

Seagrass Monitoring Protocol for Madagascar's Marine Protected Areas



Acknowledgments

The successful completion of this seagrass monitoring protocol for Madagascar's marine protected areas would not have been possible without the generous support and contributions of numerous individuals and institutions.

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Executive Summary

The Seagrass Monitoring Protocol for Madagascar's Marine Protected Areas (MPAs) was developed under the Ocean Country Partnership Programme (OCPP), funded through the Blue Planet Fund by the UK Department for Environment, Food and Rural Affairs (Defra). This document aims to provide a clear, practical framework to support rangers and managers from Madagascar National Parks (MNP) in monitoring the health of seagrass ecosystems across the national MPA network. Developed in collaboration with national and international experts, the protocol responds to the urgent need to better understand, protect, and manage these ecologically critical habitats.

The protocol is designed to be practical and scalable, supporting local implementation while generating data that contribute to national and regional conservation goals. It includes annexes with ID guides, sampling aids, photographic references, and safety templates to support fieldwork.

As a living document, the protocol will be reviewed and updated as monitoring capacity grows, and new information becomes available. Ongoing training, data sharing, and collaboration among institutions will be essential to ensure the continued success of seagrass conservation in Madagascar.

Citation

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Ocean Country Partnership Programme

The Ocean Country Partnership Programme (OCP) is a bilateral technical assistance and capacity building programme that provides tailored support to countries to manage the marine environment more sustainably, including by strengthening marine science expertise, developing science-based policy and management tools and creating educational resources for coastal communities. The OCP delivers work under three thematic areas: biodiversity, marine pollution, and sustainable seafood. Funding is provided through the overarching Blue Planet Fund (BPF) by the UK Department for the Environment, Food and Rural Affairs (Defra).

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1. Glossary of terms

Name of term	Description
Adaptive Management	A flexible approach to MPA management that allows for adjustments based on new information, monitoring data, and changing conditions.
Capacity Building	Training and development initiatives to enhance the skills and knowledge of MPA managers, staff, and stakeholders.
Controlled Use Areas (CUAs)	An area of economic development where resource use and production activities are regulated and controlled.
Ecological Indicators	Measures used to assess change in marine ecosystems and biodiversity within MPAs over time.
Ecosystem Services	The benefits people derive from ecosystems. For example, provisioning services such as food and raw materials; regulating services such as prevention of soil erosion and carbon storage or cultural services such as recreation.
Epiphyte cover	Algae, microorganisms, and other small organisms growing on seagrass leaves.
Gender Equality, Disability and Social Inclusion (GEDSI)	An approach that aims to ensure that all individuals, regardless of their gender, ethnicity, age, disability, or other characteristics, have equal rights, opportunities, and access to resources and services.
Hard Core areas (HC)	A sanctuary of biological, cultural or religious interest, historical, aesthetic, morphological and archaeological interest into integral preservation perimeter.
MPA Management	The activities and strategies employed to effectively manage MPAs.
Marine Protected Area	Geographical areas of the marine environment established and managed to achieve long-term nature conservation and sustainable use.
Remote Sensing	The use of satellite imagery and other technology to monitor MPA boundaries, habitat changes, and human activities.
Rhizome	A horizontal, underground plant stem that produces shoots and roots from its nodes. They are used in seagrass species identification.
Seagrass	A grasslike plant that lives in or close to the sea, especially eelgrass.
Stakeholder	Individuals, groups, organisations, or entities with an interest or stake in natural resources including the designation, management and outcomes of MPAs.
Tannin	Tannins are chemical compounds found in seagrass that help protect the plant from herbivores, bacteria, and fungi. They are used in seagrass species identification.
Unprotected Control Sites (UCSs)	Ecologically similar areas outside MPAs used as comparison baselines to assess the effectiveness of protection measures by contrasting them with unprotected conditions.

2. Introduction

2.1 What is seagrass?

Seagrasses are unique marine flowering plants, or angiosperms, that have adapted to live fully submerged in seawater. Despite their name, not all seagrasses resemble grass, some species have broad or paddle-shaped leaves, but many have long, ribbon-like blades that give them a grassy appearance. Seagrasses vary greatly in size, from tiny species no larger than a fingernail to those with leaves stretching up to 7 metres in length.

These plants often grow in dense underwater meadows, known as seagrass beds, which form in shallow, subtidal areas with sandy or muddy bottoms. They typically thrive in calm, sheltered marine environments where wave action is minimal. Seagrass beds play a crucial ecological role by influencing water flow, enhancing nutrient cycling, and supporting complex food webs (see **Figure 1. Green sea turtle feeding on seagrass at Nosy Sakatia, Madagascar.**).

In tropical regions, seagrass beds are frequently found alongside other important coastal habitats such as mangroves and coral reefs, forming interconnected ecosystems that support high biodiversity and productivity. This information has been drawn from a variety of reputable sources; for further reading and references, please see the links listed in [Section 15](#).



Figure 1. Green sea turtle feeding on seagrass at Nosy Sakatia, Madagascar.

2.2 Seagrass in Madagascar

Madagascar has vast expanses of seagrass beds, which play a crucial role in maintaining threatened biodiversity and the fishing economy. The most significant seagrass meadows are thought to exist in the north-west of Madagascar, in shallow coastal habitats. They often grow in lagoons, protected bays and sheltered intertidal zones. Generally located on sandy or muddy substrates, they sometimes coexist with mangroves and coral reefs, thus forming a continuum of coastal ecosystems essential to biodiversity and the storage of blue carbon.

Madagascar's common seagrass species include:

- Turtle grass (*Thalassia hemprichii*)
- Spoon grass (*Halophila ovalis*)
- Serrated ribbon seagrass (*Cymodocea serrulate*)
- Ribbon seagrass (*Cymodocea rotundata*)
- Sickle-leaved cymodocea (*Thalassodendron ciliatum*)
- Noodle seagrass (*Syringodium isoetifolium*)
- Narrowleaf seagrass (*Halodule uninervis*)
- Needle seagrass (*Halodule pinifolia*)
- Shoal grass (*Halodule wrightii*)
- Dwarf eelgrass (*Zostera capensis*)
- Tape seagrass (*Enhalus acoroides*)

There is currently quite limited information available on the seagrass habitats in Madagascar, which can make it difficult for stakeholders to effectively integrate seagrass protection into local, regional and national initiative. See [Annex A](#) for a visual guide to seagrass identification in Madagascar.

2.3 The conservation importance of seagrass

Coastal livelihoods

Seagrass supports the livelihoods of coastal communities by providing essential habitats for fish, crabs, and shellfish that are vital to local fisheries. These underwater meadows help sustain fish populations that many communities rely on for food and income. Additionally, seagrass ecosystems contribute to eco-tourism and sustainable harvesting practices, offering alternative sources of revenue.

Coastal protection

Seagrass have root systems that help stabilise them against wave action. Their roots trap and stabilise the sediment, which not only helps improve water clarity and quality, but also reduces soil erosion and protects coastlines against storms.

Carbon sequestration and storage

Seagrass are one of the most effective blue carbon habitats in the world. Through photosynthesis they absorb carbon dioxide (also known as carbon sequestration) which is then stored in the sediment as they produce organic material through growth. If undisturbed, seagrass can store nearly three times as much carbon as terrestrial forests, making them highly valuable in the face of the current climate crisis.

Biodiversity support

Seagrass meadows provide numerous ecological services. They are essential habitats, providing spawning, nursery, refuge and foraging areas for many species, including commercially and recreationally important fish species. They also provide a major source of food for a range of large herbivores such as the endangered green sea turtle, and vulnerable dugongs.

Disease control

Seagrasses can remove and reduce microbiological contamination from the water, reducing pathogen exposure of marine species and humans. It has been demonstrated that the levels of pathogenic marine bacteria are reduced by 50% in tropical areas where seagrasses are present, in comparison to areas where seagrasses are absent.

Ocean acidification buffering

Increasing levels of marine carbon dioxide causes seawater pH to drop, this is known as ocean acidification and can have negative impacts on calcareous species, such as coral and shellfish. As seagrass remove carbon dioxide through photosynthesis it reduces the associated acidity of the water, buffering ocean acidity and reducing the negative impacts experienced by nearby marine organisms.

2.4 Threats to seagrass

Seagrass meadows face a range of direct and indirect threats that compromise their health and the vital services they provide. Direct threats include physical removal through coastal development, dredging, and land reclamation, as well as physical damage caused by boat anchors, boat propellers (see [Fig Figure 2](#)), trawling, and destructive fishing practices. The introduction of invasive species can also disrupt native seagrass communities by outcompeting them for space and resources.

Indirect threats are often linked to broader environmental changes and human activities. Siltation and smothering from land runoff reduce water clarity, limiting the sunlight seagrasses need for photosynthesis. Eutrophication, driven by excess nutrients from agriculture and sewage, can lead to algal blooms that further block light and deplete oxygen. Climate change intensifies these pressures through sea-level rise,

ocean acidification, and increasing temperatures, including marine heatwaves - prolonged periods of unusually high sea temperatures that can cause widespread seagrass die-offs. These losses not only affect the seagrass itself but also the marine life it supports, such as turtles, dugongs, and seahorses. Additionally, the death of seagrass meadows can release large amounts of stored carbon, contributing to further climate change.

Despite their ecological importance, seagrass ecosystems often receive less attention than coral reefs or mangroves, resulting in significant knowledge gaps that hinder effective, evidence-based management and conservation.



Photo credit: Project Seagrass

Figure 2. Scarring in a seagrass bed from boat propellers.

2.5 What is MPA monitoring?

Monitoring habitats and species within MPAs is crucial for maintaining ecosystem health and ensuring conservation goals are met. It involves the systematic collection and analysis of data to assess the status and effectiveness of these designated areas. It often requires measuring and tracking ecological, socio-economic and management-related evidence and indicators, e.g. habitat quality, species abundance, and biodiversity, through surveys, remote sensing, and other methods.

Regular monitoring helps identify threats like overfishing, pollution, and climate change, guiding adaptive management and conservation strategies. This data ensures MPAs are effective, supporting sustainable marine resource use and long-term biodiversity preservation.

2.6 Why do we monitor?

MPA monitoring plays a crucial role in the MPA Implementation cycle (see **Figure 3**) by providing insights into ecological changes, human activity impacts, and MPA management effectiveness over time.

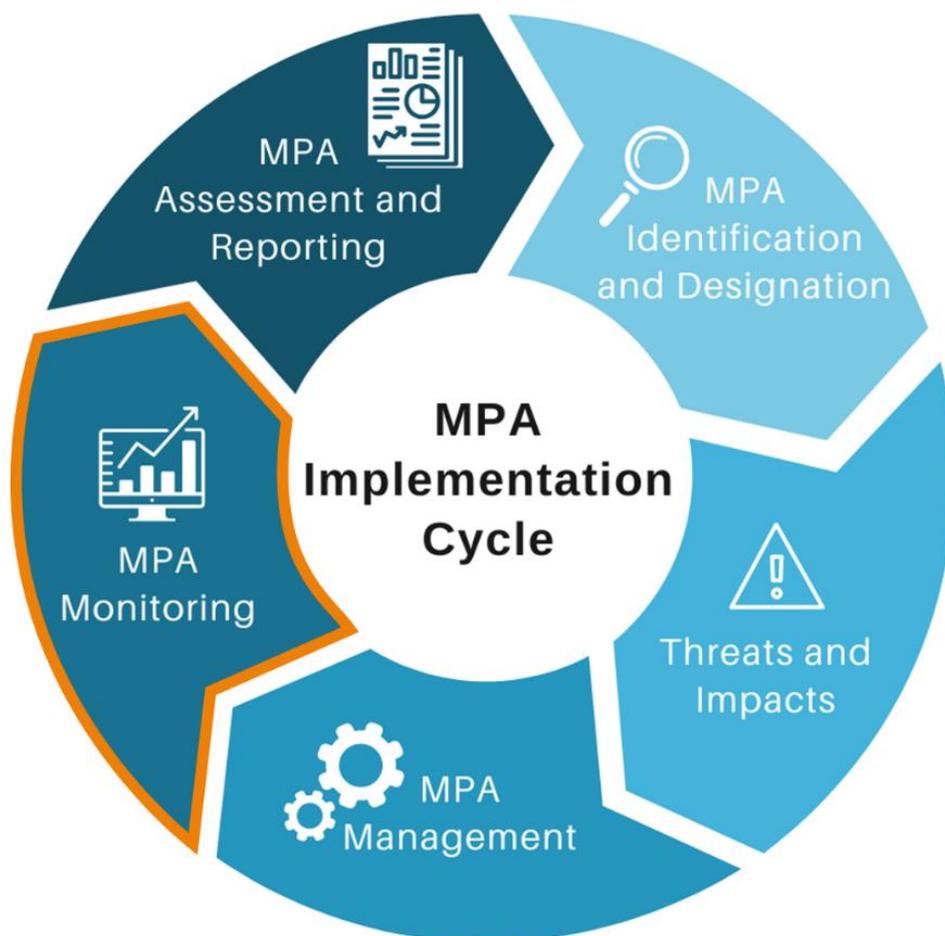


Figure 3. The Marine Protected Area (MPA) Implementation Cycle. This diagram is a visual tool to illustrate the key stages involved in the planning, establishment, and ongoing management of MPAs.

Monitoring helps:

Assess conservation objectives:

- Helps evaluate whether conservation goals and objectives are being met or what the progress is towards achieving the objective, informs adaptive management strategies, and ensures the sustainable protection of marine ecosystems and biodiversity within MPAs.
- Provides feedback for adaptive management of the MPA by identifying necessary adjustments to management strategies and objectives.

Evaluate ecological health and resilience:

- Assess the status of key monitoring indicators (described in [Section 13.2](#)).

- Tracking changes can help identify long-term trends and potential threats or pressures on marine ecosystems.
- Leads to more effective conservation and management actions through the feedback and incorporation of data.

Measure socioeconomic benefits and costs:

- Assesses how MPAs affect local communities and economies.
- Informs cost-benefit analysis, ecosystem valuation, and engagement.
- Supports planning that balances ecology, economy, and society.
- Encourages inclusive decisions and builds community support.

Enhance management and policy decisions:

- Supports evidence-based decision making and policy development.
- Highlights the success or failure of specific management strategies.
- Enables adaptive management through continuous feedback.
- Assesses and tracks the effectiveness of MPA management over time.

3. Monitoring protocol objectives

To establish a specific and standardised protocol for monitoring seagrass ecosystems within Madagascar's MPA network. This protocol aims to assess the health and biodiversity of seagrass beds, as well as evaluate the effectiveness of MPAs in conserving these vital habitats.

The objectives of this monitoring protocol are to assess:

- The spatial and temporal dynamics of seagrass habitats within Madagascar's MPA network.
- Changes in the health and extent of seagrass.
- Distribution of seagrass species across Madagascar.
- Variations in the abiotic environmental parameters associated to seagrass health and distribution e.g. sediment type, temperature, salinity, and pH.
- Anthropogenic impacts on seagrass beds e.g. litter, physical damage or trampling.
- Marine macrofauna and features associated with seagrass.
- The success of the conservation measures already applied in the MPAs by comparing the monitoring carried out in the Hard Core (HC) areas, in the Controlled Use Areas (CUAs) and in the Unprotected Control Sites (UCSs).

4. Study area and site selection

4.1 Geographic scope

This protocol should be undertaken in all MPAs with seagrass present in Madagascar, however, if resources are limited, MPA monitoring can be prioritised based on:

- **Seagrass coverage:** MPAs with extensive and diverse seagrass beds, e.g. Nosy Hara, Sahamalaza-Iles Radama National Park, Kirindy Mitea National Park, Masoala National Park and Nosy Ve-Androaka National Park.
- **Zonation within MPAs:** Include sites from different management zones to assess the impact of varying levels of protection e.g. seagrass found across the Hard Core (HC) and the buffer zone at Sahamalaza-Iles Radama National Park.
- **Ecosystem connectivity:** MPAs adjacent to other critical habitats like coral reefs or mangroves, to evaluate the role of seagrass in supporting broader ecosystem services.
- **Accessibility:** MPAs that have seagrass beds that are easy to access and survey. Future changes in understanding, resources or available capacity should result in the monitoring of less accessible sites.
- **Previously monitored:** Repeated monitoring in the same area supports the production of a data time-series which highlights natural variation trends, changes over time, environmental impacts on the habitat and the effectiveness of conservation efforts over time (See the link to the Seagrass-Watch website in [Section 15](#) for a list of monitoring sites in Madagascar).

4.2 Control sites

Where possible, identify control sites located just outside the MPA boundaries to serve as a baseline for comparison with seagrass conditions inside the protected areas.

These control sites provide a reference point to assess differences in habitat quality, biodiversity, and resilience between areas with protection and those without. By comparing seagrass health and other ecological indicators inside and outside MPAs, you can better understand the impact of the MPA's protection and management measures. This comparative approach helps to evaluate the effectiveness of conservation strategies, identify potential threats or weaknesses in management, and guide future improvements to enhance the MPA's ecological benefits.

5. Survey timing and frequency

5.1 Frequency

Changes affecting seagrass meadows are potentially rapid, and ecological monitoring of ecosystems such as this require relatively basic equipment and skills. Seagrass monitoring surveys will be conducted twice per year, to account for seasonal variations:

- **Once in dry season:** April to September.
- **Once in wet season:** October to March.

These surveys will be repeated annually to track long-term changes in seagrass extent and condition. This will allow frequent assessment of the effectiveness of the MPA over time.

5.2 Tide times

Before conducting a seagrass survey, it is essential to review the tide schedule for the selected site to ensure accessibility of the site and to optimise visibility and safety conditions. Water depth at the time of survey will influence the method used and the type of equipment required.

Recommended survey methods by water depth:

- **Walking survey:** 0 - 0.49 m
- **Snorkel survey:** 0.5 - 3 m
- **SCUBA survey:** 3 - 20 m

Please note that some measurements, such as seagrass cover estimates, can be more difficult to collect accurately when seagrass beds are exposed during low tide. For more consistent and reliable data, snorkel or dive surveys are recommended where possible and safe to do so.

6. Equipment and logistics

6.1 Sample team

"The monitoring of seagrass ecosystems will be carried out by members of the MNP monitoring team who have been fully trained in the ecological monitoring methods covered in this protocol (see [Figure 4](#)). A risk assessment should be undertaken prior to the commencement of any survey activities to ensure the safety of all participants (see [Annex B](#) for example risk assessment). For snorkel and SCUBA surveys, the team should comprise at least 4 experienced divers (minimum PADI Open Water Diver).



Figure 4. Madagascar National Parks staff conducting a practice seagrass survey at Nosy Sakatia during the Seagrass Monitoring Workshop in March 2025.

6.2 Walking survey equipment

This equipment list is to be used when surveying seagrass beds that are exposed or up to 0.49m deep.

- Suitable waterproof footwear
- Submersible slates and plastic pencil held in place by a string ([Annex C](#) for slate template)
- Drilled or weighted 50 x 50 cm PVC quadrat divided into 4 quarters
- 1m tape measure
- 3 x 50 m tape measure with reel
- Camera and waterproof housing (not essential)
- Seagrass ID guide
- GPS in waterproof pouch
- Laptop and internet key for data entry and transmission.

6.3 Snorkel survey equipment

This equipment list is to be used when surveying seagrass beds that are 0.5 – 3m deep.

- Fins, mask and snorkel
- Weight belt and weights.

- Submersible slates and plastic pencil held in place by a string ([Annex C](#) for slate template)
- Drilled or weighted 50 x 50 cm PVC quadrat divided into 4 quarters
- 1m tape measure
- 3 x 50 m tape measure with reel
- Compass
- Camera and waterproof housing (not essential)
- Seagrass ID guide
- GPS in waterproof pouch
- Laptop and internet key for data entry and transmission.

6.4 SCUBA survey equipment

This equipment list is to be used when surveying seagrass beds that are over 3 m deep.

- SCUBA gear
- Submersible slates and plastic pencil held in place by a string
- Drilled or weighted 50 x 50 cm PVC quadrat divided into 4 quarters
- 1m tape measure or ruler markings on dive slate
- 50 m tape measure with reel
- Compass
- Camera and waterproof housing (not essential)
- Seagrass ID guide
- GPS in waterproof pouch
- Laptop and internet key for data entry and transmission.

7. Survey design and transect setup

7.1 Sample design

Use a stratified sampling approach to select representative sites within the MPA. This method involves dividing the area into distinct sub-groups or “strata” (e.g., management zones or depth ranges) and sampling within each to ensure all key habitat types and conditions are represented.

Where applicable, include different management zones such as Hard Core (HC), Controlled Use Areas (CUA), Unprotected Control Sites (UCS), and buffer zones. If management zones are not defined, stratify sampling based on depth gradients or other relevant environmental features.

Where feasible and permitted, establish permanent transects within each selected zone. This allows for consistent, repeatable monitoring over time and improves the ability to detect ecological changes and trends.

7.2 Permanent transect setup

The permanent transect method is used to assess seagrass cover, species composition, and biodiversity across marine meadows in a consistent and repeatable way. To ensure comparability over time, establish three permanent transects within each MPA.

Once a seagrass bed is identified, lay a 50-metre baseline transect perpendicular to the shoreline, extending toward the open sea. Along this baseline, select three stations to serve as the centre points for three 50-metre transects running parallel to the coast (see **Figure 5**). Record the GPS coordinates at each station and mark them with permanent benthic markers to ensure accurate relocation for future surveys.

These markers define the following transects:

- **Shallow transect** – located at least 1 metre inside the edge of the seagrass meadow
- **Mid-depth transect** – positioned midway between the shallow and deep transects, or at a notable transition in species or habitat
- **Deep transect** – placed up to 50 metres from the shore and at least 1 metre inside the seagrass meadow boundary

This layout captures ecological variation across depth gradients and improves the ability to detect spatial and temporal changes in seagrass condition.

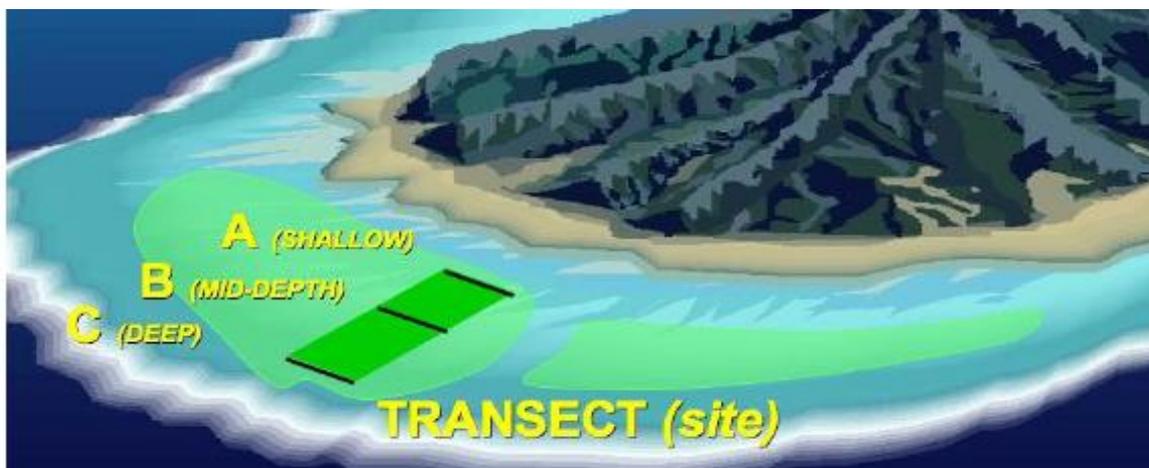


Figure 5. Transect set-up for monitoring marine seagrass beds.

Permanent marker options:

- **GPS Reference Point** - A handheld GPS device is used to record the exact coordinates of each station. These points should be saved with clear labels and stored both digitally and in hard copy. While GPS alone may not offer precise underwater relocation, it is a helpful backup reference in combination with physical markers.
- **Sand Screw** (see installation method in [Annex E](#)) - A sand screw provides a stable, long-term anchoring point in sandy or soft sediment environments. These should be installed by twisting the screw deep into the substrate to ensure it remains fixed over time. A short rope or marker can be attached to make visual relocation easier during surveys.

- **Makeshift Buoy** - A surface or subsurface buoy can be installed as a visual marker for each station. This is especially useful in areas where underwater visibility is low. Buoys should be securely anchored and labelled if possible. However, be aware that buoys may be subject to movement or loss due to currents, storms, or human activity, so they should be checked regularly.

7.3 General procedure for quadrat sampling

- 1) Locate the 3 permanent transect markers.
- 2) Unroll a 50m tape measure, parallel to the shoreline, at each marker. Ensure the 25m mark on the tape measure is as close to the permanent marker as possible.
- 3) If the current is strong, secure the unrolled tape measure with loose rocks or loose debris.
- 4) Note the characteristics of the transect (site, transect type, date, time, coordinates, visibility etc.).
- 5) If feasible, take a water sample (see protocol in [Section 8.1](#))
- 6) Starting at 0 m, quadrats samples are taken every 5 meters along each transect line. The quadrat should be positioned on the left of the transect line so that the bottom right-hand corner is placed on the distance mark (see [Figure 6](#)). If you have a camera available, take a picture roughly 50cm above the quadrat.
- 7) See [Sections 8 & 9](#) for what data should be collected throughout the survey.

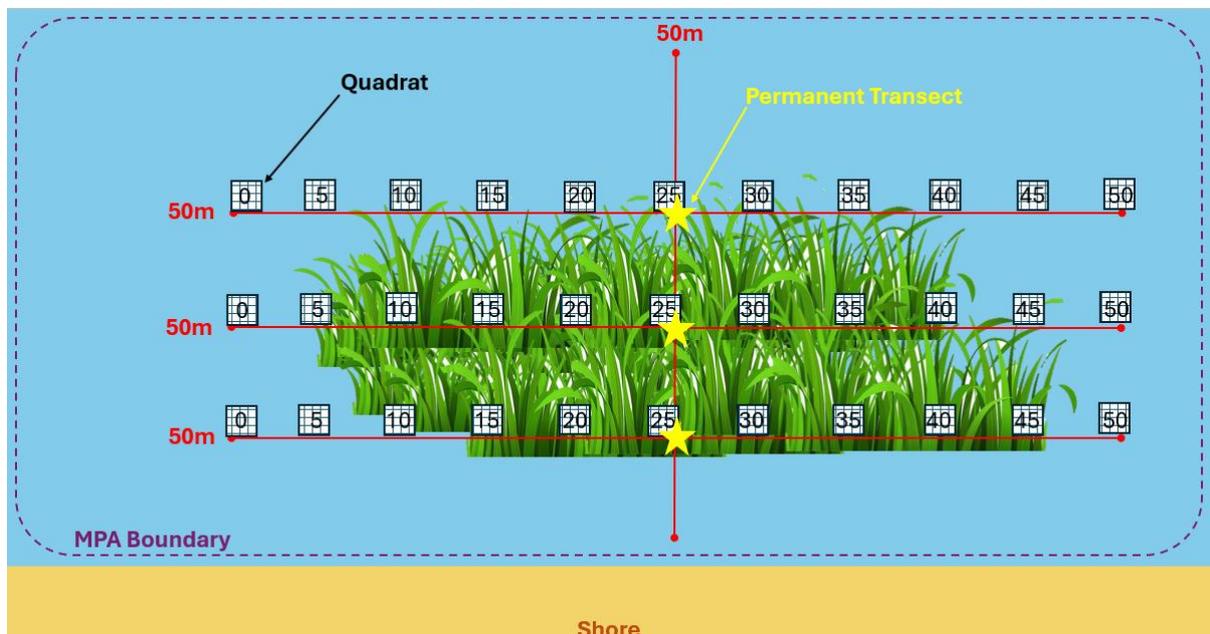


Figure 6. *Quadrats sample design for monitoring marine phanerogam meadows.*

In instances where the shallow transect is above the water line, at the time of sampling, it is important to be mindful of potential footfall damage on the seagrass while sampling.

8. Pre-survey data collection

8.1 Water quality

At the start of the survey day, if possible, measure water quality at each site to assess the water conditions within the MPA.

- 1) At the sampling site, walk, wade or boat to the seagrass bed area.
- 2) Use a clean bottle (500 ml to 1 l) and rinse the bottle three times with the site water before collecting the sample.
- 3) Collect water from just above the seagrass canopy (~10 cm above). Avoid disturbing sediments if possible.
- 4) Fill the bottle completely to minimise air space and cap it tightly.
- 5) Collect the water temperature in situ from a dive computer. As soon as possible use a multiparameter water quality probe to test the temperature, salinity and pH.
- 6) Record the measurements for each.

These measurements are important for understanding the abiotic factors influencing seagrass health inside the protected area.

8.2 Sediment characteristics

At the start of the survey, take note of the in-water visibility (in meters) on the horizontal plane as an indicator of sedimentation levels in the water.

In the 0m, 25m and 50m quadrat of the survey transect, rub a small sample of sediment between your fingers to assess and note the grain size and texture:

- **Sandy:** Gritty texture.
- **Muddy:** Smooth, sticky texture.
- **Mixed:** Combination of gritty and smooth.

Sediment composition affects seagrass rooting, and changes can reflect broader environmental shifts.

9. Quadrat data collection

In each quadrat, record data for all parameters listed below (see dive slate layout in [Annex C](#)). If possible, take a photo of each quadrat using the underwater camera to support further analysis.

9.1 Seagrass percent cover

Looking down on the quadrat from above, visually estimate the total percentage (%) of seabed covered by seagrass leaves within the quadrat (see **Figure 7**). Further examples can be found in [Annex E](#).

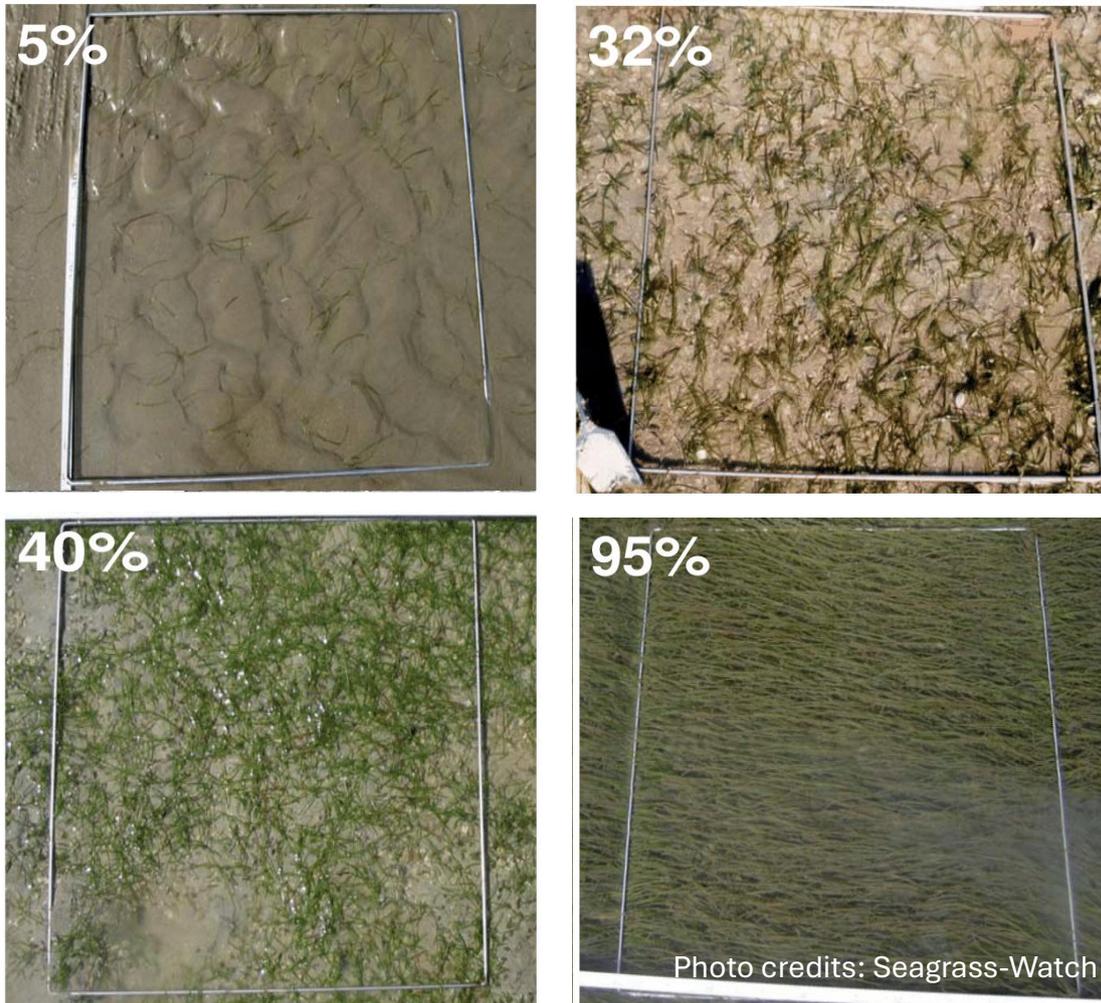


Figure 7. Example images of percentage cover of seagrass in a quadrat.

9.2 Seagrass density

In the most representative quarter of the quadrat, count the number of above-ground seagrass shoots and stems to estimate seagrass density. *Note: Be careful not to include rhizomes in your count - only visible shoots and stems should be recorded.*

An effective MPA should ideally show stable or increasing seagrass percentage cover over time. Higher shoot densities are also often associated with better habitat health and recovery in protected zones.

9.3 Species composition

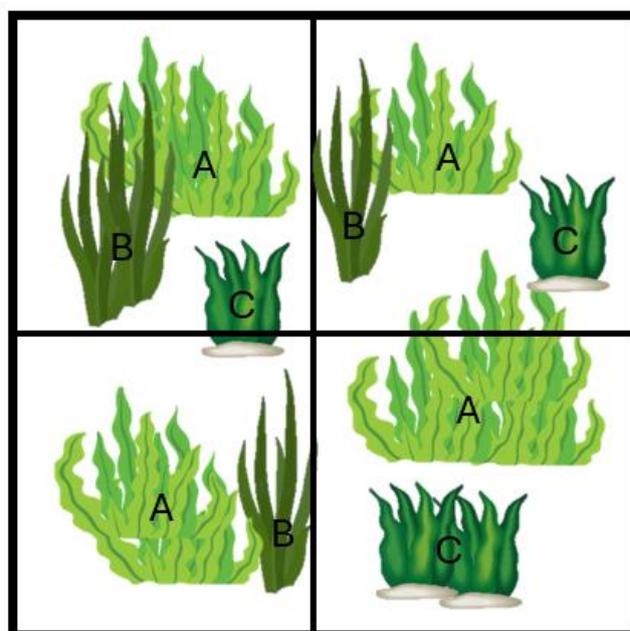
Identify the seagrass species present within the quadrat and calculate the percentage contribution of each species, starting with the least abundant. The total composition must equal 100% of the seagrass habitat identified within the quadrat (refer to the example image below).

Species identification is based on distinct morphological characteristics, including rhizome structure and branching, number of roots per node, and leaf features such as shape and the presence of tannin cells (see [Annex A](#) for the full identification guide). Reliable resources such as Seagrass-Watch and the World Atlas of Seagrasses should be used to support identification (see [Section 15](#) of the protocol).

In cases of uncertainty in the field, confirmation should be sought through camera image analysis or by collecting samples for laboratory verification. Documented changes in species composition over time may indicate ecosystem stress or recovery.

Madagascar's seagrass species and ID codes:

- EA** - *Enhalus acoroides*
- Cs** - *Cymodocea serrulate*
- Cr** - *Cymodocea rotundata*
- Ho** - *Halophila ovalis*
- Hp** - *Halodule pinifolia*
- Hw** - *Halodule wrightii*
- Hu** - *Halodule uninervis*
- Si** - *Syringodium isoetifolium*
- Th** - *Thalassia hemprichii*
- Tc** - *Thalassodendron ciliatum*
- Zc** - *Zostera capensis*



**Species A – 60%, Species B – 20%,
Species C – 20 %**

9.4 Canopy height

Measure the average canopy height (in centimetres) of the dominant species inside the quadrat. Measure distance from the sediment surface to average leaf tip (see [Figure 8](#)).

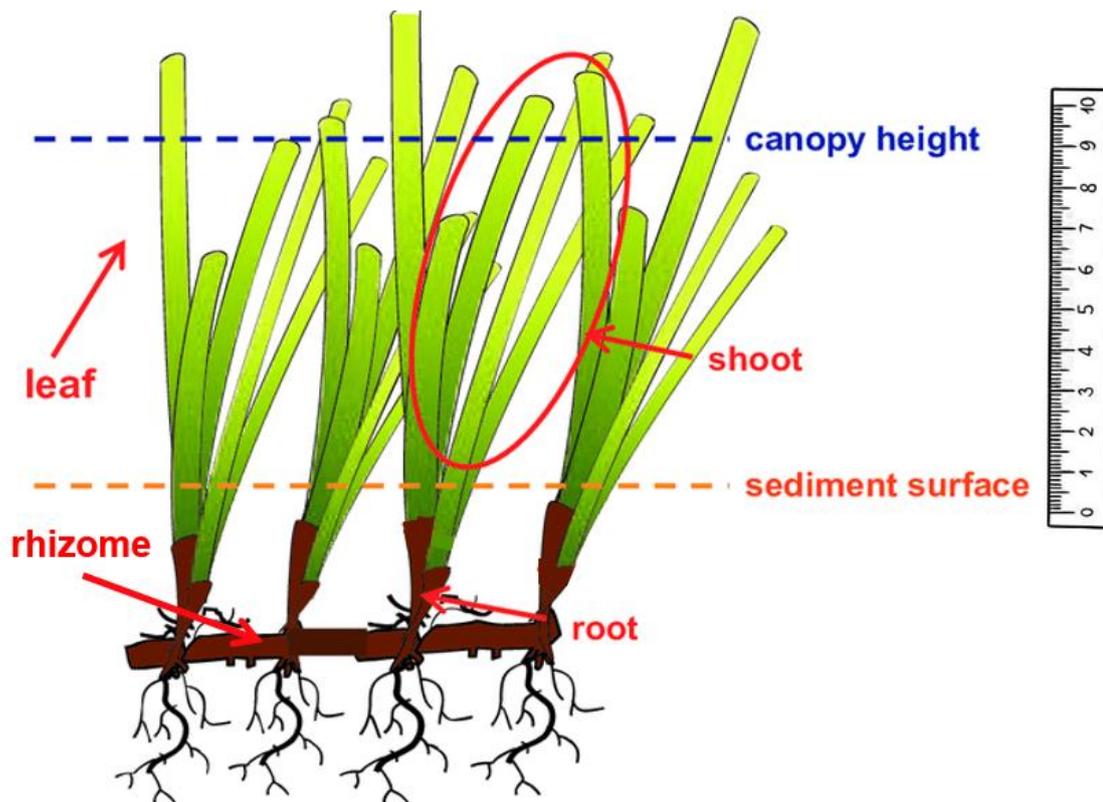


Figure 8. Method for measuring the canopy height of seagrass.

9.5 Additional features and macrofauna

Document any associated macrofauna or features up to 5m either side of the transect line which may be of interest to the transect site (example images can be found in the [Annex F](#)). Additional features may include:

- Presence of turtles, fish, invertebrates (e.g. crabs, sea urchins, hermit crabs, snails), crab burrows, worm holes etc.
- Evidence of herbivory from key species such as sea turtles, dugongs, and fish species e.g. parrot fish. The presence of herbivores may indicate ecosystem health, as these species rely on well-functioning seagrass beds.
- High percentage cover of epiphyte (algae, microorganisms, and other small organisms growing on seagrass leaves) cover on the seagrass beds. High epiphyte cover often indicates eutrophication and can block light from reaching seagrass, reducing seagrass health and growth.
- Assess signs of physical damage (e.g., scars from boat propellers, trampling) (see [Figure 2](#)). or pollution (e.g., plastic debris). Monitoring anthropogenic impacts helps evaluate MPA enforcement and the need for additional management actions.

10. Data management and analysis

10.1 Data recording and processing

Use standardised field data sheets with consistent categories for all zones within the MPA, ensuring the data are comparable across sites.

- Data is entered as soon as possible after it has been collected. Each observer enters his or her own data.
- The TPhM results and abiotic parameter values recorded on the slates are entered directly into the standard Excel file template provided, entitled "SaisieTPhM".
- The Excel file containing the data will be saved under a new title with the following code: "APM_Station_Year_TPhM".

The file is then immediately sent by internet to the person responsible for centralising the data at MNP headquarters.

10.2 Data storage and best practice

All data collected through the monitoring program should be stored securely in a digital database. This ensures the information is preserved over time, can be easily accessed when needed, and is available to support decision-making.

Best Practices for Data Storage:

- **Centralised digital storage:** Use a cloud-based platform or shared server that can be accessed by relevant stakeholders, including MPA managers, government agencies, and research institutions.
- **Consistent file naming and formatting:** Use standardised templates and clear file names (e.g. SiteName_Date_Variable.xlsx) to keep records organised and easy to find.
- **Regular backups:** Back up data frequently to prevent loss due to hardware failure, accidental deletion, or natural disasters.
- **Metadata and documentation:** Include notes describing how and when the data was collected, who collected it, and any relevant methods used. This makes the data understandable and usable in the future.
- **Version control:** Keep track of edits or changes made to datasets to maintain a clear record of updates over time.
- **Access control:** Define who can view, edit, or share data to ensure information is used responsibly and securely.

Proper data storage not only protects your hard work but also ensures the data can be used to inform long-term monitoring, guide adaptive management, and support scientific research and collaboration.

10.3 Statistical analysis

Statistical analysis helps turn the data you collect into useful information that can guide management decisions and future planning. By analysing trends and patterns in the data, you can understand how seagrass meadows are changing over time, what might be influencing those changes, and how effective different protection measures (like marine protected areas) are.

Statistical analysis allows you to:

- Detect changes in seagrass health over time or between different zones.
- Compare areas with different management levels, such as no-take zones versus areas open to some use.
- Identify relationships between seagrass health and environmental conditions like water clarity or sediment type.
- Support adaptive management by providing evidence for what's working and what needs adjustment.

This helps ensure that decisions about marine resource use and conservation are based on sound evidence, not guesswork.

Key Types of Statistical Analysis

You don't need to be a statistician to understand or apply basic statistical tools. Here are three common approaches used in seagrass monitoring:

1. Comparing Areas Using ANOVA (Analysis of Variance)

- ANOVA is used when you want to compare the average values between three or more groups.
- **Example:** Does the average percent cover of seagrass differ between no-take, buffer, and unprotected zones? ANOVA can tell you if the differences you observe are statistically meaningful or likely due to random variation.

2. Identifying Relationships Using Regression Analysis

- Regression is used to explore how one variable affects another.
- **Example:** Does seagrass canopy height increase as water clarity improves? Regression analysis helps you answer questions like this by measuring how closely two factors are related.

3. Visualising Patterns with Spatial Mapping

- Mapping your data allows you to see how seagrass health and habitat features vary across space.
- **Example:** You can create a map showing where seagrass is densest, where epiphyte cover is highest, or where propeller scarring is most severe. This helps identify priority areas for protection or restoration.

What to analyse?

- You can apply these statistical tools to a wide range of the data you collect, including:
- Seagrass density, percent cover, species composition, and canopy height.
- Environmental conditions like water visibility and sediment type.
- Indicators of ecosystem use and impact, such as herbivory, presence of key species (e.g., turtles), litter, and propeller scarring.

By combining these variables, you can build a more complete picture of what's happening in the seagrass ecosystem.

Feeding Into Management and Planning

Results from statistical analysis can be:

- Reported to decision-makers and stakeholders to justify conservation actions or changes in policy.
- Used to evaluate the success of Marine Protected Areas (MPAs) or restoration efforts.
- Incorporated into adaptive management plans, allowing strategies to evolve based on evidence.
- Shared with communities and funders to show outcomes and promote transparency.

Getting Help with Statistics

You don't have to do everything yourself. Many free or low-cost tools (like Excel, R, or QGIS) can help you run basic analyses or create maps. Partnering with universities, NGOs, or data-savvy volunteers can also provide support.

11. Capacity building

11.1 Training and protocol updates

It is essential to conduct regular training workshops for relevant MNP staff on seagrass identification, data collection techniques, and MPA management principles. These

workshops should be designed to enhance staff knowledge and skills, ensuring they are well-equipped to carry out accurate and reliable surveys.

To maintain high survey standards and consistent data quality, we recommend the continuous training of new staff members, as well as periodic refresher courses for existing staff. This ensures that all personnel are up to date with current best practices and new developments in seagrass monitoring and MPA management. Additionally, it's crucial to establish a system for reviewing and updating the survey protocols regularly, ensuring they reflect new scientific findings, advancements in monitoring methods, or changes in management strategies.

12. Reporting and adaptive management

12.1 Annual reporting and adaptive management

Prepare annual reports that summarise:

- Seagrass health indicators (e.g., seagrass cover, species composition).
- Biodiversity assessments (e.g., associated fauna).
- MPA effectiveness (e.g., trends in protected vs. non-protected zones).

Share findings with MPA managers, local government agencies, and conservation organisations to inform policy decisions.

The reported monitoring data can then be used to guide adaptive management actions:

- Adjusting MPA zoning or enforcement if declines are observed in key areas.
- Implementing restoration efforts in degraded seagrass beds.
- Enhancing community outreach and education if human impacts are detected.

13. Conservation targets and monitoring objectives

13.1 Setting conservation targets

A conservation target refers to the specific goal or target aimed at protecting and maintaining the health of the marine ecosystem within that area, including its habitats and species, by defining the desired long-term conservation state of the site; essentially, it outlines what the MPA is trying to achieve in terms of conservation.

- **Specificity:** Each MPA will have its own set of conservation targets based on the unique ecological features found there.

- **Measurable targets:** These targets should be clearly defined and include measurable indicators to track progress towards achieving the desired conservation state.
- **Species and habitat focus:** Conservation targets may focus on protecting specific threatened species, maintaining healthy populations of key species, or preserving important habitats.
- **Socio-economic focus:** Conservation targets may focus on the protection and maintenance of biodiversity features that local communities rely on, through tourism or fisheries, for example.
- **Management strategies:** Once conservation objectives are established, management plans are developed to implement actions that will help achieve those goals.

Example conservation objectives for an MPA:

- Maintain an average seagrass percentage cover of $\geq 70\%$ and species richness of at least 3 seagrass species per site (based on species composition data) in all monitored sites within the protected area by 2029, with no significant decrease in canopy height ($>10\%$) compared to the 2025 baseline.
- Increase seagrass percentage cover in designated degraded zones from $<30\%$ to $\geq 60\%$, and increase species composition from ≤ 1 species to ≥ 2 species by 2028, using annual monitoring of seagrass metrics and evidence of recovery (e.g. canopy height ≥ 5 cm, reduced bare patches).
- Support sustainable fish populations by ensuring seagrass habitats maintain $\geq 70\%$ cover and diverse structure (≥ 2 seagrass species, canopy height ≥ 6 cm), as indicators of fish habitat quality, and record presence of key fish species annually through visual surveys through 2029.

13.2 What are monitoring indicators?

Indicators, in the context of MPAs, refer to specific metrics or parameters used to measure and track environmental changes (see [Table 1](#)). These metrics serve as a valuable tool for answering various questions related to an MPA. Using indicators can streamline monitoring efforts.

Table 1. Example of biodiversity, habitat and human activities indicators.

Biodiversity indicators	Species richness, diversity indices, population abundance
	Presence and health of keystone species
	Changes in composition of ecological communities

Habitat indicators	Cover, extent or health of a habitat-forming species (coral cover, seagrass extent, health of mangroves)
	Physical characteristics (substrate complexity, ...)
	Sedimentation rates and water clarity
Human activities and pressure	Fishing effort, catch composition
	Pollution levels (e.g. nutrient runoffs, oil spills, ...)
	Tourism, recreational activities

By employing indicators, MPA managers can evaluate the condition of habitats, species, and ecosystems, analyse species distribution across time and space, and gauge the impact of human activities, contributing to a comprehensive understanding of the MPA's ecological dynamics.

The infographic below shows an example of two indicators, the relevant metrics and associated monitoring activities for an MPA which can be used to monitor and report on the conservation objective: *maintain the seagrass in favourable condition* (see **Figure 9**).

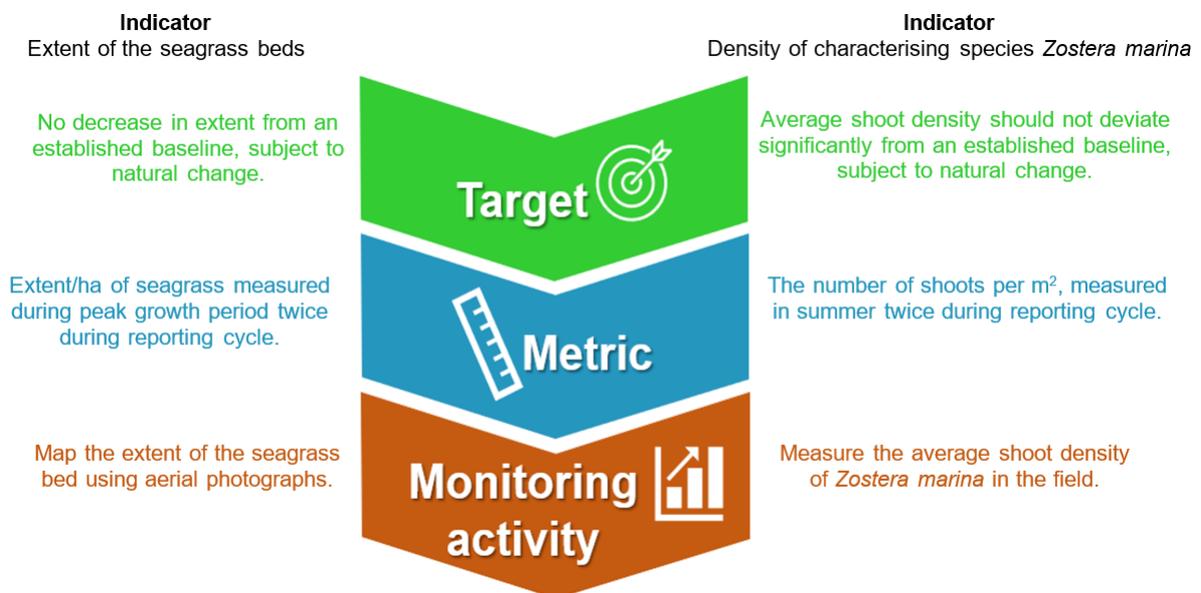


Figure 9. Example of indicators for monitoring seagrass habitats.

13.3 Management plan integration

Integrating evidence into management plans means actively incorporating scientific data, socio-economic information, and local knowledge to inform decision-making

within the MPA. This ensures management strategies are based on the best available understanding of the ecosystem and its interactions with human activities, leading to more effective conservation outcomes.

Current MNP management goals focus on a 5-year protection cycle of the protected feature. The threats and associated management actions are identified for the protected feature, and this is integrated into the site-specific conservation targets and management plan.

13.4 Global dataset contribution

To maximise the value of seagrass monitoring efforts and contribute to global conservation, it is strongly recommended that data collected using this protocol be submitted to recognised international databases, including **Seagrass-Watch** and **SeagrassNet**.

These platforms serve as global repositories for seagrass monitoring data, enabling scientists, policymakers, and conservation practitioners to track trends, compare data across regions, and better understand the status of seagrass ecosystems worldwide. By contributing to these networks, Madagascar can ensure that its data not only supports local management and adaptive planning, but also informs global assessments, such as those conducted by the UNEP, IUCN, and the IPBES.

Both platforms welcome contributions from new regions and provide valuable feedback and networking opportunities. For submission guidance, refer to the respective websites listed in [Section 15](#).

14. Seagrass restoration

Seagrasses provide essential ecological services, including habitat for marine life, shoreline protection, carbon storage, and support for coastal livelihoods. When seagrass beds decline, restoration can be a valuable tool to recover lost function and preserve ecosystem resilience. While restoration is not a substitute for protection, it is increasingly necessary to reverse degradation, support biodiversity, stabilise the climate, and strengthen community resilience in the face of global change.

14.1 Signs of human impact on seagrass beds

Visible and chemical indicators help identify when restoration may be needed:

Physical and biological indicators:

- Decreased seagrass cover or fragmentation of meadows
- Increased water turbidity from suspended sediments (often due to erosion or coastal construction)
- Blooms of opportunistic algae or epiphytes, indicating nutrient pollution from sewage or agriculture
- Decline in associated fauna (e.g. fish, turtles, dugongs, invertebrates)
- Dredging or anchoring scars across the seabed

Chemical and environmental indicators:

- Low dissolved oxygen (often caused by eutrophication)
- Shifts in pH or salinity (linked to freshwater flow changes)
- Presence of pollutants such as heavy metals, pesticides, or hydrocarbons in water, sediment, or plant tissue

14.2 Restoration approaches

Restoration strategies depend on the extent and cause of degradation. Broadly, there are two key approaches:

1. Reduce Human Pressures (Passive Restoration)

Addressing root causes is essential before active restoration efforts can succeed.

Common actions include:

- **Nutrient management:** Improve wastewater treatment and reduce agricultural runoff
- **Control maritime impacts:** Establish MPAs, introduce ecological moorings, and restrict destructive fishing
- **Sediment control:** Reforest upstream catchments and limit coastal development to reduce erosion

2. Active Restoration

When natural recovery is not occurring, active interventions can help re-establish seagrass beds. Active restoration should be carefully planned, with monitoring in place to assess success and adjust methods as needed. (See [Annex G](#) for images of common active restoration methods). Common techniques include:

- **Transplantation:** Moving seagrass shoots or root systems from healthy donor sites or nurseries to degraded areas (see [Figure 10](#)). Transplants may include intact sediment ("plugs") or just plant material.
- **Seed-based restoration:** Collecting and dispersing seeds to encourage natural germination and meadow expansion. This is often less invasive and allows for broader-scale restoration if seed availability is high.



Photo credit: IH.SM, University of Toliara

Figure 10. Image of seagrass transplantation in Madagascar.

Site selection is crucial. Restoration should focus on areas that historically supported seagrass but have since been degraded. Avoid planting in locations that have never sustained seagrass, as these may not offer the necessary conditions for long-term survival and growth.

Restoration should work with nature, not against it - aim to assist natural recovery in areas with the best chance of success.

For detailed guidance and practical resources on seagrass restoration techniques, visit the Project Seagrass website (see [Section 15](#)).

14.3 Participatory approach and monitoring

Successful seagrass restoration depends not only on the right techniques but also on community involvement and ongoing monitoring. Restoration is most effective when it is inclusive, adaptive, and grounded in the local context.

Key Elements for Effective Restoration

- **Community Engagement:** Involve local communities through awareness-raising, education, and participation in restoration and conservation activities. Local knowledge and stewardship are critical for long-term success and sustainability. All engagement activities must prioritise the safety and well-being of participants by incorporating thorough risk assessments and ensuring that actions are supervised by qualified and appropriately trained personnel, in line with the principle of 'do no harm'.
- **Ecological Monitoring:** Use satellite imagery, drone surveys, or in situ monitoring to track the progress of restored areas over time. Monitoring allows you to assess regeneration, detect problems early, and measure outcomes.
- **Adaptive Management:** Restoration strategies should be adjusted based on monitoring results and changing environmental conditions. Flexibility and responsiveness are essential to ensure that methods remain effective and appropriate.

15. Useful resources

- **Green E.P., Short F.T. (2003)** *World Atlas of Seagrasses. Prepared by the UNEP World Conservation Monitoring Centre. University of California Press, Berkeley, USA.*
<https://resources.unep-wcmc.org/products/world-atlas-seagrasses/download/1293948>
Prepared by UNEP-WCMC, this global atlas outlines the distribution, status, and ecological value of seagrass habitats across 24 regions, highlighting their role in biodiversity, fisheries, and coastal protection, as well as threats from human activities and environmental change.

- **Large-scale Seagrass Mapping and Management Initiative (LaSMMI)**
<https://www.lasmmi.org/>
The LaSMMI website presents a partnership led by WIOMSA, The Pew Charitable Trusts, and the University of Southampton, which aims to create field-verified maps of seagrass meadows across the Western Indian Ocean to inform conservation, policy, and climate resilience efforts.

- **McKenzie, L.J. & Yoshida, R.L. (2018)** *Seagrass-Watch: Proceedings of a Workshop for Monitoring and Mapping Seagrass Habitats in Madagascar, Nosy Bé, 19–21 March 2018.*
https://www.seagrasswatch.org/wp-content/uploads/Resources/Proceeding/PDF/Madagascar_Mar18.pdf
This report outlines training activities, monitoring methods, and key findings from a regional workshop in Madagascar. It provides valuable insights into local seagrass ecosystems and community-based monitoring.

- **Project Seagrass – Peer-Reviewed Publications**
<https://www.projectseagrass.org/our-publications/>
An extensive collection of scientific publications covering topics such as food security, small-scale fisheries, pollution, restoration, and citizen science in seagrass ecosystems.

- **Seagrass Restoration Handbook - UK & Ireland (2021)**
<https://www.decadeonrestoration.org/publications/seagrass-restoration-handbook>
A practical guide detailing techniques and case studies for restoring seagrass meadows in temperate regions. It provides step-by-step instructions on planning, implementation, and monitoring of restoration projects.

- **Seagrass Net**
<https://www.seagrassnet.org/>
A global ecological monitoring network focused on seagrass science, conservation, and restoration. It provides tools, training, and a collaborative platform for researchers and communities.

- **Seagrass-Watch**
<https://www.seagrasswatch.org/madagascar/>
A global seagrass monitoring program offering training, data collection methods, and long-term monitoring strategies. It supports over 335 sites worldwide.

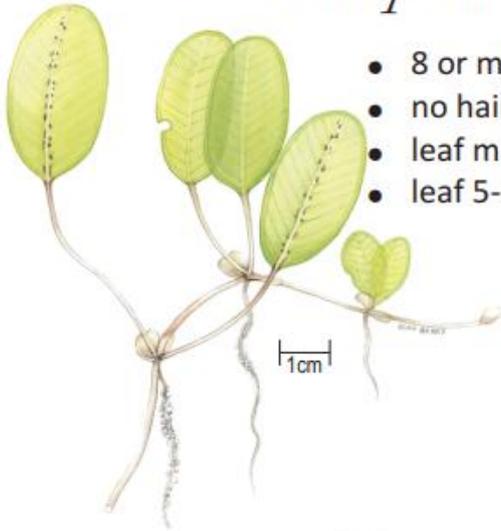
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Annex A. Seagrass ID Guide

Ho

Halophila ovalis



- 8 or more cross veins
- no hairs on leaf surface
- leaf margins smooth
- leaf 5-20mm long

Th

Thalassia hemprichii

- ribbon-like, curved leaves 10-40cm long
- leaf tip rounded, slightly serrated
- short black tannin cells, 1-2mm long, in leaf blade
- thick rhizome with scars between shoots



Si

Syringodium isoetifolium

- narrow spaghetti-like leaves
- cylindrical in cross section, 1-2mm diameter
- leaves contain air cavities
- leaf tip tapered
- leaves 7-15cm long



Cs

Cymodocea serrulata

- serrated leaf tip
- wide leaf blade (5-9mm wide)
- leaves 6-15cm long
- 13-17 longitudinal veins
- robust/strong rhizome



Cr

Cymodocea rotundata

- rounded leaf tip
- narrow leaf blade (2-4mm wide)
- leaves 7-15 cm long
- 9-15 longitudinal veins
- well developed leaf sheath



Hp

Halodule pinifolia

- rounded leaf tip
- 1 central vein
- usually pale rhizome, with clean black leaf scars



Tc

Thalassodendron ciliatum

- cluster of ribbon-like curved leaves
- round, serrated leaf tip
- very coiled, branched roots
- tough, woody rhizomes with scars from successive shoots
- typically found in rocky areas with strong reef crests



Hu

Halodule uninervis

- trident leaf tip
- 1 central vein
- usually pale rhizome, with clean black leaf scars





Ea

Enhalus acoroides

- very long ribbon-like leaves 30-150 cm long
- leaves with inrolled leaf margins
- thick rhizome with long black bristles and cord-like roots
- found on shallow / intertidal sand and mud banks (often adjacent to mangrove forests)

Hw

Halodule wrightii

- leaves are narrow, flat, and ribbon-like, typically 1–3 mm wide and 5–15 cm long.
- leaf tips have a distinctive three-toothed (trident) shape.
- a dark central vein is visible along the length of each leaf.
- rhizomes are slender and spread laterally, helping form dense mats.



Zc

Zostera capensis

- leaves are long, flat, and ribbon-like, typically 2–5 mm wide and can reach lengths of up to 30 cm.
- leaf tips are rounded or slightly pointed, with no teeth or splits.
- leaves have multiple faint parallel veins, not a single dark midrib.
- can also be found mixed with other seagrass species in lower salinity environments.



Annex B. Example Seagrass Survey Risk Assessment

Assessment carried out by: ...Lee Mur.....

Date assessment was carried out:...01/01/2025.....

Location: Madagascar Site: Nosy Be..... Activity: Snorkel seagrass monitoring survey.....

If you are aware of any further risks/hazards for this activity, please add them to the form and discuss with Health & Safety.

Participants should carry or have access to a first aid kit and fully charged mobile phone. Snorkelling and sea swimming should only be undertaken with a buddy/nominated contact to check in with.

Hazards	Who is at risk of harm and how?	Control measures	Who is responsible for the action?
Currents	Participants Being swept away from shore, drowning.	<ul style="list-style-type: none"> Use tide tables where appropriate. Have contingency exit points available for shore. Only swim or snorkel in areas designated as safe to do so. Let someone in your travelling group know you are going and check in with them when back. Ask at your accommodation or local contacts where it is safe to swim and be mindful about leaving items unattended on the beach. 	Participants
Poor weather conditions	Participants Snorkeller becoming disorientated, swallowing water, electrocution from lightning, drowning.	<ul style="list-style-type: none"> Check weather forecasts before snorkelling. Do not swim or snorkel in poor weather conditions. If conditions deteriorate during the session, vacate the water immediately. Be aware of local weather patterns and their impact on snorkelling conditions. 	Participants
Boats	Participants Serious injury to snorkellers or swimmers/death	<ul style="list-style-type: none"> Avoid swimming and snorkelling in areas of high boat traffic. Be aware of the types and sizes of boats that use the areas. Break regularly from snorkelling or swimming to check activity in the area. 	Participants
Accidental Falls Overboard	Participants Drowning, hypothermia, or injuries from the fall.	<ul style="list-style-type: none"> Always ensure all passengers wear life jackets in boat. Only strong swimmers will engage in the snorkelling activities Conduct regular headcounts to ensure all passengers are accounted for. Have a man-overboard drill and recovery plan in place. 	Boat Operator and participants
Cold water and or wind chill	Participants	<ul style="list-style-type: none"> Snorkellers/swimmers to choose appropriate, well-fitting exposure protection in good condition. Be prepared to leave the water if you become cold and have appropriate warm 	Participants

	Hypothermia	weather gear to change into.	
Poor visibility from the water	Participants Snorkeller/swimmer disorientation or drowning	<ul style="list-style-type: none"> Plan the area you are going to dive and check conditions before entering the water. Continuously monitor conditions when in the water and exit immediately if necessary. Do not swim or snorkel in foggy or low visibility conditions. 	Participants
Hot weather	Participants Hyperthermia/sunburn	<ul style="list-style-type: none"> Snorkellers/swimmers to take precautions against overheating/sun. Snorkellers/swimmers to avoid dehydration. Water to be available on shore. 	Participants
Sharp objects/ Coral	Participants Injury to snorkeller/swimmer	<ul style="list-style-type: none"> Snorkellers to avoid touching jagged/rusty edges of metal on wrecks unless wearing gloves. Ensure that any wounds from coral scrapes or sharp objects are treated immediately upon arrival at shore. Ensure they are cleaned/ disinfected and monitored for infection. 	Participants
Cramp	Participants Drowning	<ul style="list-style-type: none"> Stretch/warm up muscles before entering the water Stay hydrated Exit the water if cramp sets in 	Participants
Marine wildlife	Participants Bites and stings	<ul style="list-style-type: none"> Be mindful and aware of harmful local species (sharks, jellies, poisonous species and predators) Don't try and catch/touch marine wildlife 	Participants
Mask Squeeze	Participants Injury to snorkeller	<ul style="list-style-type: none"> Understand and practice mask equalisation Only masks which enclose both eyes and nose in the same airspace to be used 	Participants
Heart attack/Seizures	Participants Death	<ul style="list-style-type: none"> Snorkellers/swimmers to be medically fit to undertake the activity 	Participants
Lack of communication	Participants Death	<ul style="list-style-type: none"> Snorkellers/swimmers to check in with a colleague or their nominated contact to advise of estimated time in and out of water. 	Participants
Environment	Participants Infection, illness, injury and death	<ul style="list-style-type: none"> Be aware of tropical bacterial species that can cause harm (flesh-eating). Avoid wastewater and sewage discharge points. Be aware of hawkers/vendors trading illegally on the beach. 	Participants

Annex C. Dive slate layout example



Madagascar National Parks

Seagrass Monitoring – Slate Template

START of transect coordinates (GPS reading)

Latitude: _____ ° _____ ' _____ " Longitude: _____ ° _____ ' _____ "

OBSERVER: _____	DATE: _____
LOCATION: _____	
SITE CODE: _____	TRANSECT type: _____
START TIME: _____	END TIME: _____
VISIBILITY: _____ M	SEA STATE: _____

Quadrat	Sediment type (mud, sand, mixed)	Seagrass coverage (%)	Seagrass species composition (%)				Seagrass density (number)	Canopy height (cm)	Additional features
1 (0m)									
2 (5m)									
3 (10m)									
4 (15m)									
5 (20m)									
6 (25m)									
7 (30m)									
8 (35m)									
9 (40m)									
10 (45m)									
11 (50m)									

END of transect coordinates (GPS reading)

Latitude: _____ ° _____ ' _____ " Longitude: _____ ° _____ ' _____ "



Annex D. Photographic guide to seagrass percentage cover

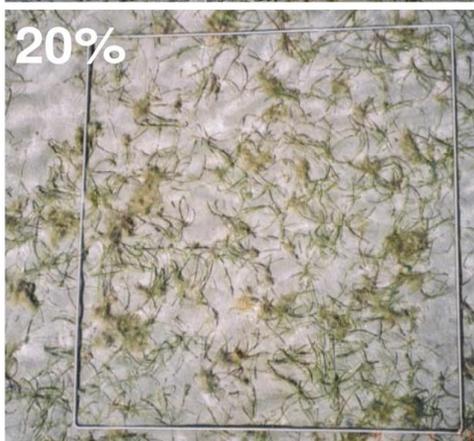
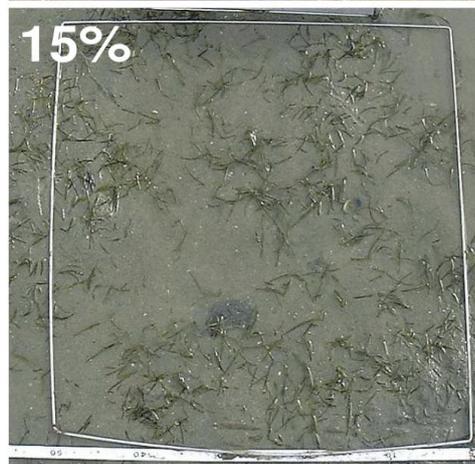
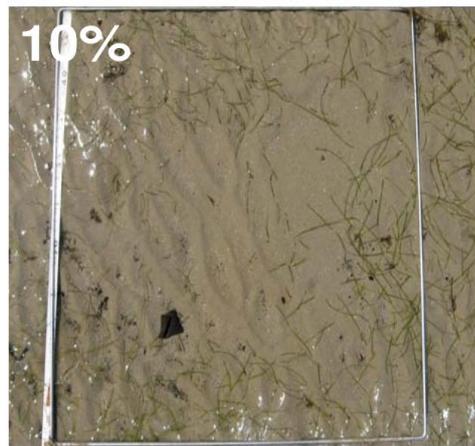
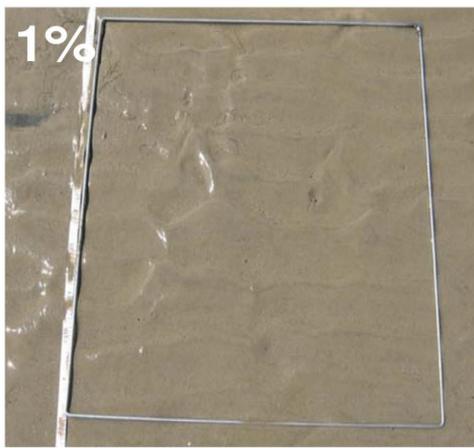
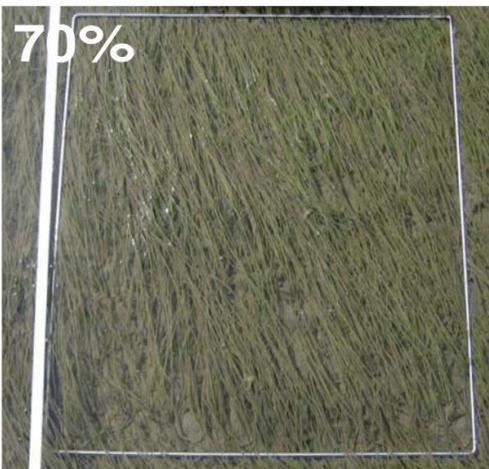
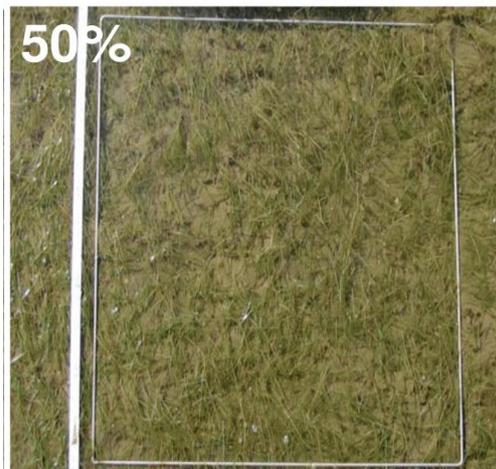
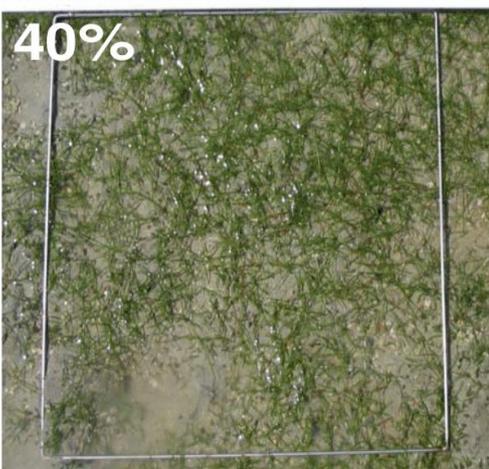
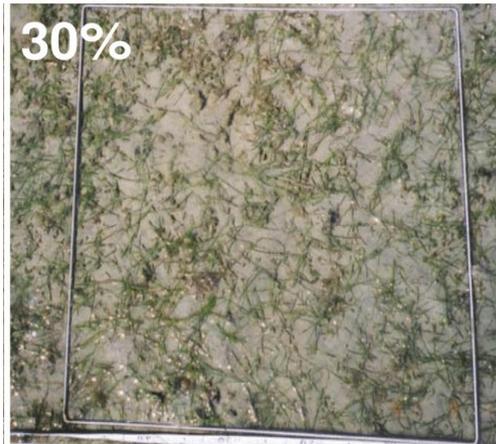
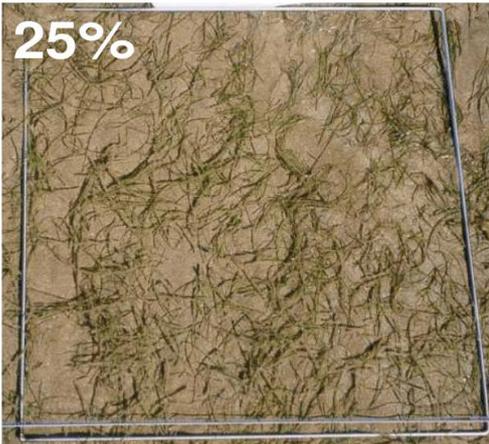
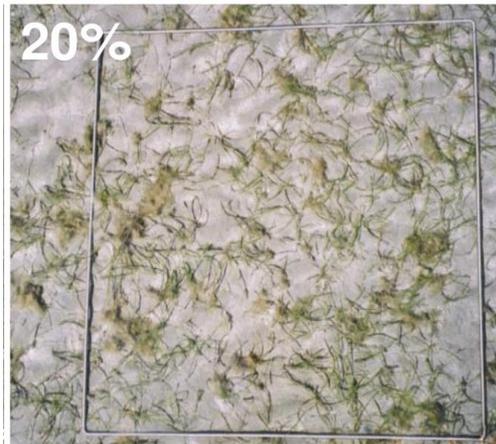


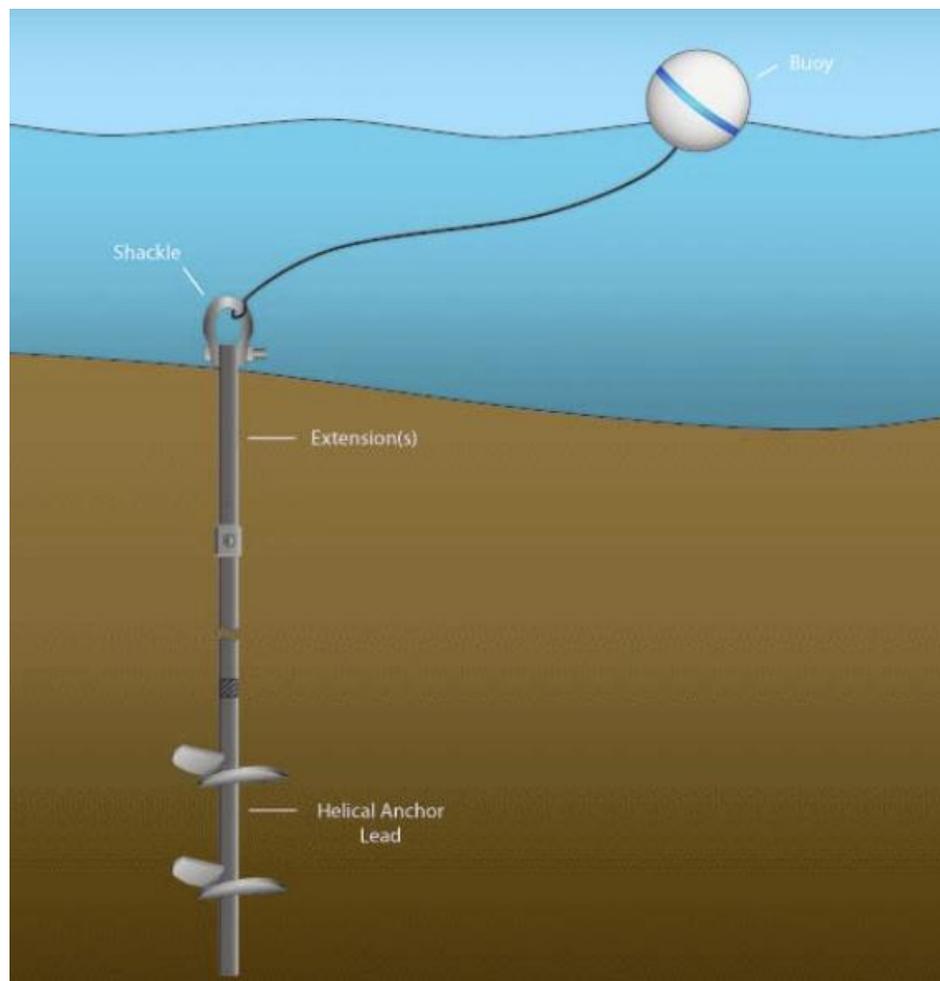
Photo credits: Seagrass-Watch



Annex E. Sand screw installation method

Method for installing permanent benthic marker e.g. sand screw / small helix anchor / screw mooring anchor:

- 1) Position the sand screw vertically and begin rotating it clockwise while applying downward pressure.
- 2) Continue turning until the screw is fully embedded and secured in the sediment with only the attachment loop or marker remaining visible.
- 3) Attach a durable, labelled tag to the sand screw using a zip tie.
- 4) If appropriate, you could also attach a small buoy to the screw with rope to make it clearly visible from the surface. Avoid using chain attached to the buoy as this can damage the seagrass.

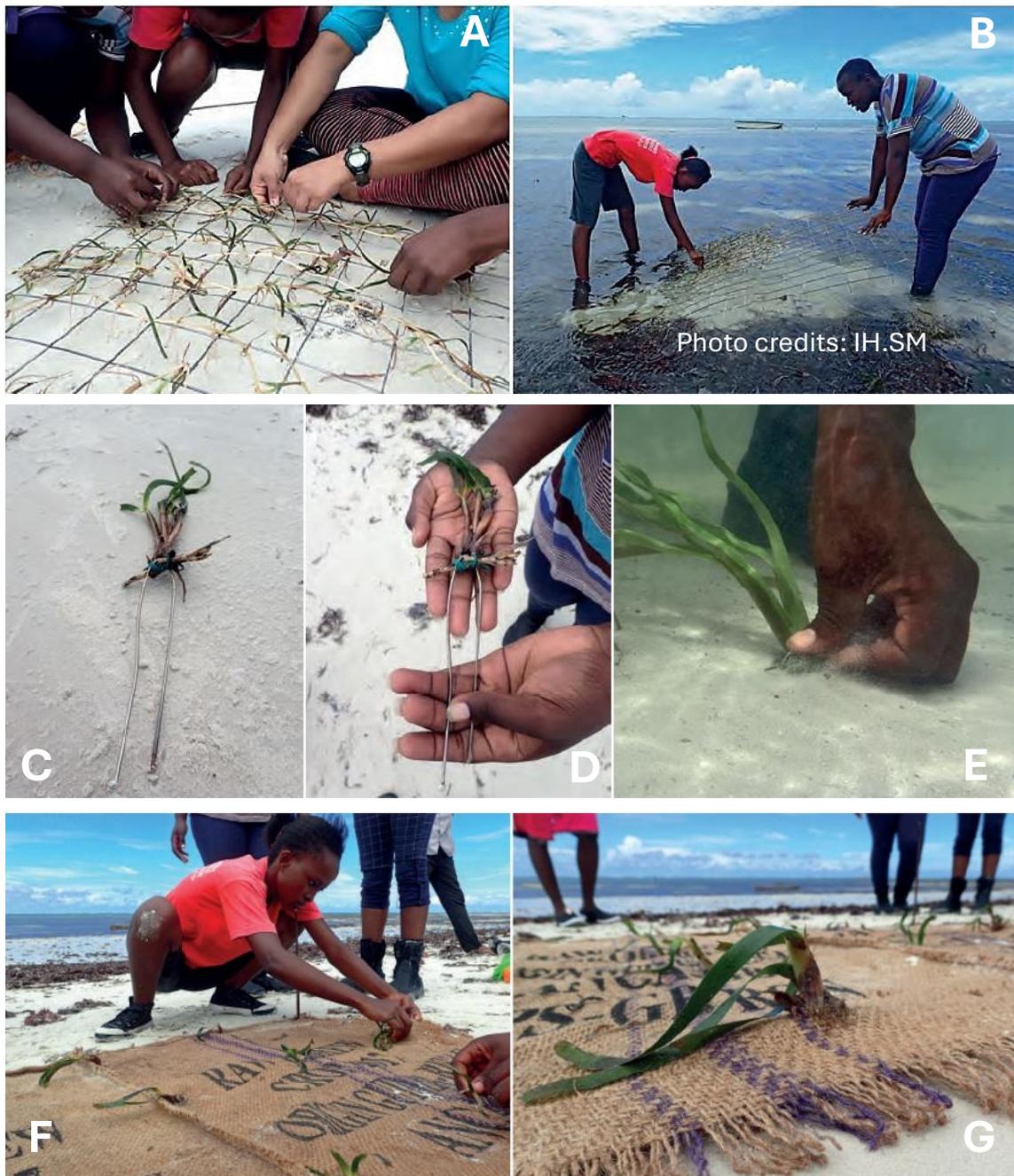


Annex F. Example images of additional features and macrofauna



A) Boat propeller scarring on seagrass bed , **B)** Trails left in seagrass bed from dugong grazing, **C)** Epiphyte cover on seagrass, **D)** Crab burrow in seagrass bed, and **E)** A naturally grazed green turtle feeding plot and an adjacent ungrazed area.

Annex G. Active seagrass restoration methods



A & B) Seagrass plants attached to a metal frame placed and held on the seabed to restore damaged areas. **C, D & E)** Attaching a seagrass shoot to the staple and inserting the staple into the sediment during planting. **F & G)** Seagrass shoots being inserted into a biodegradable fabric or mesh mat (e.g., burlap bags) that are secured to the surface of the sediment as a planting unit.

