

Bazaruto Center for Scientific Studies

# RESEARCH STATION & OCEAN OBSERVATORY

**Explore with us**, at the first permanent multi-ecosystem time series Ocean Observatory in Africa and the Indian Ocean.

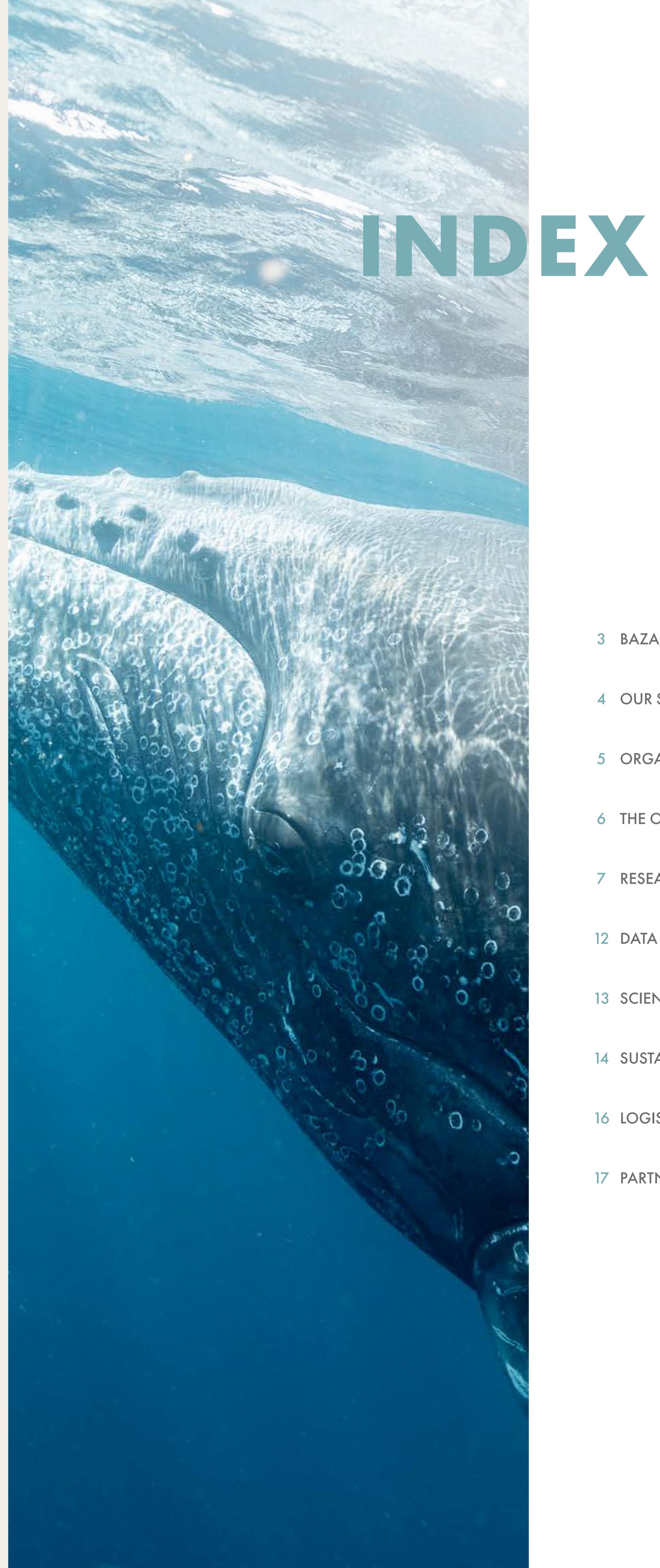
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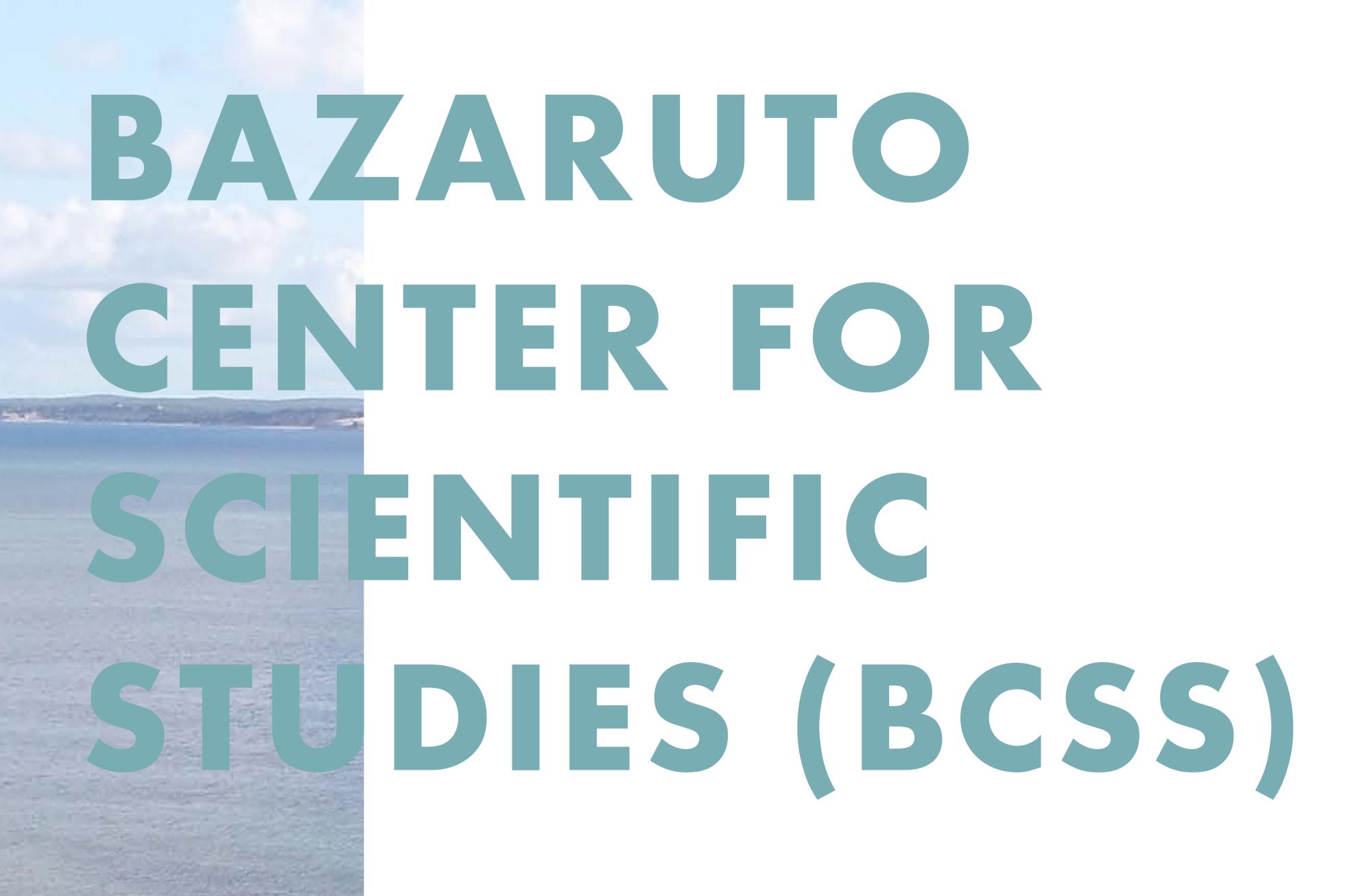
Benguerra island, Bazaruto Archipelago National Park, Mozambique





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THE BCSS



#### Who we are

The Bazaruto Center for Scientific Studies (BCSS) is an innovative platform hosting the first permanent ocean observatory focused on multi-ecosystem time series research in Africa and the Indian Ocean.

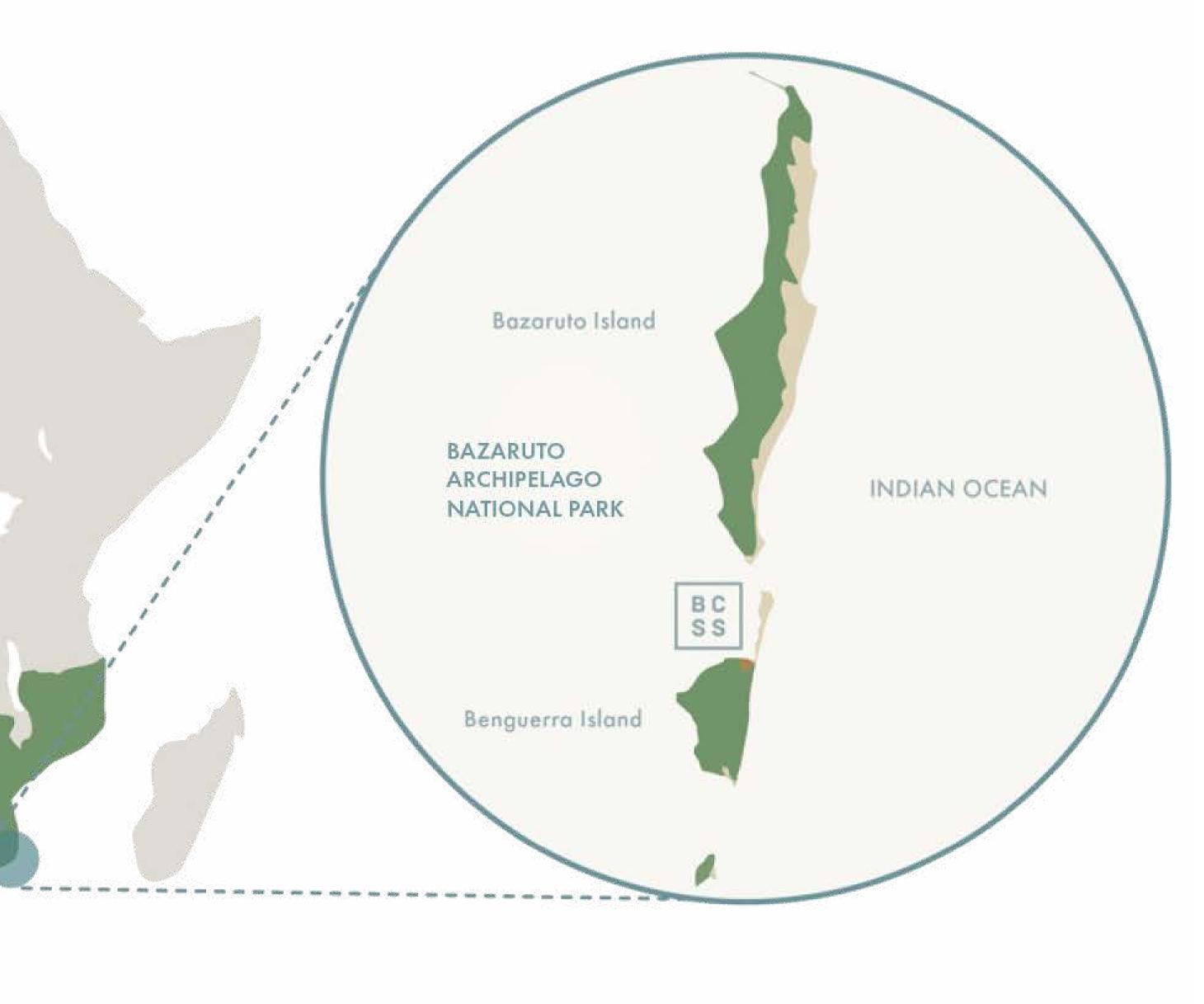
#### Our purpose

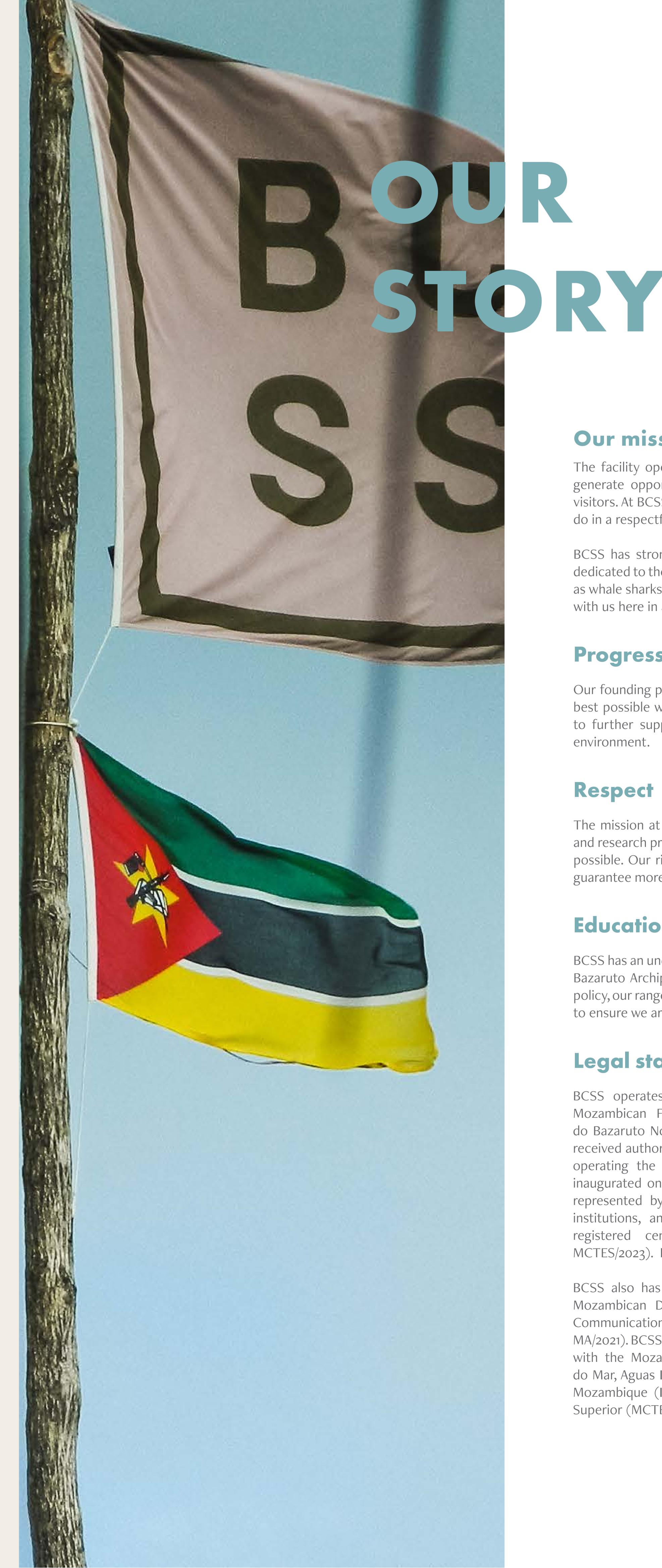
BCSS' purpose is to use its strategic location and data to support environmental management at a local level, facilitate regional collaborations, and contribute to international scientific programs.

#### The location

The Bazaruto Archipelago is a group of idyllic islands near the mainland town of Vilanculos on the coast of Mozambique. The five islands, in order of size, are Bazaruto, Benguerra, Magaruque, Santa Carolina and Bangué.

In 1971, the Bazaruto Archipelago National Park (BANP) was established in acknowledgment of its significance as a habitat boasting unparalleled marine and terrestrial biodiversity. The waters surrounding the archipelago host the last viable population of dugongs in East Africa, along with five species of sea turtles, sharks, rays, mantas, whales, dolphins, marlin, and other megafauna. Encompassing over six tropical marine ecosystems, the BANP plays a crucial role in supporting the diverse wildlife found in the park's waters and on its islands





#### Our mission

The facility opened its doors in 2017 with a mission to give back and generate opportunities for local communities as well as international visitors. At BCSS we have one simple objective: to be the best at what we do in a respectful manner, for both the community and the environment.

BCSS has strong connections with regional and international partners dedicated to the conservation and protection of emblematic animals such as whale sharks, dugongs, black marlin, and turtles, that share their home with us here in and around the Bazaruto Archipelago.

#### Progress

Our founding principles are to understand, protect and guarantee, in the best possible way, marine science in Eastern African marine ecosystems to further support present and future generations within this unique environment.

#### Respect

The mission at BCSS is to be an international example of management and research programs, with tangible results to benefit as many people as possible. Our rigorous work is openly shared, including baseline data to guarantee more researchers have access to the same critical information.

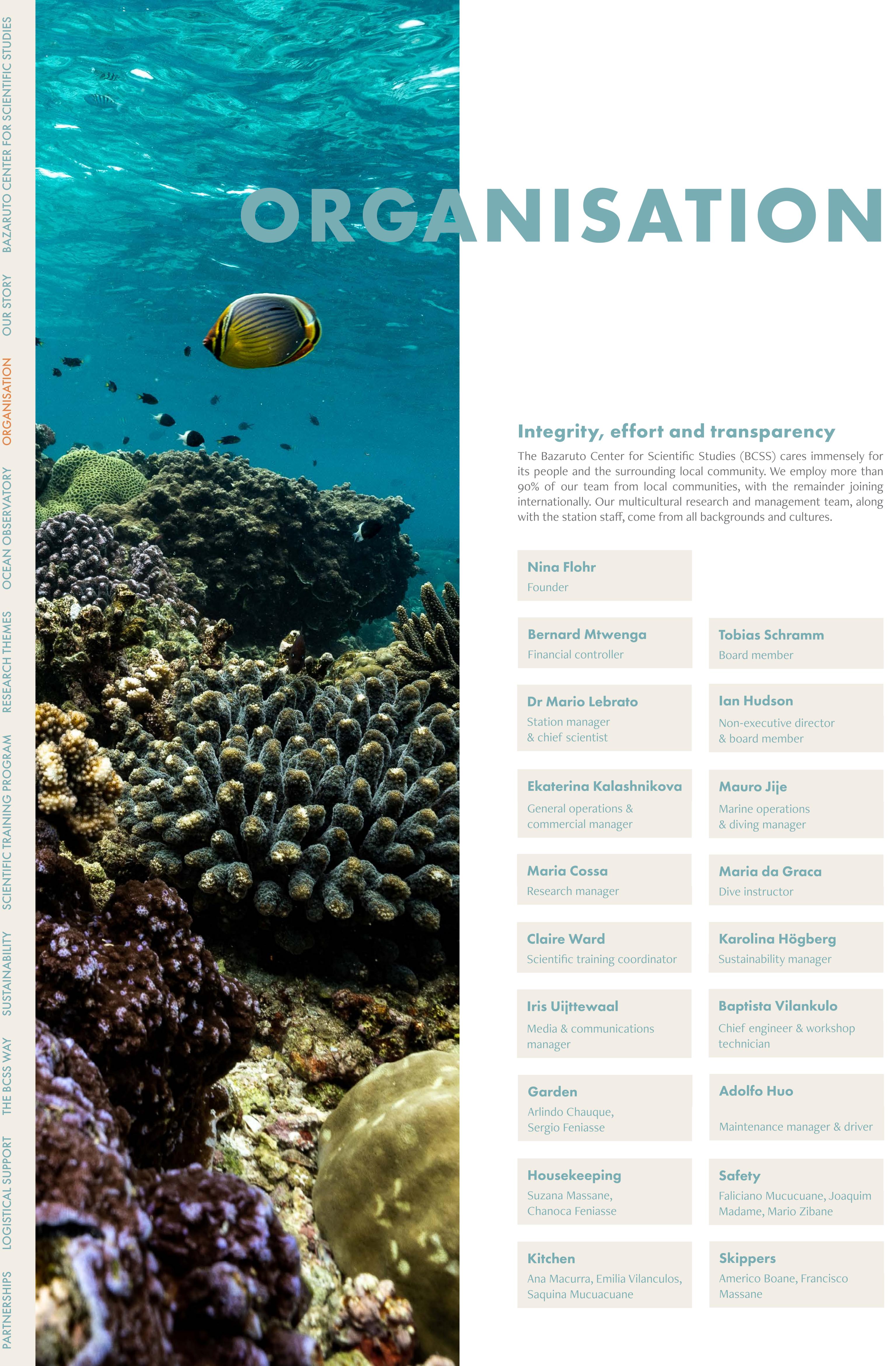
#### Education

BCSS has an underlying respect for local communities and specifically the Bazaruto Archipelago islanders. This is represented in our employment policy, our range of learning opportunities as well as our attention to detail to ensure we are a valuable addition to Mozambique.

#### Legal status

BCSS operates under the BCSS Foundation, which is a registered Mozambican Foundation (Fundação Centro de Estudos Científicos do Bazaruto No. 101218511), founded by Nina Flohr. On April 2017, BCSS received authorization from the BANP Administration and ANAC to begin operating the research center. Consequently, the BCSS station was inaugurated on December 2017 with the support of local government, represented by the Governor of Inhambane, ANAC, BANP, academic institutions, and the Benguerra Island community. BCSS is a MCT registered center (MCTES license nº/alvara: oo2/IICDTI/ BCSS/ MCTES/2023). Industrial property, IP process no: 42686, Class no: 42.

BCSS also has official 5\* PADI DIVE CENTER status (nº S27771) + a Mozambican Diving license issued by the Ministry of Transport & Communications + National Naval Institute (alvara no 1437/INAMAR/ MA/2021). BCSS has research working agreements & ongoing collaboration with the Mozambican Government. Main partners include: Ministerio do Mar, Aguas Interiores e Pescas (MIMAIP), Instituto Oceanografico de Mozambique (InOM), and Ministerio da Ciencia, Tecnologia, e Ensino Superior (MCTES).



#### Integrity, effort and transparency

The Bazaruto Center for Scientific Studies (BCSS) cares immensely for its people and the surrounding local community. We employ more than 90% of our team from local communities, with the remainder joining internationally. Our multicultural research and management team, along with the station staff, come from all backgrounds and cultures.

#### Nina Flohr

Founder

#### Bernard Mtwenga

Financial controller

#### Dr Mario Lebrato

Station manager & chief scientist

#### Ekaterina Kalashnikova

General operations & commercial manager

#### Maria Cossa

Research manager

#### **Claire Ward**

Scientific training coordinator

#### Iris Uijttewaal

Media & communications manager

#### Garden

Arlindo Chauque, Sergio Feniasse

#### Housekeeping

Suzana Massane, Chanoca Feniasse

#### Kitchen

Ana Macurra, Emilia Vilanculos, Saquina Mucuacuane

#### **Tobias Schramm**

Board member

#### Ian Hudson

Non-executive director & board member

#### Mauro Jije

Marine operations & diving manager

#### Maria da Graca

Dive instructor

#### Karolina Högberg

Sustainability manager

#### Baptista Vilankulo

Chief engineer & workshop technician

#### Adolfo Huo

Maintenance manager & driver

#### Safety

Faliciano Mucucuane, Joaquim Madame, Mario Zibane

#### Skippers

Americo Boane, Francisco Massane



# THE OCEAN OBSERVATORY

## The first long-term Ocean Observatory monitoring multiple ecosystems and ongoing climate change in Africa and the Indian Ocean

BCSS's in-house research focuses on the long-term monitoring of marine and coastal ecosystems through the Ocean Observatory in the Bazaruto Archipelago and beyond. Observation and monitoring across spatio temporal scales is fundamental to understand the magnitude of global environmental changes and regional anthropogenic pressures including climate change, ocean acidification, and various human impacts, such as pollution and overfishing, on marine and coastal ecosystems.

The Ocean Observatory aims to encompass monitoring platforms that will be measuring biogeochemical variables on selected ecosystems over time. This will allow scientists to link changes in oceanographic properties and marine ecosystems to other small and large-scale processes occurring in a region. The Ocean Observatory aims to provide valuable data to support evidence-based decision-making in Mozambique's growing blue economy and conservation efforts.

Monitoring across spatiotemporal scales is key to understand the magnitude of regional pressures including climate change and human impact on marine coastal ecosystems such as the BANP.

The BCSS Ocean Observatory contributes to the ongoing data gathered by cruises such as the <u>GEOTRACES Program</u>, the <u>SIBER-SCOR Indian Ocean Programme</u>, and the <u>GOA-ON</u> international network (<u>NOAA/UNESCO</u> endorsed). BCSS data also contributes to the Mozambican Government research & conservation monitoring efforts for a variety of projects.

#### Objectives

The main objectives of the Observatory are:

- i) To monitor spatiotemporal variability in seawater key parameters relevant to Climate Change/Ocean Acidification (OA) and Human Impact/Pollution concerns at a local, regional and global level.
- ii) To identify the current and future marine environmental status of the BANP and nearby ecosystems/waters, and how Climate Change/OA and Human impact/ pollution affect its ecosystems, with the ultimate goal to be a long-term oceanographic reference for the WIO region.
- iii) To effectively and timely transfer BANP and nearby ecosystems/waters Ocean Observatory time series outcomes to relevant local, regional/ national, and international communities in a way that is used to inform management, conservation and policy decisions.

# OPEN ACCESS TO QUALITY DATA

The Bazaruto Archipelago Ocean Observatory is managed by the Bazaruto Center for Scientific Studies and is organised in four themes, working in a multi-ecosystem time-series mode to understand Earth-Ocean biogeochemical and ecological processes, mostly related to environmental constraints. The platform is organised around mooring (GPS-seabed) and floating (GPS-boat) stations where sampling takes place on a continuous and monthly basis. The sampling also involves large spatial surveys to understand couplings of marine life with their environment over time.

The Ocean Observatory platform supports a variety of measurements via weather stations, roundtrips, acoustic receivers, multi parameter sensors, bottled samples, tagging, bio-samples and remote sensing methods. The main ecosystems surveyed for time-series data include coral reefs, mangrove forests, seagrass meadows and the water column (offshore open ocean).

BCSS is proud to present an open access database, providing anyone who is interested with high quality data.

A detailed overview of the Ocean Observatory research themes is available below for downloading in PDF format. This includes the specific methodology for data types and sub-types, as well as parameters.

#### METHODOLOGY PDF

Please find links to the Ocean Observatory related pages below.

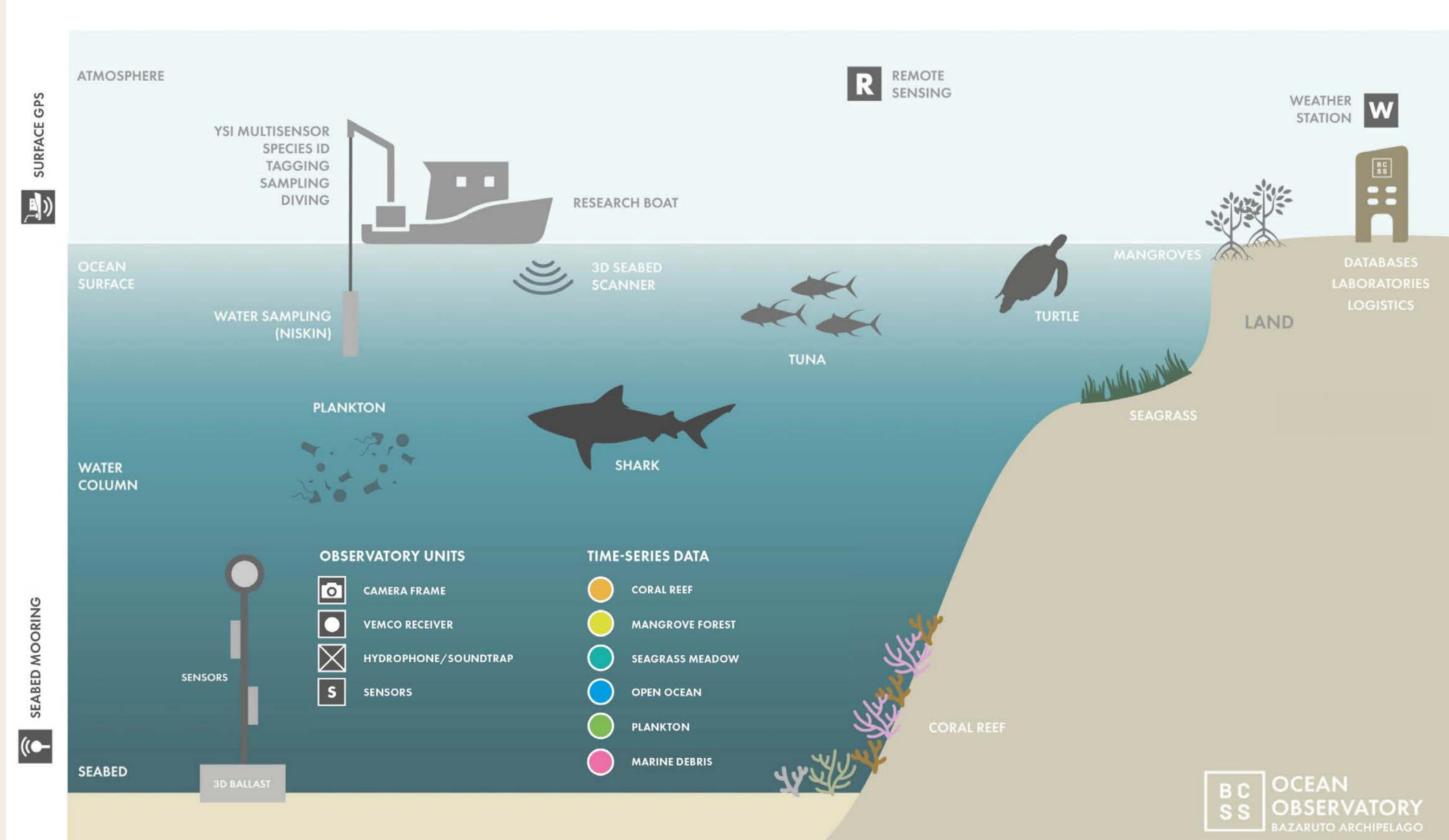
DATA REQUEST FORM

COLLABORATION OPPORTUNITIES

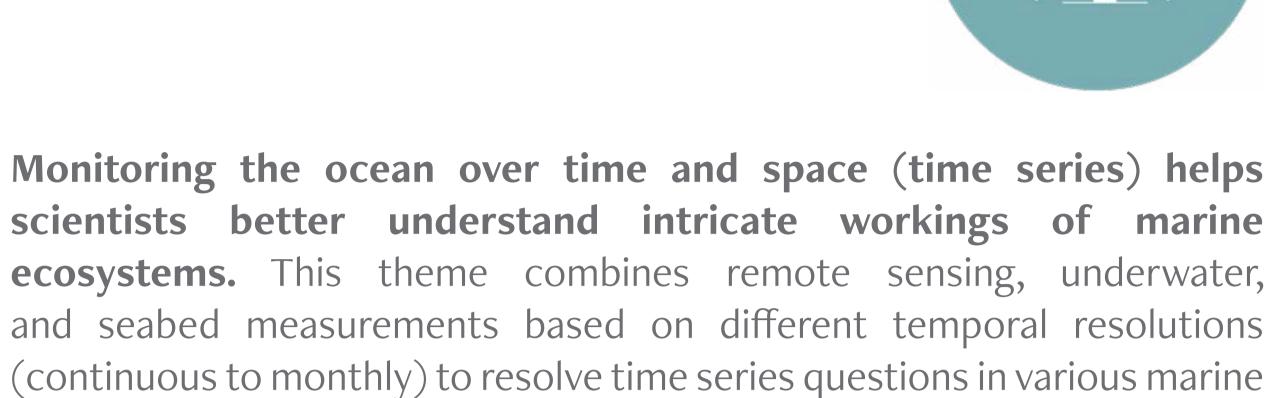
DATA ACCESS

**OVERVIEW** 

PUBLICATIONS & REPORTS







All ocean work takes place in a 7 m RIB boat or a 10 m GeCat boat equipped with a Lowrance HDS LIVE 9 and 12 plotter, respectively, as well as an AIRMAR (chirp) TM185HW 150-250 kHz, and transductor Active Imaging 3-in-1. All GPS coordinates for sampling or surveys are loaded on to the Lowrance plotters. Data gathered at the ocean seabed are obtained via different arrays of sensors, bottled methods, or other techniques, always 1 m above the seabed, using 50 to 100 kg 3D-printed sand/cement moorings as a fixed point. Deployment and recovery are always done via scuba diving from a boat. Data gathered at the ocean surface are obtained via different arrays of sensors, bottled methods, or other techniques, always 1 m below the surface. Deployment and recovery are always done from a boat. Seawater samples are obtained using 2.2 or 5 LWaterMark® horizontal polycarbonate bottles triggered via a bronce messenger. The equipment is deployed, and the bottles are triggered via a crane mounted on a boat

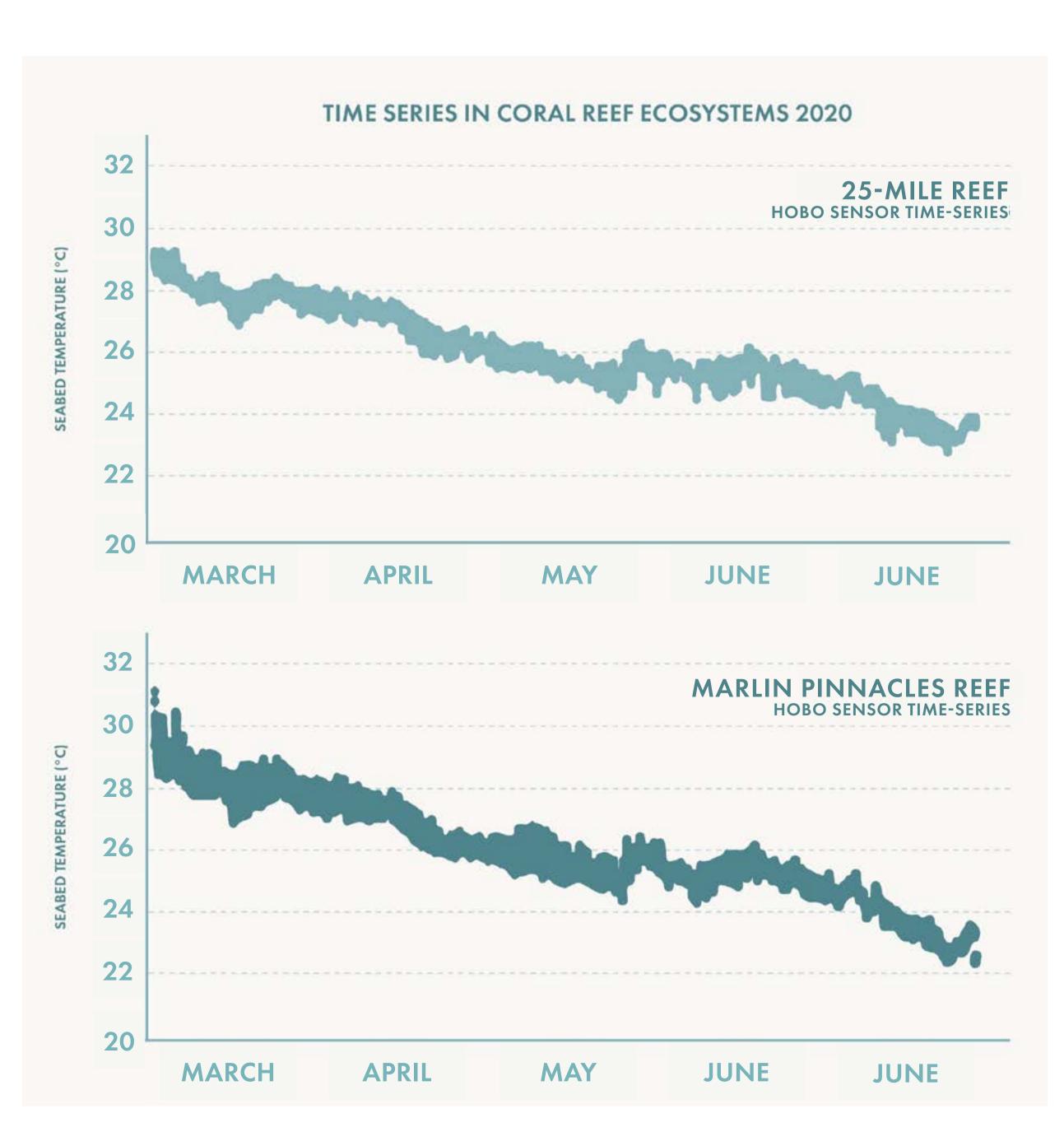
sciences domains in a timely manner. Different parameters can be found in

different stations of the Ocean Observatory, while others are monitored

Ocean acidification monitoring and platform development

at the designated mooring locations always 1 m above the seabed.

- Seawater sampling for nutrients, seawater chemistry, heavy metals plus laboratory processing
- Marine life & background noise monitoring via passive acoustic arrays using ST600 hydrophones
- Using and maintaining sensors to measure oceanographic parameters (temperature, pH, etc.)
- Scientific diving to maintain underwater equipment.



## SPECIES IDENTIFICATION & HABITAT MAPPING

THEME 2

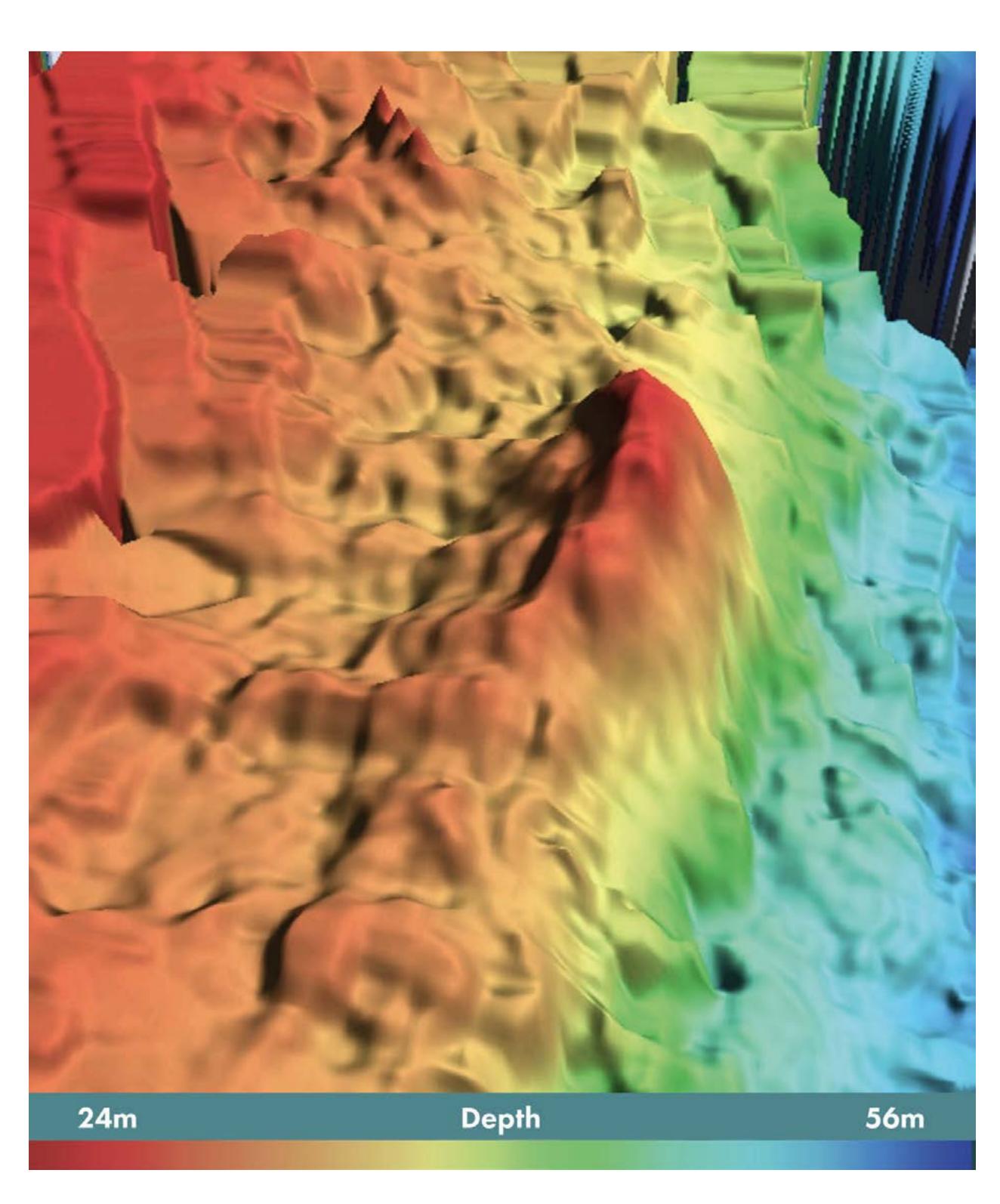


Conducting surveys in open ocean, coastal areas, seabeds, and underwater environments to study marine life hotspots and understand how organisms interact with their surroundings over time and space.

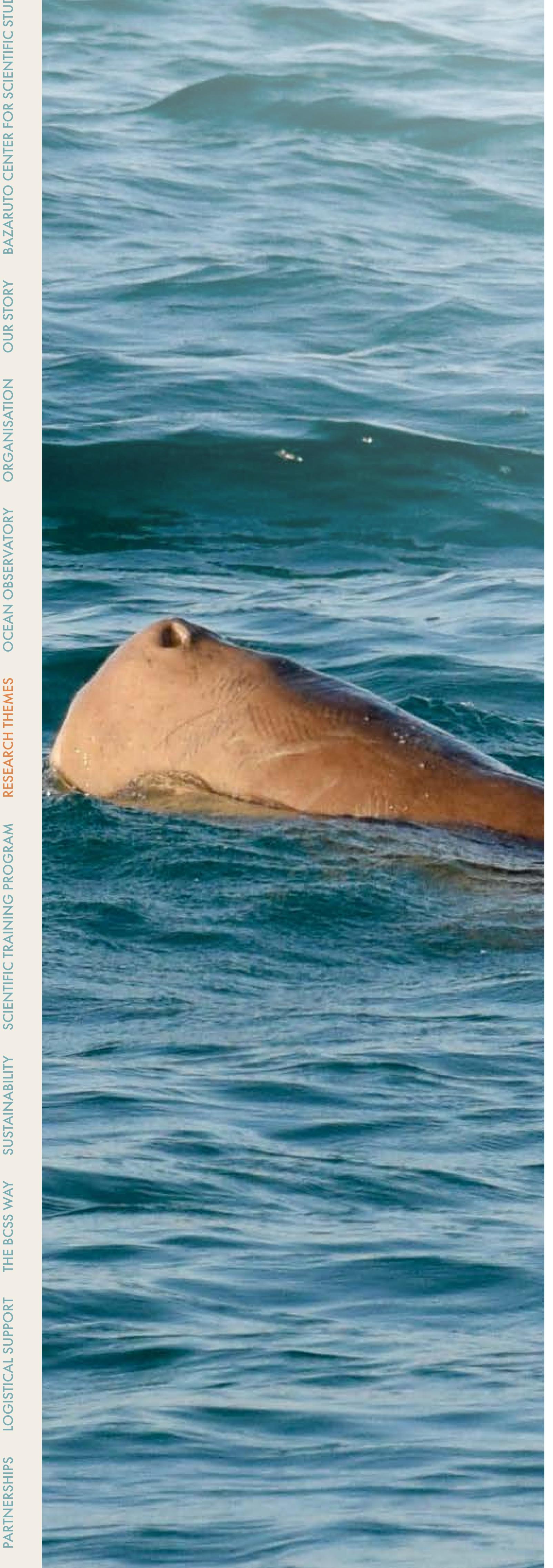
This theme focuses on resident and migratory species identification and monitoring, in space and time during the year, to help understand their distribution in a time-series mode. It allows the discovery of marine life hotspots, key habitats or important marine life corridors with respect to the seabed topography. The marine life is monitored via boat surveys for animals with surface/sub-surface behaviours or via scuba diving and fixed camera traps for animals that do not surface. This theme also works on coral reef surveys to understand the health and the roles they play in the region. All ocean works take place in a 7 m RIB boat or a 10 m GeCat boat equipped with a Lowrance HDS LIVE 9 and 12 plotter, respectively, as well as an AIRMAR (chirp) TM185HW 150-250 kHz, and transductor Active Imaging 3-in-1.

- Marine life identification surveyed from boats, scuba diving and using underwater equipment such as deep-sea landers and towing cameras.
- Coral reef scuba diving surveys
- Scientific diving to deploy and maintain landers & camera equipment
- Building a taxonomic database & assisting with ArcGIS spatial data
- 3D seabed mapping surveys using echo-sounding technology

For an overview of the data collections of the last five years, please see the next page.



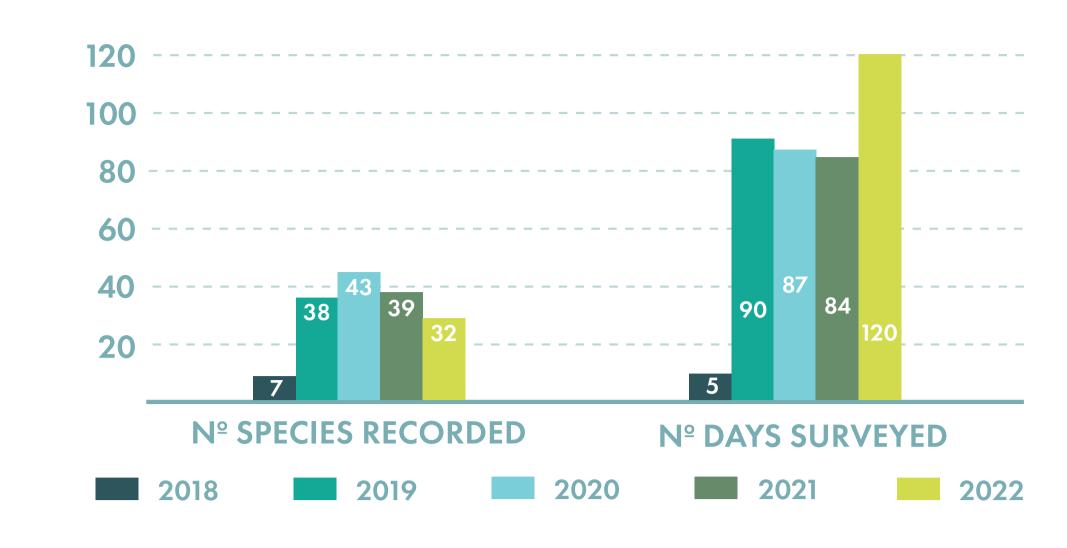
DIVE SITE 'AREA 51' IS A SEAMOUNT-LIKE REEF STRUCTURE, SOUTH OFF THE BANP



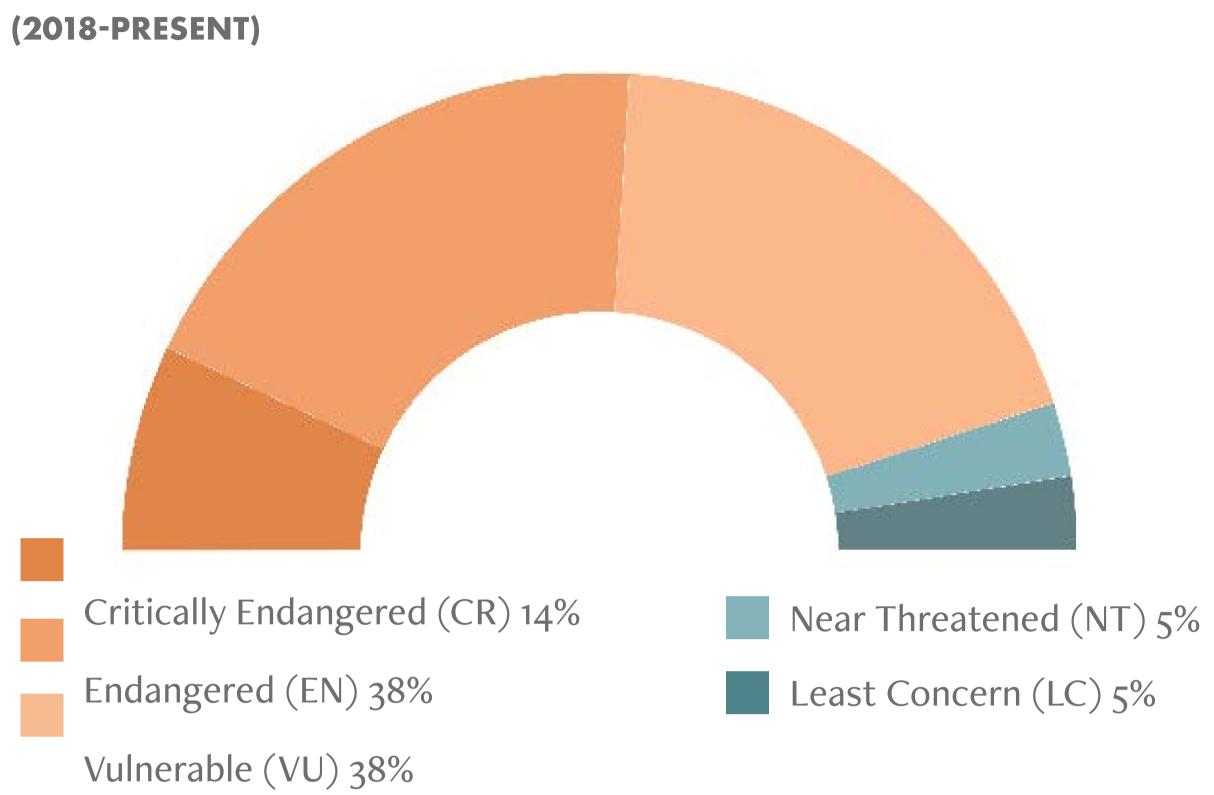
#### **MONITORING EFFORT**



#### BIODIVERSITY: >40 SPECIES RECORDED ABOVE THE SURFACE (2018-PRESENT)



#### IUCN RED LIST STATUS OF ELASMOBRANCH SPECIES ENCOUNTERED

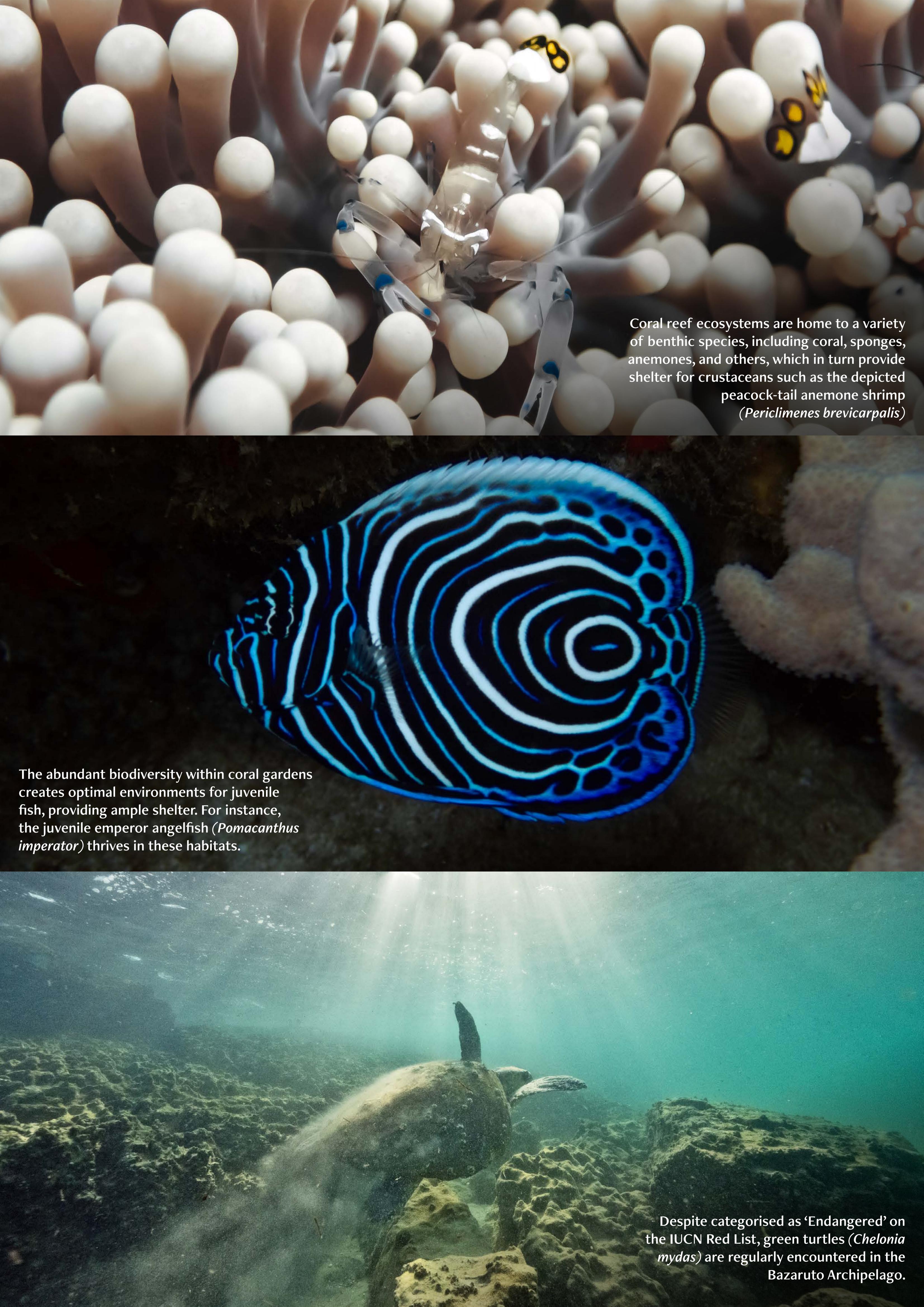


#### BCSS'S MARINE MAMMALS SIGHTINGS OFF BANP (2018-PRESENT)

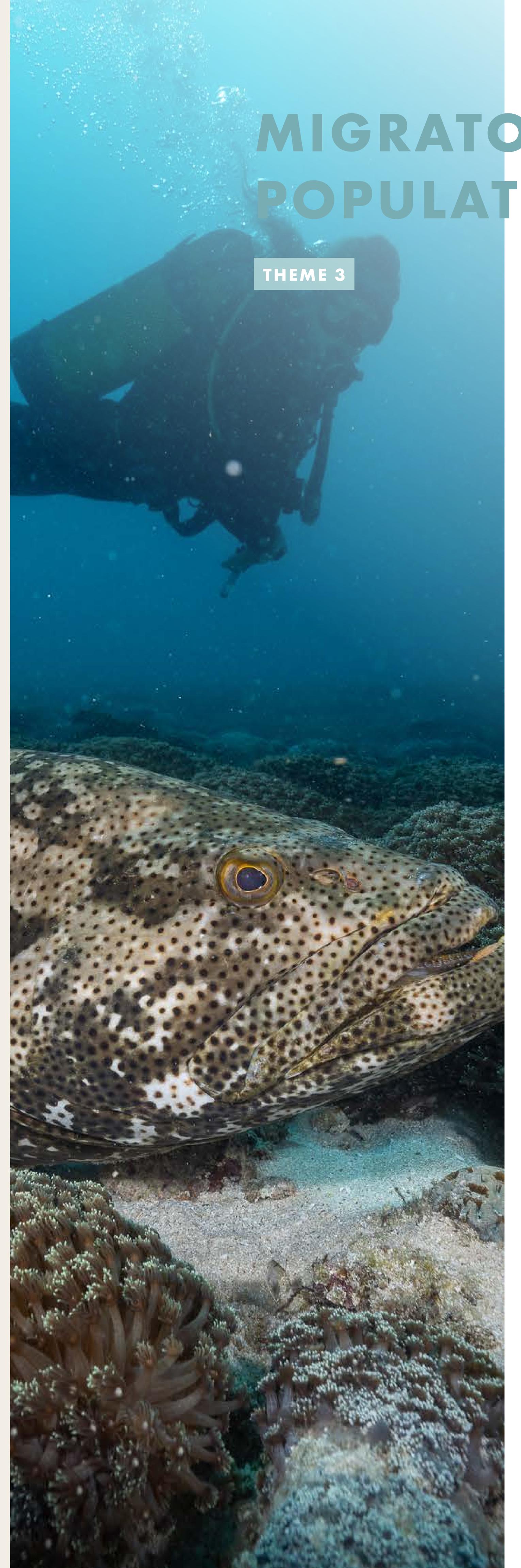
SPECIES		Nº OF SIGHTINGS	Nº OF INDIVIDUALS
SPINNER DOLPHIN Stenella longirostris	LC	130	3172
BOTTLENOSE DOLPHIN Tursiops Sp.	LC	263	1626
HUMPBACK WHALE  Megaptera novaeangliae	LC	438	1016
IO HUMPBACK DOLPHIN Sousa plumbea	EN	55	155
DUGONG Dugong dugon	CR	53	53
FALSE KILLER WHALE Pseudorca crassidens	NT	1	50
SHORT FINNED PILOT WHALE Globicephala macrorhynchus	LC	2	6
KILLER WHALE (ORCA) Orcinus orca	DD	1	4
MINKE WHALE  Balaenoptera acutorostrata	LC	1	1

#### BCSS'S ELASMOBRANCH SIGHTINGS OFF BANP (2018-PRESENT)

CRITICALLY ENDANGERI & ENDANGERED	VULNERABLE	NEAR THREATENED & LOW CONCERN			
GREAT HAMMERHEAD SHARK Sphyrna mokarran	CR	BULL SHARK Carcharhinus leucas	VU	TIGER SHARK Galeocerdo cuvier	N
SCALLOPED HAMMERHEAD SHA Sphyrna lewini	ARK CR	COPPER SHARK Carcharhinus brachyurus	VU	BLUESPOTTED RIBBONTAIL RAY Taeniura lymma	L
WHITESPOTTED WEDGEFISH Rhynchobatus djiddensis	CR	BLACKTIP REEF SHARK Carcharhinus melanopterus	VU		
ORNATE EAGLE RAY Aetomylaeus vespertilio	EN	SPINNER SHARK Carcharhinus brevipinna	VU		
DUSKY SHARK Carcharhinus obscurus	EN	REEF MANTA RAY Mobula alfredi	VU		
ZEBRA SHARK Stegostoma tigrinum	EN	OCEANIC BLACKTIP SHARK Carcharhinus limbatus	VU		
<b>DEVIL RAY</b> Mobula mobular	EN	PINK WHIPRAY Pateobatis fai	VU		
COACH WHIPRAY Himantura uarnak	EN	LEOPARD WHIPRAY Himantura leoparda	VU		
JENKINS' WHIPRAY Pateobatis jenkinsii	VU				
GREY REEF SHARK Carcharhinus amblyrhynchos	EN				
OCEANIC MANTA RAY Mobula birostris	EN				



THE BCSS





Locating and tagging of pelagic fish via research fishing techniques as well as bio-samples collection to understand ecosystem processes. This theme combines research fishing practises with bio-samples recovery from animals to answer how animals use their habitat, how environmental constraints impact their migration, as well as how they use the water masses and associated habitats. It also aids the understanding of how their muscle/tissue reflects environmental change and pollution via various measurements taken in timeseries mode. All ocean works take place in a 7 m RIB boat or a 10 m GeCat boat equipped with a Lowrance HDS LIVE 9 and 12 plotter, respectively, as well as an AIRMAR (chirp) TM185HW 150-250 kHz, and transductor Active Imaging 3-in-1. All moorings' GPS coordinates for sampling or surveys are loaded on to the Lowrance plotters. Data gathered at the ocean seabed are obtained via different arrays of sensors (e.g. acoustic receivers), 1 m above the seabed, using

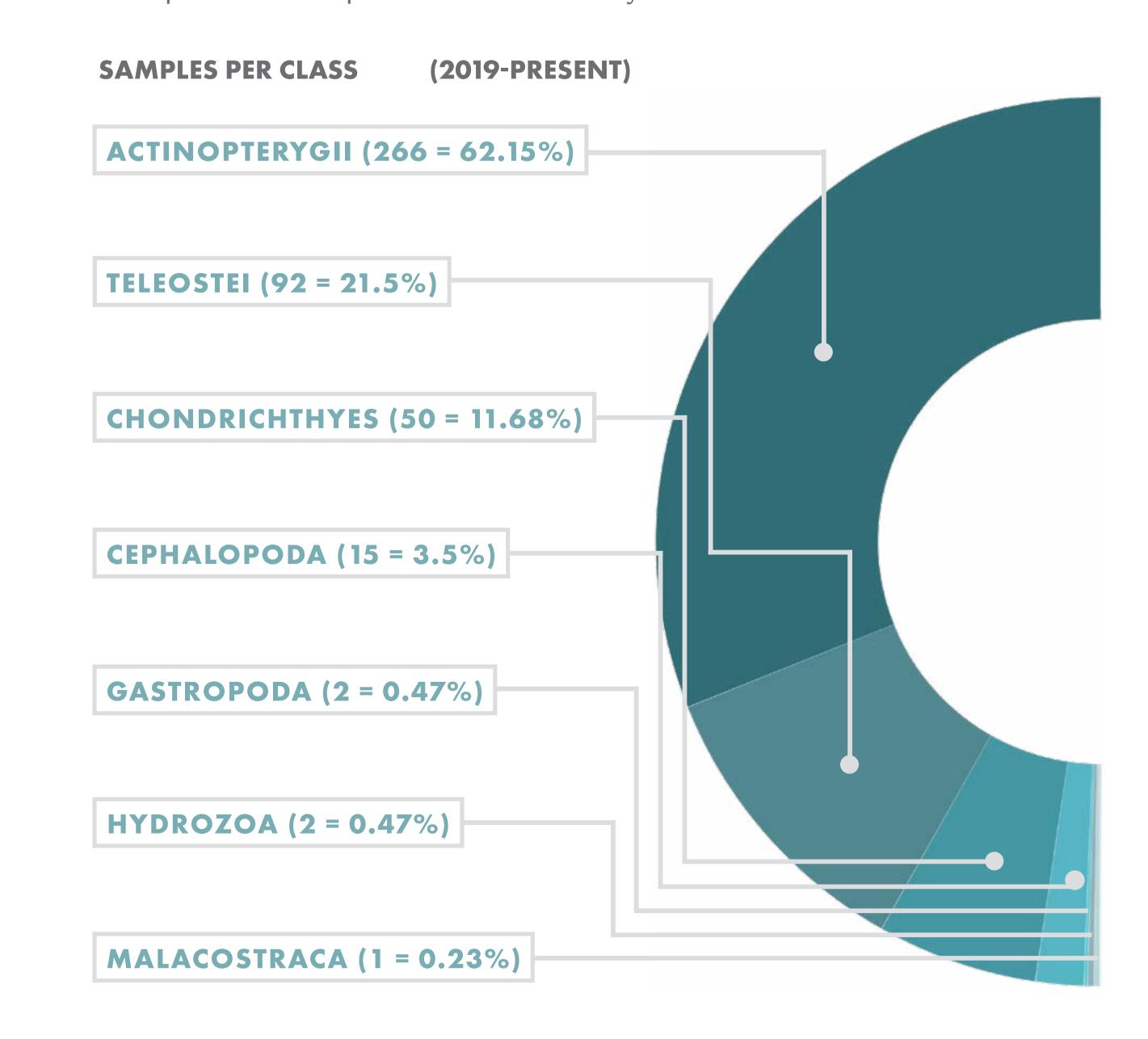
The sectors are always fished one after the other on different days to avoid extra visual search effort for any one sector. The expeditions of Theme 3 are often combined with Theme 2 following the same protocol, with the difference being that the boat normally stops to land/release a fish and/or spends more time on certain areas owing to baitballs or fish presence. At the same time the animal is landed/released, seawater data are also taken in situ using a ProQuatro portable YSI multiparameter water quality meter probe, following the protocol used in Theme 1. Survey metadata, and other environmental parameters are also noted for the timeseries in situ, or remotely derived (e.g. Date, Time, Feature/Species, SST, Salinity, pHtotal, DO, Depth, Lat, Long, Tide, Weather, Moon phase etc).

moorings as a fixed point. Deployment and recovery are always done via

Research fishing expeditions

scuba diving from a boat.

- Open ocean boat operations and echo-sounders experience
- Conventional, acoustic and satellite tagging of migratory animals such as sharks, marlin and tuna
- Fin-clip and tissue sample recovery from tagged species
- Prepare bio-samples in the laboratory



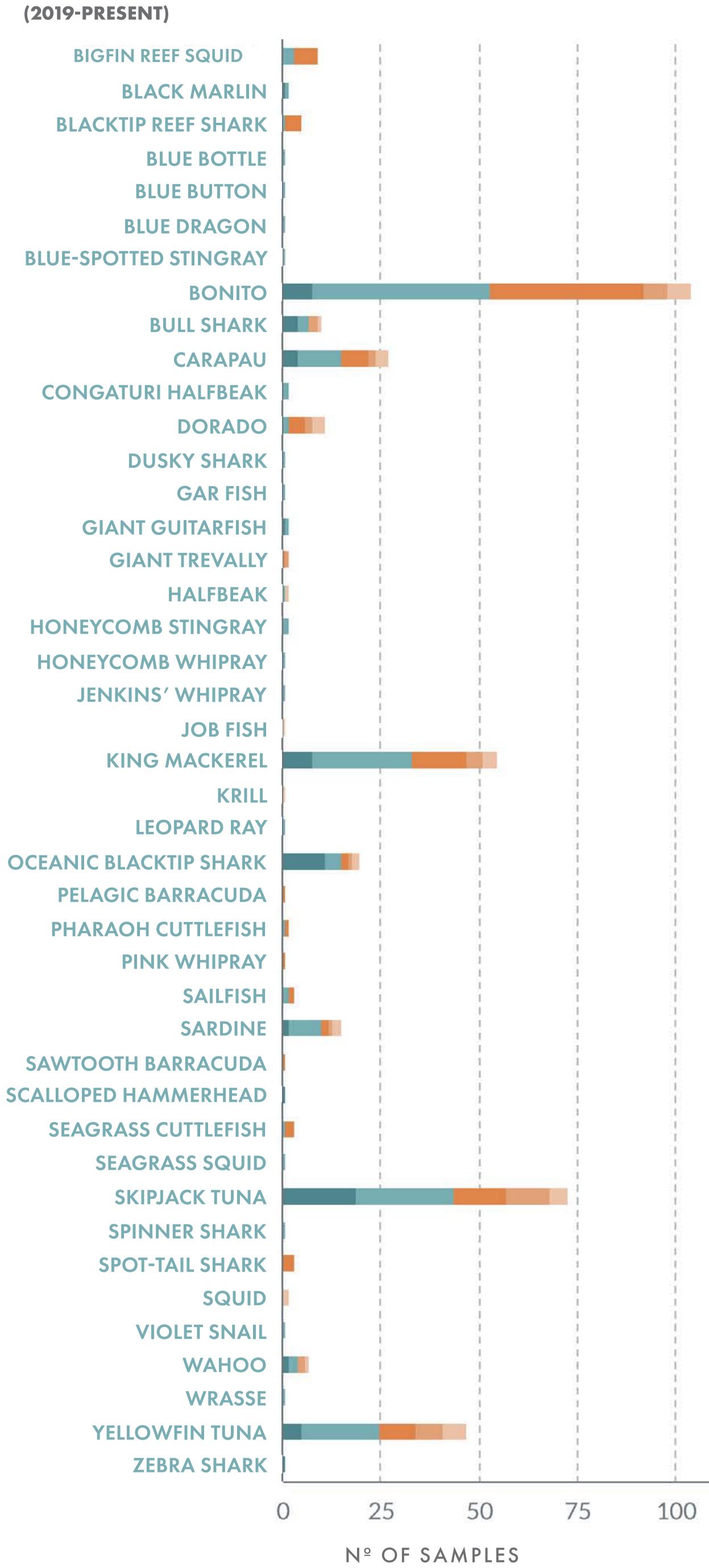
#### **BIO-SAMPLES COLLECTIONS OVER 5 YEARS**

>500 SAMPLES (ISO+DNA+PLASTIC) >50 SPECIES **SAMPLED** 

>20 ACOUSTIC **TRANSMITTERS**  **>200 SHARKS HANDLED** 





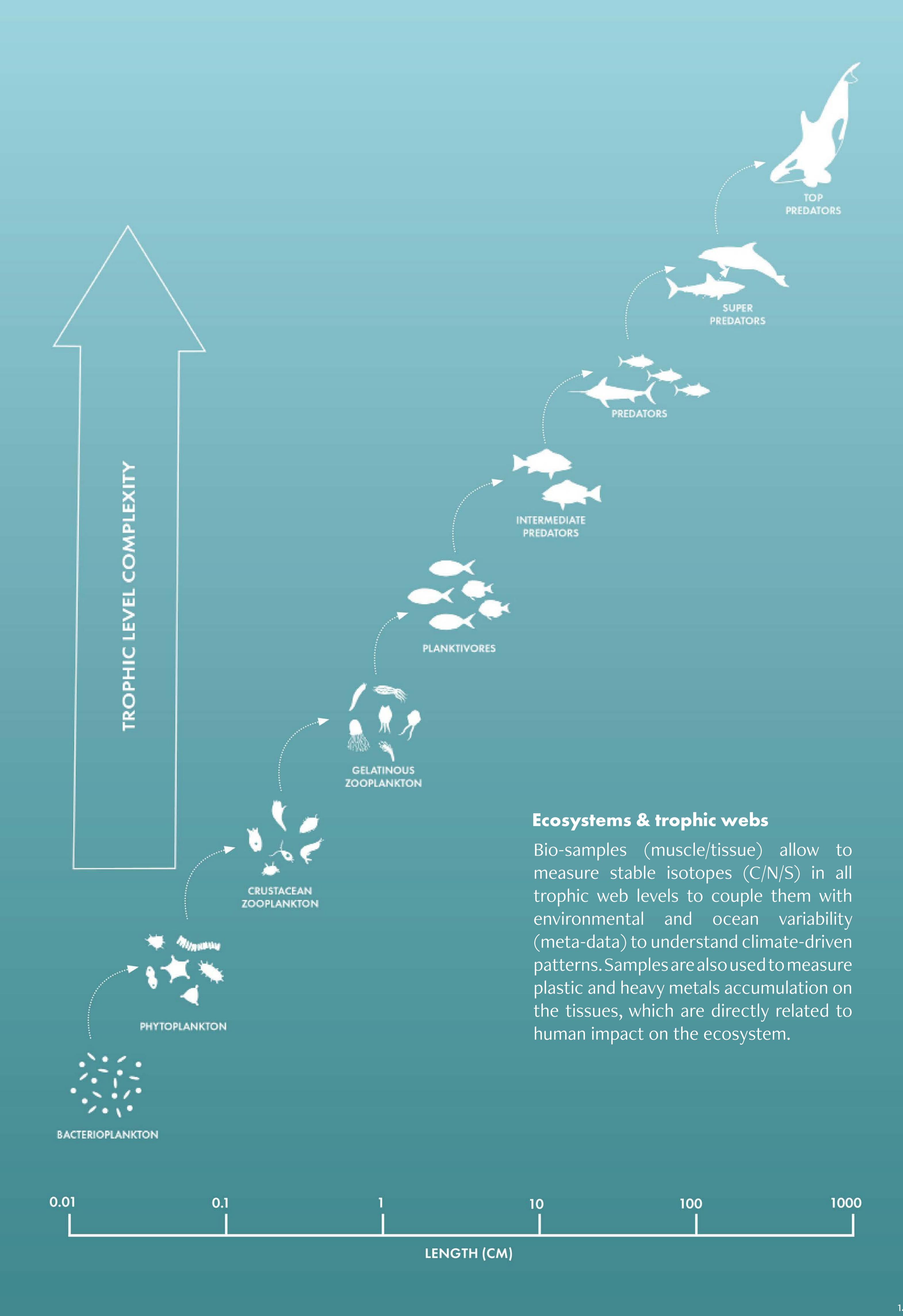


#### EACH SAMPLE COMES WITH THE FOLLOWING DATA

2019 2020 2021 2022 2023

- Date/time
- GPS coordinates
- SST
- Salinity
- pH
- Depth Light
- Wind speed and direction
- Air temperature
- Precipitation
- Cloud coverage
- Tide category/status/strength

An overview of a trophic marine ecosystem web can be found on the next page, illustrating which elements of the ecosystem theme 3 touches upon.

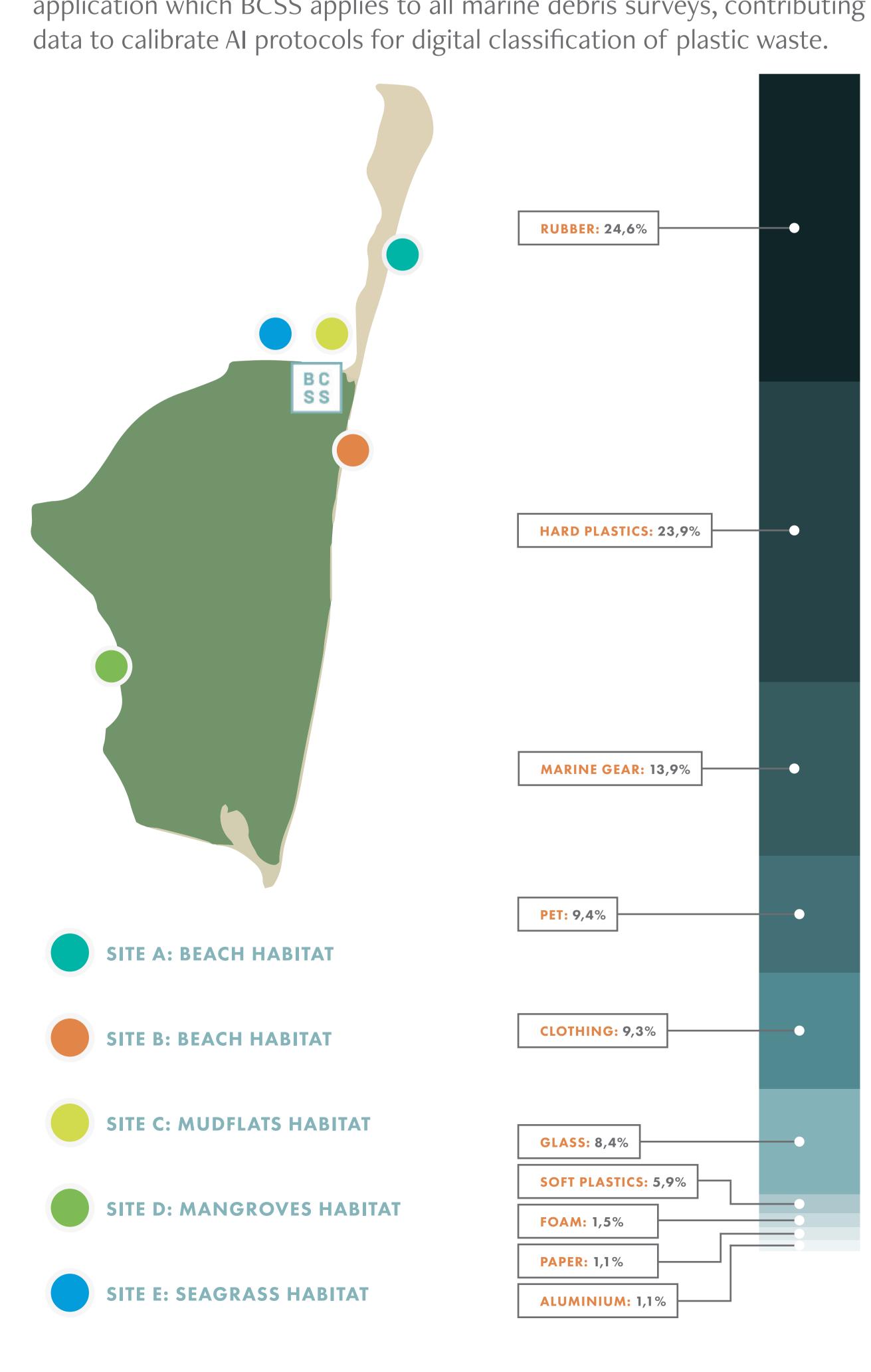


### MARINE DEBRIS MONITORING



The marine debris monitoring program is a collaborative initiative between BCSS and the Bazaruto Archipelago National Park (BANP) on Benguerra Island. The survey method adopted on pre-determined study sites is monthly accumulative surveys. The marine debris surveys compare how debris enter and accumulate in different ecosystems of Benguerra Island (Mangrove, Seagrass, Mudflats and Sandy beach) to understand links to socioeconomic and local community activities, weather, ocean, and environmental parameters. To ensure consistency in data collection, surveys are done by a trained group of surveyors that include: the BANP beach clean-up crew, BCSS staff, volunteers, and interns. All debris collected are removed from the island and sent to Mozambique mainland for recycling.

- Monitor marine debris to understand the extent of marine pollution from solid waste in the BANP
- Explore recycling solutions for marine debris and how to further reduce waste to achieve carbon-neutral strategies
- Practice permaculture principles and learn how to grow our own food in a sustainable way
- Host events involving school, children and local outreach activities
- Partnership with Universal Plastic, an organisation using an Al-powered application which BCSS applies to all marine debris surveys, contributing







#### Professional research training while exploring marine ecosystems at our Research Station & Ocean Observatory

Experience the thriving waters supporting more than 2000 fish species, boasting the world's second most diverse coral reefs, while getting training on marine biology, oceanography, and environmental sciences in the Indian Ocean. Acquire core career skills like fieldwork design, scientific writing, species identification, and hands-on scientific fieldwork - all within our high-end, on-site laboratories, during expeditions, or within office settings. Contribute significantly to the monitoring of human impacts on marine ecosystems, in an experience that will substantially contribute towards your professional career.

- Get your PADI Scuba diving certification (open water to dive master)
- Study marine ecosystems (open ocean, coral reef, seagrass, mangroves)
- Learn from a team of professional scientists & technical staff.
- Stay at the Research Station on Benguerra Island
- Gain official University credit (CPUs) & build your career.

#### Join our scientific team at the research station up to 12 weeks

Whether you are pursuing a career in marine and environmental sciences or you simply want to play a role and contribute towards BCSS's mission, the programs are meticulously prepared to ensure your training experience is maximally rewarding and constructive.



I spent 2 months at BCSS as a Science Training Participant. I learned lots of new things in marine sciences, such as diving surveys, spatial mapping and sampling. Both people at the station and on the island were lovely. If you want to relax, go on adventures and learn new marine science and scuba diving skills, all at the same time, while being in one of the most unique places in the world and seeing lots of marine life -BCSS is the place to be.

Vera van der Plas, October 2022



Having always had a love for the ocean and scuba diving, it had been a goal of mine to take part in an ocean conservation project for a while. BCSS stood out as somewhere I could make a meaning full contribution, even without having a background in marine science. It was amazing to be part of the BCSS team. Everyone shared the same passion for the ocean and we're here for the same reasons. I learned so much just though having conversations with people at the station. Coming from without a marine science background meant I was learning every day. Hollie French, June 2022



#### Sustainable design

BCSS is a unique research station committed to and built with sustainability by design in mind. It's powered partially by solar energy and designed to minimize environmental impact. Locally sourced materials such as coconut wood, reed walls, and thatched roofs were used during construction, whereby offcuts are continuously being reutilized.

#### Permaculture & self-sufficiency

BCSS follows permaculture principles to create a zero-waste food garden. This approach supports self-sufficiency while promoting healthy, organic, and chemical-free food production. By reutilising and repurposing organic waste, a circular approach is ensured.

#### Reducing carbon footprint

- Usage of renewable energy
- Continuous monitoring and mitigation of overall consumption.
- Utilization of local materials and skilled community labor.
- Implementation of a comprehensive zero-waste plan.
- Emphasizing reusing existing products before purchasing new ones.
- Active recycling of materials in Mozambique.
- Seeking sustainable alternatives when acquiring new products.
- Encouraging sustainability awareness among visitors.

#### ESG (Environmental, Social, and Governance) facts

- BCSS has implemented a solar plant energy management system and energy-saving switches.
- Water is reused within certain operations, and safe drinking water is provided to the community.
- BCSS maintains water reservoirs.
- The station features a permaculture garden for growing food.
- BCSS has its recycling system.
- Efforts to reduce single-use (and other) plastics are in place.
- The station reuses and repurposes organic waste.
- The station holds regular cleanups involving the community, incl. recycling collaboration with the Marine National Park.

#### Biodiversity & land use

- BCSS actively documents and communicates marine wildlife.
- Green spaces are offered on the property.
- Visitors receive information about local ecosystems and sustainable construction materials were used during station construction.

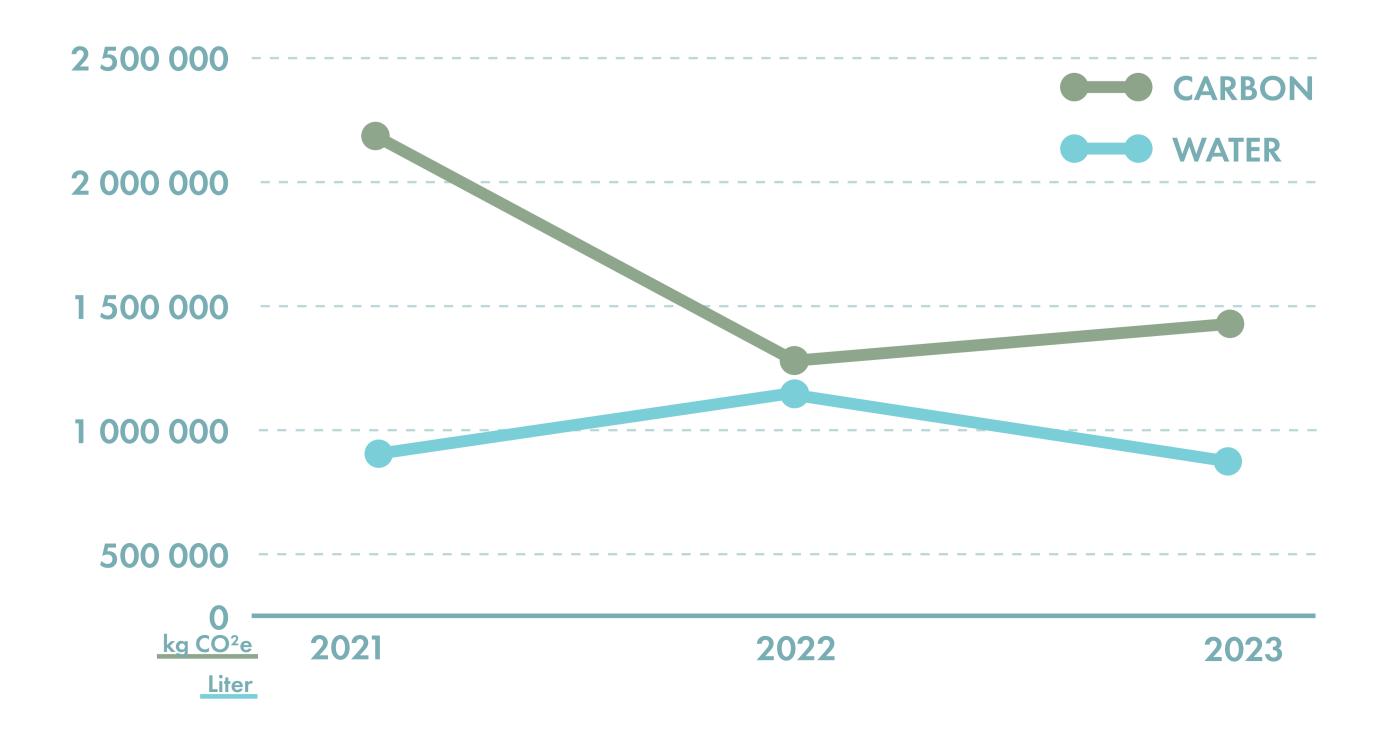
#### Conservation & research

- Extensive database with collected metrics.
- Engaging visitors in conservation and research dialogue.

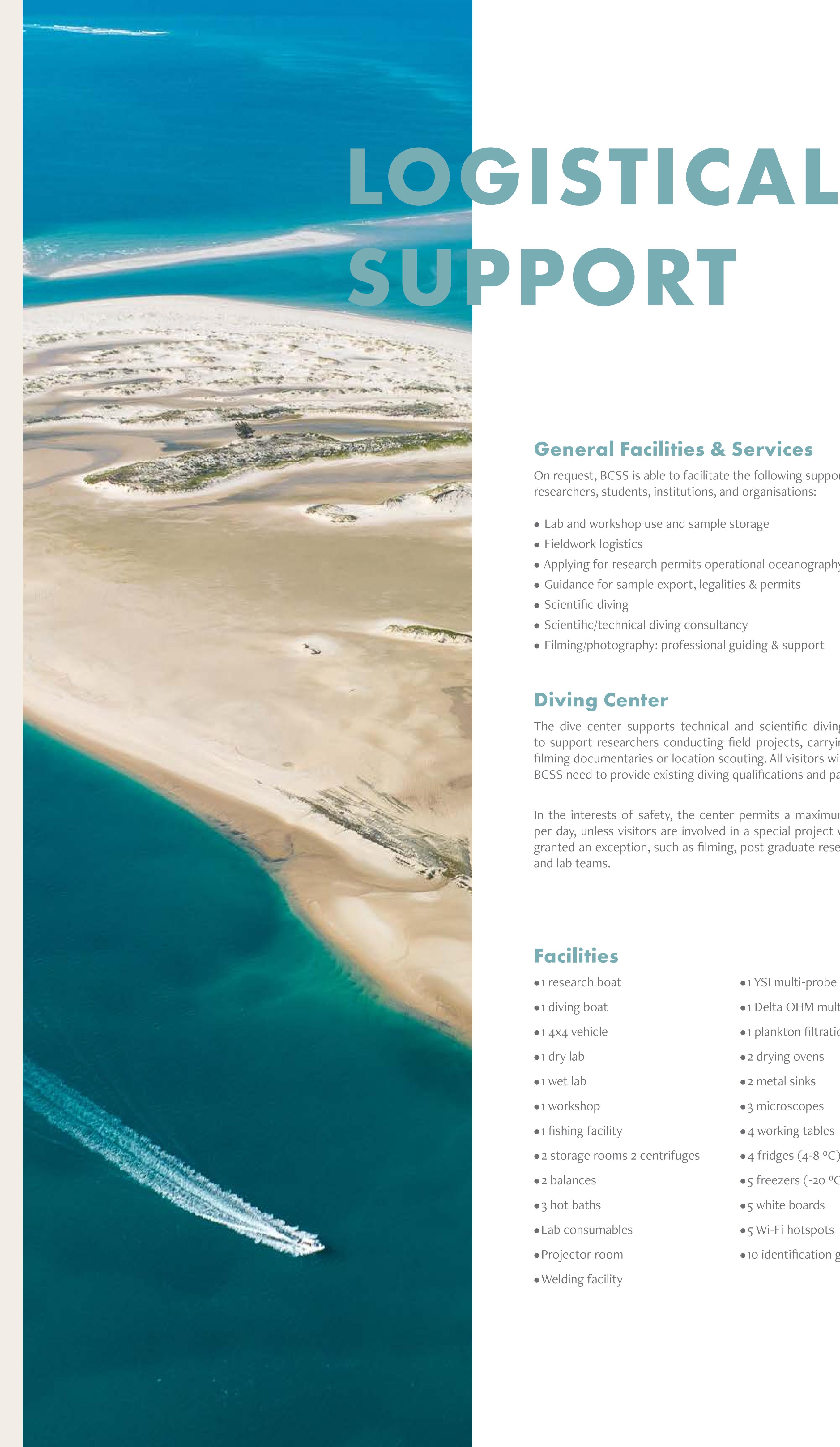
#### Community engagement & social impact

- Providing access to a private clinic and free medical insurance for all employees.
- Supporting youth education and employment.

#### TOTAL ANNUAL CARBON FOOTPRINT & WATER USAGE







#### General Facilities & Services

On request, BCSS is able to facilitate the following support to external researchers, students, institutions, and organisations:

- Lab and workshop use and sample storage
- Fieldwork logistics
- Applying for research permits operational oceanography
- Guidance for sample export, legalities & permits
- Scientific diving
- Scientific/technical diving consultancy
- Filming/photography: professional guiding & support

#### **Diving Center**

The dive center supports technical and scientific diving with the aim to support researchers conducting field projects, carrying out surveys, filming documentaries or location scouting. All visitors wishing to dive at BCSS need to provide existing diving qualifications and paperwork.

In the interests of safety, the center permits a maximum of two dives per day, unless visitors are involved in a special project which has been granted an exception, such as filming, post graduate research or seniors and lab teams.

#### **Facilities**

- 1 research boat
- 1 diving boat
- 1 4x4 vehicle
- 1 dry lab
- 1 wet lab
- 1 workshop
- 1 fishing facility
- 2 storage rooms 2 centrifuges
- 2 balances
- 3 hot baths
- Lab consumables
- Projector room
- Welding facility

- 1 YSI multi-probe
- 1 Delta OHM multi-probe
- 1 plankton filtration system
- 2 drying ovens
- 2 metal sinks
- 3 microscopes
- 4 working tables
- 4 fridges (4-8 °C)
- 5 freezers (-20 °C) • 5 white boards
- 5 Wi-Fi hotspots
- 10 identification guides

### PARTNERSHIPS



### Partnerships, Collaborations and Acknowledgments

The Bazaruto Center for Scientific Studies (BCSS) maintains strong relationships with numerous collaborators, cooperative organizations, and funding entities. As a non-profit organization, we welcome grants, donations, and sponsorship opportunities to ensure the optimal conditions for our research. Our mission is to support the future well-being of the Bazaruto Archipelago's wildlife and marine ecosystems.

We extend our sincere gratitude to our valued partners and donors for their generous support. We are especially thankful to the Government of Mozambique, including Ministerio do Mar, Aguas Interiores e Pescas (MIMAIP), Instituto Oceanografico de Mozambique (InOM), Ministerio da Ciencia, Tecnologia, e Ensino Superior (MCTES), and Ministerio da Terra e Ambiente.































#### BAZARUTO CENTER FOR SCIENTIFIC STUDIES



