu de Fora

JOSÉ PEDRO GRANADEIRO & PAULO CATRY

Monitoring the population of the berthelot's pipit *Anthus berthelotii berthelotii*

MANUEL NOGALES & FELIX M. MEDINA

Inventorying terrestrial fauna using Environmental DNA

SARA PARDAL, LILIANA FERREIRA, VANESSA LUÍS, FILIPE CADETE & JOÃO RODRIGUES

3.2. Marine environment

Monitoring the thermal habitats of the intertidal zone

RUI SEABRA

Monitoring the Selvagens giant limpet *Patella candei*

RICARDO ARAÚJO & GONÇALO CALADO

Inventorying marine fauna using Environmental DNA

SARA PARDAL, LILIANA FERREIRA, VANESSA LUÍS, FILIPE CADETE & JOÃO RODRIGUES

Prospecting habitats of interest to the Mediterranean monk seal *Monachus monachus*

MARTA ARAÚJO, SÉRGIO PEREIRA, PEDRO NASCIMENTO, CARLOS SANTOS, CLÁUDIA RIBEIRO & DÍLIA MENEZES

Monitoring cetaceans

LUÍS FREITAS, RUTH ESTEBAN, PHILIPPE VERBORGH, PAULINE GAUFFIER & DINO GOUVEIA

Monitoring the subtidal communities of ichthyofauna, macroflora and macrofauna

CLÁUDIA RIBEIRO, FILIPE HENRIQUES, PEDRO NEVES, RODRIGO SILVA, SÍLVIA TAVARES & SUSANNE SCHÄFER

Monitoring pelagic fauna

FILIPE ALVES, JOÃO GAMA MONTEIRO & ANA DINIS

Assessment and monitoring of colonisation by benthic species

SUSANNE SCHÄFER, RODRIGO SILVA, JOÃO MONTEIRO & JOÃO CANNING-CLODE

Prospecting and monitoring rhodolith beds

CLÁUDIA RIBEIRO & PEDRO NEVES

Monitoring oceanographic parameters

CÁTIA AZEVEDO, GONÇALO RAMOS & PEDRO NEVES

Monitoring plastics in white-faced storm petrels *Pelagodroma marina* in the Selvagens Islands

JOSÉ PEDRO GRANADEIRO & PAULO CATRY

Monitoring marine litter in Selvagem Pequena

NICOLA PESTANA, PEDRO SEPÚLVEDA, ANDRÉ MOREIRA & JOSÉ GOMES

3. RESULTS

3.1. Terrestrial environment

3.2. Marine environment

4. FINAL CONSIDERATIONS

1. SUMMARY

The Expedition Selvagens 50 to the Selvagens Islands Nature Reserve took place between 22nd of April and the 1st of May 2023. This was a multidisciplinary expedition organised by the Institute for Nature Conservation and Forests, IP-RAM, as part of the celebrations of the 50th anniversary of the Nature Reserve, and also following its expansion, in area and in the total protection regime of the marine element of the reserve.

Forty researchers, technicians and managers from 28 national and foreign institutions were involved. The main logistical support platforms were the Santa Maria Manuela and Goldmund vessels.

The strategic objective of this expedition was to create an integrated, transversal long-term monitoring program SMP to monitor the evolution of the conservation status of species and habitats representative of those islands and the adjacent sea.

In this report the work carried out by all the teams involved is presented in a succinct manner, as well as the PMS for the different groups and species of fauna and flora considered. The PMS also identifies existing gaps, presenting concrete work proposals that could promote and guide the involvement of new researchers or the creation / implementation of new projects.

2. INTRODUCTION

2.1. Brief description of the study area

The Selvagens Islands are a remote and isolated group of oceanic islands located in the north-east Atlantic, 293 km from Madeira Island, Portugal. They are made up of three islands of volcanic origin: Selvagem Grande (2.45 km²), Selvagem Pequena (0.20 km²), Ilhéu de Fora (0.08 km²), and several small islets. The Selvagens Islands Nature Reserve (SINR), created in 1971, includes all of this land area and has, since 2022, been delimited by the adjacent marine area up to 12 nautical miles (2677 km²). Currently, it is the largest Marine Protected Area under total protection regime, in the entire North Atlantic.

The Selvagens Islands correspond to the emerged part of two remarkable volcanic formations with unique characteristics, which rise abruptly from the abyssal plain at a depth of around 4,000 metres. Geologically, they are distinct from the other islands of the Madeira Archipelago.

The marine habitats, strongly marked by this extreme geomorphology, show high biodiversity and are among the most pristine in Macaronesia and even the North Atlantic. Some species that are practically extinct globally, such as the Selvagens giant limpet, *Patella candei*, are abundant here.

The terrestrial habitats have a high rate of endemic and/or threatened and vulnerable species on worldwide scale, reaching their most pristine state on Selvagem Pequena. No exotic species have ever been introduced to this island, which is unique in Macaronesia and extremely rare in a global context.

The Selvagens Islands Nature Reserve is an example of the representation of significant ecological and biological processes in the evolution and development of marine, coastal and terrestrial ecosystems and communities of flora and fauna. They are a unique example of very well preserved Macaronesian biota, sometimes untouched, with unique geological characteristics.

The conservation effort has been quite significant over the reserve's more than 50 years, with the most determinative initiatives worthy of being highlighted are the Selvagem Grande Terrestrial Habitat Recovery Project and the increase in the area of total protection for its marine component. Any of these initiatives is crucial if the Selvagens Islands' terrestrial and marine habitats are to reach a pristine condition.

For more detailed information on the Selvagens Islands Nature Reserve, its projects and studies to date, visit ifcn.madeira.gov.pt.

2.2. Objectives of The Expedition Selvagens 50

The Expedition Selvagens 50 was organised by the IFCN and is part of the 50th anniversary of the Selvagens Islands Nature Reserve, also following the expansion in its area and total protection regime in its marine area.

After 50 years of intense nature conservation work, the strategic objective of this expedition was to provide a forum for discussion and reflection carried out on site, the main output of which is the creation of this monitoring programme (PMS). The PMS, duly documented and based on science, will make it possible to monitor the evolution and conservation status of species and habitats representative of those islands and the surrounding sea. The PMS also identifies existing gaps, presenting concrete work proposals that could promote and guide the involvement of new researchers or the creation / implementation of new projects.

It should be noted that, whenever possible, the basic reference for the work now being carried out is based on studies carried out over the last few decades by numerous researchers.

The specific objectives of The Expedition Selvagens 50 were:

- Evaluate the effect of the Selvagem Grande terrestrial habitat restoration project (2000-2003) on fauna and flora;
- Assess the conservation status of coastal and subtidal marine ecosystems;
- Create a specific monitoring programme with defining indicators which would allow the detection of the effects of climate change, particularly in terms of oceanography and intertidal communities;
- Define minimum methodologies and sampling for future work, within the framework of that carried out in the past, on land and at sea;
- Identify knowledge gaps, both at sea and on land, define priorities and implement specific monitoring programmes to be integrated into a general one;
- Implement a pilot experiment to inventory and monitor terrestrial communities using environmental DNA;
- Use non-invasive molecular tools to generate complementary data to the marine and terrestrial biodiversity surveys;
- To divulge and make known to the scientific community the opportunities that the Selvagens islands offer as a field of study and the possibility of integrating them into this general monitoring programme;

- Divulge the importance and position of this nature reserve, in particular its marine area, in the global panorama of nature conservation;
- Gather information and adopt the necessary measures to continue the work in the short term and long term.

2.3. Partners and funding

The Expedition Selvagens 50 counted on the participation of various partners who, for the most part, over the last few years have been involved in acquiring knowledge at the Selvagens Islands Nature Reserve, as well as in its governance.

It is important to emphasise that the core group of partners was made up of entities and the regional scientific community, which have a strong critical mass and are best positioned to follow-up the established SMP in the long run.

3. RESULTS

3.1. Terrestrial environment



Inventorying and monitoring of bryoflora

By CARLOS LOBO ^{1*} & SUSANA FONTINHA ^{2,3}

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Objectives / Ecological parameters under assessment

To establish a monitoring programme aimed at bryophytes, as well as their inventory.

Background information

Unpublished reports from the Selvagem Grande Terrestrial Habitat Recovery Project between 2001 and 2005. The reference list of bryophyte species for the Selvagens islands is that proposed by SIM-SIM *et al.* (2010).

Description of the activities undertaken

The sampling methodology was developed on the basis of that proposed by SIM-SIM *et al.* (2005), with monitoring taking place only in Selvagem Grande. The bryophyte inventories were carried out in eleven quadrats with 10 x 10 m edges, coinciding with those where the vascular vegetation was sampled. The aim was to detect possible associations between the presence of bryophytes and vascular species. The position of each quadrat on the island was georeferenced with a GPS and signposted on the ground with four permanent stakes, each corresponding to one of the vertices of the 10 x 10 m quadrat.

To sample the bryoflora, each 10 x 10 m quadrat was delimited and divided with rope into a grid of nine 3.3 x 3.3 m subquadrats. The edge of the quadrat with a northerly position was determined and the squares numbered from 1 to 9, in a west-east direction.

The entire area of the 10 x 10 quadrat was carefully surveyed to detect bryophyte clusters, the location of which was marked on the ground with a coloured tile. Following the order of subquadrats from 1 to 9, each subquadrat was subdivided into 9 sampling plots of 1.1 x 1.1 metres. Each 1.1 x 1.1 metre sampling plot containing bryophyte clusters was photographed over its entire area, and detail photographs were taken of the bryophyte clusters found. Samples of plants from each bryophyte cluster were collected for later species identification in the laboratory. Each sample collected was categorised with a code consisting of the subquadrat number (10 x 10 m), subquadrat number (3.3 x 3.3 m), sampling plot number (1.1 x 1.1 m) and sample number; *e.g.*, 5-4-9-1 (quadrat 5, subquadrat 4, sampling plot 9, sample 1). The total number of sampling plots for each sampling station is eighty one.

From the photographs taken in the field, the area and percentage coverage of each avascular species in the quadrat was calculated using a computer, which also provides a photographic reference database for comparison with future monitoring.

Given that the bryoflora sampling areas coincide with those of the vascular vegetation, all the information collected in the vascular vegetation inventories can be used for future analyses of bryoflora coverage.



Map 1 – Inventorying and monitoring of bryoflora: Selvagens Islands, 2023.

Planning future monitoring

Considering that during the Selvagens Expedition 50 the bryoflora in the quadrats was dry and out of season for optimal monitoring, it will be important to carry out a campaign next year (2024), preferably just after the rainy season and before spring. This campaign will make it possible to obtain data on the bryoflora when the diversity of species on the ground and their coverage are at their highest. Subsequently, it is recommended to repeat the sampling at this time every three years.

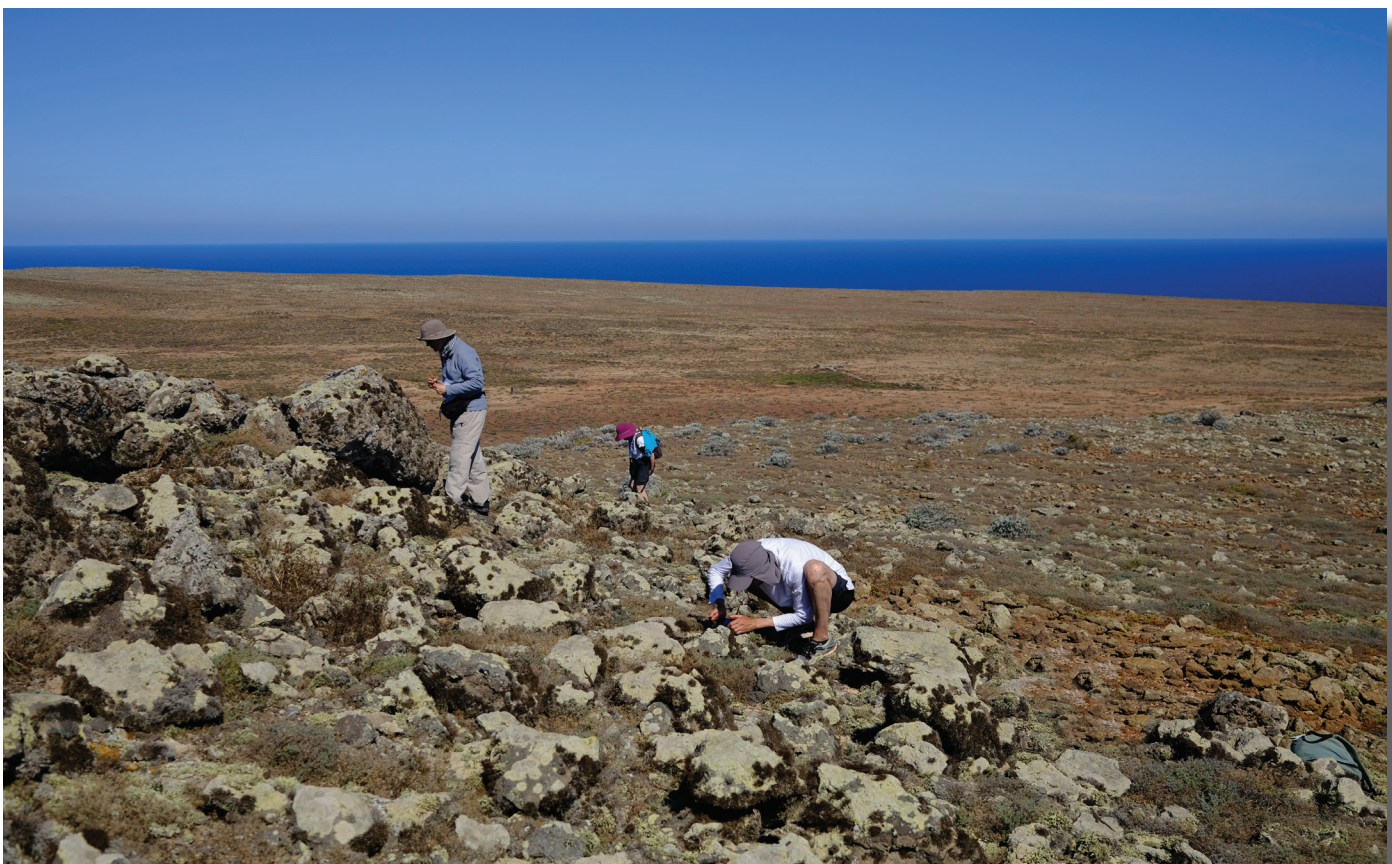
Although the coverage of bryophytes in Selvagem Grande appears to be scarce, the presence of these plants can be observed in some more sheltered places or those with particular soil and climatic conditions. We recommend a more exhaustive and free survey of the island's bryoflora in order to georeference the bryophyte clusters observed, as well as carrying out several transects along Selvagem

Grande in order to systematically detect distribution patterns and better understand the distribution of this group of plants on the island.

Considering the area of Selvagem Grande, and the possible existence of microhabitats, it is recommended to increase the number of quadrats, establishing them in microhabitat areas and also in unrepresentative areas of the island.

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Inventorying and monitoring of flora and vegetation

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Objective / Ecological parameters being assessed

To monitor and evaluate the impact of the Selvagem Grande habitat restoration project (2000-2003) on flora and vegetation.

Background information

The methodology applied was based on that described in OLIVEIRA *et al.* (2010) and unpublished reports from the Selvagem Grande Terrestrial Habitat Recovery Project, employed between 2001 and 2005.

Description of the activities undertaken

The vegetation inventories were carried out in ten quadrats measuring 10 x 10 m, distributed throughout the Selvagem Grande. Six quadrats were established in 2002, two in 2003 and the remaining two were created on this expedition, which constitutes a positive change in the methodology in question. The position of each quadrat on the island was georeferenced with GPS and signposted on the ground with 4 permanent stakes, each corresponding to one of the vertices of the 10 x 10 m quadrat.

For sampling, each 10 x 10 metre quadrat was delimited and divided with rope into a grid of 3 x 3.3 m subquadrats. The edge of the quadrat with a northerly position was determined and the grids were numbered from 1 to 9, in a west-east direction. In each subquadrat, in order from 1 to 9, the vascular plant species and their relative coverage were recorded using the normal Braun-Blanquet scale, as well as the relative coverage of rock, unoccupied soil, herbaceous vegetation, shrub vegetation, lichens and bryophytes (total relative coverage). The maximum height of herbaceous and shrub vegetation was also recorded.

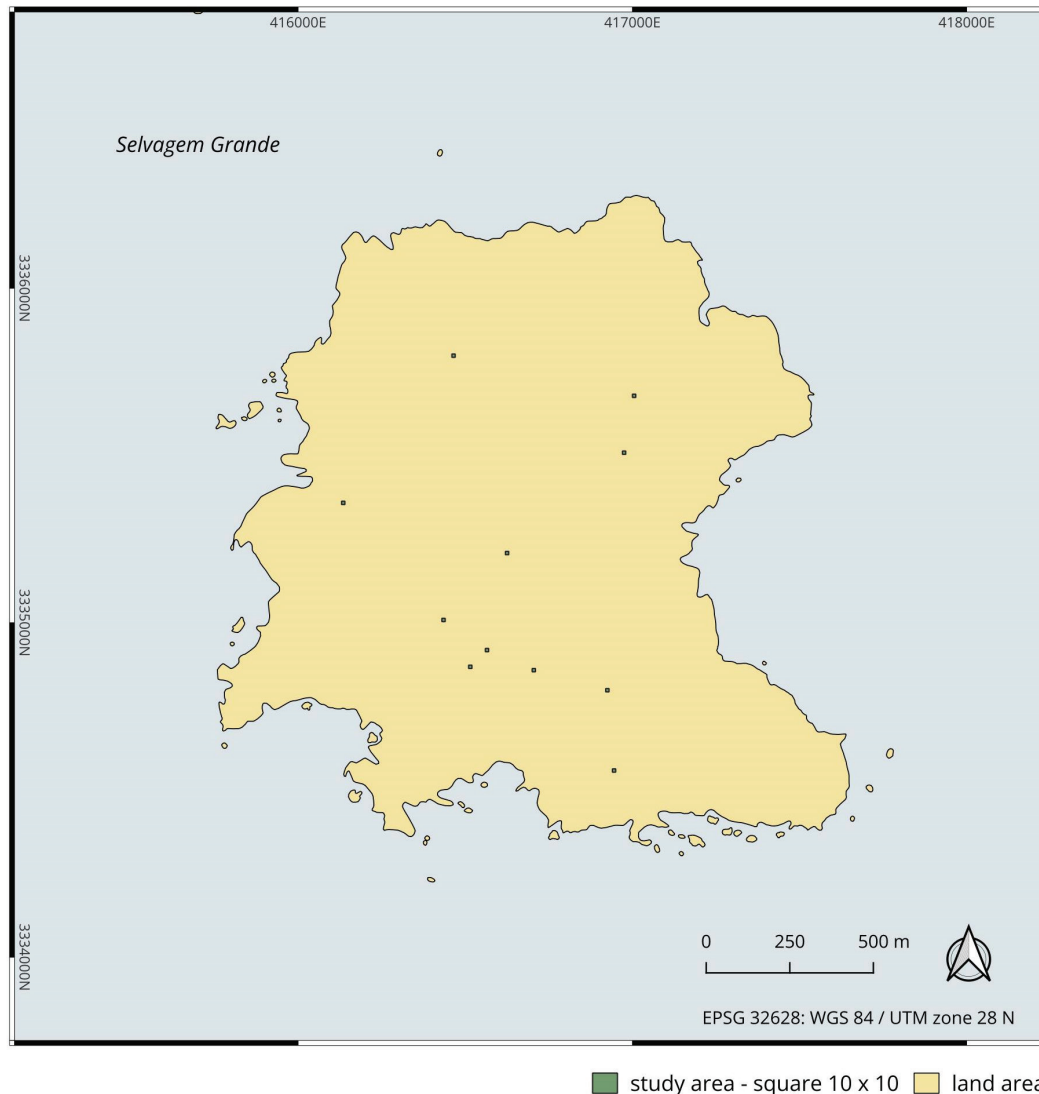
Planning future monitoring

Considering that during the Selvagens Expedition 50 the vegetation in the squares was dry and out of the ideal season for monitoring, it will be important to carry out a monitoring campaign next year (2024), at the beginning of March. This campaign will make it possible to obtain data on the vegetation when the diversity of species on the ground, flowering and their respective cover are at their highest, as well as to obtain information on the vegetation at the same time of year as the previous monitoring

(March). This will allow the data to be compared more accurately and trends to be detected more reliably campaigns. Subsequently, it is recommended to repeat the sampling in the quadrat every 3 years, preferably in early spring, at the end of March.

We recommend dividing the 10 x 10 m quadrats into 2 x 2 m subquadrats instead of 3.3 x 3.3 m. This option will result in twenty-five grids, instead of nine, for assessing the frequency of each plant species. This change will improve the definition of the frequency of each species, which is essential for calculating biodiversity indices more reliably.

Although the Braun-Blanquet scale is widely used in phytosociological studies, it is essentially a qualitative scale. In order to carry out statistical analyses with the information collected in the field using this scale, it is necessary to convert the qualitative information into quantitative information. Although this procedure is correct and accepted in the scientific community, it entails the loss of some information. Therefore, and considering the need to carry out statistical analyses with the data obtained from the sampling plot, as well as the low number of sampling plots in this monitoring programme, it is recommended to record the exact relative coverage of each species.



Map 2 – Inventorying and monitoring of flora and vegetation: Selvagens Islands, 2023.

Considering the Selvagem Grande area, and the possible existence of microhabitats, it is recommended that the number of quadrats be increased, establishing them in microhabitat areas and also in areas of the island without representativeness.

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Inventorying and monitoring of the endemic terrestrial mollusc *Theba macandrewiana*

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Objective / Ecological parameters being assessed

To establish a monitoring programme for the endemic terrestrial mollusc *Theba macandrewiana* in Selvagem Grande, calculating its relative density and distribution area.

Background information

The methodology applied was based on that described in OLIVEIRA *et al.* 2010 and unpublished reports from the Selvagem Grande Terrestrial Habitat Recovery Project, used between 2001 and 2005. The methodology described in CAMERON & COOK (2001), CAMERON & POKRYSZKO (2005) and COPPOLINO (2010) was also used to assess the specific richness, abundance and composition of terrestrial mollusc communities.

Description of the activities undertaken

To calculate the relative density and respective distribution area of the endemic terrestrial mollusc *Theba macandrewiana*, six transects were drawn across the island, with various orientations: 1 = North, 2 = South, 3 = East, 4 = West, 5 = Centre-East, 6 = Centre-West.

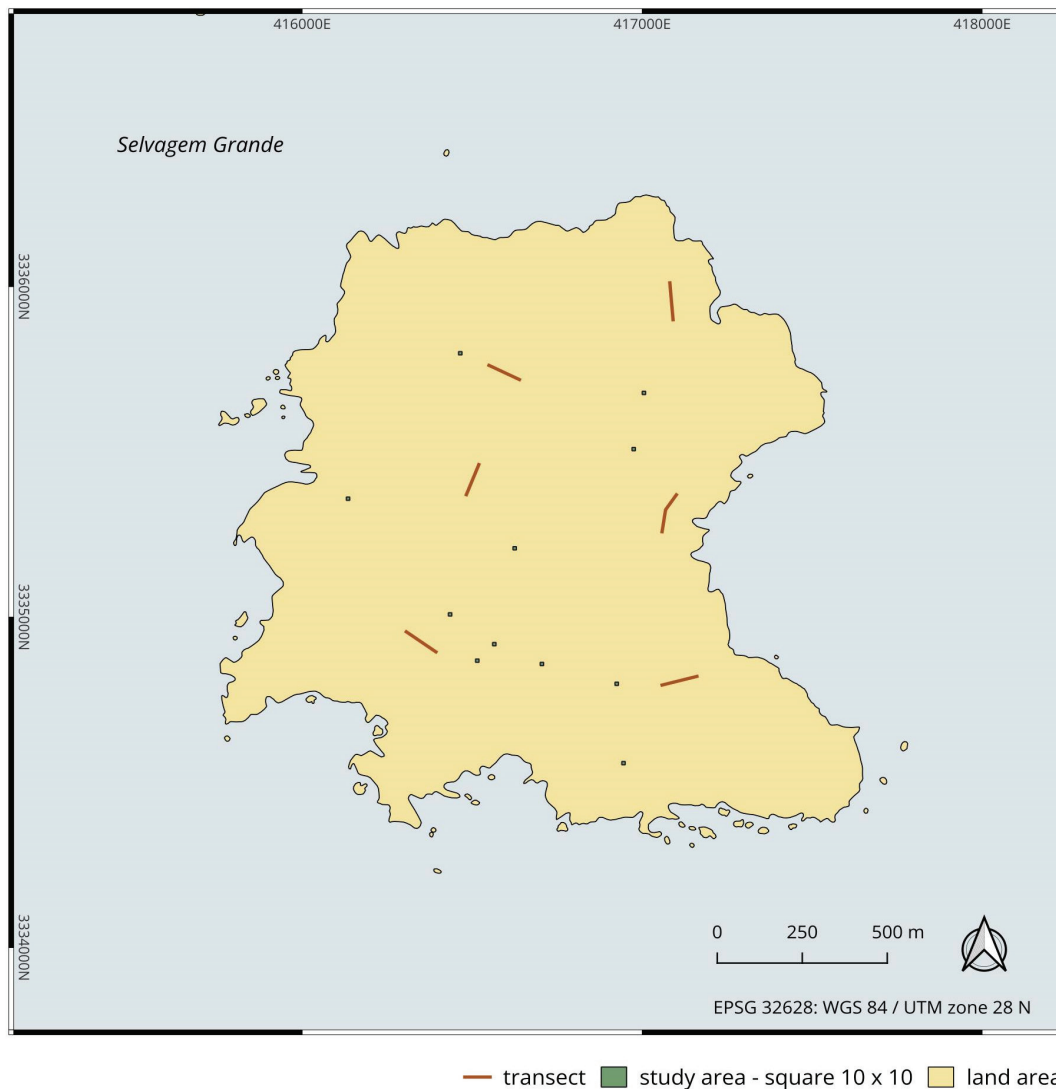
The linear transects were carried out over four days from 8.30 a.m. to 6.30 p.m.. A total of hundred segments were assessed, with surveys of the abundance of the target species within a radius of 2 m from the centre point.

All *Theba macandrewiana* specimens were counted in each segment, divided into two classes (adults and juveniles), and the degree of ground cover (% of cover, soil and stones) was noted in a 1 x 1 m area.

Eleven quadrats were also drawn up, trying to cover the distinct biotypes of the island, with distinct locations. Ten of these quadrats are from the baseline survey carried out before the invasive species were removed, and coincide with three other biological groups: vascular plants, arthropods and bryophytes. The remaining quadrat was defined during the current sampling, with the aim of complementing the biotypes covered.

The quadrats were assessed over four days, from 8.30 a.m. to 6.30 p.m.. Sampling took place in 5 x 5 metre squares, defined within the 10 x 10 m quadrats pre-designated in the 2004 sampling. In each quadrat, the abundance of the target terrestrial mollusc species and the rate of ground cover were measured for thirty minutes by two people. Abiotic data was also measured, namely air temperature, relative humidity, and soil pH, were also measured.

Finally, soil samples (1 L) were taken in each of the quadrats and transects carried out, in an area of 2 x 2 m from the centroid if carried out in a transect or in an area of 5 x 5 m if carried out in a square, in order to assess the soil microfauna (terrestrial molluscs) and identify new records for the island.



Map 3 – Inventorying and monitoring of the endemic terrestrial mollusc *Theba macandrewiana*: Selvagens Islands, 2023.

Planning future monitoring

It is recommended that this monitoring method be continued, the six linear transects with the current location and length, allowing data to be compared in the different sampling years. This monitoring should be carried out every two years, at the same time of year (April / May), also maintaining the sampling effort (number and length of transects and quadrats).

In the subsequent censuses, sampling should also be carried out during the night, when the land snails are active, to compare the results and rule out any potential bias.

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Monitoring and assessment of terrestrial arthropods

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Objective / Ecological parameters being assessed

To assess and monitor the taxonomic richness and relative abundance of certain groups of terrestrial arthropods. This approach aims to assess the impact of the Selvagem Grande Terrestrial Habitat Recovery Project.

Background information

The methodology applied was based on that described in OLIVEIRA *et al.* (2010) and unpublished reports from the Selvagem Grande Terrestrial Habitat Recovery project, applied between 2001 and 2005.

Description of the work undertaken

The methodology applied consisted of three complementary sampling techniques, namely direct sampling in quadrats, pitfall traps and vegetation beating.

Direct sampling was carried out in previously established 10 x 10 m quadrats and in three new quadrats not previously sampled, as shown on the map below (map with the distribution of sampling sites).

In each quadrat, three parallel lines were marked, spaced 2.5 metres apart from each other and the edges of the quadrat. All the arthropods that were on the ground, vegetation or under stones, within a width of 1 m (0.5 m either side of the line), were collected, preserved in ethanol (90%) and labelled.

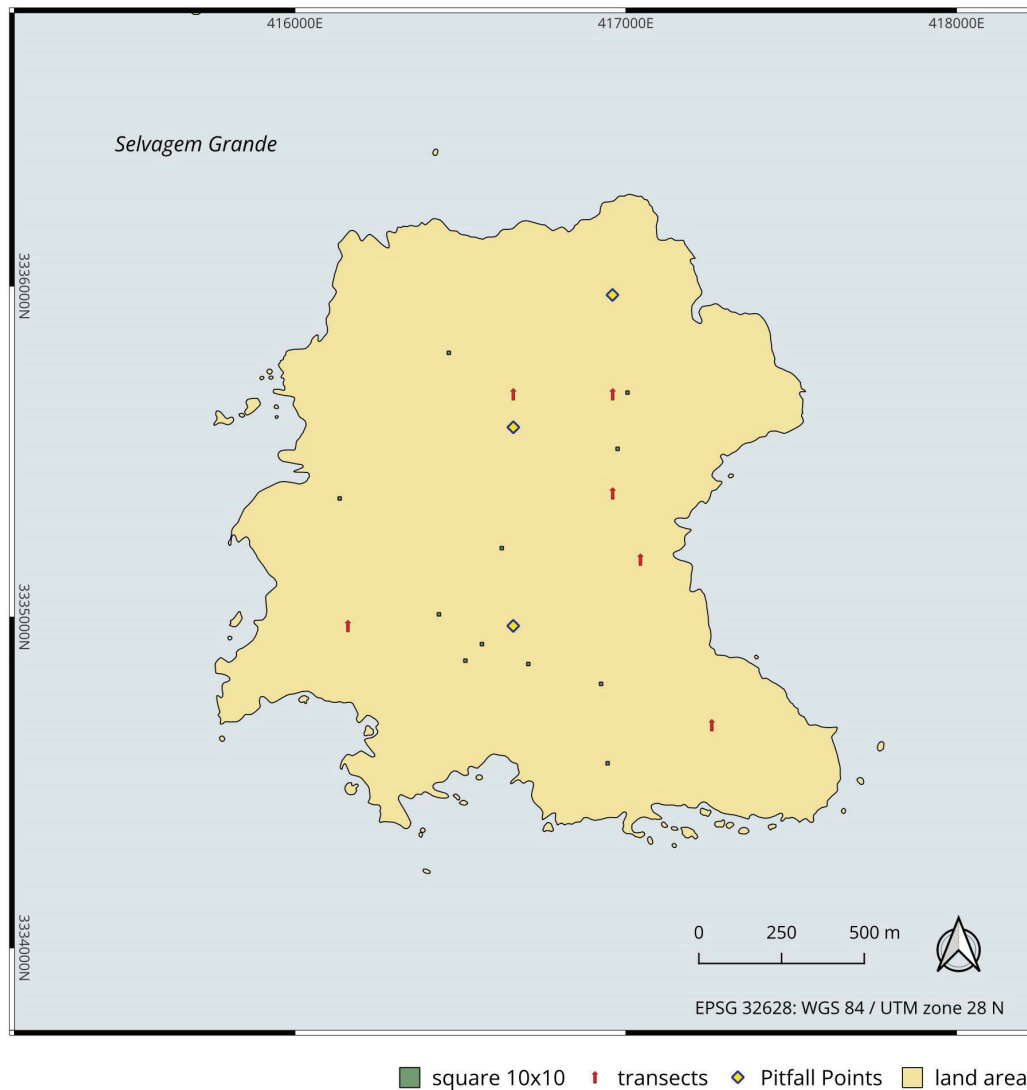
Pitfall sampling was carried out at the three previously established sites. At each site, six traps were placed, arranged in two rows with three traps each, with the traps spaced 2 m apart. The traps consisted of 12 cm diameter plastic cups containing a solution of water + beer (2%) and a drop of detergent and were covered by a cardboard plate supported by wires to minimise accidental catches. The traps were active for five consecutive nights and the samples were then collected, labelled and preserved in ethanol (90%).

The vegetation beatings were carried out along previously established transects and in other locations now defined, as referenced in the table below. These surveys were carried out along transects 10 m long x 1 m wide, using an entomological net, and the arthropods were collected using an entomological aspirator, preserved in ethanol (90%) and the samples labelled individually.

We also selected areas where the beatings were only carried out on one plant species, using an entomological net. Five individuals of each plant species were sampled using seven beatings. The

arthropods were collected using an entomological aspirator, preserved in ethanol (90%) and the samples labelled individually.

All the samples were transported to the Funchal Natural History Museum laboratory where they will be sorted. The specimens will be identified to the lowest possible taxonomic level by members of the team and other specialists.



Map 4 – Monitoring and assessment of terrestrial arthropods: Selvagens Islands, 2023.

Planning future monitoring

In the future, monitoring should be carried out at the beginning of spring, preferably in the month of March, as the data from previous monitorisations (2002, 2003, 2004 and 2005) were obtained in that month, making comparisons more reliable. On the other hand, this period also corresponds to the peak activity of various groups of terrestrial arthropods.

Consideration should be given to carrying out beatings on some plants in other areas that have not been sampled, such as the Chão dos Caramujos area (as far as it is possible to access) in order to provide greater coverage of the different types of habitats on the island.

The proposed monitoring should be repeated in 2024 and then spaced out every 3 or 4 years according to the logistical capacity and human and financial resources to carry out the programme detailed above.

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Monitoring and population assessment of the Selvagens Gecko *Tarentola bischoffi*

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Objective / Ecological parameters under evaluation

To monitor and evaluate the impact of the Selvagem Grande habitat restoration project on the Selvagens Gecko *Tarentola bischoffi* by (i) estimating the relative abundance of the population, and (ii) estimating the body size structure, respectively, in different types of habitats in Selvagem Grande.

Background information

The methodology used to estimate the relative abundance of the Selvagens Gecko was based on that described in OLIVEIRA *et al.* (2010) and unpublished reports from the Selvagem Grande Terrestrial Habitat Recovery Project, conducted between 2001 and 2005. The methodology described in GIL (2011) was used to estimate the body size structure of this species.

Description of the activities undertaken

To calculate relative abundance, the baseline methodology was followed, with visits to sixteen quadrats (D7, D11, G6, H9, H15, I9, I12, J6, K12, L4, L8, P11, O4, O13, Q11, Q15). The censuses were carried out over three days, between 10.00 a.m. and 6.00 p.m..

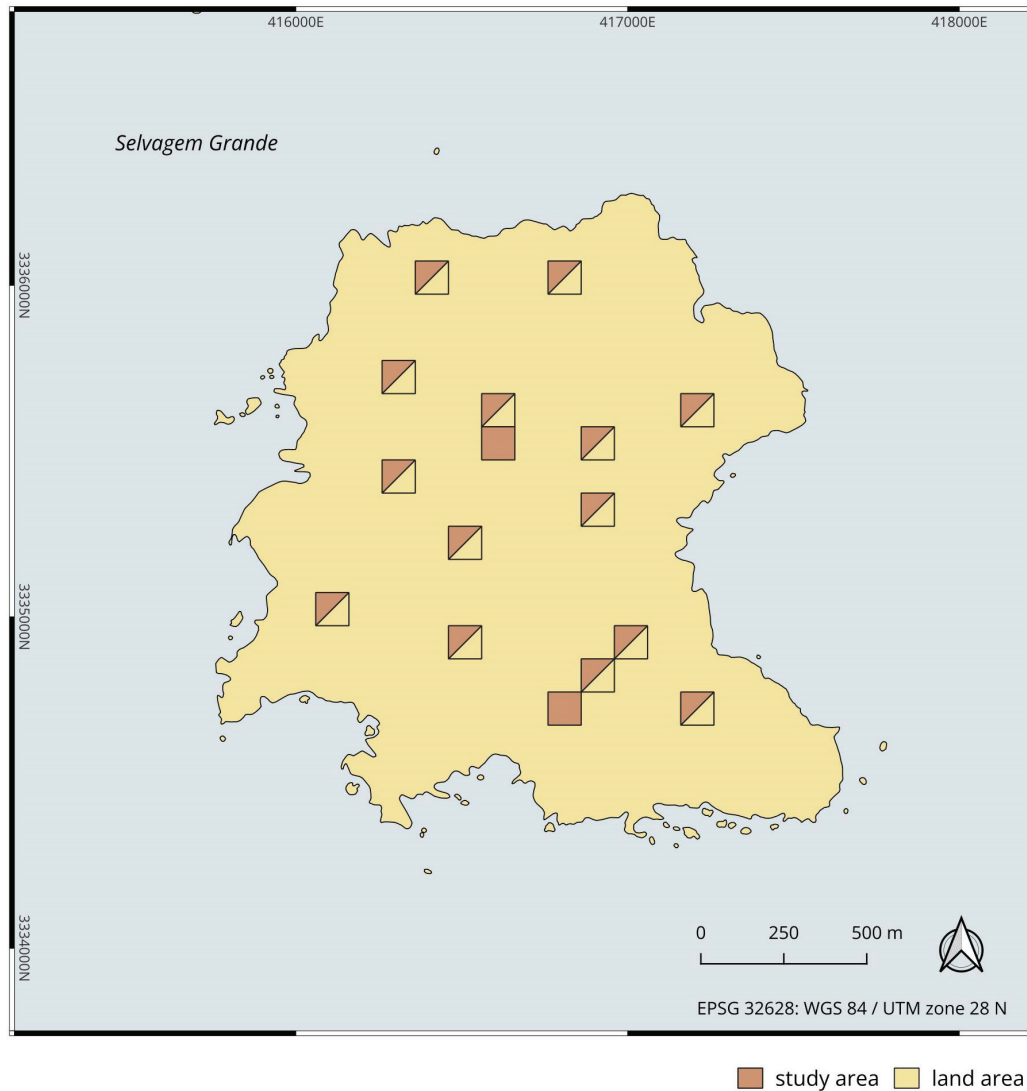
Each quadrat was divided by the SO-NE diagonal into two half-hectare triangles. The NO quadrant was sampled by one person for half an hour, lifting stones over 15 cm. Geckos and lizards were counted, with separate records of the number of juveniles and the coexistence of more than one individual (of the same or different species) under the same stone.

With regard to the base methodology, the following changes were made: (i) an additional grid – Q11 – was sampled in order to sample one of the sites on the island with more developed plant communities, (ii) grid G15 was replaced by the adjacent grid H15, due to the expansion of a colony of White-faced Storm Petrel, and (iii) grid N13 was replaced by the adjacent grid O13 for the same reason as (ii).

To calculate the relative abundance of the selvagens gecko, night-time transects were carried out (between 10.00 a.m. and 1.00 a.m.) on the plateau in order to test the viability of a new census method, the counting of active animals along linear transects. 400-Lumen head torches were used and active geckos were surveyed along linear transects in the first phase, and along the marked path in the second phase.

The weather conditions during the two nights of work, strong winds and relatively low temperatures, did not allow the methodology to be properly developed and a low number of animals was recorded (see Planning future monitoring section).

To define the size structure, the methodology described by GIL (2011) was followed. All possible stones were surveyed in squares I9 and Q11. The geckos were captured, measured (snout-to-vent length, with digital calipers to 0.01 mm), sexed and weighed (with a digital scale to 0.01 g). The irises of both eyes were photographed for individual identification. Each occupied stone was georeferenced. As with the estimate of abundance, cases of occurrence under the same rock were also noted.



Map 5 – Monitoring and population assesment of the Selvagens Gecko *Tarentola bischoffii*: Selvagens Islands, 2023.

Planning future monitoring

With regard to calculating the relative abundance of the Selvagens Gecko, it is recommended that the current method be continued, using the same grids and the adaptation mentioned in this report – a visit to half a grid by one person for half an hour.

This monitoring should be carried out every three years. The method is replicable as long as the geckos are active (at least from April to October) and there are no constraints on the hour of the visit. If possible, the individuals counted should be counted separately as juveniles (very small, 4 cm or less) and adults (all other sizes).

It would be useful to re-test the feasibility of carrying out nocturnal surveys between June and September, on nights with little wind. This method can be combined with the previous one and will allow us to estimate the abundance of the species in places with few stones or with stones too large to lift.

This species has seen a steady increase in the average size of adults since the eradication of mammals. It is therefore of great interest to continue monitoring this phenomenon. However, prior training is required, both for handling the specimens and for measuring them correctly (snout-to-vent length). This monitoring can be repeated with the same regularity as the previous one.

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Monitoring and population assessment of the Selvagens Wall Lizard *Teira dugesii selvagensis*

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Objective / Ecological parameters being assessed

Monitor and assess the impact of the Selvagem Grande habitat restoration project on the Selvagem Lizard *Teira dugesii selvagensis* by (i) estimating relative population abundance and (ii) estimating body size structure, respectively, in different habitat types on Selvagem Grande.

Background Information

The methodology used to estimate the relative abundance of selvagens lizards and their size structure is described in AGUILAR (2016).

Description of the activities undertaken

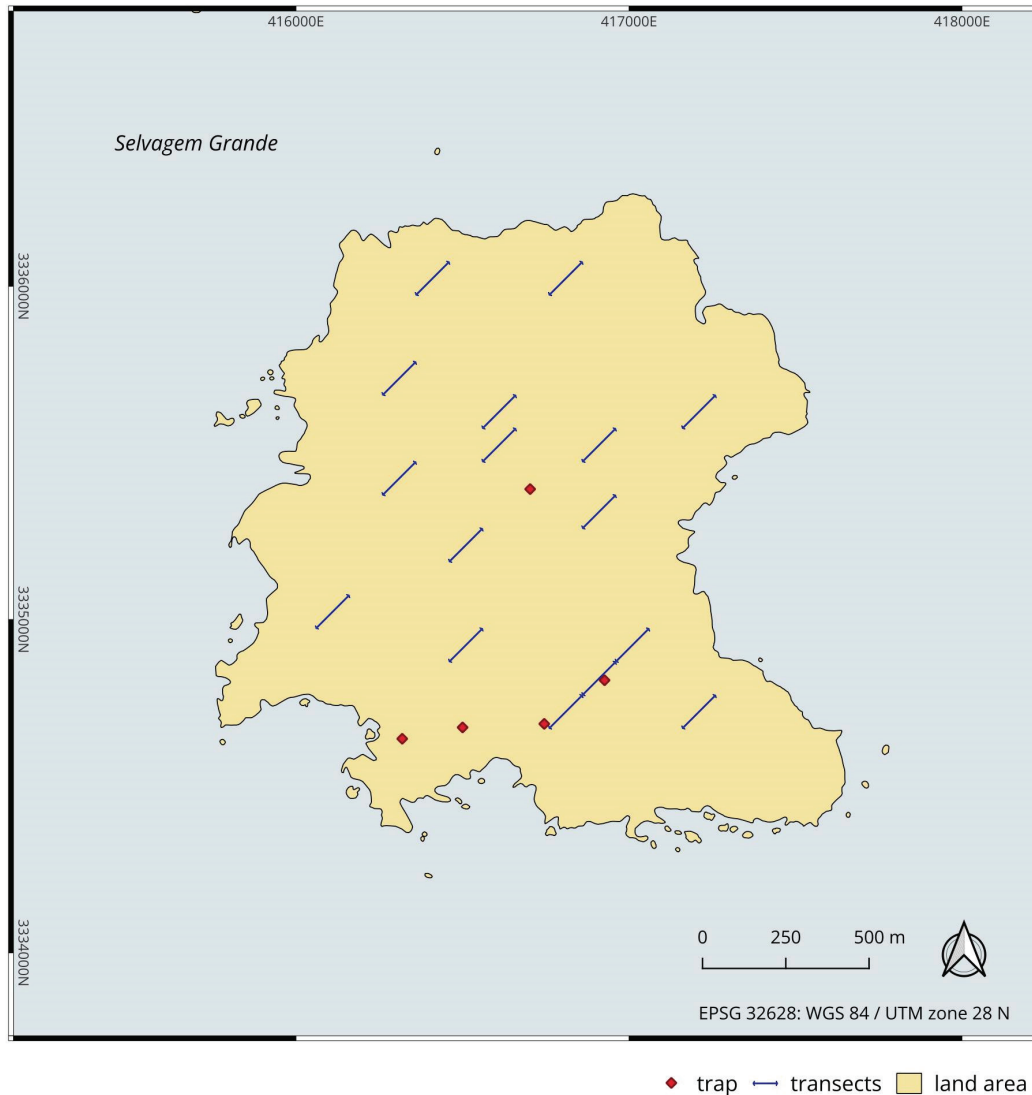
The methodology described in AGUILAR (2016) was used to calculate the relative abundance and size structure of the Selvagens lizard. Buckets baited with banana were leant against natural (e.g. rocks) or humanised (stone walls) vertical structures to capture specimens. The number of buckets varied between one and three. The trap was functional for 30 minutes during the morning (10.00 a.m. and 12.00 p.m.) or late afternoon (4.00 p.m. and 18.30 p.m.).

Of the eight sampling sites established in the reference bibliography, it was only possible, due to time constraints, to sample five. These sites were: the enclosure; the cliff of Galinhas cove; the cliff of Fonte Salgada; the plateau to the west of Tornozeiros; and the cliff of Portinho das Cagarras.

The captured lizards were measured (snout-to-vent length, with digital callipers, to 0.01 mm), weighed (with a digital scale to 0.01 g) and sexed. Ventral colouration (blue, orange or white) was recorded.

Complementarily, a new methodology for calculating relative abundance was tested, based on counting along linear transects. This is because the use of baited pitfall traps is time-consuming and greatly influenced by the time of sampling. We used the same sixteen grids visited in the selvagens gecko census as the sampling unit (see respective section), more specifically the SO-NE diagonals of each grid. The time and weather conditions (temperature, cloudiness, wind) were recorded. The habitat (substrate and vegetation) was characterised by percentage cover along the diagonal.

Each diagonal was covered on foot for about five minutes. All the lizards seen, whether still or moving, were counted in a 1 m strip on either side of the diagonal. The sound of lizards fleeing was also counted as corresponding to at least one individual.



Map 6 – Monitoring and population assesment of the Selvagens Wall Lizard *Teira dugesii selvagensis*: Selvagens Islands, 2023.

Planning future monitoring

To calculate the relative abundance of Selvagens lizard, it is recommended to continue testing the new method – counting along linear transects. The advantages of this method are that it is relatively quick and can be carried out by inexperienced observers after basic training. It also avoids possible accidents with traps that may be exposed to the sun or forgotten. Disadvantages include the fact that the method is only reliable if several counts (at least 5, preferably more) are carried out in a relatively short period.

This monitoring should be carried out every 3 years, between April and October. A normal census will take between 5 and 8 mornings (avoid the hottest hours) over the course of one month.

With regard to monitoring the size structure of the Selvagens lizard population, the use of baited pitfall traps is suitable for obtaining biometric measurements, but prior training is required for handling the specimens and measuring them (snout-to-vent length). Care must also be taken with the locations where the pitfall traps are placed, as well as the duration of their operation.

This monitoring can also be carried out every 3 years, during the same periods as the counts. The sites to be sampled can be found in AGUILAR (2016). On the cliffs of Pardela cove and Galinhas cove, the traps should be placed in areas with tomato plants (*Lycopersicum esculentum*).

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Monitoring the breeding population of Cory's Shearwaters *Calonectris borealis*

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Objective / Ecological parameters being assessed

To determine the population trends of Cory's Shearwaters in Selvagem Grande and monitor the impact of the Selvagem Grande habitat restoration project on this species.

Background information

The existing baseline refers to the last global count (in 2005) of the number of shearwaters nesting in Selvagem Grande (GRANADEIRO, *et al.*, 2006).

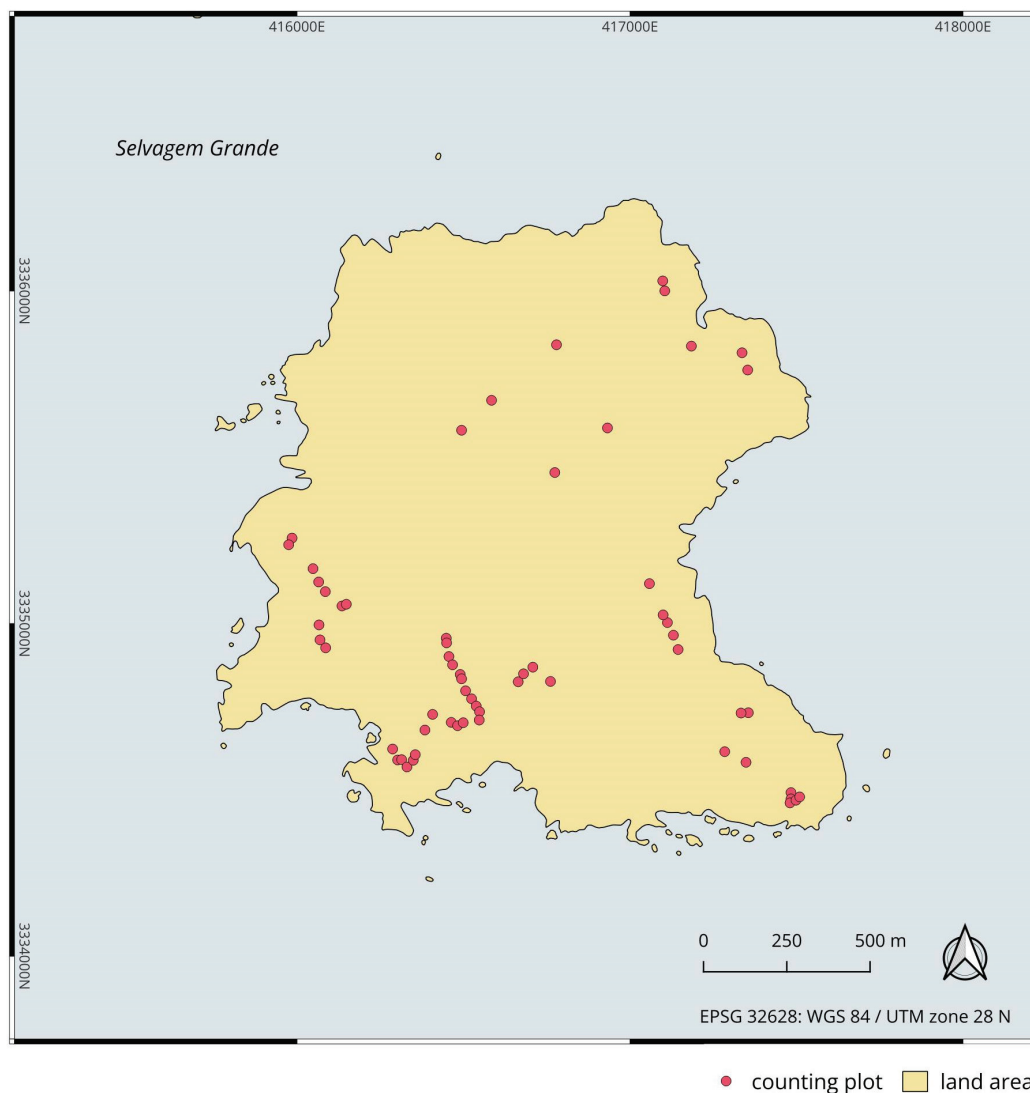
Description of the work undertaken

The methodology, applied annually from 2009 to the present, consists of counting the number of nests with Cory's shearwater eggs in sixty fixed circular plots (the centre of which is recorded by GPS and marked with a numbers on a rock), spread throughout Selvagem Grande. The plots have a radius of 5 m (in denser areas) or 10 m. The count is carried out on the 15th and 16th of June each year, or on the closest dates immediately afterwards.

During the Expedition Selvagens 50, which took place at the end of April, the shearwaters were still in the pre-laying phase (no eggs had yet been laid). The work carried out therefore consisted of photographing the sixty monitoring plots (aerial photography with a drone and from the ground) as well as measuring / estimating the shrub cover (*Suaeda vera* and *Schizogyne sericea*) within each plot, since these plants often provide shelter for the shearwaters to set up their nests (refer to Map 7).

Planning future monitoring

It is recommended that this monitoring be continued on an annual basis. The results already obtained (*in prep.*) indicate that this method provides good population trend estimates to be obtained, with very narrow confidence intervals. Thus, this annual monitoring allow for the detection of small population increases or decreases in a short period of time. It also makes it possible, by extrapolation and based on the census by GRANADEIRO *et al.* (2006), to obtain up-to-date estimates of the Cory's shearwater population in Selvagem Grande without carrying out global counts of the island, which are very demanding in terms of human resources. We currently estimate that the population of shearwaters on Selvagem Grande to be closed to 40,000 pairs (a clear increase since the 2005 census).



Map 7 – Monitoring the breeding populations of Cory's Shearwaters *Calonectris borealis*: Selvagens Islands, 2023.

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Monitoring the chronology and reproductive success of Cory's Shearwater *Calonectris borealis*

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Objective / Ecological parameters being assessed

To determine long-term trends in the breeding colony of Cory's Shearwater, *Calonectris borealis*, on Selvagem Grande and to monitor the impact of the restoration of the habitat on the reproduction of the species.

Background information

Work on Cory's Shearwater colony on Selvagem Grande, was initiated by Christian Jouanin and Francis Roux during the Museu de História Natural do Funchal organised expedition of 1963 (JOUANIN & ROUX, 1966). In 1971 two quadrats, ABCD at Baía das Pardelas and EFGH below Pico Atalaia (see map below) were defined and have resulted in multiple publications (e.g. ZINO, 1971, ZINO *et al.* 1987).

Description of the activities undertaken

Given the nature of this work, which has been consolidated in the field for more than five decades, it was not feasible to carry it out during the period in which the Selvagens 50 Expedition took place.

The breeding success of the two quadrats has been monitored since 1971. At least two visits to the sites are carried out each year. Firstly, during egg laying (20th May to 14th June) when the number of eggs laid is registered and unringed birds ringed. Egg predation is also registered. A second visit is made in early October when all the chicks are ringed. Other parameters have also been studied over the years, which imply extra visits. These studies have made it possible to monitor the recovery of the colony after the massacre of 1975/6. It was also possible to assess the effect of the removal of rodents from Selvagem Grande (ZINO *et al.*, 2008 and ZINO *et al.*, 2021).

Planning future monitoring

At the time of writing this work has been carried out for 54 years on a yearly basis and so trends such as times spent feeding at sea can be monitored as an indicator of food availability etc. The authors feel that it is important that this study should be ongoing.

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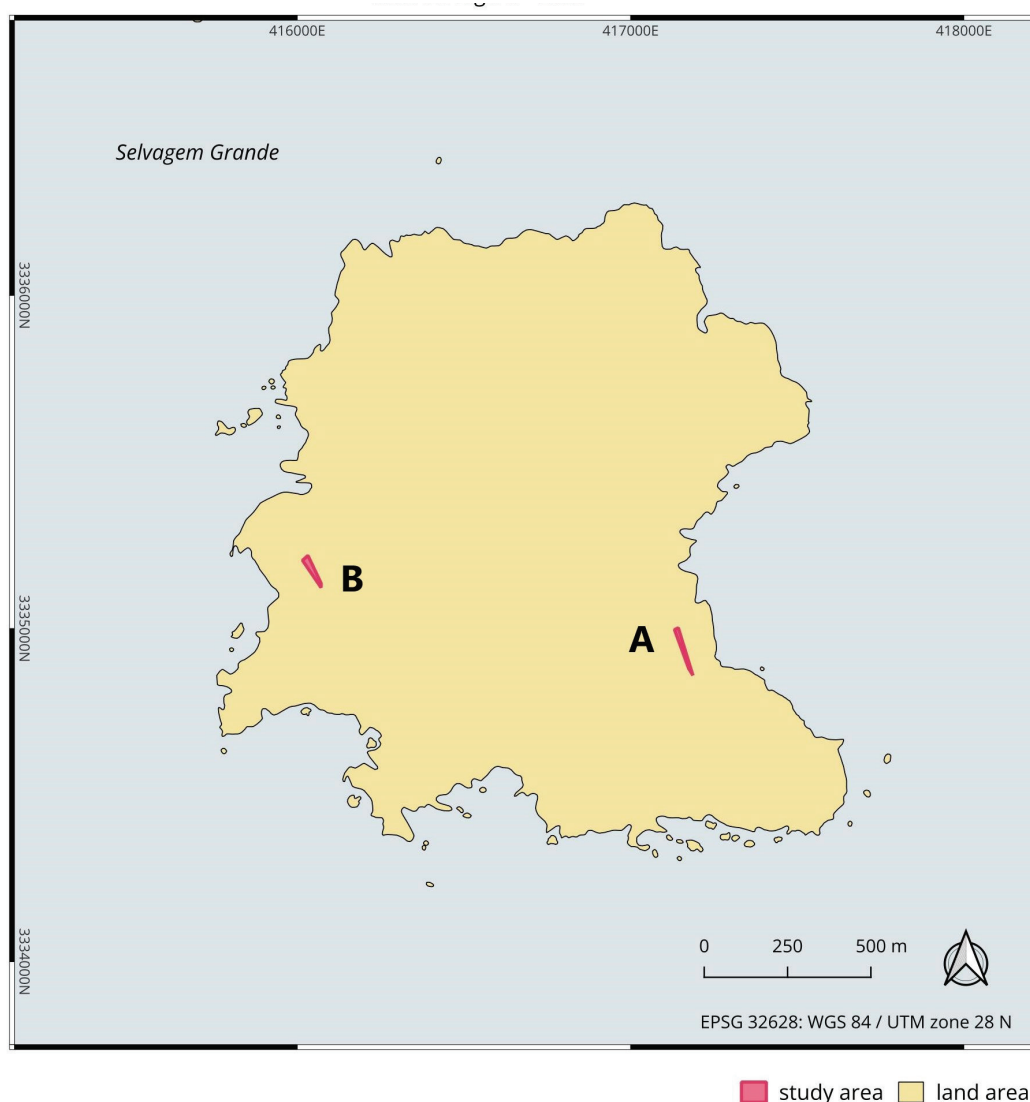
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Map 8 – Monitoring the chronology and reproductive success of Cory's Shearwaters *Calonectris bolearis*: Selvagens Islands, 2023.

Study areas: **A**: ABCD; **B**: EFGH.

Monitoring the breeding population of Yellow-legged Gulls *Larus michahellis* at Selvagem Grande, Selvagem Pequena and Ilhéu de Fora

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Objective / Ecological parameters being assessed

To determine the population trend of Yellow-legged Gulls on the Selvagens Islands.

Background information

The existing background information are the estimates resulting from systematic counts presented by CATRY *et al* (2010), CATRY & MATIAS (2010), and CATRY *et al* (2023).

Description of the activities undertaken

The methodology consists of travelling along the coastline of the three islands (Selvagem Grande, Selvagem Pequena and Ilhéu de Fora) in an attempt to count all the gulls seen (taking care to distinguish between adult and immature birds) and their nests. The gulls' behaviour is carefully observed in order to obtain an indication of the presence of nests or young through their behaviour (e.g. emission of alarm calls or other). Nests are looked for on the ground or on cliffs, particularly where there are indications of their possible presence given by adult birds. Where it is not possible to find nests, the presence and number of adult birds with behaviours showing anxiety are recorded. It should be noted that these gulls rarely feed at sea, so it is easy to count them from land. A final figure of observed nests and probable pairs is obtained.

Expedition Selvagens 50 took place precisely during the incubation period (with some early nests already hatching) of the yellow-legged gulls. During the expedition it was possible to apply the census methodology described above to the three islands of the archipelago and thus obtain an up-to-date estimate of the population (CATRY *et al.*, 2023).

Planning future monitoring

We recommended that this monitoring continues in the future, as gulls have a potential impact on other seabirds. Further, given that gulls often depend on human resources and activities, they give indications on the degree of anthropogenic influence on the environment. However, annual monitoring doesn't seem necessary, especially as the April visits do not fit in with other seabird study projects. Monitoring every 5 years will be enough to assess population trends. On the other hand, it is recommended that the regular counts of gulls in Selvagem Grande carried out by the wardens on duty in the Reserve continue.

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Monitoring the breeding population of Berthelot's Pipit *Anthus berthelotii berthelotii*

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Objective / Ecological parameters being assessed

To monitor the population of Berthelot's Pipit from Selvagem Grande (the only breeding terrestrial bird species) by calculating its relative and absolute density. This approach also aims to assess the impact of the Selvagem Grande terrestrial habitat restoration project on this species.

Background information

The methodology applied was based on that described in OLIVEIRA *et al.* 2010 and unpublished reports from the Selvagem Grande Terrestrial Habitat Recovery Project, used between 2001 and 2005.

Description of the activities undertaken

In order to calculate the relative densities of the Berthelot's Pipit, the four line censuses established in the above baseline reference were carried out: 1 = North, 2 = Wall, 3 = Top House and 4 = South.

The censuses were repeated over four consecutive days from 8.30 a.m. to 10.30 a.m. by two observers. The number of segments studied in each transect (each 100 m long) varied from 7 to 9 (North = 7, Wall = 9, Top House = 8 and South = 7). The average ground speed per segment was three minutes.

All the birds seen or heard were counted in each segment, noting the approximate distance between the contact and the observer (± 10 m). For each contact, it was indicated whether the bird was seen or heard. The surveys were carried out in a W-E direction, which made orientation on the ground difficult.

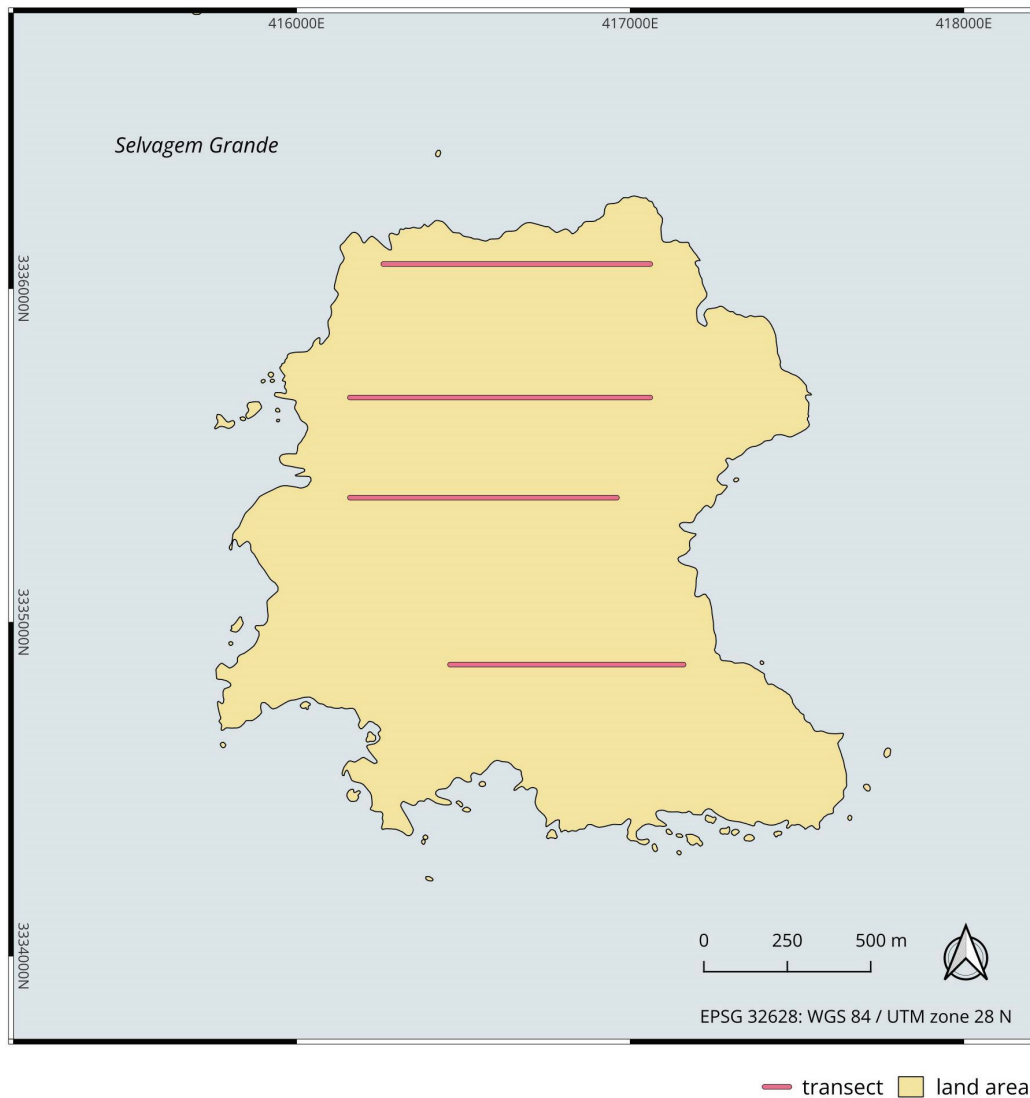
Complementarily, in order to obtain more data such as absolute density, the Distance Sampling method (BUCKLAND *et al.*, 2004) was incorporated. This method requires recording the distances at which birds are detected in relation to the observer's position.

Planning future monitoring

It is recommended that the current monitoring method be continued, *i.e.*, the four linear transects with the current location and length, so that the data can be comparable between years. The work should be carried out every 3 years, at the same time of year, also maintaining the sampling effort (number and length of transects).

To avoid direct sunlight, which makes it difficult to carry out the census, it is recommended to change the direction of the census to E-W. It would also be advisable to check the condition of the signposts to make them more visible and to restore any that have deteriorated or fallen down.

The development of the Distance Sampling methodology for calculating absolute densities still requires processing of the information collected, but it could become a method to be considered in future monitoring. It is important to note that the application of this methodology requires prior training for observers in order to standardise the criteria for estimating distances.



Map 9 – Monitoring the breeding population of Berthelot's Pipit *Anthus berthelotii berthelot*: Selvagens Islands, 2023.

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<https://doi.org/10.1111/j.1749-4877.2010.00186>

Inventorying terrestrial fauna using environmental DNA

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Objective / Ecological parameters under evaluation

Implement a pilot experiment to collect and characterise terrestrial biodiversity and capture genetic signatures of focal taxonomic groups (reptiles) using molecular tools to generate complementary biodiversity data of terrestrial groups (insects).

The aim is to increase the power of detection and identification of terrestrial species, especially those considered cryptic, elusive and/or present in lower abundance at the site, or easily missed detection during the biodiversity assessment period.

The molecular data is intended to complement the one collected by the field teams, especially regarding marine vertebrates and terrestrial and marine invertebrates. Part of the samples collected will be for the exclusive use of the Global Biosciences Centre to test and validate sampling techniques in the field.

Background information

The methodologies applied followed internally validated GBC protocols based on published scientific literature (TABERLET *et al.*, 2018) developed to aim, capture and enrich the molecular signatures of the targeted groups.

Description of the activities undertaken

Concerning the reptile group, composite environmental samples (surface water) were collected in two independent sampling units (100 by 100 m plots) in which *Tarentola bischoffi* (quadrat I9) and *Teira dugesii* (quadrat P13) were visually confirmed and individually counted (see herpetofauna section). In addition, other samples (negative controls) were collected in two independent plots outside Selvagem (coastal areas on the mainland), in places where the species were absent and following the same sampling protocol.

Originally the negative environmental controls were planned to be collected on the island, but due to the ubiquitous presence of both species throughout their area, decision was to collect the controls outside Selvagens to ensure the robustness.

Regarding terrestrial arthropods (*e.g.* insects), vegetation samples were collected within the previously delineated sampling squares (see flora and insect monitoring section). In each of the sampling units (quadrats 3, 4, 5, 6 and Cadeira do Bispo) 100 m linear transects were made. At every 2 m within each transect, vegetation clippings of leaves, flowers and stems were collected paying extra

attention to include the representative plant species from each site, as well as plant body parts from the base, middle and top sections. In total, around 500 mL of vegetation clippings were collected per transect. All sampling material used to process vegetation (e.g. scissors) was carefully sanitized or discarded (gloves) between transects to avoid cross-contamination of samples.

Planning future monitoring

In the future, we propose that the collection of vegetation for environmental DNA be carried out in March, encompassing the peak of arthropod activity and flowering, while also overlapping with the period where previous ecological surveys for arthropods were undertaken in the island. The aim is to increase the chances of detection, but also to assess the applicability and comparability of environmental DNA for characterising the islands biodiversity. It also enables the identifications of existing gaps of genetic barcode coverage for local species. Furthermore, it is recommended to gather other types of vegetation cover and inclusion of micro-habitats that occupy to a lesser extent the islands landscape, given the species' unique ability to use different ecological niches. When it comes to reptiles, the experimental non-destructive sampling approach for occupancy assessment of local species used in this study, demonstrated to not be effective for large-scale application. Additional field studies to assess the sensitivity environmental DNA for detection of target species outside of their activity period (April-October), should also be envisioned in the future.

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3. RESULTS

3.2. Marine environment



Monitoring the thermal habitats of the intertidal zone

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Objective / Ecological parameters under evaluation

To create an integrated monitoring programme for the intertidal zone. This approach aims to monitor temperature and biodiversity in rocky habitats in the intertidal zone of Selvagem Grande and Selvagem Pequena.

Background information

The methodology applied was based on that described in SEABRA *et al.* (2011), SEABRA *et al.* (2015) and new methodologies not yet published developed within the CCTBON network (www.coastalwarming.com/cctbon).

Description of the activities undertaken

The work was carried out at two points, one in Selvagem Grande and the other in Selvagem Pequena. In both cases, work took place on rocky intertidal locations in the vicinity of the landing zones. At each site, temperature loggers were permanently installed in holes in the rocks. These sensors were programmed to record the temperature every hour and will operate for at least 10 years.

At Selvagem Grande, thirty loggers were installed in different microhabitats:

- 3 in the low shore, fully exposed to solar radiation,
- 3 in the low shore, in the shade,
- 5 in the mid-shore, fully exposed to solar radiation,
- 5 in the mid-shore, in the shade,
- 3 in the high shore, fully exposed to solar radiation,
- 3 in the high shore, in the shade,
- 2 on the supralittoral, fully exposed to solar radiation,
- 2 on the supralittoral, in the shade,
- 4 in tide pools in the mid-shore, two pairs with one logger inside the tide pool and the other on the edge.

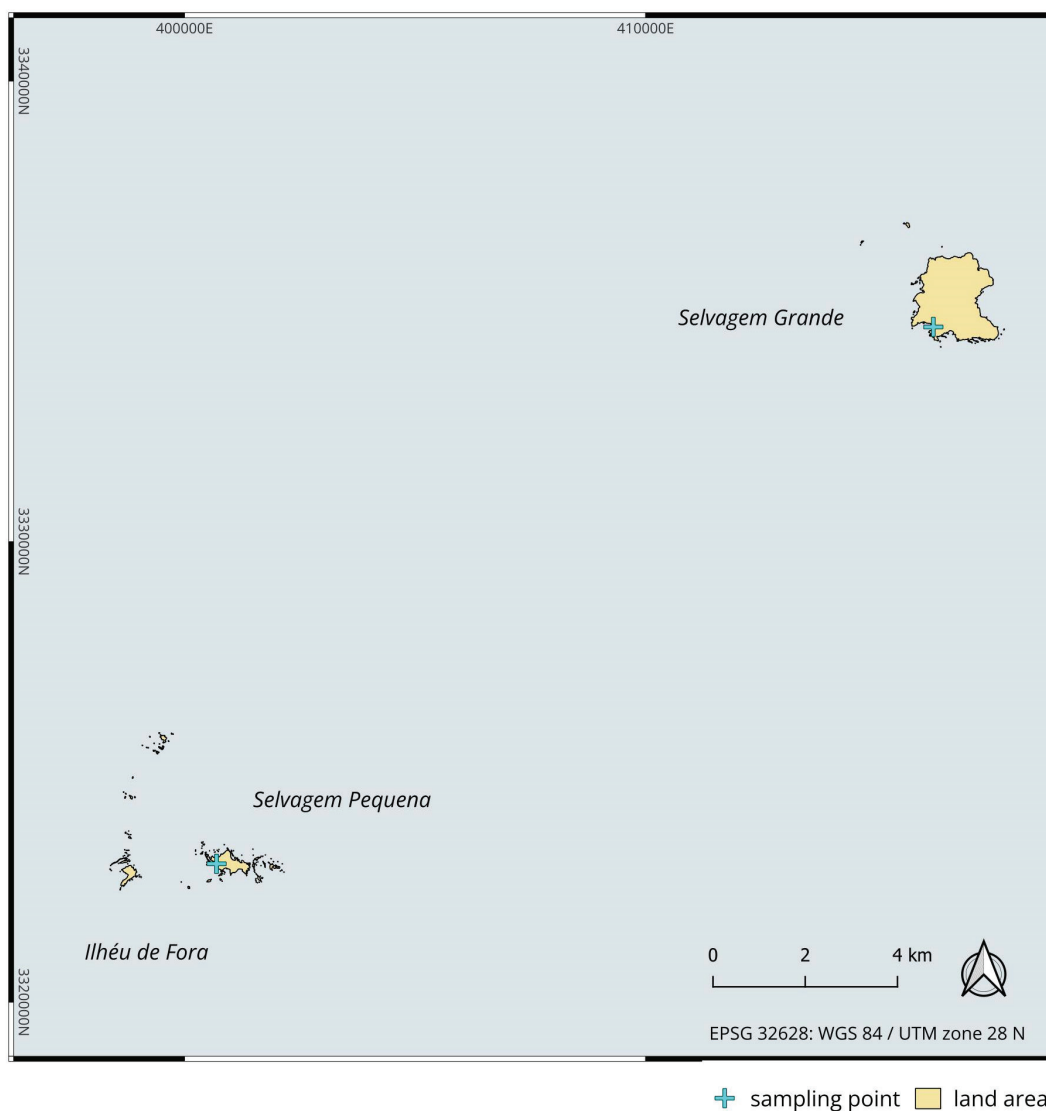
In Selvagem Pequena, 10 loggers were installed:

- 5 in the mid-shore, fully exposed to solar radiation,
- 5 in the mid-shore, in the shade.

At both sites, a survey of the biodiversity present was also carried out by collecting fifty photo-quadrats:

- 10 in the low shore, in flat areas,
- 10 in the mid-shore, in areas fully exposed to the sun,
- 10 in the mid-shore, in shaded areas,
- 10 in the high shore, in areas fully exposed to the sun,
- 10 in the high shore, in shaded areas.

Finally, spherical photographs (360°) were taken of the sites to further contextualise the data collected.



Map 10 – Monitoring the thermal habitats of the intertidal zone: Selvagens Islands, 2023.

Planning future monitoring

On future visits, the temperature data recorded by the sensors will be downloaded, and new biodiversity surveys will be carried out using the same methodology (photo- quadrats). The collection of this data can be flexible in time, but ideally, it should be carried out annually. The CIBIO team will endeavour to speed up this data collection, either by members of the team, or by other researchers or IFCN staff on site. Technological tools (smartphone apps) are currently being developed to facilitate this data collection by people outside the CIBIO team.

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Monitoring the Selvagens Giant Limpet *Patella candei*

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Objective / Ecological parameters under evaluation

To characterise the Selvagens Giant Limpet population with a view to monitoring it.

Background information

The methodology to be used is based on GULLART *et al.* (2022), and follows the protocol prepared by the project SLIP – The Selvagens Limpet Project (ALBUQUERQUE *et al.*, 2023).

Description of the activities undertaken

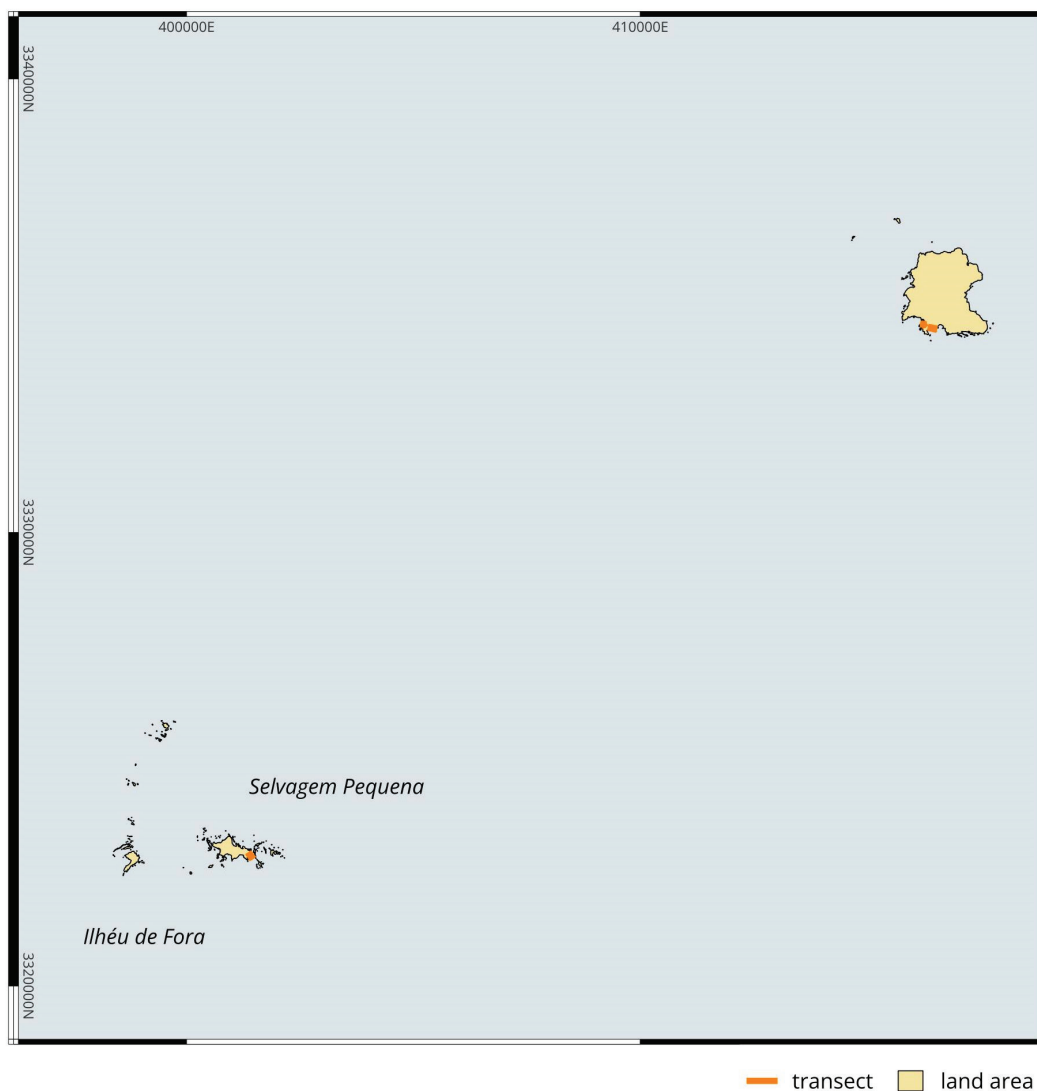
Due to logistics and sampling conditions (unsuitable tidal range) it was not possible to carry out this work during the period of the Expedition Selvagens 50, so it was only carried out later in the first semester of 2024 (summer) and beginning of 2025 (winter).

The Selvagens Giant Limpet population was characterised using the usual methodologies for species with similar ecological characteristics, in order to estimate its population and enable an appropriate monitoring programme. Visual censuses were carried out along parallel transects, perpendicular to the tide line, point-intercept transects and quadrats. All the transects were perpendicular to the tide line and all the specimens spotted were counted, georeferenced and their diameter measured in order to characterise the size structure of the specimens in the population, according to their distribution and density.

Fixed transects were set up along the coastline of Selvagem Grande and Selvagem Pequena so that it will be possible to monitor the population on these two islands (for details refer to ALBUQUERQUE *et al.*, 2023).

Planning future monitoring

Using the fixed transects and the same sampling sites monitoring campaigns should be carried every two years, in the same seasons of year. The summer and winter campaigns of 2024/2025 were also very important to refine field methodologies. It is expected that monitoring campaigns will be carried out by personnel with prior and appropriate training, namely Nature Wardens, as was the case in 2024/2025.



Map 11 – Monitoring the Selvagens Giant Limpet *Patella candei*: Selvagens Islands, 2023.

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[https://doi.org/ 10.1017/S0025315422000923](https://doi.org/10.1017/S0025315422000923)

Inventoring marine fauna using environmental DNA

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Objective / Ecological parameters under evaluation

To implement a pilot study for the collection and characterisation of marine biodiversity using molecular tools to generate complementary marine biodiversity information.

The aim is to increase the power of detection and identification of marine species, especially those considered cryptic, elusive and/or present in lower abundance at the site, or easily escape detection during the period. The molecular data is intended to complement the one collected by the field teams, especially with regard to marine vertebrates and terrestrial and marine invertebrates. Part of the samples collected will be for the exclusive use of the Global Biosciences Centre to test and validate sampling techniques in the field.

Background information

The methodologies applied followed internally GBC protocols based on published scientific literature (TABERLET *et al.*, 2018) developed to aim, capture and enrich the molecular signatures of the targeted groups.

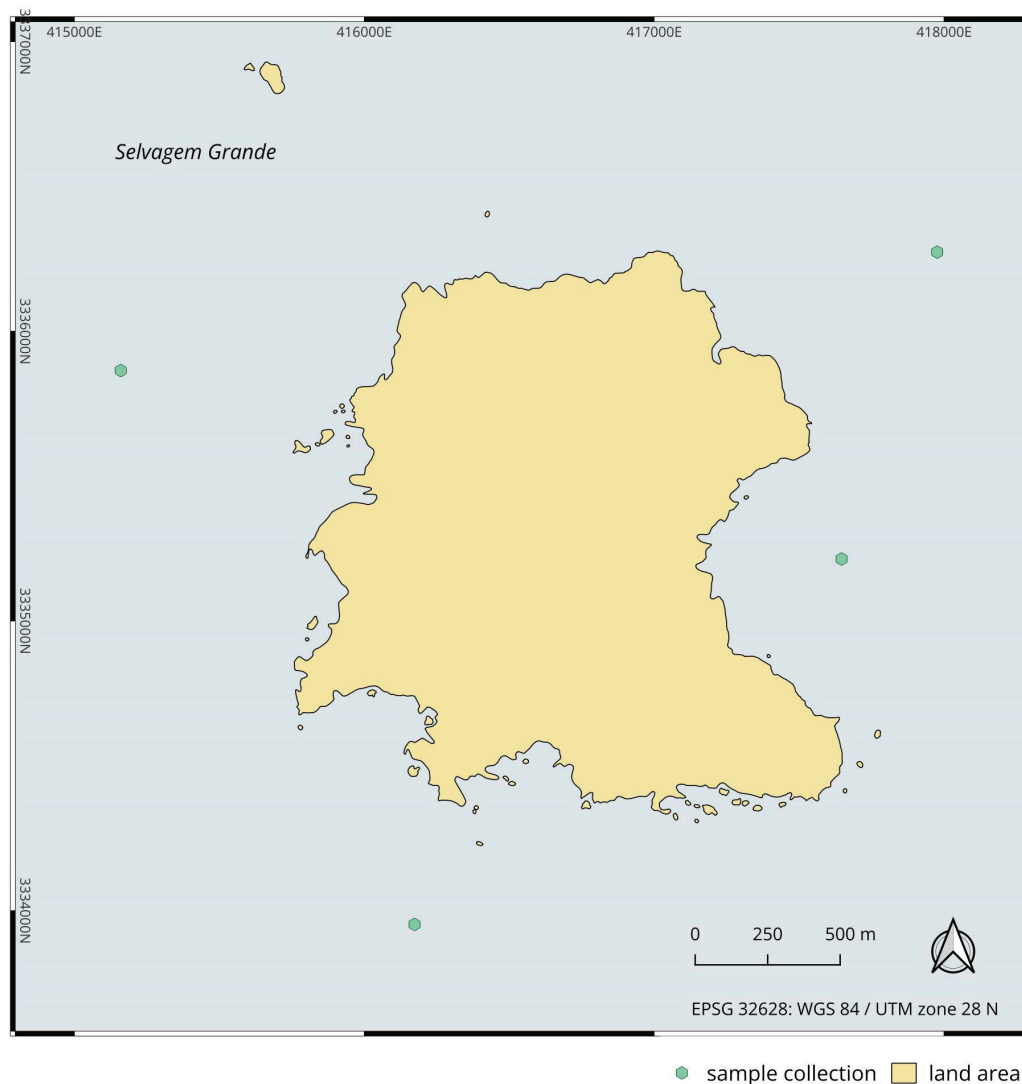
Description of the activities undertaken

To characterize coastal marine biodiversity, deep water samples collections were made. In each of the four dive stations (see section on monitoring coastal ichthyofauna: stations 3, 17, 20 and 26) two water samples (biological replicates) were collected at fixed depth of 20 m. At each diving station, a team of divers collected around 2400 mL of marine water while using sterile bags that were opened, filled, and sealed completely underwater. Prior collection, all samples were kept refrigerated during transportation to then be filtered on the same day using encapsulated 0.8 µm pore filters that extract, concentrate and preserve the environmental DNA until it is extracted in the laboratory analysis. The average processing volume per sampling station was 1200 ± 675 mL.

Due to the allocation and prioritization of field material for other means, it was not possible to carry out the negative controls on site. In addition, unforeseen logistical limitations had not made possible the sampling of a fifth diving station, like originally planned.

To characterize coastal intertidal biodiversity, composite environmental samples (*i.e.* water from puddles in the intertidal zone) were taken in two independent sampling locations, one in Baía das Cagarras (4 x 2 m plot) and another in Baía das Galinhas (10 x 10 m plot). At each sampling location, two environmental duplicates were taken, encompassing six water samples, whose average processed volumes were 433 ± 261 mL. All samples were filtered immediately with the use of encapsulated 0.8 µm pore filters that extract, concentrate and keep environmental DNA integrity until laboratory arrival.

In parallel to water sampling that cover the high and low tide period, in both locations air samples were also taken and processed with the help of airpump units and encapsulated filters for eDNA. The air sampling window varied between 3 and 5 hours.



Map 12 – Inventorying marine fauna using environmental DNA: Selvagens Islands, 2023.

Planning future monitoring

It is advisable to collect stratified samples throughout the water column and to include sampling quadrats for spatial coverage enhancement around the islands, with a special focus on areas of conservation interest. To characterize seasonal or temporal community (e.g. migration or assessment the impact of total protection measures), sampling can be adapted to fixed transects and conducted with the support of vessels that regularly provide logistical assistant in the field.

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Prospecting habitats of interest to the Mediterranean Monk Seal, *Monachus monachus*

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Objective / Ecological parameters being assessed

To assess the potential of the Selvagens Islands as a habitat for the Mediterranean Monk Seal by mapping and characterising caves and beaches of interest to the species.

Background information

The exploration and assessment of submerged coastal caves was carried out using a methodology adapted from the protocol for exploring submerged caves (CBD-Habitat, 2015), created by the CBD Habitat Foundation as part of the LIFE Madeira Monk Seal Project (LIFE13 NAT/ ES/000974).

In turn, the methodology applied to the exploration and assessment of beaches was based on the coastal characterisation work carried out by SILVEIRA *et al.* (2013), adapted to the context and objective of the work.

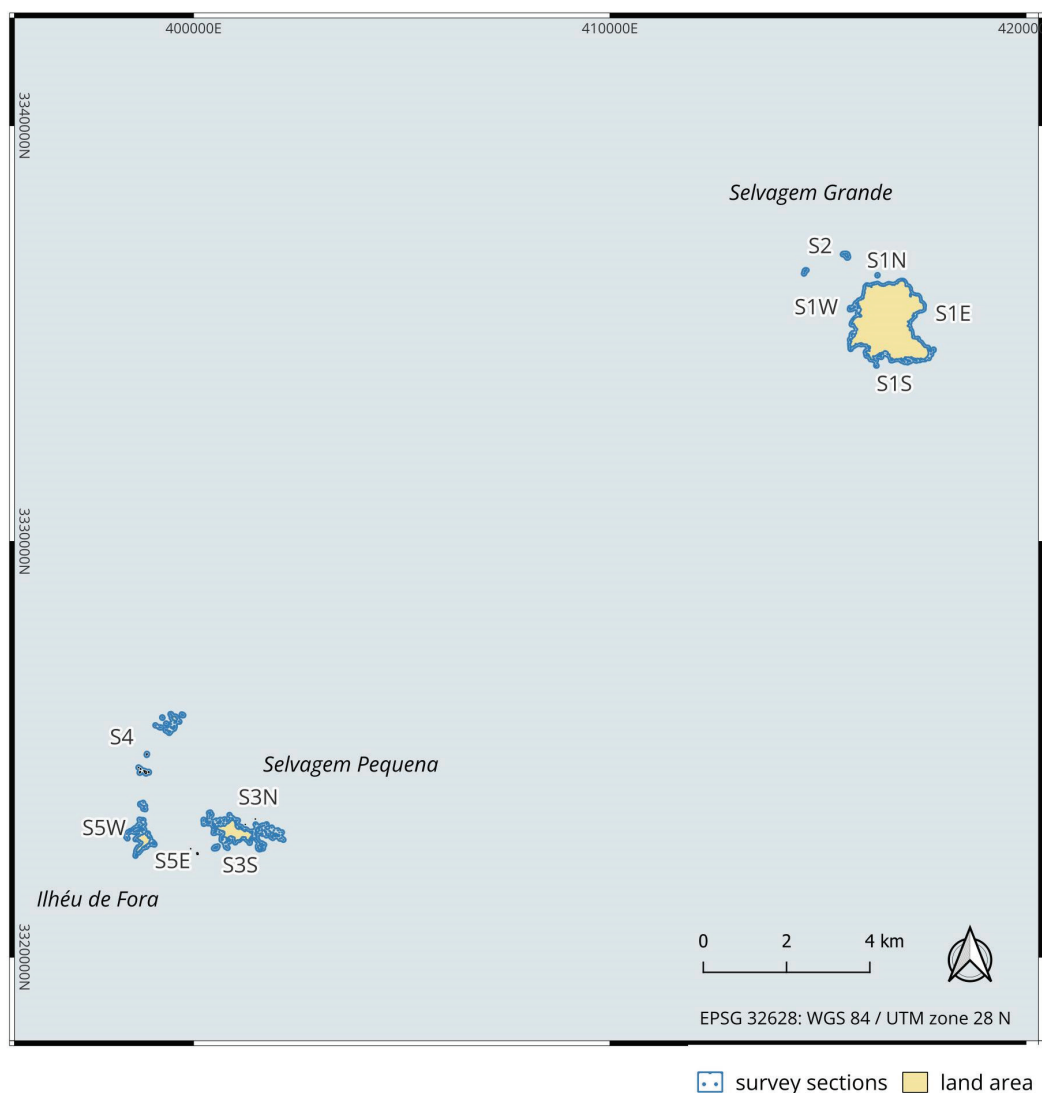
Description of the activities undertaken

The Selvagens Islands were divided into ten main sections, which in turn were subdivided into sub-sections. In each sub-section, the coastline was surveyed using a boat (inflatable boat) and with a team of four elements.

In this study, caves and beaches of interest to the monk seal were considered to be those with access by sea, suitable for the comfortable passage of seals, and an area emerged at high tide that can be used to carry out their activities (*e.g.* resting, calving, breastfeeding, socialising, etc.). In the case of caves, they should also have an airlock.

Each cave and beach assessed was assigned a code and information was collected on its location, morphological characteristics, dimensions of the different sections (resting surface, airlock, tunnel and entrance), access and blockages of passage / access routes, and other specific characteristics that might be relevant to each site. All the caves and beaches were photographed on land and from the air (using a drone). This data was taken at high tide and low tide. In addition, for each cave and beach an approximate drawing of reality was made, which will later be worked on with the rest of the data, with the aim of creating a 2D image of the caves and beaches.

Given the logistical and time constraints, the exploration of submerged caves was not considered, and only those with surface entrances and beaches were explored.



Map 13 – Prospecting habitats of interest to the Mediterranean Monk Seal, *Monachus monachus*: Selvagens Islands, 2023.

Planning future monitoring

The data collected could be complemented with monitoring at different times of the year and with different tidal ranges, in order to obtain a more in-depth study of the dynamics of these sedimentary environments, especially the beaches.

It would also be interesting to complement this study with monitoring of the food resources available to this species in the Selvagens Islands, which could be done using the information gathered by the team that carried out the ichthyofauna censuses in the subdital.

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Monitoring of cetaceans

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Objective / Ecological parameters being assessed

Passive acoustic monitoring and point sampling from land to assess cetacean populations around Selvagem Grande.

Background information

The methodology applied was based on that described in FREITAS *et al.* (2004), BUCKLAND *et al.* (2004) and ZIMMER (2011).

Description of the activities undertaken

Three transects were surveyed from the ship: (i) between the island of Madeira and Selvagem Grande, (ii) between Selvagem Grande and Selvagem Pequena and (iii) between Selvagem Pequena and the island of Madeira back to Madeira. Point surveys were also carried out from land, at the top of Selvagem Grande in a southerly orientation covering an angle of 160 to 270 degrees, with an average of six hours of effort per day over four days.

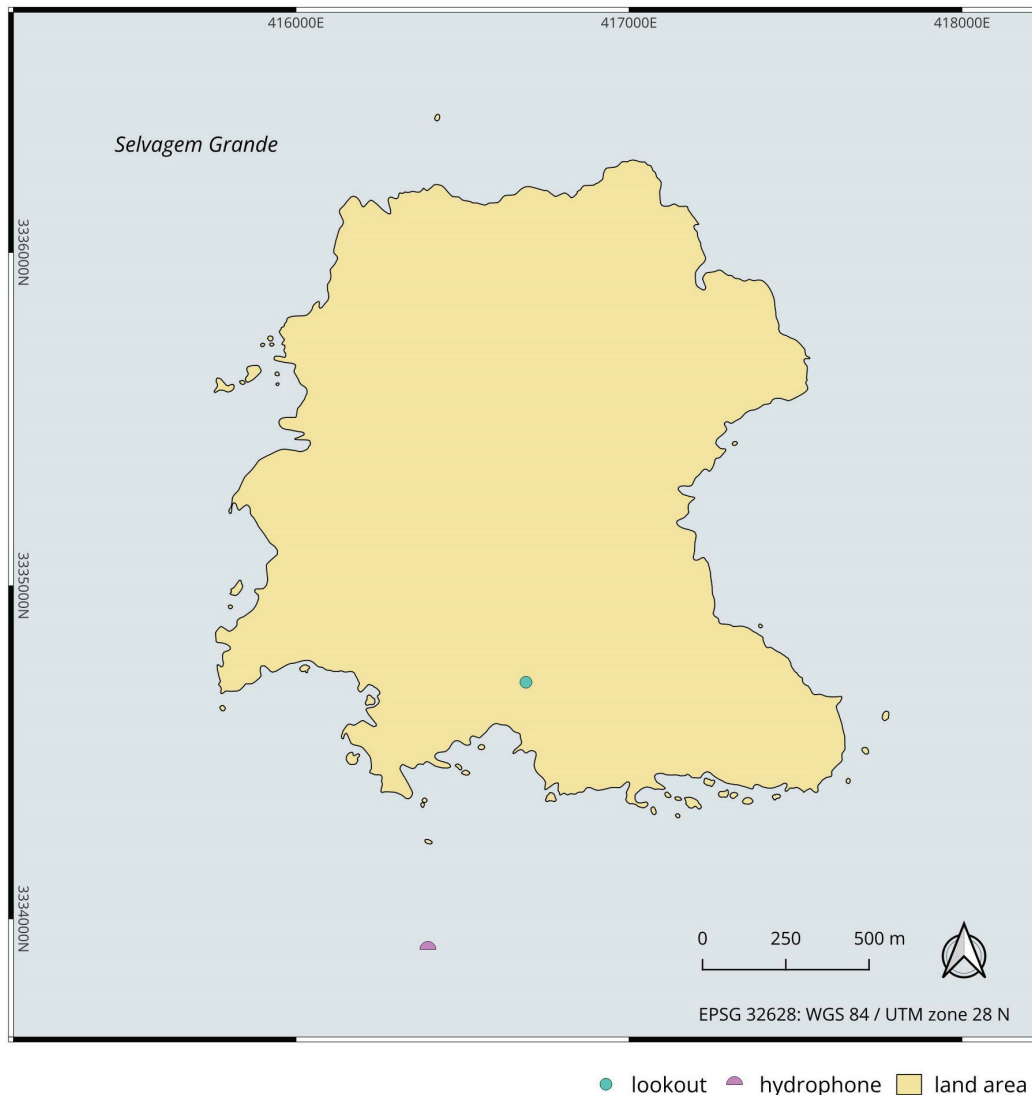
In addition, a hydrophone was anchored in Selvagem Grande for four days, recording three minutes every 15 minutes at 192 kHz. The coverage area of the hydrophone varies according to the frequency bands of the cetacean species detected and the propagation conditions of the medium and the depth of the hydrophone (ZIMMER, 2011).

Visual and acoustic data will be cross-referenced to compare visual detections with acoustic detections.

Planning future monitoring

This census method is recommended to be continued, both visually and acoustically. This monitoring should be carried out every 3 years, at the same time of year, while maintaining the sampling effort.

It is recommended to implement systematic visual censuses (distance sampling) and photo-identification campaigns on the Selvagens Islands as standard monitoring methodologies, as they produce comparable results over time. These methodologies were not proposed for this campaign due to the logistical and time constraints for their planning and implementation. Systematic visual and photo-identification campaigns were carried out by the Whale Museum in 2002 (FREITAS *et al.*, 2004) and could be considered to be complementarily implemented in the Selvagens Islands.



Map 14 – Monitoring of cetaceans: Selvagens Islands, 2023.

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Monitoring the sub-tidal communities of ichthyofauna, macroflora and macrofauna

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Objective / Ecological parameters being assessed

To characterise the subtidal marine biodiversity of the rocky bottoms of the Selvagens Islands in the 10 and 20 m depth strata, by assessing: (i) species composition, (ii) density of fish and mobile macrofauna, (iii) biomass and trophic structure of the fish community, as well as (iv) percentages of coverage of sessile functional groups (flora and fauna). Subsequently, the aim is to consolidate a monitoring programme aimed at these communities.

Background information

The methodology used was based on FRIEDLANDER *et al.*, 2017.

Description of the activities undertaken

A total of 84 dives (man / dive) were carried out covering 14 sites (of which 11 in Selvagem Grande and 3 in Selvagem Pequena), in two depth strata, 10 and 20 m.

The underwater sampling was carried out between 8.30 am and 5.00 pm by three teams of two divers, totalling 78 hours of underwater work. A total of 83 transects were carried out (25 x 4 m - 100 m² transects to identify and quantify benthopelagic fish and 25 x 2 m - 50 m² transects to identify and quantify cryptic fish), comprising 3 transects for each depth stratum at each of the sites.

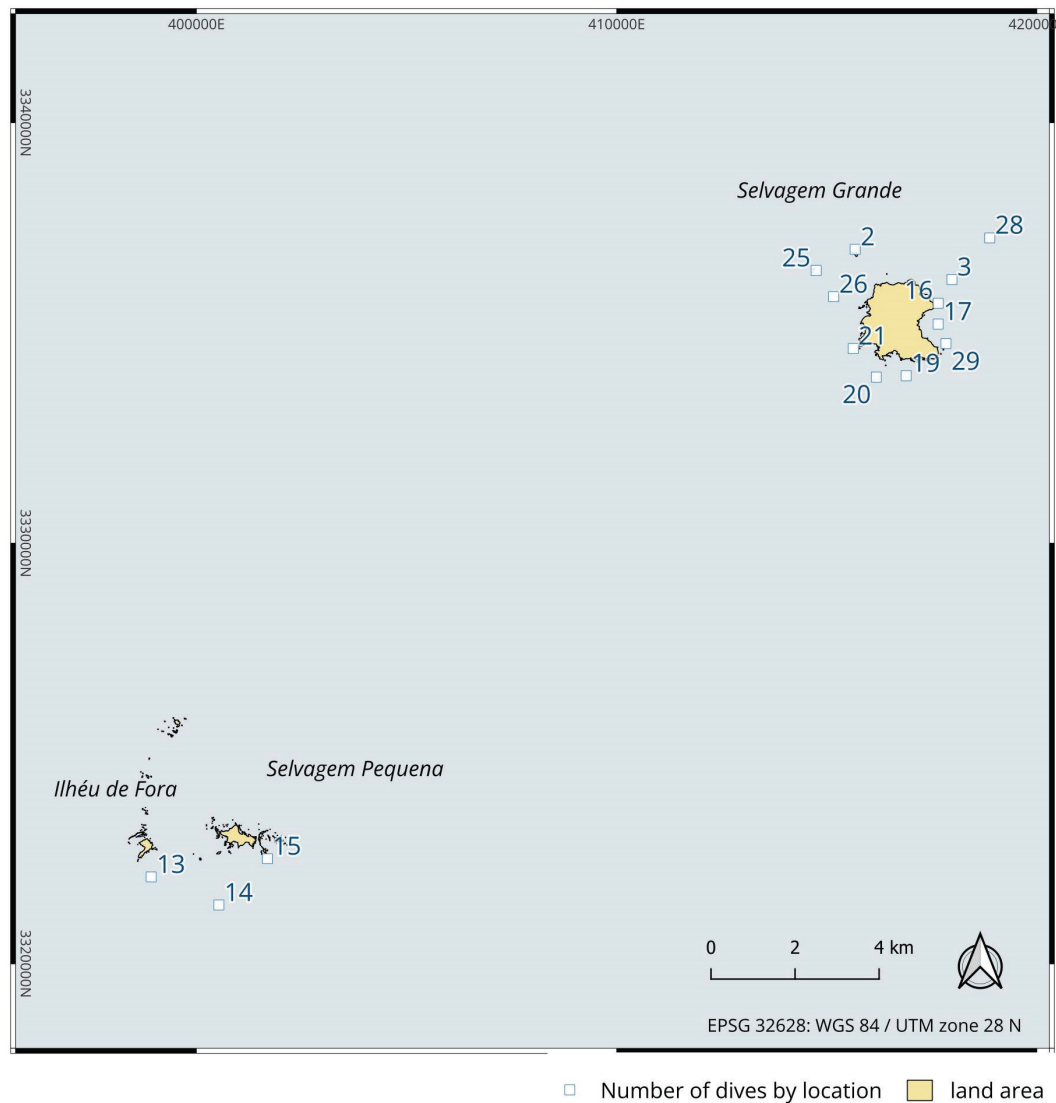
In terms of the sessile macrofauna and flora, 27 transects of 25 metres in length were carried out using the point-intercept method (every 20 cm). In turn, the identification and quantification of the mobile macrofauna was carried out in a total of 27 transects (25 x 2 m), along the same transect in which the estimate of the sessile cover of macroflora and macrofauna was carried out. In addition, images were taken of the habitat, the species and the work carried out by the observers.

In the transects designed to identify and quantify the ichthyofauna, as the observer moved along, he unwound the cable and identified and quantified all the fish species (down to the lowest possible taxonomic level) detected in a 2 metre area on either side of the line, until it was 25 metres long. As well as counting the number of fish per species, he also estimated the size of the individuals to the nearest centimetre. On the return journey, the same observer identified, quantified and estimated the size (to the nearest centimetre) of the cryptic fish he detected (fish that hide in holes, crevices), within a 1 m strip on either side of the transect line.

In addition to the species observed during the transects, all the fish species seen at the dive sites were recorded to complete the list of species present.

For the sessile fauna and flora, once the transect had been established, the observer moved along the measuring tape previously extended and, every 20 cm, recorded the functional groups of algae and invertebrates (according to a pre-defined list) under the tape, until the total length was reached (25 m).

It should be noted that as part of this underwater characterisation work, some changes were made to the FRIEDLANDER *et al.* (2017) methodology (for more information contact the team responsible). Nevertheless, the data obtained is comparable to that of FRIEDLANDER *et al.* (2017).



Map 15 – Monitoring the sub-tidal communities of ichthyofauna, macroflora and macrofauna: Selvagens Islands, 2023.

Planning future monitoring

It is recommended that the methodology of underwater censuses be continued, which should be carried out every 3 years in spring and summer. However, in order to maximise the effectiveness of the teams and collect more detailed information, some changes are recommended, particularly in the

methods and operation: (i) use 2 teams of 3 divers; (ii) eliminate the point intercept transect method for sessile fauna and flora, and replace it with the Point intercept method in situ quadrats (10 quadrats with 15 intercept points) and photo quadrats (6 to 10) along the transects targeting ichthyofauna and macrofauna; (iii) change the mobile macrofauna transects to 3 strip transects (25 x 2 m). They should be carried out under the ichthyofauna transects and just after the benthopelagic ichthyofauna transects; (iv) it is proposed to place temperature and light sensors at some of the sites in the two depth strata, for periods of at least 6 months, but in order to cover several annual cycles; (v) if possible, additionally implement other methodologies such as BRUV'S (Baited Remote Underwater Video) and Drop-cam.

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Monitoring pelagic fauna

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Objective / Ecological parameters being assessed

To assess the presence of pelagic marine fauna species and their temporal distribution with a view to implementing a non-intrusive monitoring programme.

Background information

Passive acoustic monitoring, with the deployment of a hydrophone based on the methodology described in ROMAGOSA *et al.* (2021), MERKENS *et al.* (2021), and WARREN *et al.* (2021). At the same time, BRUV (Baited Remote Underwater Video) surveys will be used, following the methodology described in GOETZE *et al.* (2021) and MACNEIL *et al.* (2020).

Description of the activities undertaken

For logistical reasons, it was not possible to carry out this work during the Expedition Selvagens 50, so it will take place during the first semester of 2024. At that time, following the basic reference methodology, we will place a hydrophone (RTsys sylence LP with RTsys integrated hydrophone; <https://rtsys.eu/acoustic-recorders>) in a location to be defined between 18-30 m deep for six months in order to record the sounds of pelagic fauna, with particular emphasis on marine mammals, to study their seasonal distribution. The hydrophone will then be collected at a later date for the data to be downloaded and analysed.

At the same time, the use of BRUVs will make it possible to collect video images to study and monitor the pelagic marine ecosystem, in particular its biodiversity and abundance. It is an effective, non-invasive and very efficient method. It will be carried out at a location to be agreed upon with the IFCN team, depending on the weather conditions at the time of the campaign, over four days. It can be repeated in each campaign to allow biodiversity to be monitored.

Planning future monitoring

This planning can only be carried out after evaluating the results obtained during the 2024-2025 campaign.

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Assessment and monitoring of colonisation by benthic species

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Objective / Ecological parameters being assessed

To study the colonisation of benthic species in artificial structures with the aim of creating a specific monitoring programme. This approach aims to assess the benthic, sessile and mobile macro-invertebrate communities of the submerged coastal rocky bottoms of Selvagem Grande.

Background information

Pilot study in the Madeira Archipelago focused on the recruitment and structure of the sessile benthic community and associated cryptic organisms, using 'ARMS – Autonomous Reef Monitoring Structures' developed by the Smithsonian Institution (PEARMAN *et al.*, 2019, DIEM *et al.*, 2023).

The study is part of the development of monitoring programmes developed / optimised in the PLASMAR+ project and is part of the Smithsonian Institute's Global ARMS Monitoring Programme.

Description of the activities undertaken

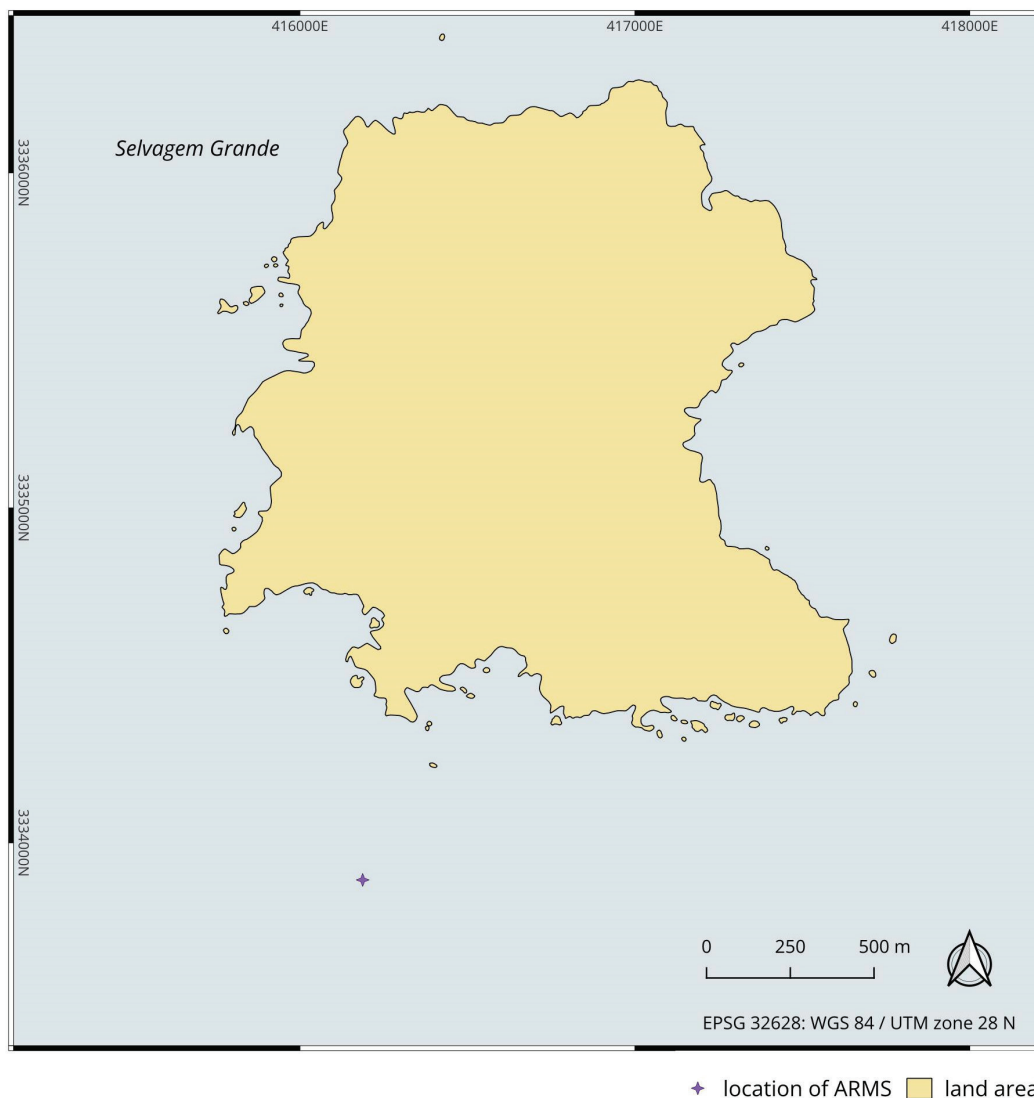
The work involved placing three ARMS structures, 20 kg each, at a depth of 24 m (in order to reduce the risk of losing or damaging the structures due to adverse weather conditions) on the south coast of Selvagem Grande (N 30.13343° W 15.87015°). The ARMS are polyvinyl chloride (PVC) structures made up of a stack of nine plates resting on a base with two lead ingots (10 kg each). In the spacing between plates, four are open, allowing sessile organisms to attach to the plates, and four contain a cross-shaped structure to provide refuge for mobile macrofauna. The operations were carried out on board one of the support boats and involved a total of four operatives. The ARMS were placed 3-5 metres apart on a rocky bottom consisting mainly of pebbles, in a protected bay between two underwater lava flows.

Planning future monitoring

In general, ARMS structures should be monitored regularly every 24 months. However, given the isolation of the Selvagens Islands and all the logistical constraints that this entails, monitoring ARMS in the Selvagens may have to be opportunistic.

Depending on the weather conditions, the state of the sea and the logistics of access to Selvagens, the structures will be collected and, if deemed relevant, replaced with new ARMS, in order to guarantee sampling and temporal monitoring.

Even so, the MARE-Madeira team, after carrying out the first sampling of the ARMS already placed on the south coast of Madeira Island, will evaluate the possibility of using this method for a future specific monitoring programme.



Map 16 – Assessment and monitoring of colonisation by benthic species: Selvagens Islands, 2023.

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Prospecting and monitoring rhodolith beds

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Objective / Ecological parameters being assessed

To survey the seabed around the Selvagens Islands using a drop-cam with the aim of (i) confirming the presence of rhodoliths in areas already reported in previous work (MARBIS, SEDMAR), (ii) scan areas not yet surveyed in the bathymetric range of 30 to 50 m, and subsequently (iii) create a monitoring programme targeted at this habitat.

Background information

The methodology used was based on that described in NEVES *et al.*, 2021.

Description of the activities undertaken

Due to the limited time available to carry out this work and an electronic problem with the equipment, it was not possible to carry out the proposed work.

However, during other work carried out as part of the Expedition Selvagens 50, by scuba diving (see section on community monitoring), it was possible to detect several previously unknown rhodolith beds.

Planning future monitoring

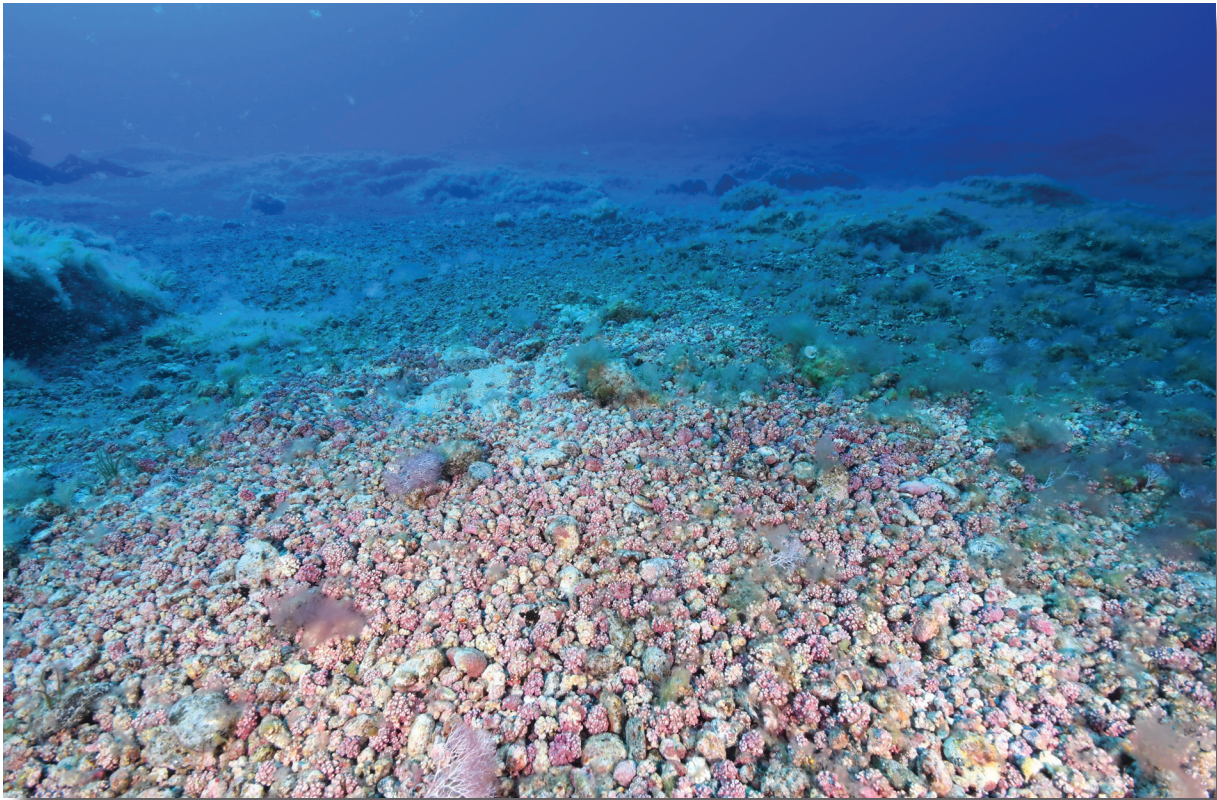
The data obtained during the dives allows us to predict the occurrence of the habitat in various other places in the archipelago, especially at greater depths. In this context, it is recommended that complementary methodologies be used to detect and quantify the areas occupied by rhodolith beds in the Selvagens Islands, namely: ROV, Drop-Cam and diving. The use of Drop-Cam is the method that seems most feasible due to its lesser logistical involvement, as well as the speed with which it can cover a larger area to be prospected, as long as it is in shallower areas (up to 50 metres).

A general survey of the bottom of the Selvagens Islands should be carried out to a depth of around 150 metres, in order to map the existing rhodolith beds. Once this habitat has been mapped, rhodoliths should be collected for taxonomic identification of the species that make up the beds, as well as the associated fauna and flora. In shallower beds (< 30 m), collecting can be made by diving with a corer and in deeper areas, dredging can be carried out (*e.g.* with a Van Veen grab sampler).

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Monitoring oceanographic parameters

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Background information

The methodology applied was based on that described in PINKEL *et al.*, 2011 and AZEVEDO *et al.*, 2021.

Description of work carried out

The wirewalker (WW) was used to carry out work around the Selvagens Islands. The WW is an autonomous (drifting) oceanographic platform that uses waves to profile the water column vertically. It generates one-dimensional vertical profiles that are converted into two-dimensional depth-time records. In this study, the water column was profiled to a depth of 50 m using a CTD sensor (Conductivity, Temperature and Pressure – RBRconcerto3), sampling at 6Hz. Scientific data were collected during free and uninterrupted ascent, which occurred at a rate of 0.5 m/s. A carbon dioxide sensor was also used at 1.2 m below the sea surface. In the lower atmosphere, parameters such as air temperature, wind speed and direction, and carbon dioxide concentrations were also sampled. A total of four launches were carried out: three in the east and west of Selvagem Grande, and one in the south-west of Selvagem Pequena, covering a total of 19 km. All launches and retrievals of the equipment were logistically supported by the vessel Santa Maria Manuela, along with its tender and crew.

Planning future monitoring

Monitoring oceanographic / atmospheric parameters is essential for characterising the surrounding ocean. Sustained, continuous measurements will allow us to gain knowledge and thus take informed action to recover and protect the Nature Reserve. To this end, it would be advisable to deploy equipment, such as the WW, for cyclical periods (1 month) throughout the year to identify seasonal variations. From a climate change perspective, carbon dioxide measurements have made it possible to assess how the presence of oceanic islands such as Madeira and the Selvagens can influence the global carbon balance.

Monitoring plastics in white-faced Storm Petrels *Pelagodroma marina* in the Selvagens Islands

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Objective / Ecological parameters being assessed

To determine the degree of plastic contamination in the white-faced storm petrels, as biological samplers of the ocean around the Selvagens Islands.

Background information

The methodology followed is that presented in FURTADO *et al.*, 2016.

Description of the activities undertaken

White-faced storm petrels are one of the main prey items of gulls nesting on the Selvagens Islands. The gulls often swallow their prey whole and then regurgitate a pellet made up of bones and feathers, which also includes plastics that were present in the digestive tract of the prey. The method consists of collecting fresh and apparently intact gull pellets (including the wings and legs of their prey). These pellets should be placed individually in clean plastic bags and then analysed in the laboratory using a magnifying glass, counting and characterising the plastic particles. This procedure provides a measure of plastic contamination in the white-faced storm petrels. The pellets can be collected on any of the three islands (Selvagem Grande, Selvagem Pequena or Ilhéu de Fora).

During the Expedition Selvagens 50, around twenty fresh, intact pellets were collected on Selvagem Pequena and Ilhéu de Fora. Due to time constraints and the existence of other tasks, sampling could not be more extensive.

Planning future monitoring

White-faced storm petrels, which are highly mobile pelagic birds, represent a rare opportunity to monitor the presence of microplastics in a vast area of ocean around Selvagens. This region of the subtropical Atlantic, especially in pelagic environments, is considerably under-sampled in this respect, so this monitoring is of considerable interest. It is recommended that this monitoring is continued at regular intervals, according to funding opportunities.

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Monitoring marine litter on Selvagem Pequena

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Objective / Ecological parameters being assessed

Setting up a marine litter monitoring programme in Selvagem Pequena by carrying out a 100 m linear transect with characterisation of the items collected (individual counting and total weighing).

Background information

The basic methodology is that defined in the OSPAR Convention's guidelines for monitoring marine litter on beaches (WENNEKER *et al.*, 2010, OSPAR AGREEMENT, 2020).

Description of the activities undertaken

The work programme consisted of marking out a 100 m transect at Praia do Cerno, in the north-western part of Selvagem Pequena, to collect and characterise marine macro-litter. This was the first task in setting up a programme to systematically monitor and analyse this issue on the island. This beach was chosen because it is the only beach on the island that fully complies with the requirements of the OSPAR Convention's reference methodology, and it is also the beach where litter has accumulated the most over the years.

Marine litter was monitored over two days, then characterised and weighed.

It should be noted that certain items, due to their size / weight (such as wood, nets and cables), were counted, characterised and weighed but were not collected or transported to Funchal, due to logistical constraints.

In parallel with this work, a survey of marine litter was also carried out on the remaining beaches of Selvagem Pequena.

In addition, drone images were taken along Praia do Cerno, in Selvagem Pequena, to explore the possibility of using analysis software to calculate the presence of marine litter on that island, comparing it with the data produced by the methodology implemented and described here.

Planning future monitoring

It is recommended that this monitoring method be continued by carrying out a linear transect with the current location and length, at least once a year, if possible at the same time of the year, so that the data can be comparable between years.

It would also be important to guarantee the logistics needed to clean up and remove the marine litter on the other beaches in Selvagem Pequena, given the potential damage that the permanence of this waste has on the site's pristine ecosystems.



Map 17 – Monitoring marine litter on Selvagem Pequena: Selvagens Islands, 2023.

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4. FINAL CONSIDERATIONS

Taking into account all the work carried out during the Expedition Selvagens 50 described here, as well as the planning presented for future specific monitoring, it is clear that the Nature Reserve of Selvagens Islands is now well-appointed with a monitoring programme that will enable a continuous assessment of the conservation status of its species and habitats, guiding decision-making and the management of this important reserve. The methodologies and approaches now defined are replicable, simple and in some cases could be developed by people other than specialists. In addition, they are generally based on traditional techniques that do not require the use of expensive equipment or heavy and / or costly logistics. Obviously, there is a clear exception here for surveys carried out using DNA techniques.

An easily identifiable gap that should guide future investments and approaches has to do with prospecting and monitoring the water column and deeper seabeds. The first priority, as it is also the simplest to achieve, should be to repeat the surveys carried out by the National Geographic Expedition between 20 and 200 metres deep. Given the logistics and costs associated with this work, it is possible that it will be carried out soon.

The deep sea work is more complex, logistically and financially. We think this is the biggest challenge for the future, and it is important to bear in mind that the marine area of this reserve reaches depths of over 3000 metres.



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32 Fotografias // Photographs
18 Mapas // Maps

CONTRACAPA

