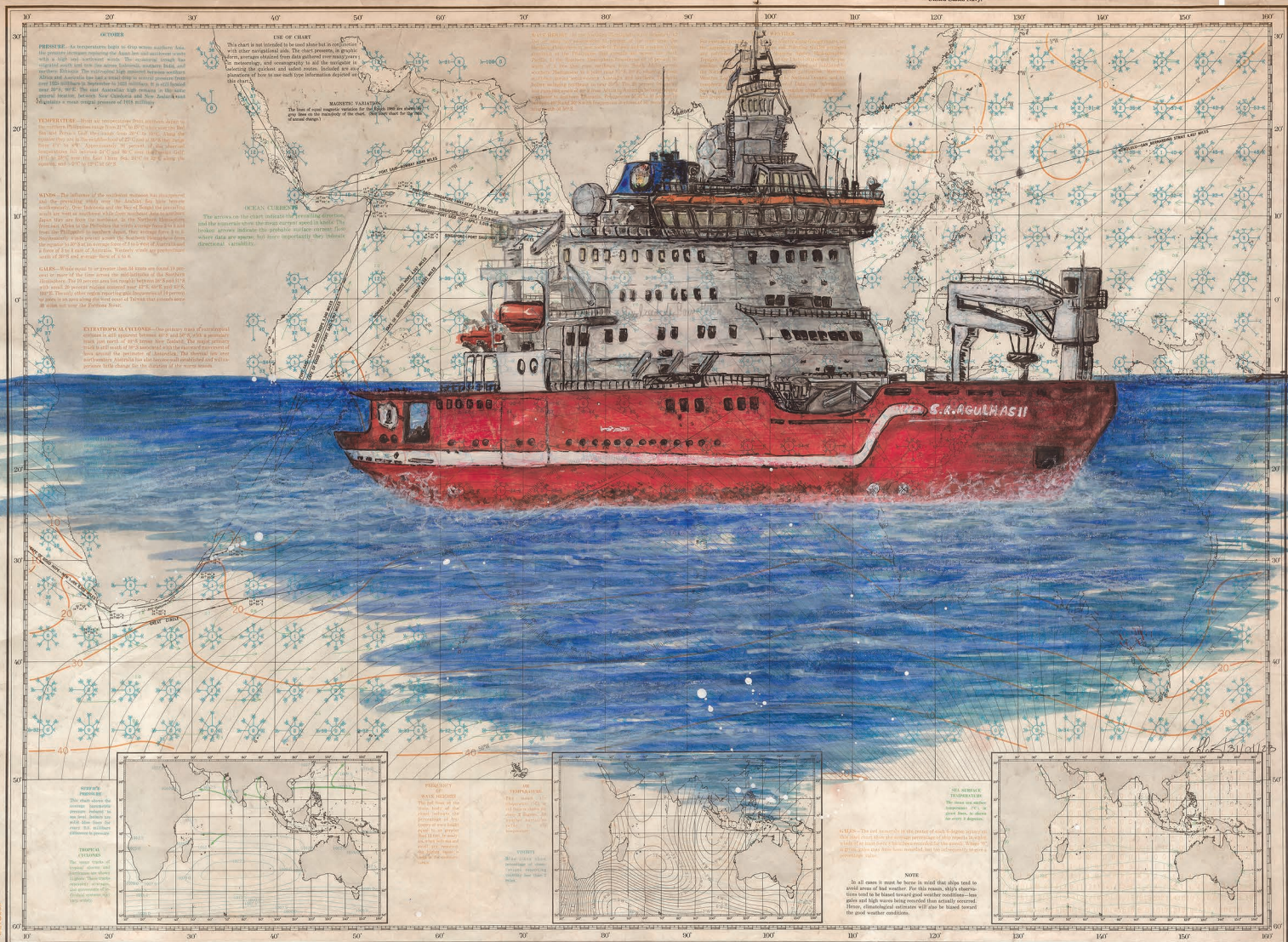




**MONACO EXPLORATIONS**  
Reconnecting Humanity and the Sea

PILOT CHART OF THE INDIAN OCEAN

Founded upon the researches made in the early part of the nineteenth century by Matthew Fontaine Maury, while serving as a Lieutenant in the United States Navy.



# INDIAN OCEAN EXPEDITION

## 2022 FINAL REPORT

### MAY 2026

Presented from data furnished by the UNITED STATES NAVAL OCEANOGRAPHIC OFFICE of the Department of the Navy and by the ENVIRONMENTAL DATA AND INFORMATION SERVICE, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION of the Department of Commerce, and published by the GEODETIC SURVEYING SERVICE, HYDROGRAPHIC OFFICE, WASHINGTON, D.C., 20540.

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**MONACO EXPLORATIONS**

*Reconnecting Humanity and the Sea*

# INDIAN OCEAN EXPEDITION 2022 FINAL REPORT MAY 2026



**2021  
2030** United Nations Decade  
of Ocean Science  
for Sustainable Development



2nd International  
**Indian Ocean  
Expedition**  
2015-2025



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# 1. INTRODUCTION

## 1.1. OBJECTIVE AND SCOPE OF THE REPORT

This is the final report of the 2022 Indian Ocean Expedition organized by Monaco Explorations. It builds on and supersedes the preliminary reported in August 2023 and provides a summary of the cruise, an assessment of the data, samples and research results

to date, a description of all outreach, capacity building, and communication activities related to the expedition, as well as a description of the governance and policy-related actions. It offers recommendations on follow-up actions.

## 1.2. OBJECTIVES OF THE EXPEDITION

Monaco Explorations “Indian Ocean Expedition” is the first element of the “Monaco Explorations” project endorsed by the United Nations Decade of Ocean Sciences for Sustainable Development 2021-2030. The project is composed of collaborative international expeditions combining scientific research, public outreach, and government cooperation through the transdisciplinary approach underpinned by sustainability science. It will investigate selected marine areas worldwide with the following objectives:

- To understand through a multidisciplinary scientific approach the ecosystemic status and functioning of the area explored and to advise stakeholders through a holistic scientific approach (sustainability science).
- To share the issues and knowledge with the greatest number of people through an ambitious outreach programme.
- To mobilize governments through diplomatic action by making available information and analyses to support the sustainable management of maritime areas.

The aim of the expedition was to investigate the area between Réunion Island, Mauritius, and Seychelles with three different geographic scopes:

- The region as a whole: the objective was to improve the understanding of the regional ocean dynamics.
- Two visible islands: Aldabra (Seychelles) and Saint-Brandon (Mauritius). The objective was to characterize the function of shelters for biodiversity and to help preserve them against the impacts of anthropic pressure and climate change.
- The invisible island: the Saya de Malha Joint Management Area of Extended Continental Shelf between Mauritius and Seychelles. This area was the priority focus of the expedition. The objective was to gather scientific elements that could help consolidate the joint governance of a relatively unknown area with potential outstanding universal value.



Map of the expedition area.

The expedition was endorsed by the 2<sup>nd</sup> International Indian Ocean Expedition (IIOE-2). It took place onboard the South African oceanographic research and supply ship *S.A. Agulhas II*. It involved more than 150 participants, from about 20 different countries, including scientists, young researchers and students at the onboard school, filmmakers and photographers, divers, artists, communicators, and the vessel crew.

Atoll (Seychelles), on the Saya de Malha Bank, to which 15 days of investigations were devoted, and finally around the island of Saint Brandon (Mauritius).

Guided by an Advisory Committee of fourteen international experts which was established in February 2021 (see list in [Appendix A](#)), the expedition adopted a holistic approach through a multidisciplinary research programme including natural and social sciences.



The journey of the expedition was approximately 10,000 nautical miles (18,500 km) from Cape Town and back, with four stopovers in Mauritius, Réunion Island, Mahe (Seychelles), and Mauritius again on the way back to Cape Town. The two months of navigation were dedicated to research and field operations. Dedicated activities took place underway during the transits, around the Aldabra

The scientific programme facilitated by international teams focused on the four main themes of Monaco Explorations: coral protection, megafauna protection, marine protected areas and new exploration techniques.

The expedition also provided a platform for the exchange of knowledge and resources to a diverse range of participants and stakeholders through a varied outreach programme. Its various components targeted a broad public: schools, civil society, and decision-makers. The outcome of the expedition is the production of a documentary film for international distribution and other educational and artistic content.

From a diplomacy perspective, the expedition was graced by an official visit of H.S.H. Prince Albert II of Monaco from 24 to 26 October 2022.



## 1.3. BACKGROUND

Over the past hundred and fifty years, Prince Albert I (1848-1922) and then Prince Rainier III (1923-2005) have forged a strong link between the Principality of Monaco and the marine environment through their commitment and strong actions in favour of the Ocean. Since His accession to the throne in 2005, H.S.H. Prince Albert II of Monaco has not only strengthened this powerful link but has also increased Monaco's influence and action internationally.

This commitment resulted in the relaunch of the Principality's exploration expeditions, with the creation of Monaco Explorations in 2017. Since then, this collaborative platform serving the commitment of H.S.H. Prince Albert II of Monaco to the knowledge, sustainable management and protection of the Ocean has conducted numerous multidisciplinary expeditions throughout the world.

Following discussions with the French Research Institute for Sustainable Development (IRD), the French Institute for Exploitation of the Sea (Ifremer) and the Bertarelli Programme in Marine Sciences, the preparation of the Indian Ocean Expedition was initiated in 2019 through preliminary contacts with the representatives of the Government of Seychelles that participated in the 2019 Monaco Ocean Week. A call for proposals was issued in January 2020 on the assumption that the expedition would be conducted on board a research vessel of the French oceanographic fleet operating from Reunion Island in the first semester of 2021. Following the

outbreak of the Covid-19 pandemic, it was decided to postpone the expedition. Because of the lack of prospects for the availability of a French oceanographic research vessel in 2022-2023, alternative solutions were explored. The possibility of chartering the South African oceanographic research and supply vessel *S.A. Agulhas II* in October and November 2022 was identified, and a letter of intent to charter the vessel was signed on 28 May 2021.

The programme of the expedition was developed in connection with the authorities of Mauritius and Seychelles, based on the responses to the call for proposals and guided by the Advisory Committee.

Authorization was granted by the governments of Mauritius and Seychelles and by the Joint Commission of the Extended Continental Shelf Mascarene Plateau Region to conduct marine scientific research in the maritime zones of Mauritius, Seychelles and in the Joint Management Area respectively.

The Indian Ocean Expedition was presented as the first element of the Decade Action submitted by Monaco Explorations in response to the first Call for Decade Actions of the UN Decade of Ocean Science for Sustainable Development launched on 15 October 2020. The Monaco Explorations programme was endorsed as a Decade Action in June 2021 (action No 202). The expedition itself was endorsed by the 2<sup>nd</sup> International Indian Ocean Expedition in October 2022 (EP49).

## 1.4. RESOURCES

The expedition was carried out through a time charter agreement onboard the supply and oceanographic research vessel *S.A. Agulhas II* owned by the Government

of South Africa (Department of Forestry, Fisheries and the Environment DFFE) and operated by African Marine Solutions (Pty) Ltd (AMSOL).



The supply and oceanographic research vessel, S.A. Agulhas II © Filip Kulisev - Amazing Planet / Monaco Explorations.

In addition to her standard crew and equipment, the additional resources were mobilized with the vessel (see [Appendix B](#)):

Through the time charter agreement:

- Two Hydro-Bios 25kg bottom samplers;
- Two C-Worker 880 SRP dive support boats;
- One ABS SL containerized A1500 decompression chamber;
- One dive chamber supervisor and two coxswains, one of whom was qualified as a decompression chamber operator;
- A 24/7 telemedicine service specialized in hyperbaric medicine activated during the diving periods.



Dive support boat  
© Nicolas Mathys - Zeppelin / Monaco Explorations.

Through a separate service agreement between Monaco Explorations and Marine Solutions (Pty) Ltd:

- One Saab Seaeye Cougar XT ROV;
- the ROV Launch and Recovery System (LARS) with 700 m main lift cable;

- the positioning service based on two Veripos DGPS position systems and one iXblue GAPS MS USBL system with six mini beacons;
- One Sound Velocity Profiler (SVP) Valeport MIDAS SVX2;
- One ROV supervisor, two ROV pilot technicians and one surveyor.

Through the partnership agreements with the scientific partners of the expedition:

- Three types of towed gears for bottom sampling: two dredges, one beam trawl and one epibenthic sledge;

- Multinet and Bongo plankton nets;
- Manta trawl;
- Diving tanks and compressor;
- Argo floats, sea surface drifters and buoys;
- XBT probes;
- Tanks and accessories for the conservation of live coral samples;
- Laboratory equipment for the analysis and conditioning of samples.



Dredge © Didier Théron - Monaco Explorations.



Multinet © Didier Théron - Monaco Explorations.



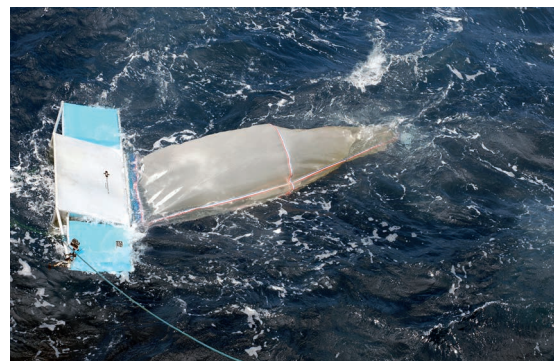
Beam trawl © Nicolas Mathys - Zeppelin / Monaco Explorations.



Bongo net © Tim Teichmann - Autentic / Monaco Explorations.



Epibenthic Sledge © Nicolas Mathys - Zeppelin / Monaco Explorations.



Manta net © Didier Théron - Monaco Explorations.

## 1.5. GEOGRAPHY

This section is derived from the Baseline Study prepared by the Advisory Committee (see [section 3.7.1.1](#)).

### 1.5.1. INDIAN OCEAN

The Indian Ocean ([Figure 1](#)) is the third largest of the world's oceanic divisions, covering 70,560,000 km<sup>2</sup> or 19.8% of the water on the Earth's surface. It is bounded

by Asia to the north, Africa and the meridian of Cape Agulhas to the west, and Australia and the meridian of South East Cape (Tasmania) to the east. To the south it is bounded by the Southern Ocean or Antarctica, depending on the definition in use. Along its core, the Indian Ocean has some large marginal or regional seas such as the Arabian Sea, the Laccadive Sea, the Gulf of Aden and the Red Sea, the Bay of Bengal, and the Andaman Sea.



Figure 1: Map of the Indian Ocean

### 1.5.2. MASCARENE PLATEAU

The Mascarene Plateau, also known as the Mascarene Ridge, is a submarine plateau in the Indian Ocean, north and east of Madagascar ([Figure 2](#)). The plateau extends approximately 2,000 km from the Seychelles Plateau in the north, to Mauritius and Réunion Islands in the south, although these islands are separated from the actual Plateau by deep channels ([Figure 3](#)). The plateau covers an area of over 115,000 km<sup>2</sup> of shallow water, with depths ranging from 8 to 150 m, plunging to 4,000 m to the abyssal plain at its edges.

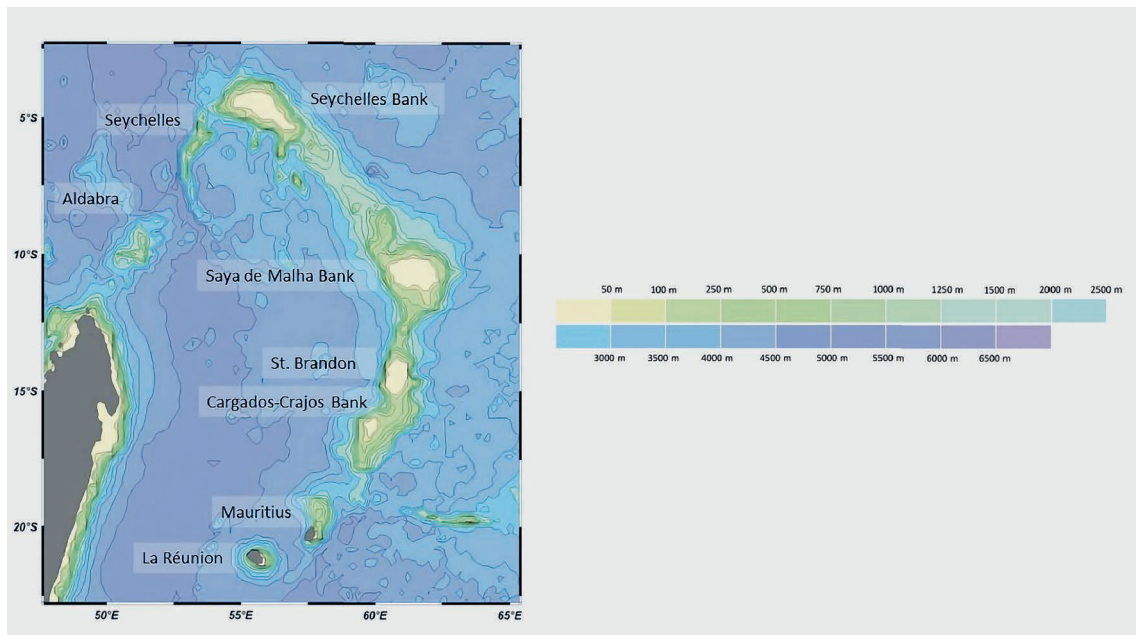
The northern part of the Mascarene Plateau includes the Seychelles Islands. The middle part of the Mascarene Plateau includes the Ritchie Bank and the Saya de Malha Bank. The southern part of the Mascarene Plateau includes the Nazareth Bank, the Cargados Carajos Shoals, the Soudan Bank and the Mascarene islands. The Mascarene islands comprise the two volcanic islands of Mauritius and Reunion.

The Mascarene plateau is the most prominent bathymetric feature of the Indian Ocean and extends as a complex submerged seafloor elevation. It is larger than the Great Barrier Reef, longer than the Red Sea and is one of the few submerged features visible from space.



**Figure 2:** Map of the Western Indian Ocean region

The region covers approximately 22.3 million km<sup>2</sup> and includes three Large Marine Ecosystems: The Agulhas Current, the Somali Current and the Mascarene Plateau.



**Figure 3:** Map of the Mascarene Plateau.

A colour bar highlights isobath values

### 1.5.3. THE VISIBLE ISLANDS: ALDABRA AND SAINT BRANDON



Aerial view of the Aldabra Atoll © Filip Kulisev - Amazing Planet / Monaco Explorations.

The Aldabra Group is part of the Outer Islands of Seychelles, lying in the south-west of the island nation, 1,000 km from the capital, Victoria, on Mahé Island (Figure 4). It comprises four elements:

- Aldabra Atoll: a raised atoll with four main islands and some 40 small islets.
- Assumption Island: a single island on a raised reef.
- Cosmoledo Atoll: a raised atoll with two main islands and about 18 smaller islets.
- Astove Island: a raised atoll with one island only.



Figure 4: Map of the Outer Islands of Seychelles © Ezilon 2009.

Aldabra is the world's second-largest coral atoll. Its geographical isolation, rough terrain and scarcity of fresh water have deterred large human populations from settling. As a result, Aldabra is significantly less disturbed than other atolls worldwide. It remains as a universally outstanding example of a coral atoll and, in 1982, was registered as a UNESCO Marine World Heritage Site. The atoll is a refuge for many endangered and

unique species. It is part of a global biodiversity hotspot and one of the world's natural wonders. It is managed by the Seychelles Islands Foundation (SIF), a non-profit charitable organization that was established as a public trust by the Government of Seychelles in 1979. SIF operates a limited and strictly controlled tourism policy. All visitors to the atoll must receive prior authorisation from SIF.



Aerial view of Saint Brandon © Nicolas Mathys - Zeppelin / Monaco Explorations

Saint Brandon, also known as the Cargados Carajos Shoals, is an Indian Ocean archipelago about 430 km northeast of Mauritius, consisting of a number of sand banks, shoals, and islets (Figure 5). It consists of five island groups, with about 28-40 islands and islets in total, depending on seasonal storms and related sand movements. There are 22 named islands and shoals. Their aggregate land area is estimated variously at 1.3 km<sup>2</sup> and 2.0 km<sup>2</sup>. The very extensive shallow bank covers approximately 2,300 km<sup>2</sup> around the islands. Of this, the reef covers an area of 190 km<sup>2</sup> and is more than

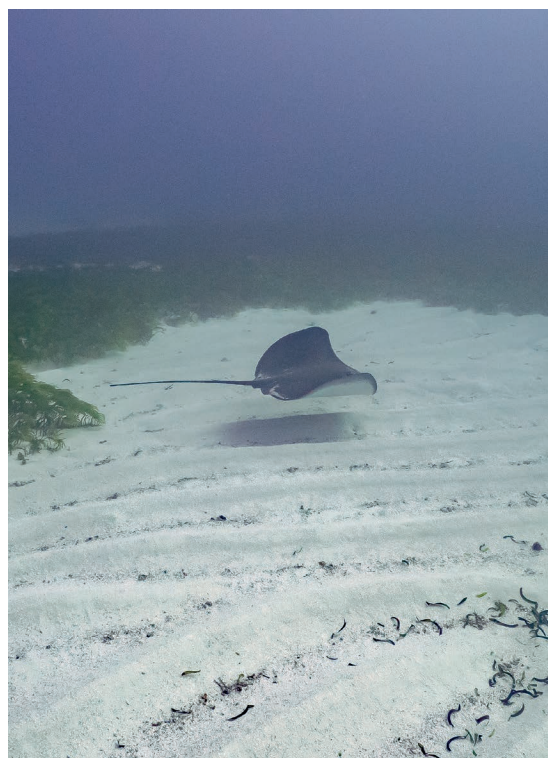
50 km long from north to south, 5 km wide, and cut by three passes.

A group of 13 islets are held under a permanent grant by the Raphael Fishing Company which carries out small-scale fishing around them.

The islets are important nesting grounds for green turtles (*Chelonia mydas*), hawksbill turtles (*Eretmochelys imbricata*) and seabirds. It has a few non-permanent inhabitants, mostly fishermen and Government of Mauritius officials.



Figure 5: Map of Saint Brandon.



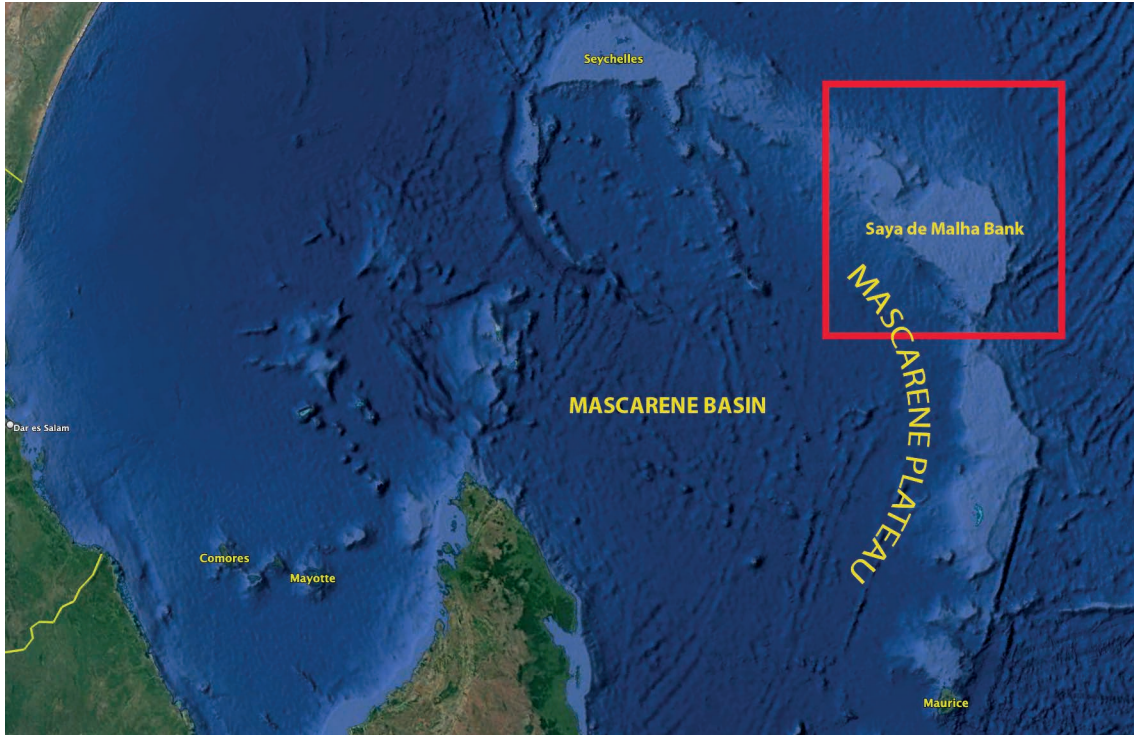
Underwater view of the invisible island © Sven Bender - Autentic / Monaco Explorations.

#### 1.5.4. THE INVISIBLE ISLAND: SAYA DE MALHA BANK

The Saya de Malha Bank is one of the underwater features of the arc-shaped Mascarene Ridge, which stretches over 2,000 km between Seychelles in the North and Mauritius in the South (Figure 6). It is also one of the largest submerged banks in the world (40,000 km<sup>2</sup>) with a surface area equivalent to Switzerland. The Ridge is comprised of elements of very different geological origins and ages. At one end of the Ridge, the Seychelles Plateau comprises Precambrian granite about 650 million years (MY) old. At the other end, Mauritius is only a few million years old (approx. 8-10 MY) and was formed by the hotspot which is presently located under the volcanically active Réunion Island. The Saya de Malha Bank itself was formed around 45 MY ago by the Réunion hotspot and is composed of basaltic basal rock overlaid with limestone, a 1,500 m thick cover, the remnants of coral reefs. Millions of years ago, the bank was one or more mountainous volcanic islands, like present-day Mauritius and Réunion Islands, which subsequently sank below the waves. Some of the banks may have been low islands as recently as 18,000 to 6,000 years ago, when sea levels were up to 130 m lower during the most recent ice age. Some features outcrop less

than 10 m from the surface and the depth is less than 50 m on the sectors located at the eastern periphery of the bank. Depths generally remain less than 200 m in the central part of the Bank; but can reach 350 m in the south-west region of the Bank.

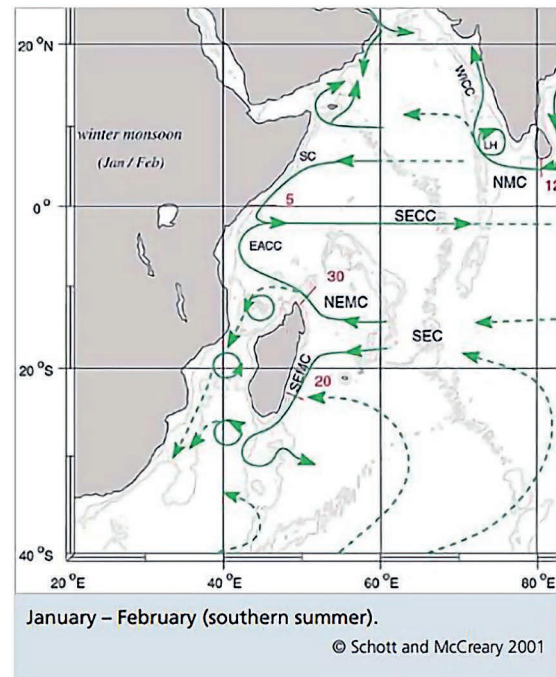
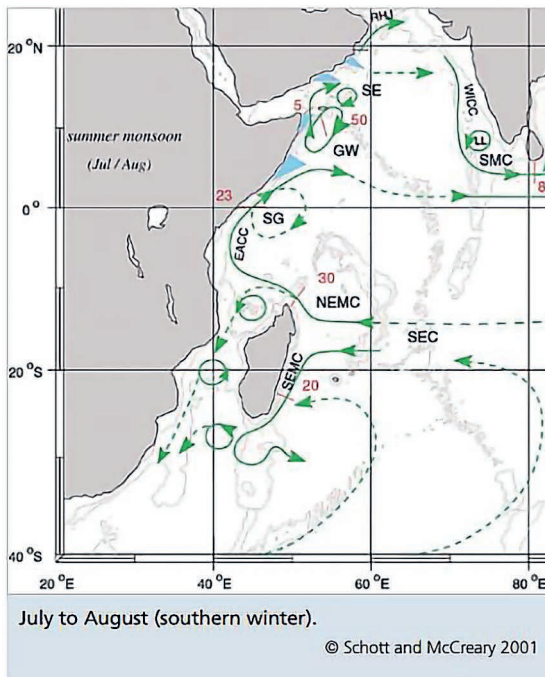
Current inferred knowledge holds that Saya de Malha supports the largest contiguous seagrass meadow in the world with 80 to 90% of shallow depths being possibly covered by seagrasses dominated almost exclusively by *Thalassodendron ciliatum* from depths up to 30-40m. This estimated seagrass coverage should be taken with precaution as it is to be noted that only ~1.5/1 000 000 of the bank's surface area was surveyed during this expedition and previous expeditions had only covered specific and smaller parts of the bank.



**Figure 6:** The regional setting of Saya de Malha Bank (red square) in the Mascarene Ridge.

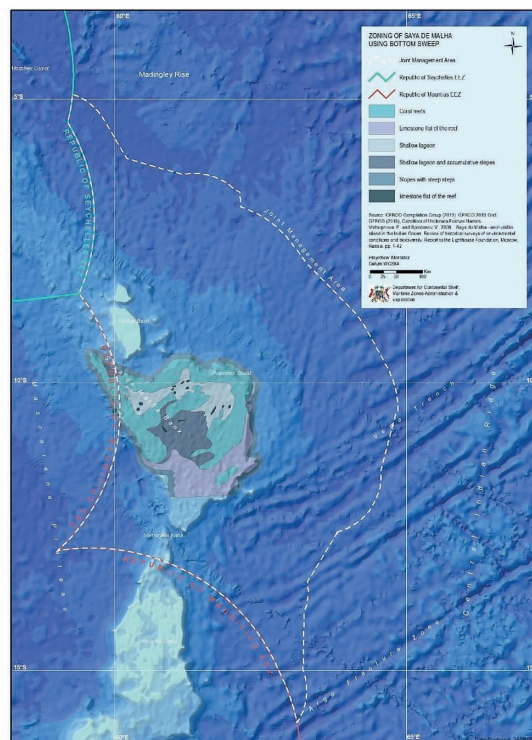
The Saya de Malha Bank is located at the northern branch of the South Subtropical Gyre of the Indian Ocean. The South Equatorial Current (SEC) driven by the south-east trade winds carries water of the Indonesian Throughflow in a westerly direction, all the way to Madagascar. It crosses the Mascarene Ridge, and a part of the flow is deflected around the topographic rise. The

current increases in velocity in the pass between Ritchie Bank and Saya de Malha in the North, and in the sill separating Saya de Malha to Nazareth Bank in the South. The current pattern is modified by the monsoon (north-east or south-west), but these seasonal changes do not affect the circulation on the Mascarene Ridge south of 7°S (**Figure 7**).



**Figure 7:** Circulation pattern in the West Indian Ocean during the winter (or north-east) monsoon (left) and during the summer (or south-east) monsoon (right).

Beyond its biogeographical and scientific interest, Saya de Malha has a special status in terms of governance. In 2011, following a joint request by Seychelles and Mauritius to the United Nations Commission on the Limits of the Continental Shelf for the extension of their continental shelf, these two countries obtained the shared sovereignty of Saya de Malha granting them rights to exploit sedentary living resources and mineral resources of the soil (metals) and subsoil (oil, gas). It is currently the only Joint Management Area (JMA) in the Indian Ocean, with specific limits beyond the EEZ boundaries of the two island countries (**Figure 8**).



**Figure 8:** Delimitation of the Saya de Maha Joint Management Area. The jurisdiction only concerns the seabed and subsoils, whereas the water column remains in the High Seas domain.

## 1.6. OVERVIEW OF THE SCIENTIFIC PROGRAMME

The scientific programme was initially composed of eight research projects addressing the regional ocean dynamics, two visible islands, Aldabra (Seychelles) and Saint-Brandon (Mauritius) and the invisible island, the Saya de Malha Joint Management Area of Extended Continental Shelf between Mauritius and Seychelles, priority focus of the expedition.

The scientific programme was complemented with opportunistic activities such as marine megafauna monitoring, routine underway observations and ROV surveys. At the request of the Mauritius Oceanography Institute (MOI), an additional project devoted to the bioprospection of marine sponges was implemented during the Saya de Malha and Saint Brandon sequences.



## 1.7. CRUISE SUMMARY INFORMATION AND NARRATIVE



**Figure 9:** Monaco Explorations Indian Ocean Expedition

**Table 1** provides the basic information about the Expedition.

**Table 1**

<b>EXPEDITION DESIGNATION</b>	Monaco Explorations Indian Ocean Expedition Monaco Explorations V055
<b>EXPEDITION LEADER</b>	Gilles Bessero
<b>DATES</b>	1 October - 1 December 2022
<b>SHIP</b>	
• Name	<i>S.A. Agulhas II</i>
• Flag	South Africa
• Port of Registry	Cape Town
• IMO Number	9577135
• Call Sign	ZSNO
• MMSI	601986000
• Master	Knowledge Bengu

<b>PORTS OF CALL</b>	Cape Town, South Africa Port Louis, Mauritius Le Port, Réunion, France Port Victoria, Seychelles Port Louis, Mauritius Cape Town, South Africa
<b>PROJECT LEADERS</b>	4SEA: Sylvain Bonhommeau, Ifremer, France GECOS: Jérôme Bourjea, Ifremer, France BGC-Argo: Hervé Claustre, IMEV, France Sea Surface Drifters: Nick D'Adamo, UWA, Australia Coral Connect: Heather Koldewey, ZSL, United Kingdom Onboard School: Fabien Lombard, IMEV, France Saya de Malha: Francis Marsac, IRD, France MADCAPS: Margot Thibault, University of Réunion, France World Coral Conservatory: Didier Zoccola, CSM, Monaco Marine Mammal Observation: Bernard Rota, Globice Réunion, France
<b>PARTICIPANTS</b>	See <a href="#">Appendix C</a>

*S.A. Agulhas II* was mobilized in Cape Town, South Africa, from 26 September to 1 October 2022. She left Cape Town on 3 October.

During the cruise, routine underway observations were recorded through the onboard scientific data system whenever possible, as indicated in [Table 2](#).

For the first part of the expedition, *S.A. Agulhas II* called successively in Port Louis, Mauritius (10-12 October) and Le Port, Reunion Island (13-14 October). The small

expedition team that had signed on in Cape Town reached 80 participants altogether. The additional scientific equipment from France was loaded on board in Reunion Island. They included Argo floats transported in a 20-ft container that was returned to the shipping company and diving equipment, towed gears, and tanks transported in a 40-ft container that was stowed on the helicopter deck. A test dive of the ROV had been conducted shortly after leaving Cape Town, and a possible seamount signature from the GEBCO grid was investigated during a few hours between Mauritius and Reunion Island.

Table 2

PARAMETER	EQUIPMENT	COMMENT
Current	Drop-keel mounted 75 kHz Teledyne RDI Acoustic Doppler Current Profiler (ADCP) system	The recording is stopped when the vessel steams above 14 knots
Sea surface temperature (SST) and conductivity	Seabird SBE45 MicroTSG ThermoSalinoGraph flowthrough system	Several interruptions due to plumbing issues
Depth	Single beam Simrad EK60 scientific echosounder (38, 120 & 200 kHz)	
Sub-bottom profile	Kongsberg TOPAS PS 18 parametric subbottom profiler (18 kHz)	System failure from 9 to 12 October

Besides routine underway observations, three scientific projects began during the transit from Réunion to Aldabra with the deployment of Argo floats in conjunction with

CTD stations (BGC-Argo Project), the deployment of sea-surface drifters (SSD Project), and Manta trawl transects to collect microplastics (MADCAPS Project).



Launch of the CTD Rosette  
© Filip Kulisev - Amazing Planet / Monaco Explorations.



Deployment of a sea surface drifter  
© Tim Teichmann - Autentic / Monaco Explorations.



Launch of the Manta net  
© Nicolas Mathys - Zeppelin / Monaco Explorations.

All scientific observations were suspended during the transit in the Exclusive Economic Zone (EEZ) of Tromelin, whose jurisdiction is claimed by France and Mauritius. After entering the EEZ of Seychelles, about 10 hours were devoted to investigating another possible seamount signature from the GEBCO grid during the night from 16 to 17 October.

*S.A. Agulhas II* reached Aldabra at sunrise on 19 October. The sequence devoted to investigating the area around Aldabra

started with an emergency response plan drill to check the arrangements in the event of a dive emergency. Then, three teams composed of nine scientists were transferred ashore to carry out their projects related respectively to:

- Monitoring marine turtles (GECOS Project);



Measuring the size of the carapace of a green turtle  
© Jérôme Bourjea - Ifremer / Monaco Explorations.

- Assessing the coastal environment (4SEA Project);



Boards connected before launching  
© Sylvain Poulain - Ifremer / Monaco Explorations.

- Monitoring plastic pollution (MADCAPS Project).



Sorting plastic waste on board *S.A. Agulhas II* after a Manta net transect  
© Nicolas Mathys - Zeppelin / Monaco Explorations

Later that day, the two dive teams operating from the vessel were deployed to start their investigations related to:

- Collecting coral samples (World Coral Conservatory Project);
- Assessing the connectivity of coral species and the associated invertebrate biodiversity (Coral Connect Project).



Collecting coral colonies in Aldabra  
© Katia Quéméré - WCC / Oceanopolis / Monaco Explorations

Two Argo floats and one SSD were opportunistically deployed during the transit back from Moroni to Aldabra on the evening of 21 October.

The operations off Aldabra resumed on 22 October and continued as planned until 25 October.



One of the species of fish observed by the ROV on the slopes of the Aldabra reef at a depth of 698 m  
© Marine Solutions / Monaco Explorations

This was followed by the first ROV exploration dive off the west coast of Aldabra.

The next morning was disrupted by an accident while launching one of the two dive boats. Unfortunately, one diver was injured and required a medical evacuation. The operations from the vessel were suspended while she transited to Moroni, Comoros. A detailed review of the procedures related to the launch and recovery of the dive boats and to dive operations was conducted, and the associated safety protocols were adapted accordingly.



Operational briefing between the crew and the World Coral Conservatory and Coral Connect teams before departure for a dive session © Nick D'Adamo - UWA / Monaco Explorations

In addition to the scientific teams working ashore, day visits on Aldabra were organized for other participants in liaison with the Seychelles Islands Foundation team on the island.

A high-level delegation led by H.S.H. Prince Albert II of Monaco and Mr. Jean-François Ferrari, Seychelles' Designated Minister and Minister for Fisheries and the Blue Economy, visited Aldabra from 24 to 25 October and then embarked on *S.A. Agulhas II* in the late afternoon of 25 October. The delegation stayed on board until midday the next day for an intensive programme, including a tour of the ship, meetings with the crew and scientific teams, and a presentation of the investigations carried out during this first part of the expedition.

After disembarking the delegation on Assomption Island, *S.A. Agulhas II* continued the scientific programme on the way to Port Victoria, Seychelles. The call at Port Victoria from 29 to 31 October marked the end of the first part of the expedition with the changeover of many participants.



Participants in the first part of the expedition with H.S.H. Prince Albert II of Monaco, 26 October 2022  
© Nicolas Mathys - Zeppelin / Monaco Explorations

The second part of the expedition was dedicated mainly to the Saya de Malha Ecosystem Project and the continuation of the underway projects.

In addition, a marine mammal observer joined the expedition. The Saya de Malha Bank sequence took place from 2 to 17 November.

## 26



Samples taken during a dive on the Saya de Malha Bank  
© Sven Bender - Autentic / Monaco Explorations

It was followed by operations around Saint Brandon from 19 to 21 November. In accordance with the prevailing sanitary protocol for Saint Brandon which required a 7-day quarantine in Mauritius before transiting to Saint Brandon no operation could be conducted ashore and no contact with the people living on the island was allowed. Then *S.A. Agulhas II* called again in Port Louis, Mauritius, from 22 to 24 November, where most participants disembarked. An overview of the expedition was presented to H.E. Mr. Eddy Boissezon, Vice-President of the Republic of Mauritius and Mr. Sudheer Maudhoo, Minister of Blue Economy, Marine Resources, Fisheries and Shipping and other officials from Mauritius.



Observation and first identification of the biodiversity of the Saya de Malha Bank © Nicolas Mathys - Zeppelin / Monaco Explorations

The small team that remained on board carried out the last three stations of the BGC-Argo Project between Port Louis and Cape Town. The scientific equipment to be returned to France and the samples conditioned for further laboratory analysis were stored back in the 40-ft container.

*S.A. Agulhas II* returned to Cape Town on the night of 30 November to 1 December. 1 and 2 December were devoted to the final demobilization operations, including disembarking the 40-ft container that was stored ashore until it could be loaded onto a container ship bound for Europe. The container waited in Cape Town for a long time and was not delivered to MNHN until 6 April 2023.



Participants in the second part of the expedition  
 © Nicolas Mathys - Zeppelin / Monaco Explorations

## 1.8. CONNECTION WITH DIDEM

In 2018 IRD approached Monaco Explorations about the development of a project called DiDEM (Dialogue Science-Decision Makers for the Integrated Management of the Coastal and Marine Environment) with the objective to test, validate and deploy innovative scientific outreach tools and methods in the Western Indian Ocean in support of regional initiatives dedicated to ocean governance. Eight countries were concerned: Comoros, Madagascar, Mauritius, Mozambique, Seychelles, Tanzania, Kenya. IRD and Monaco Explorations agreed to coordinate their efforts in the region. A financial endowment protocol in support of DiDEM that set out the relationship between DiDEM and the expedition was developed and signed in January 2021.

Besides the contribution of IRD and Monaco Explorations, DiDEM benefits from the financial support of the International Development Research Center of Canada (IDRC), the French Facility for Global Environment (FFEM), the United Nations Development Programme (UNDP), the United Nations Environment Programme (UNEP), and Fondation de France. It officially started on 7 January 2021 for a period of 3 years, until 6 January 2024.

The project focuses on three types of ecosystems and deploys its activities in three large Workshop Zones: the islands and archipelagos, the deltas, and the high seas, deep seas and distant seabeds which include international waters, the abyssal plain and seamounts.

It is divided in three components:

- A/** Tools to bring scientific knowledge to decision-makers;
- B/** Capacity building and training;
- C/** Raising awareness among civil society.

Four DiDEM activities were supported by Monaco Explorations in relation with the Indian Ocean Expedition:

- **component A:** contribution to the development of a regional ocean governance strategy covering the high seas, deep seas and distant seabeds, based on marine science.
- **component B:** organization of a thematic school on reef geosystems in Seychelles.
- **component C:**
  - › setting up of a Marine Educational Area (MEA) in Seychelles through the extension to Seychelles of the PAREO project (PATrimoine RÉcifal de l'Océan Indien entre nos mains) which aims to raise awareness of the need to protect coral reefs.



- › application of the “The Future of®” approach to the development of the blue economy of Seychelles focusing on the management of plastic waste.



Figure 10: The DiDEM project © IRD

## 1.9. POST-CRUISE EVALUATION

The Advisory Committee conducted an evaluation of the expedition focusing on the expedition planning and conduct of processes. The main objective of this evaluation was to provide recommendations to Monaco Explorations to inform and improve the scope and conduct of future expeditions. The scope of the evaluation

covered the design, planning, and implementation of the expedition, as well as its overall relevance, financing, and the participation of stakeholders. It included preliminary comments about the use and management of the data collected during the expedition. The results of this evaluation are presented in [Appendix D](#).

# 2. PRESENTATION OF SCIENTIFIC OPERATIONS AND RESULTS

The projects selected by Monaco Explorations were rolled out in three different environmental settings:

- The region as a whole: the objective was to improve the understanding of the regional ocean dynamics as regards circulation, productivity and connectivity, including plastic pollution;
- Two islands: Aldabra (Seychelles) and Saint Brandon (Mauritius). The objective was to characterize the function of shelters for biodiversity and to help preserve them against the impacts of anthropogenic pressure and climate change;
- The Saya de Malha Joint Management Area between Mauritius and Seychelles, located beyond the

Exclusive Economic Zones of the two States. The expedition aimed at gathering scientific elements that could help consolidate the joint governance of a poorly known area with potential outstanding universal value. This area was one of the expedition's priorities.

The sampling strategy was specific to each project, and good coordination was required to achieve the specific objectives and overall, the expedition's scientific objectives. The instruments described earlier in this report were mostly used in common, however several of these instruments were deployed for specific projects. Together, these complementary tools provided an unprecedented integrated dataset to support ecosystem understanding and governance-oriented analyses.

## 2.1. REGIONAL DYNAMICS

### 2.1.1. OVERVIEW

The expedition's primary regional focus was to enhance the observational network in alignment with the objectives of the UNESCO IOC-led Global Ocean Observing System (GOOS), and provide robust data for decision-making in response to international calls to action, such as the UN Decade of Ocean Science for Sustainable Development, the Second International Indian Ocean Expedition, and the Indian Ocean Observing System (IndOOS). The research aimed to deepen understanding of the region's hydrodynamics, ecological processes, and the threats facing marine ecosystems, thereby supporting natural resource managers with improved scientific foundations for policy and management decisions.

#### **ENHANCEMENT OF OBSERVATIONAL NETWORKS**

A central achievement of the expedition was the deployment of advanced oceanographic instruments, including Argo floats, sea surface drifters, SVP drogues. In addition, specialized projects such as MADCAPS (plastic debris and associated microorganisms), Globice (marine fauna observations), GECOS (green turtle research), and Coral Connect (genetic connectivity of coral reefs) were executed. The deployments were designed to capture

the regional hydrodynamic scheme and to assess the scientific outcomes of each project within this scheme. The regional element of the expedition began with a comprehensive review of the current knowledge regarding the southwest Indian Ocean (SWIO) major current systems, which provided essential context for subsequent biogeochemical and ecological analyses.

#### **HYDRODYNAMIC SYSTEMS AND THEIR ECOLOGICAL RELEVANCE**

The regional hydrodynamics is driven by the South Equatorial Current (SEC), a dominant westward flow between approximately 5° and 20°S, which traverses the Mascarene Plateau and influences the distribution of water masses, nutrients, and biological propagules. The SEC's flow is relatively stable year-round, with seasonal variations of about 10%, peaking in June-August and weakening in December-February. Originating primarily from Indonesian Throughflow waters, the SEC undergoes lateral fragmentation over the Mascarene Plateau, splitting into northwest, west, and southwest cores. These offshoots feed into various regional currents, including the East African Coastal Current (EACC), Northeast Madagascar Current (NEMC), Southeast Madagascar Current (SEMC), and the South



Indian Counter Current (SICC). The northwest flow can also retroflect and input into the eastward flowing South Equatorial Counter Current (SECC). The interplay of these currents shapes the region's ecological connectivity, influencing the movement of physical and biological matter, such as plastic debris, coral larvae, and marine fauna.

The Seychelles-Chagos Thermocline Ridge (SCTR), located between the SEC and the SECC, is characterized by sub-surface temperature doming, which affects nutrient availability and primary production. The westward core of the SEC, passing through the deep sill between Saya de Malha and Nazareth banks, feeds into the EACC and NEMC, which further splits to supply both the EACC and the Mozambique Channel. The southward flow contributes to mesoscale eddy formation and ultimately to the Agulhas Current system. The SEC's southwestward offshoot supports the SEMC, which retroflects and feeds into the SICC, and also generates cyclonic and anti-cyclonic eddies that impact water temperature, nutrient distribution, and the transport of biota.

### **SCIENTIFIC DEPLOYMENTS AND DATA COLLECTION**

The expedition's deployment of 29 Argo floats (17 biogeochemical and 12 physical) provided the first sustained biogeochemical observations across the SWIO, collecting over 1,000 vertical profiles down to 4,000 m. These data have yielded unprecedented insights into regional ocean dynamics, confirming circulation patterns and their influence on biogeochemical regimes. The SWIO is structured by three major circulation cells: the cyclonic tropical system (SCTR and SEC), the anticyclonic subtropical gyre, and the shallow Mascarene bowl. These features regulate the depth of the thermocline and nitracline, controlling nutrient availability and primary production. In the tropical band, shallow nutrient-rich layers support sustained phytoplankton growth, while the subtropical gyre and Mascarene bowl exhibit oligotrophic conditions with deep chlorophyll maxima. Seasonal cycles reveal a meridional gradient, with continuous productivity in the north and short-lived winter blooms in the south. Float trajectories indicate strong exchanges between the SCTR and SEC, while floats in the subtropical gyre remain confined for extended periods. These findings demonstrate the tight coupling between circulation, nutrient supply, and ecosystem functioning, providing a robust framework for future interdisciplinary studies.

Complementary to the Argo project, 18 sea surface drifters and four SVP drogues were deployed to track surface currents and infer connectivity rates between high biodiversity areas. The connectivity inferred from these tracks ranged from weeks to a few months between regions such as the Mascarene Plateau, East African coastal zone, and islands and atolls in between. For example, the northern Mascarene Plateau to the islands and atoll region (including Aldabra) exhibited connectivity times of less than 2-3 months, while Saint Brandon to southeast Madagascar was less than 2 months, and Aldabra to east Africa or the Mozambique Channel was less than 4 weeks. These rates are consistent with existing literature and modelling studies.

### **ECOLOGICAL IMPLICATIONS**

The MADCAPS project investigated the role of plastic debris as a vector for coral-associated pathogenic bacteria. Samples from Saya de Malha and Nazareth banks revealed significant counts of pathogenic bacteria, including those associated with coral diseases and human pathogens, as well as probiotic bacteria. The main source of plastic debris was identified as the SEC, which carries pollution from southeast Asian rivers, maritime traffic, local terrestrial sources, and atmospheric pollution. The survival of pathogens on plastic debris for weeks to months, protected by biofilms, underscores the relevance of regional connectivity and dynamic transport. Plastic debris carrying threatening biota can travel rapidly enough to impact biodiversity hotspots downstream, posing an internationalized threat that requires multinational cooperation for research and management responses.

The Coral Connect project highlighted the potential for viable recruitment of corals downstream of upstream source reefs, given that coral larvae can survive for weeks to months. Surface connectivity rates inferred from regional dynamics are within the survival times of coral larvae, facilitating dispersal between the Mascarene Plateau, islands and atolls, east Madagascar coast, Mozambique Channel, and East African coastline. Population genomics revealed strong connectivity between the Chagos Archipelago and Inner Seychelles, with a permeable barrier between inner and outer Seychelles. Understanding connectivity and temperature resilience is crucial for identifying reefs likely to survive future warming.

The GECOS project examined the genetic composition of juvenile green turtles at recruitment sites, finding stability over two decades, potentially correlated with the stability of regional ocean currents. This finding further emphasizes the importance of hydrodynamic phenomena in shaping ecological connectivity and biodiversity patterns.

### **MANAGEMENT AND POLICY IMPLICATIONS**

The inter-connectivity of hydrodynamic phenomena in the SWIO has direct implications for biodiversity management across national jurisdictions. Natural or anthropogenic activities in one jurisdiction can affect or be affected by those in another, as exemplified by the movement of bacteria-laden microplastics and coral larvae across the region. This underscores the need for international coordination and collaboration in targeted investigations and policy responses to ecological threats and pressures.

The expedition represents a significant contribution to global ocean science and natural resource management. The availability of the RV *S.A. Agulhas II* enabled complex, multidisciplinary measurements that are typically beyond the financial and logistical reach of most researchers. The scientific results achieved, particularly through the Argo project, are important not only in the SWIO context but also globally, providing new insights into ocean dynamics, biogeochemical processes, and ecosystem functioning.

### **CONCLUSION**

In summary, the expedition's integrated approach to studying the regional dynamics of the SWIO has advanced scientific understanding of hydrodynamic systems, the movement of physical and biological matter, and ecological connectivity. The findings highlight the critical role of ocean currents in shaping ecosystem structure and function, the threats posed by plastic pollution and pathogenic bacteria, and the importance of international collaboration in managing biodiversity and responding to ecological challenges. The data and insights generated provide a foundation for future interdisciplinary research and informed natural resource management in the southwest Indian Ocean.

## **2.1.2. BIOGEOCHEMICAL-ARGO**

### **SUMMARY**

This project was a contribution to the international Biogeochemical-Argo (BGC-Argo) programme that aims to establish a global ocean observation system composed of 1,000 profiling floats equipped with autonomous bio-optical sensors. They measure physical, chemical, and biological variables essential to understanding the evolution of the ocean's health and its response to climate change. These variables, measured every 10 days between the surface and 2,000 m depth, are: temperature, salinity, pH, oxygen, nitrate and chlorophyll a concentration, suspended particles, as well as irradiance.

The project objective was to deploy floats in a hitherto poorly equipped area and to contribute to the REFINE programme funded by the European Research Council (ERC) that develops a new generation of highly instrumented jumboized profiling floats required to investigate the various carbon pumps and associated carbon transformation processes within the twilight zone (from around 100 m to 1,000 m depth).

The project was led by the Oceanography Laboratory of Villefranche-sur-Mer, France (LOV) and involved partners from the Mediterranean Institute of Oceanography (MIO Aix-Marseille University, University of Toulon, CNRS, IRD), the Ecce-Terra Observatory (Sorbonne University, CNRS, IRD), as well as the US Universities of Maine and Stanford.



Deployment of a BGC Argo float during the expedition © Tim Teichmann - Autentic / Monaco Explorations

The implementation of the project took advantage of the occupation of 12 stations (Figure 11) where samples were also collected for additional chemical and biological analyses, intended in particular to check the factory calibration of the sensors installed on

the profiling floats. At the same time, the team used the unique setting of the cruise to develop scientific outreach activities, particularly within the framework of the *Adopt a float* project.

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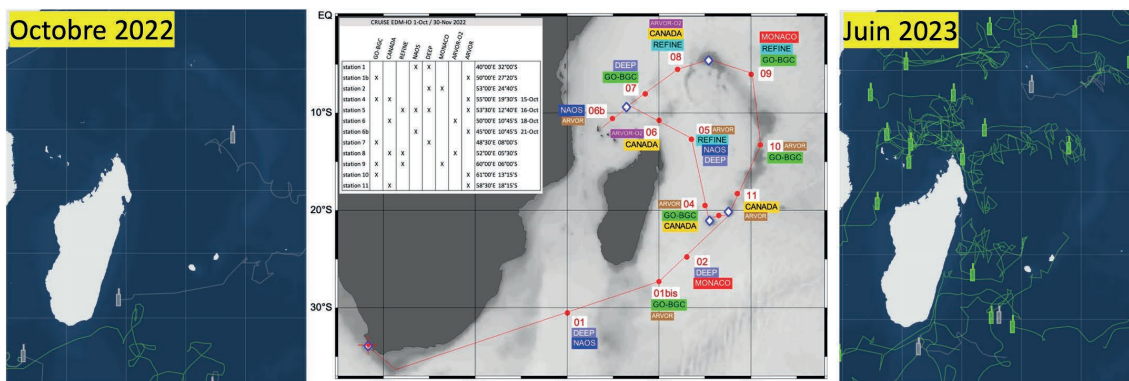


Figure 11: Oceanographic stations occupied during the expedition and status of deployments and observations by BGC-Argo floats before and 21 months after (June 2024) the expedition

The vast majority of the 29 floats deployed are operating nominally. Each float sends its data every ten days. According to the OneArgo programme recommendations, these data are accessible in real time to the entire scientific community, either from the BGC-Argo programme website for floats with biogeochemical sensors, or from the Euro-Argo website for floats measuring exclusively temperature and salinity. These data are currently qualified and distributed in real time, within 24 hours of being transmitted by the profiling floats; the deferred-time qualification procedures have begun to be launched.

The samples collected by the CTD rosette at the twelve profiling float deployment stations were analyzed and the measurements validated. The corresponding dataset was published in March 2024 and a DOI was assigned.

In conclusion, the project was successfully implemented according to the initial proposal. Significantly, it helped lay the foundations for a sustainable observation system for the region, a prerequisite for the establishment of an information system for future management of the area.

## A. Description and timetable of achievements

The scientific component of the project focused on two main actions.

**Action 1:** Acquisition of hydrological and biogeochemical data by multi-sensor rosette CTD probe at twelve offshore stations placed along the ship's route (Figure 12).

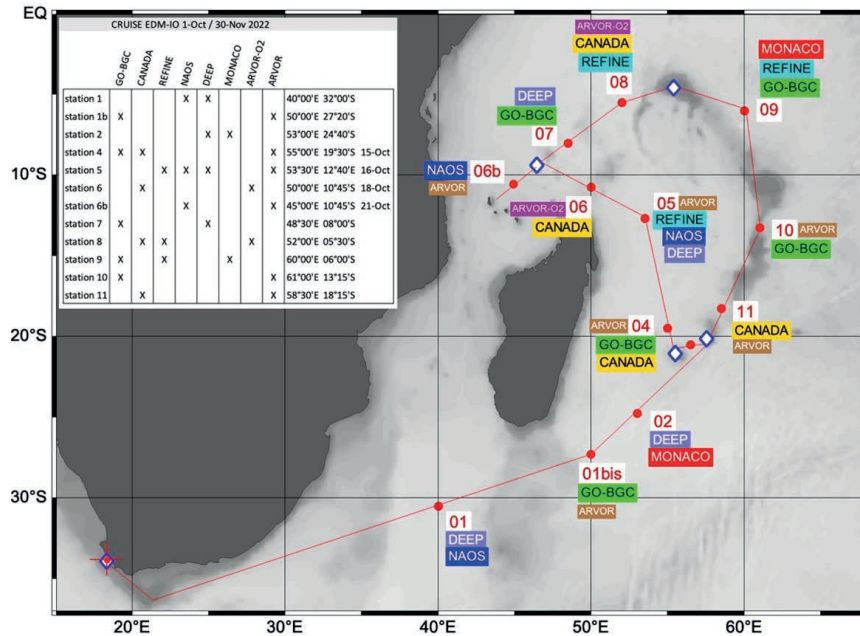


Figure 12: Oceanographic stations occupied during the cruise.

At each station, at least one CTD rosette was launched to acquire hydro-biogeochemical parameters. Water samples were taken to collect samples for future analyses. Finally, at least two floats from the OneArgo programme were deployed at each of these stations. They are identified either by the country or by the observation programmes that acquired them and made them available for the expedition.

Data from the CTD and additional sensors mounted on the rosette were validated:

- Data from sensors provided by DFFE (pressure, temperature, salinity, oxygen, transmissometer),
- Data from additional sensors (fluorimeter, backscatter meter, UV spectrophotometer for nitrate measurement).

Post-cruise processing based on discrete measurements taken on seawater samples was conducted once all analyses were completed. A set of qualified profiles concatenating all calibrated sensor measurements via discrete samples was made available to all participants.

Analyses performed on seawater samples taken at the twelve deployment stations were also made available to all participants. These include measurements of salinity, alkalinity, pH, dissolved oxygen concentration, macronutrients, and pigments.

This set of qualified profiles and the discrete reference data are freely available on the SeaNoe platform: <https://doi.org/10.17882/98833>.

The data from the UVP sensor and the multinet were processed by the onboard school staff, following a standardized database procedure.

The discrete samples focused on phytoplankton biomass and composition were analyzed and qualified. The pigment data by high performance liquid chromatography (HPLC) were made available through the SeaNoe platform. In addition, data for the following types of measurement are available upon request in the form of an Excel file:

- Particulate organic carbon,
- Particulate inorganic carbon,
- Picophytoplankton and heterotrophic bacteria by flow cytometry,
- Microphytoplankton by microscopy.



The results of these discrete measurements were matched with the bio-optical data (transmissometer, backscatter meter, fluorimeter) collected by the CTD sensors at the same depths as the water samples. This step constituted an additional and cross-validation between the bio-optical measurements by sensors and the discrete measurements of biomass and phytoplankton pigments. An aggregated Excel file between these two types of data is available on demand ([antoine.poteau@imev-mer.fr](mailto:antoine.poteau@imev-mer.fr)).

**Action 2:** Deployment, during the twelve offshore stations, of 29 floats of the OneArgo programme with a focus on the BGC-Argo floats (19 floats), and in particular the deployment of three new types of floats (Jumbo and multi-instrumented) prepared within the framework of the ERC REFINE programme.

The following tasks were carried out:

- Monitoring the proper functioning of the deployed fleet, particularly the BGC-Argo floats (see [Appendix E, Table E2](#)).
- Modification of the Iridium data reception mode for a float that had lost its GPS connexion. This change provides geolocation of this float (WMO 5906972), which had been lost during the cruise.
- Real-time and delayed availability of BGC-Argo biogeochemical parameters labelled by the OneArgo programme.

For the new variables implemented and tested as part of the REFINE project and not yet labelled by OneArgo (UVP and hyperspectral radiometry), the acquired data was visualized and made available through a dedicated web portal: see, for example, <http://oao2022.imev-mer.fr/bioargo/lovuse021b/lovuse021b.html>. These new variables are now accessible through the OneArgo programme's dedicated access points.

## B. Objectives and results obtained

While the completion of twelve stations may seem small compared to the standards of offshore oceanographic cruises of equivalent duration, the scientific feedback is extremely positive. The study area was among the most undersampled in the ocean. The systematic deployment of two or three floats at each station was extremely effective. **Figure 13** provides an appreciation of the observational coverage now permitted by these deployments. This is the first time, at least on a European scale, that an oceanographic cruise has deployed so many floats of diverse origins and configurations for the OneArgo programme. The first results demonstrate that nutrient availability, controlled by water mass distribution and stratification, is the primary driver of phytoplankton dynamics in the region. Persistent upwelling supports productivity in the tropical band, whereas nutrient limitation dominates in the subtropical gyre (*Riom et al., 2025*).



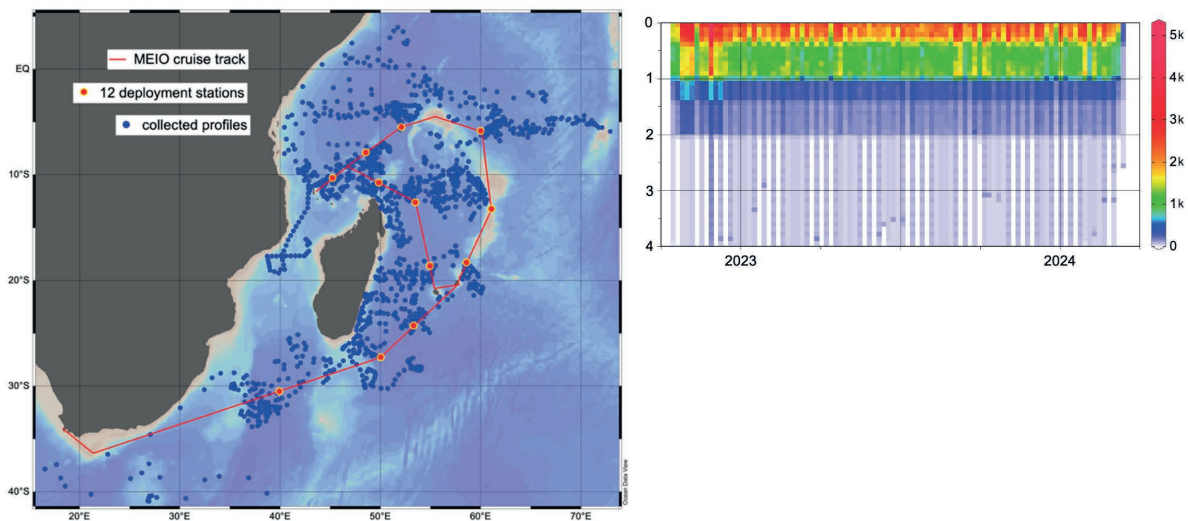
**Figure 13:** Status of BGC-Argo float deployments and observations before and after the cruise.

A summary of the float deployments and CTD stations is provided in [Appendix E](#).

## CONCLUSION

The study area was virtually devoid of recurring biogeochemical observations. The deployment of 29 floats, the vast majority of which operate nominally, filled this observational gap ([Figure 14](#)). Recently supplemented by deployments from other international

groups, this area now benefits from quite remarkable coverage that must continue to be maintained to have a sustainable network. The rapid densification of data for this area will allow for unique analyses of its regional and temporal variability (seasonal, interannual). This type of indicator is also crucial for assessing and better predicting pressures related to climate change and will be used in the information system being built as part of the French priority research programme Bridges (see <https://www.bridges-wio.com/>).



**Figure 14:** Status of horizontal (left), vertical and temporal (right) distributions of data obtained by the fleet after 18 months of operations.

The benefits can be identified as follows.

**Action 1:** Discrete data (made available to the community). On the one hand, this data was essential for qualifying and validating the data acquired by the sensors mounted on the floats. On the other hand, the data specifically relating to the assessment of phytoplankton composition (microscopy, cytometry, pigment measurement by HPLC and Particulate Organic Carbon) will enable the development of a method for estimating the major classes of phytoplankton based on bio-optical measurements taken by the profiling floats. This is an important exploratory step that is central to the work of a postdoctoral fellow (European Curie Fellowship).

**Action 2:** Float data (open access). It is clear that the float coverage of the area achieved during the expedition has made a unique contribution to initiating an observation system for the region. The description of the establishment and qualification of this network is

the subject of an article published in the special issue of *Deep-Sea Research Part II* (Riom et al., 2025).

According to this article, the recent IndOOS-2 roadmap stressed the need to expand the BGC-Argo observing system in the Indian Ocean. The expedition offered a unique opportunity to meet this goal in the southwestern sector which was, in this regard and at that time, one of the least covered oceanic regions. The deployment strategy for the biogeochemical float array was based on past experiences, existing knowledge, and the analysis of historical datasets to cover the contrasting biophysical regimes from the Seychelles Chagos Thermocline Ridge to the subtropical gyre. Aligning with IndOOS-2 recommendations, a denser float distribution was set in the tropical band to enhance biogeochemical observations in upwelling zones. Following this strategy, a fleet of seventeen biogeochemical floats was successfully deployed during the expedition in October-November 2022. After two years of operations, the spatio-temporal distribution covered by the fleet



confirmed that the goals of the deployment strategy had been reached, revealing seasonal modulations of the meridional trophic gradient with respect to phytoplankton biomass from tropical mesotrophy to subtropical oligotrophy.

Furthermore, the densification of data in the area over time (amplified in particular by new deployments by U.S. partners) will make it possible to address the nuances of the biogeochemical characteristics of the area from both a seasonal and interannual variability point of view.

Finally, the unique data acquired from hyperspectral radiometry and UVP make it possible to address new disciplinary fields (current work of two students) in the context of a diversification of the variables acquired by the BGC-Argo programme.

### 2.1.3. CURRENTS AND INTER-CONNECTIVITY OF THE INDIAN OCEAN WEST OF MASCARENE PLATEAU: AN IOE-2 / MONACO EXPLORATIONS INDIAN OCEAN EXPEDITION COLLABORATION

#### SUMMARY

The University of Western Australia, Oceans Institute (UWA-OI), IRD and Météo-France (French meteorological agency) joined forces to carry out a

joint regional project designed to provide new data and biophysical oceanographic information on the hydrodynamics of surface flows within and around the study region. Cost-effective floating devices (18 sea surface drifters or SSDs and four 15m depth SVP drogues), the speeds of which are used as a proxy of the movement and related inter-connectivity of biological propagules (incl. coral and fish larvae) and anthropogenic substances (e.g., oil, other toxicants, plastics), were deployed from *S.A. Agulhas II* along her track. The deployments included a cluster immediately west of Aldabra Atoll, a set deployed around the periphery of the Saya de Malha Bank (SDMB), and the remainder at various spot locations along the overall circuit. The Nelson Mandela University, South Africa undertook the bulk of data processing and provided key assistance with related data and scientific interpretations.

At the largest scales, observations showed lateral divergence of the South Equatorial Current (SEC) flow after passing westward through the relatively deep zone (~4,000 m) between the shallow Saya de Malha and Nazareth Banks. Observed circulation features included those consistent with previously studied dynamics related to the westward flowing SEC through the region and the South Equatorial Counter Current (SECC), as well as connections between the two.



Sea Surface drifters deployed at Aldabra © Heather Koldewey - Zoological Society of London / Monaco Explorations

Two drogues from the central and south Mascarene Plateau areas, respectively, deviated to the south-southwest towards areas east of Madagascar before retroflecting eastward, where propagations became characterised by sub-mesoscale eddying and more variability in the flow (meandering and slower). This sub-mesoscale eddying was evident both visually and through spectral energy analyses at scales including inertial, diurnal and semi-diurnal.

In addition, mesoscale counter-clockwise eddies were recorded in some tracks and in spectral energy plots. Such mesoscale eddies may have significant biological signatures. Counter-clockwise rotational behaviour was also noted at sub-mesoscale, with energy peaks at the inertial periods (between 1.5-4.5 days, for the latitudinal range traversed by the drogues), and more commonly, at the semi-diurnal and diurnal tidal periods.

Such rotating meso-scale features may be important in terms of biological responses, such as with cyclonic eddies that tend to be associated with upwelling and the elevation of nutrients into higher photic zones and anticyclonic eddies with downwelling that may promote access to mesopelagic prey by larger ocean predators. The current at the edge of the eddy can also participate in the larval dispersal offshore when the eddy moves close to productive coastal areas (for example in the Mozambique Channel).

Five SSD were deployed close to each other off west Aldabra and headed approximately westward to east Africa, grounding themselves with relatively minimal separation on the Tanzanian coast in less than 3 weeks. Larvae of some coral species can survive up to 2-3 months during their drift after spawning. Pathogenic bacteria can have similar survival time limits as they drift adhered to plastic debris (see [section 2.1.4](#)). Two SVP drogues deployed off Saya De Malha Bank (SDMB)

headed westward and reached the Aldabra and Seychelles regions in around 2 and 3 months respectively. Overall, connectivity rates inferred by the drifter velocities between habitats with relatively high biodiversity were less than about 2-3 months. For example, between the Mascarene Plateau and, respectively, east Madagascar and the island/atoll region between Madagascar and Seychelles; and between that island/atoll region and, respectively, the Mozambique Channel area and east African coastal zone off Tanzania.

The data from the project aimed to be useful transversally to other research projects conducted during the expedition. They also complement recent hydrodynamic and biological inter-connectivity studies of the adjacent Indian Ocean region to the south of the cruise area (*Crochelet et al., 2016, 2020*).

#### A. Description and timeline of achievements

Two different types of surface drifters were deployed during the Expedition:

- Sea Surface Drifters (SSD): UWA-01 provided lightweight (~1.5 kg) drifters ([Figure 15](#)) designed to move with the current in the upper 50-60 cm of the sea. They are made of a 60 cm-long plastic casing and contain an internal SPOT Trace satellite tracker powered by small AAA Alkaline batteries. They are tracked via the Globalstar service, with up to 3-4 months of monitoring life if sampling hourly. The data is stored on the UWA system. Nineteen SSDs were deployed (nine SSDs between Réunion and Seychelles, ten SSDs between Seychelles and Mauritius - [Figure 16](#) and [Table 3](#)) during the expedition. Six of them had a shorter lifetime due to improper (five minutes) data acquisition rate, and the last unit of the second batch failed to provide any data.

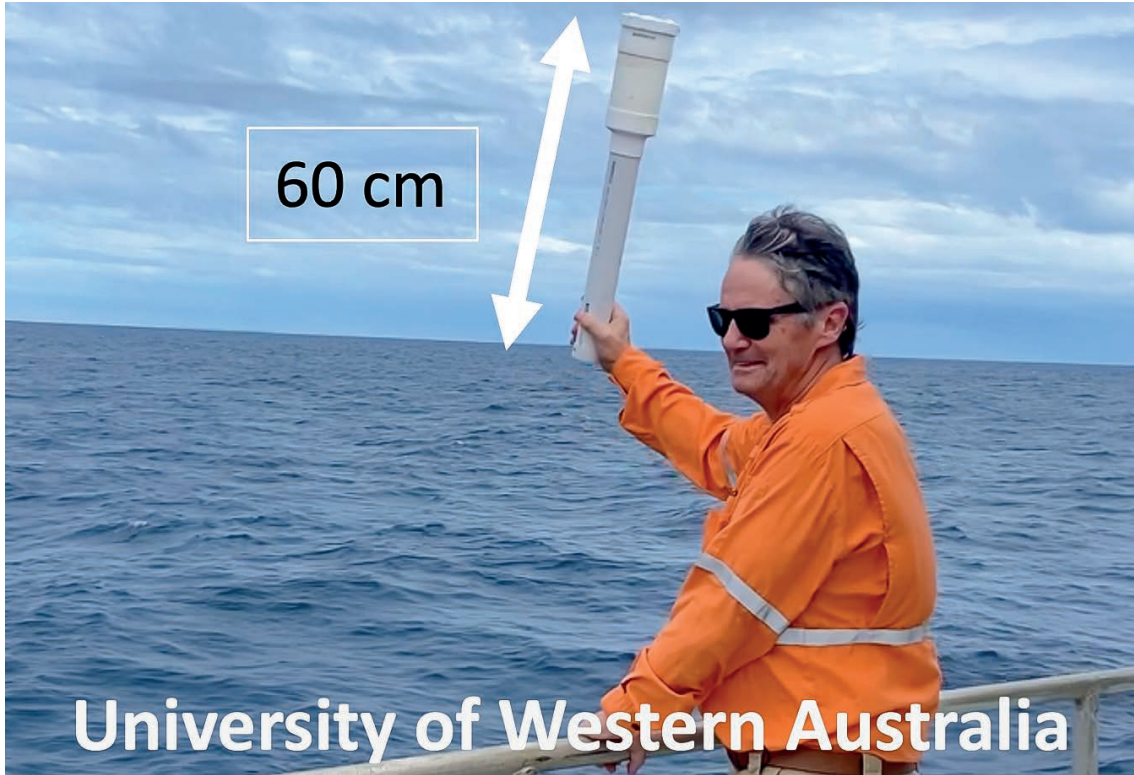


Figure 15: Sea Surface Drifter (SSD)

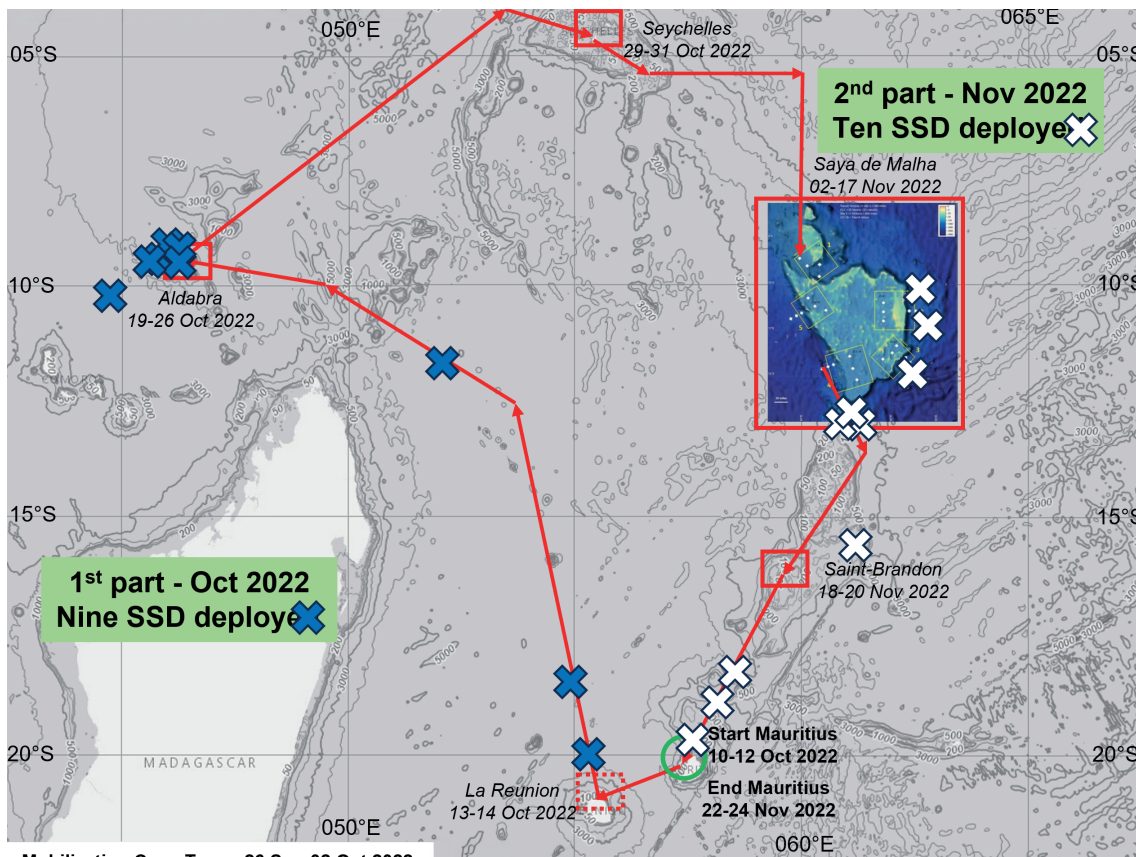


Figure 16: Map of SSD deployments

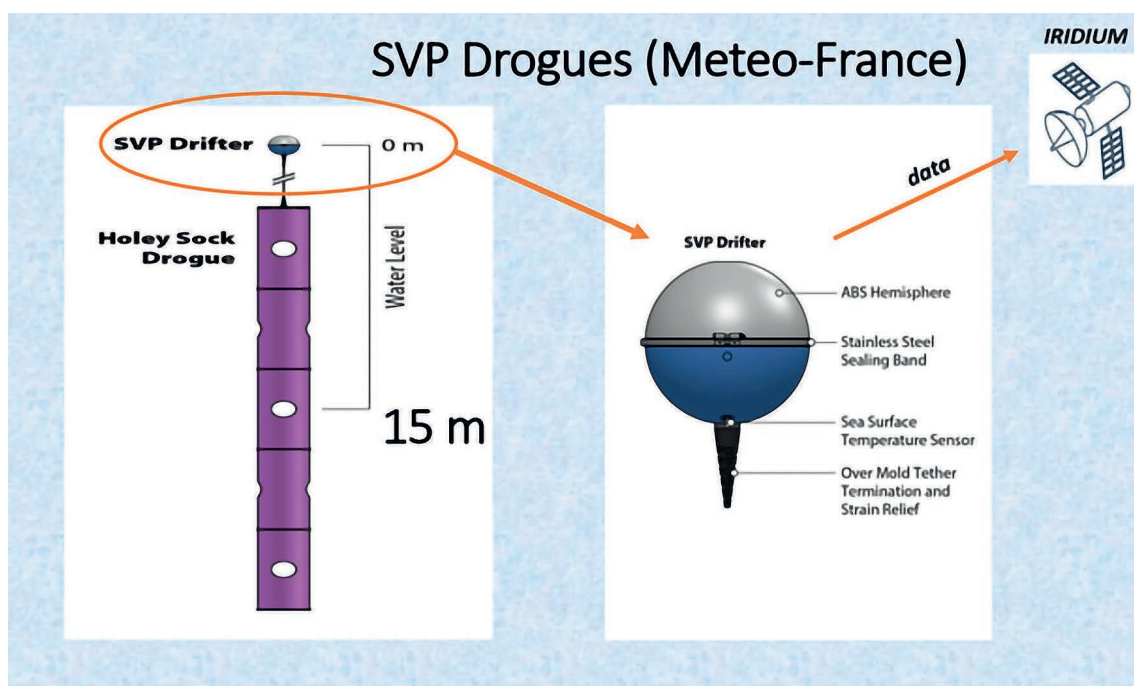
Table 3: Time and position of SSD deployments

ESN SERIAL NUMBER	MEIO SSD NUMBER	DATE / TIME (UTC) DD/MM/YYYY HH:MM	POSITION LON (E) LAT (S)	RECORDING INTERVAL (MIN)	COMMENT
ESN 0-4437514	SSD01	14/10/2022 19:00	055°04.9' 20°00.3'	5	Northward of Reunion Island
ESN 0-4437208	SSD02	15/10/2022 09:50	054°44.8' 18°19.1'	5	
ESN 0-4437206	SSD03	17/10/2022 13:05	051°55.5' 11°47.8'	5	
ESN 0-4437014	SSD6S	21/10/2022 17:45	044°47.8' 10°18.4'	60	Between Comoros and Aldabra
ESN 0-4425407	SSD04	23/10/2022 12:50	046°13.9' 09°22.0'	60	Deployed from a dive boat approx. 2-3 km out (seaward) from the centre of the mouth of Grand Passe, Aldabra
ESN 0-4437201	SSD05	23/10/2022 12:50	046°13.9' 09°22.0'	60	Deployed from a dive boat approx. 2-3 km out (seaward) from the centre of the mouth of Grand Passe, Aldabra
ESN 0-4437508	SSD07	23/10/2022 12:50	046°13.9' 09°22.0'	60	Deployed from a dive boat approx. 2-3 km out (seaward) from the centre of the mouth of Grand Passe, Aldabra
ESN 0-4440776	SSD08	23/10/2022 12:50	046°13.9' 09°22.0'	60	Deployed from a dive boat approx. 2-3 km out (seaward) from the centre of the mouth of Grand Passe, Aldabra
ESN 0-4437203	SSD06	23/10/2022 19:00	045°55.0' 09°25.5'	60	Approx. 30 km west of western end of Aldabra
ESN 0-4437211	SSD09	09/11/2022 15:50	10°12.2' 062°34.9'	60	St 17 - box 3
ESN 0-4441194	SSD10	12/11/2022 00:20	10°54.1' 062°38.8'	60	St 20 - box 3
ESN 0-4436324	SSD11	14/11/2022 14:45	11°53.3' 062°20.1'E	60	St 29R - box 4
ESN 0-4437210	SSD12	18/11/2022 01:20	12°48.6' 061°20.5'	60	East Channel South of Saya de Malha
ESN 0-4440269	SSD13	18/11/2022 01:30	12°49.5' 061°22.5'	60	East Channel South of Saya de Malha
ESN 0-4450210	SSD14	18/11/2022 01:40	12°50.4' 061°24.4'	60	East Channel South of Saya de Malha
ESN 0-4447625	SSD15	18/11/2022 12:55	15°40.7' 061°33.6'	5	East Channel South of Saya de Malha
ESN 0-4450211	SSD16	21/11/2022 18:00	18°13.8' 058°30.8'	5	Between Saint Brandon and Mauritius
ESN 0-4450221	SSD17	22/11/2022 00:10	19°02.9' 058°01.0'	5	Between Saint Brandon and Mauritius
ENS 0-4450215	SSD18	22/11/2022 04:20	20°00.4' 057°26.2'	5	Between Saint Brandon and Mauritius

- Surface Velocity Profilers (SVP drogues): four surface buoys drogued at 15m below sea surface (**Figure 17**) were provided by Météo-France, as a contribution to the Global Drifter Programme (GDP). The SVP drogues are equipped with air pressure (P) and sea surface temperature (SST) sensors and tracked via the Iridium service. Data (long, lat, P and SST) are transmitted hourly. They can be accessed online in nearly real time (<https://www.ocean-ops.org/board>). Three SVPs were deployed on the western side of the SDMB and one between Saint Brandon and Mauritius (**Figure 18** and **Table 4**).



**Figure 17a:** SVP drogue



**Figure 17b:** SVP drogue

**Table 4:** Time and position of SVP deployments

WMO NUMBER <sup>2</sup>	MEIO SVP NUMBER	DATE / TIME (UTC) dd/mm/yyyy hh:mm	POSITION LON (E) LAT (S)	COMMENT
1601738	SVP1	02/11/2022 15:40	059°57.0' 09°20.3'	West Channel North of Saya de Malha
1601739	SVP2	05/11/2022 20:55	060°00.7' 11°12.3'	St 9 - box 2
1601741	SVP3	16/11/2022 14:30	060°30.2' 12°01.7'	St 37R - box 5
1601740	SVP4	21/11/2022 18:00	058°30.8' 18°13.8'	Between St Brandon and Mauritius

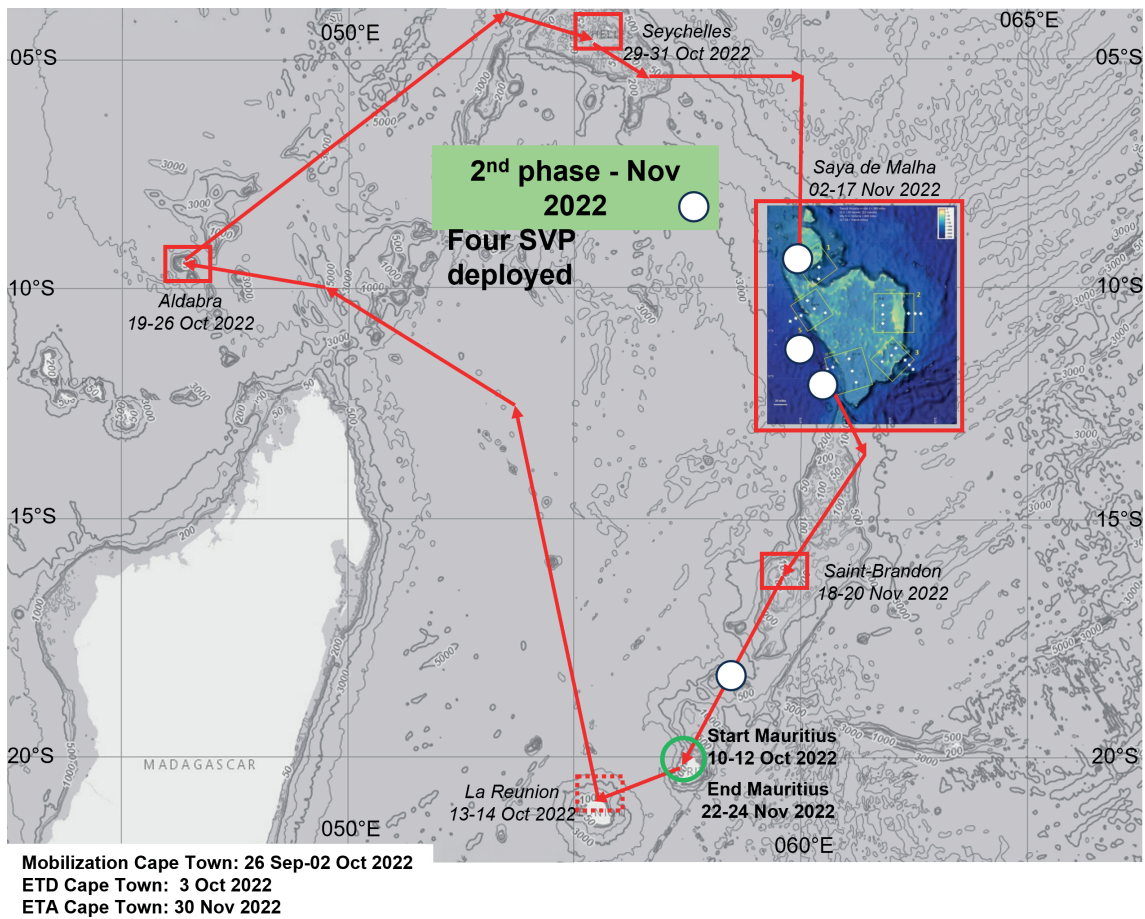


Figure 18: Map of SVP deployments

- Eighteen SSDs and the four SVP drogues have provided good quality data. Figures 19 and 20 present all the tracks up to 5 June 2024. The last tracked SSD (D4437514) stopped emitting on 9 February 2023. SVP drogue 1601739 stopped

emitting on 20 March 2023. SVP drogue 1601738 stopped emitting on 30 August 2023, having most likely grounded on the southern Somalia coast. SVP drogues 1601740 and 1601741 were still emitting as of April 2026.

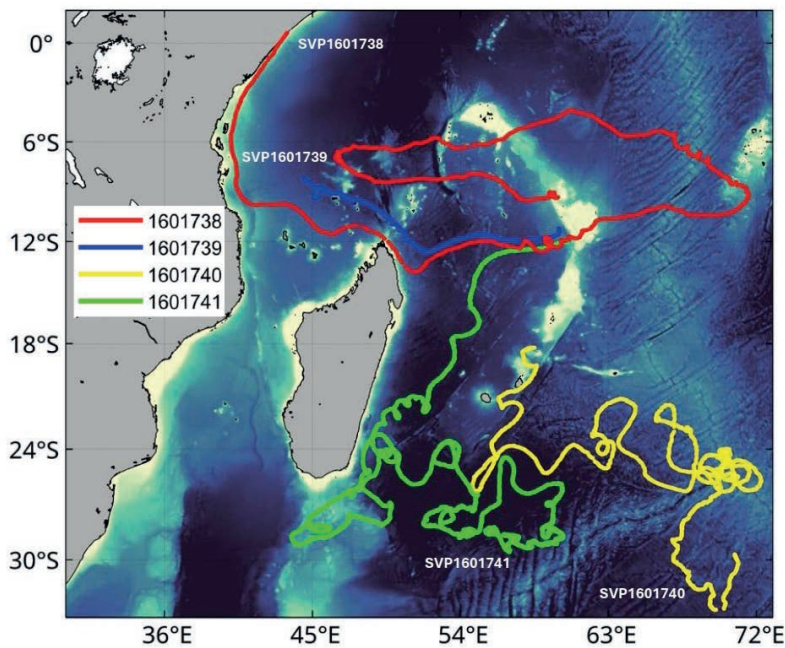
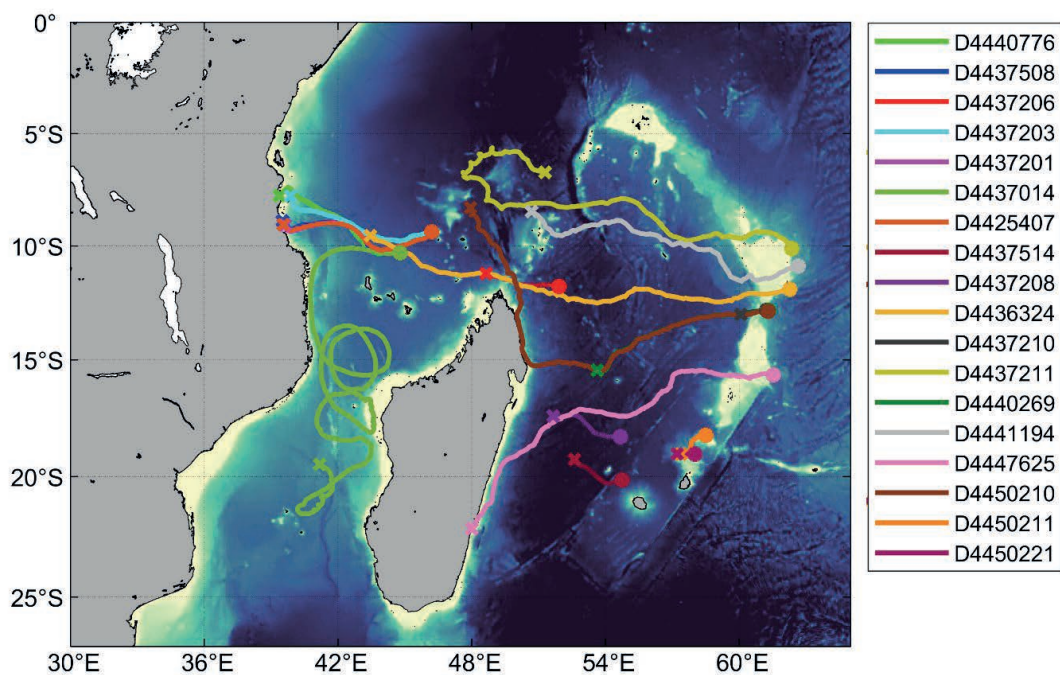


Figure 19: Trajectories of the SVP drogues, from the start of records on 2 November 2022 to 5 June 2024.



**Figure 20:** Trajectories of the SSD (from the start of records by D4437514 on 14 October 2022 to the time of the final record provided by the SSDs, being that of D4450210 on 9 Feb 2023).

X denotes either the end of a SSD location transmission (i.e. when it stopped recording) or where it became grounded.

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### B. Objectives and results achieved

The principal motivation for this project was to add to the knowledge on the oceanography of the study region by measuring currents near the surface, which was achieved using SSDs and 15 m SVP drogues to measure surface currents and the related potential for the transport of biological propagules and substances of ecological interest from source to receiving regions. Some questions of interest were: can surface waters from Aldabra (a high biodiversity zone) reach the east African coastal zone and its habitats in times less than survival times for some species of coral? And: can the rates of movement from high biodiversity zones of the Mascarene Plateau to downstream habitats render the downstream habitats as biologically important settlement or recruitment areas? The Expedition was also an opportunity to add to existing measurements of flow speeds and hydrodynamic characteristics within and outside of the study region focus.

The GlobCurrent model (<https://www.copernicus.eu/en/globcurrent>) at 25 km resolution provided useful real time simulations before and during the expedition to help in the selection of deployment positions and interpretation of SSD and SVP behaviours.

In the following sections, we highlight some interesting results obtained from both the SSDs and the SVPs. We also mention relevant patterns in the spectral analysis of temporal variability of a drifter's behaviour. A complete description of the results is available in D'Adamo *et al.* (A complete description of the results is still in preparation as of the date of this report).

#### B.1. Observations and inferences from the SSD data

In this section, we present three main results obtained from SSD drifters related to inter-connectivity (**Figure 20**):

- The cluster of SSDs deployed just off Aldabra and the one deployed 30 km west of Aldabra moved relatively close to each other and approximately westward at mean speeds of about 0.3-0.5 m/s. These SSDs reached the Tanzanian coastline with relatively minimal separation and beached within about 20 days. This is within coral larval survival times for many species, whilst noting that for some species survival times can be up to two-three months.
- The SSDs released around Saya de Malha Bank and in the gap between Saya de Malha and Nazareth Banks all moved generally towards the west at mean speeds between 0.28 and 0.42 m/s, with maximums

between 0.43 and 1.05 m/s. These drifters reached the general ocean region to the north-northwest of Madagascar within two-three months.

- One SSD deployed off east Saya de Malha Bank on 14 November flowed westward to south of Aldabra within two months and entered the same strongly flowing westward pathway that the cluster of 4 SSDs flowed within after deployment off west Aldabra in October 2022. This suggests the possibility for inter-connectivity between the habitats of northern Mascarene Plateau and Aldabra region and thence potentially on to the east African coastal zone

### **B.2. Observations and inferences from the SVP drogue data**

The four SVP drogues recorded for much longer times than the SSDs. They provide data over longer time scales and at larger spatial scales than the SSD data set and hence offer additional insights with respect to the broad circulation of the region (**Figure 19**). We present here two results illustrating large scale circulation patterns.

- Like the SSDs from the Saya de Malha Bank / Nazareth Bank gap, the two SVPs deployed in that vicinity (SVPs 1601739 and 1601741) displayed a diverging trajectory, with SVP 1601739 heading approximately westward towards and beyond the Aldabra area and SVP 1601741 heading south-westward towards southeast Madagascar. The westward heading SVP reached the Aldabra region about 4.5 months after deployment. Its trajectory was consistent with that of SSD 4436324 (released at a similar latitude but on the east side of Saya de Malha Bank) and of SVP 1601738 which, after a long clockwise circulation, arrived back to that proximate location and headed towards Aldabra following a similar pathway. This points to a consistency in this component of the SEC's trajectory behaviour once passing through the Saya de Malha / Nazareth banks region.
- Another feature evident in the SVP tracks and generally matched by the SSD tracks, was the characteristic of the SEC diverging and flowing towards the W, NW and SW (**Figure 19**). For instance, drogues from the SEC waters south of Saya de Malha Bank headed towards Madagascar. After about 3 to 4 months of travel, they turned

their general direction to head broadly towards the east (in the area known for the East Madagascar Current), and thence slowing markedly and flowing in patterns characterised by greater meandering and variability

### **B.3. Observations and inferences from spectral density plots**

- Spectral analyses were performed on the SSD and SVP drogue time series using the processing framework of the UWA BODY programme. When overviewed as a complete set of tracks, energy peaks were almost always found at the semi-diurnal and diurnal periods, reflecting semi-diurnal and diurnal tides, respectively. In addition, our observations highlighted, among other results, that:
  - Energy peaks are evident across the set of spectra within the 1.5-to-4.5 day period range, likely reflecting inertial forcing as would be consistent with the inertial periods associated within the latitude range of 6 to 25°S. Visual examination of the drogue tracks (**Figures 19 & 20**) shows sections of tracks where such rotations occur.
  - Peaks appear in some of the tracks at around 10-20 days, likely reflecting periodicities associated with clockwise meso-scale eddies such as those known to be characteristic within the Mozambique Channel and in the broader scale SEC and its retroflexion regions.

### **CONCLUSION**

Important insights were obtained on the inter-connectivity of the upper Indian Ocean between Mascarene Plateau and east Africa by the cost-effective tracking of 18 sea surface drifters (SSD) and four 15m-depth SVP drogues. They add to the knowledge base on physical and biological inter-connectivity of the region, highlighting potential routes connecting high biodiversity areas of the region in times compatible with larvae survival.

Circulation features observed were consistent with the major surface current dynamics in the region, at large scale (South Equatorial Current and Counter Current and their connection, East and Northeast Madagascar Currents), mesoscale (Mozambique Channel eddies) and sub-mesoscale (at tidal and inertial periodicities).

These results provide insights into the potential for viable ecological inter-connectivity between areas of spawning generation and downstream recruitment in the context of biological propagule transport. They also have relevance to improving the understanding of the potential for transport of other biota such as pathogenic bacteria adhered to plastic debris (see [section 2.1.4](#)). They are thus of relevance to biodiversity conservation management of important high biodiversity habitats of the reefs within the study region. In addition, they provide insights on the transport of undesirable materials such as surface contaminants and rubbish (e.g. plastics). They complement recent inter-connectivity studies of the adjacent Indian Ocean region to the south of the expedition area (*Crochelet et al., 2016, 2020*).

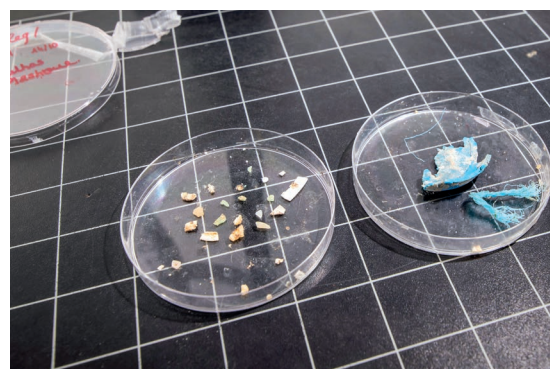
The data are freely available and may be of utility to bio-physical modelling interests as well.

### 2.1.4. MICROPLASTICS AND CORAL PATHOGENS (MADCAPS)

#### SUMMARY

The MADCAPS (Microplastics AnD CorAlS PathogenS) project was developed in 2020 by the BESTRUN Association in collaboration with UMR ENTROPIE, University of Réunion Island and The Ocean Cleanup.

Plastic pollution is increasing, impacting marine biota. Plastic debris constitute now a new ecosystem called “Plastisphere” with attracts microorganisms and bacteria. In the Indian Ocean, the abundance of plastic debris and their impacts are not well studied. The objectives of MADCAPS were divided into two components: scientific and artistic. The scientific objectives were 1/ to study the abundance and distribution of floating plastic debris and 2/ to describe the coral microbiome fixed on plastic debris. In parallel, an artist embarked on the vessel to produce an aquacolor book illustrating the research project. This part is presented in Chapter 3 (see [section 3.6.2](#)).



Microplastic samples collected with the Manta net  
© Nicolas Mathys - Zeppelin / Monaco Explorations

From October to November 2022, 60 samples of floating plastic debris were collected with the Manta trawl in the region from 21°/4°S to 45°/62°E. Of these samples, 30 were used for DNA and microbial analysis. On Aldabra Island, beached plastic debris were collected on 11 transects and their origin was assessed using a brand audit (see [section 2.2.4](#)). More than 90% of the plastic debris collected by Manta netting was of the hard type, with a high concentration of 100,000 microplastics items.km<sup>-2</sup> observed northwest of Réunion Island, east of Cap d’Ambre of Madagascar and at the Mascarene Bank. This preliminary study revealed the presence on plastic debris of potential coral pathogens (*Acinetobacter*, *Psychrobacter*, *Pseudomonas*) and probiotic bacteria (*Exiguobacterium*, *Rheinheimera*).

Even though the region is protected, plastic pollution is still present with the big problem of pathogens causing disease on biodiversity. For future projects, the evaluation of human pathogens attached to plastic debris that can affect human health is recommended. The development of solutions is also recommended to reduce plastic pollution in the region, such as waste management factories and including in the future international treaty against plastic pollution limitations on the use of plastic bottles, fishing nets and lines.

#### A. Description and timelines of achievements

The project was initially conceived in 2018 by Margot Thibault and Grégoire Henrion in response to a Monaco Explorations call for proposals. It was accepted in 2019. Following the postponement of the Indian Ocean Expedition to 2022, the MADCAPS project was further developed in association with a PhD project (2021-2024, Margot Thibault) in collaboration with IRD, UMR

ENTROPIE and The Ocean Cleanup. In preparation for the “Indian Ocean Expedition 2022”, a 15-day training course was organized in July 2022 as part of the “École Bleue Outremer” program, aboard the French oceanographic vessel *Marion Dufresne*, operating from Réunion. This training focused on plastic debris sampling methodologies.

The “Indian Ocean Expedition 2022” was carried out from October to November 2022. Data were collected at 60 sampling stations across Mauritius, Aldabra, the Seychelles, and along the Mascarene Ridge.

Thanks to Te Me Um 2023 funding from the French Office for Biodiversity, environmental DNA (eDNA) and associated microbiome analyses were conducted between November and December 2023, followed by further analyses from June to August 2024. The writing of the scientific paper (Marillac et al., 2025) took place from August 2024, leading to submission in October 2024, acceptance in October 2025, and publication in November 2025.

In parallel, the data were also valorised in Thibault’s doctoral manuscript (2024) and in a related research article (Thibault et al., 2025).

## B. Objectives and results achieved

Microplastics were collected with the Manta trawl (mouth: rectangular, depth: 0.88 m, length: 0.165 m, mesh size: 500  $\mu\text{m}$ ) designed by The Ocean Cleanup. A flowmeter was installed at the entrance of the net to measure the flow and the distance travelled was determined by noting GPS coordinates. At each location, the Manta trawl was deployed at the sea surface for 30 minutes at a speed of two knots under good weather condition (wave height < 2 m). Between each transect, the trawl was rinsed with seawater on the outside to remove any missed plastic debris from the cod-end. The cod-end was then detached, placed in a zip lock bag with all information noted (date, cod-end number), stored in a freezer on board and replaced with a new one (Figure 21). Most of the possible environmental parameters were recorded: Beaufort number, wave height, wind speed, atmospheric pressure. 24 samples were collected during the first leg and 36 during the second leg.

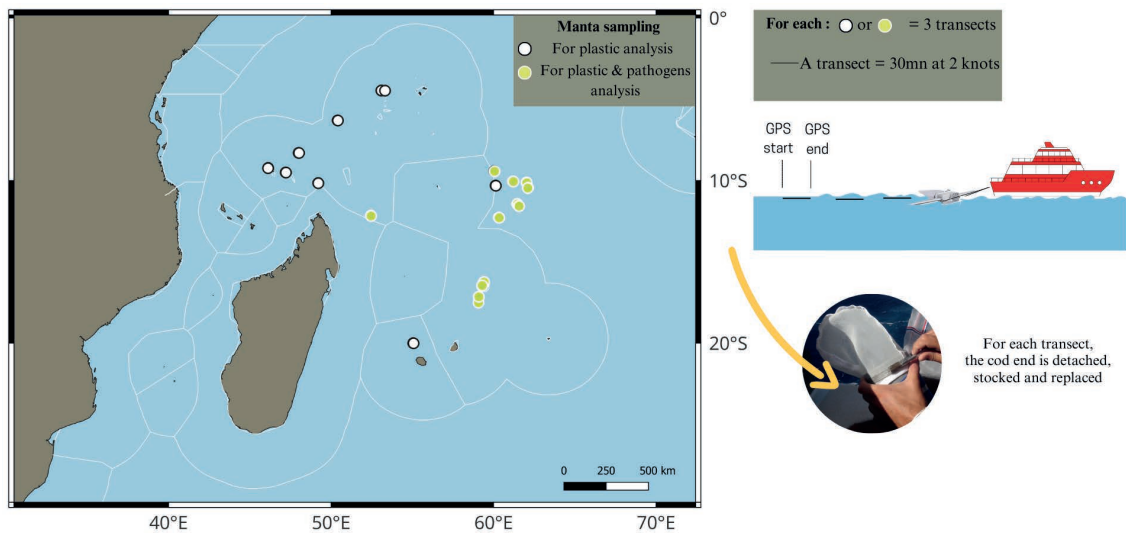


Figure 21: MADCAPS sampling methodology

Back at the laboratory in the University of Réunion Island, each cod-end was externally rinsed to deposit all plastic debris on a sieve (500 $\mu\text{m}$ ). Under light and a magnifying glass, all the plastic debris were collected with ultra-fine tweezers (0.3mm diameter) and placed in a Petri dish until analysis and characterization. For each

particle collected, the following characteristics were noted: weight ( $10^{-5}$  g), category (hard, film, foam, fibre, pellet), polymer type, size class (small microplastics [500  $\mu\text{m}$ -1.5 mm], large microplastics [1.5-5 mm], mesoplastics [5 mm-1.5 cm], small macroplastics [1.5 cm-5.0 cm]), colours.



More than 90% of the plastic debris collected were hard type. Other types such as soft plastic, film, pellet, or fibre were found too. This result is consistent with other studies. Hard plastics, in the study, were mostly polyethylene and polypropylene. These types of polymers have a lower density than other types (polystyrene, polyvinylchloride, polyterephthalate). Degradation time of hard plastic can take more time by wind, salt or wave than film or fibre category. As a consequence, they can float across the ocean for a longer period.

Overall, an abundance of (mean +/- sd) 70,859 +/- 173,951 item.km<sup>-2</sup> was noted (minimum: 0; maximum: 1,176,398 item.km<sup>-2</sup>) with a size between 500 µm (minimum) and 5 cm (maximum). The distribution by size class is as follows: small microplastics: 21%, large microplastics: 59%, mesoplastics: 17%, and small macroplastics: 3%.

The maximum abundance was observed north-west of Réunion Island at 1,176,398 item.km<sup>-2</sup> with 53% of small microplastics. For Saya de Malha Bank, an abundance of 7,354 +/- 12,020 item.km<sup>-2</sup> (maximum: 52,083 item.km<sup>-2</sup>) with 56% of large microplastics was observed. For Saint Brandon (Nazareth Bank), an abundance of 15,941 +/- 21,466 item.km<sup>-2</sup> (maximum: 71,285 item.km<sup>-2</sup>) with 77% of large microplastics was observed.

The analysis of coral pathogens fixed on plastic debris was delayed due to the withdrawal of the partner initially planned. It was undertaken at the end of 2023. The associated microbiome, along with the viable bacterial communities attached to the plastic, were analyzed in 30 samples using 16S rDNA high-throughput sequencing and traditional molecular and microbiological techniques. The mean viable bacterial count was 15,519 +/- 9,340 CFU/g of plastic debris. Nine bacterial phyla were identified, with *Firmicutes* (58% of the total) and *Proteobacteria* (42%) being the dominant groups. The bacterial diversity on the plastic was identified with coral pathogens, such as *Acinetobacter* (27%), *Psychrobacter* (2%), and *Pseudomonas* (2%). In addition, probiotic bacteria such as *Exiguobacterium* (58%), *Rheinheimera* (1%), and *Idiomarina* (1%) were also detected.

## CONCLUSION

The MADCAPS project provides valuable insights into plastic pollution and the pathogenic and probiotic bacteria associated with it in this region.

High concentrations of plastic pollution (100,000 items.km<sup>-2</sup>) were identified northwest of Réunion Island, Cap d'Ambre in northern Madagascar, Saya de Malha and Nazareth Banks, comparable to the North Pacific garbage patch. This has significant impacts on marine biodiversity and associated ecosystems.

This pollution can affect ecosystems by introducing pathogens and causing other impacts that have not yet been studied, such as endocrine disruptors. It may also influence the survival of local species (endemic and indigenous), increase coral diseases, can enter the food chain through bioaccumulation, and ultimately affect humans.

## 2.1.5. MARINE MEGAFUNA MONITORING

### SUMMARY

Globice-Réunion, a scientific-based organization whose objective is the study and conservation of cetaceans in Réunion Island, was authorized to embark a Marine Mammal Observer (MMO) during the second part of the cruise from 1 to 22 November from Seychelles to Mauritius.

The MMO participation aimed at carrying out a visual and acoustic survey on cetaceans, and marine megafauna at large, in this remote oceanic area. This survey represented a unique opportunity to assess the presence of cetaceans along the Mascarene Plateau, and in particular on Saya de Malha Bank and around Saint Brandon shoal, which had been very little surveyed for cetacean to date.

The MMO onboard was in charge of monitoring marine megafauna using both visual and acoustic methodology. The targeted taxa were marine mammals, seabirds, marine turtles. Detection of marine litter was also part of the protocol. A standard visual survey method was applied along the vessel track. This consisted of continuous monitoring at the front and on each side of the vessel to detect the presence of cetaceans (or other marine megafauna) at the surface. Acoustic monitoring consisted of deploying a recorder during dive trips to get away from the noise generated by the vessel.

A total of 148h14min of survey effort was carried out by the observer for 21 days, representing an average daily survey effort of 7h.

Three sightings of cetaceans (bottlenose dolphin and undetermined baleen whale), 56 sightings of seabirds (nine identified species), two sightings of marine turtles (hawksbills and green turtle) and 52 observations of marine litter were made during the survey.

Acoustic monitoring did not allow to detect marine mammals, but other wildlife (fish sound mainly) was detected in the recordings.

The low number of sightings is probably due to the poor sea-state and visibility conditions encountered during the survey but also to the fact that this was not a megafauna dedicated survey. A lot of time was spent in shallow waters, on the shelf of the Saya de Malha Bank, as opposed to the edge and the slope of the bank usually hosting a high cetacean diversity. The speed of the vessel during transit was also faster than specific cetacean surveys, which also made cetacean detection difficult. Finally, standard method involves 3 observers scanning the at the front and each side of the vessel. During this survey, visual monitoring was conducted by a single observer, reducing survey effort and efficiency. These cetacean observations however complement the data available for this remote area, which have been only poorly surveyed for cetaceans.

The data will contribute to the IndoCet regional database, which aims at collating cetacean distribution data collected by MMO in offshore waters of the south-west Indian Ocean. The results will be disseminated on a regional scale, via the Indocet Consortium, and will contribute to increase knowledge within existing Important Marine Mammal Areas (IMMAs) or might contribute to the identification of new ones. The results of the survey will also be disseminated locally by the partner organizations, via their various networks and outreach activities.

## A. Description and schedule of achievements

### › Visual monitoring

A standard visual survey method was applied along the vessel track. This consists of continuous monitoring at the front and on each side of the vessel to detect the presence of cetaceans (or other marine megafauna) at the surface.

The upper deck of the vessel, above the bridge, located 23m above the water, provided a 320° field of vision on the horizon, allowing a visual detection up to several hundred meters (for dolphins) to few kilometres (large whales), depending on the species. A glass shelter was also provided. During transit, vessel speed was around 14 knots and visual survey effort was mainly focused on the front, at an angle of about 120°. This visual field was extended to 320° (160° on each side) when the vessel was stationary or steering at low speed (1.3 knots) to drag gear. Visual monitoring was carried out every day, over a period ranging from 8:15 am. to 6:15 pm., with some breaks for lunch and resting (no possibility for switching observers since there was only one MMO on board).

The vessel track was recorded using a handheld GPS. Visibility conditions were rated on a scale of 1 to 5, based on an assessment of environmental factors that may hinder animal detection, mainly wind speed, swell height and light conditions:

1. Null (wind > 4 Beaufort, waves or night),
2. Poor (wind >3 Beaufort, many white caps or low light),
3. Average (wind at 2-3 Beaufort, with some white caps or moderate swell),
4. Good (wind ≤ 2 Beaufort, calm sea, no swell),
5. Excellent (flat sea).

The detection of cetaceans and seabirds was carried out with naked-eyes, binoculars being used only to confirm the detection and the species identification and to collect sighting data. Whenever possible, photographs were systematically taken to confirm the species identification.

When observing cetaceans, or other megafauna, the following sighting data was recorded using a standardised datasheet:

- GPS position (latitude/longitude)
- Species
- Estimated group size



- Group activity (surface resting, foraging, breeding, travelling, undetermined)
- Radial distance between the animals and the vessel
- Bearing angle of the animals in relation to the vessel's heading.

These last two parameters allow to compute the perpendicular distance (x) of the animals to the vessel's track and therefore to estimate the width of the band being surveyed on either side of the vessel).

Monitoring of avifauna (and other megafauna) was carried out in conjunction with cetacean monitoring. Because sightings of seabirds are generally more numerous, only the number of individuals and their activity (flight, landing, hunting) were noted. Most identifications were made with binoculars based on morphological (size, colour, wing shape, etc.) and behavioural characteristics (frequency of wing beats, flight altitude, hunting technique, etc.).

Photographs were taken when there was a doubt on the species identification.

Observations of marine debris were also recorded. A photograph was systematically taken for further description.

#### › Acoustic monitoring

The Sound Trap 300STD was deployed from the dinghy, during the dive trips, to get away from the noise generated by *S.A. Agulhas II* (Table 5). The acoustic recorder was either attached to a mooring deployed at the bottom by the IRD divers in depths of 25-30 m or towed behind the boat in deeper waters. The ST300STD was set to record continuously, using a sampling rate of 92kHz, for period of 1-2 hours. Recordings were analysed at the end of the survey to detect the presence of cetacean's vocalisations, within a radius of a few hundred metres (dolphins) to a few kilometres (large whales and sperm whales).

**Table 5: Schedule of the visual and acoustic monitoring conducted during the survey**

DATE	ACTION
› Visual monitoring	
2022/11/01 – 2022/11/17	Visual monitoring on Saya de Malha Bank during daytime.
2022/11/18 – 2022/11/22	Visual monitoring between Saya de Malha Bank and Mauritius during daytime.
› Acoustic sampling	
2022/11/09	Acoustic recording
2022/11/10	Acoustic recording
2022/11/11	Acoustic recording
2022/11/11	Acoustic recording
2022/11/13	Acoustic recording
2022/11/19	Acoustic recording
2022/11/19	Acoustic recording
2022/11/19	Acoustic recording
2022/11/20	Acoustic recording
2022/11/20	Acoustic recording
2022/11/21	Acoustic recording

## B. Objectives and results obtained

### > Cetaceans

Only three cetacean sightings were made during the survey. Two of them were common bottlenose dolphins (*Tursiops truncatus*) representing a cumulative number of around 65 individuals. Both

sightings occurred on the Saya de Malha Bank. An undetermined whale (blow) was also recorded on the edge of the Nazareth Bank, during transit from Saya de Malha to Mauritius.

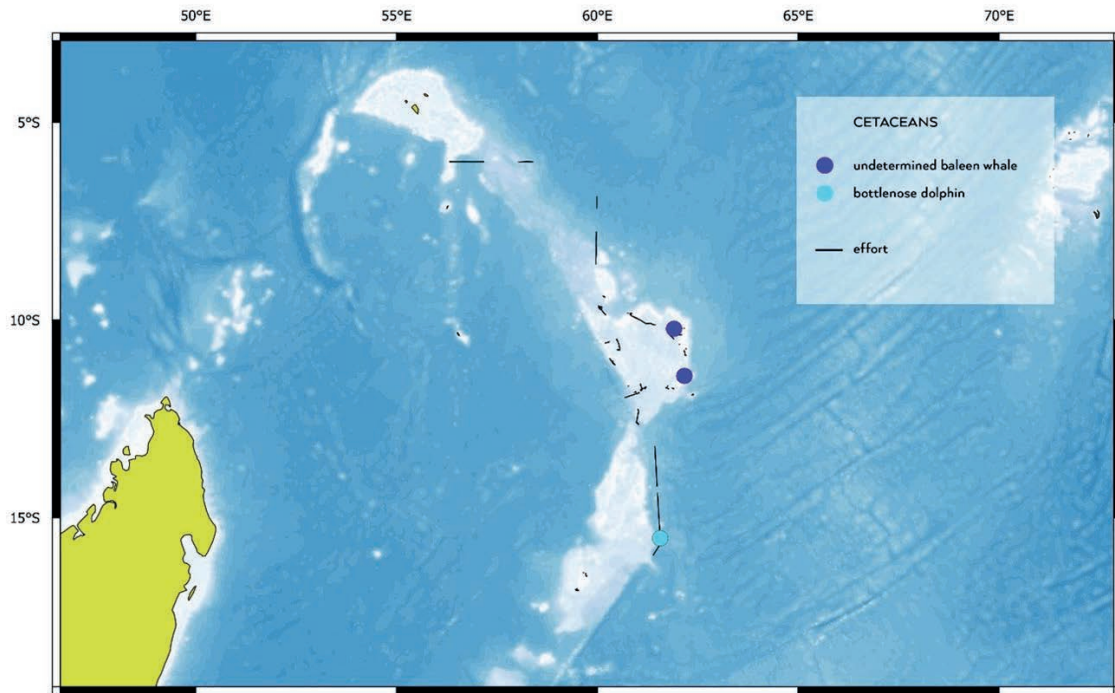


Figure 22: Maps of cetacean visual sightings.



Pictures of common bottlenose dolphins observed on Saya de Malha Bank © Bernard Rota - Globice / Monaco Explorations.

## › Seabirds

Seabirds were the most common taxa observed, 56 sightings were made (9 clear identified species). However, 4 days without any bird sightings should be noted. Notably the red footed booby and the masked

booby were mostly observed when the ship stopped north of Saint Brandon. South, they were replaced by white terns and brown noddies.

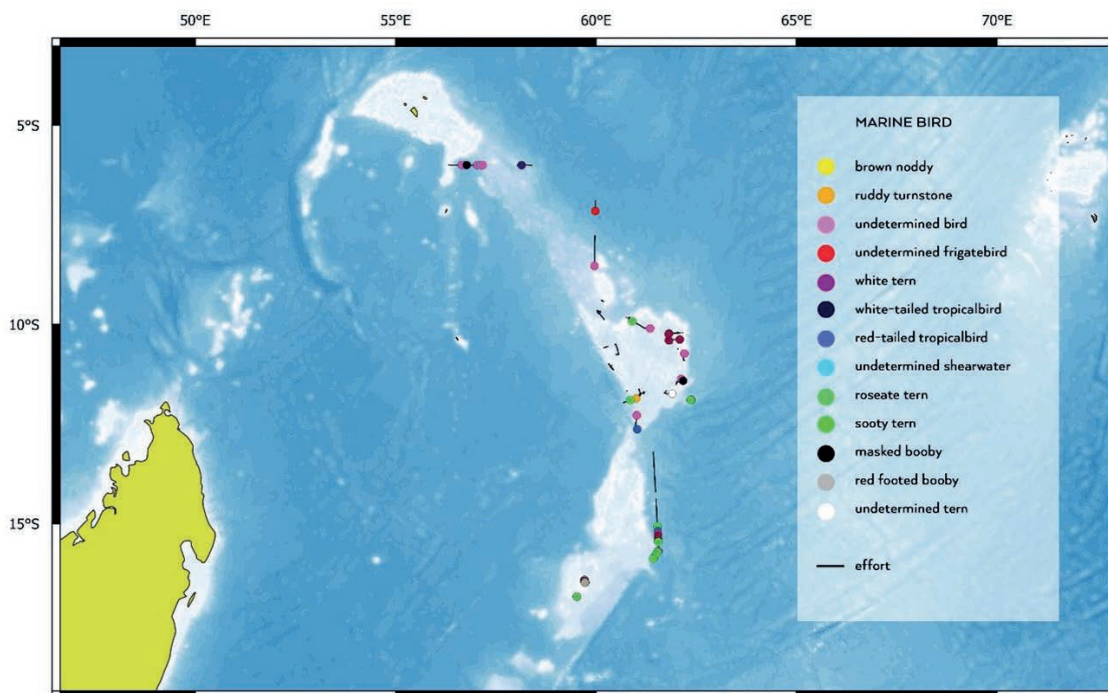
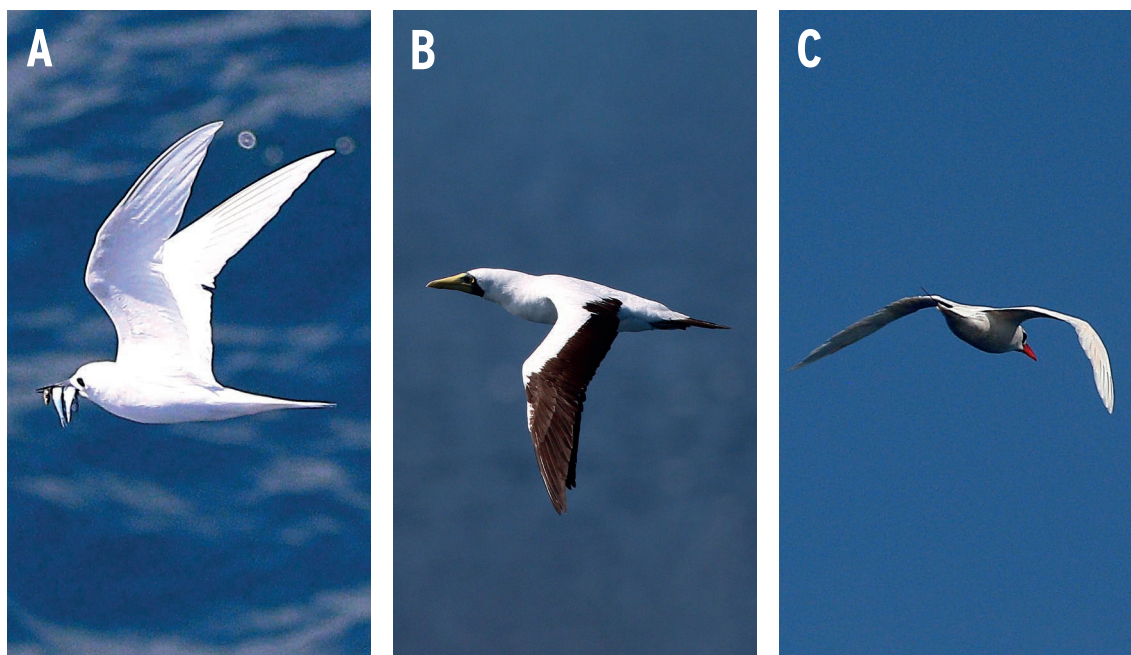


Figure 23: Maps of seabird sightings.



Pictures of white tern (A), masked booby (B) and red-tailed tropical bird (C) observed during the survey  
© Bernard Rota - Globice / Monaco Explorations

### > Other marine megafauna

One green turtle (*Chelonia mydas*) and one hawksbill turtle (*Eretmochelys imbricata*) were sighted close to the vessel, on Saya de Malha Bank.

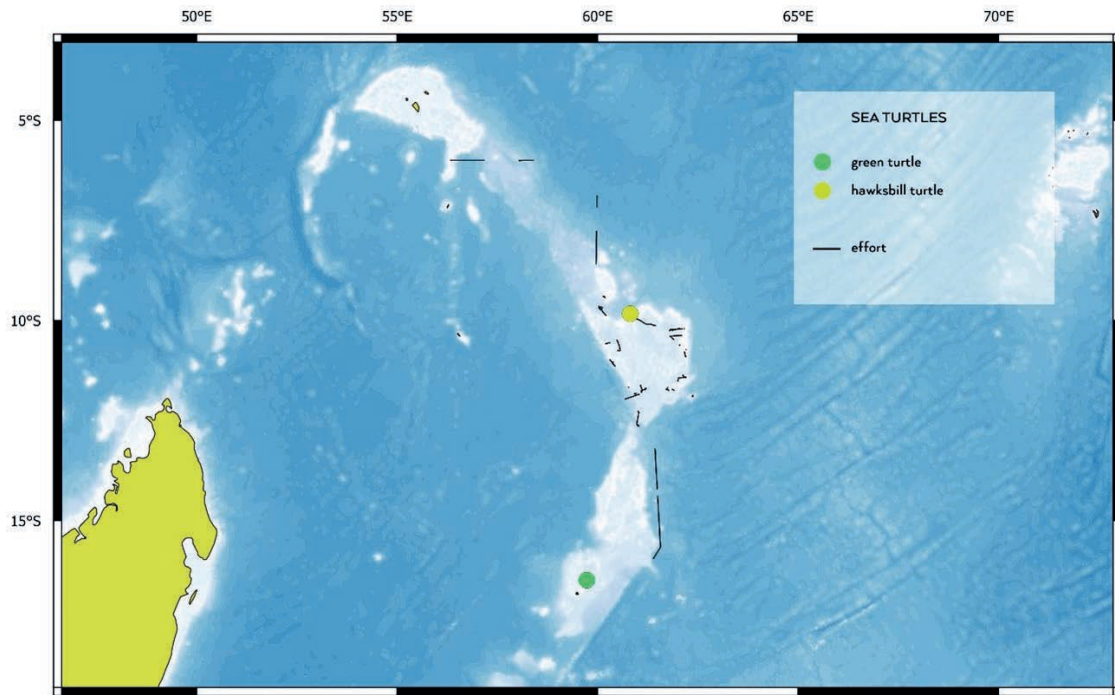


Figure 24: Maps of sea turtle sightings.

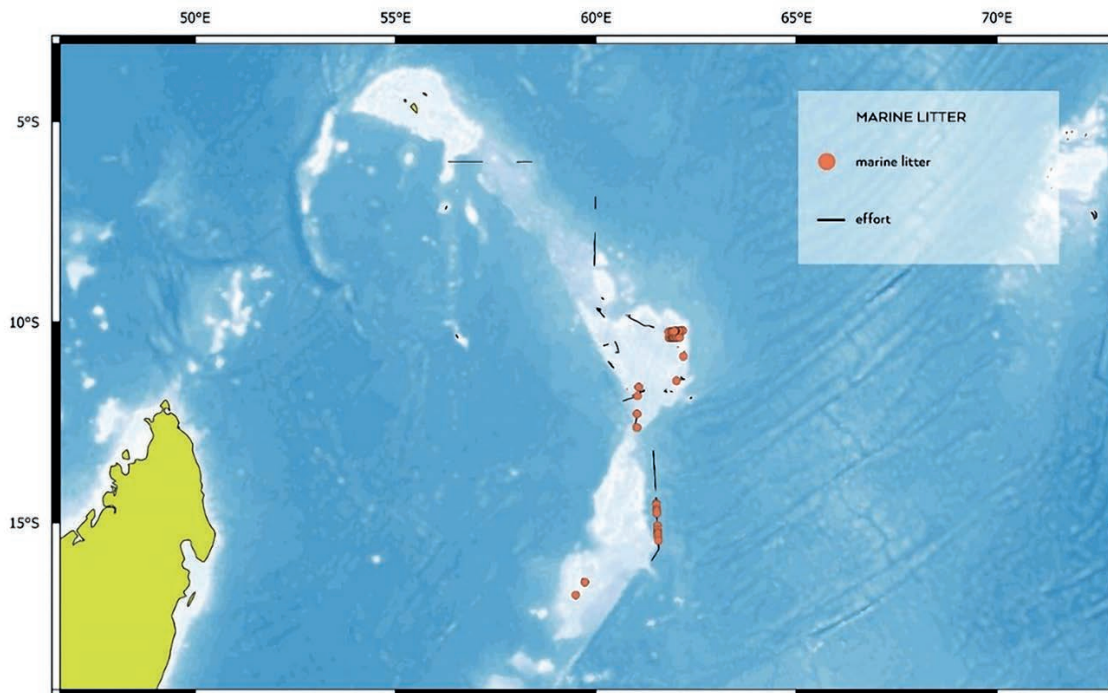
### > Marine litter

During the survey, a total of 52 observations of floating marine debris were made. The majority of these were spotted on 2 days: 15 pieces of marine debris were seen on 9 November 2022 and 19 on 10 November 2022 in box 3, east of Saya de Malha Bank. On 9 November the debris concentrated between 10.3876°S / 61.8549°E and 10.38°S / 62.0903°E, and on 10 November between 10.210°S / 62.160°E and 10.20°S / 62.0055°E. This concentration of litter could be the result of marine currents. Some life was

observed on the debris (shell, crabs) or under them (fish). The data of these marine litter survey were including the research paper of Thibault et al., 2025 : Thibault, M., Fajean, A., Ramanampanjy, A., Royer, S.J., Fustemberg, G., Marillac, V., Gindrey, J., Saloma, A., Condet, M., Mangion, P., Burt, A., Egger, M., Amy, M., Jaquemet, S., Mulochau, T., Jourand, P., Halle, A. ter, Corre, M. Le, Lebreton, L., 2025. Concentration gradient of plastic debris larger than 500 µm detected across the Southwest Indian Ocean.



Pictures of marine litter observed during the survey © Bernard Rota - Globice / Monaco Explorations.



**Figure 25:** Maps of marine litter recorded during the visual survey.

### › Acoustic monitoring

52

11 recordings of approximately one-hour duration each were made on Saya de Malha Bank and around Saint Brandon. The acoustic analysis of the recording

indicated that no cetacean sound was recorded, while other types of biological sound were recorded (**Table 6**).

**Table 6:** Acoustic recordings during the expedition

DATE	LATITUDE (°S)	LONGITUDE (°E)	RECORDING DURATION (HH:MM:SS)	BIOLOGICAL SOUNDS
2022/11/09	10.61	62.04	01:34:12	Fish sounds
2022/11/10	10.38	62.13	01:40:55	Fish sounds
2022/11/11	10.73	62.20	01:10:11	No biological sound
2022/11/11	10.90	62.19	01:25:03	Fish sounds
2022/11/13	10.90	62.01	01:24:04	Fish sounds
2022/11/19	16.65	59.65	02:31:54	Fish sounds and snapping shrimps
2022/11/19	16.38	59.65	00:23:15	Noise
2022/11/19	16.38	59.38	00:49:24	Noise
2022/11/20	16.84	59.52	00:52:22	No biological sounds
2022/11/20	16.80	59.48	01:25:36	No biological sounds
2022/11/21	16.60	59.51	01:27:48	Snapping shrimps

## CONCLUSION

This opportunistic marine megafauna survey during the second part of the expedition allowed the collection of few visual sightings of cetacean and megafauna species in general. The low number of sightings is probably due to the poor sea-state and visibility conditions encountered during the survey but also to the fact that this was not a megafauna dedicated survey. A lot of time was spent in shallow waters, on the shelf of the Saya de Malha Bank, as opposed to the edge and the slope of the bank usually hosting a higher cetacean diversity. The relatively high speed of the vessel during transit was also limiting, making cetacean detection difficult. These observations however complement the data available for this remote area, which has been only poorly surveyed for cetaceans.

The marine megafauna sighting data obtained during this survey contributes to a regional strategic objective to increase the number of observers onboard opportunistic platforms in order to collect data in oceanic habitats (such as seamounts and banks), in the high seas and in poorly-studied areas. The ultimate aim is to create a regional database that can be used on a regional scale by scientists, politicians, conservationists and the general public from the different territories.

The data will contribute to the IndoCet regional database, which aims at collating cetacean distribution data collected by MMO in offshore waters of the south-west Indian Ocean. The results will be disseminated on a regional scale, via the Indocet Consortium, and will contribute to increase knowledge within existing Important Marine Mammal Areas (IMMAs) or might contribute to the identification of new ones. The results of the survey will also be disseminated locally by the partner organizations, via their various networks and outreach activities.

### 2.1.6. ROUTINE UNDERWAY OPERATIONS

#### SEAFLOOR MAPPING

No Multi Beam Echo Sounder (MBES) is mounted on *S.A. Agulhas II* for undertaking swath bathymetry surveys.

Bathymetry transects were carried out with two single-beam echosounders (SBES): the Simrad EA600 hydrographic echosounder (18 kHz) and the Simrad EK60 scientific echosounder (38, 120 and 200 kHz). Both were used to collect accurate depth data.

The Kongsberg TOPAS PS 18 parametric sub-bottom profiler (18 kHz) was also used for imaging of the sediment layers (sub seafloor imaging) along bathymetry transects.

The passage soundings were conducted by the surveyor contracted by Marine Solutions to provide positioning for the ROV. The three sounders were interfaced to Qinsy for this purpose. No heave or motion compensator was available. All soundings were corrected using GNSS height aiding. Sound velocity was corrected to wherever a profile was available. All soundings were processed onboard. The processing entailed: correction for heights, vessel offsets (heading only as no motion reference unit was available), sound velocity profile (where available) and automated filtering. This was followed by manual de-spiking and suspect data rejection. All data was exported to sounder specific ASCII data files containing the agreed to file header (see [Appendix F](#)).

The data collected in high sea areas was provided directly to Seabed 2030 Atlantic-Indian Regional Center. The data collected in areas under national jurisdiction was provided to the relevant coastal State. Subject to their authorization, the data will also be made available to Seabed 2030 Atlantic-Indian Regional Center. The South African Navy Hydrographic Office, as Seabed 2030 and GEBCO regional coordinator, offered to compare the data to the GEBCO Grid and check any discrepancies.

#### CURRENT

The drop-keel mounted Acoustic Doppler Current Profiler (ADCP) from RDI was operated to measure ocean current velocities and directions. The frequency of the ADCP is 75 kHz with 8 m vertical resolution and a maximum depth of 800 m. The recording was stopped when the drop-keel had to be taken up when the ship's speed exceeded 14 knots.

Some results related to the analysis of the data collected at 30 m depth during the Saya de Malha sequence are presented in [section 2.3.4](#) - WP2 - Physical and chemical oceanography.

#### SEA SURFACE TEMPERATURE AND SALINITY

Sea surface temperature and salinity were recorded all along the ship track using the ship's SBE45 thermosalinograph (TSG). The sampling rate was set at 6 s.

The raw data was recorded through the SDS.



## 2.2. THE VISIBLE ISLANDS: ALDABRA AND SAINT BRANDON

### 2.2.1. OVERVIEW

The Visible Islands component of the expedition encompassed multidisciplinary research conducted across two remote, ecologically critical sites: Aldabra Atoll (Seychelles) and Saint Brandon (Mauritius). These studies integrated biological, ecological, and oceanographic approaches to advance understanding of biodiversity patterns, ecosystem health, and connectivity across the Western Indian Ocean's island and bank systems. Each project generated complementary datasets that together form a coherent assessment of environmental status, resilience, and regional linkages among oceanic islands and atolls.

At Aldabra, the **GECOS project** assessed the genetic structure, contaminant exposure, and physiological health of juvenile green (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricata*) turtles, revealing stable population genetics over two decades, and low but spatially variable contamination levels. Higher hepatic degradation markers relative to samples from nearby Réunion Island suggested increased detoxification activity, whereas cortisol analyses indicated lower cumulative stress, reflecting limited local anthropogenic pressures. Satellite-tagged juveniles displayed restricted juvenile home ranges within Aldabra's lagoon, confirming site fidelity and minimal intra-lagoon exchange.

The **4Sea project** developed and validated autonomous platforms for integrated bathymetric, habitat, and species mapping, employing autonomous instrumental board (ASV) and aerial drone (UAV) surveys at both Aldabra and Saint Brandon. High-resolution datasets, processed with advanced AI recognition algorithms, yielded georeferenced maps of benthic habitats, including seagrass, coral, and sand assemblages. The successful deployment of these low-cost, easily replicable platforms demonstrated their potential for large-scale monitoring and long-term coastal habitat assessment throughout the region.

Complementing these ecosystem-level studies, the **MADCAPS project** team conducted a quantitative assessment of beached macro-litter on Aldabra. Despite the atoll's isolation, plastic debris constituted 71% of

collected items, most originating outside the Seychelles. Comparative analysis with Sainte-Marie (Madagascar) highlighted that even remote islands accumulate ocean-borne waste at rates comparable to inhabited coasts, underscoring the transboundary nature of marine pollution. Data were valorised into the PhD manuscript of Thibault, 2024.

At the interface of biodiversity conservation and restoration, the **World Coral Conservatory** implemented its first field collection at Aldabra, gathering 58 colonies from 21 scleractinian species for ex-situ preservation in a network of European public aquariums. An 88% survival rate after 18 months validated the collection and transport protocols and confirmed the feasibility of establishing a global "living ark" for coral genetic diversity. Subsequent molecular and taxonomic analyses will further refine species identifications and support future assisted-evolution experiments.

The **Coral Connect project**, conducted in coordination with the World Coral Conservatory, focused on coral connectivity and resilience across Aldabra and Saint Brandon relative to the Chagos Archipelago. Photogrammetry transects found Aldabra's reefs were overwhelmingly dominated by stress-tolerant corals, while genetic analyses of *Acropora* samples showed strong connectivity of coral larvae between the Chagos Archipelago and the Inner Seychelles, with a permeable barrier to dispersal between the Inner and Outer Seychelles (including Aldabra). These early findings support the "stepping-stone" hypothesis linking oceanic atolls via seasonally reversing currents.

Complementary **Remote Operated Vehicle (ROV) surveys** at depths to ~700 m off both Aldabra and Saint Brandon expanded the expedition's spatial and ecological scope, yielding the first video records from these depths and enabling collection of deep-water eDNA samples for subsequent taxonomic and biodiversity analyses. Parallel bioprospecting efforts by the Mauritius Oceanography Institute collected sponges across depth gradients (10-70 m), establishing a foundation for chemo-taxonomic and bioactivity comparisons within the region.

Finally, targeted oceanographic measurements (CTD and XBT casts) and satellite-derived bathymetry at Saint Brandon contributed to the regional hydrographic baseline and to the Seabed 2030 initiative, linking biological observations with physical ocean conditions to improve future environmental modelling and management.

Together, these interlinked projects demonstrate the scientific and conservation value of integrated, multi-scale observation of remote oceanic islands. They provide new baselines for biodiversity, genetic connectivity, pollution, and habitat structure that is invaluable for informing regional management decision-making. Collectively, the Visible Islands programme reinforces Aldabra Atoll and Saint Brandon as important sites for understanding and supporting the ecological status and resilience of the Western Indian Ocean's island ecosystems.

### 2.2.2. GENETIC STRUCTURE, CONTAMINANT AND STRESS LEVELS: AN ASSESSMENT FOR MARINE TURTLE CONSERVATION IN THE INDIAN OCEAN (GECOS)

#### SUMMARY

The entire Ocean is now affected by human activities, in addition to the strong pressures of climate change. Biodiversity and habitats of coastal ecosystems are the first to be impacted and have decreased by 30 to 60%. The increase in the human population and the growing anthropic and climatic pressures on marine ecosystems raises the question of the sustainability of the exploitation and conservation of these marine ecosystems. This conservation depends above all on the ability to measure these changes daily, as well as to have this data collection sustainable over the long term in order to develop relevant and reliable indicators of these pressures on the ecosystems. Marine megafauna is particularly sensitive to these pressures and there are unfortunately many examples of entire populations disappearing. The case of marine turtles is particularly interesting because, as emblematic species of marine diversity, they have contributed to the development of a species-based approach to the conservation of a habitat, community, or ecosystem.



Green turtle, *Chelonia mydas*, Aldabra © Stéphane Ciccione - Kélonia / Monaco Explorations.

The project targeted only the Aldabra area. All necessary research authorizations for this project were obtained in accordance with the Convention on

International Trade in Endangered Species of Wild Fauna and Flora (CITES) and the Nagoya Protocol on Access and Benefit Sharing (ABS).



This project, led by Ifremer in collaboration with Centre d'étude et de découverte des tortues marines (CEDTM - France / Réunion), Kélonia (France / Réunion), Alborg University (Denmark) and Murcia (Spain), as well as the Seychelles Island Foundation (SIF - Seychelles), had the following main objectives:

- (i) place the genetic structure of juvenile green and hawksbill turtles in a regional context;
- (ii) estimate the physiological state of these individuals through analyses of inorganic contamination and stress-related parameters; and
- (iii) assess, through the placement of Argos-GPS tags, whether the home range size of juvenile green turtles is similar to those found at other sites in the Indian Ocean and whether there is any exchange between areas.

Six days on Aldabra allowed to achieve the sampling objective, capturing 30 juvenile green turtles (*Chelonia mydas*) (15 in the Picard station area, on Picard West, and 15 in the Middle Camp - Malabar East area), as well as 10 juvenile hawksbill turtles (*Eretmochelys imbricata*) in the Middle Camp - Malabar East area. This phase also allowed to deploy two Argos GPS tags on juvenile green turtles (one on Picard West and one on Malabar East). All field objectives were met.

Analysis of the samples and data collected yielded the following results:

- Genetic structure: Combined with other regional data (Réunion, Glorieuses, and Mayotte), the analysis shows that the genetic structure of juveniles in these lagoons has been stable over the last 20 years, but that this structure varies within the Aldabra lagoon depending on the area, probably due to the large size of the lagoon.
- Inorganic contamination: Combined with other available regional data (Réunion in particular), statistical analyses show that contamination levels vary greatly between sites, and that green and hawksbill turtles are more contaminated in Aldabra than in Réunion. Nevertheless, contaminant levels for these two species in these two territories remain relatively low.

- Stress levels: Aldabra turtles show higher levels of liver degradation markers than those from Réunion Island (potentially related to greater contamination), but lower levels of accumulated stress (cortisol in the scales). The latter may reflect greater cumulative anthropogenic stress on Réunion Island. However, general metabolic stress markers remain similar between these two populations (Aldabra vs. Réunion), suggesting a low impact of these contaminants at the individual level.
- Movement and home range: The two turtles monitored exhibit behaviours similar to those observed in other Indian Ocean lagoons, with restricted home ranges and no exchange of individuals between the Picard and Middle Camp areas during the study.

The stated ambition is to pursue projects aimed at better understanding the health of juvenile and adult marine turtles in the whole Indian Ocean.

#### A. Description and schedule of achievements

The GECOS project targeted only the Aldabra area. During the stay on Aldabra, the objective was to capture 30 juvenile green turtles (*Chelonia mydas*) (15 in the Picard Station area, on Picard West, and 15 in the Middle Camp - Malabar East area), as well as 10 juvenile hawksbill turtles (*Eretmochelys imbricata*) (5 in the Picard Station area, on Picard West, and 5 in the Middle Camp - Malabar East area) (Figure 26).

The turtles were captured either using the «Turtle Rodeo» technique using a motorized tender (in the Picard area) or directly on foot (in the Middle Camp area).



A "Turtle Rodeo" in Aldabra lagoon  
© Elise Rigot - Monaco Explorations

Each turtle was subjected to the following samplings:

- A skin sample for genetic analysis,
- A blood sample in two 5ml tubes for contamination and physiological parameter analyses,

- Two scale samples were taken using an 8mm diameter Biopunch.

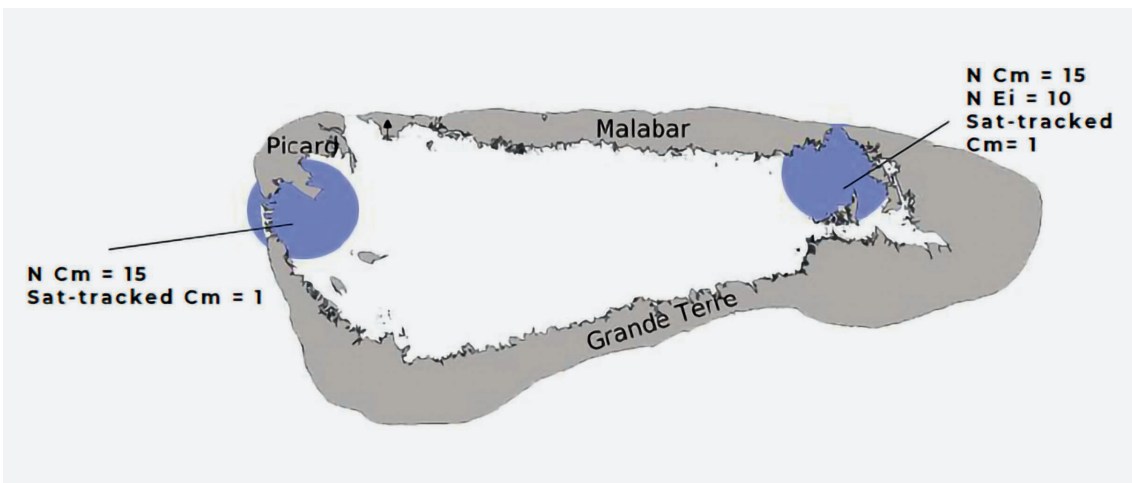
Finally, two Argos-GPS tags (Argos Fast-loc GPS) were deployed on green turtles only, the first in the Middle Camp area, the second in the Picard area.



Blood and scale sampling  
© DR



Attaching an Argos-GPS tag to the shell of a juvenile green turtle  
© DR



**Figure 26:** Juvenile marine turtle sampling areas at Aldabra

*Cm* = *Chelonia mydas*; *Ei* = *Eretmochelys imbricata*; *Sat-tracked* = individual tracked with an Argos-GPS tag

The analyses were carried out according to the following schedule:

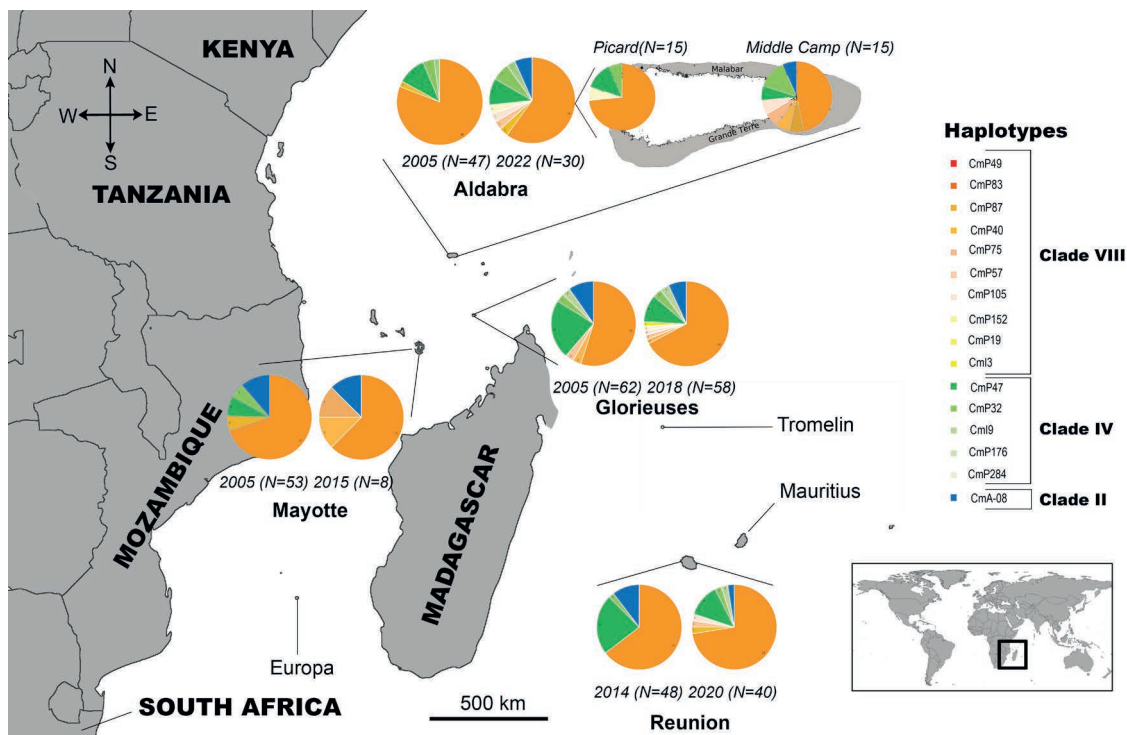
- December 2022: DNA extractions;
- January 2023: DNA sequencing of the 40 individuals;
- February 2023: Analysis of inorganic contamination;
- April-May 2024: Analysis of stress markers;
- 2024-2025: Valorisation through publication of results.

## B. Objectives and results obtained

The main scientific results obtained are as follows:

- Genetic structure: Combined with other regional data (Réunion, Glorieuses, and Mayotte), the results demonstrate the temporal stability of the genetic structure of juvenile green turtles in these lagoons (Figure 27). However, a different structure between the east and west of the Aldabra lagoon, certainly

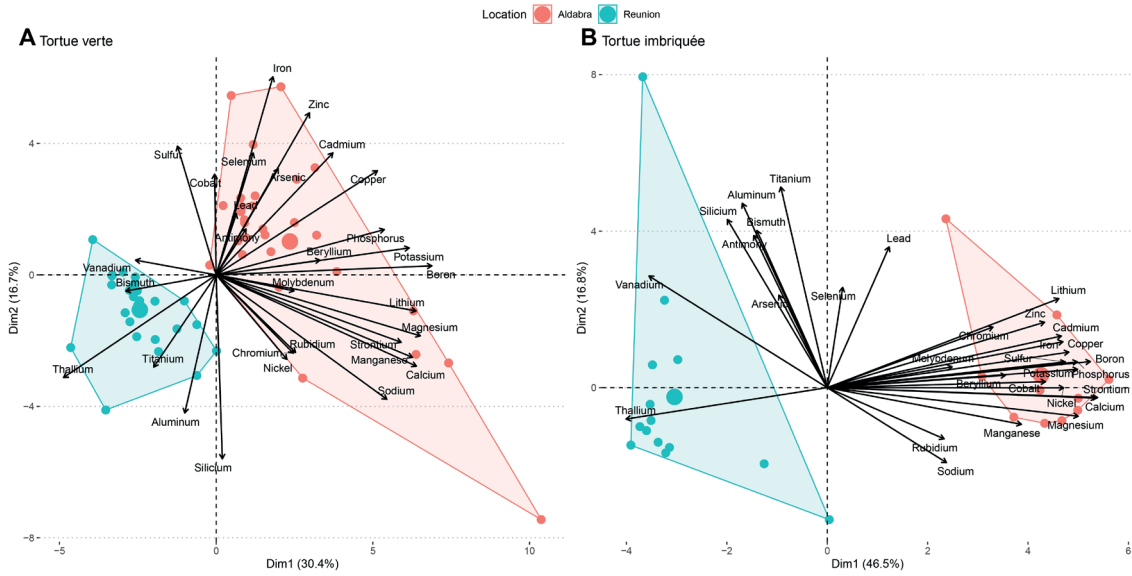
related to its size, was detected. This work is now published in a peer reviewed journal. For hawksbill turtles, the small sample size (N=10) does not allow for a quantitative analysis. The results were integrated as planned into the regional TIMOI (Tortues imbriquées de l'océan Indien - Hawksbill turtles of the Indian Ocean) project led by the CEDTM. All regional analysis are done and the paper is now at the publishing stage with a submission expected in April 2026.



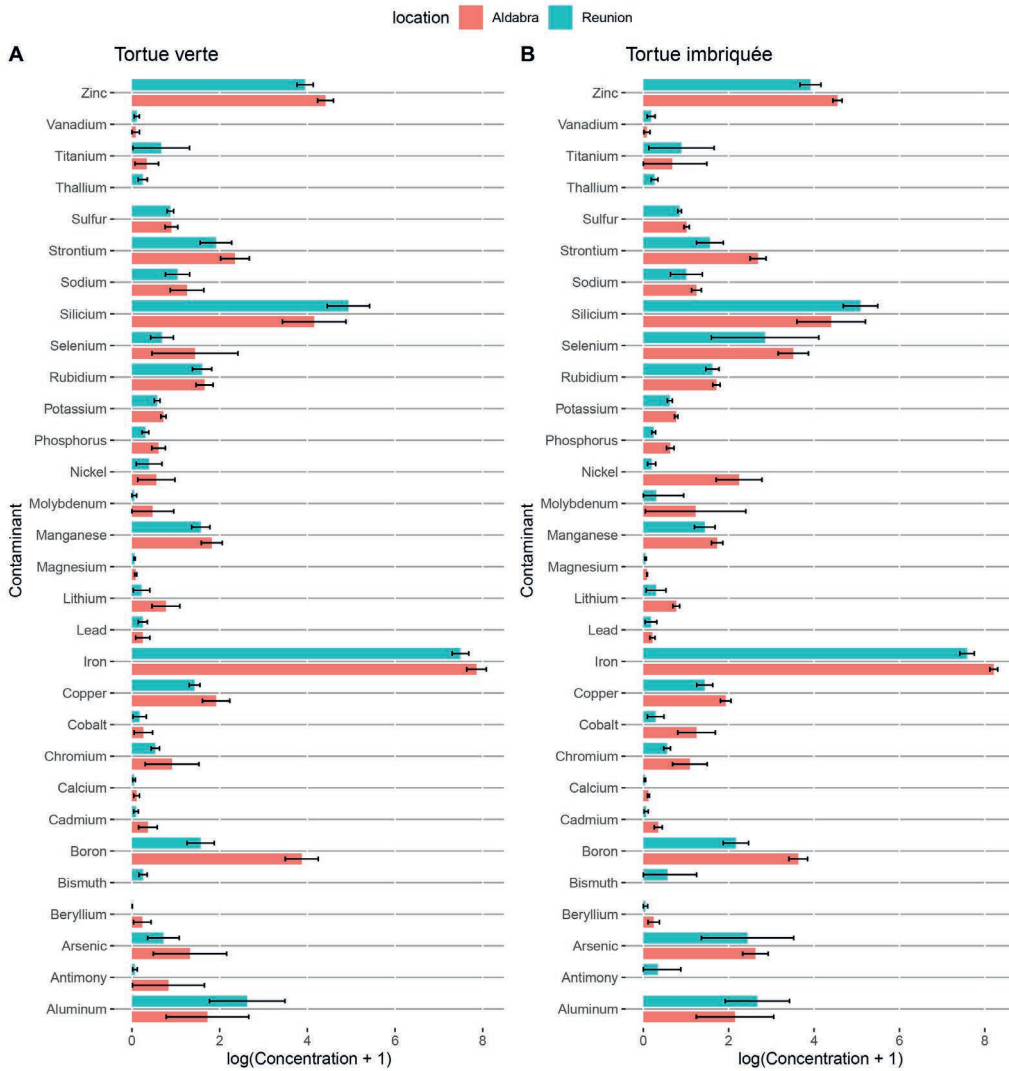
**Figure 27:** Temporal evolution of haplotype frequencies (mtDNA 386bp control region) in the lagoons of the southwest Indian Ocean.

- Inorganic contamination: the comparison of trace element concentrations in the blood of turtles in this study with those of green and hawksbill turtles worldwide suggests that individuals from Réunion and Aldabra have relatively low contaminant levels (within the global average), with a few exceptions. However, most studies focus on heavy metals, resulting in a lack of data on other contaminants. In addition, contamination data on hawksbill turtles are scarce, making it difficult to assess their contamination levels relative to other populations. However, within the framework of this project, it was possible to directly compare individuals from Aldabra with individuals from Réunion on a wide range of

inorganic contaminants. This comparison showed that the contamination levels are different between sites and a significantly higher average contamination level was observed in the green and hawksbill turtles from Aldabra (Figures 28 and 29) except for thallium, vanadium, silicon and aluminium, which are on average higher in the turtles from Réunion.



**Figure 28:** Comparison of levels of 30 inorganic compounds between Aldabra and Réunion (Principal Component Analysis) for green (A) and hawksbill (B) turtles.



**Figure 29:** Comparison of levels of contaminants between Aldabra and Réunion for green (A) and hawksbill (B) turtles.



- Stress level: For both species, Aldabra turtles showed significantly higher levels of liver degradation biomarkers (AST and ALT), markers that are known to be particularly (but not exclusively) sensitive to contaminant exposures. In contrast, Réunion turtles showed higher levels of cortisol (the main circulating stress hormone) accumulating in their scales. No significant difference is observed in the levels of oxidative stress biomarkers (Figure 30). This therefore seems to indicate a higher inorganic

contamination in Aldabra associated with a higher liver degradation/detoxification metabolism versus a set of anthropogenic pressures on Réunion and therefore higher stress. However, general metabolic stress markers (oxidative stress) do not suggest any deleterious effects on the health of individuals. Obviously, further investigations would be necessary before any conclusion, including regular monitoring to detect potential long-term effects.

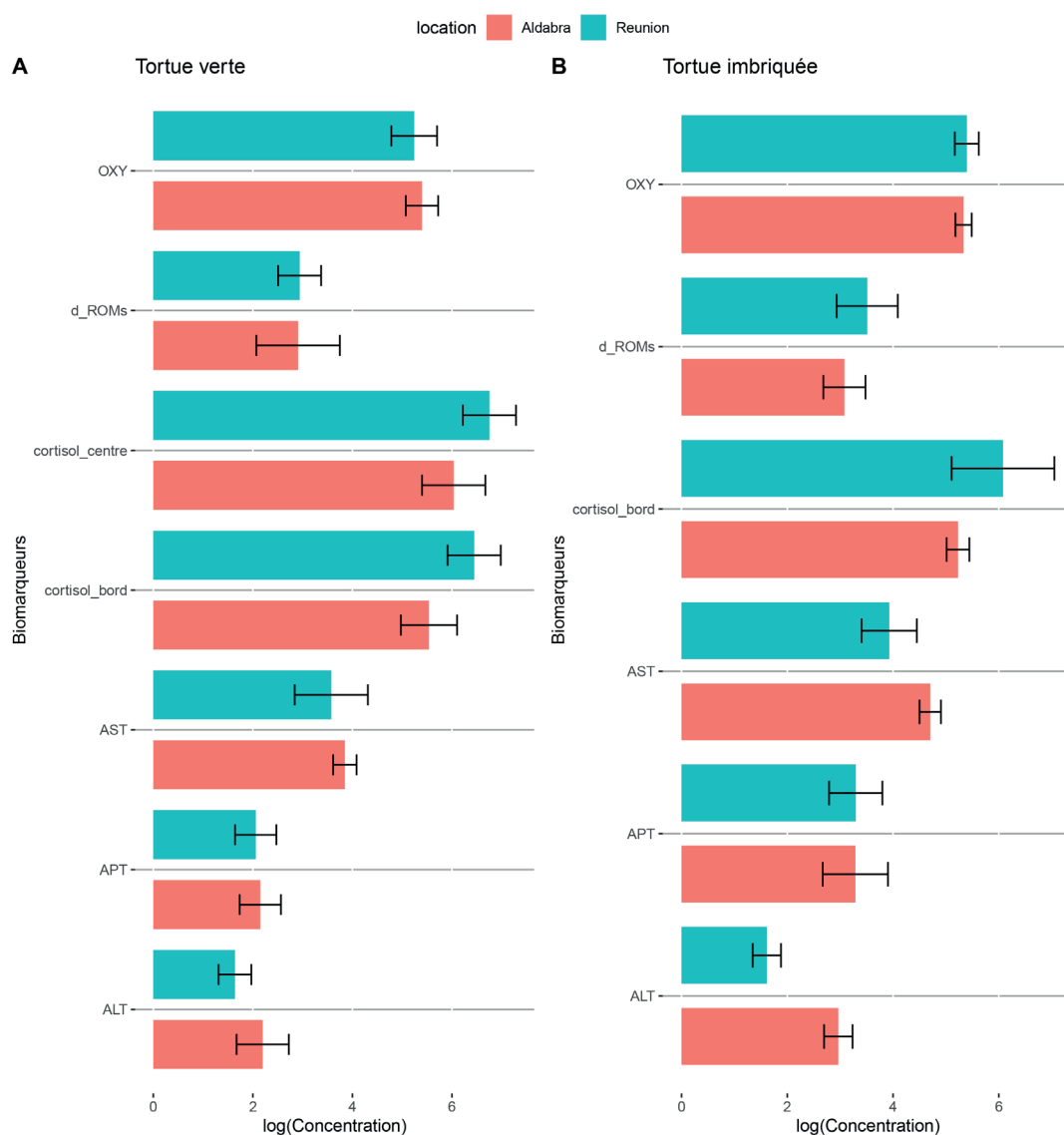
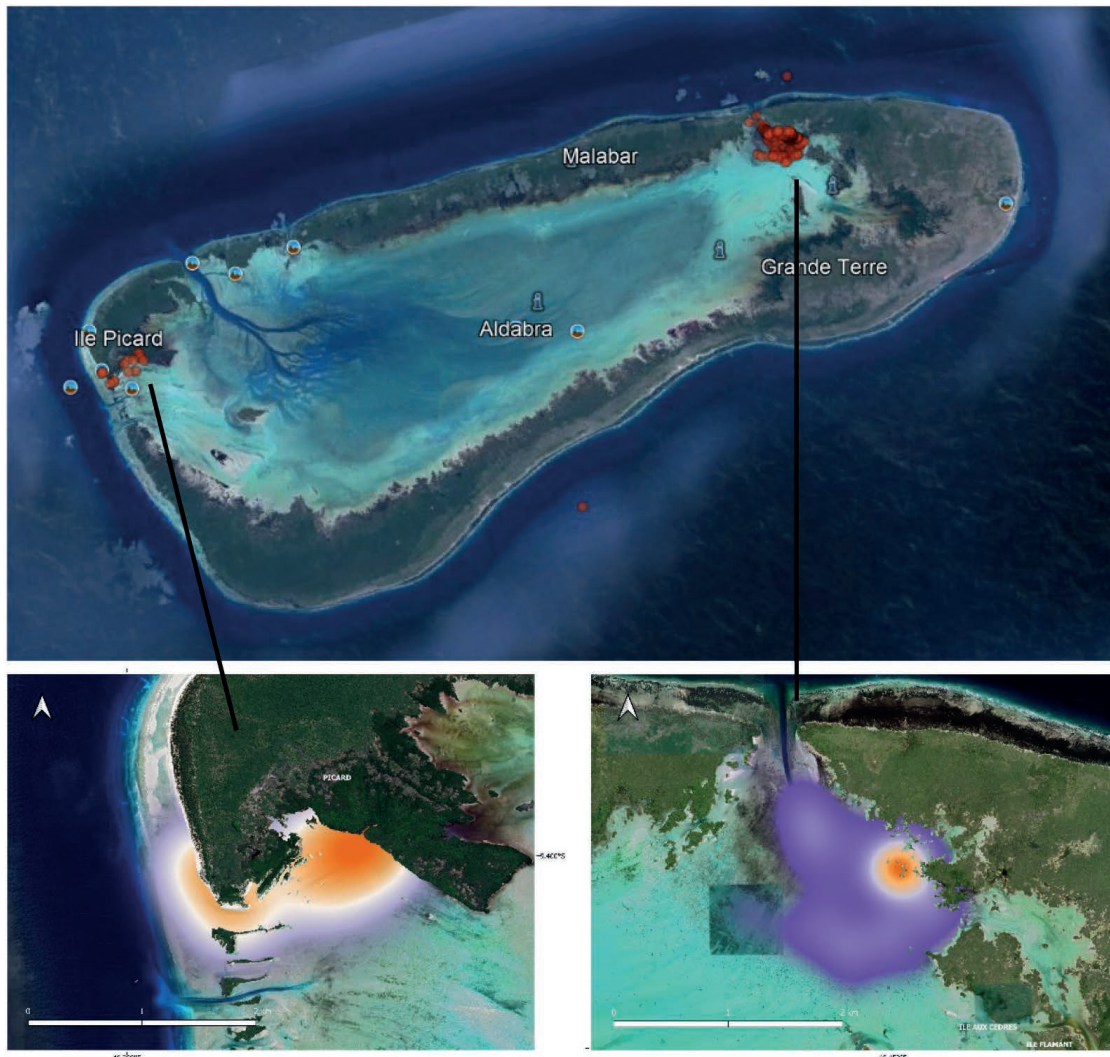


Figure 30: Comparisons of biomarker levels (log transformed) between Aldabra and Réunion for green (A) and hawksbill (B) turtles.

- Movement and home range: the two green turtles tracked with Argos-GPS tags (Figure 31) showed behaviours like those observed in other lagoons in

the Indian Ocean, with restricted home ranges and no exchange of individuals between the Picard and Middle Camp areas.



**Figure 31:** Geolocation (GPS) and home ranges (constructed from GPS data) of two juvenile green turtles equipped with Argos-GPS tags, west (Picard) and east (Middle Camp) of the Aldabra lagoon.

## CONCLUSION

The project has a primarily regional impact. The collected data were combined with data already acquired on marine turtles at the regional level to supplement the knowledge of the behaviour of juvenile green and hawksbill turtles in their habitats; this knowledge is essential for defining management and protection policies and measures at the local (e.g., Aldabra) and regional levels (e.g., assessment of the status of green turtles in the Southwest Indian Ocean within the framework of the IUCN Red List).

The main beneficiaries of the project are the managers of Aldabra Atoll (SIF). The results provide a better understanding of the behaviour of juvenile turtles inhabiting the lagoon and allow for better adaptation of their management practices.

Overall, putting the results into regional perspective allows the scientific community working on the conservation of endangered species to better understand juvenile recruitment processes at the oceanic scale for these species with complex biology. These results contributed to the assessment published in December 2023 of the health status of the green turtle population in the western Indian Ocean, which concluded that their conservation status had improved. These results also allowed to publish a regional multi-island analysis that demonstrates the temporal stability in genetic origin of juvenile green turtle recruits at remote western Indian Ocean islands.

Finally, this project opens up avenues of research, particularly on the impact of the environment on individuals.

### 2.2.3. 4SEA

#### SUMMARY

The 4Sea project aimed to disentangle the combined impacts of coastal human activities and climate change on marine ecosystems in the Western Indian Ocean. By deploying autonomous observing systems such as autonomous instrumented boards (ASV) and aerial drones (UAV) in pristine and anthropogenically impacted ecosystems this project aimed to answer key scientific questions. The project relied on the collection of bathymetry data and images and their analysis using artificial intelligence to map habitats and species and changes in their surface area and abundance.

The project was led by Ifremer in collaboration with IRD and CNRS in liaison with Ifremer participatory science project "Seatizen" involving members of French UMR MARBEC. The project focused on Aldabra, in liaison with the GECOS project, and Saint Brandon and contributed also to the investigation of the Saya de Malha Bank.



One of the connected boards used by the 4Sea project team. Aldabra station in the background © Mervyn Ravitchandrane - Ifremer / Monaco Explorations

The objectives planned for the first leg at Aldabra were achieved with 24 and 33 sites covered by the boards and the aerial drone respectively over six days. During the second leg, the aerial drone was no longer on board, and the weather or depth conditions allowed only two acquisitions, one with the autonomous boards (1h45 transect) and one by equipping the expedition ROV with the project cameras. On Saint Brandon, the conditions were favorable and allowed seven acquisitions with the autonomous boards.

The main results obtained are the bathymetries of the different sites using the ASV echo sounder and UAV SfM<sup>1</sup> photogrammetry to which were added the orthophotos produced from aerial images. Habitat and species mapping was carried out using an automatic recognition algorithm. All the images collected were georeferenced and for the aerial drone images, photogrammetric processing was applied.

During the final phase of the project, a special effort was made to improve the performance of the artificial intelligence models, with significant manual annotation and model retraining. The model's performance was substantially improved, allowing for mappings for each of the classes predicted by the model.

The data collected and generated through post-processing are standardized (naming conventions, metadata, and access protocols) so that they can be shared with the scientific community in accordance with best practices (FAIR<sup>2</sup> principles) for data management. All raw and processed data have been deposited on open-access data infrastructures.

The actions carried out by the 4Sea project were presented at two international conferences (GeoHab May 2023, FOSS4G June 2023) and two workshops on photogrammetry and deep learning (IH.SM Toliara, Madagascar, May 2023 and Station Seas-01, November 2022). Two articles were published: one in the form of a data paper describing the collected data and making it public with DOIs (*Contini et al. 2025a*), and the other one on the identification of reef habitats and species using deep learning (*Contini et al. 2025b*).

The 4Sea project has deployed an innovative platform for collecting scientific data on bathymetry and habitats/species present in tropical ecosystems. This project has demonstrated the feasibility of this methodology for application on a larger scale and in other ecosystems. The addition of other equipment to this platform, such as an eDNA pump, will provide additional information on biodiversity.

<sup>1</sup> SfM: Structure from Motion. See <https://doi.org/10.1016/j.geomorph.2012.08.021>

<sup>2</sup> FAIR principles: Findable, Accessible, Interoperable, Reusable.

### A. Description and schedule of achievements

During the first leg, all studies took place in the western part of the Aldabra Atoll, focusing on 4 sites with 24 surveys carried out by the autonomous boards for a total acquisition time of 30 hours and 33 drone overflights representing eight hours of acquisition (Figure 32). The deployment of a reference GPS base and control points was carried out on land to correct and improve the geolocation of the acquired data (centimetric precision). This allowed to overlay data from different sources (ASV and UAV) precisely. During the second leg two operations were carried out in Saint-Brandon, for a total of 5 hours of acquisition. Acquisitions with aerial drones were not planned for this second leg, because the project team responsible for this component was only involved in the first leg.

The report of the operations carried out during the expedition to Aldabra is accessible at this [link](#).

In addition to survey preparation and data acquisition, the main actions carried out during the 4Sea project were:

- Standardization of the collected data and associated metadata to make them available to the community,
- Photogrammetric processing of the images collected by drones and autonomous boards at the various study sites,
- Processing of the data collected by the autonomous boards and drones to provide bathymetric maps and compare them,

- Manual annotation of habitats and species identified on the collected images to train a deep learning model.

### ALDABRA

During the six-day data collection period, the research team collected data from four different locations, chosen after discussion with the Seychelles Islands Foundation (SIF) team. The first location, ARM01, near the research station on Picard Island, was chosen due to its inclusion in the SIF team's ongoing monitoring programmes (Figure 32). Similarly, data acquisitions were carried out at site ARM06, located in the northern part of Picard Island, to ensure consistency with local monitoring initiatives. The choice of the Plage Gigi site, easily accessible on foot from the research station and with a greater abundance of corals than ARM01, added a layer of diversity to the dataset. The final location, Passe du Bois, is the deepest channel in a series along the west coast of the atoll, between the islands of Picard and Grand Terre. Data collection at this location required careful planning due to the tides. Strong tidal currents, which can reach up to 1.5 m/s during high or low tides (Hamilton et al., 2018), made it difficult for the ASV, which had to move at 1 m/s for optimal data acquisition.

Two ASVs conducted a total of 24 surveys, contributing to an overall acquisition time of approximately 20 hours and an area of 151,060 square meters. In parallel, a UAV conducted 33 flights, representing 8 hours and 15 minutes of acquisition. Details on the survey positions are shown in Figure 32.

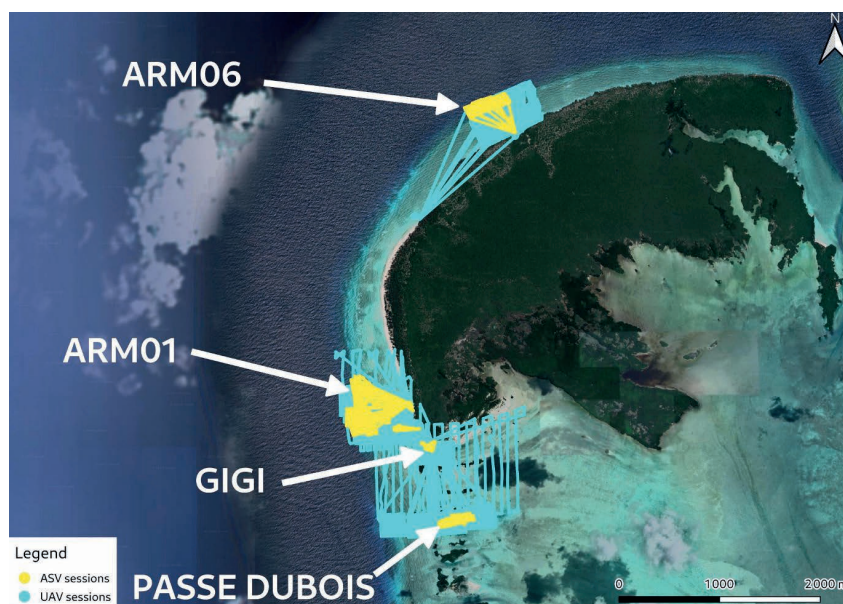
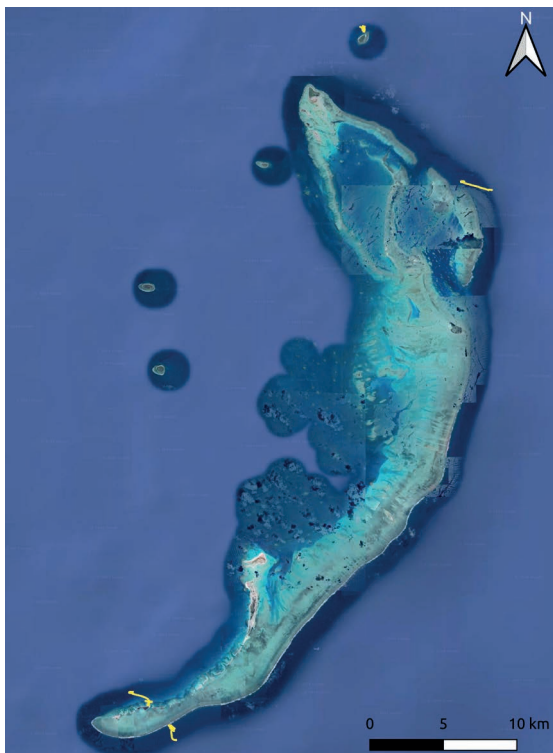


Figure 32: GPS trajectories of UAV transects during acquisitions at Aldabra (UAV / aerial drone in blue, ASV / autonomous board in yellow).



## SAINT BRANDON

Seven surveys, two north around North Island, one east near Tortue Island, and four near South Island, were conducted during the study with ASVs (**Figure 33**). No operations were conducted with the UAV. Due to restrictions preventing going ashore, no GPS base was used for any of the surveys. Therefore, ASV positions were not corrected using post-processing kinematics (PPK) techniques.



**Figure 33:** GPS trajectories of UAV transects during acquisitions at Saint Brandon (UAV / aerial drone in blue, ASV / autonomous board in yellow)

## DATA PROCESSING AND ANALYSIS

### Development of a habitat / species recognition algorithm

As part of the project, a recognition algorithm was developed to identify GCRMN<sup>3</sup> classes in the collected photos. The development of this algorithm includes manual image annotation, which constitutes the model's training set. The recognition model used is based on the DinoV2 model family (Oquab et al., 2024), which is based

on a transformer-type architecture. For information purposes, the model took 75 hours to train on Ifremer's Datarmor supercomputer. The model's performance was statistically evaluated and showed that the training process allows for predictions that can be used to map the different classes.

### Species habitat mapping

Using the recognition algorithm, GCRMN classes were predicted, based on the images collected as part of the project. Since these images were georeferenced, maps could be produced for each class.

### Bathymetry

The bathymetric surveys carried out with the ASV using a single-beam echo sounder follow the criteria specified in the IHO<sup>4</sup> *Standards for Hydrographic Surveys*, Ed. 6.0.0 Sept 2020. These surveys were designed to meet the requirements of the "order 1a" classification, specifically suited to data acquisition in ports, port approach channels, coastal regions, or inland navigation canals, with a depth limit of less than 100m. The collected data, including echo sounder, GPS, and inertial measurement unit (IMU) measurements, were extracted from the ASV autopilot log file. Post-processing of the data is imperative to ensure the accuracy and fidelity of the seafloor representation, requiring a series of steps including filtering, compensation, and georeferencing.

## B. Objectives and results obtained

### Bathymetric maps

Underwater and aerial images were collected and then processed by photogrammetry or deep learning to obtain cartographic products (orthophotos, digital elevation models [DEMs], habitat distribution maps or species occurrence maps, etc.). The echosounder data were processed separately to produce bathymetric maps. The main results concerning the analyses of bathymetric data from the echosounder, the deep learning processing and the photogrammetric processing are presented here.

**Figure 34** shows the surveys carried out at Aldabra. **Figure 35** shows the surveys carried out at Saint-Brandon.

<sup>3</sup> GCRMN: Global Coral Reef Monitoring Network.

<sup>4</sup> IHO: International Hydrographic Organization.

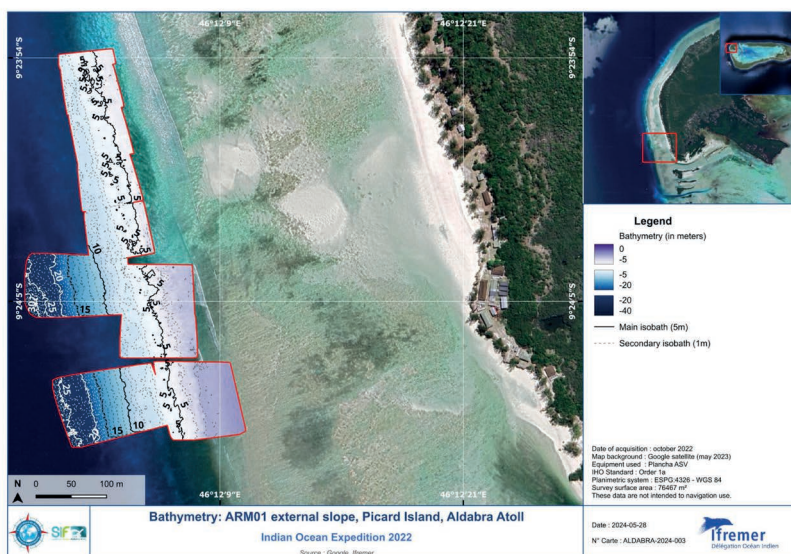
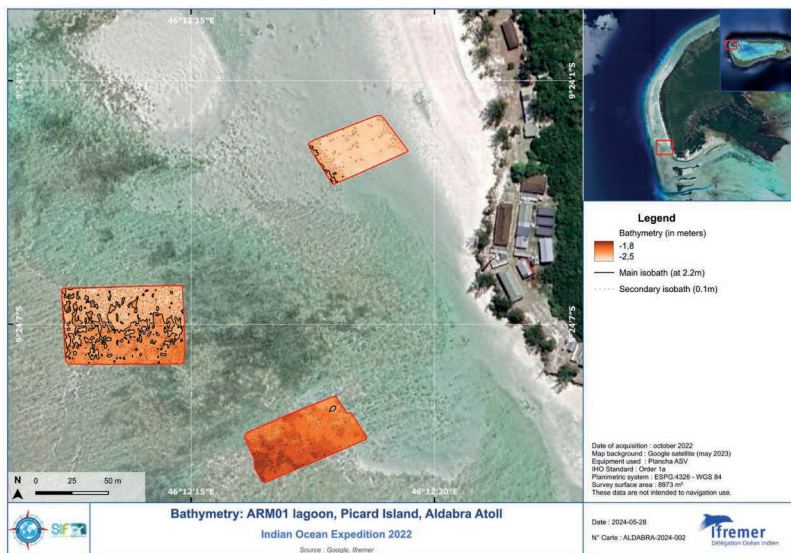
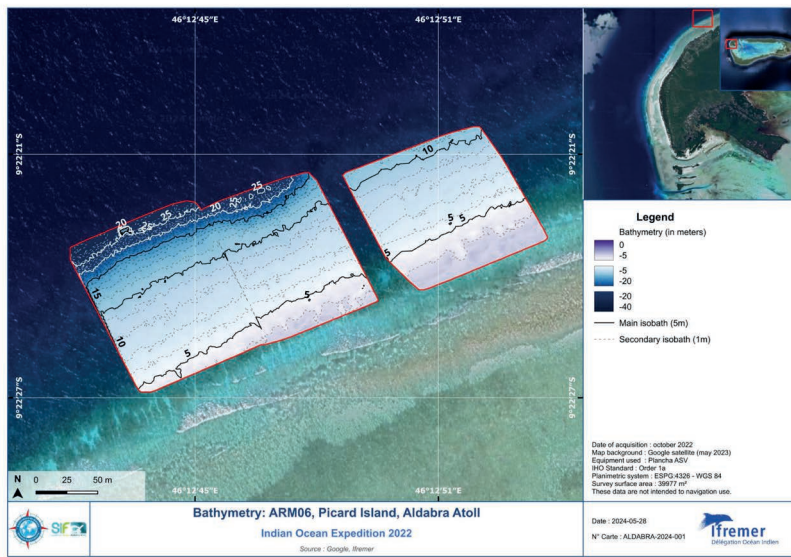


Figure 34a: Bathymetry carried out at Aldabra on the different sites

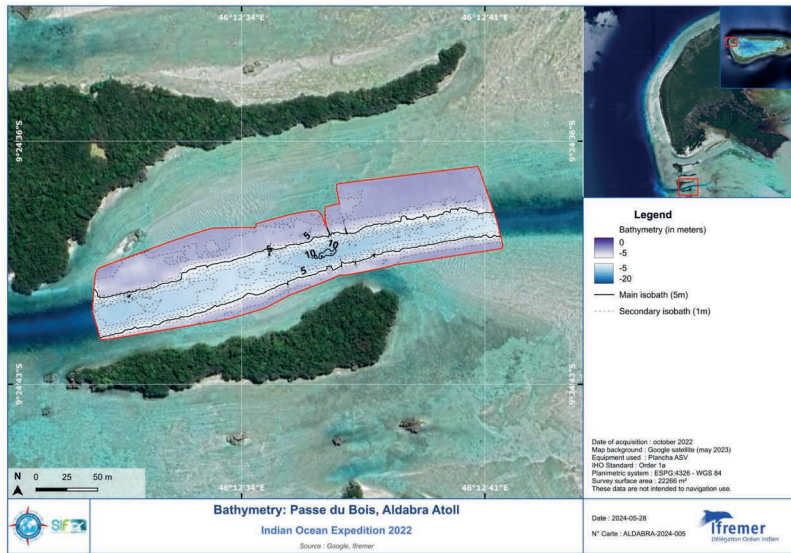
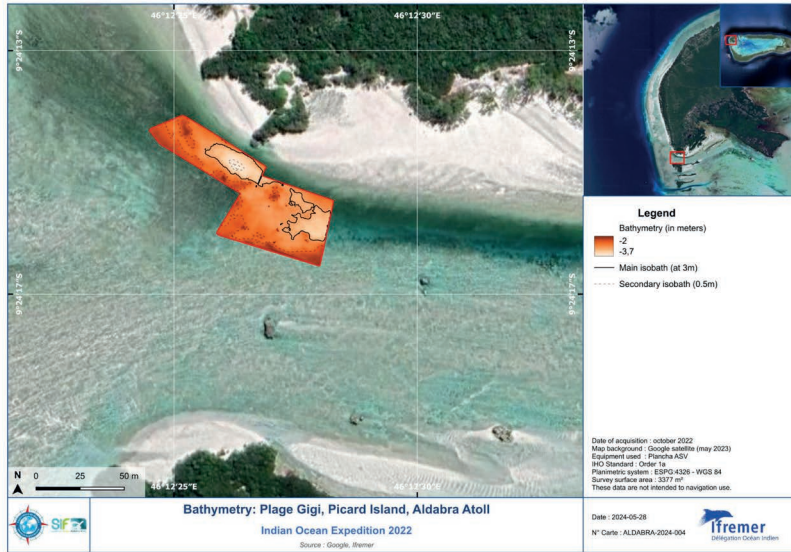


Figure 34b: Bathymetry carried out at Aldabra on the different sites

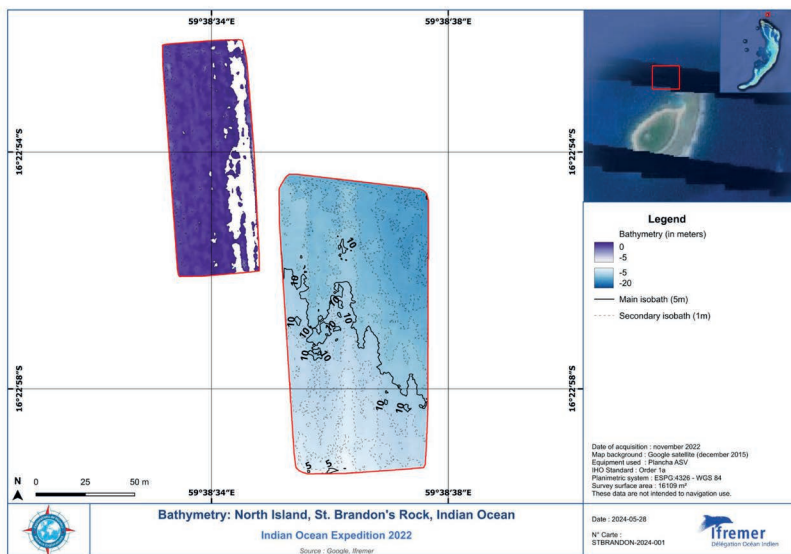


Figure 35a: Bathymetry carried out at Saint-Brandon on the different sites

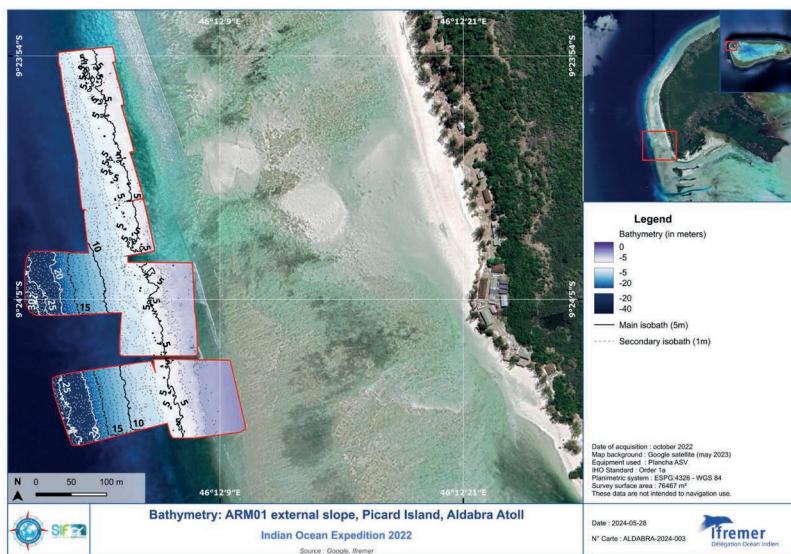
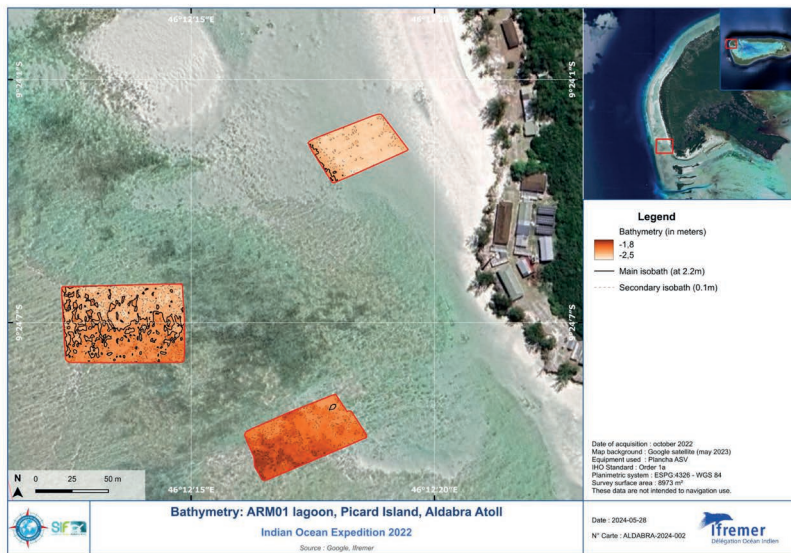
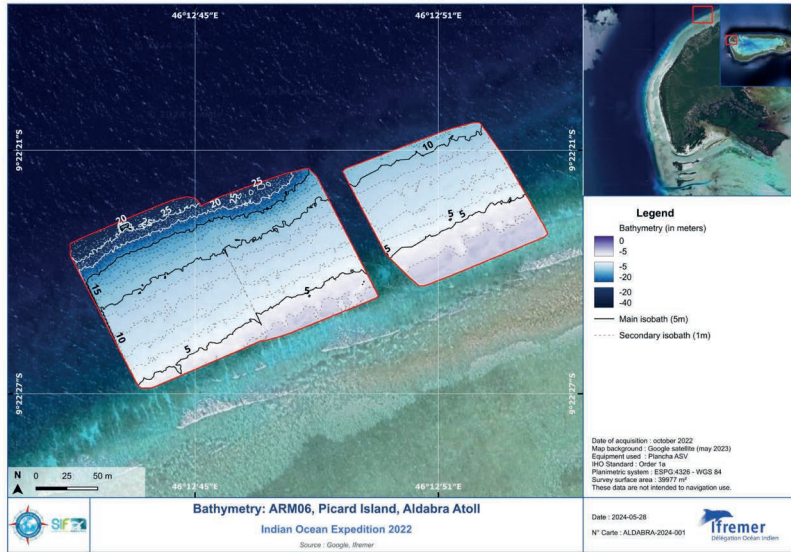


Figure 35b: Bathymetry carried out at Saint-Brandon on the different sites

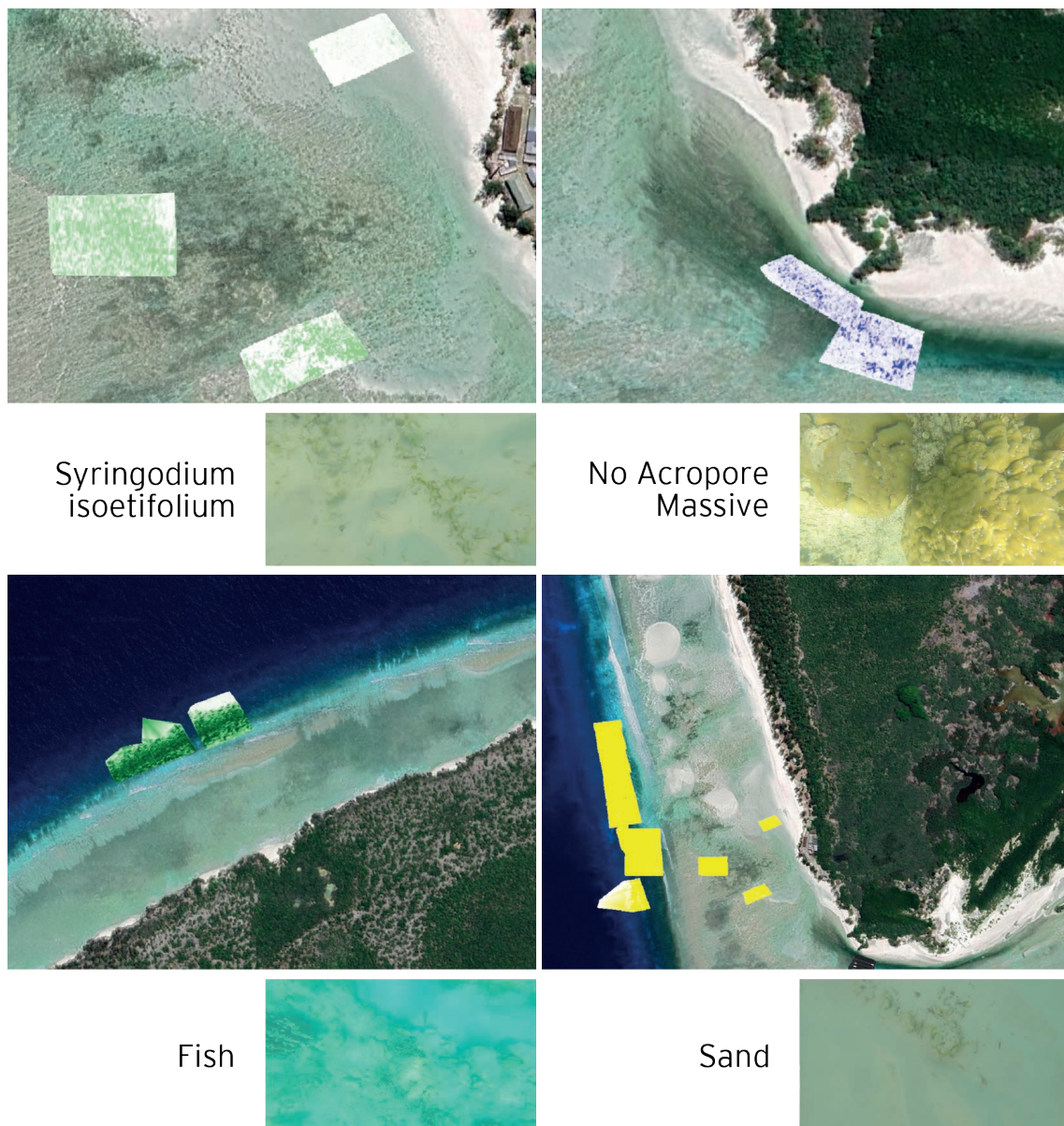
### Species and Habitat Mapping Using Artificial Intelligence Techniques

The artificial intelligence models developed allow for the separate processing of images (as they are collected). The presence of species in the studied areas required training the models to automatically recognize them. To achieve this, the main steps of the project involved:

- Improving image annotation by increasing the number of images available for existing object categories and creating new object categories to be annotated (manual work with prospects for partial automation).

- train the models on manually annotated images, to better recognize these categories
- predict the presence of these categories on georeferenced images unknown to the models: individual images or orthophotos.

As an example, **Figure 36** shows the result of predictions from the deep learning model on the areas covered during the expedition. The result shows the detection densities of the different predicted classes (here, for example, seagrass, corals, fish and sand).



**Figure 36:** Densities of *Syringodium isoetifolium* seagrass, massive coral, fish, and sand estimated by the automatic recognition model in areas ARM01, GIGI, ARM06, and ARM01, respectively, at Aldabra. Darker areas indicate higher probabilities of presence

## CONCLUSION

The 4Sea project collected data on the bathymetries of the study sites as well as georeferenced underwater videos accessible to the scientific community. These images made it possible to produce species occurrence and habitat maps that can be compared with future acquisitions or with data already collected by site managers. This project demonstrated the value of the platforms developed, which are low-cost, easy to deploy, and allow acquisition campaigns to be reproduced thanks to centimetre-level georeferencing of the data.

This project will enable local managers and partners to obtain relevant and useful information. This project made bathymetry data, images, and species and habitat identification available at 31 sites: sites related to Aldabra (24) and Saint Brandon (7). The automatic

identification model was improved through the annotation of new images in different contexts. This project enabled the deployment of these innovative platforms in a scientific expedition context and demonstrated the ease of deployment and acquisition at isolated sites.

### 2.2.4. MADCAPS

The MADCAPS team took advantage of the Aldabra sequence to characterize the abundance of macro litter beached on the atoll, using Sustainable Seas Trust protocol in partnership with the Seychelles Islands Foundation.

11 transects of 50 m parallel to the shore were completed to collect all size class plastic debris from the vegetation zone to the sea (Figure 37).

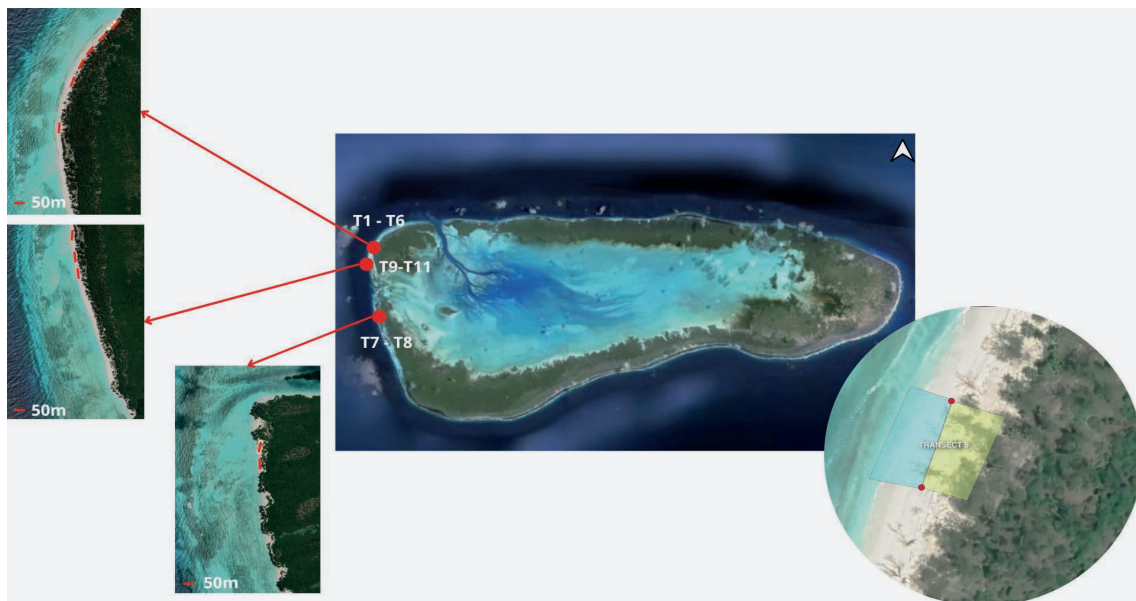


Figure 37: MADCAPS transects on Aldabra.

Among the 828 items collected 71% were plastic debris followed by textile debris, with an average abundance of 1.5 item.m<sup>-1</sup>, with an average mass of 36.9 g.m<sup>-1</sup>.

The brand identification from 26 items with legible marking revealed 17 different brands all foreign to Aldabra. Some of the brands analysed originate from a specific region, such as Aqua or Kratingdaeng, which are sold in South-East Asia and were present on 10 of the 26 items of waste displaying a legible brand name. Others

are international brands sold worldwide, such as Coca Cola products. In most cases, the area of production and export is not easily identifiable.

The origin of textiles is more complicated to determine and less reliable. Textiles from local Seychelles brands were found.

Comparisons with other islands are always complex, given the many factors that influence them, such as the season or specific events of anthropogenic or natural



origin. Aldabra was compared to Sainte Marie Island (Madagascar), considering that on Aldabra, the waste found on the coast is of outside origin, whereas on Sainte Marie Island, the sources of pollution are local and outside. Aldabra has an average of 1.5 items of waste per metre, which is comparable to the 1.1 items of waste per metre found on the least polluted beaches of Sainte Marie. Data were published in the PhD manuscript of Thibault, 2024.

## 2.2.5. WORLD CORAL CONSERVATORY

### SUMMARY

Coral reefs are threatened by climate change and in particular by rising water temperatures. In order to counter this disappearance announced by the end of this century, many initiatives are emerging: the World Coral Conservatory (WCC) is one of them.

The WCC unites scientists, aquarium curators, and reef-restoration NGOs around a proposal led by the Scientific Centre of Monaco and the Oceanographic Institute (Prince Albert I<sup>st</sup> of Monaco Foundation), with support from the Prince Albert II of Monaco Foundation. Together, they aim to build a “Noah’s Ark” for reef-

building corals—a living genetic reservoir to support conservation, research, and restoration.

The goal is to establish a global reference centre: a network of public and private aquaria housing living colonies that represent most described scleractinian (reef-building) coral species and strains. This network will serve as a platform for sharing biological material and for generating and exchanging knowledge. Public aquaria will act as conservation and research reservoirs, while partner laboratories will advance fundamental coral biology and implement selective breeding for stress tolerance.

By coupling science, conservation, and reef management, this initiative will safeguard coral biodiversity and enhance reef resilience, using assisted-evolution approaches to increase stress tolerance and support recovery after disturbances.

The plan was to initiate the collection process in Aldabra through an agreement with the Seychelles Islands Foundation. For this first collection cycle, coral species with certain characteristics were targeted: endangered corals, resistant corals, species that are easy to cultivate and propagate, endemic species.



Aldabra reef © Katia Quéméré - WCC / Oceanopolis / Monaco Explorations

## A. Description and schedule of achievements

The activities carried out within the framework of the World Coral Conservatory involved the collection of corals on the Aldabra Atoll in the Seychelles, their transfer to Europe and their maintenance in four public aquariums: Oceanopolis in Brest and Nausicaa in Boulogne-sur-Mer, in France, Burgers' Zoo in Arnhem in the Netherlands and the Oceanographic Museum of Monaco.

Coral collection took place from 19 to 25 October 2022, during the expedition stopover in Aldabra. Fifty-eight colonies of 21 different species were collected, in agreement with the Seychelles Island Foundation (SIF), as part of a research agreement signed between the programme partners. Each collection was precisely documented with the GPS location, photos of the colony in its biotope, depth, colony size, etc.

After a few days at sea, the colonies were transferred to the Seychelles Fisheries Authority (SFA) technical facilities on Mahé on 29 October and stored until their departure by air to Paris on 2 November, arriving midday on 3 November and being transferred to the various aquariums that evening. The distribution of colonies among the four aquariums is presented in **Appendix G**.

Since their arrival at the partner aquariums, the corals have been kept backstage in dedicated tanks. Water quality parameters and all technical data are collected regularly, and a monthly exchange between partners allows for discussion on the conditions for maintaining the colonies and on the technical issues raised by the storage of these «non-standard» colonies. All data and photos are stored on a cloud accessible to all partners and managed by the WCC.

As the collection of samples for molecular and taxonomic analyses was not authorized during the expedition, these analyses were conducted later. Taxonomic analysis consists of a morphological observation of the skeleton using electron microscopy. Molecular analysis, on the other hand, comprises the extraction of RNA and DNA from samples, followed by high-throughput next-generation sequencing (NGS). Together with collection records, these analyses make possible a unique biobank, with each colony labelled by a passive radio-frequency identification (RFID) transponder to ensure persistent identification.

## B. Objectives and results obtained

All colonies collected at Aldabra were healthy in situ. The on-deck life-support system maintained them in excellent condition during the transit from Aldabra to Mahé. Transfer to the SFA and the short holding period at their facilities also proceeded smoothly. Anticipating that the Seychelles-to-France airlift would be the most demanding step, substantial preparation was invested to meet strict husbandry conditions. Corals were packed under precise protocols—including pH buffering and tight temperature control—to maximize survival. After ~40 hours in transit, nearly all colonies arrived in Europe in good condition.

Only a few colonies arrived with a disturbing visual appearance:

- *Isopora palifera* (977200010159170) in Monaco;
- *Stylophora palmata* (977200010159377) in Nausicaa;
- *Stylophora palmata* (977200010159251) in Oceanopolis.

Upon arrival, the water in the plastic bag used for transport was brown and had a very unpleasant odour. This typically indicates the colony has expelled its symbiotic zooxanthellae in response to severe stress. Despite good care and rapid acclimatization, the *Isopora* from Monaco died, as did the *Stylophora* from Nausicaa. The one from Oceanopolis was almost entirely dead, but a small portion was saved. Since these three colonies were quite large, it is likely that their size was too large to provide optimal transport conditions for more than 40 hours. The impact of their metabolism on the small amount of water contained in the bag was too great.

The rest of the corals acclimated quite well in the quarantine tanks, but after a few weeks, several health issues led to the loss of other colonies:

- *Isopora palifera* at Burgers' Zoo began bleaching at the end of March 2023. Despite several treatments and changes in light management, the aquarists were unable to stop the phenomenon, and the colony finally died on 7 April 2023.
- *Pocillopora eydouxi* in Monaco was extremely difficult to maintain and had to be cut several times to remove the dying parts. Despite several



attempts at propagating cuttings, the colony and the fragments could not be kept alive. The last ones died in June 2023.

- *Gardineroseris planulata* at Nausicaa died in March 2023 after several treatment attempts and relocations to different tanks with varying light conditions.
- *Acropora valida* at Burgers' Zoo died, likely following necrosis. Despite several treatment attempts, the original colony could not be saved, but several fragments were collected before the main colony was lost.
- *Pocillopora eydouxi* at Nausicaa was able to be propagated before dying. This species appears to be extremely difficult to maintain, and only the colony at Océanopolis is still healthy.

All the other colonies are doing very well. Three and a half years after collecting 58 colonies from Aldabra, only seven were lost—an 88% survival rate, which is high and encouraging, especially given that several species are being maintained in aquaria for the first time. Representatives of 21 of the original species are still alive, thanks to cuttings, even though parent colonies have disappeared.

Some colonies are growing rapidly. The most impressive growth is observed on the *Tubastrea micranthus* housed in Monaco. The *Acropora valida* from Monaco and Brest are also showing very good growth, even if this is only a visual assessment.

After more than three years of ex-situ maintenance in aquariums, the results are still very good with the same level of survival as obtained after eighteen months. Most of the colonies have been cut to produce frags, which have been dispatched on the different locations to secure the genetics.

A scientific publication (Brunel et al., 2025) was released during the summer 2025, gathering all the protocols used during the collection phase, and technical information on the ex-situ maintenance of the collected corals.

Regarding scientific analyses, the taxonomic analysis will be carried out first, subject to receiving samples from the French and Dutch aquaria. The delay is due to the time it takes to obtain CITES permits for the transfer

of aquariums to the CSM, as Monaco is not part of the European Union.

The colonies have had time to acclimatize and grow, but starting in 2025 molecular analyses will be conducted on 10 colonies kept at the Oceanographic Museum, which will be processed at Génoscope (France). This initial sequencing will be used to train a technician from the CSM. Therefore, future analyses will be carried out in Monaco.

## CONCLUSION

Thanks to this expedition, the World Coral Conservatory has demonstrated proof of concept for its conservation programme, at least for the collection phase. The feasibility of housing corals across a network of partner public aquaria was also validated, underscoring the pivotal role these institutions can play in ex situ conservation, a modern “Noah’s Ark”. Concerns about transport and acclimation were largely dispelled for the Aldabra colonies.

The immediate priority is scientific analyses: researchers must characterize the collected species, implement study designs and assisted-evolution protocols to capitalize on these living collections, and lay the groundwork for long-term, actionable interventions in coral-reef conservation.

## 2.2.6. CORAL CONNECT

### SUMMARY

This Bertarelli Foundation Marine Science Programme project was led by the Zoological Society of London (ZSL) and the University of Oxford and supported by the UK diving and underwater research company Tritonia Scientific Ltd.

The project aimed to understand whether the Central Indian Ocean atolls and banks (Chagos Archipelago, Aldabra and Saya de Malha) act as a “stepping stone” for invertebrate (particularly coral) recruitment and biodiversity between the Eastern and Western Indian Ocean regions. The project investigated several areas of research, relating to:

- the mechanisms of resilience and recovery of *Acropora* and *Porites* corals in the Central Indian Ocean;

- the population structure and connectivity of *Acropora* and *Porites* corals in the Central and Western Indian Ocean;
- the biodiversity of oceanic cryptic invertebrates;
- and the ecology and biology of the world's rarest coral, *Ctenella chagius*.

The participation in the expedition in Aldabra, Saya de Malha and Saint Brandon aimed to extend and complement the existing dataset from the Chagos Archipelago with the collection of coral samples and video transects. Ultimately, collection of these data will allow to understand if these atolls and banks in the Central Indian Ocean are acting as "stepping stones" for invertebrate (particularly coral) recruitment and biodiversity between the Eastern and Western Indian Ocean regions, as has been surmised due to the

prevailing westerly ocean currents connecting the two which reverse halfway through the year. In addition, *Acropora* species recently collected in the Chagos Archipelago were recently revealed to be a new species and the project aimed to investigate whether this new species is also found in Seychelles and Saya de Malha.

The project was also aiming at the conservation of the critically endangered Chagos brain coral, *Ctenella chagius*, which had historically been considered endemic to the Chagos Archipelago; however, archive specimens stored at the Natural History Museum of London were collected from Saya de Malha on the Percy Sladen Linnean Society expedition in 1905 (and subsequently described in 1928), and colonies on reefs there were photographed by David Obura (CORDIO East Africa) in 2010. Unfortunately, no colonies of *Ctenella chagius* were recorded during the Monaco Explorations expedition.



Underwater view of Aldabra Reef © Heather Koldewey - Zoological Society of London / Monaco Explorations.

The analysis of coral samples collected during the expedition was delayed by a very slow process securing the CITES permits, meaning they only arrived at ZSL in early 2024. However, Dr Catherine Head (leader of this research area) has two PhD students (with the University of Essex and University College London) who are

working with the coral and eDNA samples respectively. In addition, she is collaborating with the Queensland Museum, Australia who are working on a complete revision of the *Acropora* phylogeny that is revealing new species. A Seychellois PhD student is leading the analysis of samples from the Western Indian Ocean.



Good progress has been made in analysing the reef transects. This has used the analysis of the photogrammetry imagery collected during the expedition and processed to determine coral cover, species, abundance, and distribution.

### A. Description and schedule of achievement

#### Field operations

The operations were conducted by scuba divers.

The sampling in Aldabra was coordinated with the World

Coral Conservatory team and broadly followed the same dive times and site plan. A team member stayed on in Aldabra after the vessel had left and was able to collect additional samples.

The team also enabled and supported a Mauritian PhD student, University of Mauritius to collect video transect data at three sites in Aldabra to allow comparative work on coral connectivity in collaboration with the Seychelles Islands Foundation.

Figure 38 and Table 7 provide the details of the sampling sites.

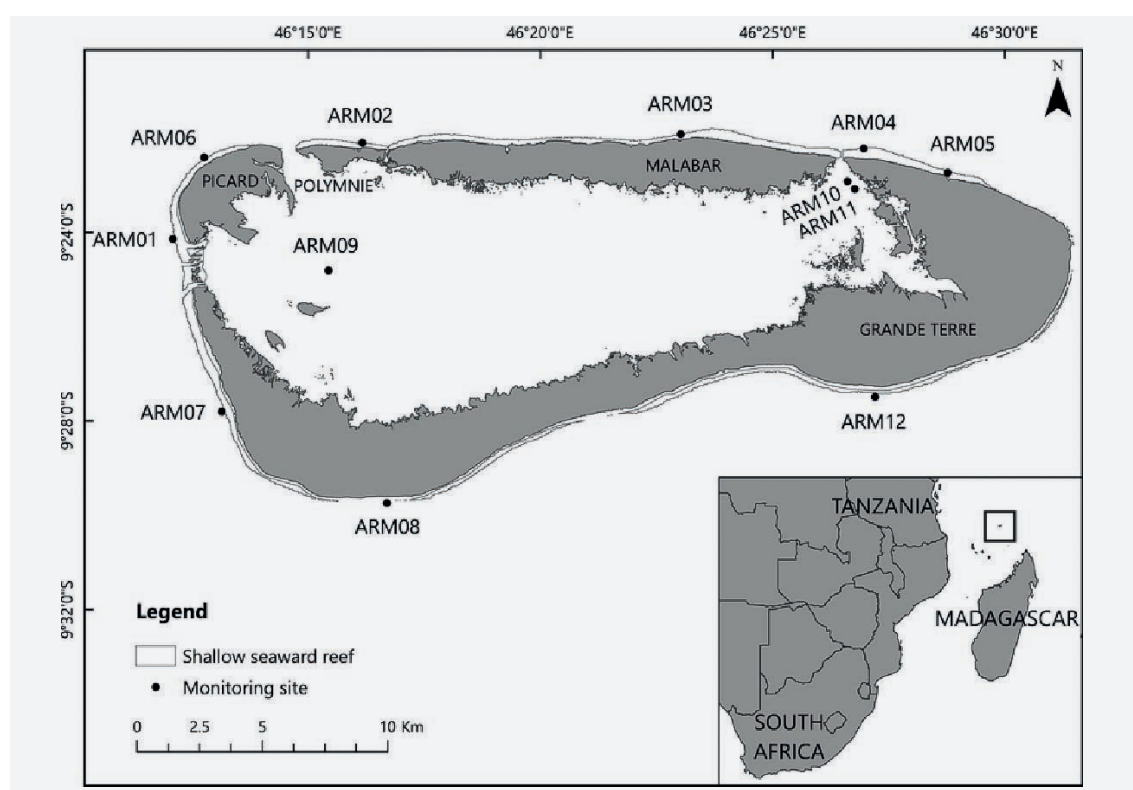


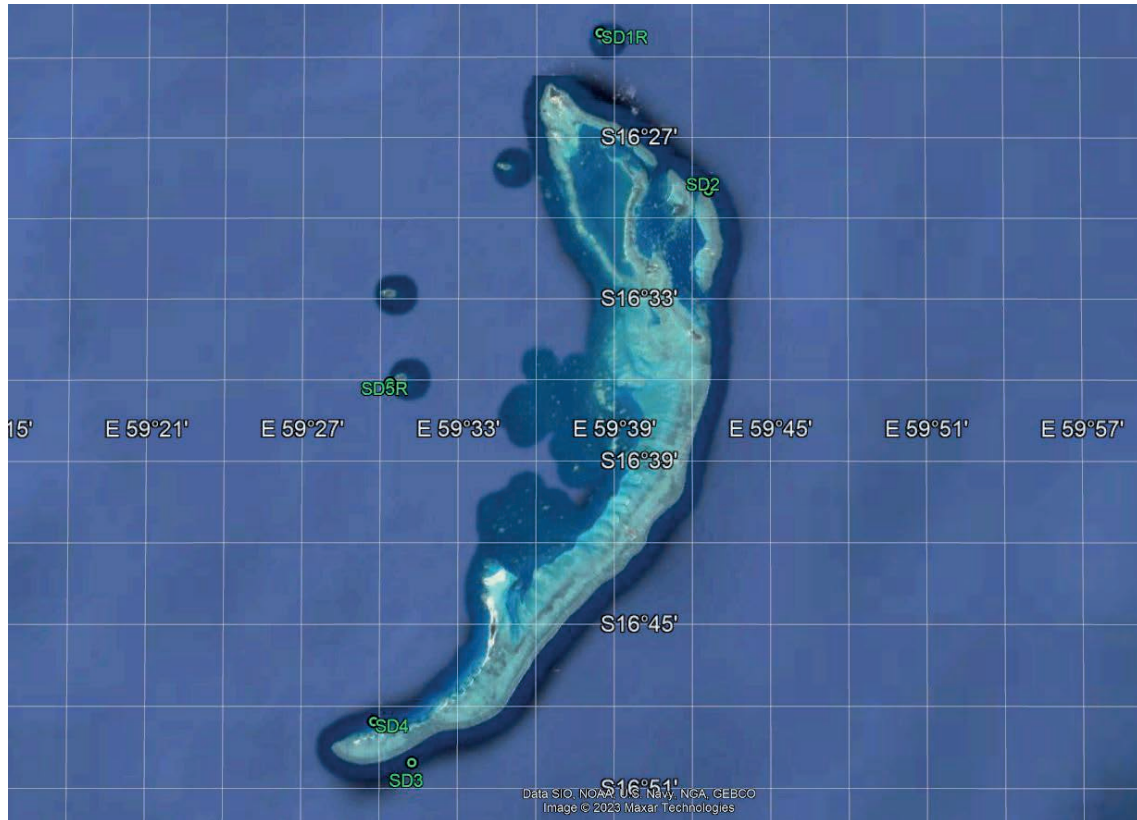
Figure 38: Location of Aldabra sampling sites.

Table 7: Details of Aldabra sampling sites

SITE CODE	SITE NAME	LON (E)	LAT (S)	DEPTH
ARM01	Settlement Reef	046°12.05'	09°24.12'	15 m
ARM01	Settlement Reef	046°12.22'	09°24.12'	5 m
ARM06	Anse Var	046°12.75'	09°22.38'	15 m
ARM06	Anse Var	046°12.76'	09°22.41'	5 m
ARM07	Anse Mais	046°13.13'	09°27.81'	15 m
ARM07	Anse Mais	046°13.24'	09°27.78'	5 m

The sampling in Saint Brandon was coordinated with the researchers from the University of Mauritius, Mauritius Fisheries Training and Extension Centre and the French National Museum of Natural History and included the

collection of sponges, giant clams and nudibranchs. **Figure 39** indicates the location of the five sites that were explored.



**Figure 39:** Location of Saint Brandon sampling sites.

Whole coral colonies were photographed from approximately 1 m above with a scale bar, as well as in close-up (showing corallites and polyps). Tissues were collected in Ziplock bags with fragments (approximately 2 cm<sup>3</sup>) removed underwater using either bone cutters or a small chisel. On the surface, samples were rinsed in filter-sterilised sea water and immersed fully into 99% ethanol/RNAlater, before storage in a chilled cooler box. Upon return to the ship, samples were stored at -20°C.

Triplicate two-litre water samples were collected from a range of reef locations throughout the expedition using sterile Whirl-Pak bags. These water samples were then filtered aboard the ship, using sterile filters and a vacuum pump set-up. The filters were frozen dried aboard the ship and stored at -20°C and transported to the United Kingdom on ice.

To build structure-from-motion (SfM) 3D models from an uncalibrated GoPro™ camera system, a diver filmed slowly over a 25 m section of reef in a straight line (transect). The area for filming was marked out with a measuring tape, and scale bars used for scale calibration. The team aimed to film transects at 8 m and 15 m during each dive. Videos were downloaded after each dive.

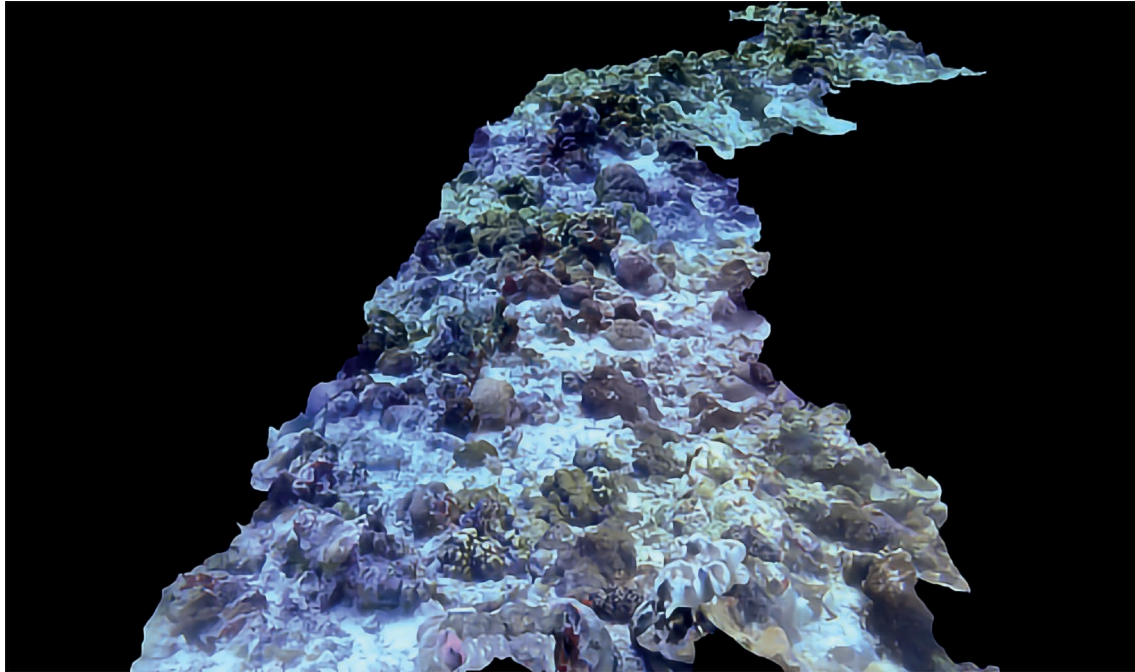
### Scientific results

A total of 55 coral samples from five species were collected during the expedition. Unfortunately, there were considerable challenges with securing the CITES permits, with the samples ultimately arriving at ZSL in March 2024. The analysis of these samples is still underway at the time of finalising the report, through collaborations with the University of Essex (connectivity) and Queensland Museum (species identification).

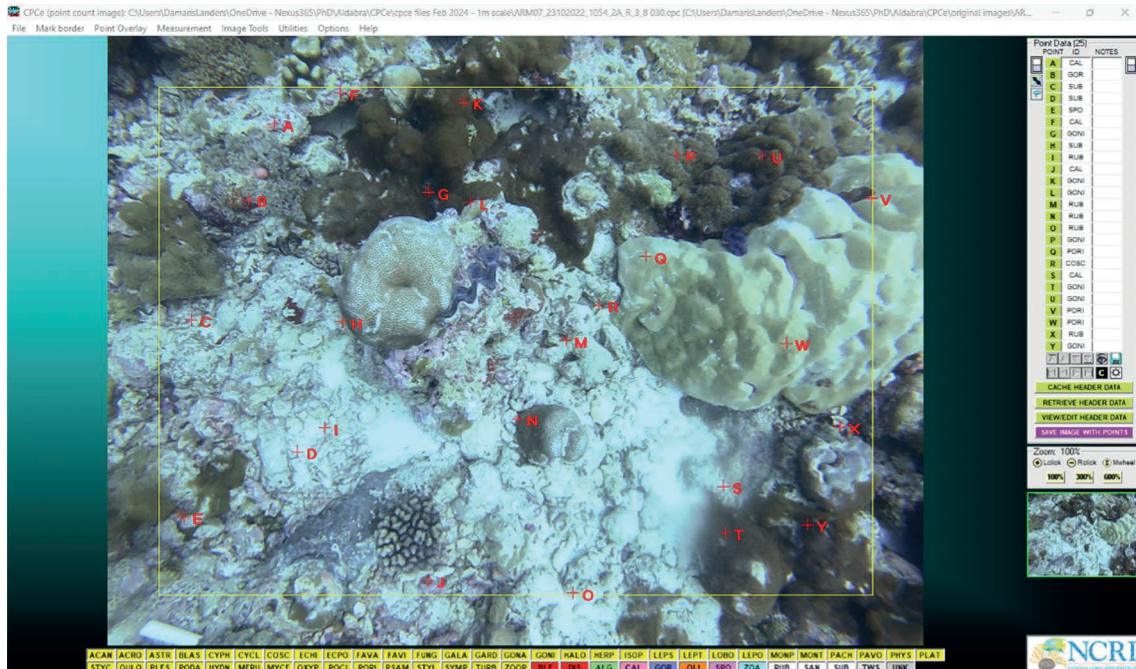


3D photogrammetry data were generated from the reef transects conducted during the expedition. These were analysed in more detail to establish coral cover, species, and

distribution. By then looking at the coral species' life histories, the impact of different spawning strategies on the relative abundance and distribution of corals can be determined.



Example photogrammetry transect that demonstrates the 3D structure of the reef © Damaris Landers, University of Oxford/ZSL



Example of the Coral Point Count (CPCe) method that was used to analyse the data © Damaris Landers, University of Oxford/ZSL

The water samples collected around Aldabra were filtered for eDNA analysis and stored for laboratory analysis. The analysis of these samples is still underway

at the time of finalising the report, by a PhD student from ZSL and University College London.

## B. Objectives and results achieved

The research objectives are detailed below with the progress summarised for each.

i) Is there connectivity between populations of *Acropora* and *Porites* corals and other marine invertebrates in Aldabra, Saya de Malha, and the Chagos Archipelago?

There is evidence of long-distance coral larvae dispersal between the Chagos Archipelago and the Seychelles from population genomic studies of the broadcasting coral, *Acropora cf. tenuis* 'WIO'. This connectivity is particularly strong between the Chagos Archipelago and the Inner Seychelles, whereas there is evidence of a permeable barrier to dispersal between the Inner and Outer Seychelles (including Aldabra). These results are near submission in the following paper:

Head CEI, Colin L, Taylor M, Arias-Mella MB, Steyaert M, Burt A, Bridge TCL, Hosegood P, Yesson C (*In prep.*) Indian Ocean Wide Connectivity of the Reef-Building Coral, *Acropora tenuis*, revealed using next generation sequencing and particle tracking models. *Global Change Biology*.

Due to a series of delays and complications in the CITES permits, samples collected in Aldabra during the expedition finally arrived at ZSL in March 2024, so were not included in the paper analysis. However, these samples will extend sample numbers and species (to include both *Acropora* and *Porites*) and analysis is still underway at the time of finalising the report, by PhD student, Jason Burk (ZSL/University of Essex).

Data on benthic community composition and four life history strategies (competitive, stress-tolerant, weedy, generalist) was collected and analysed at various spatial scales. The findings reveal that Aldabra's reefs were overwhelmingly dominated by stress-tolerant corals, followed by generalist corals, with competitive and weedy species being sparse. This community structure is largely a result of site-specific environmental filtering favouring resilient, longer-lived taxa.

These findings have recently been submitted for peer review, still in review with the journal at the time of finalising the report:

Landers, D., Koester, A., Burt, A., Head, C., Koldewey, H., Bonsall, M.B. (in review). Spatial patterns and competitive

interactions in a remote Western Indian Ocean coral community: a life history strategy perspective. *Frontiers in Marine Science*.

ii) Is the novel species of *Acropora* recently discovered in the Chagos Archipelago also found in the Seychelles and Saya de Malha?

There is a novel species of *Acropora* that was confirmed in both the Chagos Archipelago and the Seychelles. It is currently named *Acropora cf. tenuis* 'WIO' and is awaiting further samples to be sequenced before this can be formalised and published. This forms part of a wider collaboration with the Queensland Museum on a complete revision of the *Acropora* phylogeny:

Cowman P, Bridge TCL, Quattrini AM, Benzoni F, Bonito V, Beruman M, Bhagooli R, Burt JA, Camilleri RE, Colin PL, Crosbie A, Fadli N, Halafih T, Harii S, Head CEI, Huang D, Hung J, Mera H, Miller DJ, Naruse T, Rongo T, Rassmussen SH, Sinniger F, Tan CH, Baird. AH (In revision). Phylogenomics reveals the dark diversity of reef corals. *Science*.

iii) What is the biodiversity of the cryptic reef invertebrates and is this biodiversity related to reef complexity?

PhD student Cameron White-Spunner at UCL, London is currently processing these samples to add to the Chagos dataset to look at fish diversity at remote atolls in the Indian Ocean and should have some results from this in the first half of 2026.

iv) Is the Chagos brain coral, *Ctenella chagius*, found in the Seychelles and Saya de Malha and if so, how closely related are these populations to those in the Chagos Archipelago, and archive specimens in the NHM?

There were no Chagos brain corals recorded during the expedition. Dr Wilson (Oxford University) contributed to the research of the University of Mauritius and co-authored the resulting special issue paper (*Munbodhe et al., 2025*).

All datasets associated with the research on the Bertarelli Foundation's Marine Science Programme are available open access on the Marine Science Harvard Data Platform ([Marine Science Programme](#)).



## CONCLUSION

The expedition provided valuable research opportunities that have progressed well, with some delays due to the slow process of securing CITES permits for coral specimens. However, the samples are now being analysed by a series of PhD students which will ensure their analysis and ultimate publication. Evidence has been found of the strong connectivity of corals between the Chagos Archipelago and the Seychelles, particularly the Inner Islands. Strong collaborations have been built in the region, with engagement on a wider range of research and conservation topics following the expedition. New opportunities have arisen, including training for regional collaborators, and collaboration with the World Coral Conservatory on the rescue mission for the Chagos brain coral and

further expeditions to Saint Brandon to assess whether the coral can still be found there.

### 2.2.7. ROV SURVEYS

The presence of the ROV installed on board *S.A. Agulhas II* for the Saya de Malha survey triggered the idea to conduct both video transects and opportunistic sampling using a standard transect and depth methodology (Figure 40) that had been used by Seychelles and Nekton First Descent Expedition in 2019 and then replicated by Seychelles colleagues in the region in subsequent years. The reason for this was to ensure that the data as it was opportunistically collected could feed into a regional understanding of fish and benthic species which will be undertaken over 2026-2028.

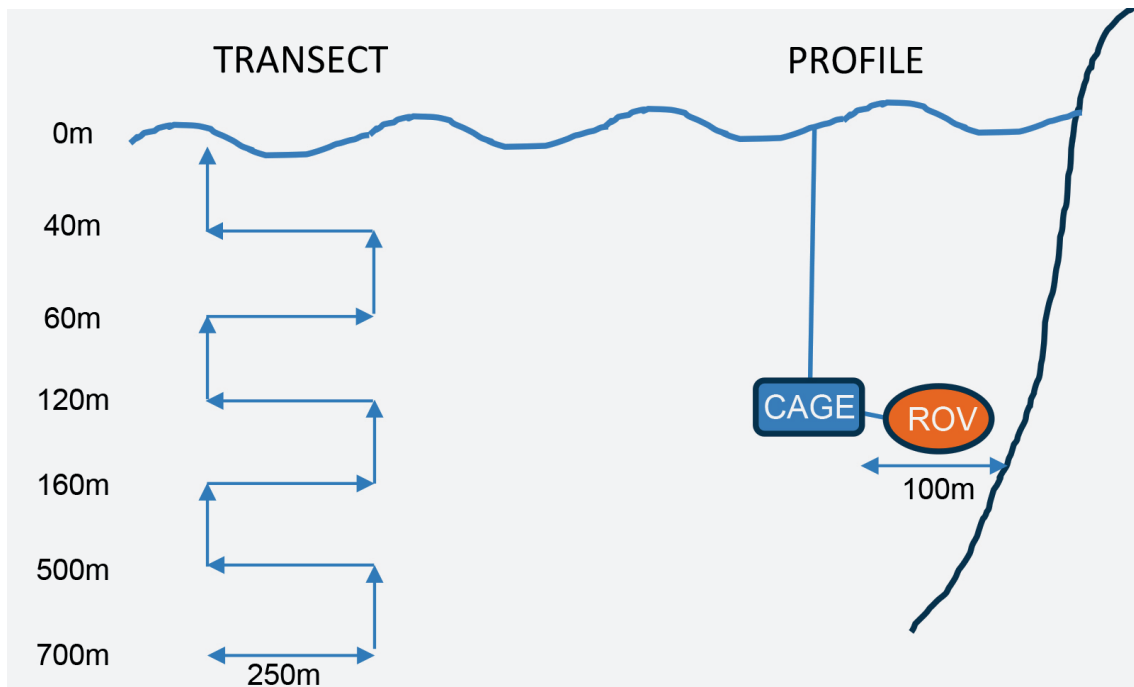


Figure 40: ROV deployment plan.

The 700 m transect was replaced with more exploratory surveys due to the cable length and difficulty manoeuvring at that depth

An operation plan was developed in collaboration between the Coral Connect team and researchers from Seychelles and Mauritius.

Video transects were completed at three sites off Aldabra and two off Saint Brandon. This was the first occasion whereby ROV's had been used to collect data at this depth. The ROV also collected five water samples for eDNA analysis, three at ~700 m and two

at ~120 m off Aldabra, and a further three samples off Saint Brandon.

In addition, two surface transects were conducted with one of the ship's boats towing an underwater camera provided by IRD.

All ROV videos from Aldabra were provided to the Seychelles Islands Foundation (SIF) on hard drives on arrival in Mahé.

## 2.2.8. BIOPROSPECTION OF MARINE SPONGES

The Mauritius Oceanography Institute (MOI) took advantage of the sequence in Saint Brandon to complete their ongoing inventory of marine sponges using the protocol deployed during the Saya de Malha sequence (see sections 2.3.2 and 2.3.4 - WP5 - Benthic invertebrates and sponges inventory).

## 2.2.9. PHOTO-PHYSIOLOGICAL STUDIES OF PHOTOSYNTHETIC ORGANISMS

The methodology and results are presented in the WP6 of Saya de Malha (see section 2.3.4)

## 2.2.10. OCEANOGRAPHIC OBSERVATIONS

One CTD cast and three XBT profiles were recorded (Figure 41 and Table 8).



Figure 41: Location of oceanographic observations off Saint Brandon

Table 8: Oceanographic observations off Saint Brandon

NO	DAY (DD/MM/YYYY)	START TIME (UTC) (HH:MM)	LON (E)	LAT (S)	MAX DEPTH (M)	FILE NAME	COMMENT
CTD1	18/11/2022	17:09	061°01.92"	16°31.47"	2000	I0_035	VOY-055-SB-1
XBT17	18/11/2022	20:35	060°43.46"	16°29.83"	900	drop019.nc	Saint Brandon transect
XBT18	18/11/2022	21:52	060°23.22"	16°31.23"	640	drop020.nc	Saint Brandon transect
XBT19	18/11/2022	21:52	060°12.15"	16°31.24"	220	drop021.nc	Saint Brandon transect



### 2.2.11. BATHYMETRY

Monaco Explorations obtained through the GEBCO-Nippon Foundation Seabed2030 project 30 m resolution satellite derived bathymetry (SDB) for Saint Brandon.

The data provided by TCarta was based on Landsat 8 multispectral imagery (2017-2022).

Single beam echosounder depth data was collected along the ship's track (see [section 2.1.6](#)).

## 2.3. THE INVISIBLE ISLAND: SAYA DE MALHA

### 2.3.1. OVERVIEW

The Saya de Malha Bank had been explored by only a few research cruises over the past century. Monaco Explorations Indian Ocean Expedition was therefore a great opportunity to complement the scientific knowledge of this under-sampled site, with a special focus on the benthic biodiversity. An array of instruments and gears was deployed during the expedition to investigate the pelagic and benthic components of the Saya de Malha Bank.

Hydrological observations indicate a clear separation of water masses along the Saya de Malha Bank with less saline waters encountered on the eastern compared to the western bank, as well as between the northern and southern boundary channels of the bank. The velocity of the westward flowing South Equatorial Current (SEC) was the highest at 30 m depth on the bank and along its slopes.

Based on the total chlorophyll-a, higher pelagic productivity was found on the shelf in the north-eastern section of the bank, decreasing towards the south. The maximum phytoplankton biomass aligned with the dominant current velocities at 30 m depth across the bank, and therefore can be used to inform the likely export patterns of biomass towards the rest of the Western Indian Ocean and the contribution of the Saya de Malha Bank as a carbon sink and a carbon exporter to the rest of the pelagic trophic web in the region.

The benthic biodiversity survey was extremely successful for most of the taxonomic groups sampled and already considered as a milestone in the inventory of benthic species on Saya de Malha, although it was conducted during 16 days only. The Global Biodiversity Information Facility (GBIF) reports 1,979 occurrences of species from Saya de Malha Bank. The expedition has provided 1,484 new occurrences, representing

74% of the existing dataset. For algae, 17 species were recognised as endemic. Several rare or iconic molluscs species, including *Tridacna rosewateri* and *Conus primus*, were rediscovered, some with confirmed genetic distinctiveness. Three new species are not yet fully described. Among crustaceans, notable findings include the re-discovery and range extension of *Praebebalia extensiva* and *Merocryptus boletisculpta*, as well as the identification of four new species described within Stenopodidae and Galatheaidea families. Among the Annelids (worms), a new species was described (*Iphione corbariae*) and other taxa has new distribution records. As for the fish, several species, such as *Parabothus malhensis* (a flatfish) and *Neobythites malhaensis* appear to be endemic. New regional records and significant genetic divergences were noted, including *Draconetta xenica* suggesting overlooked cryptic species and complex biogeographic patterns. The sampling strategy that produced these results integrated two complementary approaches: scuba diving for shallow habitats and the deployment of towed gears for deeper environments. This dual methodology enabled optimized sampling across a range of benthic habitats, including soft and rocky substrates, seagrass meadows, algal beds, and various coral communities.

Corals are among the marine organisms most impacted by climate change. The expedition was an opportunity to investigate thermal acclimation for two coral species, the regionally endemic *Pocillopora indiana* and the commonly occurring and thermally resistant *Heliopora coerulea*. The response to thermal stress was quantified by the measure of photosynthetic performances in controlled mesocosm onboard the ship. The collection of corals in Saya de Malha, Saint Brandon and Mauritius enabled to consider two factors jointly in the analysis, a latitudinal gradient and contrasted human footprints. The corals from Saya de Malha and Saint Brandon showed higher photosynthetic performances than

their conspecifics in Mauritius with increasing thermal stress. The study also confirms that corals from reefs remote from human population centres cope better with warming conditions than those from impacted reefs. These results advocate for having the reefs of the Mascarene Ridge protected from direct human impacts such that they might act as coral refugia under future climate change scenarios.

The presence of a Remotely Operated Vehicle (ROV) on board *S.A. Agulhas II*, especially chartered for the expedition, gave invaluable insights in the knowledge of the biodiversity along the slopes of Saya de Malha, along seven dives cumulating 39 h of video footage. The survey conformed to a standardized sampling design to allow comparative analyses in terms of habitats and species diversity with other sites in the region (i.e. Aldabra, Seychelles or Maldives) where similar surveys were carried out. Between the depth of 30 to 250 m, over 120 specimen have been identified to species level so far. Several of these identifications require verification by taxonomic experts. An additional 70 fish specimens remain to be identified. Subsequent stages of analysis will focus on quantifying temporal and spatial distribution patterns and performing size-based comparisons across sites and depth strata, where footage quality permits.

The cetacean survey conducted during the expedition (see [section 2.1.5](#)) did not result in numerous observations around Saya de Malha, primarily because the weather conditions were not the best for sightings and that the cruise was not dedicated to megafauna search. However, previous cruises and tagging studies around Saya de Malha had brought the evidence that a diversity of marine mammals species wander in its waters. The Saya de Malha Bank, located between two Important Marine Mammal Areas (IMMA), one in the North (Seychelles) and one in the South (Réunion-Mauritius-Saint Brandon) could suggest that Saya de Malha be included in the current IMMA designations.

Scientific knowledge is meant to deliver facts and evidence (and/or uncertainty) on the status of the marine environment and resources, to inform the process of decision-making in the field of ocean governance. In this line, the articulation between marine research and the international Law of the Sea is a largely debated issue requiring an open dialogue between scientists and policymakers. The simultaneous presence of legal experts and natural scientists on the ship during the expedition triggered such dialogue through

training sessions delivered on board. The very positive feedback from the participants led to the creation of a regional network of marine researchers working on national and international submerged structures, the WIO NOISE (National Or International SEamounts, banks and submerged structures) (see [section 3.8.1](#)).

### 2.3.2. SYNOPSIS

This multidisciplinary project was designed with the objective of “science for marine governance and planning support” with the following objectives:

- To complement the existing scientific information on the marine environment of the shallow areas of the bank and its slopes;
- To undertake an inventory of the benthic biodiversity, to assess the species richness and possible endemism, in order to map the sensitive habitats that may require specific conservation measures or to regulate extractive activities supporting the blue economy of Mauritius and Seychelles;
- To produce fact sheets on the habitats and communities of the Bank;
- To contribute to policy briefs for institutional stakeholders and policy makers in Seychelles and Mauritius;
- To publish the main results in international journals.

It combined open water and seabed measurements. The water column, both on the bank (ranging in depth from 15 to 120 m) and up to 35 km beyond the slopes, was sampled using vertical CTD profiles with water sampling at various depths to determine physical, chemical, and biological parameters. The project also included a survey of the benthic biodiversity (fauna and flora attached to the seabed) by means of scientific rebreather dives, enabling work to be carried out at depths of over 60 m, and by means of towed gears or with the ROV. Led by IRD in collaboration with the French National Museum of Natural History (MNHN), the project team included representatives from Mauritius (Department for Continental Shelf, Maritime Zones Administration and Exploration, Prime Minister's Office [CSMZAE]; Ministry of Blue Economy, Marine Resources, Fisheries and Shipping; Mauritius Oceanography Institute [MOI]; University of Mauritius

[UOM]), Seychelles (Ministry of Fisheries and the Blue Economy; Seychelles Fishing Authority; Seychelles Parks and Gardens Authority; University of Seychelles;

Talma Consultancy), and other institutions such as the University of Lodz, Poland and Nelson Mandela University, South Africa.



Underwater view of the herbarium of *Talassodendron ciliatum*, Saya de Malha Bank © Sven Bender - Autentic / Monaco Explorations.

The data collected during the expedition are not fully analysed. Yet very promising results are already emerging, notably in the inventory of the benthic life. From the 3,074 invertebrates collected, 83% have been identified at families and/or genus and species level representing 250 species/morphospecies of mollusc and crustacean. The expedition provided 1,207 new occurrences of species, in addition to the existing 1,979 occurrences reported in the GBIF<sup>5</sup> data bank, then representing 60% new information. So far, three specimens are confirmed new to science, and several other specimens might join the list, once confirmed by molecular analyses. The collected samples were shared according to particular agreements including benefit-sharing provisions, intellectual property rights and dissemination of scientific knowledge and skills through the participation and tutoring of early-career researchers.

The various research activities deployed during the Saya de Malha project will lead to the publications of 10 of the 21 scientific articles in the Special Issue in Deep Sea Research II dedicated to the expedition (see [section 3.7.3.1](#)).

This expedition turned out to be an extraordinary training opportunity for students and young researchers of the region. It strengthened the bond between Seychellois and Mauritian scientists. The expedition contributed to the establishment of a regional team ready to engage in other expeditions, especially those concerning the JMA between the two States. An initiative to create an International Scientific Coordination Network - South (IRN) with countries of the WIO region is being discussed focusing on coordinated research and management of oceanic submerged structures.

The challenge is now to incorporate such an enhanced knowledge into marine spatial planning exercises and ocean governance, with a coordinated and shared vision from the two concerned States.

### 2.3.3. DESCRIPTION AND TIMELINE OF ACHIEVEMENTS

The research programme included 10 work packages (WPs). Each WP gathered between 4 and 19 members (except WP9 with a single member). The same individual could be assigned to several WPs. There were one or two coordinators by WP:

<sup>5</sup> GBIF : Global Biodiversity Information Facility

- WP1 - Seafloor mapping
- WP2 - Physical and chemical oceanography
- WP3 - Phytoplankton
- WP4 - Marine particles and zooplankton
- WP5 - Benthic invertebrates and sponges inventory
- WP6 - Photo-physiological studies of photosynthetic organisms
- WP7 - Scuba diving and towed gears sampling and specimen collection
- WP8 - ROV surveys
- WP9 - Megafauna
- WP10 - International Law of the Sea and its relationships with marine science

Five WPs (2, 3, 4, 5 and 8) included operations undertaken during day and night, with specific teams for each shift; consequently, there were two coordinators for each of these day/night WPs.

The first set of operations started on 2 November at 22:45 local time (UTC+2) by a series of three CTD stations in the strait between Ritchie Bank and Saya de Malha Bank. The last series of measurements associated with the project took place during the night between 17 and 18 November when six XBT casts were done in the strait between Saya de Malha and Nazareth Banks.

## 2.3.4. OBJECTIVES AND RESULTS ACHIEVED

### WP1 - Seafloor mapping

The objective was to collect bathymetric data on the shelf and slopes of Saya de Malha Bank (SDMB). A major limitation was the absence of a Multibeam Echo Sounder (MBES) on board the vessel. As only a single-beam system (SBES) was available, the spatial extent of the survey was restricted. It was therefore not possible to cover previously non-surveyed areas on the Saya de Malha Bank, as operating a large vessel without 3D bathymetric data posed excessive risk in unknown depths. The collected SBES data provided depth information below the vessel along its route (and transits) for the uncovered/uncharted areas. Despite these limitations, these data constitute new information to add to the current database for seafloor mapping of the bank and for navigation purposes.

Figure 42 shows the depth along the vessel tracks. It displays two of the four frequencies used by the SBES, 38 kHz to cover the deeper areas and 200 kHz for a finer description of the shallow areas.

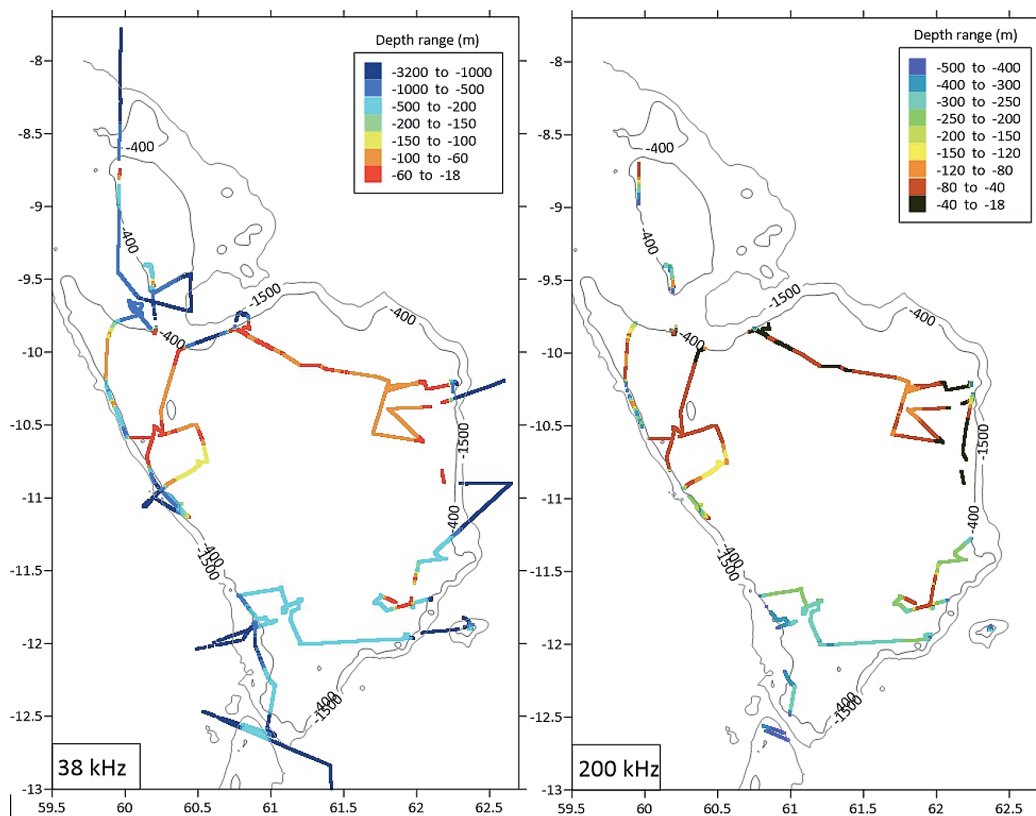
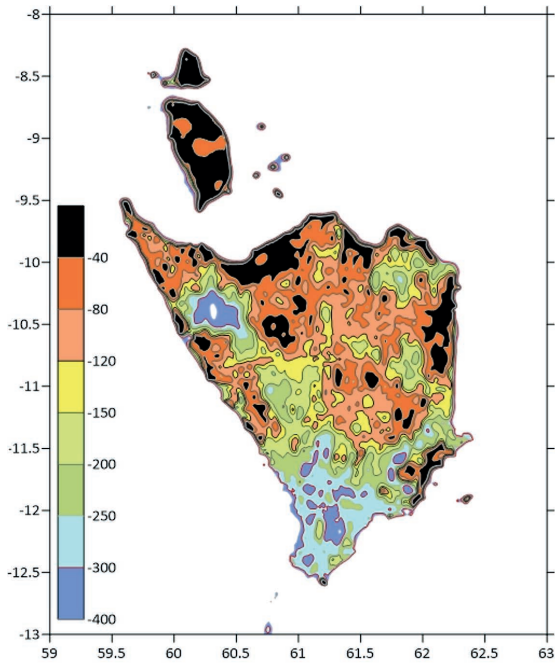


Figure 42: Depth measured by the SBES of S.A. *Agulhas II* along sailing lines over the Saya de Maha Bank and outside its slope (shallow areas: 200 kHz; deeper areas: 38 kHz)

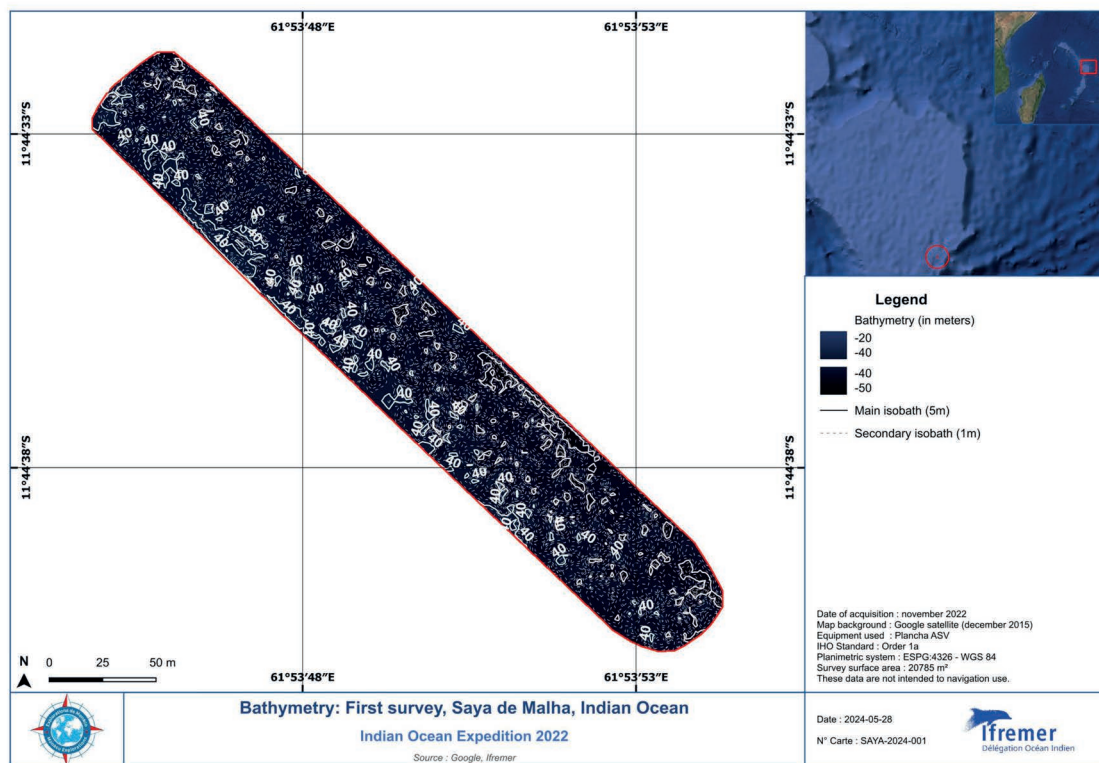


**Figure 43:** GEBCO 2022 bathymetry map of the Saya de Malha Bank

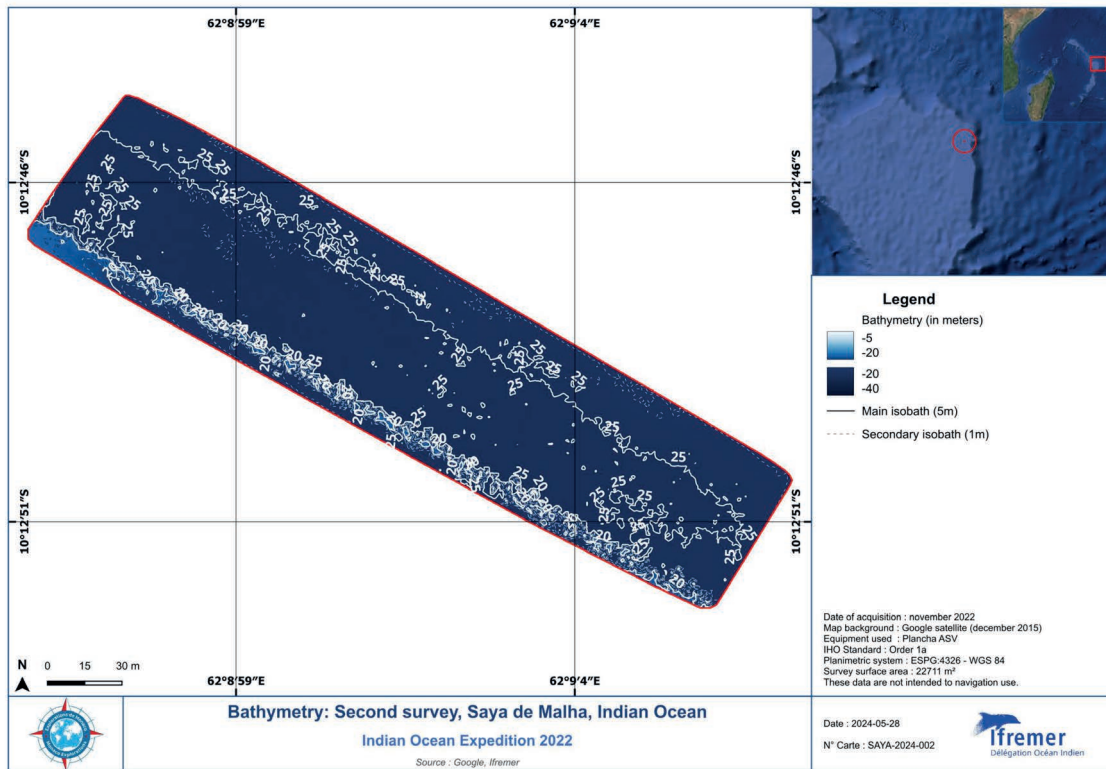
The information collected by the ship highlighted some discrepancy with the GEBCO bathymetric dataset (2022 version) in a few sectors of the bank (see **Figure 43**).

For instance, the deep basin (> 300 m) indicated on the GEBCO map in the northwest part of the bank does not exist. In this area, *S.A. Agulhas II* measured depths comprised between 80 and 40 m. Similarly, in the northeast corner of the bank, GEBCO indicates larger depths (up to 250 m) than those measured during our survey (< 120 m). The GEBCO data of the southern region of the bank indicates depth often deeper than 300 m, whereas *S.A. Agulhas II* recorded flat bottom not exceeding 300 m.

In addition, the 4Sea project (see **section 2.2.3**) conducted two surveys in the south part of the SDMB. The results are shown in **Figure 44**.



**Figure 44a:** Bathymetry from the 4Sea surveys of two sites of the Saya de Malha Bank

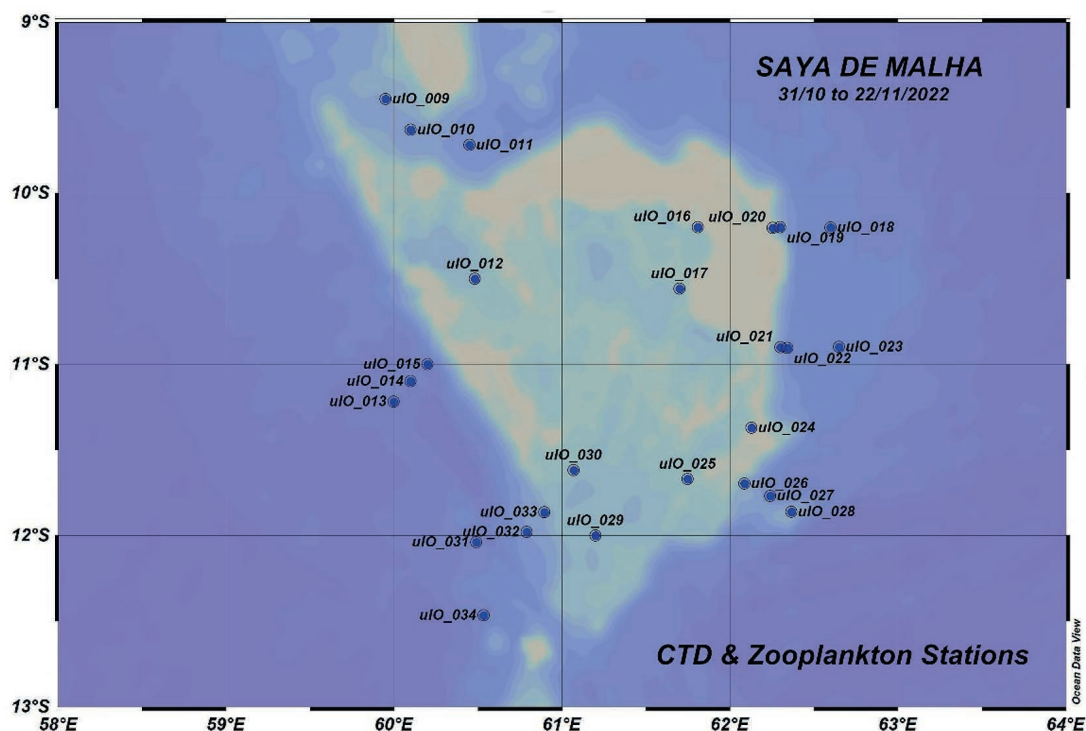


**Figure 44b:** Bathymetry from the 4Sea surveys of two sites of the Saya de Malha Bank

## WP2 - Physical and chemical oceanography

The physical and chemical environment of the studied area was described based on vertical profiles of temperature, salinity, dissolved oxygen and fluorescence (CTD profiles) conducted at 25 stations (around and above the Saya de Malha Bank - see [Figure 45](#)). At CTD stations, seawater has been collected at different depths from surface to bottom (up to 19 sampling levels for the deepest profiles) for nutrients (nitrate, nitrite, phosphate and silicate), oxygen and salinity (at a limited number of depths, for CTD calibration purpose) measurements as well as for phytoplankton sampling (see WP3). In addition, current measurement (velocity and direction) was performed all along the ship track, with the ship

mounted Acoustic Doppler Current Profiler (ADCP) operating at 75 kHz, with a 8m vertical resolution and a maximum measurement depth of 800m. Along-track measurements also concerned sea surface temperature (SST) and salinity (SSS) measured underway with a Thermosalinograph (TSG). In order to complete the limited number of CTD profiles, 25 additional temperature vertical profiles have been acquired using XBT (eXpandable Bathy Thermograph) probes from Seychelles to Mauritius, 16 of which were launched around the Saya de Malha Bank. 4 SVP (Surface Velocity profiler) buoys provided by Météo France and 10 SSD (Sea Surface Drifters) provided by UWA (University of Western Australia) were deployed between Seychelles and Mauritius, with a focus on the Saya de Malha Bank region (see [section 2.1.3](#)).



**Figure 45:** Location and name of the CTD stations during the Saya de Malha cruise. Note the first station is IO\_009 as stations occurred before the cruise as part on the Monaco Explorations Indian Ocean Expedition.

Most of the data collected onboard (apart from XBT profiles) required post cruise analysis (nutrients), post-cruise processing (ADCP), and calibration (CTD).

The IRD IMAGO laboratory performed the nutrients analysis by classical colorimetric method (324 samples collected during the Saya de Malha Bank exploration) and delivered the final data set in June 2023.

ADCP measurements were first pre-processed onboard (removing erroneous data, bottom masking, and correction of the misalignment between the ship and the ADCP beam axis). The final data processing was done at CSZMAE using the "OSSI" toolbox developed at GEOMAR, Germany and adapted to the specifics of fishery surveys at IMR, Norway (Ostrowski, personal communication). The final current dataset can be provided to the participants upon request at CSZMAE.

The CTD profiles were calibrated by the IRD IMAGO laboratory in Brest, independently from the calibration of the few profiles common with the BGC-ARGO project (see [section 2.1.2](#)). Calibration of the conductivity (salinity) and oxygen sensors was achieved based on onboard measurements on selected water samples during the cruise. The calibration of the CTD fluorometer took advantage of the onboard chlorophyll<sub>a</sub>

measurements by the phytoplankton team (WP3). Due to malfunctioning of the oxygen sensor in the surface layer, oxygen concentration received a quality code qc=3 (questionable) down to 15m at all stations. In addition, after station IO-019, the oxygen sensor became unstable and some CTD oxygen profiles were partly discarded during the calibration process (oxygen value set at -9999 and qc=9). For these stations (IO-020 to IO-033), oxygen concentration quality code was set to qc=3 from the surface down to 40m. Due to the complex oxygen data processing, the CTD calibration has been completed only by July 2024. The calibrated data was distributed to all participants (netcdf, Excel and ODV files).

## RESULTS

Being of multidisciplinary nature (from physics to plankton, to benthic fauna, to seagrass and to ROV surveys), the cruise did not prioritize on the physical and chemical oceanography of the Saya de Malha Bank. Previous cruises (e.g. ASCLME, Fridjof Nansen, 2018, *Coopen et al., 2021*) were better designed to address such issues. Instead, the WP2 component reached the goal of providing environmental information to other components (biological studies, WP3 in particular, see *Gordon et al., 2025*). This section presents some general information.

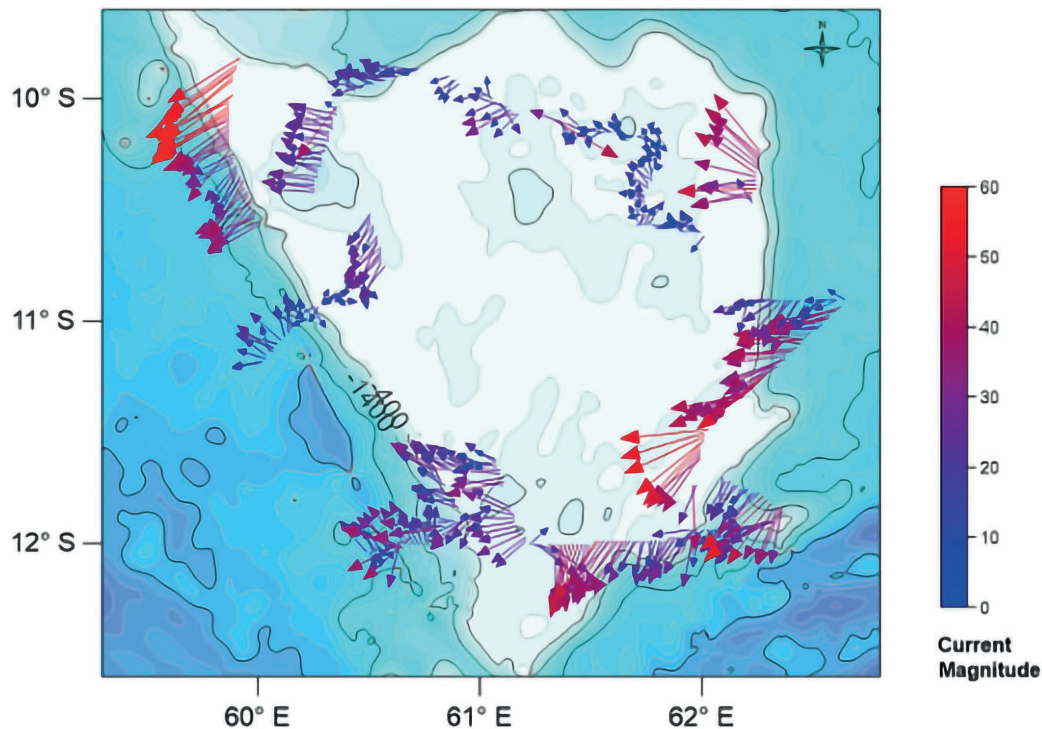
## Currents

During the transit from Seychelles to Saya de Malha Bank, the westward-flowing South Equatorial Current (SEC) could be observed at latitudes 7°S - 9°S reaching velocities of about 40 cm s<sup>-1</sup> at the surface water (30 m deep). Along the 6°S transect, the current was flowing in a northward direction on the western part and in a southward direction on the eastern part of the transect, which might be due to the influence of a cyclonic eddy centred on 4°S. Further south, north of Ritchie bank (8.6°S), the SEC intensified and reached velocities of approximately 60 cm s<sup>-1</sup>.

The well-established SEC was observed over the surveyed region of Saya de Malha bank (10° S to 12.5° S, 59° E to 62.5° E). Upon reaching the eastern slope, the

SEC diverged into a northwestward and southwestward direction between latitudes 10°S and 11°S. In addition, the current velocities varied between 0 to 30 cm s<sup>-1</sup> over the bank and up to 63 cm s<sup>-1</sup> along the slopes during the surveyed period (Figure 46).

At depths between 100-200 m, the zonal velocity showed a relatively strong westward propagating current in the eastern side of the bank (40-50 cm s<sup>-1</sup>) and a strong eastward current (30-40 cm s<sup>-1</sup>) between longitudes 61.4°E and 61.7°E. The meridional velocity was northward between two southward-moving currents across the bank. This pattern might be due to the presence of internal waves, which have been well documented in the region, forming at the sill between the Saya de Malha and Nazareth Banks and propagating inside the SDMB (New et al., 2013).

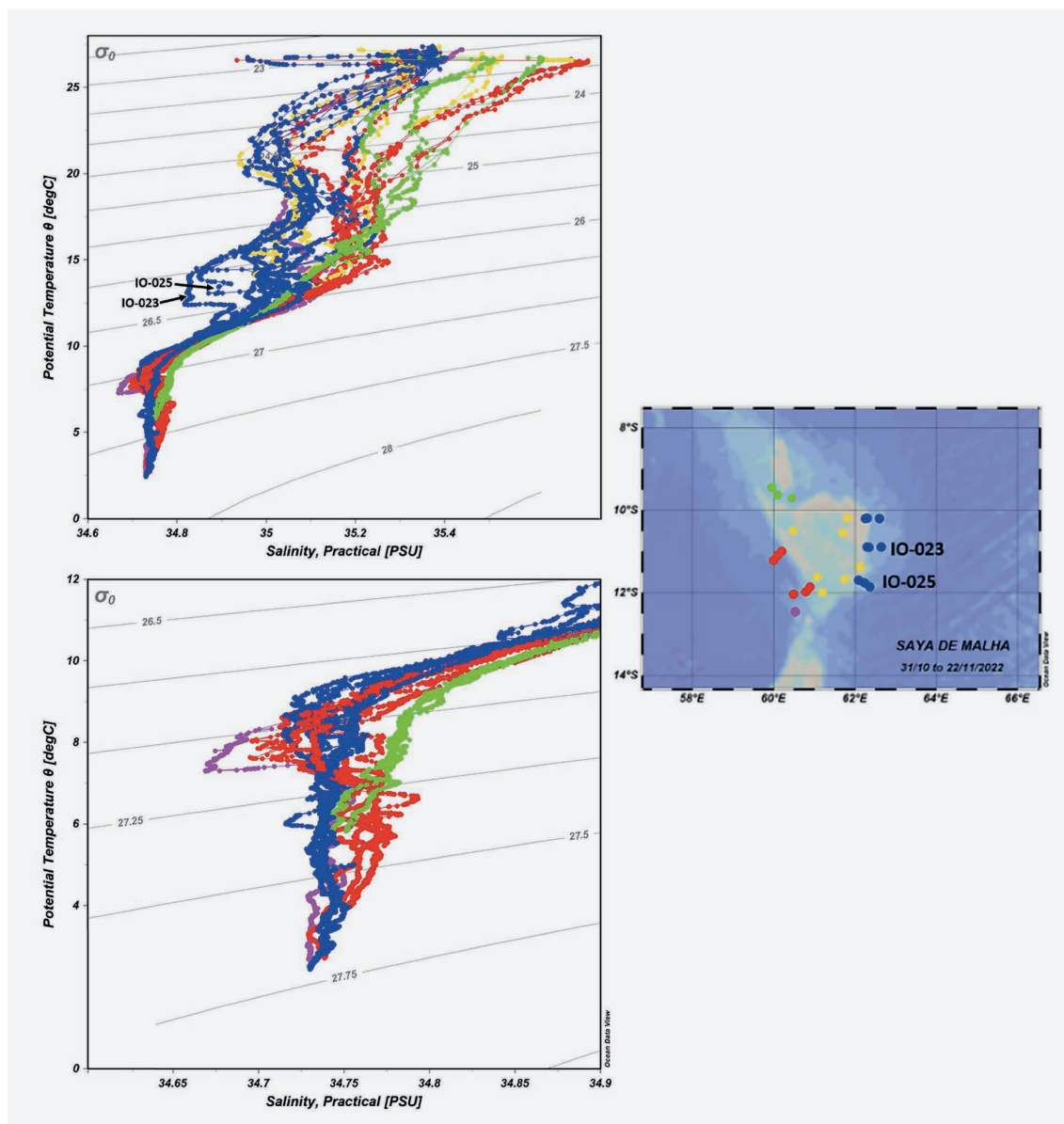


**Figure 46:** Current velocity (in cm s<sup>-1</sup>) and direction at 30 m deep measured by ADCP over Saya de Malha Bank (delimited by isobaths -400 m), from 2 to 17 November 2022

## Water masses

Water masses were first characterized using the temperature-salinity ( $\Theta$ -S) diagrams at each of the CTD stations. These diagrams show a clear distinction between the stations depending on their location relative to the Saya de Malha Bank, both for surface and sub-surface (left) and deep (right) water masses

(Figure 47). Less salty waters are present east of the bank compared to the western side. This illustrates the westward transport of fresher Pacific Ocean waters by the South Equatorial Current. Water masses within the channels north and south of Saya de Malha have still distinct characteristics (i.e., origin and mixing). The two easternmost stations (10-023 and 10-025) also show distinct  $\Theta$  S signature at sub-surface ( $26.0 < \sigma < 26.5$ ).



**Figure 47:** On top:  $\Theta$ -S diagram for all SDMB CTD stations.

Colour code refers to the station location (blue: east of the bank; red: west of the bank; green: channel between Ritchie and Saya de Malha Banks; yellow: on Saya de Malha Bank; pink: east of the channel between Saya de Malha and Nazareth Banks).

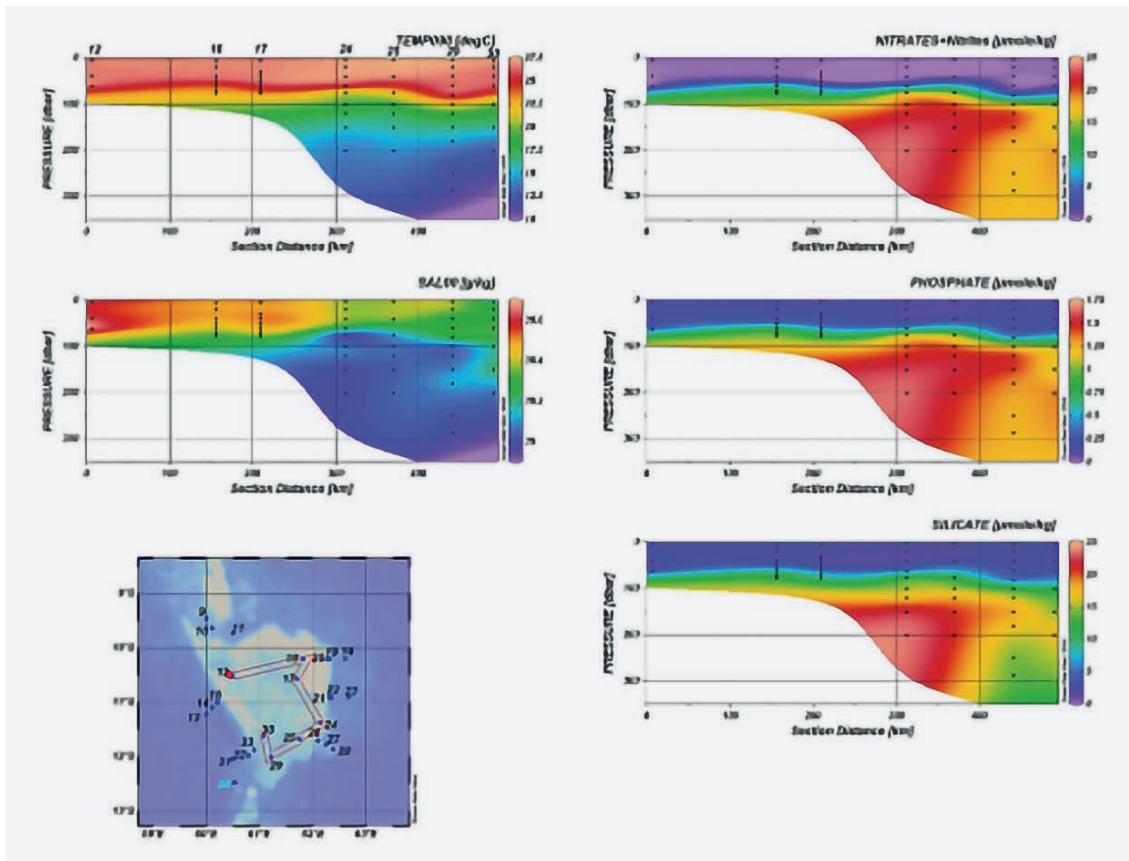
At the bottom: zoom on the deepest part of the CTD profiles.

## Nutrients

The nutrient distribution measured on the SDMB summit clearly shows enrichment at the south-east stations (IO\_024 and IO\_025) in the deeper layer (100-200m) that propagates to the west (stations IO\_29 and IO\_30) - (Figure 48). The salinity vertical distribution shows similar pattern (lower salinity corresponding to the high nutrient level), which demonstrates the enrichment of the Saya de Malha Bank by the east water masses transported by the SEC. The upper layer remains depleted in nutrients, and the nitracline has a similar shape than the thermocline

all over the sampled area. The presence of high salinity at station IO\_012 is the signature of high salinity water mass on the west of the bank.

The vertical distribution of nutrients along the two transects perpendicular to the east side the bank did not give clear evidence of nutrient upwelling along the slope. This may be due to the limited number of vertical profiles close to the slope. On another hand, the comparison of vertical profiles east and west of the bank highlights the higher load of nutrients east of the structure, below the nitracline.



**Figure 48:** Vertical section of temperature, salinity, nitrate + nitrite, phosphate and silicate along a transect linking the CTD stations at the SDMB summit (stations 12, 16, 17, 24, 25 29 and 30). The dotted vertical lines represent the water sample's location and depth. The station numbers are reported on the temperature section.

### WP3 - Phytoplankton

The objective was to assess the ocean productivity on the bank and at the slopes by measurements of phytoplankton biomass, overall and by size categories. Phytoplankton biomass was assessed based on the total chlorophyll-a content of seawater samples collected from the upper 200 m of the water column, by the Niskin bottles used for physical and chemical measurements (WP2). For size fractionated chlorophyll-a, 250 ml seawater was sequentially gravity filtered through 20 µm, 2 µm and 0.2 µm 47 mm Nuclepore filters, and all filters placed in 6 ml of 90 % Acetone for extraction. The total Chl-a concentration was used to assess the calibration of the fluorescence sensor of the CTD while the size fractionated Chl-a was used as an index of the proportion of micro-, nano- and picoplankton, an indicator of the productivity level of the pelagic ecosystem. The samples were collected at 7 shallow stations (on the plateau), 5 stations on the slope, 10 stations in the deep sea and 3 stations within the northern channel between Saya de Malha and Ritchie Banks.

The maximum phytoplankton biomass was recorded at intermediate depths, between 60-80 m. The highest biomass was measured in the shallow shelf areas in the north-eastern part of the bank. In the northwestern and southeastern part of the bank, higher biomass was measured at the nitracline (depth of maximum nutrients) indicating nutrient input from deeper waters sustaining phytoplankton productivity in the photic zone. Size distribution of phytoplankton biomass indicated that the communities of the Saya de Malha Bank were dominated by the very small picoplankton at the surface (~46 %), a characteristic of oligotrophic waters. The larger micro-plankton was in low abundance at the surface (~13%) increasing to ~36% towards the deeper waters and toward the southern edge of the bank, due to the sinking of larger, ungrazed and generally heavier cells during the normal diel cycle. In addition, mixing related to the presence of internal wave in the deep layer in the south of SDMB might contribute to the increase of microplankton with depth.



The SDMB is subject to major ocean circulation patterns, and its productivity is greatly influenced by the westward flow and north-south migration of the South Equatorial Current that bring nutrient-rich bottom water to the surface along the eastern ridge of the bank. These currents across the bank impact the distribution of phytoplankton size classes, with cascading impacts to the food web and the export of biomass (carbon) to the rest of the Western Indian Ocean. The dominance of larger sized plankton within the bottom waters may indicate the export of C-biomass and the recycling of nutrients to deeper water, thereby contributing to deep water productivity in what would otherwise be nutrient poor habitats.

#### WP4 - Marine particles and zooplankton

The objective was to investigate the diversity and biomass of zooplankton species at SDBM plateau and slopes. Three different types of gears were used:

- 1) an Underwater Vision profiler (UVP-5);
- 2) traditional plankton nets (200  $\mu\text{m}$  mesh size Bongo) used in in oblique tows in the upper 200 m; and
- 3) multiple layer plankton sampler (Multinet, 9 nets of 300  $\mu\text{m}$  mesh size).

Overall, 33 UVP profiles, 20 Bongo oblique tows and 5 Multinet tows were carried out. At the time of finalising the report, the UVP data have not been processed and the sorting and analysis of the plankton samples is still pending. All the samples are well preserved and can be analysed any time, once human resources are found for this investigation.

#### WP5 - Benthic invertebrates and sponges inventory

The expedition yielded significant preliminary insights into the biodiversity of the Saya de Malha Bank. Investigations spanned multiple taxonomic groups, employing integrative approaches including morphological identification, DNA barcoding, and ecological assessments across depth gradients. The main taxonomist collaborators working in network with the MNHN for that expedition belong to 16 research institutions from 10 different countries.

#### SPONGES

55 sponge samples were collected at depths between 10-45 m (five shallow dives), 40-60 m (one ROV dive), and 45-70 m (four deep dives). Same sponge specimens were observed at different sites and depths. Some specimens

were unique to one site. A few specimens seem to be the same as the ones collected around Mauritius and Rodrigues.

The field operations are to be followed by taxonomy and DNA identification of sponges, investigation of pharmacological properties, capacity building and collaboration for work on sponge symbiotic microorganisms and chemotaxonomy, and comparative studies of the bioactivity of same sponge species in different regions.

#### ALGAE AND SEAGRASS

Prior data on macroalgae from Saya de Malha were limited to early 20<sup>th</sup>-century studies. The recent survey recorded six taxa, including extensive rhodolith beds primarily composed of coralline red algae (CCRA). Molecular analyses of 33 coralline algal specimens revealed 17 species (5 *Sporolithales*, 4 *Corallinales*, and 8 *Hapalidiales*), all potentially endemic, underscoring the bank's isolation and high cryptic diversity. The algae inventory is available on the *iNaturalist* website, an Indian Ocean citizen science platform [Indian Ocean Citizen science \(Monaco Exploration - Seychelles & Mauritius · iNaturalist\)](#).

#### MOLLUSCS

The expedition collected an estimated 300-400 mollusc species, demonstrating significant vertical zonation between shallow (20-50 m) and deep (>70 m) faunal assemblages. Small-bodied species, particularly among *Marginellidae* and *Columbellidae* dominated collections. Families such as *Strombidae*, *Mitridae*, and *Nassariidae* were unexpectedly scarce. Several rare or iconic species, including *Tridacna rosewaterii* and *Conus primus*, were rediscovered, some with confirmed genetic distinctiveness.

#### CRUSTACEANS

Crustacean diversity was vastly underestimated prior to this survey. Approximately 200 species were collected, with Decapoda representing the majority. Notable findings include the re-discovery and range extension of *Praebebalia extensiva* and *Merocryptus boletisculpta*, as well as the identification of new species within *Galatheoidea* and *Ethusidae*. Integrative taxonomy based on genetic and morphological data revealed high cryptic diversity, particularly in the genus *Coralliogalathea*. Peracarid crustaceans, notably *Amphipoda* and *Isopoda*, were abundant, with over 2,300 specimens collected and a strong depth-related diversity pattern observed.

## ANNELIDS

Polychaete data from Saya de Malha were previously minimal. The current inventory includes 331 lots, with 20 families identified. The expedition led to the description of a new species (*Iphione corbariae*) and new distribution records for other taxa. Symbiotic associations with other benthic invertebrates were also documented.

## FISH

A total of 196 fish specimens from 39 stations (76-1,441 m depth) were collected and genetically analyzed. The collection spans 19 orders and at least 98 species, with notable dominance of flatfishes (*Pleuronectoidei*) and scorpaeniform taxa. Several species, such as *Parabothus malhensis* and *Neobythites malhaensis*, appear to be endemic. New regional records and significant genetic divergences were noted, including in *Draconetta xenica*, suggesting overlooked cryptic species and complex biogeographic patterns.

## DATABASING AND ACCESSIBILITY

The data are integrated into the MNHN collection and are accessible via institutional and global platforms (e.g. GBIF, GenBank, BOLD). Of the estimated 6,962 specimens collected, 60% have been catalogued, with 83% identified to family, genus, or species level. Genetic analyses are ongoing to refine species delimitations using integrative taxonomy. Three new species have already been described from the collected material.

## WP6 - Photo-physiological studies of photosynthetic organisms

Corals are among the marine organisms most impacted by climate change. The expedition was an opportunity to investigate thermal stress responses of two coral species over the Mascarene Plateau, more specifically from Saya de Malha to Saint Brandon (10°S to 16°S). The two species studied are the regionally endemic *Pocillopora indiania* and the commonly occurring and thermally resistant *Heliopora coerulea*. Coral colonies were collected by divers. The responses to thermal exposures (26°C, 29°C and 32°C) were quantified by the measure of photosynthetic performance using an Imaging Pulse-Amplitude-Modulated (IPAM) fluorometer, in controlled mesocosm onboard the ship. The results from the expedition complemented a similar study made in Mauritius in 2023, at a more southern latitude (20°S). Overall, the photosynthetic performance could then be studied along a latitudinal gradient.

The results indicate that the corals from Saint Brandon (16°S) have a better resistance to thermal stress than those from Saya de Malha, followed by Mauritius. The study indicates that corals from reefs remote from human population centres have better ability to cope with warming conditions compared to corals from impacted reefs, such as in Mauritius (*Munbodhe et al., 2025*).

## WP7 - Scuba diving and towed gears sampling and specimen collection

The MNHN team adapted its standardized sampling protocols from the “Tropical Deep-Sea Benthos” and “Our Planet Reviewed” programmes to conduct a comprehensive marine biodiversity survey of the Saya de Malha Bank. The sampling strategy integrated two complementary approaches: scuba diving for shallow habitats and the deployment of towed gears for deeper environments. This dual methodology enabled optimized sampling across a range of benthic habitats, including soft and rocky substrates, seagrass meadows, algal beds, and various coral communities.

Diving-based methods were employed at 35 stations and included visual documentation and specimen collection, brushing techniques, suction sampling of sediment layers, and targeted on-sight collection of specific or symbiotic species. These methods enabled precise microhabitat sampling in depths typically less than 60 m.

Towed gear sampling, conducted at 46 stations, involved the use of benthic sledge, Warén dredge, and beam trawl, each selected according to substrate type and bathymetry. The benthic sledge targeted suprabenthic macrofauna; the Warén dredge was suited for hard, uneven terrain; and the beam trawl was used on soft-bottom habitats. Depths sampled using towed gear ranged from 73 to 1,441 m. Sampling was performed across four primary areas of the Saya de Malha Bank—Northern, Eastern, Western, and Southern—selected for their ecological heterogeneity and accessibility. The Northern and Southern areas exhibited the greatest depth variability, whereas the Eastern area was primarily sampled through diving. The Southern region, being the deepest, was predominantly explored using towed gear.

Shallow water habitats were characterized by dense meadows of the seagrass *Thalassodendron ciliatum*, interspersed with reef patches and coral-dominated substrates. In contrast, deeper areas yielded a diverse array of sediment types—including globigerina mud, pumice, gravel, and rocky substrates—supporting varied megafaunal assemblages. A total of 81 stations were



sampled, with comprehensive metadata (including station coordinates, sampling gear, depth, and habitat descriptions) systematically recorded. All specimens were labelled with standardized codes and linked to the MNHN's Saya database, accessible online at <https://expeditions.mnhn.fr/campaign/saya>

### WP8 - ROV surveys

The ROV was equipped with 4K video cameras, an articulated sampling arm, and four specimen storage boxes to house collected samples. Additionally, a low-cost deep-sea prototype camera, designed by the Ocean Discovery League, was attached to the ROV during dives. This prototype is being field-tested to evaluate its performance and to explore its potential for broadening access to deep-sea exploration technologies.

A total of seven ROV surveys were completed to document and sample benthic communities below scuba depth limits. Survey design followed protocols established by the Nekton Project and regional collaborators, enabling comparative analyses with other expeditions conducted in Seychelles, Comoros and Maldives.

Surveys targeted four priority depths 30 m, 60 m, 120 m, and 250 m, though these depths were not always attainable due to time constraints and local topography. Each survey covered a 250 m transect at an average speed of 0.2 knots, with two replicate transects conducted at each depth to ensure sufficient data for statistical analysis.

The ROV survey videos from the Saya de Malha Bank were handed over to the Blue Economy Department of Seychelles following the expedition.

The Seychellois researcher who co-led the original surveys obtained official permission to use the dataset for her doctoral research. The analysis now contributes to a broader comparative dataset encompassing sites across the Indian Ocean region.

Preliminary results from the development of a morphological catalogue of fish species observed in the ROV footage indicate that over 120 specimens have been identified to species level. These identifications will undergo verification by taxonomic experts in the coming months. An additional 70 fish specimens remain to be identified. Once the species list is confirmed, it will be integrated with existing regional inventories, enhancing the overall understanding of fish biodiversity in the Western Indian Ocean.

### WP9 - Megafauna

This activity is reported in [section 2.1.5](#).

### WP10 - International Law of the Sea and its relationships with marine science

This activity is reported in [section 3.8.1](#).

## 2.3.5. CONCLUSION

The Expedition provided a very efficient collaborative framework between the scientists of the region (Mauritius and Seychelles) and the other scientists from outside the region. Training opportunities to novel technologies were provided to early-career scientists on board.

It was also a great opportunity to study an under-sampled marine region, which is also a jointly managed area (JMA) between two neighbouring SIDS, a unique governance mechanism. Both countries (Mauritius and Seychelles) are implementing a science-based approach in the management of this particular region. The scientific outcomes of this project complement greatly the current knowledge to design a Marine Spatial Plan and inform decision making.

Mobilising marine and human sciences together on the same high-level scientific network to support WIO public decision is new, both at national and regional level, for example the WIO "Regional Ocean Governance Strategy" (ROGS) finalised in 2024 under the auspices of the Nairobi Convention (Nairobi Convention COP 11 held in August 2024).

Overall, the project can be considered as successful. Apart from the seafloor bathymetric survey, which needed a multibeam echosounder (not mounted on the ship) to reconstruct a 3D view of the seafloor on a wide path, all the other operations were successfully carried out. Lab-based experiments in controlled mesocosms were deployed on board, using freshly collected coral and photosynthetic organisms by the diving team. The most striking achievement was the vast collection of benthic specimens, which has already resulted in the description of 40 species new to science. In addition, around 200 other specimens are considered potential new or rare species, with taxonomic descriptions currently underway using the most advanced molecular analytical tools. Training activities could be developed on board, during the cruise.

# 3. COMMUNICATION AND OUTREACH

## 3.1. INTRODUCTION

In parallel to its scientific and diplomatic objectives, the expedition aimed to share the issues and knowledge gained through an ambitious communication and outreach programme with as many people as possible: the general public, teachers, civil society stakeholders, decision-makers, the young generation, etc. This programme was based on the concept of Ocean Literacy<sup>6</sup>, the most widely used definition of which is as follows: “the understanding of our individual and collective impact on the ocean and its impact on our lives and well-being” (UNESCO, 2017).

This concept has evolved in recent years, particularly since it was included as a mechanism for changing attitudes and perceptions of the ocean in the objectives of the UN Ocean Decade (McKinley et al., 2023). Additional concepts have now been added that contribute to triggering or creating an individual or collective sense of “Ocean Knowledge” and belonging or adhering to an “Ocean Community” and its values. This new approach includes additional dimensions such as marine citizenship, ocean connectivity, and notions of emotional connection, adaptation, and transparency.

Ocean Literacy encompasses not only pure knowledge but also shared values and a form of shared experience of the ocean (Worm et al., 2021)

To pool and share this knowledge, bring the scientific and human adventure to as many people as possible, and encourage action, different types of outreaches, in the sense of cultural, scientific and artistic outreach, were used and many expedition participants took on the role of mediator, each with their own skills, know-how, experience and personal and professional backgrounds. They included scientists, crew members, artists and professional facilitators. The decision to include artists and facilitators in the expedition was intended to go beyond the traditional framework of scientific communication and achieve emotional and social understanding, which is essential for the emergence of active ocean citizenship (Kelly, R, et al.; McKinley, E. et al.; McRuer, J. et al.).

This chapter describes the strategy deployed, the actions developed, and the results, based on the Ocean Literacy theoretical framework.

## 3.2. OUTREACH AND COMMUNICATION STRATEGY AND OBJECTIVES

### 3.2.1. COMMUNICATION AND OUTREACH PLAN

The overall strategy could be summarized in a few words: make people love, know, and protect the Ocean.

The goal is to contribute to a collective narrative: that of the protection and sustainable management of the ocean. The expedition put in place an ambitious communication

strategy to raise awareness among a wide audience, while promoting and publicising the importance of the scientific work carried out during the expedition. This strategy was based on a combination of disseminating the scientific programme, raising awareness of environmental issues and an artistic approach designed to enrich the outreach activities and provide a different perspective through its originality and creativity, with a fresh and emotional understanding of these themes.

<sup>6</sup> A seminal guide first published in 2005 (NOAA, 2024), “Ocean Literacy: Essential Principles and Fundamental Concepts” established the seven fundamental principles of Ocean Literacy: 1- The Earth has one big Ocean with many features, 2- The Ocean and life in the Ocean shape the features of Earth, 3- The Ocean is a major influence on weather and climate, 4- The Ocean makes the Earth habitable, 5. The Ocean supports a great diversity of life and ecosystems, 6- The Ocean and humans are inextricably interconnected, 7- The Ocean is largely unexplored.



This approach, combining art and science in the service of a common cause, that of the ocean, helped connecting a wide range of audiences, from young schoolchildren to policymakers. It echoed the desire of Prince Albert I<sup>st</sup> of Monaco (1848-1922), a pioneer of modern oceanography and founder of the Oceanographic Institute, to “bring together in the same brilliance the two guiding forces of civilisation: ‘art and science’”, as he put it in his inaugural speech at the Oceanographic Museum on 29 March 1910.

Based on the outline approved by Monaco Explorations Board in April 2022, the expedition communication and outreach plan was developed in liaison with the partners’ communication manager with the support of the Oceanographic Institute.

The plan called for a multi-channel approach, integrating both traditional media and digital platforms to ensure a strong media presence, using a variety of communication tools.

### 3.2.2. OUTREACH OBJECTIVES

The expedition’s outreach objectives were in line with the seven fundamental principles of Ocean Literacy<sup>6</sup>. Three of these principles guided the implementation of the actions carried out:

- **Ensure accessible and rigorous dissemination of scientific knowledge to a variety of audiences** (*Shellock et al., 2024*): In line with principle 2, “The Ocean and life in the Ocean shape the features of Earth”, raising awareness of how the ocean works, the living beings that inhabit it, the importance of different ecosystems, and the risks and solutions identified by the expedition to strengthen global understanding of the vital role of the ocean.
- **Encourage engagement, curiosity and involvement** (Kelly, R. *et al.*): In line with principle 6, “The Ocean and humans are inextricably connected”, raising emotional and cognitive awareness to lead to real commitment and concrete actions for marine conservation.
- **Promote and develop dialogue and interaction between different stakeholders and disciplines** (McKinley, E. *et al.* ; McRuer, J. *et al.*): In line with principle 7, “The Ocean is largely unexplored”, developing exchanges between the fundamental and

social sciences, dialogue between art and science, and the appropriation of scientific information by decision-makers and the general public to achieve a collective perception and understanding of the issues at stake.

The overall communication strategy and outreach objectives also aimed to respond to political and societal expectations, in particular by contributing to the promotion of regional and international environmental diplomacy based on cooperation and knowledge. The strategy and related objectives were implemented through a joint reflection process involving the various institutional stakeholders, partners of Monaco Explorations, and local stakeholders in the explored area, namely: the Prince’s Government, the Prince Albert II of Monaco Foundation, the Oceanographic Institute - Prince Albert I<sup>st</sup> Foundation, the Monaco Scientific Centre, the Monaco Yacht Club, and representatives of the French, Seychelles and Mauritian governments.

### 3.2.3. INFORMATION OF THE PARTNERS AND PARTICIPANTS

#### 3.2.3.1. IN FRANCE AND MONACO

Before the expedition set off, its value as an educational resource was presented on several occasions and at different levels in the Principality of Monaco, the Provence-Alpes-Côte-d’Azur region and at national level in France.

With the collaboration of the *Centre de formation pédagogique de l’Education nationale monégasque*, two online information sessions were offered to Monegasque primary school teachers on Wednesday 14 September and to secondary school teachers on Wednesday 21 September 2022.

In collaboration with the *Délégation académique à l’éducation artistique et culturelle* (DAAC) of the *Rectorat de l’Académie de Nice*, information was also distributed in September 2022 in the Alpes-Maritimes and Var districts. This announcement presented the possibilities for online monitoring of the expedition via the dedicated page on Monaco Explorations website and the possibilities of direct contact with the scientists.

A presentation was also given at the Teachers’ Information Day organized on 3 October 2022 by Monaco Oceanographic Museum’s Events and Education Department.

Finally, the announcement was relayed throughout France to the science and technology inspectors of the school districts, via the Artistic and Cultural Education Mission of the French Ministry of Education and Youth.

### 3.2.3.2. AT REGIONAL LEVEL IN THE INDIAN OCEAN

At regional level in the Indian Ocean, diplomatic processes and procedures, concentrated in this pre-expedition phase on applications for consent to conduct marine scientific research in the various zones studied during the expedition, as well as a post-Covid context still very present in 2022, slowed down the process of contacting and informing educational bodies in the Indian Ocean region concerned by the expedition. All

these factors made it difficult to inform the educational authorities in advance. Information was only provided during the preparation of the ports of call when the outreach teams were already at sea.

### 3.2.3.3. PARTICIPANTS

An information videoconference open to all participants in the expedition was organised on 22 September 2022, a few days before the departure of the vessel. The expedition programme was presented to the crew of *S.A. Agulhas II* on 8 October. A general briefing with all the participants on board was organized on 14 October after the stopover at Réunion Island and on 31 October after the stopover at Port Victoria.



General briefing with Knowledge Bengu, Master of *S.A. Agulhas II* © Didier Théron - Monaco Explorations

## 3.3. COMMUNICATION AND OUTREACH ARRANGEMENTS

### 3.3.1. OVERVIEW

The main arrangements and resources implemented are summarised in **Appendix J** where the arrangements are cross-referenced with the objectives. The main environmental diplomacy actions carried out at the

same time are also shown. The strategy deployed was inspired by the practices and arrangements identified by the European Marine Board (2024), (*Eparkhina et al., 2021*).



It was translated into several types of actions:

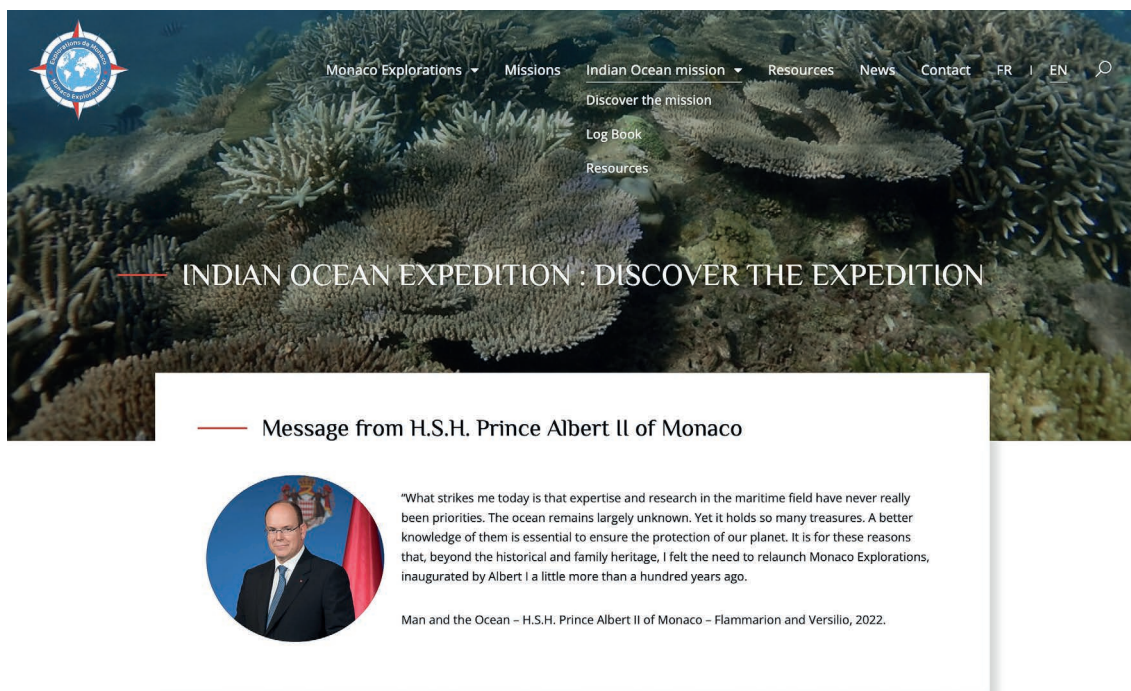
- Multi-channel communication: multi-platform digital animation, dedicated web page<sup>7</sup>, social networks, traditional media approach, daily newsletter<sup>8</sup>,
- Multi-media production: reports, podcasts<sup>9</sup>, documentaries, YouTube channel<sup>10</sup>
- School and public outreach: interactive and educational workshops, meetings with members of the expedition, guided tours, long-term educational programmes
- Production of scientific resources: databases, scientific reports, preliminary report, final report, etc.

- Teaching and knowledge transfer: onboard school, thematic course, training sessions, etc.
- Artistic creation: artist residencies on board, exhibitions, conferences and art and science dialogue.

### 3.3.2. MULTI-CHANNEL COMMUNICATION: A QUEST FOR MAXIMUM VISIBILITY

A multi-channel approach was used by the Monaco Explorations team and its partners, integrating both traditional media and digital platforms to ensure a strong media presence, using a variety of communication tools (Figure 49).

#### 3.3.2.1. MONACO EXPLORATIONS WEB PAGE



Home page dedicated to the Indian Ocean Expedition on Monaco Explorations website

<sup>7</sup> MEIO-2022 Expedition webpage: <https://www.monacoexplorations.org/en/missions/indian-ocean-2022-mission/>

<sup>8</sup> Saya de Malha Daily: <https://www.monacoexplorations.org/en/saya-de-malha-daily/>

<sup>9</sup> Stéphane Dugast "L'écho des labos" podcasts : [https://www.monacoexplorations.org/ressources/?\\_recherche\\_ressources=L%27écho%20des%20labos&\\_mission=47774](https://www.monacoexplorations.org/ressources/?_recherche_ressources=L%27écho%20des%20labos&_mission=47774)

Elise Rigot "Voix de l'océan Indien" podcasts : [https://www.monacoexplorations.org/ressources/?\\_recherche\\_ressources=Les%20voix%20de%20l%27océan%20Indien](https://www.monacoexplorations.org/ressources/?_recherche_ressources=Les%20voix%20de%20l%27océan%20Indien)

<sup>10</sup> Monaco Explorations YouTube Channel - Playlist Indian Ocean 2022: [https://www.youtube.com/playlist?list=PLcb8hRbh3\\_YQWxH3aw\\_Rb9qC4qKASzH8k](https://www.youtube.com/playlist?list=PLcb8hRbh3_YQWxH3aw_Rb9qC4qKASzH8k)

A dedicated page was set up on the Monaco Explorations website to centralize and share content relating to the expedition, including a logbook, diary, ship tracking, opinion pieces, photo galleries, video and audio reports, and up-to-date information on the progress of the scientific work. This site has ensured lasting visibility over time, during and after the expedition, by facilitating access to the resources produced.

Between the start of the communication campaign ahead of the expedition, in June 2022, and June 2023, 85% of new users visited the website, with peaks linked to the launch of the expedition, its progress and the feedback day in March 2023.

### 3.3.2.2. MEDIA COVERAGE

At the same time, strategic communication tools such as press kits and press releases were distributed, boosting media coverage of the expedition. Meetings with journalists during the stopovers, as well as interviews with the expedition's spokespersons, helped to raise the profile of the expedition. These efforts resulted in extensive press coverage, with over 250 articles and reports published in local, national, regional and international media (**Table 9**).

**Table 9: Main publications**

MEDIA	REPORT	COUNTRY
Terre Sauvage	One twelve-page report	France
Science Magazine	One nine-page report	France
Embarquement	One six-page report + One special height-page issue	France
Point de Vue	One two-page report on Prince Albert II of Monaco's visit to the Seychelles	France
TV5 Monde	Interview with Robert Calcagno, Managing Director of Monaco Explorations	Belgium Canada (Québec) France Switzerland Monaco
France3	Interview with Gilles Bessero, leader of the Expedition	France Belgium Andorra Monaco (French-speaking) Switzerland Luxembourg United Kingdom Ireland United States Canada Australia New Zealand Germany Italy Spain
France Inter (radio),	Interview with Robert Calcagno	France
Today in Seychelles, SBC TV & Radio, Seychelles Nation, Seychelles New Agency, TV 8 o'clock News, Paradise FM, Pure FM	8 main articles on the expedition (Interview Robert Calcagno, Inauguration Curieuse MEA, Visits of <i>S.A. Agulhas II</i> , H.S.H. Albert II official visit...)	Seychelles (Kreol, French and English languages)
Mauritius News, MBC, Télé Plus, le Mauricien, Lexpress.mu	5 main articles on the expedition (official visit on <i>S.A. Agulhas II</i> , interviews of scientists...)	Mauritius (Kreol, French and English languages)



250 news reports on the MEIO-2022 Expedition © Monaco Explorations

The coverage illustrated the extent of the interest generated by the actions carried out. Some publications appeared in media specialising in science and the environment, while others were aimed at a general audience. Coverage focused on key moments of the expedition, such as its launch and the official visit of H.S.H. Prince Albert II of Monaco, drawing particular attention to the efforts made to protect marine ecosystems in the Indian Ocean.

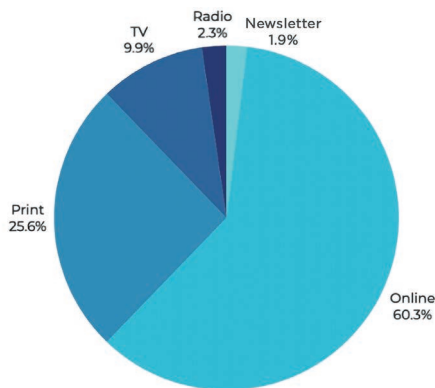


Figure 49: Distribution of communication tools

### 3.3.2.3. PARTNERSHIP WITH A PHOTO AGENCY

The partnership signed between Monaco Explorations and the Zeppelin photo agency enabled the production of high-quality content, such as photo reports and podcasts, broadcast through their own channels and via Monaco Explorations social networks. Topics included articles on *Saya de Malha, the green gold of the Mascarene Islands* and *the princely visit of the oceanographic vessel*. This partnership enhanced the quality of the visual content and its distribution to a wide audience.

### 3.3.2.4. SOCIAL NETWORKS AND ONLINE EVENTS

In addition, Monaco Explorations social networks played a key role in the communication strategy, with a strong presence that generated strong engagement, with a total of 15,000 interactions on the main platforms (Facebook, Instagram, Twitter). In 2023, 51 publications on LinkedIn generated more than 12,498 impressions, and Facebook recorded 3,192 impressions for 41 publications. A diverse audience was thus reached, from science enthusiasts to youngsters interested in marine exploration.

Highlights, such as the official visit of H.S.H. Prince Albert II, generated peaks in engagement (see [section 3.3.3](#)).

Interaction and active participation rates in online events (number of questions, comments, clicks, likes, time spent viewing content...) increased, with an average engagement rate<sup>11</sup> of 35% in 2023, compared to 30% in the previous year. This result reflects a higher degree of interaction and an audience more involved in the issues addressed by the expedition.

### 3.3.3. COMMUNICATION AND OUTREACH RELAYS

The implementation of the communication and outreach plan was also supported by the establishment of local relays, which enabled communication and outreach operations to be launched before the ship's stopovers.

Before the expedition, each scientific partner appointed a communication officer and an outreach officer to facilitate the widespread dissemination of information and smooth exchanges with the Monaco Explorations communication and mediation team.

The scientific partners also communicated about the expedition through their own networks throughout its duration and beyond:

#### BGC Argo team

The "Adopt a float" web site was initiated and enhanced by the media material collected during the expedition. The story of the floats and the research programme related to the float were disseminated by the "Adopt a float" team on board to the "Ocean Culture" community through the social networks:

- Twitter (@adoptafloat, @ERC\_REFINE): posts on the start of the expedition, deployments of the profiling floats, and the adopting classes, summary of the sessions in the "Adopt a float" classes.
- Instagram (@adoptafloat) posts and stories on the expedition and its sequences, people and life on board, oceanographic tools, ship, places.

The finalization of the new "Adopt a float" site during the expedition (and its continuous improvement thereafter) provided the team with a unique tool for getting involved in Ocean Literacy. Initially in English, the site was translated into French, and its usability and access to resources were improved.

#### Globice team

The target of Globice communication via the social media was the people generally interested in marine mammals and their protection, mainly on Réunion Island, in France and in the South-West Indian Ocean.

The social media platforms, and in particular Facebook and Instagram Globice pages, reaching respectively 22K and 5K followers, were the two different media used to communicate about activities conducted during the expedition.

Globice also communicated via the IndoCet network medias (website: [www.indocet.org](http://www.indocet.org), Newsletter, Webinar, etc.)

#### World Coral Conservatory team

The project conducted in Aldabra received extensive media coverage in both the local and national press. Articles were published in the following journals: Monaco Observer, Nice Matin, BFM Nice Côte d'Azur, Les Echos Planète (France and Monaco), lemauricien.com, Today in Seychelles, etc.

As for social networks, there were 106 publications (Twitter, Facebook and Instagram) reaching 214 people and 7,500 likes.

#### MADCAPS team

From the beginning of the project, different communication supports were created on Instagram (@best\_run), Facebook BESTRUN pages. For all publication, Monaco Explorations was identified to be followed: @explorationdemonaco or #edm, #oceanmonacoweek

Depending on the target, different tools of communication and outreach were used to communicate, educate,

<sup>11</sup> There are several methods for calculating engagement rates depending on the type of content and platform (Facebook, Instagram, Web, etc.). Generally speaking, to determine this, you need to divide the total number of interactions (shares, clicks, likes, etc.) by the number of users exposed to the post.

raise awareness, and consult with local, regional, and international stakeholders about the project to improve understanding of the waste issue and support

actions already in place. The onboard artist Chloé Thibault, [@la\\_petitechaloupe](#), produced a water-colour comic book printed in [250 copies](#).

SUPPORT	PUBLIC	EVENT	MEDIA
Post Communication	Large	Online	Instagram : <a href="#">@best_run</a>
Newsletter Article	Large	Online	<a href="#">Réunion La Première</a>
Talk presentation	Scientists	Ocean Monaco Week PhD defense	YouTube (1,2,3) <a href="#">PhD defense</a>
Exhibition	Large	Ocean Monaco Week Kelonia Museum	YouTube (1) Newsletter et reportage (1) Instagram : <a href="#">@la_petitechaloupe</a>
Website	Scientists	Online	<a href="#">IRD - Zeppelin - Collège - Académie</a>

### 3.3.4. CASE STUDIES ILLUSTRATING KEY MOMENTS IN OUTREACH AND COMMUNICATION

#### INAUGURATION OF THE CURIEUSE MARINE EDUCATIONAL AREA<sup>12</sup> (See [section 3.4.3](#)):

The inauguration of the Curieuse Marine Educational Area (MEA) was a highlight of the expedition.

This event took place on 28 October 2022 in the presence of representatives from Baie St-Anne, the Seychelles Ministries of the Environment and Education, the Seychelles Parks and Gardens Authority partner, Pascale Chabanet (IRD), the school principal and the pupils' parents. Dr Francis Marsac (IRD), represented Monaco Explorations, as the event took place before the arrival of *S.A. Agulhas II* in Seychelles.



Inauguration of the Ile Curieuse Marine Educational Area. 28 October 2022 © Nicolas Mathys - Zeppelin / Monaco Explorations

<sup>12</sup> Marine Educational Areas: created in 2012 in the Marquesas Islands, the Marine Educational Areas (MEAs) enable pupils and their teachers to manage a small coastal marine area in a participatory manner. The aim of this educational and eco-citizen approach is to raise young people's awareness of the need to protect the marine environment, and also to introduce them to the people involved (Source: Office Français de la Biodiversité: <https://www.ofb.gouv.fr/les-aires-marines-educatives>).

The inauguration was covered by local media and the Zeppelin agency, as well as on social media, reaching an audience of 50,000 people. Specific posts were published on social media platforms, drawing attention to the importance of marine conservation education. The presence of local stakeholders, policy makers and scientists reinforced the legitimacy and impact of this event.

The children involved in the project and their parents were welcomed on board *S.A. Agulhas II* on 31 October for a guided tour of the vessel and a workshop with artists Elise Rigot and Rémi Leroy. They made recordings of their sea stories, and they were introduced to illustration techniques.

#### **VISIT BY H.S.H. PRINCE ALBERT II OF MONACO:**

The visit of H.S.H. Prince Albert II of Monaco in October 2022 was a symbolic and strategic moment for the expedition. As a world leader recognised for his

commitment to ocean protection, Prince Albert II's presence reinforced the messages conveyed by the expedition, attracting the attention of international media and policymakers. The event was orchestrated to maximise its media and diplomatic impact.

The Prince's visit was widely covered in the international press, generating 15 articles in influential newspapers and magazines. This media coverage increased the visibility of the expedition, reaching an audience of several hundred thousand readers.

On social networks, Prince Albert II's visit was a resounding success in terms of engagement, with posts reaching 35,000 viewers on platforms such as Facebook, Instagram and Twitter. The content shared generated 5,000 interactions in the form of likes, comments and shares. The public showed increased interest in marine conservation issues, particularly through videos and photos capturing the Prince in the field, surrounded by scientists and local stakeholders.



H.S.H. Prince Albert II of Monaco during his visit on board *S.A. Agulhas II* in October 2022 © Nicolas Mathys - Zeppelin / Monaco Explorations

## 3.4. SCHOOL AND PUBLIC OUTREACH

### 3.4.1. 200 STUDENTS ATTENDED LIVE EXCHANGES WITH THE SHIP

Eight interactive sessions were organised from *S.A. Agulhas II* during operations at sea so that scientists, artists and facilitators could interact live with classes of different levels (primary, secondary and University) in France (Paris, Réunion), Monaco, and Seychelles, then gathering participants sometimes located thousands of kilometres from the vessel.

To strengthen the connection with the public and encourage dialogue between the public and those involved in the expedition, live broadcasts on social networks were a key tool.

The live interactive sessions were as follows:

- 16 October 2022: Fête de la Science, Paris, France. Hervé Claustre, co-chair of the international BGC Argo programme, discussed with the audience at Sorbonne University in Paris.
- 28 October 2022: children from the Oceano for All Club at the Monaco Oceanographic Museum (aged 8-10) discussed with the scientific teams from the BGC Argo, MADCAPS and the World Coral Conservatory projects.
- 7 November 2022: the 6<sup>th</sup> grade class from Lucet Langenier secondary school on Réunion Island

interacted with the MADCAPS team as part of an educational project on plastic pollution, with the professor Cécile Delebarre.

- 11 November 2022: Gaëla Huet's cycle 3 class from Cours St-Maur in Monaco discussed with the MADCAPS and BGC Argo teams and the two artists Rémi Leroy and Elise Rigot.
- 16 November 2022: Students in the "Conservation and enhancement of marine resources" Master's course at the University of Nice interacted with three of the scientists in charge of the study of the Saya de Malha Bank: Line Le Gall and Philippe Bouchet (MNHN) and Francis Marsac (IRD).
- 17 November 2022: English teacher Julie Wilson's 1<sup>st</sup> 1B pupils at Le Rebours High School in Paris talked to Bryan Wilson and Damaris Landers, two scientists working on the Coral Connect project.
- 21 November 2022: Another class led by the same teacher interacted with the two artists, Elise Rigot and Rémi Leroy.

On the same day, another live session took place between the team of young Seychellois researchers on board (Mariette Dine, Sheena Talma, Camilla Labonte and Rosabelle Mangroo) and Lynndinna Essack from Seychelles National Education Service in Victoria. The recordings of the live presentations were then used in several Seychelles classrooms.



Live broadcast on the ship side  
© Didier Théron - Monaco Explorations



Live broadcast on the public side  
© Michel Dagnino - Monaco Explorations

### 3.4.2. EDUCATIONAL ACTIVITIES AND VISITS ON BOARD DURING STOPOVERS

#### 500 PEOPLE WELCOMED FOR VISITS AND INTERACTIVE WORKSHOPS ON BOARD THE SHIP DURING STOPOVERS

At each port of call (Cape Town, Mauritius, Réunion, Seychelles, Mauritius, Cape Town) a total of about 500 people were welcomed on board *S.A. Agulhas II* for guided tours of the ship with school children and media and presentations to officials on the objectives of the expedition... These visits and workshops provided an ideal opportunity to bring together the media, decision-makers, researchers, artists, young people, teachers, and the general public. These exchanges between the various stakeholders facilitated the understanding of complex subjects and enabled a wide dissemination of the activities conducted during the expedition and its objectives.

The school groups welcomed on board took part in practical workshops linked to marine science, such as with the MADCAPS team on the theme of plastic pollution, or the BGC Argo team, who explained how the floats launched during the expedition were used to take the pulse of the Ocean and understand it better. During the art workshops conducted by the artists on board, they were also able to express their creativity, their relationship with the Ocean and their feelings.

Numerous researchers, including teams from Mauritius and Seychelles, as well as members of the ship's crew, contributed to the success of these onboard visits and workshops, passing on their knowledge and passion for the ocean and oceanography.

These activities helped raise awareness of marine conservation issues from an early age, while offering young students a unique immersive experience that will undoubtedly leave a lasting impression on them and contribute to the birth of marine vocations.



500 people welcomed on board *S.A. Agulhas II* for guided tours and workshops  
© Monaco Explorations



### 3.4.3. LONG TERM EDUCATIONAL PROGRAMMES

#### MORE THAN 550 PUPILS WITH THEIR TEACHERS INVOLVED IN LONG-TERM EDUCATIONAL ACTIVITIES (2022-2025)

The port calls provided also an opportunity for the outreach teams to establish lasting contacts with representatives of the national education systems and to present educational projects related to the research carried out during the expedition and the development of ocean knowledge. Educational programmes and actions were developed over time in Mauritius, Seychelles and Réunion, such as Adopt a float in 2022-23 and the Oceano for All educational competition, which in 2023-2024 saw significant participation from schools on these islands, with participation continuing into 2024-2025.

#### › The “Adopt a Float<sup>13</sup>” programme and its extensions (2022-2023)

Throughout the 2023 school year, the IMEV’s Adopt a Float outreach team supported two adoptive classes in Réunion, seven classes in Mauritius and one class in the Seychelles. This scientific outreach was conducted primarily with these school groups and visitors on board during the stopovers. The pupils and their teachers were able to follow the progress and movements of the BGC Argo float adopted by their class using data and information collected regularly via satellite link. This was an effective way of passing on important knowledge about how the ocean works. This work resulted in several presentations during which the pupils were able to give oral presentations on their work to IMEV scientists and the Monaco Explorations team.

This educational programme contributes to the BGC Argo project as a whole. Other activities, in line with those carried out during the expedition, are being organized “on an ongoing basis”.

#### › The “Oceano for All<sup>14</sup>” contest and its implementation (2022-2025)

A total of 20 classes from Mauritius, Seychelles and Réunion entered the 2023-2024 and 2024-2025 competitions and participated in the “Indian Ocean” category. Two classes from Réunion had already participated in 2022-2023 after visiting *S.A. Agulhas II* during her stopover in Réunion on 13 October 2022. The projects developed by the classes and presented in the competition were engaging and participatory: they ranged from the creation of an escape game to raising awareness of marine ecosystem issues, for example, on coastal restoration using endemic plants to prevent coastal erosion. Several classes won awards in the Indian Ocean category in these editions, demonstrating the motivation and quality of the educational projects implemented.

#### › The MADCAPS educational activities in Réunion Island (2022-2023)

Throughout the 2022-2023 school year, the MADCAPS scientific team supported a class from the Collège Quartier Français -Lucet Langenier in its participation in the “Oceano for All” competition. The students followed the different phases of the work carried out and were involved in the important stages of the project. They also had the opportunity to visit *S.A. Agulhas II* during its stopover in Réunion from 14 to 16 October 2022 and the possibility to follow the MADCAPS team by online meeting from Aldabra and Seychelles. The students produced a digital maritime book on plastic pollution and waste treatment, a creation that won them the competition (Overseas category). This digital maritime book was also exposed during one year at the Sea Turtle Rehabilitation Museum, Kelonia.

<sup>13</sup> Adopt a float is a multidisciplinary educational programme related to the scientific BGC Argo project that offers students the opportunity to explore the global ocean by tracking Argo BGC floats and to appreciate the importance of scientific research in order to better understand and protect it. <https://adoptafloat.com/accueil/>.

<sup>14</sup> The aim of the Oceano for All educational competition organized by the Oceanographic Institute of Monaco, institutional partner of Monaco Explorations, is to support teachers and their classes in discovering and understanding the Ocean and in implementing a collective social project for its protection, in line with the United Nations Sustainable Development Goals (SDGs) 13 - Climate Action and 14 - Life below Water. <https://musee.oceano.org/en/oceano-for-all/>

› **Follow-up to the Seychelles Marine Educational Area and the PAREO programme**

As part of the DIDEM project “Dialogue Science-Decision-Makers for the Integrated Management of the Coastal and Marine Environment” managed by the French National Research Institute for Sustainable Development (IRD) (see [section 1.8](#)), Monaco Explorations supported the PAREO (Patrimoine REcifal de l’Océan Indien entre nos mains) Programme’s Marine Educational Area (MEA) project in Seychelles, run throughout the Indian Ocean region by Pascale Chabanet and Lola Massé (IRD). Launched in January 2022 with the Baie St-Anne public primary school on Praslin Island, the programme began in May 2022 with around thirty sessions to raise awareness and pass on knowledge about the reef environment and the underwater fauna and flora of the Indian Ocean. The participants also went out to meet the people involved in the Marine Park - managers, fishermen, etc. - and produced reports and interviews, gradually assuming their role as involved and responsible stakeholders in the MEA. The sessions were held not only at the school but also included outings with flippers, mask and snorkel in the MEA itself located within the Curieuse Island Marine Park. Underwater cameras were also used

to make recordings so that the species encountered could be identified in class.

**EXTENSIONS OVER TIME**

Following the inauguration of the MEA in October 2022 (see [section 3.3.3](#)), the related activities in Seychelles resumed in March 2023 thanks to funding granted for phase 2 of the PAREO project (INTERREG V co-financed by Europe, France and the Réunion Region) for one school year until December 2023. During this second year of MEA activities, students worked on projects to raise awareness of plastics found on beaches and participated in an exchange of experiences with their Mauritian counterparts. Their achievements were presented during two days of PAREO project feedback in the Indian Ocean in Mauritius, in the presence of the Vice-President of the Republic.

Monaco Explorations then supported MEA activities until 30 June 2024, before new INTERREG funding was secured for 2025. The activities initiated in January 2022 have therefore been made permanent and now involve several classes at the Baie St-Anne school on Praslin Island.



Snorkelling activity. Discovery of the biodiversity of the Ile Curieuse Marine Education Area by children from Baie Ste-Anne school in Praslin, Seychelles © Lola Massé - IRD



## 3.5. ONBOARD TRAINING: A MAJOR OPPORTUNITY FOR STUDENTS AND YOUNG RESEARCHERS

### 3.5.1. THE ONBOARD SCHOOL

#### 30 YOUNG MARINE SCIENTISTS TRAINED IN FIELD SCIENCE

In addition to the outreach activities aimed at the general public, the Indian Ocean 2022 expedition included a high-level teaching component aimed at young researchers specializing in marine sciences. With a few adjustments to the teaching sequence, it proved possible to organize the practical module of the course on instrumentation and oceanographic data acquisition, as part of the curriculum of the Master's degree in Marine Sciences at Sorbonne University in Paris, during the leg between Réunion Island and Seychelles of the first part of the expedition. In addition to twelve students from the Master's programme and eight students from the European and International Master's in Marine Biological Resources (IMBRSea), five students and young researchers from Mauritius and five students and young researchers from Seychelles also took part in this onboard school.

The onboard school experience offered the students a unique immersion enabling them to learn oceanographic research first-hand. As well as preparing for the specific project they were asked to conduct as part of their teaching module, they were able to exchange ideas and work with the scientific teams, benefiting from the contributions of the project managers, technicians and operators involved in the expedition.

This onboard school was an ideal way to connect different disciplines by mobilizing and organizing theoretical knowledge to respond to concrete problems encountered.

As part of the IMBRSea master's degree and the Ocean Literacy specialization module, practical work directly linked to the onboard school and the expedition was also carried out. This involved developing an educational activity and educational resources for a young audience - kindergarten/early primary school.



Onboard school: learning about field research © Didier Théron - Monaco Explorations

### 3.5.2. TRAINING SESSIONS

#### STRENGTHEN ABILITY TO PROCESS MARINE DATA AND FIND A WAY IN GLOBAL OCEAN GOVERNANCE.

During the second leg, between Seychelles and Mauritius, three training sessions were organized for young researchers from Mauritius and Seychelles, as well as members of the various scientific teams. These training sessions enabled participants to acquire both technical and legal expertise, helping to strengthen their ability to process marine data and to find their way in global ocean governance.

They discussed the following topics:

1. **Processing and analyzing CTD data with Seasoft**, 16 November 2022, by Jean-François Ternon (IRD).

18 participants learned how to use Seasoft software to analyze CTD recordings, based on data collected during the expedition.

2. **Multidimensional scientific data processing**, 17-18 November 2022 by Francis Marsac, (IRD): 19 participants were trained in the use of NetCDF files to create oceanographic maps, manipulating four-dimensional files to visualize data such as bathymetry and marine currents.

3. **International law of the sea dealt** by Florence Galletti (IRD) in three workshops on 18, 19 and 20 November 2022, covering topics such as the division of ocean areas, the protection of remote marine environmental heritage, and the interactions between scientific research and international legal regimes.



Training session in the S.A. Agulhas II auditorium © Didier Théron - Monaco Explorations

## 3.6. GENERATING AND SHARING RESOURCES RELATED TO THE EXPEDITION

Various types of resources were generated by the expedition and the participants involved:

- Multimedia and audiovisual productions;

- Artistic productions and cultural resources;
- Scientific resources (see [section 3.7.1](#)).

This section details these various productions.



### 3.6.1. MULTI-MEDIA AND AUDIOVISUAL PRODUCTION: REPORTS, PODCASTS, DOCUMENTARIES, YOUTUBE CHANNEL

Content creation played a major role in communicating about and mediating the expedition. A huge amount of written and multimedia content was generated, including opinion pieces, photos and videos, scientific recordings and data, podcasts, reports, a newsletter and blog articles.

Here are some key figures:

1. More than 6 terabytes of photos and videos produced during the expedition, enriching the Monaco Explorations image bank.
2. Two series of podcasts: 11 podcasts of "*L'écho des labos*" by Stéphane Dugast and 8 podcasts of "*Les voix de l'Océan Indien*" by Élise Rigot, created to capture and share the highlights of the expedition, featuring the actions of the scientists on board. These podcasts include titles such as *Trois chercheurs d'excellente humeur*, *L'école de la mer* for "*L'écho des Labos*", or "*Petit matin à la Gigi*" et "*le Bénitier de Sundry*" for "*Les voix de l'Océan Indien*", which highlighted the day-to-day experience of the researchers or simply the beauty of the marine ecosystems studied and the feelings of some members of the expedition.
3. 11 video clips of 3 to 5 minutes, produced by Sylvain Péroumal during and immediately after the expedition to summarize and explain the various scientific activities carried out on board the ship.

4. 16 blog entries written by various people involved in the expedition: for some, these entries were an opportunity to share their feelings and impressions, while for others they were an opportunity to shed light on a fundamental subject.
5. 20 issues of *Saya de Malha Daily* newsletter.
6. A 20 min film-report in 2023 used during the feedback day of the expedition on 21 March 2023.

The distribution of this content was optimized through Monaco Explorations social networks and YouTube channel. These productions reached a wide audience, both during and after the expedition.

#### AN 88-MINUTE DOCUMENTARY

- › More than 1.2 million viewers for the screening of the expedition documentary

The documentary "Mission Saving Paradise - Expedition to the Last Treasures of the Indian Ocean " was one of the expedition flagship productions. Directed by Harald Pokieser and co-produced by Autentic and TV Monaco, this 88-minute film retraces the MEIO-2022 Expedition. It was broadcast on Arte TV (France and Germany) in October 2023 and reached more than 1.2 million viewers when it was first aired, with VOD access until January 2024 and repeat broadcasts continuing until April 2024. The documentary was presented by TV Monaco at MIPCOM 2023 in Cannes and then made available on their VOD platform (<https://videos.tvmonaco.com/content/au-coeur-des-atolls-de-locean-indien>). Other TV broadcasters included: ORF (Austria), RTHK (China Hong Kong), SRF (Switzerland) and TPBS (Thailand), The documentary was also procured by TCS World Travel, a US company specialized in luxury jet travels.



Harald Pokieser, director of the MEIO-2022 Expedition documentary,  
in discussion with his cameraman Sven Bender during filming © Didier Théron - Monaco Explorations

A screening was organized on 9 April 2024 as a side-event of the Second UN Ocean Decade Conference in Barcelona in the presence of H.S.H. Prince Albert II of Monaco, HE Mr Wavel Ramkalawan, President of the Republic of Seychelles and Mr Yutaka Michida, President of UNESCO's Intergovernmental Oceanographic Commission. 200 persons attended the screening.

The documentary was also screened at the 2024 Lumexplore Festival in La Ciotat (France) and at the 2024 International Environment Film Festival (FReDD) 2024 in Toulouse and Castres (France).



The poster of the documentary broadcast on Arte

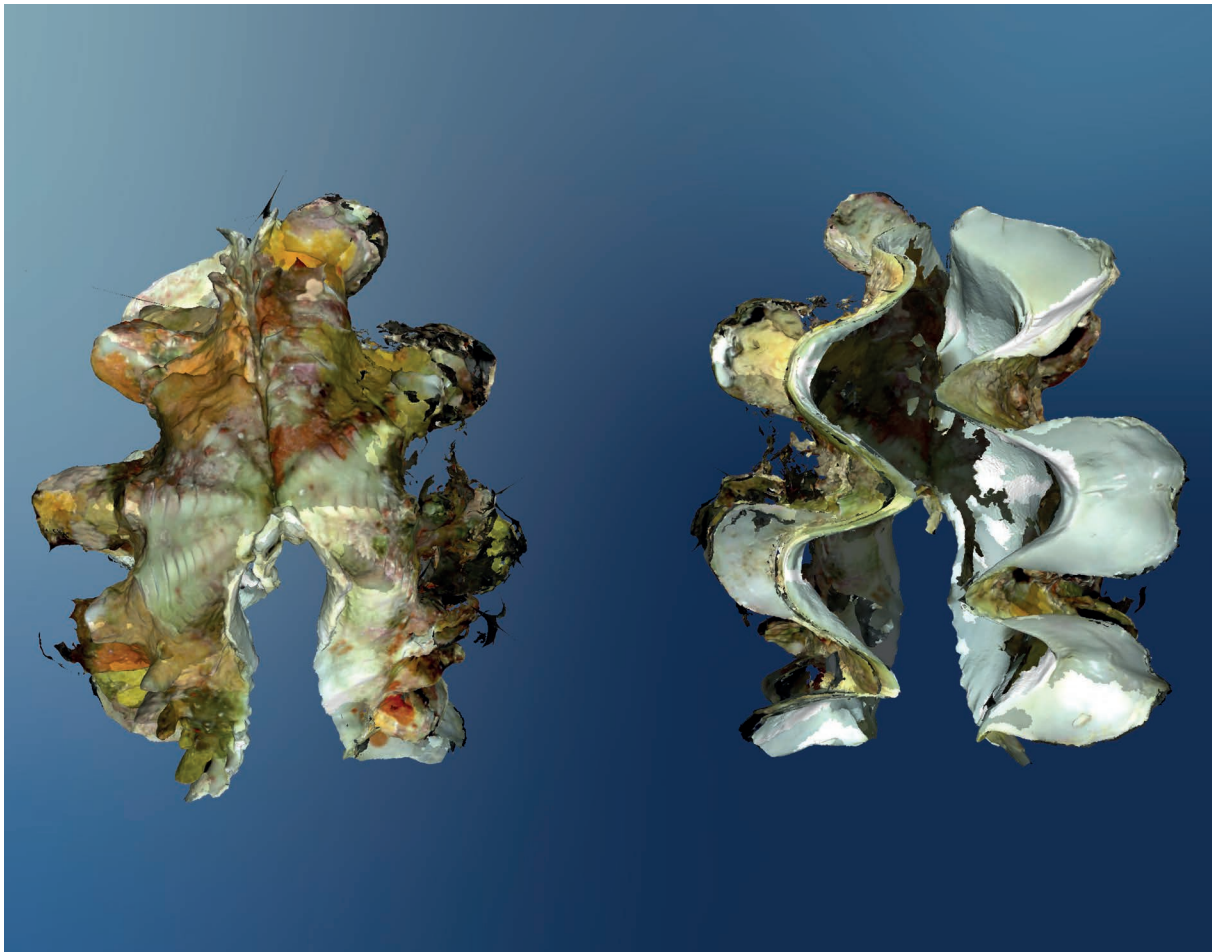
## 3.6.2. ARTISTIC PRODUCTION AND CULTURAL RESOURCES

### 3.6.2.1. THREE ARTISTS ON BOARD: A DIALOGUE BETWEEN ART AND SCIENCE

After examining the 56 applications received from all over the world at the end of 2021, in response to the call for expression of interest for the artists' residency on board *S.A. Agulhas II*, the selection committee, made up of leading figures from the Monegasque art world recommended to the Board of Directors of Monaco

Explorations the selection of Elise Rigot and Rémi Leroy to take part in the expedition:

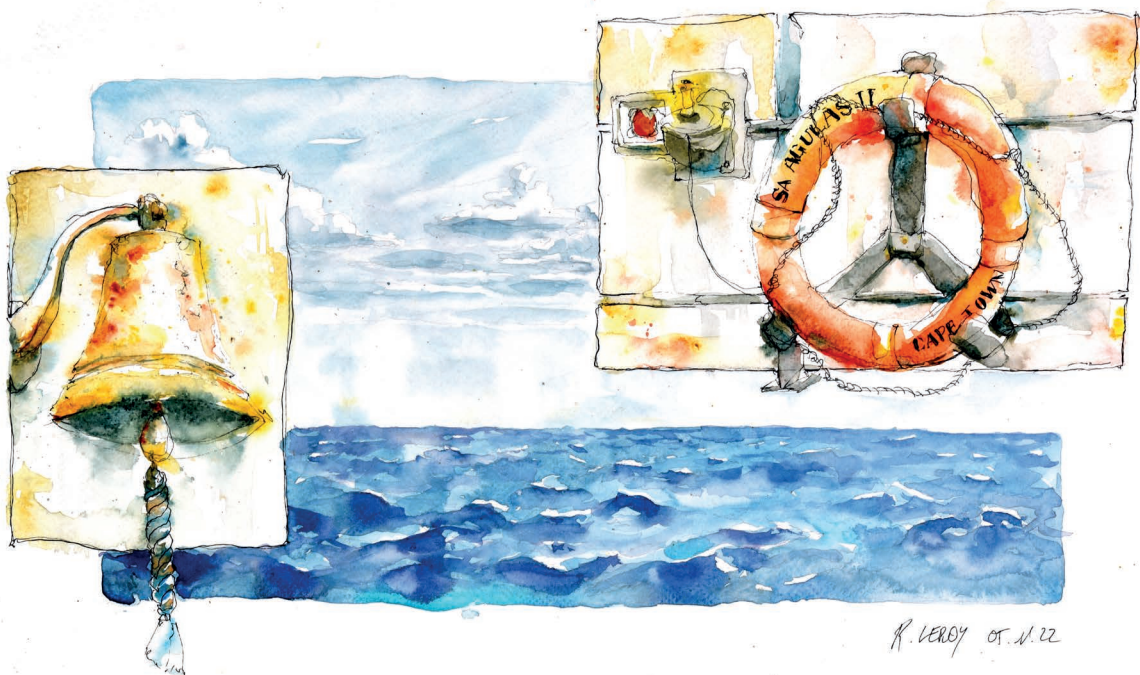
- Elise Rigot is a design researcher and 3D visual artist. Her artistic approach brings together marine biology, 3D technologies and media design. She documented the expedition using 3D footage, notebooks, drawings and watercolours, and captured soundscapes and personal accounts that were used to produce podcasts. The powerful experience of life on board also led her to write about it.



The Clam, 2023. Graphic composition and photogrammetric scans ©Elise Rigot - Monaco Explorations

- Rémi Leroy, notebook artist, watercolourist and draughtsman, was selected for his project involving a dialogue between Art and Science through illustrated stories. He produced 112 illustrations, a series of works directly inspired by the seascapes and human interactions he observed during the expedition.

Finally, two BGC-Argo floats provided to the governments of Mauritius and Seychelles by the Principality of Monaco were decorated by the artist. Invited by the artist to illustrate the symbolic representations associated with their country, some of the people on board took part in the creation of these "frescoes", which unfolded endlessly as they circled the floats.



The Gangway, 2022 ©Rémi Leroy - Monaco Explorations

- In parallel to the call for artistic residencies, the MADCAPS scientific team included another artist, Chloé Thibault Vanderlynden, who was also invited to join the expedition. The project of Chloé consisted of documenting the work of the MADCAPS team, also very active in raising awareness and

creating a comic strip recounting this scientific and human adventure (see [section 3.3.3](#)). Her creations were included into an exhibition at the museum Kelonia, Reunion Island, during 2023-2024. The comic book was printed into 250 copies and distributed to schools.



The Manta protocol, 2022 © Chloé Thibault - MADCAPS / Monaco Explorations

Through the presence and activities on board of these three artists, the intent was also to seek partnership, complementarity or association between artists and scientists. This interdisciplinary approach, combining Art and Science in the service of the same cause, the Ocean, helped create connections between a wide range of audiences, from young pupils to decision-makers.

During the expedition, and as they did during live broadcasts with schools or during visits on board and workshops, the artists on board also enthusiastically shared their creative processes, their creations on the spot and their technical and aesthetic choices with all those present on board: scientists, technical and supervisory staff and crew. This approach gave rise to some very rewarding exchanges between the various stakeholders during several presentations of the work on deck 7 of the ship.



Elise Rigot presents her creations on deck 7 of S.A. Agulhas II during the expedition © Nicolas Mathys - Zeppelin / Monaco Explorations

The feedback underlined the importance of this time of exchange to better understand the nature and implementation of the artistic approach on board, as well as the nature of the scientific approach, two different but not so far apart in their common objective of achieving a better understanding and perception of the world and of the major natural balances.

### 3.6.2.2. EXHIBITIONS

#### › The “*Regards croisés*” exhibition (collective creation)

#### 10,000 visitors for the “*Regards croisés*” exhibition

The “*Regards croisés*” (Multiple perspectives) photographic exhibition, retracing the highlights of the Indian Ocean expedition, was inaugurated

in Monaco on 21 March 2023 in the presence of H.S.H. Prince Albert II of Monaco. The idea behind this retrospective was to bring together the views of the various people involved in the expedition. Photographs by Nicolas Mathys and Filip Kulisev were displayed alongside works by artists Élise Rigot, Chloé Thibaut and Rémi Leroy. QR codes also enabled visitors to access podcasts created during the expedition by journalist Stéphane Dugast and visual artist Élise Rigot.

This exhibition was presented in the Conference Room of the Oceanographic Museum of Monaco from 27 March to 27 June 2023 and then installed on the railings of the St-Martin Gardens in Monaco Ville from 28 June to 31 August 2023.



Opening of the "Regards croisés" exhibition by H.S.H. Prince Albert II of Monaco.  
Conference Room of the Oceanographic Museum. 21 March 2023 © Michel Dagnino - Oceanographic Institute of Monaco

› **Exhibition "Retour d'expédition océan Indien, une expérience sensible" by Elise Rigot**

**The series of five corallines altars is now part of the permanent collections of MUDAC Museum in Lausanne**

Elise Rigot's creations from the Indian Ocean expedition were presented at the Halles de la Transition in Toulouse, France during the FReDD Festival in September 2023. For the occasion, the artist produced an installation (light, sound, wall hanging and sculptures) reflecting her sensitive experience of the expedition. Looking back on this experience, which she likes to describe as out of the ordinary, Élise Rigot worked to bring to life the being-in-the-world of corallines, encrusting algae that are particularly present on Saya de Malha Bank. In this exhibition, she devoted a series of five microarchitectures to them in the form of small altars, each accompanied by a literary text that combined scientific outreach, poetry and her work on the object. Each altar highlighted one of the coralline's properties: its ability to aggregate species as a world-rock, its very ancient geological time scale, the place where it was discovered: Saya de Malha... The series of five altars,

a tribute to the expedition's corallines, is now part of the collections of the *Musée cantonal de design et d'arts appliqués contemporains* (MUDAC), a museum in Lausanne, Switzerland.

She captured also the sounds, shapes, textures, atmospheres, stories and emotional attachments of researchers to the species they study.

Three other events showcased these creations and encouraged dialogue between the arts and sciences:

- In Toulouse, on 15 December 2023, during the study day "The power of the object".
- In Lausanne, Switzerland, on 23 May 2024, for the international conference "Beyond the Earth's Sorrows: Ways of Thinking, Artistic Practices and Commitments".
- In Sète, France, in June 2024, at the Ifremer Station, for the 16<sup>th</sup> symposium of the *Association française d'halieutique* on the theme "What paths to fair and sustainable exploitation of fisheries resources?"



Introduction to the exhibition 'Retour d'expédition océan Indien, une expérience sensible' in Toulouse © Elise Rigot - Monaco Explorations

› Exhibition "*Jeter l'encre*" by Remi Leroy

Rémi Leroy exhibited his work at two events for the general public:

- On **22 June 2023** at IMEV, on the occasion of the "Adopt a float" day attended by Sylvie Retailleau, the French Minister for Higher Education and Research, H.S.H. Prince Albert II of Monaco and Antoine Petit, Chairman and CEO of the National Centre of Scientific Research (CNRS). The drawings, grouped together under the name "Mission Océan Indien", were then displayed at the station for most of summer 2023.
- From **16 September to 16 October 2023** at the restaurant Les Perles de Monte-Carlo in Monaco. The exhibition, entitled "*Jeter l'encre*" ("Throwing ink"), was the subject of an article in the daily Monaco Matin.

For the sake of coherence and clarity, Rémi Leroy grouped his creations into five themes: the Aldabra Atoll, the Saya de Malha Bank, *S.A. Agulhas II*, the scientific programme and the human adventure. For each, a descriptive text in poetic language presented the context in which the illustrations were set. A final selection was made based on the aesthetic quality and iconographic relevance of the illustrations.



Exhibition Poster "*Jeter l'encre*" (Throwing ink)  
© Rémi Leroy - Monaco Explorations

› **Contribution of Chloé Thibault to the exhibition "Ziska kan torti / manz plastic!"**

As an artist member of the MADCAPS project, Chloé Thibault (La Petite Chaloupe) participated in the creation of this exhibition, which was developed by the scientific department of Kelonia, the Réunion Island Sea Turtle Rehabilitation and Care Center (whose director, Stéphane Ciccione, was a member of the GECOS project during the expedition). It was presented at the Kelonia Center from 1 July 2023, to 30 May 2024, and welcomed tens of thousands of visitors.

This exhibition brought visitors face to face with the reality of plastic pollution and illustrated its impact on sea turtles, the environment, and human health.

This exhibition was produced by Kelonia's Scientific Department, with Aktion (scenography), Cécile Jeancolas (editor), ABJ Réunion (structures and lighting), Béatrice Neirinckx-CanB, Chloé Thibault-La Petite Chaloupe, and the participation of students from the Pointe des Châteaux middle school and their art teacher, Virginie Salquèbre, thanks to financial support from the Réunion Region and SPL RMR. YouTube link: <https://www.youtube.com/watch?v=zPGwZEpSJA8&t=15s>

## 3.7. RESULT DISSEMINATION / PRESENTATIONS / SCIENTIFIC PUBLICATIONS

### 3.7.1. RESULT DISSEMINATION / SCIENTIFIC RESOURCES

#### 3.7.1.1. BASELINE STUDY 2022

In accordance with its terms of reference, the Advisory Committee developed a Baseline Study to support and guide the preparation and refinement of the Expedition programme. It was drafted from existing data and information and from communications provided by the Committee members to provide an assessment combining different perspectives: geography, oceanography, ecology, and policy and governance. A chapter about threats to biodiversity and associated measures was also included.

The final document was published in September 2022 and is available on Monaco Explorations website at: [EDM Baseline-Study-2022\\_final](#).

#### 3.7.1.2. FEEDBACK DAY IN MONACO

##### 1,250 PEOPLE ATTENDED THE FEEDBACK DAY ON 21 MARCH 2023

The first results and perspectives of the expedition were discussed at a hybrid event organized on 21 March 2023 during the annual Monaco Ocean Week at the Oceanographic Museum of Monaco. About 150 participants attended on site and more than 1,100 connections to the live feed were registered.

The event was moderated by Carl Gustav Lundin, Advisor, Mission Blue, and Chair of the Expedition Advisory Committee. It began with a 20-min video summary of the expedition produced by Sylvain Peroumal (<https://youtu.be/Be-QsW4y2w4>) followed by a review of the importance of regional knowledge and cooperation in the South-West Indian Ocean complex geostrategic and socio-economic context and an overview of the expedition itself. Next, a high-level sequence in the presence of H.S.H. Prince Albert II of Monaco included the views from Mauritius, by Dr M Rezah Badal, Director General of the Department for Continental Shelf, Maritime Zones Administration and Exploration, Prime Minister's Office and from Seychelles, by Mr. Jean François Ferrari, Designated Minister, Minister of Fisheries and the Blue Economy, and the visit of an artistic and photographic exhibition displayed around the Conference Hall to evoke the key moments, places and atmospheres that characterized the expedition (see [section 3.6.2.2](#)).

An overview of the UN Ocean Decade and of the IIOE-2 under which the expedition was conducted followed. Then, the teacher and the pupils of a Monaco primary school that had participated in a live session with the artists and the scientists during the expedition shared their experience in their own touching words.

A roundtable devoted to the "The invisible island - Saya de Malha" discussed the first results of the investigation of this area in terms of physical, chemical and biological oceanography, bottom characteristics and benthic biodiversity. It concluded the morning session.

The first roundtable of the afternoon session discussed the benefit of the onboard school on oceanographic instrumentation and data processing that had taken place during the first part of the expedition between Réunion and Seychelles. The second roundtable considered the preliminary results of the different investigations that were conducted around the “Visible Islands” of Aldabra and Saint Brandon.

Outreach panels punctuated the day, along with presentations of the preliminary scientific results by the different research teams. In addition to the 300 people present in the room, 2,800 people followed the live broadcast on Facebook, demonstrating the expedition impact on social networks and the interest generated by the expedition.

A video summary of the event is available here: <https://youtu.be/D4KKJWgsDk0>.



Feedback Day on 21 March 2023 © Monaco Explorations

### 3.7.1.3. PRELIMINARY REPORT 2023

Each scientific project leader produced an intermediate report six months after the end of the expedition. These reports were compiled to form a preliminary overall expedition report. This preliminary report was distributed at the end of 2023 to the coastal States (Seychelles, Mauritius, and France) through diplomatic channels, then communicated to all partners.

This Preliminary report is available on the Monaco Explorations website:

[https://www.monacoexplorations.org/wp-content/uploads/2023/10/2023-08\\_EDM\\_Preliminary-Report-2023\\_A4\\_Final\\_BD.pdf](https://www.monacoexplorations.org/wp-content/uploads/2023/10/2023-08_EDM_Preliminary-Report-2023_A4_Final_BD.pdf).

### 3.7.1.4. FINAL SCIENTIFIC REPORTS 2024

The final scientific reports were submitted to Monaco Explorations by the leaders of each project during 2024. They bring together the results of the extensive fieldwork carried out during the expedition. These results are used and appears in this final report.

### 3.7.1.5. DATABASES (OPEN DATA)

See [Appendix I](#).

## 3.7.2. PRESENTATIONS

Various presentations have been given since the end of the expedition in 2022 and in subsequent years by the scientists who took part in the expedition. These

events provided them with an opportunity to present and promote their work, as well as to highlight the importance of the expedition.

### 3.7.2.1. SAYA DE MALHA

22 November 2022, Mauritius: Oral presentation (by F. Marsac) to describe the work done during Leg 2 of the MEIO expedition, before the Vice President of the Republic of Seychelles, the Minister of Fisheries and the Blue Economy, and other officials, onboard *S.A. Agulhas II*.

29 November 2023 (online): Oral presentation (by F. Marsac) before the Commission of the Saya de Malha Joint Management Area. Focus on the research and preliminary results from the Saya de Malha bank, and potential interest for a shared governance of the area between Seychelles and Mauritius.

02 February 2023, Seychelles: Oral presentation (by F. Marsac) to highlight the outcomes of the MEIO expedition before the Minister of Fisheries and Blue Economy of Seychelles, officials of the government, and general public, including students, in presence of M. Robert Calcagno, CEO of the Monaco Explorations, at the SITE auditorium, Mont Fleuri, Seychelles. Several of the early career scientists from Seychelles who were on the ship also presented their research activities. This event was coupled with the launching of the Seychellois Scientists Society.

07 February 2023, Australia: Overview of the expedition presented by F. Marsac at the International Indian Ocean conference 2023, Perth, Australia.

30 January 2025, France: Oral presentations by Hervé Claustre (Institut de la Mer, Villefranche), Olivier Brunel (Oceanographic Institute of Monaco), Francis Marsac (IRD), Didier Théron and Xavier Prache (Monaco Explorations) presenting several projects of the expedition. The event was organised in the framework of the “Sciences sur Mer” conference cycles. A round table with the public to exchange views followed the presentations.

### 3.7.2.2. MADCAPS

The project was included into different global talk presentations on plastic pollution by Margot Thibault:

10 March 2023, La Réunion MT180 regional final: «Où s'accumule le plastique dans l'océan Indien ?» <https://www.youtube.com/watch?v=hilta0zLiTU>

30 September 2023, La Réunion “Zero Waste Event”: “A plastic patch in the Indian Ocean”

16 February 2024, La Réunion, PhD defense: Composition, abundance, origin and distribution of plastic pollution accumulated in the Southern Indian Ocean gyre. <https://www.youtube.com/watch?v=WyFFj10T9I>

20 February 2025, La Réunion, BIOECOTROP University of La Reunion: “Un patch de plastique dans l'océan Indien?”

27 November 2025, La Réunion, Jeudi du CIROY: “Un ring de boxe à la surface des plastiques, projet MADCAPS» <https://cyroi.re/jeudi-du-cyroi-pollution-plastique-et-recifs-coralliens-plongee-au-coeur-du-projet-madcaps/>

### 3.7.2.3. GECOS

An overview of the project was presented during the 12<sup>th</sup> WIOMSA Scientific Symposium, 10-15 October 2022, at a workshop dedicated to the Marine Turtle Task Force of the Western Indian Ocean (WIO-MTTF), bringing together marine turtle specialists from this region of the Indian Ocean. The aim here was not to promote the project, but to indicate the type of research being carried out on marine turtles in the region.

### 3.7.2.4. 4SEA

The data collected during the expedition was used to generate analyses (bathymetric maps, digital elevation models, orthophotographs) of the Aldabra site. These analyses were promoted through a popularisation video, a methodological description article, and presentations at international and national events:

- SEAS-OI Station (Réunion, France, November 2022): workshop on photogrammetry tools.
- GEOHAB 2023 Conference (Réunion, France, May 2023): oral presentation available with a DOI at <https://doi.org/10.5281/zenodo.7923093>.
- IHSM Workshop (Toliara, Madagascar, May 2023): oral presentations on data acquisition and image processing techniques using photogrammetry and deep learning available with a DOI at <https://doi.org/10.5281/zenodo.7928814>.



### 3.7.2.5. BGC-ARGO

Some of the results acquired during the expedition or later by profiling floats were presented at relevant meetings:

- Adopt a float event, Villefranche-sur-Mer, France (Ocean Science Day) 22 June 2023.
- GO-GBC/BGC-Argo Science Workshop, Boston, USA. 21-23 August 2023.
- United Nations Framework Convention on Climate Change (UNFCCC) COP 28, Dubai, United Arab Emirates, 30 November-12 December 2023.
- 25<sup>th</sup> Argo Steering Team Meeting, Southampton, United Kingdom, 18-22 March 2024.

### 3.7.2.6. SSD-SVP

The results were presented at two IIOE-2 related events:

- 6-9 February 2023: Reporting at IIOE-2 Steering Committee Meeting No 6, Perth, Australia.
- 13 July 2023: Presentation in 'IIOE-2' Session of the IAPSO Symposium at IUGG 2023 Berlin.

### 3.7.2.7. WORLD CORAL CONSERVATORY

An oral presentation of the project was given by Olivier BRUNEL at the 11<sup>th</sup> International Aquarium Congress (IAC), held in Nausicaa, Boulogne sur Mer, France in November 2022.

### 3.7.2.8. CORAL CONNECT

The following presentations and panel discussions were delivered that featured the expedition:

- 01 February 2024. Heather Koldewey. Challenge 2: Protect and restore ecosystems and biodiversity. Indian Ocean Region Decade Collaborative Centre conference, Hyderabad, India.
- 27 February 2024. Heather Koldewey. Bertarelli Foundation's Marine Science Programme. Chagos Archipelago MPA workshop, Mauritius.
- 19 March 2024. Heather Koldewey. Coral Connect update. Monaco Explorations meeting. Monaco Ocean Week, Monaco.

- 22 March 2024. Heather Koldewey. Challenges and Opportunities in Indian Ocean Conservation. University of Exeter, Penryn campus.
- 4 April 2024. Bryan Wilson. Chagos Brain Coral. Chagos Conservation Trust Annual General Meeting, Royal Geographical Society, London.
- 9 April 2024. Heather Koldewey. Panellist Enhancing coastal resilience in the Indian Ocean region. IOCINDIO event at the UN Ocean Decade Conference.
- 10 April 2024. Heather Koldewey. Panellist Bridging billions to Barcelona: the Indian Ocean event. INCOIS event at the UN Ocean Decade Conference, Barcelona.

### 3.7.2.9. GLOBICE MEGAFUNA

Globice promoted the NeMMO initiative, to which the expedition contributed, on two occasions:

- A poster was presented at the Conference of the European Cetacean Society, Azores, 12-15 May 2025: Dulau *et al.*, 2025: A new regional cetacean visual survey initiative in the South-Western Indian Ocean: welcome to the Network of Marine Mammal Observers of IndoCet.
- An oral presentation providing an update of the regional database, during the IndoCet Special Session of the 13<sup>th</sup> WIOMSA Scientific Symposium, 3 October 2025.

## 3.7.3. SCIENTIFIC PUBLICATIONS

### 3.7.3.1. SPECIAL ISSUE OF A SCIENTIFIC JOURNAL: DEEP SEA RESEARCH PART II

At its 12<sup>th</sup> meeting on 22 March 2023, the Expedition Advisory Committee agreed to plan a special issue of a reputed scientific journal to encompass the whole expedition and add value to separate publications based on the different projects. A publication group composed of members of the Committee and project leaders was established to carry out this project. First a summary was developed to approach different journals, discuss their conditions, and select the most attractive solution in terms of accessibility, readership, impact factor, and cost.

This deliberation process ultimately led to the selection of the international journal *Deep Sea Research Part II: Topical Studies on Oceanography*.

Not all projects of the expedition resulted in a research article in *Deep Sea Research Part II*. Two or three articles will be published later in other journals. The deadline for acceptance was 20 October 2025. The special issue, entitled 'The Monaco Explorations Indian Ocean Expedition 2022: advancing scientific interactions in the Mascarene region' includes eight articles presented in an editorial, as follows:

Editorial paper: **Advancing scientific interactions in the Mascarene Basin and Plateau to support ocean governance**, Marsac, F., Bessero, G., Bhagooli, R., Claustre, H., Sorry, A., Simard, F.

Bourjea, J., Schull, Q., Lapègue, S. *et al.* **Temporal stability in genetic origin of juvenile green turtle recruits at remote western Indian Ocean islands**

Brunel, O., Barthelemy, D., Janse, M. *et al.* **Establishment of a Global Coral Biobank: Implementation of the protocols from coral collection to long distance shipping and long-term maintenance in public aquariums**

Corbari, L., Bouchet, P., Le Gall, L. *et al.* **New insights in benthic biodiversity of the Saya de Malha Bank**

Gordon, N., Noyon, M., Kaullysing, D. *et al.* **Distribution and drivers of phytoplankton biomass along the Saya de Malha Bank in the Western Indian Ocean**

Munbodhe, V., Ramah, S., Kaullysing, D. *et al.* **Variable photosystem II thermal stress responses of reef-building corals *Pocillopora indiana* and *Heliopora coerulea* across latitudes from the Mascarene Plateau, Indian Ocean**

Riom, W., Taillandier, V., Dimier, C., D'Ortenzio, F. Claustre, H. **Biogeochemical float deployment strategy in the Southwestern Indian Ocean**

Marillac, V., Jourand P., Stenger, P-L., *et al.* **Plastic pollution: a potential vector for both pathogens and probiotics for corals on the Mascarene Ridge, Indian Ocean**

Théron, D., Gasquy, O., Simard, F. *et al.* **Awareness raising, communication methods and objectives for an ocean expedition: the example of the Monaco Explorations Indian Ocean Expedition 2022.**

The papers are accessible on the Deep Sea Research Part II web page (<https://www.sciencedirect.com/special-issue/1092P6TN79Q>). They will remain on free access for a period of one year, after which they will only be accessible by subscription to the journal. Printed copies of the special issue will also be produced for communication purposes.

### 3.7.3.2. OTHER SCIENTIFIC PUBLICATIONS

Two taxonomic papers were published outside the Special Issue. The first one (2023) described a new species of shrimp, of the *Stenopus* genera. Only a juvenile stage had been observed previously but the adult stage was required to confirm the new finding. The only adult specimen was collected on Saya de Malha by the expedition. The second taxonomic paper (2025) was about a crab which was rediscovered on Saya de Malha by the expedition, after over a century without records.

Chen, C-L., Chan, T-Y. (2023). **The use of three-dimensional uCT imaging technique in the description of a new species of *Stenopus* Latreille, 1819 (Decapoda: Stenopodidea: Stenopodidae), with a revised key to the species of *Stenopus*.** *Journal of Crustacean Biology*, 43, 1-12

Galil, B. (2025). **Long time no see – 117 years after its first and only record *Praebebalia extensiva* Rathbun 1911 (Decapoda, Leucosiidae) was collected from Saya de Malha.** *WIO Journal of Marine Science* 24(1): 39-42.

Macpherson, E., Machordom, A. (2025). **Squat lobsters (Decapoda: Chirostyloidea and Galatheaidea) from Saya de Malha Bank, SW Indian Ocean, with the descriptions of three new species.** *European Journal of Taxonomy*, 1012: 27-48

Two other articles were published in newsletters of international programmes:

Bessero, G. (2022). **Monaco Explorations "Indian Ocean Expedition"**. IIOE-2 Newsletter, Vol 6, Issue 10, October 2022, 1-2.

Marsac, F. and Bessero, G. (2023). **The Monaco Explorations research voyage in the South-western Indian Ocean.** *The Indian Ocean Bubble*, Issue 17 July 2023, International Indian Ocean Expedition, 15-18.



## 3.8. DIDEM RELATED ACTIVITIES

### 3.8.1. COMPONENT A OF THE DIDEM PROJECT INCLUDING HIGH SEAS, REMOTE AND/OR DEEP SEABED [HS/RS/DS] & ABNJ: TOOLS TO BRING SCIENTIFIC KNOWLEDGE TO DECISION-MAKERS

The “Dialogue Science-Decision Makers for Integrated Management of Coastal and Marine Environment” Project, known as the DiDEM project led by IRD (see [section 1.8](#)), proposed a participatory and inclusive response to the issues of Science-Decision dialogue related to ocean and coastal governance in several countries of the Western Indian Ocean: Comoros, Madagascar, Mauritius, Mozambique, Seychelles, Tanzania, Kenya.

The project started officially on 7 January 2021 for a period of 3 years, then extended to 4 years. The project chose to focus on three types of ecosystems, deploying its activities in three large Workshop Zones (ZAs): islands and archipelagos, the deltas of the Mozambique Channel and those further north in the Indian Ocean, the high seas, the deep and distant seabed, which includes international waters, the deep ocean and the seamounts of the ocean basin, particularly in order to “A/ Deploy innovative methodologies and tools for decision support to WIO decision makers”; and “B/Train experts who can advise local decision-makers”.

These objectives include the component “**High Seas, Remote and/or Deep Seabed [HS/RS/DS] & Areas beyond national jurisdiction ABNJ**” led by Florence Galletti - scientific co-coordinator and referent, assisted by Jean François Ternon - referent.

This component benefited from the support of several funders: IRD, France, the French Facility for Global Environment (FFEM, France), United Nations Development Programme UNDP through the SAPPHIRE programme with which the component shares topics of interest (JMA as a demonstration project inside the Western Indian Ocean Large Marine Ecosystems Strategic Action Programme Policy Harmonisation and Institutional Reforms “WIO LME SAPPHIRE” executed by the Nairobi Convention), and Monaco Explorations.

The component linked also with related opportunities and mechanisms, specifically the Nairobi Convention communication team and secretariat, involved with the communication. The Western Indian Ocean Marine Science Association (WIOMSA), that has a very established system to get information out in the region as well, was also approached.

The expedition was presented at the mini-symposium dedicated to “The contribution of marine sciences in areas of the Western Indian Ocean (WIO) beyond national jurisdiction to the development of a regional ocean governance strategy”, hosted by the 12<sup>th</sup> WIOMSA Scientific Symposium. On this occasion, the establishment of a network of researchers working on National Or International SEamounts, banks and submarine structures was announced (NOISE). Supposed to be co-hosted both by a researcher in social sciences and a researcher in marine sciences, the network is based on political neutrality, voluntary commitment, free of charge membership, and non-profit operations. As such, it was launched on 11 October 2022, for an initial duration of two years. In 2024, an option to extend the initiative by another year (2025) was requested, agreed, and then funded by Monaco Explorations.



Meeting of the future members of the WIO N.O.I.S.E. network at the 12<sup>th</sup> WIOMSA Scientific Symposium, 12 October 2022. From left to right: Jean-François Ternon, IRD, Deepeeka Kaulysing, University of Mauritius (UOM), Ranjeet Bhagooli, UOM, Florence Galletti, IRD, Francis Marsac IRD, Sundy Ramah, Mauritius' Ministry of Blue Economy, Marine Resources, Fisheries and Shipping, Arshad Rawat, Department for Continental Shelf, Maritime Zones Administration and Exploration, Mauritius' Prime Minister's Office © IRD.

The importance of the topic results from the large number of seamounts concentrated along the South-West Indian Ridge, on the Mozambique Plateau and on the plateau that extends over 1,100 km south of Madagascar (Madagascar Ridge, Walters Shoal, etc.), to the north of Madagascar and to the north of Mauritius, and as far as Seychelles, the Mascarene Plateau (from south to north, Saint Brandon, Nazareth and Saya de Malha Banks, etc.). Many of them are probably remarkable in many ways: abundant biodiversity, concentration of preys for predators, waypoints in the displacement of migratory species, vulnerable marine ecosystems (VMEs). Because of their supposed biological abundance and richness (fishing operations are common), sometimes because of their potential mineral resources, these structures are of interest to many operators. This can threaten their specific ecosystems. The legal protection, by means of in the form of a governance framework to regulate exploitation of these features is lacking. At least it would be insufficient, except for regulations related to some benthic fisheries (e.g. SIOFA conservation and management measures [CMM]), the JMA and marine spatial planning exercises subject to further additions to acts and regulations.

Advanced ecological knowledge, based on data collected during this expedition is expected to inform science-based conservation and encourage the coastal States (action within EEZ and continental shelf, action within bilateral agreements, and multilateral strategies/actions) to engage any form of network's prescriptive protections on sites. Such remote sites are partially documented by the WIO LME SAPPHERE programme, by the identification of Ecologically or Biologically Significant Marine Areas (EBSA), or by previous WIO research cruises.

The objective of the network is:

- 1) to bring together oceanographic and legal sciences, and
- 2) characterize the ecological features and legal status of these areas, in order
- 3) to inform a responsible public decision-making process.

The WIO N.O.I.S.E. initiative was strengthened during the second part of the cruise on the Saya de Malha Bank, with a first post-launching meeting, organized on board. The second meeting took place in Monaco on 30 March 2023;

it marked the start of planning for the first scientific workshop of the network. To keep the momentum, this workshop was organized in Mauritius from 3 to 5 May 2023 to gather the main parties to the expedition and consolidate their collaborations. The workshop was hosted and strongly supported by the Department for Continental Shelf, Maritime Zones Administration and Exploration (CSMZAE), with authorization of the Prime Minister's Office, and by the University of Mauritius (UOM). The first two days gathered about 40 participants from France (mainland, Réunion Island), Mauritius, Seychelles, and Madagascar. With more than 30 presentations, the meeting, covered four themes: (1)

marine and legal sciences interaction, (2) science support to Marine Spatial Planning, (3) importance of physical and biological in situ data for public and conservation actions, (4) marine and coastal connectivity. The second part of the workshop on the third day was hosted at the UOM, in a slightly more pedagogical way, less marked by expertise. Forty students and scientists, attentive to marine science, economics, coastal law, and law of the sea, attended the presentations and shared their experiences of ocean cruises and research projects. The backdrop was the management and conservation issues faced by policy makers, as an introduction to science-to-policy dialogue.



WIO NOISE working group in Mauritius, May 2023 © Sundy Ramah.

The latest workshop funded by Monaco Explorations took place on 10 and 11 November 2025 in Mauritius. Members of the WIO-NOISE group drew up a list of 43 recommendations and proposed concrete measures to facilitate effective decision-making by policymakers, based on the use of scientific findings. These recommendations were presented at the 'Science to Policy' experts workshop held in Mauritius from 12 to 14 November 2025, following this first workshop. Most of them were taken into account in the final recommendations of this report.

### 3.8.2. COMPONENT B OF THE DIDEM PROGRAMME: CAPACITY BUILDING AND TRAINING

Several meetings took place in 2023 between Monaco Explorations and IRD representatives, responsible for organizing a thematic school in the Seychelles. Initially planned in 2023, this school, with the theme "Vulnerability of Recifal Heritage," took place from 10 to 15 June 2024, on the island of Mahé. It was aimed at scientists from the Indian Ocean, young doctoral students and above, as well as MPA managers, NGOs, local actors, and decision-makers. Several expedition participants were present as presenter or participant.

For this session in Seychelles, the school was hosted by the James Michel Blue Economy Research Institute of the University of Seychelles, whose Dean Dr. Michael Hall gave the introductory speech. This was followed by an introductory speech by Mr Xavier Prache, Director of Monaco Explorations, to set the scene.

The main objective of this school was to compare the different knowledge, representations and methods of different disciplines concerning:

- assessment of reef ecosystem resilience,
- consideration of coral reefs as a natural heritage,
- the construction of a coral socio-ecological system.

Through an integrated approach, the ultimate aim is to make coral reef heritage a transversal element of analysis and management.

As is the case with each thematic school, this session provided an opportunity for **exchange and transmission of theoretical and practical knowledge**. It was an effective, unifying tool for strengthening participants' knowledge and skills, and building a community of coastal practitioners in the Indian Ocean Islands (*Koenig et al., 2025*).

Today, to achieve ecosystem resilience and restoration objectives, it is becoming necessary to combine skills and know-how, and to learn from different sectors' expertise by combining different viewpoints and analyses. This is the very essence of these thematic schools.



Thematic school, 2024 © DR

### 3.8.3. COMPONENT C OF THE DIDEM PROGRAMME: RAISE AWARENESS AMONG CIVIL SOCIETY AND CHILDREN

#### 3.8.3.1. MARINE EDUCATIONAL AREA IN SEYCHELLES. PAREO PROGRAMME

See [sections 3.3.4](#) and [3.4.3](#).

#### 3.8.3.2. THE FUTURE OF PLASTIC WASTE

Two of the three projects selected in 2021 to receive support under this programme began in March/April 2022 (Collect-connect and Recycling Machine). It subsequently became apparent that their implementation was contingent on the acquisition of additional funds, which could not be found. This was also the case for the third selected project (Awareness campaign).



## 3.9. DISCUSSION

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The expedition perfectly illustrates the scope and importance of Ocean Literacy in the current context of growing environmental pressures on the Ocean. The overall objective is to promote a shared deeper and intimate understanding of the Ocean, not only as an essential component of the Earth system, but also as a common good that is intimately interconnected with human societies. This knowledge, which is scientific, cultural and emotional, is the essential foundation for inspiring responsible behaviour and acting collectively for the conservation and sustainable management of marine environments.

By integrating a combined approach of scientific research, environmental diplomacy and sensibilisation, the expedition has made it possible to disseminate knowledge in formats accessible to the various target audiences.

The quantitative and qualitative assessment of this combined approach shows an emotional and civic engagement with the ocean, a willingness to get involved and a lasting commitment that suggest that the objectives have been at least partially achieved.

More details on this assessment are provided in an article published in *Deep Sea Research Part II* (Théron et al., 2025), in particular chapters 5.3 to 8.

# 4. POLICY AND GOVERNANCE

## 4.1. DIPLOMATIC ARRANGEMENTS

Following a round of discussions with the focal points designated by the Governments of Mauritius and Seychelles, the outline of the expedition and a preliminary plan were submitted to both Governments in November 2021. Requests for consent to conduct marine scientific research in maritime areas under the jurisdiction of France, Mauritius Seychelles and the joint management area (JMA) authority for the extension of the Saya de Malha continental shelf, were prepared with the scientific partners and finalised with the focal points designated by Mauritius and Seychelles. They were submitted through diplomatic channels in March 2022.

In accordance with the guidance of the Prince Cabinet, an initial framework for the visit of H.S.H. the Sovereign Prince to Seychelles during the expedition was set during Monaco Ocean Week 2022 (21 to 25 March) with the delegation representing Seychelles led by Mr. Jean-François Ferrari, Designated Minister, Minister for Fisheries and the Blue Economy.

H.S.H. the Sovereign Prince was officially invited to visit Seychelles on 7 April by the President of the Republic of Seychelles and Mauritius on 1 June by the Prime Minister of the Republic of Mauritius. Only the first invitation could be accepted within the timeframe of the expedition, considering the busy schedule of the Prince.

The diplomatic approach initiated in 2021 to include the chartering of *S.A. Agulhas II* in the scope of the cooperation between South Africa and Monaco was not

successful. It was not possible to obtain the participation of the South African Navy Hydrographic Office in the expedition.

After discussions with the executive secretariat of the Southern Indian Ocean Fisheries Agreement (SIOFA) and via the Seychelles delegation, the expedition was presented on 23 March at the 7<sup>th</sup> meeting of the Scientific Committee of the Agreement. On the recommendation Committee, the 9<sup>th</sup> Meeting of the Parties held in July expressed its support for the project.

Discussions on the requests for consent to conduct marine scientific research led to three memorandums of understanding aimed at developing develop cooperation in the field of fundamental and basic and applied marine research, which were signed respectively with:

- the Department for Continental Shelf, Maritime Zones Administration and Exploration (CSMZAE), Prime Minister's Office of the Republic of Mauritius;
- the Government of the Republic of Seychelles, represented by the Department of Blue Economy;
- the Saya de Malha Management Authority.

Within this framework, Monaco Explorations took charge of the acquisition of two Argo floats for donation to Mauritius and Seychelles with a view to deployment to contribute to the BGC-Argo project during the expedition.

## 4.2. VISIT OF H.S.H. PRINCE ALBERT II OF MONACO

The diplomatic highlight of the expedition was the visit to the region by H.S.H. Prince Albert II of Monaco from 24 to 26 October. The Prince and His delegation were welcomed in Seychelles on the morning of 24 October by Mr. Sylvestre Radegonde, Minister of Foreign Affairs and Tourism. Together with a Seychelles delegation led by Mr. Jean-François Ferrari, Designated Minister and Minister for Fisheries and the Blue Economy, accompanied by

Mr. Flavien Joubert, Minister for Agriculture, Climate Change and the Environment, they visited the island of Aldabra. Their stay on the island, until late afternoon of 25 October was devoted to exploring the island and discussing possible actions with the Seychelles Islands Foundation and the Government of Seychelles. The visit ended with the signing of a scientific collaboration agreement between the Seychelles Islands Foundation;

the Scientific Centre of Monaco and the Oceanographic Institute related to the World Coral Conservatory project.

After their visit on board *S.A. Agulhas II* (see [section 1.7](#)), the two delegations were transferred to Assomption Island and then flew back to Mahé.

The official segment of the visit continued with a meeting at the State Residence between H.E. Mr Wavel Ramkalawan, President of the Republic of Seychelles and the Prince, followed by a working meeting co-chaired by the two Heads of State. The Prince left Seychelles in the evening.



Official visit: H.S.H. Prince Albert II of Monaco welcomed by H.E. Mr. Wavel Ramkalawan, President of the Republic of Seychelles, at the State House, Mahé © Nicolas Mathys - Zeppelin / Monaco Explorations.



Working meeting co-chaired by the two Heads at the State House, Mahé, Seychelles © Nicolas Mathys - Zeppelin / Monaco Explorations.

## 4.3. DIDEM RELATED ACTIVITIES

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See [section 3.8](#).

## 4.4. RELATIONS WITH SIOFA

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In 2021, Prof. Alex Rogers, member of the Expedition Advisory Committee, wrote a *Report on the Ecology of the Saya de Malha Bank and Current Threats to its Marine Biodiversity* in relation with the preparation of the Expedition. The report identified and analyzed the danger to the unique ecosystem of the Saya de Malha Bank posed by bottom trawling. It was presented as an Info Paper to the 8<sup>th</sup> Meeting of Parties of the Southern Indian Ocean Fisheries Agreement (SIOFA), held online from 5 to 9 July 2021, through the Deep-Sea Conservation Coalition (DSCC), observer to SIOFA. The meeting agreed to request the Scientific Committee to conduct further studies of the ecology of the Saya de Malha Bank and the potential impact of bottom trawling fisheries on its ecosystem, as part of the planned study of the Saya de Malha Bank in the Scientific Committee workplan.

At the request of the SIOFA Secretariat, a progress report on the expedition was submitted through the delegations of Mauritius and Seychelles to the 8<sup>th</sup> meeting of SIOFA Scientific Committee (SC) on 29 March 2023. The SC thanked Monaco Explorations for undertaking this work and for providing the information and requested Monaco Explorations to share the data collected on Saya de Malha and continue to update the SC on its progress. Additional information on the fishing vessels met during the expedition were provided through the Seychelles representative. The request to share the scientific data collected during the expedition was left to the consideration of the JMA.

The preliminary report of the expedition was submitted to the 9<sup>th</sup> SC meeting in March 2024.

## 4.5. SCIENCE TO POLICY WORKSHOP

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A Science to Policy Workshop (S2PW) was organised by Monaco Explorations, the Government of Mauritius and the Government of Seychelles. It took place in Port-Louis, Mauritius from 12 to 14 of November 2025.

The Science to Policy Workshop report is available on the Monaco Explorations website : <https://shorturl.at/YTROC>

The objectives of the workshop were:

- Inform stakeholders of the latest scientific findings from the expedition,
- Analyse the implications for regional management and governance,
- Propose concrete recommendations for policy and action relevant to Mauritius, Seychelles, and regional ocean governance stakeholders,
- Foster regional and international collaboration for ocean stewardship.

The S2PW gathered around 50 participants including representatives of both Mauritius and Seychelles governments, scientific projects leaders, representatives of regional and global relevant organizations (such as WIOMSA, Nairobi Convention, SIOFA, IOTC, IUCN, IORA, etc.), members of MEIO Expedition Advisory Committee, invited experts and Monaco Explorations staff members.

The S2PW agenda included presentations sessions on global ocean issues such as UNCLOS BBNJ Agreement and on the Expedition results as well as brainstorming, discussion, drafting and reporting sessions. Social events (welcome cocktail, dinner and screening of the Expedition documentary) were organised on the evenings thanks to Monaco Explorations and to the Government of Mauritius.

The workshop developed a set of recommendations aimed at integrating scientific knowledge into policy processes, fostering regional collaboration, and identifying potential finance sources for conservation and sustainable development.



## 5. PERSPECTIVES / CONCLUSIONS

The MEIOE is the most successful expedition since Monaco Explorations was founded by H.S.H. Prince Albert II of Monaco. Given the number and importance of the scientific projects that have been carried out, the resources mobilised by all stakeholders, and the commitment of all those who contributed to the success of this expedition, we can salute the considerable work accomplished and the results achieved in terms of diplomacy, science and outreach.

Our thoughts are of course with Dr Andrew Mogg, who was injured during the expedition.

This report reveals that the Indian Ocean expedition carried out by Monaco Explorations has enabled the first two objectives set to be met in concrete terms:

- A better understanding of the areas explored through a multidisciplinary scientific approach.
- Sharing knowledge and raising awareness of the issues at stake.

The work carried out during the Science to Policy Workshop held in Port Louis (Mauritius) from 12 to 14 November 2025 then enabled the third objective to be met: to draw up 25 recommendations based on the results obtained and made available to the governments concerned in order to support the sustainable management of the areas explored.

These recommendations can be grouped according to the following themes:

### › Ecosystem Connectivity

1. Integrate ecosystem connectivity into marine spatial planning (MSP).
2. Protect source reefs, and foster regional collaboration and funding.

This supports recognition of transboundary connectivity under international frameworks such as BBNJ and CBD.

### › Regional Coordination

3. Establish a regional mechanism to support research continuity.
4. Facilitate exchange of students and marine scientists.
5. Coordinate the design of shared activities for ecosystem monitoring
6. Promote cumulative knowledge-building.

### › World Coral Bank (Conservatory)

7. Support the establishment of a regional eDNA database/reference library and coral repository node.

### › Microplastics & Pathogens

8. Conduct regional pollutant mapping.
9. Integrate findings into ecosystem-health monitoring.

### › Mesophotic / Deep-Sea Ecosystems

10. Expand deep-sea ecosystem surveys.
11. Develop national management plans.

### › Monitoring and Warning Systems

12. Contribute to the development of real-time monitoring and early warning systems through targeted capacity building.

### › Monitoring, Control, and Surveillance (MCS)

13. Assess existing MCS systems.
14. Explore new emerging technologies for collaborative enhancement.

### › Blue Economy

15. Engage with private sector, civil society, and research institutions to develop regenerative blue-economy models.
16. Investigate Blue Carbon potential of Saya de Malha Bank for inclusion in strategy.

### › Governance and Engagement

17. Strengthen capacity building to support the strengthening of international ocean governance agreements relevant to the SWIO such as the BBNJ Agreement.
18. Support regional states in advancing their ratification and their effective implementation.

### › Communication and Engagement

19. Build environmental-policy literacy and science-policy messaging for civil society.

### › Climate Resilience

20. Prioritize Nature-based Solutions within blue-economy frameworks.

### › Joint Management Area

21. Investigate management options for coherence between water column and continental shelf regimes.
22. Use the lull in bottom trawling to promote precautionary measures.
23. Highlight JMA as a pioneering initiative and living laboratory for science and governance.

### › Cross-cutting Themes

24. Science-Law-Policy Interface: Strengthen the interface with feedback loops for evidence-based processes.
25. Data Transparency: Ensure data transparency and sharing through collaborative mechanisms.

The commitment shown in the preparation, implementation and promotion of the MEIOE demonstrated the power of partnership and evidence-based decision-making in addressing the complex challenges of ocean governance in the SWIO.

The 25 recommendations developed provide a roadmap for integrating scientific knowledge into policy, fostering regional collaboration, and unlocking innovative financing for conservation and sustainable development.

This expedition revealed an extraordinary site on the high seas, the Saya de Malha Bank, which is currently managed jointly by Mauritius and the Seychelles. The entry into force of the BBNJ Agreement, to which the Principality of Monaco is strongly committed, could undoubtedly provide an interesting framework for its practical implementation in the field. Some of the 25 recommendations resulting from the outcomes of the Monaco Explorations Indian Ocean Expedition point in this direction, which can be encouraging and motivating.

This final report is not the last act of an exploration expedition whose results reinforce Monaco's commitment to ocean protection and serve as a model for science-driven governance in other regions. It is rather a beginning, and Monaco Explorations would be delighted to continue working alongside Mauritius and Seychelles, supporting them in their reflection and the implementation of the recommendations issued. Indeed, the success of this initiative will ultimately be measured by the translation of these recommendations into concrete actions, ensuring the health of marine ecosystems and the well-being of current and future generations.



## 6. ACKNOWLEDGEMENTS

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- H.S.H. Prince Albert II of Monaco
- The Government of the Principality of Monaco
- The Government of the French Republic
- The Government of the Republic of Mauritius
- The Government of the Republic of Seychelles
- The members of the advisory committee
- The partner scientific institutions and their teams, the vessel's operator and crew, the teachers and students of the on-board school, the artists, videographers, photographers, journalists and all the people and organizations involved in this project
- All those who have contributed to the final report and the recommendations.



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## 8. APPENDICIES

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- **Appendix B:**  
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# APPENDIX A

## MONACO EXPLORATIONS INDIAN OCEAN EXPEDITION MEMBERSHIP OF THE ADVISORY COMMITTEE

<b>CARL GUSTAF LUNDIN</b>	Chair	Mission Blue, USA (formerly Director, Global Marine and Polar Programme, IUCN)
<b>DOMINIQUE BENZAKEN</b>		Australian National Centre for Ocean Resources and Security, University of Wollongong, Australia - World Bank (consultant)
<b>NICK D'ADAMO</b>		University of Western Australia - Oceans Institute (formerly Head, UNESCO IOC Perth Programme Office)
<b>SYLVIA EARLE</b>		Mission Blue, USA
<b>TESSA HEMPSON</b>		Mission Blue, USA (formerly at Oceans without Borders)
<b>HEATHER KOLDEWEY</b>		Zoological Society of London & Bertarelli Foundation, UK
<b>OLIVIER LAROUSSINIE</b>		CEREMA, France
<b>MARGARET LEINEN</b>		Scripps Institution of Oceanography, USA
<b>NADINE MARSHALL</b>		formerly at CSIRO
<b>DAVID OBURA</b>		CORDIO East Africa
<b>ALEX ROGERS</b>		REV Ocean, Norway
<b>ANWAR RUMJAUN</b>		Mauritius Institute of Education
<b>NIRMAL JIVAN SHAH</b>		Nature Seychelles
<b>FRANÇOIS SIMARD</b>	Secretary	formerly Deputy Director, Global Marine and Polar Programme and Advisor for Fisheries, IUCN



# APPENDIX B

## SPECIFICATIONS OF S.A. AGULHAS II



**'S.A. AGULHAS II'**  
**Steel Hulled, Ice strengthened**  
**Antarctic Supply /**  
**Oceanographic**  
**Research Vessel**

### SPECIFICATIONS

Classification	1A1 Passenger ship BIS Clean (Design) COMF (C-2, V-2) DAT (-35°C) C DEICE DYNPOS(AUT) E0 HELDK (S, H, F) LFL (*) NAUT(AW) PC (5) RP TMON Winterized (Basic)
Built	2011 STX Finland Oy, Rauma, Finland
Flag	South Africa
Port of Registry	Cape Town
IMO Number	9577135
Call Sign	ZSNO
MMSI	601986000

### MAIN DIMENSIONS

Length OA	134.0m
Breadth	22.0m
Maximum Draft	7.70m
GRT	12,897T
NRT	3,870T
Main Engines	4 x 3,000kW
Power	9,000kW shafts
Prop. Motors	2 x 4,500kW

Cruising speed	14.0 knots
Maximum speed	18.0 knots
Range	15,000 nautical miles
Endurance	90 days
Complement	144 comprising 44 crew and 100 scientific/other staff
Affiliation	Manned and managed by African Marine Solutions (AMSOL) on behalf of Department of Forestry, Fisheries & the Environment (DFFE) Directorate Antarctica and Islands Republic of South Africa

### PROPULSION

- Four uni-directional Wartsila 6L32 turbo-charged and intercooled 6 cylinder 4 stroke diesel engines directly coupled to four Converteam B128P8 Generators.
- Total power MCR 12,000kW, service power at 85% MCR 10,200kW
- Two Converteam N3HXCH2LL8CH Propulsion motors, Total power 9,000kW
- Two 750kW Rolls-Royce TT2000 DPN FP Bow thrusters, Total power 1,500kW
- One 1,200kW Rolls-Royce TT2400 DPN FP Stern thruster, Total power 1,200kW
- Bunker oil capacity: Maximum 3,009 tonnes, at 95% 2,858 tonnes.

### ELECTRICAL POWER

- Generated for propulsion at 3.3kVA, 3 phases, 50Hz, by the Wartsila/Converteam combination mentioned above. From the above Hotel Services are supplied at 3 phases, 50 Hz, 400V
- Harbour Generator: Mitsubishi S12R-Z3MPTAW-4 diesel engine, developing 1351kVA, 3 phases, 50Hz, 400 v. Generator Stamford PM734CZ
- Emergency Generator: Volvo-Penta D 16MG diesel engine, developing 490kVA, 3 phases, 50Hz, 400V. Generator Stamford HCM534E-1
- 220v AC, 50Hz domestic supply
- 220v AC, 50Hz stabilized domestic supply.

African Marine Solutions Group (Pty) Ltd  
 31 Carlisle Street, Paarden Eiland, 7405  
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[www.amsol.co.za](http://www.amsol.co.za)

NOTICE: The data contained herein is provided for convenience of reference to allow users to determine the suitability of the Company's equipment. The data may vary from the current condition of equipment which can only be determined by physical inspection. Company has exercised due diligence to ensure that the data contained herein is reasonably accurate. However, Company does not warrant the accuracy or completeness of the data. In no event shall Company be liable for any damages whatsoever arising out of the use or inability to use the data contained herein.

#### NAVIGATION EQUIPMENT

- Integrated Navigation System by Raytheon Anschutz, GMBH, Kiel, Germany
- Gyrocompass 2 x Anschutz Type 22 Digital
- Autopilot Anschutz NautoPilot 2025
- Radars 1 x Raytheon Anschutz S-Band 30kW ARPA Chartradar Blackbox System  
2 x Raytheon Anschutz X-Band 25kW ARPA Chartradar Blackbox Systems.  
One fitted with a high-speed scanner.  
1 x Sigma S6 Integrated Radar Processing System, for ice navigation
- GPS 2 x Saab R4 DGPS Receivers
- ECDIS 2 x (Main + Secondary) Raytheon Anschutz ECDIS Blackbox Version with overlay
- Speed log Skipper DL850 2 Axis Doppler Log
- Echo Sounder Raytheon Anschutz GDS101 50/200kHz
- Conning Screen The ship's operating parameters such as position, speed, propeller pitch, rudder angle, wind direction, wind speed, etc. are displayed either in graphic or alpha numeric form on the bridge and in the Captain's cabin.

#### METEOROLOGICAL EQUIPMENT

- 2 x Lambrecht Weather Sensors, indicating wind speed and direction, air temperature, barometric pressure and relative humidity.
- Sea temperature given by the Skipper Log

#### DYNAMIC POSITIONING SYSTEM (LEVEL 1)

- 1 x Navis 4001 DP System
- 1 x Navis 4011 Joystick Control System
- 1 x Model LID3-G1 DGPS Receiver for the DP system
- FMEA trials not conducted
- Vessel not classed as a DP vessel

#### COMMUNICATIONS

- Radio and Satellite Equipment, to GMDSS Sea Area 4

#### BRIDGE Communication Console

- 2 x Raytheon Anschutz MF/HF DSC Radio Controllers CU 5100
- 1 x Raytheon Anschutz VHF DSC Controller RT 5022
- 1 x Sailor Inmarsat C Message Terminal TT3606E
- 3 x Raytheon Anschutz printers H1252B/TT-3608A for above
- 1 x Raytheon Anschutz GMDSS Alarm Panel AP 5042
- 3 x Sailor GMDSS VHF Portable Radios, SP 3520
- 1 x ICOM Air band Portable VHF Radio (with headset and microphone)

#### Bridge Main Console

- 1 x Raytheon Anschutz VHF DSC Duplex Controller RT 5020
- 1 x Motorola GM 360 UHF radio
- 1 x Raytheon Anschutz GMDSS Alarm Panel AP 5065



#### Bridge Helicopter Console

- 1 x Raytheon Anschutz VHF Radio Controller CU 5000
- 1 x Becker Air band VHF Radio
- 1 x Motorola VHF Radio DM 3600

#### Bridge Starboard Console

- 1 x Sailor VHF Radio 6210

#### Bridge Port Console

- 1 x Sailor VHF Radio 6210

#### Bridge, After Bulkhead

- 1 x SARTs, Sailor 6913A-SART (1 Port, 1 Starboard)
- 1 x EPIRB, TRON 40S Mk II 406 MHz

#### Monkey Island (Deck 10)

- 1 x EPIRB (Float Free), TRON 40S Mk II 406 MHz
- 1 x VDR Capsule

#### Bridge, Office

- 22 x UHF Radios, Motorola
- Navtex Receiver, NCR-333
- Weather Facsimile Receiver, Raytheon Anschutz Blackbox FAX-30

#### SCIENTIFIC WINCHES

- 1 x Rapp Hydema HW 2300 E CTD Winch, 6,000m x 11.73mm conductor cable (usable cable 5,850m)
- 1 x Rapp Hydema HW 2300 E CTD Winch, 6,000m x 12mm Kevlar cable (usable cable 5,190m)
- 1 x Rapp Hydema HW 200 E Vertical Plankton Winch, 1,650m x 6.35mm conductor cable (usable cable 538m)
- 1 x Rapp Hydema DSW-4006 E Deep-water Coring Winch, 5,000m x 14mm SWR (usable cable 4,100m)
- 1 x Rapp Hydema HW 500 E Plankton Towing Winch, 2,500m x 11.73mm SWR (usable cable 1,980m)
- 1 x Rapp Hydema HW 500 E General Purpose Towing Winch, 2,500m x 12mm SWR (usable cable 1,900m)
- 1 x Rapp Hydema HW 500 E Undulating Vehicle Winch, 760m x 8.41mm SWR (100m faired) (usable cable 580m)

#### MOORING WINCHES

- 1 x Hatlapa Electric Windlass with 2 x 160kN @ 5/15m/min. Cable Lifters and 2 x 150kN @ 15/30m/min. Warping Drums
- 2 x Hatlapa Electric Capstans, 100kN @ 15/30m/min
- 1 x Rapp Hydema CF 600 E General Purpose Capstan, 3.0T @ 12m/min

#### LABORATORIES

- Meteorological Laboratory
- Operations Room
- Underway Sampling Laboratory
- Wet Biological Laboratory
- Dry Biological Laboratory
- Wet Geological Laboratory
- Liquid Scintillation Counter Laboratory
- General Chemistry Laboratory.
- Provision made for 6 "Own-User" Container Laboratories on deck aft.

### SCIENTIFIC WORKING AREAS

- Helicopter flight deck and hangar, when available
- Enclosed poop deck space of 400m<sup>2</sup> with a 50m<sup>2</sup> wooden working deck served by a hydraulic A-frame with 6 loading points and a vertical sliding stern gate.
- AFT deck 4T SWL Deep Corer Davit by Triplex, with a 1T SWL Deep Corer handling Frame attached.
- The Environmental Hangar boasts a Triplex A-Frame for CTD deployment, with a SWL of 7T

### ON BOARD SCIENTIFIC SYSTEMS

A Network Data System acquires data from selected navigational, meteorological and scientific instrumentation. The data is sent to a dedicated server once per second and mean values logged once per minute. The real time data is transmitted continuously over the LAN and the logged data is made available in a shared folder on the network.

- Seabird 911 CTD and Rosette Sampling System
- Seabird S38 Remote Temperature Probe
- Seabird SBE 45 Thermosalinograph and De-Bubbler
- Kongsberg Topaz P18 Sub-bottom Profiler
- A Moon Pool, dimensions 2.4 x 2.4m, for CTD deployment in ice covered waters

A Drop Keel, extending to a depth of 3.0m, containing:

- Scientific Echo Sounder, Simrad EK 60, 38/120/200kHz
- Scientific Deep-Water Echo Sounder, Simrad EA 600
- Acoustic Doppler Current Profiler, RDI Instruments Ocean Surveyor II, 75kHz

### ADDITIONAL SCIENTIFIC & LABORATORY EQUIPMENT

- Grab Sampler + Backup unit
- Seabird 911 CTD and Rosette Sampling System (Back up unit)
- Milli-Q water generator
- Microbiological Safety cabinet with vertical laminar flow hood

#### Available to Charterer

- Cold storage
  - Blast Freezer (-20) – scientific store. 1.85 m3
  - Freezer (-20) – scientific store. 7.14 m3
  - Scientific cold store (+5) DK3 aft 19.15 m3
  - Cargo freezer (-20) DK 3 fwd 21.71 m3
  - Cargo freezer (-20) DK 3 fwd 26.32 m3
  - Mini freezers (-20) Port aft lab 0.12 m3 x 3 units
- 2 x -80c Freezers (one for chemistry + one for biological samples)
  - Upright freezer (-80) Port lab aft 0.83 m3 x 3 draws
  - Chest freezer(-80) Port aft lab 0.29m3

#### Not Available to Charterer

- Cargo fridge (+5) DK 3 fwd 10.84m3 (used for ship stores)



## HABITABILITY - ACCOMMODATION

All officers and crew are housed in single quarters. Vessel is air conditioned as well as heated for Antarctic conditions.

### Passenger accommodation:

- 2 VIP suites
- 16 single berth cabins
- 15 two berth cabins
- 13 four berth cabins
- Upper and lower passenger lounges
- Library
- Live TV, via satellite, streamed to all cabins
- Full laundry facilities
- Fresh water capacity is 290T supplemented by a 28T/day fresh water generation capability when at sea
- Hospital with surgery facilities
- Doctor
- Small gymnasium, with sauna, shower and change room facilities
- Baggage Room

## LIFE SAVING APPLIANCES

- 2 x FRC's
- 254 x Life Jackets
- 150 x immersion Suits
- 19 x Lifebuoys
- 6 x (25 Man) Life Rafts
- 2 x (75 Man) Life Boats

## CARGO CAPACITIES AND CARGO HANDLING EQUIPMENT

- Three cargo hatches, all with tween deck and lower hold.  
Total dry cargo capacity:

Bale	3,801m <sup>3</sup>
Grain	4,602m <sup>3</sup>
Refrigerated space	79.4m <sup>3</sup>
Cargo oil capacity	510m <sup>3</sup> /408T
- 1 x TTS 35T @ 27.5m at 17m knuckle boom cargo crane on forecastle head
- 2 x TTS 10T @ 10m knuckle boom cargo cranes forward
- 1 x TTS 5T @ 18m knuckle boom stores crane aft
- Two large 10m inflatable rafts with a working capacity of 15T per paired rafts
- One 2-ton Electric Forklift Truck.

## HELICOPTER SUPPORT AND FACILITIES

- Enclosed hangar facilities for two PUMA size helicopters. Manual sprinkler system for hangar
- 113T JetA1 bunker capacity
- Helicopters fitted with flotation gear, winches and cargo slings. Long range tanks available
- Skid fittings
- Radar and GPS receivers fitted

## RADIOS

- 1 HF SSB transceiver
- 2 VHF (AM) aeronautical transceiver, and
- 1 VHF (FM) marine band transceiver

#### OTHER FEATURES

- Roll damping tank
- Ice breaking heeling tank/pump system
- Closed circuit television available to points around the ship
- 2 x 200hp 10-man SOLAS Fast Rescue Craft
- 1 x 230hp Weedo 710 Tug/Workboat, Bollard Pull 2.2T
- 1 x 40hp 4-man inflatable dinghy for inshore scientific work
- CO2 flooding system for machinery spaces and cargo holds
- Automatic water sprinkler system for accommodation spaces
- Inert gas system for JetA1 pump room/tank space
- Foam monitor cannons for flight deck and cargo deck helicopter operations
- Remote control fire retarding doors for accommodation space
- Cross flooding system for damage stability
- CATHELCO impressed current, cathodic protection, system

#### VSAT FACILITIES

- Bandwidth Speed: 16 384/4096 (MIR)– 8192/2048 (CIR) (2:1 ratio) specifically enhanced for this charter only. Unlimited data, but this is subject to the number of users on the system, location strength, and the controls put in place.

#### OFFICE & WORKSHOP FACILITIES

- Office spaces – Business Center with 8 Computer desks, incl Meeting room for 6 persons.
- Conference Room – 1 by 120 Person possible to split into 2 rooms.
- Video Conferencing System - Blackmagic Atem Mini pro video mixer with Rode dual wireless microphone & transmitter kit, Canon XA 11 video cameras, Rode Interview Go video handle & POP filter handheld audience microphone, Sirui K-10II Ball Head for roof mount & wall mount, streaming PC and 2 x video monitors.
- Workshops – DFFE Electronics workshop, Operations Room in Environmental hangar
- Various lab areas
- Helicopter Briefing room

#### MEDICAL EQUIPMENT

- Anesthetic Machine
- Ventilator
- Mobile X-Ray unit
- ECG & blood pressure function of LifePak defibrillator
- Infusion pump for IV fluid infusion
- Monitor in ward: Blood pressure, saturations, pulse
- Hyfercator
- Theatre Light

The supplies, consumables and other items as required.

#### DIVING EQUIPMENT

- Diving Chamber
- DMAC Medical Kit
- Medical Oxygen
- 2 x RIB

**NOTE : This specification sheet is EXCLUSIVE to the Monaco Expedition Charter Oct – Nov 2022**

African Marine Solutions Group (Pty) Ltd  
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NOTICE: The data contained herein is provided for convenience of reference to allow users to determine the suitability of the Company's equipment. The data may vary from the current condition of equipment which can only be determined by physical inspection. Company has exercised due diligence to ensure that the data contained herein is reasonably accurate. However, Company does not warrant the accuracy or completeness of the data. In no event shall Company be liable for any damages whatsoever arising out of the use or inability to use the data contained herein.



# APPENDIX C

## MONACO EXPLORATIONS INDIAN OCEAN EXPEDITION

### LIST OF PARTICIPANTS

PROJECT	LAST NAME	FIRST NAME	AFFILIATION	UNIT
Saya de Malha	Theresine	Patsy	Seychelles Parks and Gardens Authority (SPGA)	
Saya de Malha	Bonne	Rodney	Seychelles Parks and Gardens Authority (SPGA)	
Saya de Malha	Mangroo	Rosabella	Seychelles Fishing Authority (SFA)	Research Section
Saya de Malha	Vidot	Annie	Seychelles Fishing Authority (SFA)	Research Section
Saya de Malha	Barreau	Estelle	Seychelles Fishing Authority (SFA)	Research Section
Saya de Malha	Dine	Mariette	Ministry of Fisheries and the Blue Economy	
Saya de Malha	Gordon	Nuette	University of Seychelles	Blue Economy Research Institute
Saya de Malha	Sorry	Abel	Ministry of Fisheries and the Blue Economy	Department of the Blue Economy
Saya de Malha	Talma	Sheena	Talma Consultancy	
Saya de Malha	Maria	Joshua	University of Seychelles	
Saya de Malha	Marzocchi	Bianca	University of Seychelles	
Saya de Malha	Labonte	Camilla	University of Seychelles	
Saya de Malha	Jeanne	Terry	Fisherman	
Saya de Malha	Sauba	Keshav	Department for Continental Shelf, Maritime Zones Administration and Exploration, Prime Minister's Office	
Saya de Malha	Oozeeraully	Yuneeda	Department for Continental Shelf, Maritime Zones Administration and Exploration, Prime Minister's Office	
Saya de Malha	Bissessur	Dass	Department for Continental Shelf, Maritime Zones Administration and Exploration, Prime Minister's Office	
Saya de Malha	Rawat	Arshad	Department for Continental Shelf, Maritime Zones Administration and Exploration, Prime Minister's Office	
Saya de Malha	Roy	Prerna	Mauritius Oceanography Institute (MOI)	
Saya de Malha	Oogarah	Preeti Nitisha	Mauritius Oceanography Institute (MOI)	
Saya de Malha	Bhagooli	Ranjeet	University of Mauritius	Department of Biosciences and Ocean Studies
Saya de Malha	Kaullysing	Deepeeka	University of Mauritius	Department of Biosciences and Ocean Studies
Saya de Malha	Ramah	Sundy	Ministry of Blue Economy, Marine resources, Fisheries and Shipping	Fisheries Training & Extension Centre
Saya de Malha	Munbodhe	Vikash	Ministry of Blue Economy, Marine resources, Fisheries and Shipping	
Saya de Malha	Marsac	Francis	French Research Institute for Sustainable Development (IRD)	IRD Sète / UMR Marbec
Saya de Malha	Ménard	Frédéric	French Research Institute for Sustainable Development (IRD)	IRD Marseille / UMR MOI
Saya de Malha	Ternon	Jean-François	French Research Institute for Sustainable Development (IRD)	IRD Sète / UMR Marbec
Saya de Malha	Galletti	Florence	French Research Institute for Sustainable Development (IRD)	IRD Sète / UMR Marbec
Saya de Malha	Noyon	Margaux	Nelson Mandela University	Ocean Science Campus
Saya de Malha	Corbari	Laure	French National Museum of Natural History (MNHN)	UMR ISYEB

NATIONALITY	FUNCTION	CATEGORY	EMBARKATION PORT	DISEMBARKATION PORT
Seychelles	Marine Biologist	Science	Port Victoria, Seychelles	Port Louis, Mauritius
Seychelles	Marine Biologist	Science	Port Victoria, Seychelles	Port Louis, Mauritius
Seychelles	Environmental Scientist	Science	Port Victoria, Seychelles	Port Louis, Mauritius
Seychelles	Marine Biologist	Science	Port Victoria, Seychelles	Port Louis, Mauritius
Seychelles	Marine Biologist	Science	Port Victoria, Seychelles	Port Louis, Mauritius
Seychelles	Entrepreneur	Science	Port Victoria, Seychelles	Port Louis, Mauritius
South Africa	Marine Biologist	Science	Port Victoria, Seychelles	Port Louis, Mauritius
Seychelles	Environmental Scientist	Science	Port Victoria, Seychelles	Port Louis, Mauritius
Seychelles	Marine Biologist	Science	Port Victoria, Seychelles	Port Louis, Mauritius
Seychelles	Student	Science	Port Victoria, Seychelles	Port Louis, Mauritius
Seychelles	Student	Science	Port Victoria, Seychelles	Port Louis, Mauritius
Seychelles	Student	Science	Port Victoria, Seychelles	Port Louis, Mauritius
Seychelles	Observer	Science	Port Victoria, Seychelles	Port Louis, Mauritius
Mauritius	Geoscientist	Science	Port Victoria, Seychelles	Port Louis, Mauritius
Mauritius	Physical Oceanographer	Science	Port Victoria, Seychelles	Port Louis, Mauritius
Mauritius	Geoscientist	Science	Port Victoria, Seychelles	Port Louis, Mauritius
Mauritius	Physical Oceanographer	Science	Port Victoria, Seychelles	Port Louis, Mauritius
Mauritius	Chemical Oceanographer	Science	Port Victoria, Seychelles	Port Louis, Mauritius
Mauritius	Chemical Oceanographer	Science	Port Victoria, Seychelles	Port Louis, Mauritius
Mauritius	Marine Biologist	Science	Port Victoria, Seychelles	Port Louis, Mauritius
Mauritius	Taxonomist	Science	Port Victoria, Seychelles	Port Louis, Mauritius
Mauritius	Marine Ecophysiologicalist	Science	Port Victoria, Seychelles	Port Louis, Mauritius
Mauritius	Chemical Oceanographer	Science	Port Victoria, Seychelles	Port Louis, Mauritius
France	Oceanographer/Project Leader	Science	Port Victoria, Seychelles	Port Louis, Mauritius
France	Marine Ecologist	Science	Port Victoria, Seychelles	Port Louis, Mauritius
France	Physical Oceanographer	Science	Port Victoria, Seychelles	Port Louis, Mauritius
France	Marine Lawyer and Biologist	Science	Port Victoria, Seychelles	Port Louis, Mauritius
France	Marine Biologist	Science	Port Victoria, Seychelles	Port Louis, Mauritius
France	Marine Biologist	Science	Port Victoria, Seychelles	Port Louis, Mauritius



PROJECT	LAST NAME	FIRST NAME	AFFILIATION	UNIT
Saya de Malha	Bouchet	Philippe	French National Museum of Natural History (MNHN)	UMR ISYEB
Saya de Malha	Frutos	Inmaculada	University of Lodz	Department of Zoology and Marine Invertebrates
Saya de Malha	Le Gall	Line	French National Museum of Natural History (MNHN)	UMR ISYEB
Saya de Malha	Vassard	Emmanuel	French National Museum of Natural History (MNHN)	
Saya de Malha	Moutardier	Grégoire	French National Museum of Natural History (MNHN)	
Saya de Malha	Gouillieux	Benoit	University of Bordeaux	UMR EPOC
Saya de Malha	Hourdez	Stéphane	French National Centre for Scientific Research	UMR LECOB / Oceanology Observatory of Banyuls-sur-Mer
Advisory Committee / Coral Connect	Koldewey	Heather	Zoological Society of London	
Coral Connect	Burt	April	Seychelles Islands Foundation	
Coral Connect	Wilson	Bryan	University of Oxford	Department of Zoology - John Krebs Field Station
Coral Connect	Landers	Damaris	University of Oxford	
Coral Connect	Mogg	Andy	Tritonia Scientific Ltd	
MADCAPS	Fustemberg	Gwennais	University of Reunion	UMR Entropy-BESTRUN
MADCAPS	Fernandes Da Costa	Vyctoria Marillac	University of Reunion	UMR Entropy-BESTRUN
MADCAPS	Vanderlynden / Thibault	Chloé	BESTRUN	BESTRUN
GECOS	Bourjea	Jérôme	French Institute for Exploitation of the Sea (Ifremer)	Ifremer Sète / UMR MARBEC
GECOS	Schull	Quentin	French Institute for Exploitation of the Sea (Ifremer)	Ifremer Sète / UMR MARBEC
GECOS	Ciccione	Stéphane	Kelonia	
4SEA	Contini	Matteo	French Institute for Exploitation of the Sea (Ifremer)	Ifremer/Indian Ocean Delegation
4SEA	Ravitchandirane	Mervyn	French Institute for Exploitation of the Sea (Ifremer)	Ifremer/Indian Ocean Delegation
4SEA	Julien	Mohan	French National Centre for Scientific Research	CNRS/LIRMM
4SEA	Poulain	Sylvain	French Research Institute for Sustainable Development (IRD)	IRD Sète / UMR Marbec
BGC Argo	Claustre	Hervé	Sea Institute of Villefranche-sur-Mer (IMEV)	Oceanography Laboratory of Villefranche-sur-Mer (LOV)
BGC Argo	d'Ortenzio	Fabrizio	Sea Institute of Villefranche-sur-Mer (IMEV)	Oceanography Laboratory of Villefranche-sur-Mer (LOV)
BGC Argo	Dimier	Céline	Sea Institute of Villefranche-sur-Mer (IMEV)	Oceanography Laboratory of Villefranche-sur-Mer (LOV)
BGC Argo	Jessin	Thomas	Sea Institute of Villefranche-sur-Mer (IMEV)	Oceanography Laboratory of Villefranche-sur-Mer (LOV)
BGC Argo / Saya de Malha	Taillandier	Vincent	Sea Institute of Villefranche-sur-Mer (IMEV)	Oceanography Laboratory of Villefranche-sur-Mer (LOV)
World Coral Conservatory	Vimercati	Silvia	King Abdullah University of Science and Technology	
World Coral Conservatory	Zoccola	Didier	Monaco Scientific Centre (CSM)	
World Coral Conservatory	Piquet	Bruno	Monaco Oceanographic Institute	Oceanographic Museum
World Coral Conservatory	Midol	Maureen	Oceanopolis	
World Coral Conservatory	Quéméré	Katia	Oceanopolis	
Marine Mammal Observation	Rota	Bernard	Globice Reunion	

NATIONALITY	FUNCTION	CATEGORY	EMBARKATION PORT	DISEMBARKATION PORT
France	Marine Biologist	Science	Port Victoria, Seychelles	Port Louis, Mauritius
Spain	Biologist	Science	Port Victoria, Seychelles	Port Louis, Mauritius
France	Taxonomist/Diver	Science	Port Victoria, Seychelles	Port Louis, Mauritius
France	Diver	Science	Port Victoria, Seychelles	Port Louis, Mauritius
France	Diver	Science	Port Victoria, Seychelles	Port Louis, Mauritius
France	Diver	Science	Port Victoria, Seychelles	Port Louis, Mauritius
France	Diver	Science	Port Victoria, Seychelles	Port Louis, Mauritius
United Kingdom	Marine Biologist/Project Leader	Science	Le Port, Reunion	Port Victoria, Seychelles
United Kingdom	Marine Biologist	Science	Le Port, Reunion	Aldabra, Seychelles
Ireland	Marine Biologist	Science	Port Victoria, Seychelles	Port Louis, Mauritius
United Kingdom	PhD Student/Diver	Science	Le Port, Reunion	Port Louis, Mauritius
United Kingdom	Diver	Science	Le Port, Reunion	Moroni, Comoros
France	Marine Biologist	Science	Le Port, Reunion	Port Louis, Mauritius
Brazil	Marine Biologist	Science	Le Port, Reunion	Port Louis, Mauritius
France	Artist	Artist	Port Victoria, Seychelles	Port Louis, Mauritius
France	Marine Biologist/Project Leader	Science	Le Port, Reunion	Port Victoria, Seychelles
France	Marine Biologist	Science	Le Port, Reunion	Port Victoria, Seychelles
France	Outreach Specialist	Communication	Le Port, Reunion	Port Victoria, Seychelles
Italie	Drone Operator/Data Manager	Science	Le Port, Reunion	Port Louis, Mauritius
France	Drone Operator	Science	Le Port, Reunion	Port Louis, Mauritius
France	Drone Operator/Data Manager	Science	Le Port, Reunion	Port Victoria, Seychelles
France	Drone Operator/Data Manager	Science	Le Port, Reunion	Port Victoria, Seychelles
France	Oceanographer/Project Leader	Science	Le Port, Reunion	Port Louis, Mauritius
Italy	Physical Oceanographer	Science	Le Port, Reunion	Port Louis, Mauritius
France	Engineer	Science	Cape Town, South Africa	Cape Town, South Africa
France	Webdesigner	Science	Le Port, Reunion	Port Louis, Mauritius
France	CTD Specialist	Science	Le Port, Reunion	Cape Town, South Africa
Italy	Taxonomist/Diver	Science	Le Port, Reunion	Port Victoria, Seychelles
France	Biologist/Diver/Project Leader	Science	Le Port, Reunion	Port Victoria, Seychelles
France	Aquariologist/Diver	Science	Le Port, Reunion	Port Victoria, Seychelles
France	Aquariologist/Diver	Science	Le Port, Reunion	Port Victoria, Seychelles
France	Cameraman/Diver	Communication	Le Port, Reunion	Port Victoria, Seychelles
France	Marine Mammal Observer	Science	Port Victoria, Seychelles	Port Louis, Mauritius



PROJECT	LAST NAME	FIRST NAME	AFFILIATION	UNIT
Onboard School	Lombard	Fabien	Sea Institute of Villefranche-sur-Mer (IMEV)	Oceanography Laboratory of Villefranche-sur-Mer (LOV)
Onboard School	Irisson	Jean Olivier	Sea Institute of Villefranche-sur-Mer (IMEV)	Oceanography Laboratory of Villefranche-sur-Mer (LOV)
Onboard School	Mousseau	Laure	Sea Institute of Villefranche-sur-Mer (IMEV)	Oceanography Laboratory of Villefranche-sur-Mer (LOV)
Onboard School	Oh	Jun	IMBRSea	
Onboard School	Quevedo Zabala	Juliana	IMBRSea	
Onboard School	Bates	Elliott	IMBRSea	
Onboard School	van Langen Rosón	Andrea	IMBRSea	
Onboard School	Chung	Wing Yi	IMBRSea	
Onboard School	Pohl	Lotte	IMBRSea	
Onboard School	Tupper	Emiliana	IMBRSea	
Onboard School	Dukan	Nergiz	IMBRSea	
Onboard School	Finet	Thomas	Sorbonne University	
Onboard School	Monjol-Delphine	Axel	Sorbonne University	
Onboard School	Accardo	Alexandre	Sorbonne University	
Onboard School	Patier	Laura	Sorbonne University	
Onboard School	Garmirian	Zoé	Sorbonne University	
Onboard School	Lemoine	Julie	Sorbonne University	
Onboard School	Ringard	Antoine	Sorbonne University	
Onboard School	Zaccomer	Hugo	Sorbonne University	
Onboard School	Vignerou	Mathilde	Sorbonne University	
Onboard School	Ozanam	Baptiste	Sorbonne University	
Onboard School	Campos	Rebeca	Sorbonne University	
Onboard School	Barale	Ilaria	Sorbonne University	
Onboard School	Munnaroo	Sivane	Department for Continental Shelf, Maritime Zones Administration and Exploration, Prime Minister's Office	
Onboard School	Bhunjun	Devin	Department for Continental Shelf, Maritime Zones Administration and Exploration, Prime Minister's Office	
Onboard School/ Saya de Malha	Coopen	Priscilla	Department for Continental Shelf, Maritime Zones Administration and Exploration, Prime Minister's Office	
Onboard School	Jeetun	Sruti	Department for Continental Shelf, Maritime Zones Administration and Exploration, Prime Minister's Office	
Onboard School	Sadien	Murughen	Department for Continental Shelf, Maritime Zones Administration and Exploration, Prime Minister's Office	
Onboard School	Banane	Véronique Mireille	Seychelles Islands Foundation	
Onboard School	Naiken	Saratha	University of Seychelles	
Onboard School	Rocamora Solé	Magali	Consultant	
Onboard School	Nancy	Ella	University of Seychelles	
Onboard School	Julie	Corianna Lauren	Seychelles Islands Foundation	
Communication	Bender	Sven	Autentic	
Communication	Teichmann	Tim	Autentic	
Communication	Pokieser	Harald	Autentic	
ROV	Laaser	Egon	Marine Solutions	
ROV	Laaser	Robert	Marine Solutions	
ROV	Arlove	Dominique	Marine Solutions	

NATIONALITY	FUNCTION	CATEGORY	EMBARKATION PORT	DISEMBARKATION PORT
France	Teacher/Project Leader	Science	Le Port, Reunion	Port Victoria, Seychelles
France	Teacher	Science	Le Port, Reunion	Port Victoria, Seychelles
France	Teacher	Science	Le Port, Reunion	Port Victoria, Seychelles
Belgium	Student	Student	Le Port, Reunion	Port Victoria, Seychelles
Colombia	Student	Student	Le Port, Reunion	Port Victoria, Seychelles
USA	Student	Student	Le Port, Reunion	Port Victoria, Seychelles
Netherlands	Student	Student	Le Port, Reunion	Port Victoria, Seychelles
China (Hong Kong)	Student	Student	Le Port, Reunion	Port Victoria, Seychelles
Germany	Student	Student	Le Port, Reunion	Port Victoria, Seychelles
Chile	Student	Student	Le Port, Reunion	Port Victoria, Seychelles
Turkey	Student	Student	Le Port, Reunion	Port Victoria, Seychelles
France	Student	Student	Le Port, Reunion	Port Victoria, Seychelles
France	Student	Student	Le Port, Reunion	Port Victoria, Seychelles
France	Student	Student	Le Port, Reunion	Port Victoria, Seychelles
France	Student	Student	Le Port, Reunion	Port Victoria, Seychelles
France	Student	Student	Le Port, Reunion	Port Victoria, Seychelles
France	Student	Student	Le Port, Reunion	Port Victoria, Seychelles
France	Student	Student	Le Port, Reunion	Port Victoria, Seychelles
France	Student	Student	Le Port, Reunion	Port Victoria, Seychelles
France	Student	Student	Le Port, Reunion	Port Victoria, Seychelles
France	Student	Student	Le Port, Reunion	Port Victoria, Seychelles
Peru	Student	Student	Le Port, Reunion	Port Victoria, Seychelles
Italy	Student	Student	Le Port, Reunion	Port Victoria, Seychelles
Mauritius	Student	ECOP	Port Louis, Mauritius	Port Victoria, Seychelles
Mauritius	Student	ECOP	Port Louis, Mauritius	Port Victoria, Seychelles
Mauritius	Student	ECOP	Port Louis, Mauritius	Port Louis, Mauritius
Mauritius	Student	ECOP	Port Louis, Mauritius	Port Victoria, Seychelles
Mauritius	Student	ECOP	Port Louis, Mauritius	Port Victoria, Seychelles
Seychelles	Student	ECOP	Port Louis, Mauritius	Port Victoria, Seychelles
Seychelles	Student	Student	Port Louis, Mauritius	Port Victoria, Seychelles
Seychelles	Student	ECOP	Port Louis, Mauritius	Port Victoria, Seychelles
Seychelles	Student	Student	Port Louis, Mauritius	Port Victoria, Seychelles
Seychelles	Student	ECOP	Port Louis, Mauritius	Port Victoria, Seychelles
Germany	Cameraman/Diver	Communication	Port Louis, Mauritius	Port Louis, Mauritius
Germany	Film Assistant	Communication	Port Louis, Mauritius	Port Louis, Mauritius
Austria	Film Director	Communication	Port Louis, Mauritius	Port Louis, Mauritius
Namibia	ROV Supervisor	Support	Cape Town, South Africa	Cape Town, South Africa
Namibia	ROV Pilot	Support	Port Victoria, Seychelles	Port Louis, Mauritius
Namibia	ROV Pilot	Support	Cape Town, South Africa	Port Victoria, Seychelles



PROJECT	LAST NAME	FIRST NAME	AFFILIATION	UNIT
ROV	Karreman	Jeandre	Marine Solutions	
ROV	Matthew	Andrew	Underwater Surveys	
Dive support	Jacobs	Mervyn	AMSOL	
Dive support	Frankland	Derek	AMSOL	
Dive support	Miadorp	Travis	AMSOL	
Equipment support	Jacobs	Leon	Department of Forestry, Fisheries and the Environment (DFFE)	
Equipment support	Lombi	Mfundo	Department of Forestry, Fisheries and the Environment (DFFE)	
Equipment support	Anders	Darrell	Department of Forestry, Fisheries and the Environment (DFFE)	
Medical support	Quinn	Brendan	AMSOL	
Organization	Bessero	Gilles	Monaco Explorations	
Organization	Théron	Didier	Monaco Explorations	
Organization	Gasquy	Océane	Monaco Explorations	
Organization	Habbas	Mélissa	Monaco Explorations	
Organization	Ginocchio	Flora	Monaco Explorations	
Communication	Péroumal	Sylvain	Terre M'air Production	
Communication	Dugast	Stéphane	Agence Zeppelin	
Communication	Mathys	Nicolas	Agence Zeppelin	
Communication	Kulisev	Filip	Amazing Planet	
Communication	Matejbusová	Zuzana	Amazing Planet	
Artist in residence	Rigot	Elise	Monaco Explorations	
Artist in residence	Leroy	Rémi	Monaco Explorations	
Advisory Committee	Hempson	Tessa	&Beyond	Oceans without Borders
Advisory Committee	Lundin	Carl Gustaf	Mission Blue	
Advisory Committee/SSD	D'Adamo	Nick	University of Western Australia (UWA)	
Advisory Committee	Laroussinie	Olivier	French Centre for Studies on Risks, the Environment, Mobility and Urban Planning (CEREMA)	
Advisory Committee	Simard	François	Consultant	
Advisory Committee	Benzaken	Dominique	Consultant	
Observer	Fleischer-Dogley	Frauke	Seychelles Islands Foundation	
Observer	Appoo	Jennifer	Seychelles Islands Foundation	
Observer	Jeremie	Shemilla	Ministry of Agriculture, Climate Change and Environment	
Observer	Ricot	Mélanie	University of Mauritius	
Observer	Jogee	Shakeel	University of Mauritius	
Observer	Soobugh	Ritesh	University of Mauritius	

NATIONALITY	FUNCTION	CATEGORY	EMBARKATION PORT	DISEMBARKATION PORT
South Africa	ROV Pilot	Support	Port Victoria, Seychelles	Port Louis, Mauritius
South Africa	Senior Surveyor	Support	Cape Town, South Africa	Cape Town, South Africa
South Africa	Hyperbaric Chamber Operator/Dive Support Boat Coxswain	Support	Cape Town, South Africa	Port Louis, Mauritius
South Africa	Dive Control	Support	Cape Town, South Africa	Cape Town, South Africa
South Africa	Dive Support Boat Coxswain	Support	Cape Town, South Africa	Port Louis, Mauritius
South Africa	Scientific Technician	Support	Cape Town, South Africa	Cape Town, South Africa
South Africa	Engineer Technician	Support	Cape Town, South Africa	Port Louis, Mauritius
South Africa	Scientific Technician	Support	Port Victoria, Seychelles	Cape Town, South Africa
South Africa	Doctor	Support	Cape Town, South Africa	Cape Town, South Africa
France	Expedition Leader	Organization	Cape Town, South Africa	Cape Town, South Africa
France	Outreach Manager	Organization	Cape Town, South Africa	Cape Town, South Africa
France	Communication Officer	Organization	Port Louis, Mauritius	Cape Town, South Africa
France	Coordination Assistant	Organization	Cape Town, South Africa	Cape Town, South Africa
Monaco	Administration Manager	Organization	Port Louis, Mauritius	Le Port, Reunion
France	Cameraman	Communication	Le Port, Reunion	Assomption, Seychelles
France	Reporter	Communication	Port Victoria, Seychelles	Port Louis, Mauritius
France	Photographer	Communication	Port Victoria, Seychelles	Port Louis, Mauritius
Slovakia	Photographer	Communication	Le Port, Reunion	Port Victoria, Seychelles
Slovakia	Photographer	Communication	Le Port, Reunion	Port Victoria, Seychelles
France	Artist	Communication	Port Louis, Mauritius	Port Louis, Mauritius
France	Artist	Communication	Le Port, Reunion	Port Louis, Mauritius
South Africa	Observer	Organization	Port Louis, Mauritius	Port Victoria, Seychelles
Sweden	Observer	Organization	Port Louis, Mauritius	Port Victoria, Seychelles
Australia	Observer/Project Leader	Organization	Port Louis, Mauritius	Port Victoria, Seychelles
France	Observer	Organization	Cape Town, South Africa	Port Louis, Mauritius (1st stop)
France	Observer	Organization	Port Victoria, Seychelles	Port Louis, Mauritius
Australia	Observer	Organization	Port Victoria, Seychelles	Port Louis, Mauritius
Seychelles	Observer	Science	Aldabra	Port Victoria, Seychelles
Seychelles	PhD Student	Student	Le Port, Reunion	Aldabra, Seychelles
Seychelles	Observer	Science	Port Louis, Mauritius	Port Victoria, Seychelles
Mauritius	Observer	Science	Port Louis, Mauritius	Le Port, Reunion
Mauritius	Student	Student	Port Louis, Mauritius	Le Port, Reunion
Mauritius	Student	Student	Port Louis, Mauritius	Le Port, Reunion



# APPENDIX D

## EVALUATION OF THE EXPEDITION

At its 10<sup>th</sup> meeting on 19 December 2022 Monaco Explorations Indian Ocean Expedition Advisory Committee agreed to conduct an evaluation of the expedition focusing on the expedition planning and conduct processes.

The main objective of this evaluation was to provide recommendations to Monaco Explorations to inform and improve the scope and conduct of future expeditions.

The scope of the evaluation covers the design, planning, and implementation of the expedition, as well as its overall relevance, financing, and the participation of stakeholders. It includes preliminary comments about the use and management of the data collected during the expedition.

### **METHOD**

The review was conducted by the Advisory Committee secretary under the guidance of an Evaluation Sub-Committee and with the assistance of Monaco Explorations staff. A questionnaire was sent to all participants of the expedition and complemented by the interviews of a selection of key stakeholders.

The questionnaire covers different aspects of the expedition: design and planning, implementation (research and outreach), passengers' facilities and support, and role of the Advisory Committee. The questionnaire uses a 5-point Likert scale and includes the possibility to "comment" on rating as needed. The online survey was opened first between 24 February and 10 March 2023. In order to improve the return rate, it was re-opened between 2 and 23 May 2023.

The follow up interviews targeted stakeholders who were not on board of the ship, although several of them visited the ship during the stopover in Mauritius or in Seychelles. The questions for the interviews focus on the involvement of the stakeholders in the preparation and planning of the expedition and also consider the fate of the expedition results (availability, uses, etc.). Although the latter aspect was not within the strict scope of the evaluation, it was of great interest to the stakeholders keen to ensure linkages between sciences and policy.

The survey results were first presented at the 12<sup>th</sup> meeting of the Advisory Committee on 22 March 2023 (preliminary results). The final evaluation was discussed at the 14<sup>th</sup> Advisory Committee meeting on 20 June. A summary of the evaluation was presented at the meeting of the Board of Monaco Explorations on 22 June.

### **RESULTS**

The questionnaire was sent to 143 participants. 35 responses were received in March, and 23 more in May, for a total of 58 answers, which represent a return rate of 41%. 49 responses were nominative and 9 were anonymous. Most of the partners institutions were represented.

The majority of the responses came from scientists (26 / 44,8%), followed by students (14 / 24,1%), Committee members (5 / 8,6%), media and artists (4 / 6,9%), Monaco Explorations staff (4 / 6,9%), crew and technicians (2 / 3,4%), stakeholder (1), doctor (1), ROV team (1) (**Figure D1**).

## What was your role on the expedition?

58 réponses

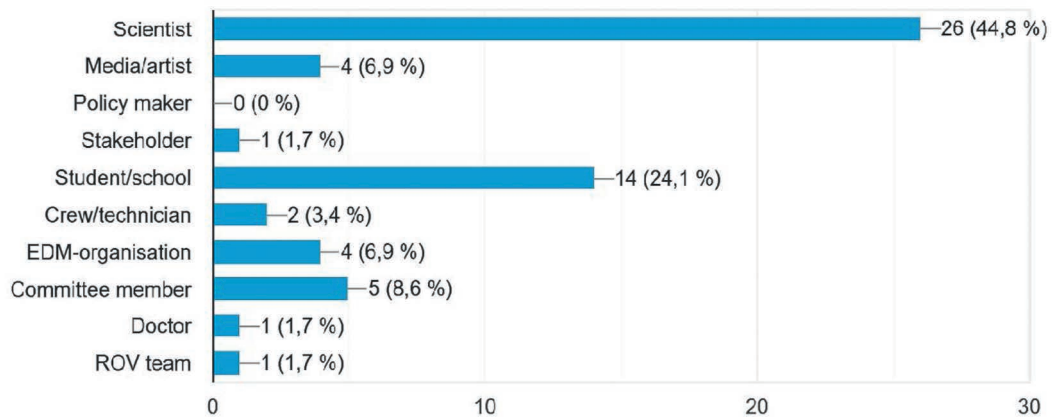


Figure D1: Respondents by categories

The return rates from scientists and students were satisfactory, although a return rate above 50% was expected: 26 answers amongst 55 scientists (47%), 14 answers amongst 35 students (40%). The rate for media and artist is similar at 40%. The best return rate is from the Committee members with 5 answers amongst 7 committee members on board (71% but 35% considering all Committee members), and Monaco Explorations (80%).

### OVERALL RATING

Most of the participants were happy with the expeditions with 95% of positive answers when adding the

“satisfactory”, “good” and “very good” ratings. The “very good rating” came first with almost half of the answers (Figure D2).

The main criticisms were about coordination, communication and planning, as well as about the diving conditions. These negative remarks seemed to be based on frustration (“we could have done much better”) than on actual impossibility to deliver during the cruise.

The interviews fully confirmed the positive rating of the expedition.

## How would you rate the overall expedition?

58 réponses

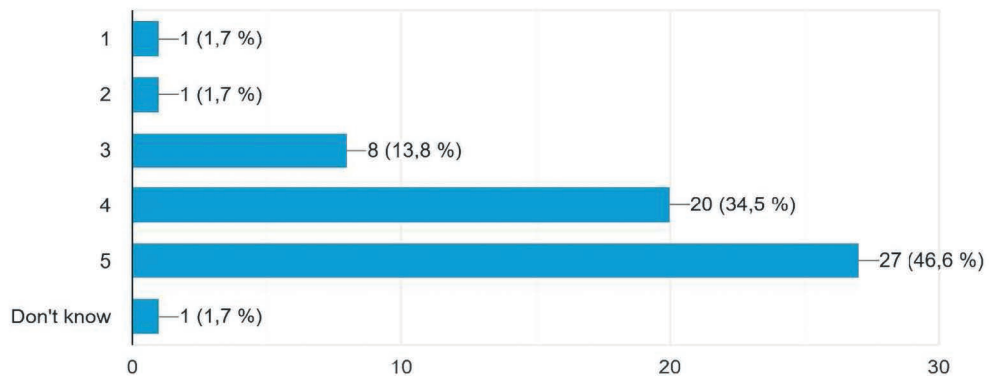


Figure D2: Overall rating.



Notes on the use and management of the data collected during the expedition and results.

These notes are drafted from the comments collected during the interviews. There was no question about data management and use of results in the questionnaire.

The collected data are important for both Mauritius and Seychelles.

It is complicated but very important to mutualize all data collected during the expedition.

A clear and robust results publication strategy is necessary. A special symposium could be envisaged.

Open access is fundamental but has a cost. Many data and results should be accessible online directly on Monaco Explorations website.

The data collected on Saya de Malha are of particular importance for the management of the Joint Management Area (JMA).

The collected data are important for the development of the Blue Economy at the regional level and at the same time for fostering sustainable fishing activities and the conservation of marine biodiversity.

The information about the seagrass meadows of Saya de Malha is also important for a better understanding of the Blue Carbon in the region.

It is important that the results be formatted so that the policy makers can access the appropriate information. "Science to Policy" is a key process for making sure that collected data are well used by policy makers.

## **CONCLUSIONS**

Overall, the appraisal of the expedition was good.

All questions received a large majority of "good" and "very good" ratings.

The major positive points were the followings:

Duration and objectives of the expedition: Aldabra, Saya de Malha, and Saint Brandon were excellent targets for such an expedition.

Quality of the ship, both in terms of technical and scientific equipment and of onboard hospitality.

Richness of the multidisciplinary programme and diversity of projects and of scientific teams.

Richness of the multi-objectives approach with the mix of research, capacity building, education, and outreach, including the artists on board.

Strong participation of research teams from Mauritius and Seychelles.

The main setbacks are about the planning and some onboard equipment:

The planning and preparation phases did not consult and involve the ocean research stakeholders enough, or adequately, in particular at the regional level.

The complexity of the cruise structure (many different projects and approaches) led to some problems in the coordination of onboard activities.

The structure of the programme did not satisfy some participants who were not much interested in the multidisciplinary approach and were frustrated not to be able to conduct fully their own programme.

About the onboard tools, although the ship was overall very well appreciated, there were two main hiccups: the lack of multibeam echosounder that hindered bathymetric survey and navigation in shallow unknown areas, and the uneasy diving facilities, especially the auxiliary boats and the access to the sea

# APPENDIX E

## MONACO EXPLORATIONS INDIAN OCEAN EXPEDITION SUMMARY OF BGC-ARGO DATA ACQUISITION

Table E1

Links for viewing and downloading data  
Programme or nation that provided the floats  
Station and date of deployment

WMO NUMBER EURO-ARGO ACCESS <sup>1</sup>	BGC-ARGO ACCESS	PROG.	STATION	DEPLOYMENT DATE (dd/mm/yyyy)
<a href="#">5906971</a>	<a href="https://maps.biogeochemical-argo.com/bgcargo/?&amp;txt=5906971">https://maps.biogeochemical-argo.com/bgcargo/?&amp;txt=5906971</a>	NAOS	1	27/11/2022
<a href="#">6903084</a>	<a href="https://maps.biogeochemical-argo.com/bgcargo/?&amp;txt=6903084">https://maps.biogeochemical-argo.com/bgcargo/?&amp;txt=6903084</a>	DEEP	1	27/11/2022
<a href="#">1902573</a>		ARVOR	1 bis	26/11/2022
<a href="#">5906538</a>	<a href="https://maps.biogeochemical-argo.com/bgcargo/?&amp;txt=5906538">https://maps.biogeochemical-argo.com/bgcargo/?&amp;txt=5906538</a>	GO-BGC	1 bis	26/11/2022
<a href="#">3902472</a>	<a href="https://maps.biogeochemical-argo.com/bgcargo/?&amp;txt=3902472">https://maps.biogeochemical-argo.com/bgcargo/?&amp;txt=3902472</a>	MONACO	2	25/11/2022
<a href="#">6903033</a>		DEEP	2	25/11/2022
<a href="#">4902620</a>	<a href="https://maps.biogeochemical-argo.com/bgcargo/?&amp;txt=4902620">https://maps.biogeochemical-argo.com/bgcargo/?&amp;txt=4902620</a>	CANADA	4	15/10/2022
<a href="#">5906536</a>	<a href="https://maps.biogeochemical-argo.com/bgcargo/?&amp;txt=5906536">https://maps.biogeochemical-argo.com/bgcargo/?&amp;txt=5906536</a>	GO-BGC	4	15/10/2022
<a href="#">6903149</a>		ARVOR	4	15/10/2022
<a href="#">5906970</a>	<a href="https://maps.biogeochemical-argo.com/bgcargo/?&amp;txt=5906970">https://maps.biogeochemical-argo.com/bgcargo/?&amp;txt=5906970</a>	REFINE	5	16/10/2022
<a href="#">6903088</a>	<a href="https://maps.biogeochemical-argo.com/bgcargo/?&amp;txt=6903088">https://maps.biogeochemical-argo.com/bgcargo/?&amp;txt=6903088</a>	DEEP	5	16/10/2022
<a href="#">6903148</a>	<a href="https://maps.biogeochemical-argo.com/bgcargo/?&amp;txt=6903148">https://maps.biogeochemical-argo.com/bgcargo/?&amp;txt=6903148</a>	ARVOR	5	16/10/2022
<a href="#">6990505</a>	<a href="https://maps.biogeochemical-argo.com/bgcargo/?&amp;txt=6990505">https://maps.biogeochemical-argo.com/bgcargo/?&amp;txt=6990505</a>	NAOS	5	16/10/2022
<a href="#">4902626</a>	<a href="https://maps.biogeochemical-argo.com/bgcargo/?&amp;txt=5906970">https://maps.biogeochemical-argo.com/bgcargo/?&amp;txt=5906970</a>	CANADA	6	18/10/2022
<a href="#">7901013</a>	<a href="https://maps.biogeochemical-argo.com/bgcargo/?&amp;txt=7901013">https://maps.biogeochemical-argo.com/bgcargo/?&amp;txt=7901013</a>	ARVOR-02	6	18/10/2022
<a href="#">5906972</a>	<a href="https://maps.biogeochemical-argo.com/bgcargo/?&amp;txt=5906972">https://maps.biogeochemical-argo.com/bgcargo/?&amp;txt=5906972</a>	NAOS	6 bis	21/10/2022
<a href="#">6903150</a>		ARVOR	6 bis	21/10/2022
<a href="#">6903031</a>	<a href="https://maps.biogeochemical-argo.com/bgcargo/?&amp;txt=6903031">https://maps.biogeochemical-argo.com/bgcargo/?&amp;txt=6903031</a>	DEEP	7	27/10/2022
<a href="#">5906540</a>	<a href="https://maps.biogeochemical-argo.com/bgcargo/?&amp;txt=5906540">https://maps.biogeochemical-argo.com/bgcargo/?&amp;txt=5906540</a>	GO-BGC	7	27/10/2022
<a href="#">4902623</a>	<a href="https://maps.biogeochemical-argo.com/bgcargo/?&amp;txt=4902623">https://maps.biogeochemical-argo.com/bgcargo/?&amp;txt=4902623</a>	CANADA	8	28/10/2022
<a href="#">5906969</a>	<a href="https://maps.biogeochemical-argo.com/bgcargo/?&amp;txt=5906969">https://maps.biogeochemical-argo.com/bgcargo/?&amp;txt=5906969</a>	ARVOR-02	8	28/10/2022
<a href="#">6990503</a>	<a href="https://maps.biogeochemical-argo.com/bgcargo/?&amp;txt=6990503">https://maps.biogeochemical-argo.com/bgcargo/?&amp;txt=6990503</a>	REFINE	8	28/10/2022
<a href="#">3902471</a>	<a href="https://maps.biogeochemical-argo.com/bgcargo/?&amp;txt=3902471">https://maps.biogeochemical-argo.com/bgcargo/?&amp;txt=3902471</a>	REFINE	9	01/11/2022
<a href="#">5906539</a>	<a href="https://maps.biogeochemical-argo.com/bgcargo/?&amp;txt=5906539">https://maps.biogeochemical-argo.com/bgcargo/?&amp;txt=5906539</a>	GO-BGC	9	01/11/2022
<a href="#">6990504</a>	<a href="https://maps.biogeochemical-argo.com/bgcargo/?&amp;txt=6990504">https://maps.biogeochemical-argo.com/bgcargo/?&amp;txt=6990504</a>	MONACO	9	01/11/2022
<a href="#">1902572</a>		ARVOR	10	17/11/2022
<a href="#">5906537</a>	<a href="https://maps.biogeochemical-argo.com/bgcargo/?&amp;txt=5906537">https://maps.biogeochemical-argo.com/bgcargo/?&amp;txt=5906537</a>	GO-BGC	10	17/11/2022
<a href="#">7901003</a>		ARVOR	11	21/11/2022
<a href="#">4902628</a>	<a href="https://maps.biogeochemical-argo.com/bgcargo/?&amp;txt=4902628">https://maps.biogeochemical-argo.com/bgcargo/?&amp;txt=4902628</a>	CANADA	11	22/11/2022

<sup>1</sup>Link format: <https://fleetmonitoring.euro-argo.eu/float/WMO Number>



**Table E2**

**Assessment of sensor performance for each float and measured variables**

- Green: nominal operation
- Yellow: non-optimal operation, but measures can be corrected
- Red: sensor not working

P: pressure; T: temperature, S: salinity; Chla: chlorophyll-a concentration; bb: particle backscattering; NO3: dissolved nitrate concentration; pH: acidity; O2: oxygen concentration; Mu\_Irr: multispectral irradiance; Tra: optical transmission of water; UVP: underwater imager; Hy\_Irr: hyperspectral irradiance; Hy-Rad: hyperspectral radiance.

WMO NUMBER EURO-ARGO ACCESS	P	T	S	Chla	bb	NO3	pH	O2	Mu_Irr	Tra	UVP	Hy_Irr	Hy_Rad
<a href="#">5906971</a>	●	●	●	●	●	●		●	●				
<a href="#">6903084</a>	●	●	●					●					
<a href="#">1902573</a>	●	●	●										
<a href="#">5906538</a>	●	●	●	●	●	●	●	●					
<a href="#">3902472</a>	●	●	●	●	●			●	●				
<a href="#">6903033</a>													
<a href="#">4902620</a>	●	●	●	●	●			●					
<a href="#">5906536</a>	●	●	●	●	●	●	●	●					
<a href="#">6903149</a>	●	●	●										
<a href="#">5906970</a>	●	●	●	●	●	●	●	●	●	●	●		
<a href="#">6903088</a>	●	●	●					●					
<a href="#">6903148</a>	●	●	●										
<a href="#">6990505</a>	●	●	●	●	●	●		●	●				
<a href="#">4902626</a>	●	●	●	●	●		●	●					
<a href="#">7901013</a>	●	●	●					●					
<a href="#">5906972</a>	●	●	●	●	●	●		●	●				
<a href="#">6903150</a>	●	●	●										
<a href="#">6903031</a>	●	●	●					●					
<a href="#">5906540</a>	●	●	●	●	●	●	●	●					
<a href="#">4902623</a>	●	●	●	●	●			●					
<a href="#">5906969</a>	●	●	●					●					
<a href="#">6990503</a>	●	●	●	●	●		●	●		●	●	●	●
<a href="#">3902471</a>	●	●	●	●	●		●	●	●	●	●		
<a href="#">5906539</a>	●	●	●	●	●	●	●	●					
<a href="#">6990504</a>	●	●	●	●	●			●					
<a href="#">1902572</a>	●	●	●										
<a href="#">5906537</a>	●	●	●	●	●	●	●	●					
<a href="#">7901003</a>	●	●	●										
<a href="#">4902628</a>	●	●	●	●	●		●	●					

**Table E3**  
**List of CTD stations**

OP REF	DATE (dd/mm/yyyy)	START TIME UTC (hh:mm)	LON (E)	LAT (S)	DEPTH (m)	MAX CTD DEPTH (m)	CTD FILE	CRUISE ID	AMSOL STAT REF
B5-4	15/10/2022	00:23	054°59,9'	19°30,1'	4873	1000	IO_001	VOY-055-B5-	AM01327
B5-5	16/10/2022	10:36	053°29,9'	12°40,1'	4227	2000	IO_002	VOY-055-B5-	AM01328
B5-6	17/10/2022	22:09	050°00,2'	10°45,0'	3600	1000	IO_003	VOY-055-B5-	AM01330
B5-6b	21/10/2022	16:06	044°47,78'	10°18,40'	3633	1000	IO_004	VOY-055-B5-	AM01333
S/N	23/10/2022	19:03	045°54,96'	09°25,53'	4062	1000	IO_005	VOY-055-B5-	AM01334
B5-7	26/10/2022	22:47	048°29,90'	07°59,93'	4629	2000	IO_006	VOY-055-B5-	AM01336
B5-8	28/10/2022	02:48	052°00,08'	05°30,03'	4200	2000	IO_007	VOY-055-B5-	AM01338
B5-9	01/11/2022	22:30	060°01,15'	05°59,44'	3360	2000	IO_008	VOY-055-B5-	AM01339
B5-10	17/11/2022	17:58	060°32,04'	12°27,99'		2000	IO_034	VOY-055-BOX	AM01414
B5-11	21/11/2022	18:18	058°30,01'	18°15,00'		1000	IO_036	VOY-055-B5-	AM01420
B5-2	25/11/2022	12:36	053°00,55'	24°59,57'		1000	IO_037	VOY-055-B5-2A	AM01421
B5-1b	26/11/2022	04:51	049°59,94'	27°20,02'		1000	IO_038	VOY-055-B5-	AM01422
B5-1	27/11/2022	19:18	039°59,78'	32°00,14'		1000	IO_039	VOY-055-B5-	AM01423



# APPENDIX F

## MONACO EXPLORATIONS INDIAN OCEAN EXPEDITION METADATA OF THE SURVEY EQUIPMENT

### Project parameters

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Survey Type:	Passage
Technique:	Single Beam Echo Sounders - Details below
Order of Survey:	Classified according to the S-44 Matrix as Ba7; Bb3; Bc7; Bd4 International Hydrographic Organization Standards for Hydrographic Surveys, S-44 - Edition 6.1.0 - Oct 2022
Geodetics:	Coordinate System: ITRF2014 (WGS84) Vertical Reference: EGM2008
Feature Detection Ability:	N/A
Feature Search:	N/A
Bathymetric Coverage:	N/A
Survey Date Range:	Start Date: 03/10/2022 End date: 30/11/2022
Survey undertaken by:	Survey Contractor: Underwater Surveys (Pty) Ltd Senior Project Surveyor: Andrew Matthew Tel: +27 21 709 6000 Email: info@underwatersurveys.com Project Reference: 22/116
Data Ownership:	Client: Monaco Explorations Project: Indian Ocean Expedition of Monaco Explorations
Grid Attributes:	N/A
Data Density:	N/A
Usage Constraints:	N/A

### Survey Equipment:

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Recording/Processing System:	QPS Qinsy: 9.4.6.781 (B 2002.04.16.1) Geodetic Resources: 3.0.3 QPS Geoid Height Models: 2.0.2
Single Beam Echo Sounders:	TOPAS PS18: TOPAS MMI: 3.2 Tx Ch Athwart/Along: 16/8 Element spacing Athwart/Along: 65.0/142.0 Analog sampling rate: 600 kHz Rx Channels: 1 Primary Frequency: 18.0kHz Offsets (set in device): None VRU: Not operational Sound velocity set: 1500 m/s  EA600: Transceiver: GPT-S18(2)-H 1.0 009072067462 Program Version: 2.4.0.0 Heave compensation: None Draft set in device: 5.0m Offsets (set in device): None Sound velocity set: 1500 m/s

EK60:

Program Version: Simrad ER60 V 2.2.1 (10/06/2009)  
Transceiver: GPT-38 kHz 009072060466 ES38B  
Angular parameters set in sounder: Along/Athwartship  
Angle sensitivity (el.deg/mec.deg): 21.90/21.90  
3dB beam width (deg): 7.15/7.13  
Angle Offset (deg): 0.23/-0.05  
Transceiver: GPT-120 kHz 0090720674c2 ES120-7C  
Angular parameters set in sounder: Along/Athwartship  
Angle sensitivity (el.deg/mec.deg): 23.00/23.00  
3dB beam width (deg): 6.59/6.37  
Angle Offset (deg): 0.02/-0.03  
Transceiver: GPT-200 kHz 0090720674e7 ES200-7C  
Angular parameters set in sounder: Along/Athwartship  
Angle sensitivity (el.deg/mec.deg): 23.00/23.00  
3dB beam width (deg): 6.61/6.54  
Angle Offset (deg): 0.01/-0.06  
Heave compensation: None  
Draft set in device: 0.0m  
Offsets (set in device): None  
Sound velocity set: 1500 m/s

GNSS System (Primary / Secondary):

Receiver: Veripos LD7/Veripos LD7  
Antenna: AD491/AD491  
Differential Method: PPP/PPP  
Correction Service: APEX2/APEX2  
L-Band Beam: 25E/IOR  
Horizontal accuracy: <5 cm at 95%  
Vertical accuracy: <12 cm at 95%

Heading Sensor (Primary / Secondary):

GNSS Heading: Veripos LD7/Veripos LD7

Vertical Reference Unit: None  
Heave sensor: None

**Offsets in meters [X (Stbd+)/Y (Bow +)/Z (Up +)]**

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GAPS Deployed: 0.00/0.00/0.00  
LD7 GNSS - Green: -7.00/-9.90/29.90  
LD7 GNSS - Blue: -10.93/-4.82/29.86  
TOPAS: 0.00/39.17/2.50  
EA600 18kHz: 0.00/30.44/2.46  
EK60 38 kHz - UP: -0.15/29.59/2.46  
EK60 120 kHz - UP: 0.33/29.90/2.46  
EK60 200 kHz - UP: 0.30/29.30/2.46  
EK60 38 kHz - DOWN: -0.15/29.59/-0.423  
EK60 120 kHz - DOWN: 0.33/29.90/-0.423  
EK60 200 kHz - DOWN: 0.30/29.30/-0.423



# APPENDIX G

## MONACO EXPLORATIONS INDIAN OCEAN EXPEDITION DISTRIBUTION OF THE CORAL COLONIES COLLECTED IN ALDABRA

LOCATION	RFID TAG	SPECIES NAMES IN THE RESEARCH AGREEMENT	SPECIES NAMES AFTER BETTER IDENTIFICATION	BREEDING TANK
Burgers' Zoo	977200010158962	<i>Leptoseris mycetoseroides</i>	<i>Leptoseris mycetoseroides</i>	Q04
Burgers' Zoo	977200010158964	<i>Gardineroseris planulata</i>	<i>Gardineroseris planulata</i>	Glas
Burgers' Zoo	977200010158974	<i>Echinopora gemmacea</i>	<i>Echinopora gemmacea</i>	Q04
Burgers' Zoo	977200010158975	<i>Tubinaria reniformis</i>	<i>Tubinaria mesenterina</i>	Q04
Burgers' Zoo	977200010158990	<i>Galaxea fascicularis</i>	<i>Galaxea fascicularis</i>	Q04
Burgers' Zoo	977200010158991	<i>Favites flexuosa</i>	<i>Favites abdita</i>	Q04
Burgers' Zoo	977200010159012	<i>Pavona varians</i>	<i>Pavona varians</i>	Glas
Burgers' Zoo	977200010159041	<i>Acropora hemprichii</i>	<i>Acropora valida</i>	Glas
Burgers' Zoo	977200010159061	<i>Cyphastrea microphthalma</i>	<i>Cyphastrea microphthalma</i>	Q04
Burgers' Zoo	977200010159131	<i>Isopora palmata</i>	<i>Isopora palifera</i>	Glas
Burgers' Zoo	977200010159177	<i>Leptastrea purpurea</i>	<i>Leptastrea purpurea</i>	Glas
Burgers' Zoo	977200010159184	<i>Goniastrea retiformis</i>	<i>Goniastrea edwardsi</i>	Glas
Burgers' Zoo	977200010159230	<i>Acanthastrea echinata</i>	<i>Acanthastrea hemprichii</i>	Q04
Burgers' Zoo	977200010159293	<i>Dipsastrea favus</i>	<i>Dipsastrea cf favus</i>	Q04
Monaco	977200010158951	<i>Pavona varians</i>	<i>Pavona varians</i>	K4
Monaco	977200010158977	<i>Lobactis scutaria</i>	<i>Lobactis scutaria</i>	K4
Monaco	977200010158979	<i>Tubinaria reniformis</i>	<i>Tubinaria reniformis</i>	K4
Monaco	977200010158988	<i>Stylophora palmata</i>	<i>Stylophora palmata</i>	K4
Monaco	977200010159014	<i>Stylocoeniella armata</i>	<i>Stylocoeniella armata</i>	K4
Monaco	977200010159022	<i>Galaxea fascicularis</i>	<i>Galaxea fascicularis</i>	K4
Monaco	977200010159094	<i>Leptoseris mycetoseroides</i>	<i>Leptoseris mycetoseroides</i>	K4
Monaco	977200010159154	<i>Acropora hemprichii</i>	<i>Acropora valida</i>	K4
Monaco	977200010159170	<i>Isopora palmata</i>	<i>Isopora palifera</i>	K4
Monaco	977200010159208	<i>Tubastrea micranthus</i>	<i>Tubastrea micranthus</i>	Tubastrea
Monaco	977200010159248	<i>Leptastrea purpurea</i>	<i>Leptastrea purpurea</i>	K4
Monaco	977200010159303	<i>Pocillopora sp.</i>	<i>Pocillopora eydouxi</i>	K4
Monaco	977200010159306	<i>Echinopora gemmacea</i>	<i>Echinopora gemmacea</i>	K4
Monaco	977200010159376	<i>Echinophyllia aspera</i>	<i>Echinophyllia aspera</i>	K4
Monaco	977200010159403	<i>Coscinarea monile</i>	<i>Coscinaraea monile</i>	K4
Nausicaa	977200010158972	<i>Pavona varians</i>	<i>Pavona varians</i>	
Nausicaa	977200010158976	<i>Tubinaria reniformis</i>	<i>Tubinaria mesenterina</i>	
Nausicaa	977200010158982	<i>Favites flexuosa</i>	<i>Favites abdita</i>	

LOCATION	RFID TAG	SPECIES NAMES IN THE RESEARCH AGREEMENT	SPECIES NAMES AFTER BETTER IDENTIFICATION	BREEDING TANK
Nausicaa	977200010158998	<i>Coscinarea monile</i>	<i>Coscinaraea monile</i>	
Nausicaa	977200010159036	<i>Galaxea fascicularis</i>	<i>Galaxea fascicularis</i>	
Nausicaa	977200010159072	<i>Lobactis scutaria</i>	<i>Lobactis scutaria</i>	
Nausicaa	977200010159079	<i>Goniastrea retiformis</i>	<i>Goniastrea edwardsi</i>	
Nausicaa	977200010159080	<i>Pocillopora eydouxi</i>	<i>Pocillopora eydouxi</i>	
Nausicaa	977200010159097	<i>Gardineroseris planulata</i>	<i>Gardineroseris planulata</i>	
Nausicaa	977200010159169	<i>Leptastrea purpurea</i>	<i>Leptastrea cf bottae</i>	
Nausicaa	977200010159420	<i>Acanthastrea echinata</i>	<i>Acanthastrea hemprichii</i>	
Nausicaa	977200010159236	<i>Dipsastrea favus</i>	<i>Dipsastrea cf favus</i>	
Nausicaa	977200010159288	<i>Cyphastrea microphthalma</i>	<i>Cyphastrea microphthalma</i>	
Nausicaa	977200010159377	<i>Stylophora palmata</i>	<i>Stylophora palmata</i>	
Oceanopolis	977200010158981	<i>Acropora hemprichii</i>	<i>Acropora valida</i>	
Oceanopolis	977200010158987	<i>Echinopora gemmacea</i>	<i>Echinopora gemmacea</i>	
Oceanopolis	977200010159009	<i>Coscinarea monile</i>	<i>Coscinaraea monile</i>	
Oceanopolis	977200010159117	<i>Goniastrea retiformis</i>	<i>Goniastrea edwardsi</i>	
Oceanopolis	977200010159144	<i>Lobactis scutaria</i>	<i>Lobactis scutaria</i>	
Oceanopolis	977200010159148	<i>Isopora palmata</i>	<i>Isopora palifera</i>	
Oceanopolis	977200010159182	<i>Pocillopora sp.</i>	<i>Pocillopora eydouxi</i>	
Oceanopolis	977200010159251	<i>Stylophora palmata</i>	<i>Stylophora palmata</i>	
Oceanopolis	977200010159259	<i>Leptoseris mycetoseroides</i>	<i>Leptoseris mycetoseroides</i>	
Oceanopolis	977200010159287	<i>Favites flexuosa</i>	<i>Favites abdita</i>	
Oceanopolis	977200010159314	<i>Echinophyllia aspera</i>	<i>Echinophyllia aspera</i>	
Oceanopolis	977200010159333	<i>Leptastrea purpurea</i>	<i>Leptastrea cf bottae</i>	
Oceanopolis	977200010159370	<i>Stylocoeniella armata</i>	<i>Stylocoeniella armata</i>	
Oceanopolis	977200010159408	<i>Dipsastrea favus</i>	<i>Dipsastrea cf favus</i>	
Oceanopolis	977200010159213	<i>Acanthastrea echinata</i>	<i>Acanthastrea hemprichii</i>	



# APPENDIX H

## MONACO EXPLORATIONS INDIAN OCEAN EXPEDITION INVENTORY OF SAYA DE MALHA OPERATIONS

- **Table H1:** List of CTD stations
- **Table H2:** List of XBT casts
- **Table H3:** List of UVP casts
- **Table H4:** List of meso-zooplankton nets
- **Table H5:** List of diving operations
- **Table H6:** List of towed operations
- **Table H7:** List of samples collected

NO	STATION ID	DATE (dd/mm/yyyy)	START TIME UTC (hh:mm)	LON (E)	LAT (S)	CTD FILE
1	ST 1	02/11/2022	16:39	059°57.00'	09°27.04'	IO_009
2	ST 2	02/11/2022	20:03	060°05.95'	09°37.80'	IO_010
3	ST 3	03/11/2022	00:13	060°26.96'	09°43.19'	IO_011
4	ST 4	05/11/2022	09:56	060°28.79'	10°30.00'	IO_012
5	ST 6	05/11/2022	17:41	059°59.90'	11°13.12'	IO_013
6	ST 7	05/11/2022	21:45	060°05.96'	11°06.01'	IO_014
7	ST 8	06/11/2022	01:18	060°11.94'	10°59.97'	IO_015
8	ST 16R	08/11/2022	15:30	061°48.58'	10°11.98'	IO_016
9	ST 15R	08/11/2022	18:12	061°42.00'	10°33.53'	IO_017
10	ST 17	09/11/2022	16:13	062°36.02'	10°12.06'	IO_018
11	ST 18R	09/11/2022	21:00	062°17.97'	10°11.96'	IO_019
12	ST 19R	09/11/2022	23:56	062°15.28'	10°12.24'	IO_020
13	ST 22R	11/11/2022	14:10	062°18.06'	10°54.03'	IO_021
14	ST 21R	11/11/2022	17:20	062°20.53'	10°54.29'	IO_022
15	ST 20R	11/11/2022	20:35	062°38.94'	10°53.96'	IO_023
16	ST 23	12/11/2022	03:25	062°07.71'	11°22.25'	IO_024
17	ST 24R	13/11/2022	06:50	061°44.96'	11°40.24'	IO_025
18	ST 31	13/11/2022	16:48	062°06.60'	11°41.83'	IO_026
19	ST 30	13/11/2022	19:20	062°14.39'	11°46.21'	IO_027
20	ST 29R	14/11/2022	00:12	062°21.99'	11°51.70'	IO_028
21	ST 32	14/11/2022	22:18	061°11.99'	12°00.03'	IO_029
22	ST 33	15/11/2022	11:50	061°04.16'	11°37.11'	IO_030
23	ST 37R	16/11/2022	14:59	060°29.40'	12°02.32'	IO_031
24	ST 38R	16/11/2022	20:03	060°47.37'	11°58.85'	IO_032
25	ST 39R	16/11/2022	23:45	060°53.72'	11°51.80'	IO_033

**Table H1**

List of the CTD stations including start date/time, lat/lon, bottom depth and maximum sampled depth, number of sampled depths, station IDs and the type of zooplankton net deployed.

The stations highlighted in light blue are the deep stations performed outside the Saya de Malha Bank

DEPTH (m)	MAXIMUM CTD DEPTH (m)	NUMBER OF BOTTLES CLOSED	SAMPLING DEPTHS	ZOOPLANKTON NET	CRUISE ID
722	700	16	12	Bongo	VOY-55-B1-1
970	950	23	14	Bongo	VOY-55-B1-2
1614	1000	23	15	Bongo	VOY-55-B1-3
60	60	9	3	Bongo	VOY-55-B2-1
2855	1500	24	16	Multinet	VOY-55-B2-2
2740	1500	24	16	Bongo	VOY-55-B2-3
1598	1000	23	13	Bongo	VOY-55-B2-4
71	76	12	7	Bongo	VOY-55-B3-1
70	76	17	8	Bongo	VOY-55-B3-2
2196	2000	24	19	Multinet	VOY-55-B3-3
1545	1500	24	17	Bongo	VOY-55-B3-4
930	900	24	17	Bongo	VOY-55-B3-5
897	850	23	17	Bongo	VOY-55-B3-6
1830	1500	24	18	Bongo	VOY-55-B3-7
2252	2000	24	19	Multinet	VOY-55-B3-8
225	200	15	9	Bongo	VOY-55-B4-1
227	200	15	9	Bongo	VOY-55-B4-2
870	880	22	15	Bongo	VOY-55-B4-3
2274	2000	24	18	Multinet	VOY-55-B4-4
667	650	19	13	Bongo	VOY-55-B4-5
284	287	18	12	Bongo	VOY-55-BOX5-1
209	200	16	10	Bongo	VOY-55-BOX5-2
2640	2000	24	18	Multinet	VOY-55-BOX5-3
1685	1500	22	16	Bongo	VOY-55-BOX5-4
765	755	23	14	Bongo	VOY-55-BOX5-5



**Table H2**  
**List of XBT casts**

<b>XBT NO</b>	<b>DAY (dd/mm/yyyy)</b>	<b>START TIME (UTC) (hh:mm)</b>	<b>LON (E)</b>	<b>LAT (S)</b>	<b>MAX DEPTH (m)</b>	<b>FILE NAME</b>	<b>COMMENT</b>
1	09/11/2022	20:04	062°29.92'	10°12.00'	820	drop003.nc	North transect box 3
2	09/11/2022	20:19	062°25.72'	10°12.00'	820	drop004.nc	North transect box 3
3	09/11/2022	20:31	062°21.55'	10°12.00'	840	drop005.nc	North transect box 3
4	11/11/2022	19:21	062°24.60'	10°54.00'	880	drop006.nc	South transect box 3
5	11/11/2022	19:39	062°28.80'	10°54.00'	760	drop007.nc	South transect box 3
6	11/11/2022	19:59	062°33.00'	10°54.00'	840	drop008.nc	South transect box 3
7	16/11/2022	18:49	060°35.40'	12°01.20'	900	drop009.nc	Transect box 5
8	16/11/2022	19:16	060°41.40'	12°00.00'	805	drop010.nc	Transect box 5
9	16/11/2022	22:29	060°50.40'	11°55.20'	820	drop011.nc	Transect box 5
10	17/11/2022	22:32	060°38.35'	12°31.85'	880	drop012.nc	Channel south of Saya de Malha
11	17/11/2022	22:49	060°42.87'	12°33.84'	920	drop013.nc	Channel south of Saya de Malha
12	17/11/2022	23:08	060°48.35'	12°35.78'	380	drop014.nc	Channel south of Saya de Malha
13	17/11/2022	23:40	060°55.50'	12°39.02'	420	drop015.nc	Channel south of Saya de Malha
14	18/11/2022	00:06	061°02.17'	12°42.15'	920	drop016.nc	Channel south of Saya de Malha
15	18/11/2022	00:35	061°09.01'	12°45.31'	880	drop017.nc	Channel south of Saya de Malha
16	18/11/2022	01:06	061°16.25'	12°48.52'	780	drop018.nc	Channel south of Saya de Malha
17	18/11/2022	20:35	060°43.46'	16°29.83'	900	drop019.nc	Saint Brandon transect
18	18/11/2022	21:52	060°23.22'	16°31.23'	640	drop020.nc	Saint Brandon transect
19	18/11/2022	21:52	060°12.15'	16°31.24'	220	drop021.nc	Saint Brandon transect
20	21/11/2022	11:08	059°11.42'	17°08'	260	drop022.nc	Transect from Saint Brandon to Mauritius
21	21/11/2022	12:34	059°08.98'	17°14.86'	290	drop023.nc	Transect from Saint Brandon to Mauritius
22	21/11/2022	15:17	058°56.08'	17°35.31'	900	drop024.nc	Transect from Saint Brandon to Mauritius
23	22/11/2022	00:10	58°02.50'	19°01.00'	850	drop025.nc	Transect from Saint Brandon to Mauritius

**Table H3**  
**List of UVP casts**

PROFILE_ID	BOTTOM DEPTH (m)	CTD FILENAME	LON (E)	LAT (S)	STATION (OR GRID #)	PHASE
io_station_001	4873	io_001	054°36.0'	19°18.1'	io_station_001	1
io_station_002	4227	io_002	053°17.9'	12°24.0'	io_station_002	1
io_station_003	3600	io_003	050°00.1'	10°27.0'	io_station_003	1
io_station_004	3633	io_004	044°28.7'	10°11.0'	io_station_004	1
io_station_005	4062	io_005	045°33.0'	09°15.3'	io_station_005	1
io_station_006	4629	io_006	048°17.9'	07°36.0'	io_station_006	1
io_station_007	4200	io_007	052°00.0'	05°18.1'	io_station_007	1
io_station_008	3360	io_008	060°00.7'	05°35.7'	io_station_008	1
io_station_009	726	io_009	059°34.1'	09°16.2'	VOY-055-B1-1	2
io_station_010	970	io_010	060°03.6'	09°22.7'	VOY-055-B1-2	2
io_station_011	1614	io_011	060°16.2'	09°25.9'	VOY-055-B1-3	2
io_station_012	62	io_012	060°17.3'	10°18.0'	VOY-055-B2-1	2
io_station_013	2855	io_013	059°35.9'	11°07.9'	VOY-055-B2-2	2
io_station_014	2740	io_014	060°03.6'	11°03.6'	VOY-055-B2-3	2
io_station_015	1598	io_015	060°07.2'	10°36.0'	VOY-055-B2-4	2
io_station_016	71	io_016	061°29.1'	10°07.2'	VOY-055-B3-1	2
io_station_017	70	io_017	061°25.2'	10°20.1'	VOY-055-B3-2	2
io_station_018	2196	io_018	062°21.6'	10°07.2'	VOY-055-B3-3	2
io_station_019	1545	io_019	062°10.8'	10°07.2'	VOY-055-B3-4	2
io_station_020	930	io_020	062°09.2'	10°07.3'	VOY-055-B3-5	2
io_station_021	897	io_021	062°10.8'	10°32.4'	VOY-055-B3-6	2
io_station_022	1830	io_022	062°12.3'	10°32.6'	VOY-055-B3-7	2
io_station_023	2252	io_023	062°23.4'	10°32.4'	VOY-055-B3-8	2
io_station_024	225	io_024	062°04.6'	11°13.4'	VOY-055-B4-1	2
io_station_025	227	io_025	061°27.0'	11°24.1'	VOY-055-B4-2	2
io_station_026	870	io_026	062°03.1'	11°25.1'	VOY-055-B4-3	2
io_station_027	2274	io_027	062°08.6'	11°27.7'	VOY-055-B4-4	2
io_station_028	667	io_028	062°13.2'	11°31.0'	VOY-055-B4-5	2
io_station_029	289	io_029	061°07.2'	12°00.0'	VOY-055-BOX5-1	2
io_station_030	209	io_030	061°02.5'	11°22.3'	VOY-055-BOX5-2	2
io_station_031	2497	io_031	060°17.6'	12°01.4'	VOY-055-BOX5-3	2
io_station_032	1740	io_032	060°28.4'	11°35.3'	VOY-055-BOX5-4	2
io_station_033	760	io_033	060°32.0'	11°31.0'	VOY-055-BOX5-5	2



**Table H4**  
**List of mesozooplankton nets**

SAMPLE_NAME	LONGITUDE (E)	LATITUDE (S)	DATE (dd/mm/yyyy)	TIME (UTC)	LOCAL TIME	DAY / NIGHT	BOTTOM DEPTH (m)
EDM_station_009	059°59.914'	09°27.036'	02/11/2022	18:06	22:06	N	726
EDM_station_010	060°05.948'	09°37.803'	02/11/2022	21:23	01:23	N	970
EDM_station_011	060°26.956'	09°43.191'	03/11/2022	0:20	04:20	N	1614
EDM_station_012	060°28.786'	10°30.00'	05/11/2022	0:20	04:20	D	62
EDM_station_013_9	059°59.896'	11°13.119'	05/11/2022	21:30	01:30	N	2855
EDM_station_013_8	059°59.896'	11°13.119'	05/11/2022	21:30	01:30	N	2855
EDM_station_013_7	059°59.896'	11°13.119'	05/11/2022	21:30	01:30	N	2855
EDM_station_013_6	059°59.896'	11°13.119'	05/11/2022	21:30	01:30	N	2855
EDM_station_013_5	059°59.896'	11°13.119'	05/11/2022	21:30	01:30	N	2855
EDM_station_013_4	059°59.896'	11°13.119'	05/11/2022	21:30	01:30	N	2855
EDM_station_013_3	059°59.896'	11°13.119'	05/11/2022	21:30	01:30	N	2855
EDM_station_013_2	059°59.896'	11°13.119'	05/11/2022	21:30	01:30	N	2855
EDM_station_013_1	059°59.896'	11°13.119'	05/11/2022	21:30	01:30	N	2855
EDM_station_014	060°05.962'	11°06.007'	05/11/2022	23:30	03:30	N	2740
EDM_station_015	060°11.944'	10°59.967'	06/11/2022	0:52	04:52	dawn	1598
EDM_station_016	061°48.576'	10°11.979'	08/11/2022	17:58	22:58	N	71
EDM_station_017	061°41.999'	10°33.532'	08/11/2022	20:36	01:36	N	70
EDM_station_018_9	062°36.025'	10°12.061'	09/11/2022	18:10	23:10	N	2196
EDM_station_018_8	062°36.025'	10°12.061'	09/11/2022	18:10	23:10	N	2196
EDM_station_018_7	062°36.025'	10°12.061'	09/11/2022	18:10	23:10	N	2196
EDM_station_018_6	062°36.025'	10°12.061'	09/11/2022	18:10	23:10	N	2196
EDM_station_018_5	062°36.025'	10°12.061'	09/11/2022	18:10	23:10	N	2196
EDM_station_018_4	062°36.025'	10°12.061'	09/11/2022	18:10	23:10	N	2196
EDM_station_018_3	062°36.025'	10°12.061'	09/11/2022	18:10	23:10	N	2196
EDM_station_018_2	062°36.025'	10°12.061'	09/11/2022	18:10	23:10	N	2196
EDM_station_018_1	062°36.025'	10°12.061'	09/11/2022	18:10	23:10	N	2196
EDM_station_019	062°17.968'	10°11.964'	09/11/2022	22:33	03:33	N	1545
EDM_station_020	062°15.278'	10°12.243'	09/11/2022	23:20	04:20	N	930
EDM_station_021	062°18.056'	10°54.028'	11/11/2022	03:58	08:58	N	897
EDM_station_022	062°20.527'	10°54.290'	11/11/2022	16:52	21:52	N	1830
EDM_station_023_9	062°38.944'	10°53.965'	11/11/2022	22:52	03:52	N	2252

STATION_ID	CTD_FILENAME	GRID #	NET TYPE & NUMBER	MAX. DEPTH (m)	MIN. DEPTH (m)	VOLUME FILTERED (m³)	BARCODE
EDM_station_009	io_009	VOY-055-B1-1	Bongo	180	0	96	EDM000000218
EDM_station_010	io_010	VOY-055-B1-2	Bongo	200	0	177	EDM000000222
EDM_station_011	io_011	VOY-055-B1-3	Bongo	200	0	139	EDM000000213
EDM_station_012	io_012	VOY-055-B2-1	Bongo	50	0	61	EDM000000214
EDM_station_013	io_013	VOY-055-B2-2	Multinet_9	899	699	137	EDM000000205
EDM_station_013	io_013	VOY-055-B2-2	Multinet_8	699	497	148	EDM000000207
EDM_station_013	io_013	VOY-055-B2-2	Multinet_7	497	349	87	EDM000000208
EDM_station_013	io_013	VOY-055-B2-2	Multinet_6	349	248	60	EDM000000209
EDM_station_013	io_013	VOY-055-B2-2	Multinet_5	247	200	29	EDM000000210
EDM_station_013	io_013	VOY-055-B2-2	Multinet_4	199	149	33	EDM000000211
EDM_station_013	io_013	VOY-055-B2-2	Multinet_3	149	97	33	EDM000000217
EDM_station_013	io_013	VOY-055-B2-2	Multinet_2	97	50	27	EDM000000215
EDM_station_013	io_013	VOY-055-B2-2	Multinet_1	50	0	47	EDM000000221
EDM_station_014	io_014	VOY-055-B2-3	Bongo	200	0	111	EDM000000206
EDM_station_015	io_015	VOY-055-B2-4	Bongo	200	0	135	EDM000000204
EDM_station_016	io_016	VOY-055-B3-1	Bongo	200	0	18	EDM000000203
EDM_station_017	io_017	VOY-055-B3-2	Bongo	200	0	2	EDM000000201
EDM_station_018	io_018	VOY-055-B3-3	Multinet_9	89ç	698	139	EDM000000190
EDM_station_018	io_018	VOY-055-B3-3	Multinet_8	697	496	136	EDM000000191
EDM_station_018	io_018	VOY-055-B3-3	Multinet_7	496	348	111	EDM000000195
EDM_station_018	io_018	VOY-055-B3-3	Multinet_6	348	248	66	EDM000000196
EDM_station_018	io_018	VOY-055-B3-3	Multinet_5	248	98	29	EDM000000198
EDM_station_018	io_018	VOY-055-B3-3	Multinet_4	198	147	31	EDM000000179
EDM_station_018	io_018	VOY-055-B3-3	Multinet_3	147	97	28	EDM000000199
EDM_station_018	io_018	VOY-055-B3-3	Multinet_2	96	48	38	EDM000000197
EDM_station_018	io_018	VOY-055-B3-3	Multinet_1	48	1	36	EDM000000200
EDM_station_019	io_019	VOY-055-B3-4	Bongo	200	0	171	EDM000000189
EDM_station_020	io_020	VOY-055-B3-5	Bongo	200	0	267	EDM000000188
EDM_station_021	io_021	VOY-055-B3-6	Bongo	200	0	123	EDM000000187
EDM_station_022	io_022	VOY-055-B3-7	Bongo	200	0	136	EDM000000192
EDM_station_023	io_023	VOY-055-B3-8	Multinet_9	899	698	139	EDM000000160



SAMPLE_NAME	LONGITUDE (E)	LATITUDE (S)	DATE (dd/mm/yyyy)	TIME (UTC)	LOCAL TIME	DAY / NIGHT	BOTTOM DEPTH (m)
EDM_station_023_8	062°38.944'	10°53.965'	11/11/2022	22:52	03:52	N	2252
EDM_station_023_7	062°38.944'	10°53.965'	11/11/2022	22:52	03:52	N	2252
EDM_station_023_6	062°38.944'	10°53.965'	11/11/2022	22:52	03:52	N	2252
EDM_station_023_5	062°38.944'	10°53.965'	11/11/2022	22:52	03:52	N	2252
EDM_station_023_4	062°38.944'	10°53.965'	11/11/2022	22:52	03:52	N	2252
EDM_station_023_3	062°38.944'	10°53.965'	11/11/2022	22:52	03:52	N	2252
EDM_station_023_2	062°38.944'	10°53.965'	11/11/2022	22:52	03:52	N	2252
EDM_station_023_1	062°38.944'	10°53.965'	11/11/2022	22:52	03:52	N	2252
EDM_station_024	062°07.707'	11°22.248'	12/11/2022	04:19	09:19	D	225
EDM_station_025	061°44.957'	11°40.241'	13/11/2022	07:25	12:25	D	227
EDM_station_026	062°05.229'	11°41.826'	13/11/2022	16:49	21:49	N	870
EDM_station_027_9	062°14.387'	11°46.213'	13/11/2022	21:20	02:20	N	2274
EDM_station_027_8	062°14.387'	11°46.213'	13/11/2022	21:20	02:20	N	2274
EDM_station_027_7	062°14.387'	11°46.213'	13/11/2022	21:20	02:20	N	2274
EDM_station_027_6	062°14.387'	11°46.213'	13/11/2022	21:20	02:20	N	2274
EDM_station_027_5	062°14.387'	11°46.213'	13/11/2022	21:20	02:20	N	2274
EDM_station_027_4	062°14.387'	11°46.213'	13/11/2022	21:20	02:20	N	2274
EDM_station_027_3	062°14.387'	11°46.213'	13/11/2022	21:20	02:20	N	2274
EDM_station_027_2	062°14.387'	11°46.213'	13/11/2022	21:20	02:20	N	2274
EDM_station_027_1	062°14.387'	11°46.213'	13/11/2022	21:20	02:20	N	2274
EDM_station_028	062°21.988'	11°51.700'	14/11/2022	23:30	04:30	N	667
EDM_station_029	061°11.988'	12°00.027'	14/11/2022	23:00	04:00	N	289
EDM_station_030	061°04.163'	11°37.114'	15/11/2022	12:53	17:53	D	209
EDM_station_031_9	060°29.399'	12°02.318'	16/11/2022	17:00	22:00	N	2497
EDM_station_031_8	060°29.399'	12°02.318'	17/11/2022	17:00	22:00	N	2497
EDM_station_031_7	060°29.399'	12°02.318'	18/11/2022	17:00	22:00	N	2497
EDM_station_031_6	060°29.399'	12°02.318'	19/11/2022	17:00	22:00	N	2497
EDM_station_031_5	060°29.399'	12°02.318'	20/11/2022	17:00	22:00	N	2497
EDM_station_031_4	060°29.399'	12°02.318'	21/11/2022	17:00	22:00	N	2497
EDM_station_031_3	060°29.399'	12°02.318'	22/11/2022	17:00	22:00	N	2497
EDM_station_031_2	060°29.399'	12°02.318'	23/11/2022	17:00	22:00	N	2497
EDM_station_031_1	060°29.399'	12°02.318'	24/11/2022	17:00	22:00	N	2497
EDM_station_032	060°47.371'	11°58.848'	16/11/2022	20:35	01:35	N	1740
EDM_station_033	060°53.723'	11°51.802'	16/11/2022	23:00	04:00	N	760

STATION_ID	CTD_FILENAME	GRID #	NET TYPE & NUMBER	MAX. DEPTH (m)	MIN. DEPTH (m)	VOLUME FILTERED (m³)	BARCODE
EDM_station_023	io_023	VOY-055-B3-8	Multinet_8	697	496	136	EDM000000163
EDM_station_023	io_023	VOY-055-B3-8	Multinet_7	496	348	111	EDM000000164
EDM_station_023	io_023	VOY-055-B3-8	Multinet_6	348	248	66	EDM000000168
EDM_station_023	io_023	VOY-055-B3-8	Multinet_5	248	198	29	EDM000000171
EDM_station_023	io_023	VOY-055-B3-8	Multinet_4	198	147	31	EDM000000172
EDM_station_023	io_023	VOY-055-B3-8	Multinet_3	148	97	28	EDM000000175
EDM_station_023	io_023	VOY-055-B3-8	Multinet_2	96	48	38	EDM000000182
EDM_station_023	io_023	VOY-055-B3-8	Multinet_1	48	1	36	EDM000000193
EDM_station_024	io_024	VOY-055-B4-1	Bongo	200	0	148	EDM000000156
EDM_station_025	io_025	VOY-055-B4-2	Bongo	200	0	205	EDM000000153
EDM_station_026	io_026	VOY-055-B4-3	Bongo	200	0	118	EDM000000155
EDM_station_027	io_027	VOY-055-B4-4	Multinet_9	898	697	119	EDM000000159
EDM_station_027	io_027	VOY-055-B4-4	Multinet_8	697	498	124	EDM000000165
EDM_station_027	io_027	VOY-055-B4-4	Multinet_7	497	348	91	EDM000000166
EDM_station_027	io_027	VOY-055-B4-4	Multinet_6	348	249	60	EDM000000167
EDM_station_027	io_027	VOY-055-B4-4	Multinet_5	249	198	30	EDM000000161
EDM_station_027	io_027	VOY-055-B4-4	Multinet_4	198	148	29	EDM000000162
EDM_station_027	io_027	VOY-055-B4-4	Multinet_3	148	98	29	EDM000000144
EDM_station_027	io_027	VOY-055-B4-4	Multinet_2	98	49	35	EDM000000158
EDM_station_027	io_027	VOY-055-B4-4	Multinet_1	48	0	37	EDM000000152
EDM_station_028	io_028	VOY-055-B4-5	Bongo	200	0	108	EDM000000157
EDM_station_029	io_029	VOY-055-BOX5-1	Bongo	200	0	137	EDM000000154
EDM_station_030	io_030	VOY-055-BOX5-2	Bongo	200	0	126	EDM000000139
EDM_station_031	io_031	VOY-055-BOX5-3	Multinet_9	899	697	134	EDM000000127
EDM_station_031	io_031	VOY-055-BOX5-3	Multinet_8	697	500	127	EDM000000180
EDM_station_031	io_031	VOY-055-BOX5-3	Multinet_7	499	350	100	EDM000000151
EDM_station_031	io_031	VOY-055-BOX5-3	Multinet_6	350	248	63	EDM000000150
EDM_station_031	io_031	VOY-055-BOX5-3	Multinet_5	247	198	28	EDM000000129
EDM_station_031	io_031	VOY-055-BOX5-3	Multinet_4	198	146	33	EDM000000130
EDM_station_031	io_031	VOY-055-BOX5-3	Multinet_3	146	98	32	EDM000000132
EDM_station_031	io_031	VOY-055-BOX5-3	Multinet_2	98	48	32	EDM000000137
EDM_station_031	io_031	VOY-055-BOX5-3	Multinet_1	48	0	35	EDM000000138
EDM_station_032	io_032	VOY-055-BOX5-4	Bongo	200	0	164	EDM000000126
EDM_station_033	io_033	VOY-055-BOX5-5	Bongo	200	0	159	EDM000000125



**Table H5**  
**List of diving operations**

DATE (dd/mm/yyyy)	AREA	SITE	TIME APPROX. (UTC)	LON (E)	LAT (S)
03/11/2022	Box 1	SD1	03:30	060°10.2'	09°34.0'
04/11/2022	Box 1	SD2	05:10	060°11.8'	09°52.3'
04/11/2022	Box 1	SD2	04:10	060°11.8'	09°52.3'
05/11/2022	Box 2	SD3	04:45	060°13.5'	10°35.6'
05/11/2022	Box 2	SD3	04:40	060°10.3'	10°37.2'
06/11/2022	Box 2	SD4	05:15	060°26.8'	11°08.2'
06/11/2022	Box 2	SD4	04:55	060°26.8'	11°08.2'
07/11/2022	North SMB	SD5	11:00	060°54.2'	09°55.5'
07/11/2022	North SMB	SD5	11:00	060°54.0'	09°55.3'
08/11/2022	North SMB	SD6	03:20	060°51.0'	09°41.9'
08/11/2022	North SMB	SD6	03:20	060°51.0'	09°41.9'
09/11/2022	Box 3	SD7	03:30	062°02.8'	10°37.2'
09/11/2022	Box 3	SD7	03:30	062°02.8'	10°37.2'
09/11/2022	Box 3	SD8	10:40	062°07.8'	10°22.8'
09/11/2022	Box 3	SD8	10:40	062°07.8'	10°22.8'
10/11/2022	Box 3	SD9	03:05	062°09.1'	10°12.1'
10/11/2022	Box 3	SD9	03:00	062°09.1'	10°12.1'
11/11/2022	Box 3	SD10	04:00	062°10.5'	10°44.0'
11/11/2022	Box 3	SD10	04:00	062°10.5'	10°44.0'
11/11/2022	Box 3	SD11	11:00	062°00.8'	10°54.0'
11/11/2022	Box 3	SD11	11:00	062°00.8'	10°54.0'
13/11/2022	Box 4	SD12	03:00	061°54.0'	11°44.0'
13/11/2022	Box 4	SD12	03:00	061°54.0'	11°44.0'

\* Sampling techniques: YS: suction; YB: brushing basket; YR: sight picking; N: net

TEAM	DEPTH (m)	BOTTOM TIME (min)	TOTAL TIME (min)	SAMPLING*	COMMENT
All	NO	NO	NO	/	Diving cancelled due to bad weather
Open circuit	42	25	70	YR01	
Rebreather	42	40	93	YR02	Suction lost, swell 2 meters, wind
Open circuit	43	15	31	YR03	
Rebreather	50	35	134	YS02-YR04	Swell 2 meters, wind
Open circuit	39	23	53	YR05	
Rebreather	37	45	106	YS04-YR06	
Open circuit	25	38	58	YR07-N01-YS01	
Rebreather	58	55	113	YS06-YR08	
Open circuit	19	58	79	YR09	
Rebreather	26	90	107	YS08-YR10	
Open circuit	27	40	60	YR11	
Rebreather	27	83	103	YS10-YR12	
Open circuit	24	37	54	YR13	
Rebreather	26	69	94	YS12-YR14	
Open circuit	24	45	80	YR15-N02-YB01	
Rebreather	24	104	129	YS14-YR16	
Open circuit	27	40	50	YR17-N03-YB03	
Rebreather	27	72	105	YS16-YR18	
Open circuit	30	31	58	YR19	
Rebreather	30	65	108	YS18-YR20	
Open circuit	47	21	68	YR21	
Rebreather	47	58	118	YS20-YR22	



**Table H6**

**List of towed operations (DW: dredge / CP: beam trawl / EB: epibenthic sledge)**

DATE (dd/mm/yyyy)	BOX	OP REF	NUMBER MNHN	GEAR TYPE	START POSITION		
					TIME UTC	LON (E)	LAT (S)
03/11/2022	1	TG1	5400	DW	11:18	060°10,13'	09°24,54'
03/11/2022	1	TG1	5401	DW	12:57	060°09,03'	09°24,17'
03/11/2022	1	TG1	5402	DW	14:19	060°10,49'	09°25,08'
04/11/2022	1	TG2	5403	CP	11:36	060°02,77'	09°40,21'
04/11/2022	1	TG2	5404	CP	13:54	060°03,83'	09°41,47'
05/11/2022	2	TG3	5405	DW	13:00	060°30,33'	10°45,50'
05/11/2022	2	TG3	5406	DW	13:41	060°30,87'	10°45,69'
06/11/2022	2	TG4	5407	DW	09:27	060°18,91'	10°59,36'
06/11/2022	2	TG4	5408	DW	10:34	060°19,32'	10°59,95'
06/11/2022	2	TG4	5409	DW	12:32	060°20,99'	11°02,05'
06/11/2022	2	TG4	5410	CP	13:50	060°21,61'	11°02,63'
07/11/2022	North SMB	TG5a	5411	DW	02:53	060°45,46'	09°49,81'
07/11/2022	North SMB	TG5b	5412	CP	07:16	060°48,05'	09°44,19'
07/11/2022	North SMB	TG5b	5413	DW	04:32	060°50,22'	09°44,81'
09/11/2022	3	TG6	5414	CP	07:08	061°48,50'	10°23,28'
09/11/2022	3	TG6	5415	EB	08:23	061°48,89'	10°23,30'
10/11/2022	3	TG7	5416	CP	07:27	061°48,60'	10°14,02'
10/11/2022	3	TG7	5417	EB	08:38	061°48,61'	10°14,52'
10/11/2022	3	TG7	5418	EB	09:12	061°48,61'	10°14,68'
10/11/2022	3	TG7	5419	CP	10:59	061°47,51'	10°15,42'
12/11/2022	4	TG8	5420	DW	05:56	062°10,33'	11°25,00'
12/11/2022	4	TG8	5421	CP	07:24	062°11,44'	11°25,12'
12/11/2022	4	TG8	5422	EB	08:52	062°12,33'	11°25,15'
12/11/2022	4	TG8	5423	DW	11:12	062°00,86'	11°26,78'

TIME UTC	END POSITION		DURATION (h:mm)	DISTANCE (m)	DEPTH (m)	AMSOL STAT REF
	LON (E)	LAT (S)				
11:39	060°10,53'	09°24,83'	0:21	924	286	AM01343
13:09	060°09,34'	09°24,34'	0:12	664	244	AM01343
14:28	060°10,62'	09°25,22'	0:09	367	317	AM01344
11:46	060°02,94'	09°40,40'	0:10	472	873	AM01345
14:12	060°04,03'	09°41,70'	0:18	572	862	AM01346
13:13	060°30,52'	10°45,60'	0:13	394	112	AM01349
13:58	060°31,14'	10°45,76'	0:17	512	110	AM01349
09:47	060°19,10'	10°59,65'	0:20	644	196	AM01353
10:50	060°19,51'	11°00,19'	0:16	572	205	AM01353
12:52	060°21,24'	11°02,29'	0:20	646	214	AM01354
14:06	060°21,83'	11°02,83'	0:16	540	201	AM01355
03:03	060°45,57'	09°49,76'	0:10	233	204	AM01357
07:46	060°48,44'	09°44,56'	0:30	988	1419	AM01358
04:42	060°50,13'	09°44,92'	0:10	261	1158	AM01359
07:19	061°48,72'	10°23,30'	0:11	408	76	AM01363
08:28	061°48,96'	10°23,30'	0:05	130	73	AM01364
07:47	061°48,61'	10°14,37'	0:20	643	76	AM01368
08:43	061°48,61'	10°14,60'	0:05	156	73	AM01369
09:18	061°48,62'	10°14,76'	0:06	159	73	AM01370
11:29	061°47,37'	10°15,96'	0:30	1021	80	AM01371
06:16	062°10,70'	11°25,04'	0:20	684	215	AM01378
07:54	062°11,93'	11°25,17'	0:30	907	215	AM01379
08:57	062°12,42'	11°25,15'	0:05	156	214	AM01380
11:32	062°00,77'	11°27,12'	0:20	651	204	AM01381



DATE (dd/mm/yyyy)	BOX	OP REF	NUMBER MNHN	GEAR TYPE	START POSITION		
					TIME UTC	LON (E)	LAT (S)
12/11/2022	4	TG8	5424	DW	12:23	062°00,60'	11°27,68'
13/11/2022	4	TG9	5425	DW	09:09	061°42,71'	11°43,53'
13/11/2022	4	TG9	5426	CP	10:39	061°43,64'	11°43,63'
13/11/2022	4	TG9	5427	EB	12:02	061°44,54'	11°43,63'
14/11/2022	4	TG10	5428	DW	10:54	062°21,62'	11°53,93'
14/11/2022	4	TG10	5429	DW	13:06	062°22,83'	11°52,33'
15/11/2022	5	TG11	5430	DW	02:06	061°09,25'	11°46,52'
15/11/2022	5	TG11	5431	CP	03:28	061°10,19'	11°46,09'
15/11/2022	5	TG11	5432	EB	05:07	061°11,30'	11°45,64'
15/11/2022	5	TG11	5433	CP	07:01	061°11,85'	11°41,95'
15/11/2022	5	TG11	5434	DW	09:45	061°05,36'	11°47,44'
16/11/2022	5	TG12	5435	DW	01:58	060°55,07'	11°49,87'
16/11/2022	5	TG12	5436	CP	03:54	060°55,63'	11°49,97'
16/11/2022	5	TG12	5437	DW	05:48	060°56,91'	11°49,57'
16/11/2022	5	TG12	5438	DW	08:08	061°00,03'	11°51,75'
16/11/2022	5	TG12	5439	CP	09:50	061°01,05'	11°51,18'
16/11/2022	5	TG12	5440	DW	11:15	061°01,82'	11°50,73'
17/11/2022	5	TG13	5441	DW	03:38	061°00,60'	12°16,27'
17/11/2022	5	TG13	5442	CP	05:24	061°01,39'	12°17,21'
17/11/2022	5	TG13	5443	CP	09:44	061°00,29'	12°36,82'
17/11/2022	5	TG13	5444	EB	12:54	061°01,56'	12°37,95'
17/11/2022	5	TG13	5445	DW	15:09	060°55,85'	12°36,05'

TIME UTC	END POSITION		DURATION (h:mm)	DISTANCE (m)	DEPTH (m)	AMSOL STAT REF
	LON (E)	LAT (S)				
12:33	062°00,55'	11°28,02'	0:10	631	161	AM01382
09:29	061°43,04'	11°43,63'	0:20	630	230	AM01384
11:09	061°44,16'	11°43,63'	0:30	956	219	AM01385
12:07	061°44,62'	11°43,63'	0:05	146	321	AM01386
11:17	062°21,74'	11°54,10'	0:23	372	307	AM01391
	entangled in rock		300	554	AM01392	
02:26	061°09,56'	11°46,36'	0:20	638	266	AM01395
04:08	061°10,90'	11°45,81'	0:40	1405	262	AM01396
05:12	061°11,37'	11°45,59'	0:05	168	263	AM01397
07:21	061°12,33'	11°42,00'	0:20	883	235	AM01398
09:56	061°05,44'	11°47,44'	0:11	137	269	AM01399
02:15	060°55,30'	11°49,82'	0:17	450	318	AM01401
04:24	060°56,28'	11°49,80'	0:30	1232	306	AM01402
06:13	060°57,37'	11°49,44'	0:25	880	292	AM01403
08:28	061°00,37'	11°51,56'	0:20	707	267	AM01404
10:10	061°01,42'	11°50,96'	0:20	786	260	AM01405
11:30	061°02,06'	11°50,59'	0:15	527	303	AM01406
03:58	061°00,86'	12°16,58'	0:20	753	303	AM01409
05:39	061°01,50'	12°17,34'	0:15	312	286	AM01410
10:24	061°00,72'	12°37,08'	0:40	936	1067	AM01411
13:04	061°01,67'	12°38,06'	0:10	288	1086	AM01412
15:28	060°55,55'	12°35,91'	0:19	615	431	AM01413



**Table H7**  
**List of samples collected**

DATE	STATION NO	SAMPLES	DEPTH (m)
Microplankton and Pico-nanoplankton			
2 Nov 22	IO-009	Water from surface + CTD	0, 3, 40, 80, 100
2 Nov 22	IO-010	Water from surface + CTD	0, 3, 40, 75, 100
3 Nov 22	IO-011	Water from surface + CTD	0, 3, 40, 80, 100
5 Nov 22	IO-012	Water from surface + CTD	0, 5, 80, 100
5 Nov 22	IO-013	Water from surface + CTD	0, 5, 65, 80, 100
6 Nov 22	IO-014	Water from surface + CTD	0, 5, 40, 60, 80, 100
6 Nov 22	IO-015	Water from surface + CTD	
8 Nov 22	IO-017	Water from surface + CTD	0, 5, 30, 50, 70
8 Nov 22	IO-016	Water from surface + CTD	0, 5, 50
9 Nov 22	IO-018	Water from surface + CTD	0, 5, 40, 100
9 Nov 22	IO-020	Water from surface + CTD	5, 40, 60, 100
11 Nov 22	IO-022	Water from surface + CTD	0, 5, 40
11 Nov 22	IO-021	Water from surface + CTD	0, 5, 40, 80, 100
12 Nov 22	IO-024	Water from surface + CTD	
13 Nov 22	IO-025	Water from surface + CTD	0, 5, 40, 100
13 Nov 22	IO-026	Water from surface + CTD	0, 5, 40, 90, 100
14 Nov 22	IO-028	Water from surface + CTD	0, 5, 40, 100
14 Nov 22	IO-029	Water from surface + CTD	0, 5, 25, 40, 100
16 Nov 22	IO-031	Water from surface + CTD	0, 5, 40, 90, 100
16 Nov 22	IO-033	Water from surface + CTD	5, 40, 100
Trawl / Towed gears			
4 Nov 22	TG2 / CP	Surface water	0

DATE	STATION NO	SAMPLES	DEPTH (m)
Diving sites / Collections			
4 Nov 22	SD 2 / YR02	Surface water	0
5 Nov 22	SD 3 / YR03	Surface water	0
6 Nov 22	SD 4 / YS04	Red Coralline Alga 1 (RCA 1) maerl	38.7
6 Nov 22	SD 4/ YR05	Fleshy Red Algae (Ceramiales)	37
7 Nov 22	SD 5/ YS06	Red Coralline Alga (RCA 2) (ball type)	58
8 Nov 22	SD 6 / YR09	<i>Acropora Branching Colony</i>	19.2
8 Nov 22	SD 6 / YR09	<i>Danafungia sp. 1</i>	19.2
8 Nov 22	SD 6 / YR09	<i>Danafungia sp. 2</i>	19.2
8 Nov 22	SD 6 / YR09	<i>Herpolitha sp.</i>	19.2
9 Nov 22	SD 8 / YR13	<i>Tridacna rosewateri (Adult)</i>	23.5
9 Nov 22	SD 8 / YR14	<i>Tridacna rosewateri (Adult)</i>	26
10 Nov 22	SD 9 / YR16	<i>Acropora robusta</i>	24
10 Nov 22	SD 9 / YR16	<i>Tridacna rosewateri (Juvenile)</i>	24
10 Nov 22	SD 9 / YR15	<i>Tridacna squamosa</i>	24
10 Nov 22	SD 9 / YR15	<i>Galaxaura rugosa</i>	24
11 Nov 22	SD 10 / YS16	<i>Heliopora coerulea</i>	27
11 Nov 22	SD 10 / YR17	<i>Acropora tabular</i>	29
11 Nov 22	SD 10 / YR17	<i>Sinuopta sp.</i>	26.5
11 Nov 22	SD 10 / YR18	<i>Pocillopora sp.</i>	27
13 Nov 22	SD 11 / YR18	<i>Gardineroseris sp.</i>	27
13 Nov 22	SD 11 / YR18	<i>Cyphastrea sp.</i>	27
13 Nov 22	SD 11 / YR22	<i>Soft Coral</i>	47
13 Nov 22	SD 11 / YR22	<i>Gorgonian</i>	47
13 Nov 22	SD 11 / YR22	<i>Favia sp.</i>	47



# APPENDIX I

## DATA MANAGEMENT AND ACCESS INFORMATION

As a principle, all data produced during the expedition are deemed to be in open access, according to the arrangements agreed between Monaco Explorations and the scientific partners of the expedition. However, scientific data collecting and sharing are regulated by international agreements such as the UN Convention on the Law of the Sea (UNCLOS) and the provisions of the UNESCO Intergovernmental Oceanographic Commission (IOC). In this context, the sharing of data collected in the areas under national jurisdiction (territorial waters and economic exclusive zones) of France, Mauritius, and Seychelles, or related to the seabed of Mauritius and Seychelles Joint Management Area of the Extended Continental is subject to the authorization of the relevant coastal States.

In any case, the issue of open access to the expedition results is key. This applies to the scientific papers that will be published in open access and for the data sets. Monaco Explorations requests that each publication and data set be identified by a DOI that will be shared through their website and the IIOE-2 metadata portal.

In accordance with its terms of reference, the Expedition Advisory Committee oversees the expedition's reporting work and the dissemination of the outcomes. A Publication Group composed of members of the Advisory Committee and project leaders was established to develop the publication plan of a special issue to be published in 2025 in a scientific journal. This special issue will encompass the whole expedition.

### **SAYA DE MALHA**

The utilization, the publication and the dissemination of the data collected in the Saya de Malha JMA, jointly managed by Mauritius and Seychelles, are regulated by the Marine Scientific Research (MSR) Code established by the JMA Commission. The approval granted to conduct the research survey in the JMA requires compliance with the provisions relevant to Intellectual Property Rights (IPR) for data and biological samples which are the property of the Designated Authority. It is understood that these provisions apply to living and non-living resources attached/associated to the seabed. They do not apply to data of the water column which

belong to the high-sea domain. Provisions regarding the use and sharing of water column data from the survey were made in a supplementary agreement between the Department for Continental Shelf, Maritime Zones Administration and Exploration (CSMZAE) of the Republic of Mauritius, the Department of Blue Economy of the Republic of Seychelles and IRD.

It is therefore necessary to consider separately the different types of data collected during the survey:

- **Bathymetry.** Bathymetric data of the Saya de Malha Bank have a high strategic and economic value for the two States. The MSR Code stipulates that the submission of the bathymetric data to international databases such as GOOS and GEBCO are subject to prior written authorization from the Designated Authority of the JMA. The data are now stored on the JMA servers in Mauritius and Seychelles and are not in open access.
- **Physical and chemical oceanography.** The seawater samples (nutrients of the water column) collected by the bottles of the rosette at each hydrological station were analysed by the IMAGO Laboratory, IRD, Brest. The results will be produced in June 2023. Other data such as salinity and dissolved oxygen were analysed on board during the survey. This set of information will be used to calibrate the raw CTD profiles. The calibration process will be achieved by September 2023. The calibrated profiles and the biogeochemical data analysed by IMAGO and on board will be transferred to SISMER (Scientific Information Systems for the Sea) and access will be restricted during a moratorium period. Other physical data such as current data will also be submitted to SISMER under the same conditions. During the moratorium period, only the scientists participating in the survey and their associated teams will be able to use the data to write scientific papers. The data will be set in open access on 1<sup>st</sup> March 2025. A digital copy of the raw CTD profiles, current data at the surface and in the water column, were given to the chief scientists of Mauritius and Seychelles at the end of the survey.

- **Plankton data.** The phytoplankton pigments data are being analysed at the IMAGO Laboratory, IRD, Brest. The chlorophyll biomass data were produced on board during the survey. These data will remain for use by the participating research teams and will be released in open access at the end of the moratorium period. Other chlorophyll data were collected by BGC Argo floats deployed during the cruise, and such data are already in open access as per the BGC-Argo programme data policy. The mesozooplankton samples will be analysed by Zooscan in the LOV in France in October-November 2023 and will become available for the participating research teams. Finally, UVP data, which are images of plankton particles along vertical profiles, have been uploaded on the open-access databases Ecopart and Ecotaxa (<http://ecotaxa.obs-vlfr.fr>). They complement the other plankton data. Likewise, phytoplankton, mesozooplankton data will be in open access at the end of the moratorium period.
  - **Benthic specimen.** The supplementary agreement concerning the terms and conditions for sharing biological materials and benefits from the Saya de Malha Project was signed between MNHN and JMA focal points from Mauritius and Seychelles (MNHN-JMA\_Conv. 1176-22). It defines the procedure for sharing the benthic specimens collected during the expedition. The sharing was made by main zoological groups (taxa). At the end of the expedition, Porifera, Fish (subsamples), Echinoderms (except Ophiurids), Corals and Crustaceans (subsamples) were delivered to JMA authorities. The others taxonomic groups such as Algae, Molluscs, Crustaceans, Annelids, Fish, Echinoderms (only Ophiurids), Ascidians and bulk samples collected by the epibenthic sledge were shipped to MNHN (Paris) and received in April 2023.
  - Specimen metadata are available at: <https://expeditions.mnhn.fr/campaign/saya>. As per the supplementary agreement, the benthic specimen database is in open access in the MNHN collection of expeditions. It compiles the references of all the sampling data of benthic specimens (station coordinates, types of gears etc.). The web page is about to be completed with all the information on the cruise and the data from the stations can be downloaded.
  - The biological material conserved by the MNHN as a long-term scientific loan has begun to be sorted and identified from a taxonomic point of view. A total of 600 batches of specimens have already been deposited in the open-access database of the MNHN collections. Photos and primary identifications are available at: <https://science.mnhn.fr/all/list?country=JMA%20Maurice/Seychelles>
  - The biological materials have been started to be examined by several experts of the MNHN network. The first publication is in progress with the description of a new species of shrimp belonging to the family *Stenopodidae*, subject to revision by the JMA Commission: Chen & Chan (In Press). The use of three-dimensional  $\mu$ CT imaging technique in the description of a new species of *Stenopus* Latreille, 1819 (Decapoda: Stenopodidea: Stenopodidae), with a revised key to the species of *Stenopus*. Journal of Crustacean Biology.
  - **ROV data.** The video footages taken by the ROV along the slopes of Saya de Malha were shared among the concerned scientists of the expedition in Mauritius and Seychelles, in the three weeks following the end of the survey. These data are submitted to the approval of the Designated Authority for utilization, publication, and dissemination
- Contact points that can assist the coastal State(s) concerned in evaluating or interpreting the data, samples and results upon request:**
- **Bathymetric data:**  
Dass Bissessur: [dpbissessur@govmu.org](mailto:dpbissessur@govmu.org) (CSMZAE, Mauritius)
  - **Physical data:**  
Jean-François Ternon: [jean-francois.ternon@ird.fr](mailto:jean-francois.ternon@ird.fr),  
Arshad Rawat: [arawat@govmu.org](mailto:arawat@govmu.org) &  
Priscilla Coopen: [pcoopen@govmu.org](mailto:pcoopen@govmu.org)
  - **Biogeochemical data:**  
Hervé Claustre: [herve.claustre@imev-mer.fr](mailto:herve.claustre@imev-mer.fr)  
Vincent Taillandier: [vincent.taillandier@imev-mer.fr](mailto:vincent.taillandier@imev-mer.fr)  
Jean-François Ternon: [jean-francois.ternon@ird.fr](mailto:jean-francois.ternon@ird.fr)
  - **Plankton data:**  
Nnette Gordon: [nnette.gordon@unisey.ac.sc](mailto:nnette.gordon@unisey.ac.sc)  
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- **Sponges:**  
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- **Corals:**  
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- **Invertebrates:**  
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Philippe Bouchet: [pbouchet@mnhn.fr](mailto:pbouchet@mnhn.fr)
- **Marine plants and algae:**  
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Mariette Dine: [mariette22dine@gmail.com](mailto:mariette22dine@gmail.com)
- **Fish:**  
Francis Marsac: [francis.marsac@ird.fr](mailto:francis.marsac@ird.fr)  
Sundy Ramah: [sundy.ramah@gmail.com](mailto:sundy.ramah@gmail.com)  
Vikash Munbodhe: [vmunbodhe@gmail.com](mailto:vmunbodhe@gmail.com)
- **ROV data:**  
Sheena Talma: [sheenatalma@gmail.com](mailto:sheenatalma@gmail.com)

#### MADCAPS

One PhD dissertation and two reserach publication were written in 2024 and 2025 with data open access :

- Thibault, M (2024).  
Abundance, composition and origin of plastic debris accumulated in the Indian Ocean subtropical gyre. PhD dissertation, University of Reunion Island. Hal. <https://theses.fr/2024LARE0001>
- Thibault, M., Fajeanu, A., Ramanampananjy, A., Royer, S.J., Fustemberg, G., Marillac, V., Gindrey, J., Saloma, A., Condet, M., Egger, M., Amy, M., Jaquemet, S., Burt, A., Mulochau, T., Jourand, J., ter Halle, A., Le Corre, L., Lebreton, L.  
Concentration gradient of plastic debris larger than 500 µm detected across the Southwest Indian ocean Scientific Reports, Vol 15, Article No 22364, 2025 <https://doi.org/10.1038/s41598-025-02893-0>
- MMarillac, V., Jourand P., Stenger, P-L., Fustemberg, G., Gindrey, J., Thibault, M.  
Plastic pollution: a potential vector for both pathogens and probiotics for corals on the Mascarene Ridge, Indian Ocean Deep Sea Research Part II: Topical Studies in Oceanography Volume 224, December 2025, Article No 105556 <https://doi.org/10.1016/j.dsr2.2025.105556>

Contact points that can assist the coastal State(s) concerned in evaluating or interpreting the data, samples and results upon request:

- **General information:**  
Margot Thibault: [margotthibault@orange.fr](mailto:margotthibault@orange.fr)
- **Genetic pathogens:**  
Philippe Jourand: [philippe.jourand@ird.fr](mailto:philippe.jourand@ird.fr)

#### GECOS

The raw data per analysis was made available directly to the main partner (Seychelles Islands Foundation) and to Monaco Explorations on an ongoing basis via computer file.

Published data and associated metadata will be made available via dedicated servers (mandatory for A-level scientific publications).

The final project data and associated metadata will be shared in accordance with the terms currently being defined by the campaign evaluation committee set up by Monaco Explorations :

- **Field metadata file:** individual sampling summary table sent to the partners after the expedition.
- **Satellite tracking:** the data was made available to all partners a few days after the beacons were deployed via a web interface: <https://my.wildlifecomputers.com/data/map/?id=6368a76831af5915db3b48a3>
- **Genetic results:** sent to the partners in January 2023. The identified haplotypes are all in the GeneBank database <https://www.ncbi.nlm.nih.gov>. The haplotype distribution is available in the publication by Bourjea *et al.*
- **Inorganic contamination results:** sent to the partners in January 2023. Raw and processed data will be accessible via deposit in databases linked to a publication (e.g. Dryad).
- **Physiological results:** sent to the partners in May 2024. Raw and processed data will be accessible via deposit in databases linked to a publication (e.g. Dryad).

The published data and associated metadata will be made available via dedicated servers. The project's final data and associated metadata will be shared in accordance with the procedures currently being defined by the Expedition Advisory Committee.

Once the beacons have stopped transmitting, a file containing all the raw data and a final map will be sent to the partners.

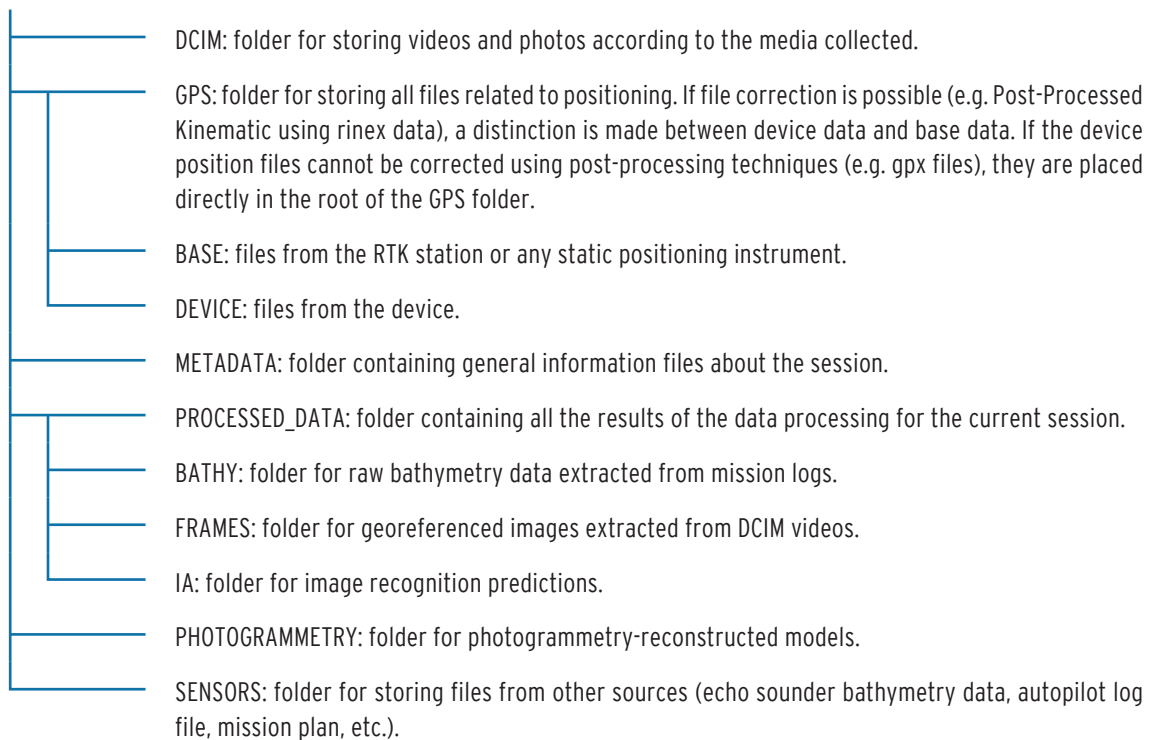
Contact points that can assist the coastal State(s) concerned in evaluating or interpreting the data, samples and results upon request:

- [General information:](#)  
Jérôme Bourjea: jbourjea@ifremer.fr
- [Satellite tracking and genetic data:](#)  
Jérôme Bourjea: jbourjea@ifremer.fr
- [Physiological and inorganic contamination data:](#)  
Quentin Schull: qschull@ifremer.fr

#### 4SEA

The raw data collected from the field is stored in a folder structured as follows:

YYYYMMDD\_COUNTRYCODE-optionalplace\_device\_session-number



Two separate versions are available for each session:

- **raw\_data:** restricted version containing raw data that may include images that cannot be shared with the community (e.g. human faces or blurred images).
- **processed\_data:** version containing data processed using the code available in this repository: <https://github.com/SeatizenDOI/plancha-workflow>.

The data can be downloaded and uploaded to Zenodo using the code available in this repository: <https://github.com/SeatizenDOI/zenodo-tools>.

AI models for image classification in Computer Vision can be trained using the code available in this repository: <https://github.com/SeatizenDOI/DinoVdeau?tab=readme-ov-file>.



Contact points that can assist the coastal State(s) concerned in evaluating or interpreting the data, samples and results upon request:

- Sylvain Bonhommeau: sylvain.bonhommeau@ifremer.fr
- Julien Barde: julien.barde@ird.fr
- Serge Bernard: serge.bernard@lirmm.fr

### **BGC-ARGO**

The calibration data will be made available once the water samples are analysed and the results are validated. A number of results files have been produced already. A mechanism remains to be identified to make these files available.

According to the recommendations of the OneArgo programme, the float data are accessible in real time either from the BGC-Argo website (floats with biogeochemical sensors <https://biogeochemical-argo.org/data-access.php>), or from the Euro-Argo site (floats measuring temperature and salinity only <https://fleetmonitoring.euro-argo.eu/dashboard>). These interfaces allow data to be viewed in profile mode (generally 0-2,000m) or in time series mode (generally one profile every 10 days).

Contact points that can assist the coastal State(s) concerned in evaluating or interpreting the data, samples and results upon request:

- Hervé Claustre: herve.claustre@imev-mer.fr
- Vincent Taillandier: vincent.taillandier@imev-mer.fr
- Fabrizio D'Ortenzio: fabrizio.dortenzio@imev-mer.fr
- Antoine Poteau : antoine.poteau@imev-mer.fr

### **SSD-SVP**

All drogue data were quality controlled and processed, with copies provided to the IIOE-2 Regional Coordination Unit for Data and Information Management at INCOIS Hyderabad, India (as the MEIOE project is endorsed by IIOE-2) (<https://iioe-2.incois.gov.in/>). Furthermore, the same SSD drogue data are also stored and available via University of Western Australia and the same SVP data are stored and available via [http://osmc.noaa.gov/erddap/taledap/OSMC\\_30day.html](http://osmc.noaa.gov/erddap/taledap/OSMC_30day.html).

The data are freely available via these sources.

Contact points that can assist the coastal State(s) concerned in evaluating or interpreting the data, samples and results upon request:

- Nick D'Adamo: nick.dadamo@uwa.edu.au
- Charitha Pattiaratchi: chari.pattiaratchi@uwa.edu.au
- Jean-François Ternon: jean-francois.ternon@ird.fr
- Olivier Desprez de Gesincourt: olivier.desprez.de.gesincourt@shom.fr
- Priscilla Coopen: pcoopen@govmu.org

### **WORLD CORAL CONSERVATORY**

At present, the data is collected but not yet put to any real use. Only project partners have access to the data.

All of the results obtained to date were also included in a report sent to the Seychelles Islands Foundation in May 2023, in accordance with the terms of the Research Agreement signed during the expedition.

It is expected that the protocols for storage, packaging and air transport and the results of the molecular and taxonomic analyses will be published.

Contact points that can assist the coastal State(s) concerned in evaluating or interpreting the data, samples and results upon request:

- Olivier Brunel: o.brunel@ocean.org
- Didier Zoccola: zoccola@centrescientifique.mc

### **CORAL CONNECT**

Data from Aldabra are owned and held by the Seychelles Islands Foundation (SIF), with other data being used by UK researchers under the terms of the permits and in collaboration with SIF.

Coral samples have been shipped from the Seychelles to the UK under a CITES agreement between SIF and ZSL.

Deep sea ROV data have been approved by SIF and Monaco Explorations for use as part of Sheena Talma's PhD at Oxford University, which began in June 2024.

All Bertarelli Foundation-funded research must be open access and under FAIR principles. We are working on a data management project at present to help signpost to diverse open-access datasets which we hope will be complete by the end of 2024.

Contact point that can assist the coastal State(s) concerned in evaluating or interpreting the data, samples and results upon request:

- Heather Koldewey: heather.koldewey@zsl.org

#### **MARINE MEGAFUNA OBSERVATION**

Data collection occurred in the Mauritian EEZ and in international waters. Regarding data collected in Mauritius waters, Globice collaborates with local partners (Marine Megafauna Conservation Organization and Green Attitude Foundation), facilitating the sharing and use of data collected in Mauritius waters.

The data is standardised and centralized in a regional IndoCet database maintained by Globice. The data collected is explicitly referenced as belonging to both Globice and Monaco Explorations, with a contact referring to each of the entities and the need to cite the owners of the data when making any use of it.

Contact point that can assist the coastal State(s) concerned in evaluating or interpreting the data, samples and results upon request:

- Violaine Dulau: violaine.dulau@globice.org

#### **ROUTINE UNDERWAY OBSERVATIONS**

The SDS files containing the depth and TSG data are available. The TSG remains to be calibrated against the CTD data.

Subject to the agreement of the coastal States and JMA Commission as appropriate, the depth data will be made available to the Data Centre for Digital Bathymetry of the International Hydrographic Organization in support of GEBCO and the TSG data will be made available to OceanOPS.



# APPENDIX J

## COMMUNICATION AND OUTREACH, ENVIRONMENTAL DIPLOMACY MECHANISMS LINKED TO OCEAN LITERACY

OBJECTIVES	PERIOD	DEVICES/RESOURCES PRODUCED
<p><b>Promote the expedition</b> (Generate interest from the media and the general public)</p> <p><b>Ensure a strong media presence</b> (Seeking maximum visibility)</p>	2022-2023	<p>A communication/mediation plan</p> <p>Multichannel communication,</p> <p>Partnership with Zeppelin Agency</p> <p>Dedicated web page</p> <p>Social media</p> <p>Communication partners</p> <p>250 articles and reports</p>
<p><b>Tell the human and scientific story</b></p>	2022-2023	<p>1 cameraman from Monaco Explorations/Monaco Info</p> <p>1 film crew (3 people)</p> <p>1 journalist</p> <p>3 artists</p> <p>2 photographers</p> <p>Editorial team</p> <p>Co-production with Autentic - TV Monaco</p> <p>TV Monaco partnership</p>
<p><b>Transmit scientific knowledge</b> Train and involve new generations of researchers (promoting intergenerational dialogue) (involving younger generations of researchers)</p>	2022	<p>Onboard school (17-28 October)</p> <p>Three onboard training sessions (16-20 November)</p>
	2023	1 <sup>st</sup> workshop of the WIO-NOISE network (3-5 May)
	2024	Thematic school in Seychelles (10-14 June)
<p><b>Raise awareness among young generations and general public</b> (Encourage commitment and a desire to get involved)</p> <p><b>Meet the expedition's participants</b></p>	2022	<p>Guided tour of the ship</p> <p>Educational workshops on board</p> <p>Inauguration of the Curieuse Island MEA (28 October)</p> <p>Live broadcasts and exchanges (x 8)</p>
<p><b>Strengthening and extending educational activities</b></p>	2022-2023	<p>Adopt a float educational programme</p> <p>Madcaps educational programme</p>
	2022-2025	Ocean for All competition
	2022-2025	PAREO educational marine area programme
<p><b>Fostering dialogue between art and science</b> (bringing Arts and Science together for a common cause) (Changing perceptions, sparking dialogue) (Creating connections between diverse audiences)</p>	2021-2022	Call for artistic residencies (60 applications)
	2022	2 artists in residence on board, one guest artist
	2023	Artistic productions

OBJECTIVES	PERIOD	DEVICES/RESOURCES PRODUCED
<b>Produce and share resources related to the expedition</b>  <b>Scientific resources</b> (open data initiative) Some data still subject to authorization	2021	Baseline study
	2022	9 databases with collected samples
	2023	Preliminary report
	2024	9 scientific reports
	2026	Final expedition report
	2026	Special issue of DeepSea Research Part II
<b>Audiovisual and cultural resources</b> (Available online)	2022- 2023	2 podcast series Saya de Malha daily newsletter (20 issues + 1 special edition) 6 terabytes of video and photo images 16 opinion pieces 11 YouTube video clips
	2023	1 x 20-minutes film 1 x 88-minutes film 3 exhibitions: <ul style="list-style-type: none"> <li>• Multiple perspectives</li> <li>• Jeter l'encre</li> <li>• Feedback from the expedition: a sensitive experience</li> </ul>
	2023-2024	1 exhibition: <ul style="list-style-type: none"> <li>• Ziska kan torti l manz plastik</li> </ul>
	2025	1 comic book (MADCAPS)
<b>Mobilising governments and the international community</b> (Diplomatic section) Contributing to sustainable governance in the Indian Ocean  <b>Develop regional and international cooperation</b>	2022-2026	
	2022	Expedition framework and guidance, Monaco Requests for research authorization from the coastal States Signatures of Memoranda of Understanding (Seychelles, Mauritius, France, Saya de Malha Joint Management Authority (JMA))
<b>Strengthening sustainable ties between States</b>	2022	Official visit of H.S.H. Albert II to the Seychelles Official meeting between Monaco and Mauritius in Port Louis
<b>Contribute to sustainable governance</b>	2023	Official feedback, Monaco
	2025	Science to Policy workshop, Mauritius
	2026	Final report of the Expedition Recommendations for decision makers Diplomatic transmission to States Transmission to international bodies



**MONACO EXPLORATIONS**  
*Reconnecting Humanity and the Sea*

# INDIAN OCEAN EXPEDITION

**2022** FINAL REPORT  
MAY 2026