MARSHALL ISLANDS
COMMUNITY MARINE MONITORING TOOLKIT

A FACILITATOR'S GUIDE TO IMPLEMENTING LOCAL MONITORING TO SUPPORT THE REIMAANLOK CONSERVATION AREA PLAN

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INTRODUCTION

Decisions on management of coastal marine resources are influenced by monitoring, whether they are informal local observations, or more formal scientific surveys. Community-based management of coastal marine resources has a long history throughout the Pacific with varying degrees of success, made even more challenging in modern times by rapidly growing human populations. However, with increasing pressures the need for more responsive management has also increased. Therefore, for communities to continue to effectively manage coastal marine resources, the development of monitoring methods that are custom designed for communities is critical. The challenge is to develop monitoring methods that balance the need to be simple for effective community-level participation while also being technical enough to provide accurate and robust data.

The need for improved monitoring in the Republic of the Marshall Islands (RMI) is supported by observed declines in coastal marine resources throughout Micronesia. Leaders responded by committing to effectively conserve 30% of nearshore marine resources and 20% of terrestrial resources by 2020 under the Micronesia Challenge, which was later renewed with more ambitious targets for 2030. The Marshall Islands developed the *Reimaanlok: National Conservation Area Plan for the Marshall Islands* (2008) to achieve the Micronesia Challenge goals. Under this Plan, establishing community-based resource management plans, protected areas, building capacity and community monitoring are all key actions.

This RMI Community Marine Monitoring Toolkit has been developed to support the *Reimaanlok: National Conservation Area Plan for the Marshall Islands* and provide guidance and tools for community-based marine monitoring. It includes locally appropriate monitoring methods that help to inform local as well as national management decisions. The development of this Toolkit also recognises that coastal resources are being depleted and communities want to be empowered to manage issues and impacts effectively.

The Toolkit was developed as a partnership between the Marshall Islands Marine Resources Authority (MIMRA) and international marine specialists from C_2O Pacific, with input from community members of the Bikirin Marine Protected Area in Majuro. The aim of the Toolkit is to provide a series of monitoring modules that are designed for trained community members to use. And to provide relevant local information to directly inform community-based decisions and improve local marine resource management as part of the 8-step Reimaanlok process (e.g. Step 7 – Monitoring, Evaluation and Adaptive Management). The Toolkit was also designed to balance the need for simplicity and data robustness. A significant benefit of the Toolkit is the enhanced awareness among communities of marine resource issues, their causes and potential solutions. The Toolkit is designed to empower communities and increase the sustainability of their activities, and to inform development of formal and effective community-based resource management.

Source: *MIMRA*

WHY IS MONITORING IMPORTANT?

Monitoring provides information on the condition of coastal marine resources (status) and if they are decreasing, increasing or stable (trends). Monitoring the health of marine environments provides the information needed to detect changes caused by human activities and natural events, and therefore when there is a need to take action. That is, monitoring informs the need for management decision-making. Monitoring can also be used to assess if existing management actions are effective. A key benefit of the Toolkit is that it can provide an early warning system that prompts communities to act (e.g. control of COTS outbreaks), or for communities to share results with government (e.g. MIMRA, Local Government Council) who may decide to conduct independent surveys.

Community-based monitoring can:

- Provide an ***early warning*** of changes or impacts (e.g. coral bleaching, crown-of-thorns starfish outbreaks, or declines in fish).
- ***Raise awareness*** within communities about the condition of their marine environment.
- ***Raise awareness*** about activities that impact coastal resources, such as poor fishing practices or mangrove clearing.
- ***Facilitate community discussions*** about the range of management actions appropriate for local issues.
- ***Empower communities*** to manage their local marine resources through an inclusive and informed process.
- Determine if local management actions are effective and ***facilitate adaptive management***.

Effective management relies on the support of the whole community and the Toolkit modules have been developed to make it simple enough for community members to be a part of the process. There is an implied responsibility of resource monitors (community members trained to conduct monitoring) to communicate regularly in their communities, particularly with local leaders and the Local Resource Committee, to share monitoring results. To achieve this, it is recommended that communities meet at least 1–2 times each year to discuss monitoring results and actions, including enforcement, that are needed to manage their marine environment.

Like other Pacific islanders, the people of the Marshall Islands have a strong dependence on the ocean and its resources and use marine habitats and animals that are connected and shared among adjacent communities. To some extent they are also protected by national Regulations, Policies and Plans that aim to safeguard and conserve Marshall Island's coastal resources. Many marine species are subject to national harvest restrictions or bans. Resource monitors should be familiar with these regulations and help ensure the wider community is also aware. This will enable the use of the Toolkit to complement relevant national regulations and effectively work in partnership with government.

HOW TO USE THIS TOOLKIT

This Toolkit includes survey methods for monitoring local marine habitats and animals that are important to RMI communities and provides a simple guide for using survey results to guide appropriate community-based decisions to manage these resources. The Toolkit has five modules for community-based monitoring:

1. Fish catch surveys
2. Intertidal invertebrate surveys
3. Coral reef surveys
4. Mangrove surveys
5. Seagrass meadow surveys

Each module is independent, and communities can select one or more modules, depending on their local needs, issues and resources. The Toolkit provides all the steps to establish and conduct community monitoring for each module, and how to interpret the results to inform local decisions. Each module collects standardized data that is plotted onto a scale from good condition (healthy) to poor condition (unhealthy). The Toolkit has standardized methods for communities to use monitoring results instantly, translating information into management actions that target key issues. This is achieved by transferring the survey results directly onto reporting posters that are shared with the community. One of the key features of the Toolkit is that the results can be directly linked to management responses appropriate to the local issues.

The monitoring results can therefore immediately identify if there is an issue and inform community discussions about what management actions can be used to address the issue (Figure 1).

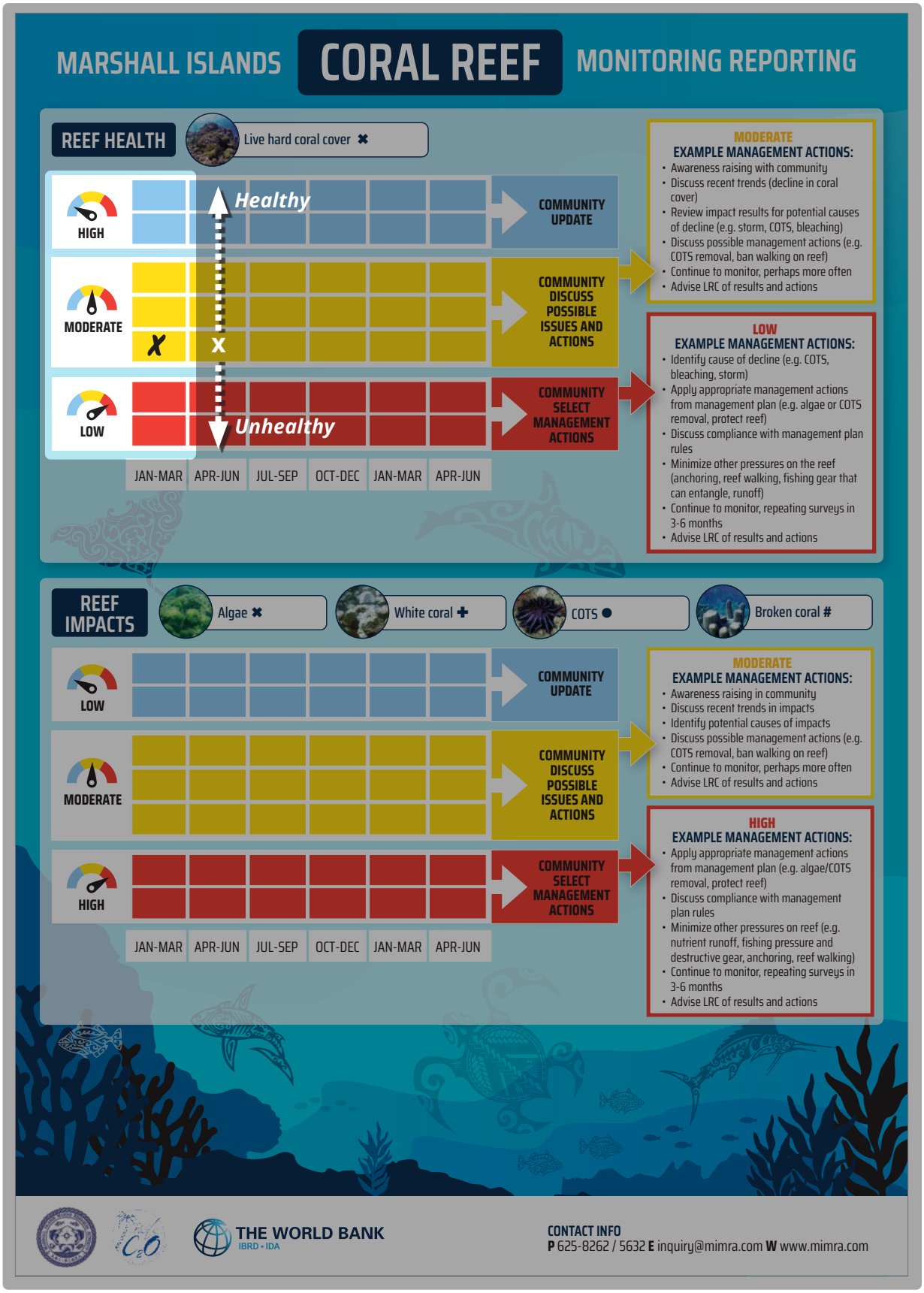


Figure 1: *Transferring survey results to the reporting posters is important for discussing results with communities and identifying relevant management responses.*

RELEVANT LAWS AND RULES

Regional: Forum Fisheries Agency Regional MCS Strategy (2010- 2015); Noumea Strategy: A new song for coastal fisheries – pathways to change (2015); Pacific Regional Roadmap on Fisheries (2010); Samoa Pathway (2014).

National: Management of Marine Resources, MIRC Title 51; National Environmental Protection Act 1984, MIRC Title 35 Chapter 1; Coastal Conservation Act 1988, MIRC Title 35 Chapter 3; Marine Zones and Protection of Mammals, MIRC Title 33; Micronesia Challenge, National and Action Plan (2007), Reimaanlok: National Conservation Area Plan for the Marshall Islands (2008), Protected Areas Network Act (2015) (to replace the PAN Amendment Act 2018), National Ocean Policy and Implementation Plan (2017), Fish Harvest Regulations (2020), local fisheries and conservation management plans.

THE SCIENCE BEHIND THE TOOLKIT

The Toolkit modules are based on established and best practice scientific methods, as well as published scientific information. The methods for each module, however, are modified to be less technical and more readily applied by community members. Therefore, each module provides methods that are a balance between being simple enough for effective community-level participation while also being sufficiently technical to provide meaningful data.

Each module draws on established survey methods and uses known species and ecosystem thresholds, and standardizes survey results to reflect the condition of the variable of interest (e.g. mangrove forest health and impacts, or the likelihood that overfishing is occurring). The results are provided on a survey scale that provides a relative measure of the condition of the indicator being monitored. For each indicator, the scale is based on available scientific information from the Marshall Islands and the wider Pacific region. For example, the range of density estimates that correspond to 'healthy to overfished' populations for marine invertebrate species in Module 2 are determined by surveys from across the Pacific, but 'healthy' densities are largely influenced by local surveys in the Marshall Islands of isolated and uninhabited atolls assumed to represent relatively natural populations for the region. For module 3, the scale for hard coral cover is based on scientific survey data from the Marshall Islands and broader Pacific region. For some modules, the measures of healthy or unhealthy are derived. For example, the fish catch survey uses 'size at maturity' estimates from the scientific literature for species not covered under national size limits. The key is that the methods are simple enough for communities to understand and apply, while the interpretation of results is supported by scientific information that is robust to inform meaningful decision-making. Each module therefore uses the scale to record survey results, which are then transferred directly onto community reporting posters.

TOOLKIT RESOURCES

This Toolkit provides the technical guidance for training in the survey methods and in conducting monitoring and is supplemented by the Field Guide that includes all survey resources, including survey sheets for recording data, identification sheets, data reporting posters, fish catch data analysis sheets, field Quick Guides for each module, and a resource list.

REVIEW AND IMPROVEMENT

Community resource monitors are responsible for storing monitoring data and at regular intervals should provide copies to be stored in a central location, such as with the Local Resource Committee or national database. While monitoring is a key part of sustainable marine resource management, it should complement existing local management plans or inform the development of new or updated local management plans so decision-making is consistent and working towards set objectives.

The process for selecting monitoring modules, conducting monitoring and reviewing and updating the monitoring schedule is outlined in Figure 2.

It is recommended that each community review their monitoring data and how it aligns with their management plan objectives at least annually. Firstly, to see if there have been changes in the condition of the resources they are monitoring (e.g. fish catch, reef health). Secondly, to identify any issues with the methods or the modules that have been selected. For example, a review will help to decide if monitoring needs to happen more or less often, if other modules should be used, if some modules aren't needed, or if local management actions need to be altered or rules better enforced. When conducting a review, two key questions that should be asked are: What is working well? What isn't working well?

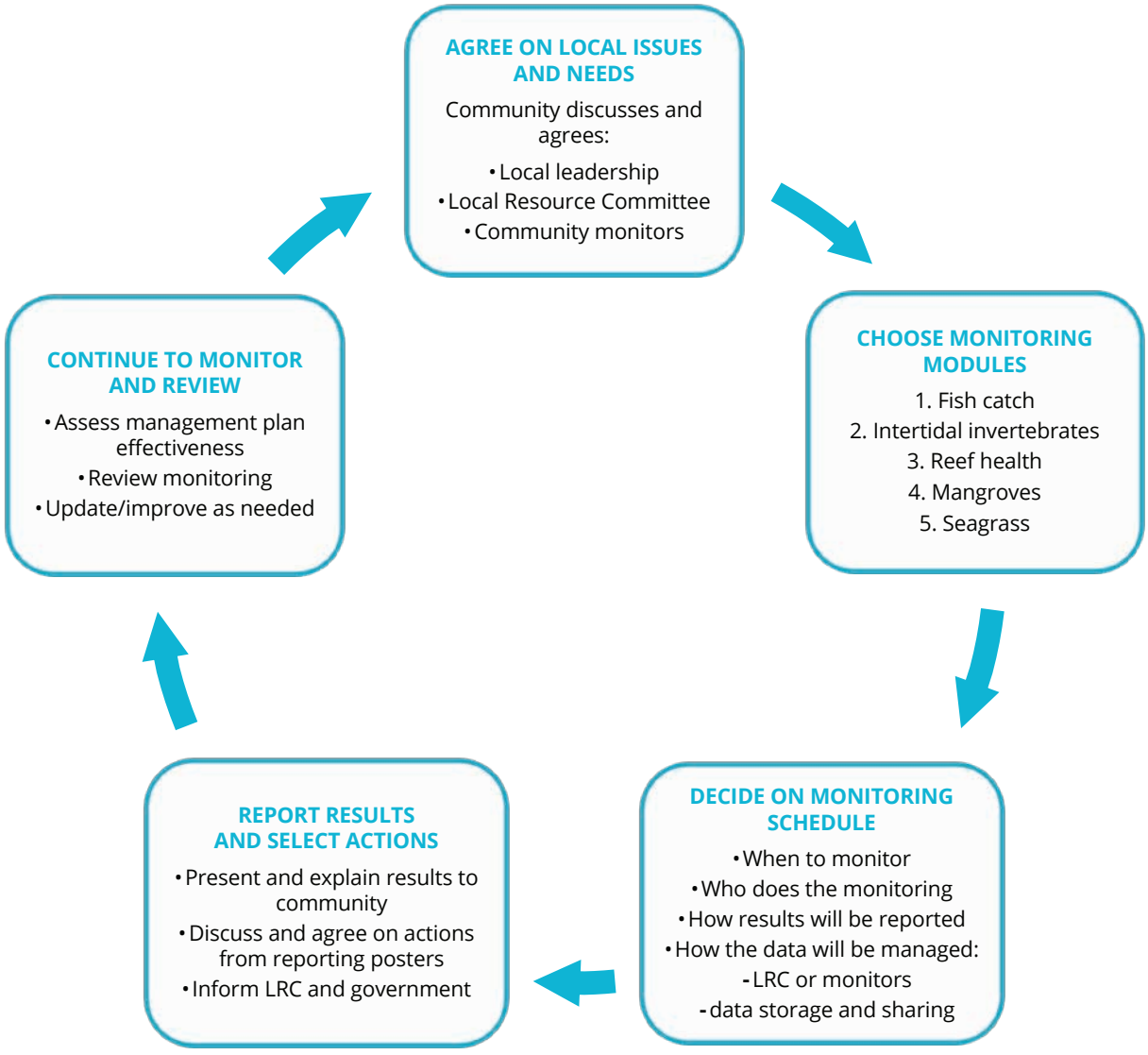


Figure 2: *Process to guide the use of the RMI Toolkit and engage communities in the process from commencement to review and improvement.*

MODULE 1:

FISH CATCH SURVEYS

PURPOSE

The purpose of the fish catch surveys for the Marshall Islands is to assess the likelihood that local fishing practices are overfishing target coastal reef fish species. Further, given the introduction of the Fish Harvest Regulations 2020 that impose a ban on destructive fishing practices and minimum size limits for key target species, the catch surveys also assess the level of compliance with these regulations. Fish catch surveys also provide a valuable opportunity to raise awareness within communities about these regulations, and the importance of not catching juvenile fish and choosing fishing practices that best achieve this.

For example, if catches are made up of too many juvenile fish (before they have reached breeding size), then the fish population will produce less fish each year, and the population will decline. This results in fewer fish to catch and more time required to catch enough fish. Because different species start breeding at different sizes (size at maturity; see Table A1 in Appendix 1), the recommended minimum size limit of capture for each species may be different. This knowledge is factored into the fish catch survey method.

The fish catch surveys have been developed to guide communities in minimizing the capture of juvenile fish and, where necessary, directly inform local management actions that can help to achieve this. For example, across the Pacific the use of small mesh gillnets is common but represents poor fishing practice, because they regularly catch many small fish. Where this is occurring effective management actions that could address this issue could include banning the use of gillnets for coastal reef fish, or introducing a rule that only allows larger mesh sizes to be used. The fish catch surveys collect data on fishing gears used which can help communities in identifying specific management responses like in the gillnet example above.

Source: *J. Capelle*

Fish catch surveys also collect data on fishing effort (e.g. number of people fishing & time spent fishing), which provides the bonus of being able to estimate fishing catch rates. This information, although potentially very useful, is more technical and should only be used in partnership between communities and technical expertise (e.g. MIMRA). The coastal reef species included in the fish catch surveys were identified in consultation with MIMRA as key local target species, and includes species regulated nationally with legal size limits.

Below are two key issues that are commonly reported throughout the Pacific, and the fish catch surveys can help to address.

Issue 1: Fish are harder to catch

If certain types of fish are becoming harder to catch (that is, it takes more time to catch the same number of fish = declining catch rate), this indicates that the fish population is getting smaller.

Issue 2: Too many small fish are being caught

If a large part of the catch is made up of very small fish (before they have grown large enough to breed), the capacity of the fish population to breed and replenish populations for the next year is reduced. Over time, this will result in smaller fish populations and fewer fish.

SURVEY METHOD

Materials:

- Fish measuring ruler/measuring board
- Field survey sheet (in Field Guide)
- Pencil
- Fish identification sheet (in Field Guide)

Time: Approximately 15 minutes per survey (with each fisher).

Frequency: Aim to conduct a minimum of 20 fisher surveys every 6 months to ensure the data is accurate.

CONDUCTING THE SURVEY

Each resource monitor should carry out surveys in their local community by meeting fishers when they return to shore from fishing with their catch. Using the survey form, monitors collect information about the fishing trip each fisher just completed. This will include information on what species were caught and their sizes. ***Survey as many different fishers (men and women) as possible.*** The more surveys conducted the stronger the results.

At the beginning of each survey, it should be explained to fishers:

- The purpose of the survey. For example, "*...this survey aims to collect fish catch information to better understand local fishing activity and to inform management for sustainable fishing*".
- That the survey is voluntary, and they do not have to participate if they don't want to.
- That their name will not be linked to the information collected so other people won't know what they caught or their favorite fishing spots.

The catch surveys should collect information that is typical of catches in each community. For example, because each fisher may have different methods or species they prefer, surveying different fishers will ensure information is obtained that is representative of different fishing practices used in the community.

DATA COLLECTION:

Catch survey information should be collected using the catch survey form provided in the Field Guide. Resource monitors need to read the form carefully and ***be sure to accurately collect all the information on the survey sheet***.

There are three main sections of the survey form:

1. **SURVEY DETAILS** – Basic information about where and when the survey was conducted: date and time of survey, fisher's name and gender, and the fisher's community.
2. **FISHING DETAILS** – Basic information about the fishing trip being surveyed.
    - Whether fishing was done during the day or night
    - The total number of people fishing
    - The **main** fishing method/gear used during the fishing trip. Fishing method choices are given and **only** the method used most of the time during the latest fishing trip should be circled in this section. This information helps to understand the catch taken with each gear type, which can inform specific management actions if issues are identified. For example, a common problem throughout the Pacific is the rapid decline of large parrotfish due to spearfishing at night with torches. Another example is small gillnet mesh sizes used in the Pacific that mostly catch small juvenile fish. The different types of fishing methods to record in the survey form include:
        - Spearfishing
        - Gillnet
        - Hook and line (Bottom fishing)
        - Hook and line (Trolling)
        - Other – if the method/gear is not listed then write it down here (e.g. traditional methods).
    - Record information in the ***'Secondary fishing methods used'*** section **ONLY** if another fishing method/gear was used during the trip. If applicable, more than one method can be circled.
    - When gillnets have been used, record the mesh size. Mesh size is the size of the largest gap in the net holes. If the fisher is not sure, the monitor should try and estimate the mesh size using locally used terms, e.g. how many fingers fit in a single mesh gap.
    - Ask the fisher to estimate how much time they spent fishing for that particular fishing trip and record it (for example, 3.5 hours).
3. **CATCH DETAILS** – Information is collected on the size of fish in the catch **only** for the species in Table 1.
    - For the fish species in the catch, the fork length (FL) for each individual fish should be measured using a ruler or measuring board (see Figure 3) and in inches (in). Where possible **ALL** fish should be measured.
    - In the catch survey form, for each species, write down the size of each individual fish measured in one of the boxes on the form. An example of a completed survey is shown below.

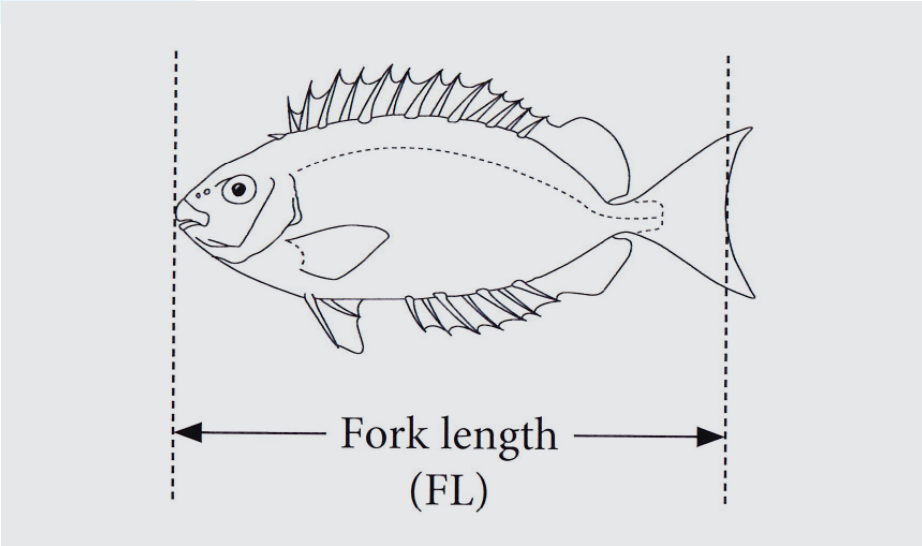


Figure 3: *Distance for measuring fork length (FL) of fish during catch surveys. Source: Moore and Colas (2016).*

Table 1: *Main target species to be included in fish catch monitoring surveys. A full identification guide is included in the Field Guide.*

Local Name	Common Name	Species Name
Kwi	Lined surgeonfish	*Acanthurus lineatus*
Kupañ	Convict tang	*Acanthurus triostegus*
Jato, Jaap	Humpback red snapper	*Lutjanus gibbus*
Ṃōtal	Dash-and-dot goatfish	*Parupeneus barberinus*
Bwilak	Orangespine unicornfish	*Naso lituratus*
Ṃọle, Ellōk	Forktail rabbitfish	*Siganus argenteus*
Jerā	Sabre squirrelfish	*Sargocentrum spiniferum*
Ekmouj	Pacific longnose parrotfish	*Hipposcarus longiceps*
Pājrōk	Blue chub/Brassy chub	*Kyphosus cinerascens/K. vaigiensis*
Ṃọṇe	Bluespine unicornfish	*Naso unicornis*
Oḷaḷo	Yellow edged lyretail	*Variola louti*
Mejmej	Humpnose big-eye bream	*Monotaxis grandoculis*
Ikbwij	Bigeye trevally	*Caranx sexfasciatus*
Ḷañe	Bluefin trevally	*Caranx melampygus*
Jọwe	Squaretail grouper	*Plectropomus areolatus*
Kūro	Camouflage grouper	*Epinephelus polyphekadion*
Ḷōjepjep	Highfin grouper	*Epinephelus maculatus*
Perak	Orange-spotted emperor	*Lethrinus erythracanthus*
Ḷappo	Humphead wrasse	*Cheilinus undulatus*
Mem	Bumphead parrotfish	*Bolbometopon muricatum*
Jutaklola	Black saddled coralgrouper	*Plectropomus laevis*

EXAMPLE FISH CATCH SURVEY

This survey aims to collect fishing information to better understand local fishing activity and to inform management for sustainable fishing.

The questions ask details about your catch from your recent fishing trip, including measuring the fish you caught. The more fishers surveyed, the better the information will be to ensure fish populations are managed for community benefit. The survey is voluntary and no fisher's name will be associated with results. Are you willing to participate?

1. SURVEY DETAILS

Atoll: **Ebeye**	Fisher name (confidential): **Jack**	Male / Female (circle)
Date: **19/06/21**	Survey time: **0615**	Monitor name: **Melba**

2. FISHING DETAILS

Number of people fishing: **1**	Time spent fishing (hours): **3.5**		Day / Night (circle one)
Main fishing method (circle one):	Speargun	Trolling	Gillnet
Bottom hook and line	Other methods (please list):		
Other fishing method/s (circle which ones):	Speargun	Trolling	Gillnet
Bottom hook and line	Other methods (please list):		
If gillnet used, what was the mesh size:			

3. CATCH DETAILS

Species group		Fish sizes – fork length (inches) (if not all individual fish are measured write * next to the species name)									
Local name	**Common name**										
Kwi	Lined surgeonfish	8	7	7							
Kupañ	Convict tang										
Jato, Jaap	Humpback red snapper	11	12								
Ṃōtal	Dash-and-dot goatfish	12									
Bwilak	Orangespine unicornfish	12	13								
Ṃọle, Ellōk	Forktail rabbitfish										
Jerā	Sabre squirrelfish										
Ekmouj	Pacific longnose parrotfish	14									
Pājrōk	Chub										
Ṃọṇe	Brown surgeonfish										
Oḷaḷo	Yellow edged lyretail	15	17								
Mejmej	Big-eye bream										
Ikbwij	Bigeye trevally	16									
Ḷañe	Bluefin trevally	18	15	19							
Jọwe	Squaretail grouper										
Kūro	Camouflage grouper										
Ḷōjepjep	Highfin grouper	14									
Perak	Orange-spotted emperor										
Ḷappo	Humphead wrasse	22									
Mem	Bumphead parrotfish										
Jutaklola	Blacksaddled coralgrouper	16									

DATA ANALYSIS

CRITICAL SIZE ESTIMATES

Knowledge of how many small fish (pre-breeding size) are taken in local fishing catches is important because removing juvenile fish before they can breed reduces the future breeding success of the population. Catching juvenile fish is only one form of overfishing. The main indicator used in this module is the percentage (proportion) of the total catch that are larger than a ***critical size***. This critical size estimate is based on minimum size limits under national regulations for the main target reef species. For species not included in the national regulations, the critical size estimates are based on scientific studies showing the size that each species become mature and can breed.

The concept of size at maturity and the need to allow fish to breed is relatively simple for communities to understand and provides a powerful yet simple indicator that can be used to better empower communities to adopt effective management approaches. See Appendix 1 for further information on critical sizes.

CONVERTING DATA INTO RESULTS

There is also a fully automated Excel spreadsheet and database available to store these data, and we highly recommend that data are stored in a computer for data security. This may be best accommodated by sharing data sheets with MIMRA. However, it is acknowledged that reliable access to computers in communities is not always possible, therefore we have designed a simple manual method to analyse catch survey data using the Catch Survey Data Analysis Sheet (provided in the field guide; see example below).

The Catch Survey Analysis Sheet is used to summarize data you collect from catch surveys, and importantly, to calculate the results for the Data Reporting Sheets for each species. The key indicator used to assess local fishing practices is the proportion of each target species captured that are larger than the minimum size limit or the size at maturity (the critical size), expressed as a percentage. This indicator acts as a proxy for each species of whether overfishing is likely to be occurring or not. The analysis sheet, along with the instructions below, enable you to calculate this indicator, which can be copied directly onto the Data Reporting Sheets, which in turn guides management decisions in response to the results.

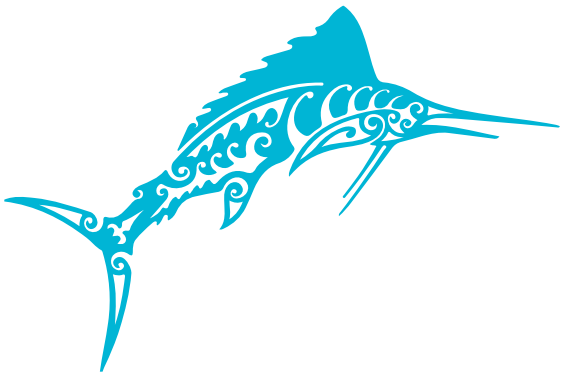
INSTRUCTIONS FOR USE:

Analyse each survey period separately – make sure to follow the recommended number of surveys (>= 20 per 6-month period).

Do one species at a time and include data from **ALL** the surveys for each survey period.

For each species:

1. Count the number of fish caught that are larger (or the same) than the critical size shown. Write this in the box labeled **A** shown on the sheet;
2. Count the total number of fish caught. Write this down in the box labeled **B** shown on the sheet;
3. Use a calculator on your phone, or ask someone to help, to divide **A** by **B**, and multiply the answer by 100. The final answer is the percentage of the catch that are larger than the critical size. For example, if 30 Kupan in total are caught, and 10 of those are larger than 7 inches (the critical size or size limit for Kupan), then we calculate 10/30 = 0.33. Multiply by 100: 0.33 x 100 = 33 %. That is, 33 % of the catch of Kupan for the survey period is greater than the critical size. Write this down in the box labeled **C** shown on the sheet;
4. Copy the % value onto the Data Reporting Sheet graph for the period of the surveys. Follow the Data Reporting Sheet guidance.



EXAMPLE FISH CATCH DATA ANALYSIS

FISH CATCH DATA ANALYSIS

Calculate the portion (%) of the catch that is above the size limit for each data collection period (e.g. quarterly, ½ yearly); recommend using >= 10 surveys.

FISH SPECIES	SIZE LIMIT (inches)	TOTAL NUMBER OF FISH			%	STATUS
		Larger or equal to the size limit	Caught	% larger than the size limit		
		A	B	(A/B) X 100		
Kwi	7”	I = 1	1	(1/1) x 100 = 100%	<100	
					= 100	☺
Kupañ	7”				<100	
					= 100	☺
Jato, Jaap	10”				<100	
					= 100	☺
Ṃōtal	10”	II = 2	3	(2/3) x 100 = 67%	<100	
					= 100	☺
Bwilak	10”	IIIII IIII = 9	10	(9/10) x 100 = 90%	<100	
					= 100	☺
Ṃọle, Ellōk	10”	IIIII I = 6	6	(6/6) x 100 = 100%	<100	
					= 100	☺
Jerā	10”				<100	
					= 100	☺
Ekmouj	12”	III = 3	3	(3/3) x 100 = 100%	<100	
					= 100	☺
Pājrōk	12”	IIIII II = 7	9	(7/9) x 100 = 78%	<100	
					= 100	☺
Ṃọṇe	14”				<100	
					= 100	☺
Oḷaḷo	14”	IIIII IIIII III = 13	13	(13/13) x 100 = 100%	<100	
					= 100	☺
Mejmej	14”				<100	
					= 100	☺
Ikbwij	14”				<100	
					= 100	☺
Ḷañe	14”				<100	
					= 100	☺
Jọwe	16”				<100	
					= 100	☺
Kūro – Camouflage grouper	16”				<100	
					= 100	☺
Ḷōjepjep	16”				<100	
					= 100	☺
Perak	18”				<100	
					= 100	☺
Ḷappo	20”				0-90	Overfished
					90-99	Declining
					= 100	☺
Mem	24”				0-90	Overfished
					90-99	Declining
					= 100	☺
Jutaklola	18”				0-90	Overfished
					90-99	Declining
					= 100	☺

DATA REPORTING

It is important to include the whole community in monitoring and decisions about managing local coastal resources. The data reporting stage in each module helps all community members to better understand how their actions impact the coastal resources the community relies on. Being inclusive also allows everyone to feel some ownership to any management decisions, as well as understanding the reasons for management actions. This leads to increased respect and compliance, which further leads to more effective management.

Data Reporting posters have been developed that allow results for each species from the Data Analysis sheet to be readily transferred to and provide an easy-to-understand visual display of the survey results. The poster allows for quarterly reporting but can be used for any reporting period. The value of the indicator calculated on the Data Analysis sheet, once transferred to the Data Reporting poster, can be presented to the community for discussion, and displays a results chart that is color coded to indicate whether overfishing is likely to be occurring. Depending on the results, the poster also provides guidance on the responses for the community to take (see Management options – next section below). Presenting the results on the Data Reporting poster provides a strong basis for discussion within the community, and to agree on management actions. There are two different types of Data Reporting posters (see below): 1. for the regulated species with minimum size limits, and 2. for other key target species without legal size limits.

All monitoring results, even those showing a healthy condition, should be presented on the Data Reporting posters to relevant community decision-makers for discussion. They can also be used as a mechanism for reporting to the general community to raise their awareness about issues as well as why management actions may be necessary. Copies of each Data Reporting poster are provided in the Field Guide.

Management options:

Fish catch monitoring is designed so results from catch surveys can inform immediate management decisions based on the results. The Data Reporting poster has colored zones where the indicator from the survey results is plotted and informs the possible management actions for that particular species.

Data reporting for species **without** formal size limits *(Unregulated Fish Reporting poster)*:

- The target is for the indicator to be at 100% to ensure that no juvenile (small) fish are caught and the population is healthy (***blue zone***).
- If the indicator is in the ***yellow zone*** (caution; 90-99%), this is a sign that the population is declining, and it is recommended that management actions are considered by the community.
- If the indicator is in the ***red zone*** (alert; 0-90%), then immediate action is strongly recommended, and a range of potential, and appropriate, management actions are provided.

Data reporting for species **with** formal size limits *(Regulated Fish Reporting poster)*:

- The target is for the indicator to be at 100% to comply with national regulations (i.e. all fish caught for that species are larger than the legal size limit; ***blue zone***).
- If the indicator is plotted in the ***red zone*** (alert; 0-99%), then some fish are being caught illegally and immediate action is required. The Data Reporting poster recommends community discussions about the possible causes, and suggests a range of possible actions to be taken.

Where possible, it is strongly encouraged that the management actions in response to local survey results be considered and agreed before monitoring and be incorporated into local Management Plans.

MARSHALL ISLANDS FISH CATCH MONITORING REPORTING

UNREGULATED FISH


Ļappo 20" **L**


Jutaklola 18" **J**


Mem 24" **M**

HEALTHY 100% → **COMMUNITY UPDATE**

DECLINING 90 - 99% → **COMMUNITY DISCUSS POSSIBLE ISSUES AND ACTIONS**

OVERFISHED 80% / 60% / 40% / 20% → **COMMUNITY SELECT MANAGEMENT ACTIONS**

JAN-MAR | APR-JUN | JUL-SEP | OCT-DEC | JAN-MAR | APR-JUN

DECLINING
EXAMPLE MANAGEMENT ACTIONS:
Consider management options listed below

OVERFISHED
EXAMPLE MANAGEMENT ACTIONS:

- Ban harvest of fish smaller than breeding size (introduce size limit)
- Ban the use of small-mesh gillnets or small hooks
- Temporary/permanent harvest ban in some areas or times (e.g. known spawning times)
- Ban spearfishing at night
- Ensure marine protected areas are effective: closed, respected, large enough

REGULATED FISH

Kwi 7" **Kw**	Kupañ 7" **Ku**	Jerā 10" **Je**	Bwilak 10" **Bw**	Jato, Jaap 10" **Jat**	Ṃōtal 10" **Mo**
Ṃọle, Ellōk 10" **MoE**	Pājrōk 12" **Pa**	Ekmouj 12" **Ek**	Ṃọṇe 14" **Mo**	Oļaļo 4" **Ol**	Mejmej 14" **Me**
Ikbwij 14" **Ik**	Ļañe 14" **La**	Ļōjepjep 16" **Lo**	Kūro 16" **Kur**	Jọwe 16" **Jo**	Perak 18" **Pe**

HEALTHY 100% → **COMMUNITY UPDATE**

OVERFISHED 90 - 99% / 80% / 60% / 40% / 20% → **COMMUNITY SELECT MANAGEMENT ACTIONS**

JAN-MAR | APR-JUN | JUL-SEP | OCT-DEC | JAN-MAR | APR-JUN

OVERFISHED
EXAMPLE MANAGEMENT ACTIONS:

- Assess if particular gears are more likely to catch undersize fish
- Assess if undersize fish are more likely to be caught in particular areas and/or times
- Assess if there are repeat offending individuals
- Take action to reduce catch of undersize fish:
  - Manage gear types that catch undersize fish (e.g. increase net mesh size, ban night spearfishing, introduce a minimum hook size)
  - Introduce time and/or place fishing restrictions
  - Advise LRC and MIMRA for increased community education and awareness

***NOTE: CATCHING ANY FISH SMALLER THAN BREEDING SIZE WILL RESULT IN DECLINING POPULATIONS**

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MODULE 2:

INTERTIDAL INVERTEBRATE SURVEYS

PURPOSE

Invertebrates are animals without a backbone and play important roles in marine environments. Some eat algae (e.g. green snail and trochus), some recycle nutrients (e.g. sea cucumbers), and others filter water (e.g. giant clam). The role of nutrient recycling by sea cucumbers has been shown to increase benthic productivity of systems such as coral reefs (Uthicke and Klump 1998, Uthicke 2001). Invertebrates are also very important as a source of local food and for external markets. Due to their very low mobility, marine invertebrate species are very easy to collect and, if not managed carefully, are easy to overfish.

The purpose of the intertidal invertebrate surveys for the Marshall Islands is to enable communities to assess whether locally important intertidal invertebrates are in a healthy or unhealthy condition. Invertebrate surveys also provide a valuable opportunity to raise awareness within communities about the important ecological roles that invertebrates play, and how easily they are overharvested. This will in turn help to empower communities to take appropriate actions when necessary.

This module focuses on counting the number of key invertebrate species only in intertidal reef flat areas, where it is safer and more feasible for communities to access. The key indicator used is the density (number per transect area) of each species, which is a useful measure of population health (see Appendix 2) since invertebrates need to be close to one another for successful breeding, as they can't move very far (or at all). Surveys can be used to help maintain healthy populations in fished areas, and to assess the effectiveness of marine protected areas by comparing fished and unfished areas.

SURVEY METHOD

Materials:

- Field survey sheet
- Slate (or similar)
- Pencil
- Mask and snorkel (if submerged intertidal site)

Time: 10 minutes per transect. Total of 40 minutes for each site.

Site selection: Select sites where you would expect to see the invertebrate species being monitored, preferably with some hard substrate areas mixed with sand patches. Also, choose a survey site that is easy to access in most tides. Select at least one site and conduct 4 transects (line walks; see below) within each site. If two sites are surveyed, sites should be at least 32 feet (10 m) apart, if the site is large enough (see Figure 4).

Figure 4: *Example of suitable invertebrate survey sites and transects for surveys.*

Transects: Four transects (or 3 if the area isn't big enough) are chosen randomly with at least 32 feet (10 m) between each transect (Figure 4). A transect is a straight line chosen in the survey site, that is 130 feet (40 m) long and 6 feet (2 m) wide (Figure 5). Measure out the 130 feet using a measuring tape or a piece of rope marked at 130 feet.

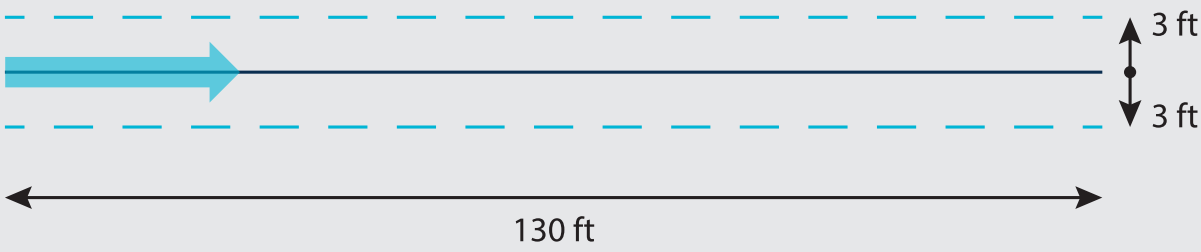


Figure 5: *Representation of a typical transect showing the area that invertebrates are counted in.*

Frequency: Once every 6 months, as these species are slow growing and unlikely to change in short timeframes.

Number of monitors: Although these surveys can be done by 1 person, it is recommended that 2 people conduct each survey to help with the counts and because it is safer.

CONDUCTING THE SURVEY

Before starting, spend 5 minutes checking the site and note:

- any safety issues or risks,
- the height of the tide (preferably surveys should be done at low tide),
- weather conditions and
- the different habitats (e.g. exposed reef, rock pools, seagrass).

Choose a site with the most area of the preferred habitat and select the starting point of the first transect path. The transect line can be walked if the site is exposed at low tide, or it can be surveyed on snorkel if it is in shallow water. As you walk/snorkel the 130 ft transect (approximately 70-80 paces) **parallel** to the shore, write down what you see in an area as wide as your arm span, which represents approximately 6 ft wide.

DATA COLLECTION:

Monitoring information should be collected using the Intertidal invertebrate survey sheet (see Field Guide). **One survey sheet for each site** will need to be filled in by monitors. Using a slate and pencil, count and record the number of each target species while walking the transect line, by marking it on the survey sheet (see example survey sheet below).

DATA ANALYSIS:

Once all 4 transects are completed at the site, the invertebrate indicator is calculated as the average of all transect counts. This can be done using a calculator on a phone, by adding together the counts for all transects in that site and dividing by the number of transects conducted. The final number provides an estimate of the density of each species, which is then plotted directly onto the scale on the survey sheet (see example below).

TARGET SPECIES:

The target species were chosen based on feedback from the RMI Toolkit development team and includes 2 giant clam species, 4 sea cucumber species, and cowrie shells.

Giant clams

Tridacna clam species

Hippopus clam species

Sea cucumbers

Black teatfish, ***Holothuria whitmaei***

Greenfish, ***Stichopus chloronotus***

Pinkfish, ***Holothuria edulis***

Lollyfish, ***Holothuria atra***

Cowrie shells

EXAMPLE INTERTIDAL INVERTEBRATE SURVEY

INTERTIDAL INVERTEBRATE SURVEY SHEET

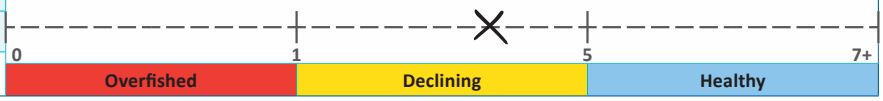
SITE DESCRIPTION (ONE FORM PER SITE)

Monitor name(s): Alana, Romalynn			Atoll: Majuro	
Site name: Bikirin MPA			Date: 18 June 2021	Time: 2:30pm
Weather: Sunny, clear			Method (circle one)	Reef Walk / Swim
Main Habitat (circle one or more)	Seagrass	Sand	Hard substrate	Algae / Other:

CLAM *TRIDACNA* SPECIES

Transect 1	Transect 2	Transect 3	Transect 4
III	IIIII III	I	III

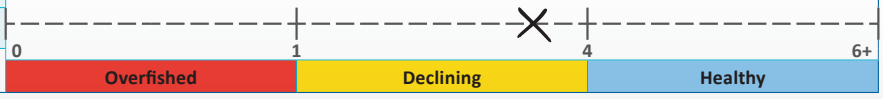
Total number counted				
T1	T2	T3	T4	Average
3	8	1	3	3.7



CLAM *HIPPOPUS* SPECIES

Transect 1	Transect 2	Transect 3	Transect 4
III			

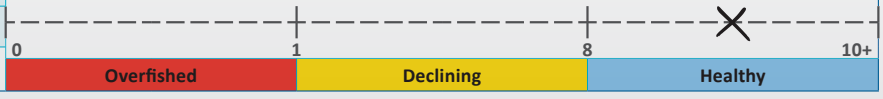
Total number counted				
T1	T2	T3	T4	Average
3	5	2	4	3.5



LOLLYFISH

Transect 1	Transect 2	Transect 3	Transect 4
IIIII IIIII IIIII	IIIII I	IIIII IIIII I	IIII

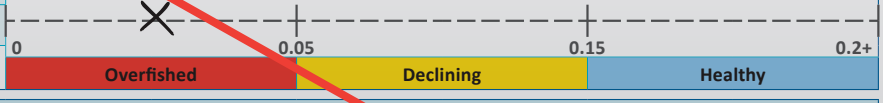
Total number counted				
T1	T2	T3	T4	Average
15	6	11	4	9



BLACK TEATFISH

Transect 1	Transect 2	Transect 3	Transect 4
	I		

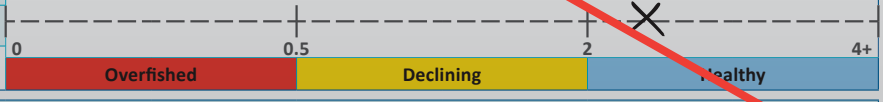
Total number counted				
T1	T2	T3	T4	Average
0	1	0	0	0.25



GREENFISH

Transect 1	Transect 2	Transect 3	Transect 4
III	II	IIII	I

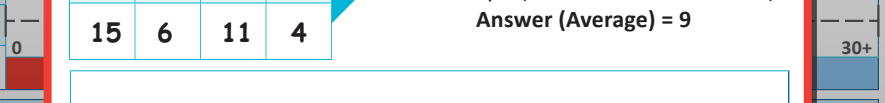
Total number counted				
T1	T2	T3	T4	Average
3	2	4	1	2.5



PINKFISH

Transect 1	Tran

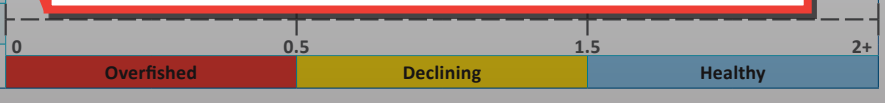
Total number counted				
T1	T2	T3	T4	Average



COWRIE SHELLS

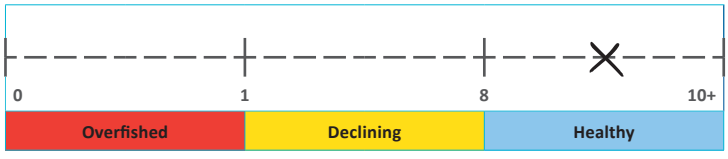
Transect 1	Tran

Total number counted				
T1	T2	T3	T4	Average



Total number counted			
T1	T2	T3	T4
15	6	11	4

TOTAL = 15 + 6 + 11 + 4 = 36
Divided by 4 (the number of transects)
Answer (Average) = 9



DATA REPORTING

The process to present invertebrate survey results to the community involves using the scale on the survey sheet, and manually transferring the result (given by the **X**) to the Invertebrate Data Reporting poster for the 6-month period that the survey was conducted. For example, in the Lollyfish example (above), the result was in the middle of the 'healthy' status. The **X** can therefore be marked on the Data Reporting poster in the middle of the healthy (blue) zone, thereby providing suggested management options (see Data Reporting poster example below). The zone that survey results are marked on the Data Reporting poster provides options to guide community discussions about possible actions to take. Survey results for each individual species can be presented on a single or individual Data Reporting posters. Community monitors or the LRC should keep all reporting posters as a long-term record of surveys.

MANAGEMENT OPTIONS:

The monitoring is designed so that results from catch surveys can inform immediate management decisions based on the survey results. For each type of Data Reporting poster, the color of the zone where the indicator from the survey results is plotted, informs on the possible actions for that particular species.

- Results in the ***blue zone*** (healthy) would indicate a healthy population and should be reported to the community for raising awareness about monitoring and the species.
- Results in the ***yellow zone*** (caution) indicate that populations are likely to be declining. Monitors should have a community meeting with the local leadership and community to discuss the results, possible reasons for the results, and actions. Example management actions include: community awareness raising (such as information on notice boards), discussion with the LRC and MIMRA to request formal monitoring, and possibly harvest restrictions to prevent further declines. The discussions should also consider if the surveys should be repeated to confirm the results if they are unexpected or cannot be easily explained.
- Results in the ***red zone*** (alert) indicate that there is an issue and should follow the recommendations for the yellow zone, with more immediate management actions suggested. This could include further restrictions on harvest or stronger enforcement of existing rules.

These actions will vary between communities and should be guided by local experience, the Traditional Leadership and the management recommendations already established in Local Management Plans.

The Field Guide provides a summary of the intertidal invertebrate surveys, data reporting sheets and photos to take in the field to assist with scoring indicators.

MARSHALL ISLANDS INVERTEBRATE MONITORING REPORTING

INTERTIDAL INVERTEBRATES CLAMS & SHELLS


Tridacna species ✖


Hippopus species ✚


Cowrie shells ●


HEALTHY


DECLINING


OVERFISHED

JAN-MAR | APR-JUN | JUL-SEP | OCT-DEC | JAN-MAR | APR-JUN

COMMUNITY UPDATE

COMMUNITY DISCUSS POSSIBLE ISSUES AND ACTIONS

COMMUNITY SELECT MANAGEMENT ACTIONS

DECLINING
EXAMPLE MANAGEMENT ACTIONS:
- Awareness raising with community
- Discuss possible management actions (e.g. set harvest limits)
- Continue to monitor, perhaps more often
- Advise LRC and MIMRA of results and actions

OVERFISHED
EXAMPLE MANAGEMENT ACTIONS:
- Educate the community about declines
- Apply actions from management plan (e.g. set harvest limits, temporary/permanent ban on harvest, spatial closure)
- Discuss compliance with management plan rules
- Minimize other pressures on the species
- Prepare species recovery plan (if none exists)
- Continue to monitor, repeating surveys in 3-6 months
- Contact the LRC and MIMRA for a detailed assessment

INTERTIDAL INVERTEBRATES SEA CUCUMBERS


Lollyfish ✖


Black teatfish ✚


Greenfish ●


Pinkfish #


HEALTHY


DECLINING


OVERFISHED

JAN-MAR | APR-JUN | JUL-SEP | OCT-DEC | JAN-MAR | APR-JUN

COMMUNITY UPDATE

COMMUNITY DISCUSS POSSIBLE ISSUES AND ACTIONS

COMMUNITY SELECT MANAGEMENT ACTIONS

DECLINING
EXAMPLE MANAGEMENT ACTIONS:
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OVERFISHED
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- Discuss compliance with management plan rules
- Minimize other pressures on the species
- Prepare species recovery plan (if none exists)
- Continue to monitor, repeating surveys in 3-6 months
- Contact the LRC and MIMRA for a detailed assessment


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MODULE 3:

CORAL REEF SURVEYS

Coral reefs are complex and dynamic ecosystems usually dominated by hard corals that support hundreds of species of plants and animals. The Marshall Islands has over 250 species of hard corals as well as diverse species of fish, sponges, molluscs, crustaceans, echinoderms, and megafauna. Diverse ecosystems are important as they support healthy and vibrant communities that provide fish and invertebrates for food and income, coastal protection from typhoons and storms, eco-tourism opportunities, and resilience to climate change and other impacts.

PURPOSE

The Coral Reef Module aims to understand reef habitat condition and identify any impacts that can affect condition. Regular monitoring helps community monitors to become familiar with their reefs, enabling them to immediately identify changes. The coral reef surveys provide a tool for:

- Regular reef health check-ups.
- Early warning of any impacts that damage the reef.
- Awareness raising for local communities about their reef.

SURVEY METHOD

Materials:

- Underwater paper, slate or other surface to record observations
- Pencil
- Mask and snorkel (fins are optional)
- Guide for estimating benthic cover (in Field Guide)

Time: 15 minute timed-swim per site. Total of 30 minutes for 2 sites plus time for consensus discussion.

Site Selection: Choose a site that is typical of the main reef type in the local marine area (Figure 6) not necessarily the healthiest. Survey 2 random sites in the local area, one inside MPA and one outside MPA if available, so results can be compared to determine if the MPA is meeting community objectives.

If the same sites are resurveyed each time, make sure to mark or identify the sites in some way to help find them each time. Choose sites that are easy and safe to access at low and high tide.

Figure 6: *Different types and zonation of RMI coral reefs showing: lagoon, reef flat, reef front and reef slope (Source: Blanchon 2011). Image copyright of Google Earth, DigitalGlobe and GeoEye 2010.*

Choose sites less than 26 feet (8 m) deep so the reef can be seen clearly when snorkeling at the surface. All sites should be similar depth and habitat type (e.g. fringing reef), and should be about 100 feet (30 m) apart if the reef area is large enough, to get good representation of the local reef habitat.

The survey is conducted by at least 2 monitors who swim steadily for 15 minutes parallel to the shore and record information for each indicator. It is important that monitors swim about 6 feet apart and survey the same reef site. Each monitor scores each indicator and makes clear notes that can be used for the consensus discussion later.

Frequency: How often reef health surveys are conducted will depend on the community objectives, and each community can decide together (see table below).

Monitoring type	Frequency (once every)
Routine monitoring	12 months
Protected area effectiveness	12 months
Impact risk monitoring	High risk period (e.g. summer season for coral bleaching, COTS outbreak)
Impact response monitoring	Within 1 month of impact occurring

Number of monitors: At least 2 monitors survey the reef at the same time and then compare their results during a consensus process afterwards. If more monitors are available, then more can conduct the survey at the same time. The more monitors, the less chance of any one person affecting the survey results.

Knowing your coral reefs

Each coral reef is different and over time, condition changes due to natural events (e.g. typhoons) and human activities (e.g. overfishing).

Resource monitors and communities who use local reefs are usually the first to notice these changes, and many remember the history of their reef. Discussing the local reef with Chiefs and Elders who remember how the reefs used to be is an important part of developing a Management Plan and objectives. It also helps monitors understand their reef and identify suitable management actions in the reporting poster.

CONDUCTING THE SURVEY

Snorkel the reef site for 15-minutes and record what you see for the 5 indicators using underwater paper, slate or other surface (e.g. nail and coconut palm frond). The following section details each of the five reef health or impact indicators and provides a guide for recording each one.

REEF HEALTH INDICATORS

1. Live hard coral cover – Live hard coral is usually colorful (e.g. blue, pink, brown, green), while dead coral is usually dark brown with algae (seaweed) overgrowing. Soft corals are not recorded and can be identified as they move and can be seen to 'sway' in the water. There are many different species of hard corals, but monitors don't need to learn coral types.

Monitors estimate the percentage of reef area covered in live coral and mark it on the scale (see table below). The scale is based on scientific monitoring results from sites around the Marshall Islands that documented coral cover of 30–35% between 2011 and 2014 (University of Guam 2014, Capelle et al. 2018), and region Pacific coral cover of 21–26% (Moritz et al. 2018).

Low live hard coral cover	0-10%
Moderate live hard coral cover	11-25%
High live hard coral cover	>25%

REEF IMPACT INDICATORS

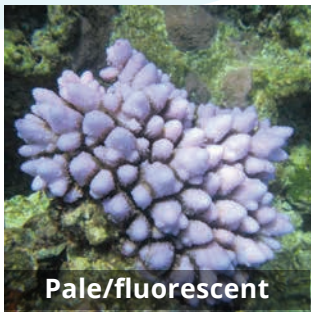
There are many events that can impact the health of coral reefs. There may be specific impacts that affect your reefs that you want to monitor in addition to the ones outlined here.

2. Algae cover – Algae (or seaweeds) are a natural part of the reef but if there is too much it can be a sign that the reef is unhealthy. When algae overgrow live hard coral, it blocks sunlight and makes it hard for the coral to grow. When algae cover bare rock, new corals can't settle.

A healthy reef has only a small percentage of algae, much less than the amount of live coral. An unhealthy reef has a lot of algae often growing over the coral, in-between coral and on bare rock.

Monitors need to estimate the percentage of area covered in algae and mark it on the scale (see table below). The scale is based on scientific monitoring results from sites around the Marshall Islands that documented algae cover of 10–25% between 2011 and 2014 (University of Guam 2014, Capelle et al. 2018), and region Pacific algae cover of 10% (Moritz et al. 2018).

Low algae cover	0–10%
Moderate algae cover	11–25%
High algae cover	>25%


Pale/fluorescent


Heat stress

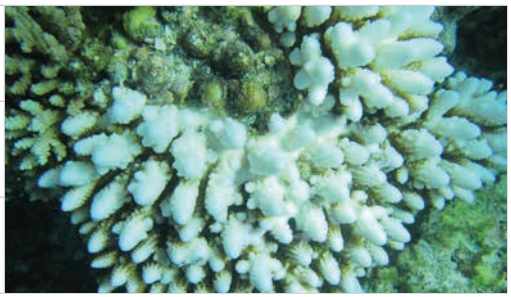

Disease


Predation (snails)

3. White coral – Coral bleaching is a stress response in corals and occurs when corals are exposed to above-average water temperature, below-average water temperature, disease, predation or freshwater. The coral loses its color so you can see the white skeleton, or sometimes becomes pale or fluorescent (see photos). The coral will eventually starve and die unless the stress ends. Monitoring for coral bleaching is especially important during periods of stress (e.g. during hot summers).

Importantly, bleached corals are not dead and can recover if conditions cool and there are no other pressures. However, bleached corals do represent a stressed reef, and recovery will benefit from immediate management actions that reduce other pressures.

Bleaching can affect individual corals or sometimes, entire sections of the reef. During each survey, take note of even a small amount of bleaching, as this may be an early warning that more severe bleaching may happen soon. Also note the overall area of bleaching at the entire survey site (ft^2). Monitors need to estimate the percentage of coral area that is white and mark it on the scale (see table below).

Low white coral cover	0-10%	
Moderate white coral cover	11–25%	
High white coral cover	>25%	

4. Crown-of-thorns starfish (COTS) – These starfish are a natural part of the reef and eat hard corals but if there are too many it can be a sign that the reef is unhealthy. It can be difficult to know what a 'normal' population of COTS should be on a reef. Research on how much coral each COTS eats in the wider Pacific has determined the density at which predation exceeds coral growth and therefore COTS numbers are considered too high for a healthy reef (Dumas et al. 2020, Westcott et al. 2016).

COTS are cryptic animals that generally hide in and under coral during the day and feed at night. So monitors may see the starfish or more likely areas of coral that have been eaten (see photos below).

Monitors need to count the number of COTS seen during each 15-minute survey and mark it on the scale (see table below).

	**Low:** No COTS outbreak	0–1
	Moderate: Potential COTS outbreak	2–5
	High: Active COTS outbreak	>5

5. Broken hard coral – Broken coral cannot provide habitat and will eventually die. It can be caused by the wave action of severe storms and typhoons, walking on corals, boat groundings or anchoring and destructive fishing practices.

Monitors need to estimate the percentage of coral area that is broken and mark it on the scale (see table below). If monitors can recognize and record what is likely to have caused the damage (e.g. storm/typhoon, boat anchoring), it will help decide on appropriate management actions. If the damage is from human activities, awareness can be raised within the community to prevent it in the future or identify 'no anchoring/ boating or reef walking' areas.

Low coral damage	0–10%	
Moderate coral damaged	11–25%	
High coral damaged	>25%	

Litter - Coastal coral reefs can also have a lot of litter (e.g. plastic bags, bottles, cigarette butts) or marine debris (e.g. discarded fishing nets or line). Litter can take years to decades to break down. For example, cigarette butts 1–5 years, plastic bags 10–20 years, aluminum cans 80 years and plastic bottles 450 years. Plastic bags are also mistaken for food – such as jellyfish – by marine animals like turtles, dolphins and seabirds that try to eat the bags and end up choking. All litter can also entangle marine animals or injure them. Monitors can record any litter they see and how much at the bottom of the survey sheet.

Things to remember while monitoring

Swim in a slow and relaxed way so you don't disturb the fish or stand on and break coral.

Stay close together while swimming, so that you all survey the same site and for safety. It's important that each monitor records their observations separately and do not share while in the water. Observations are shared afterwards during the consensus process.

Taking photos during the survey of the reef site, impacts or anything unusual can help with the discussion and filling in the survey sheet.

EXAMPLE REEF HEALTH SURVEY

REEF HEALTH SURVEY SHEET

SITE DESCRIPTION (ONE FORM PER SITE)		
Who	Monitor name: Emma, Lyla, Alicia	
Where	Atoll: Namo	Site name: Loen
When	Date: 10 June 2021	Time: 9:00 am
Conditions	Weather: calm, clear, 25 °C	Tide: high
Habitat (circle one or more)	Reef lagoon	Reef front
	(Reef flat)	Reef slope

WHAT DID YOU SEE?		
1. Hard coral cover	Comments:	
	0% | 10% | 25% | 100% (X between 10% and 25%)	
	Low | Moderate | High	

WHAT IMPACTS DID YOU SEE?		
1. Algae Cover	Comments:	
	0% | 10% | 25% | >50% (X between 0% and 10%)	
	Low | Moderate | High	
2. White Coral	Comments:	Estimated area (in f^2): 15 f^2
	0% | 25% | 25% | 100% (X between 0% and 25%)	
	Low | Moderate | High	
3. Crown-of-thorn starfish (COTS)	Comments: 1 seen by 1 monitor only	
	0% | 1 | 5 | 50+ (X between 0% and 1)	
	Low | Moderate | High	
4. Broken coral:	Comments (note type of damage):	
	0% | 25% | 25% | 100% (X between 25% and 25%)	
	Low | Moderate | High	

Litter present? (circle)	Lots	(Some)	None
Photos Taken? (circle)	(Yes)	No	
Photo Notes:	Photos of litter and broken coral		

DATA REPORTING

The survey results are reviewed in the consensus process when all monitors come together to discuss the results. Results are then entered into a single survey sheet.

THE CONSENSUS PROCESS:

Reaching consensus is an important step and simply means everybody agrees on the reef survey results using the following steps:

1. Share your results and compare how you each scored all the reef indicators.
2. Every monitor should have a chance to explain the reasons for their scores on the scale. In this process it is very important that everyone is treated equally, no matter what position they hold within the community.
3. As a group, decide where to put the final score for each reef indicator on the survey sheet. These are what you will use for reporting back to the community.

Reaching a Consensus

There could be many reasons why there are differences between what each monitor observes. For example, if only one person sees a crown-of- thorns starfish at the site, that person will mark COTS as low, whereas other monitors who didn't see any will mark them as 0. It doesn't mean that one person is right and the others are wrong, but shows the importance of having many monitors doing the survey. It also shows the importance of sharing observations during the consensus process.

At the beginning, there might be differences in the way each monitor surveys the reef, especially if some of the monitors are experienced and know what to look for. But as everyone's experience and understanding of the reef grows, there will be less differences in observations and it will be easier to 'average' what each monitor records into a single score for the survey.

The results from the single survey sheet are marked on the data reporting posters and monitors report back to the community about the results and discuss any potential issues and management actions that might be needed.

Differences in reporting 'reef health' and 'reef impacts'

Note that there is a difference between the data reporting posters for the reef health indicators and the reef impact indicators.

For reef health indicators, 'high' indicates healthy and 'low' indicates that there is an issue. Whereas with the reef impacts indicators, 'high' indicates an issue and 'low' indicates a healthy state. The color coding remains the same: blue indicates healthy condition, yellow indicates a potential problem (caution) with further investigation needed, and red indicates a problem (alert) and the need for immediate management action.

The four reef impact indicators are marked on the same reporting poster. Since coral reefs are complex, it is important to consider the different reef impact indicators together to identify any concerning issues early. Even if your reef is in a healthy state there may be one or more impact indicators that are within the yellow (caution) zone, or the red (alert) zone. If any ONE impact is in the red zone, then immediate action is needed, even if the other impacts are in the blue zone.

MANAGEMENT OPTIONS:

The value of monitoring your reef area is that you can provide immediate information that can inform local management decisions. The reporting posters provide a guide on the management actions that should be considered. For the reef health and impact indicators:

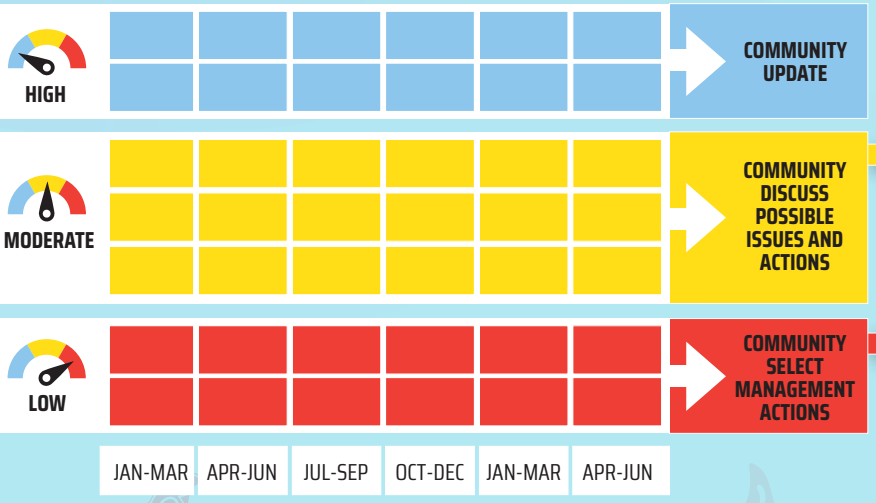
- Results in the ***blue zone*** (healthy) would indicate a healthy reef and should be reported to the community for raising awareness about monitoring and reef condition.
- Results in the ***yellow zone*** (caution) indicate a possible issue. It is recommended that monitors hold a community meeting with the local leadership and community to discuss the results, possible reasons for the results, and actions. Actions will vary between communities and should be guided by local experience, the local leadership and the management recommendations established in the local Management Plan. Compare reef impact results and fish catch surveys as it may help identify the cause of any declines, and/or introducing fishing restrictions Example management actions include: community awareness raising (such as information on notice boards), discussions to identify the cause of the impacts, and immediate management actions. The discussions should also consider if the surveys should be repeated to confirm the results if they are unexpected or cannot be easily explained.
- Results in the ***red zone*** (alert) indicate that there is a serious issue, which calls for immediate management action. This could include further restrictions on harvest or stronger enforcement of existing rules and should be guided by the local Management Plan.

The Field Guide provides a summary of the coral reef surveys, data reporting posters and photos to take in the field to assist with scoring indicators.

MARSHALL ISLANDS CORAL REEF MONITORING REPORTING

REEF HEALTH

Live hard coral cover ✖



MODERATE
EXAMPLE MANAGEMENT ACTIONS:

- Awareness raising with community
- Discuss recent trends (decline in coral cover)
- Review impact results for potential causes of decline (e.g. storm, COTS, bleaching)
- Discuss possible management actions (e.g. COTS removal, ban walking on reef)
- Continue to monitor, perhaps more often
- Advise LRC of results and actions

LOW
EXAMPLE MANAGEMENT ACTIONS:

- Identify cause of decline (e.g. COTS, bleaching, storm)
- Apply appropriate management actions from management plan (e.g. algae or COTS removal, protect reef)
- Discuss compliance with management plan rules
- Minimize other pressures on the reef (anchoring, reef walking, fishing gear that can entangle, runoff)
- Continue to monitor, repeating surveys in 3-6 months
- Advise LRC of results and actions

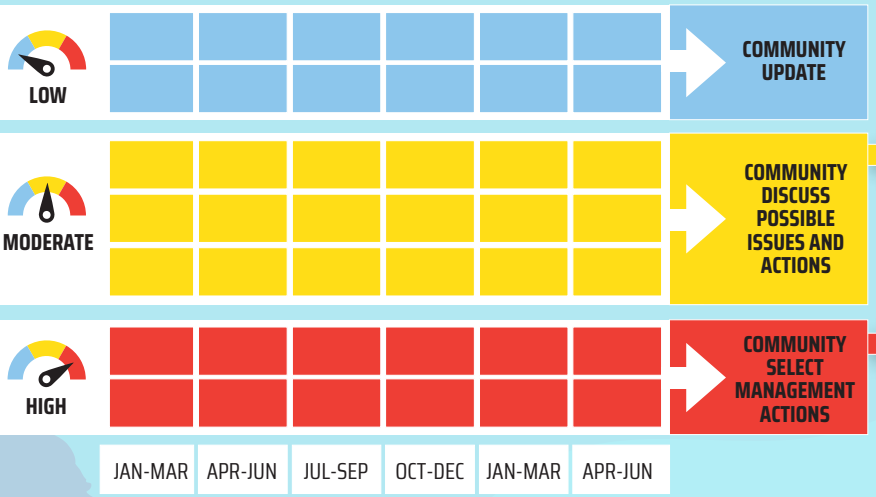
REEF IMPACTS

Algae ✖

White coral ✚

COTS ●

Broken coral #



MODERATE
EXAMPLE MANAGEMENT ACTIONS:

- Awareness raising in community
- Discuss recent trends in impacts
- Identify potential causes of impacts
- Discuss possible management actions (e.g. COTS removal, ban walking on reef)
- Continue to monitor, perhaps more often
- Advise LRC of results and actions

HIGH
EXAMPLE MANAGEMENT ACTIONS:

- Apply appropriate management actions from management plan (e.g. algae/COTS removal, protect reef)
- Discuss compliance with management plan rules
- Minimize other pressures on reef (e.g. nutrient runoff, fishing pressure and destructive gear, anchoring, reef walking)
- Continue to monitor, repeating surveys in 3-6 months
- Advise LRC of results and actions

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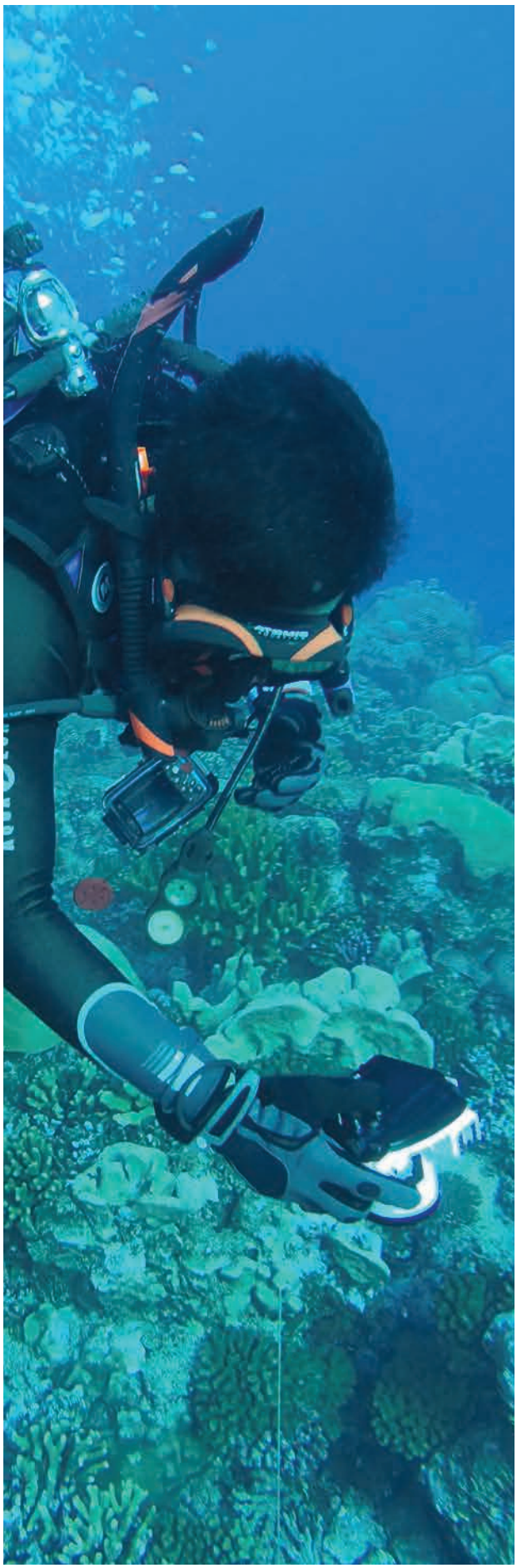


MODULE 4:

MANGROVE SURVEYS

Mangroves are tidal marine plants covered by the tide twice a day. They provide a nutrient-rich habitat for lots of animals, including those targeted by fisheries such as crabs, fish, molluscs, marine turtles, and sharks and rays. Mangrove forests provide important ecosystem services, such as food security, trapping sediment and nutrients, filtering water, providing nursery habitat, coastal protection, wood resources, and are carbon sinks. They are an important coastal habitat that is threatened by human and natural disturbances. Harvesting timber, clearing for coastal development, land-based pollution, typhoons and storms, and rising sea level all threaten mangroves. Early detection of change allows local communities to adjust their practices and act sooner to protect their mangroves.

PURPOSE

The Mangrove Module aims to understand mangrove habitat condition and identify any impacts that can affect condition. Regular monitoring helps community monitors to become familiar with their mangrove areas, enabling them to immediately identify changes. The mangrove surveys provide a tool for:

- Regular mangrove health check-ups.
- Early warning of any impacts that damage mangroves.
- Awareness raising for local communities about their mangrove areas.

The Marshall Islands have only a small area of mangrove forests, with five documented species of mangroves, and the northern islands only having one species (*Bruguiera gymnorrhiza*) (Ellison 2007, 2009). The common species are shown below, however the mangrove module does not require monitors to learn species information.

Mangrove species		Common name
Rhizophora spp. (R. stylosa, R. apiculate, R. mucronate)		Stilted or spotted mangrove
Brugiera gymnorhiza		Black mangrove

SURVEY METHOD

Materials:

- Field survey sheet
- Pencil
- Rope to measure quadrat (optional)

Time: 5-10 minutes per replicate quadrat (3 per site). Total of 20-30 minutes per site.

Site Selection: Choose sites that are easy to access and with mangroves that are typical of the local habitat. Survey one random site in your community area, with 3 replicate quadrats 32 x 32 feet (10 m x 10 m) at least 100 feet (30 m) apart, if possible. The replicate quadrats should be one close to land (A), one in the middle of the mangrove forest (B), and one close to the sea (C) (Figure 7), if possible.

If the same sites are resurveyed each time, make sure to mark or identify the sites in some way to help find them for each survey, and compare results.

Figure 7: *Example of suitable mangrove replicates within one survey site, showing landward (A), mid-forest (B) and seaward (C) replicate quadrats.*

Frequency: Once every 12 months, or within 1 month after an impact. Mangroves are relatively slow growing and even after impacts, usually take a long time to recover or die.

Number of monitors: At least 2 people should conduct each survey. This helps to discuss results and reach agreement, and it is also safer.

CONDUCTING THE SURVEY

Choose the site and select 3 random 32 x 32 feet (10m x 10 m) replicates (quadrats) at each site (Figure 7). Each 32 x 32 ft quadrat should be about 100 feet (30 m) apart (Figure 8) if the mangrove habitat is large enough. Monitors can use a rope to measure out the quadrats or can practice walking the 32 x 32 feet quadrat area, so they become familiar with estimating the survey area.

Before starting the survey, check the site and record:

- any safety issues or risks you can see (mangrove roots or mud can be difficult to walk through),
- the height of the tide (preferably surveys should be done at low tide), and
- weather conditions.

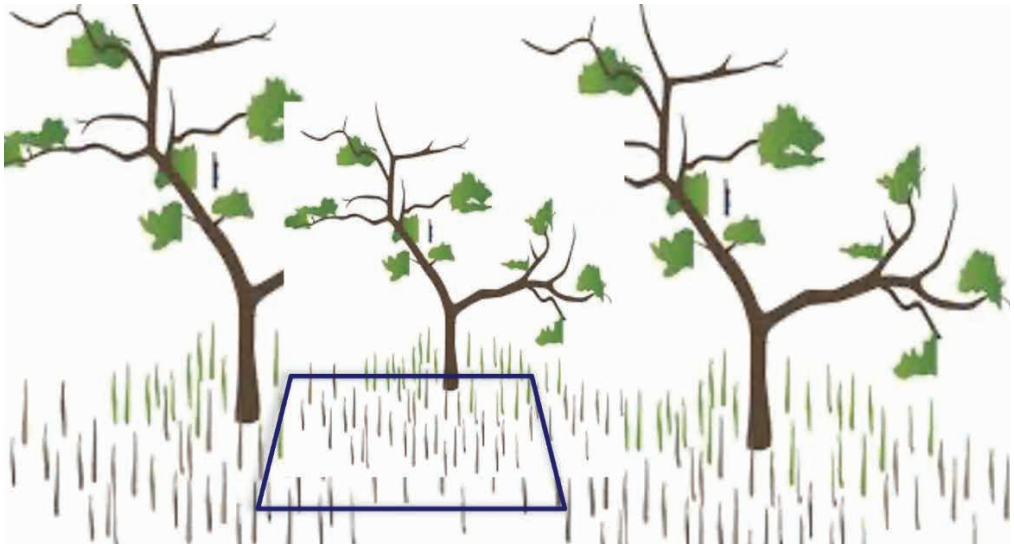


Figure 8: *Select 3 random 32 x 32 feet quadrats (replicates) at each site at least 100 feet apart.*

DATA COLLECTION

Monitors work together to record site details and discuss and record what they see for the 4 indicators on the survey sheet at each quadrat (using numbers) and then score a final average for all 3 quadrats (using a X). Once you finish the first quadrat (replicate), move 100 feet (30 m) away and repeat for the second quadrat, and then again for third quadrat. Photos of each quadrat are useful for checking and discussing results before reporting.

The following section details each of the 4 mangrove health or impact indicators and provides a guide for recording each one.

1. Mangrove canopy cover - Healthy mangrove forests have thick tree growth with an almost continuous canopy of branches and leaves. Mangrove forests that have been impacted by excessive timber harvesting, clearing or other stresses, often have large gaps in the canopy. Stand in the middle of the quadrat and look up at the forest canopy and notice whether the tree branches touch and overlap or whether there are unnatural gaps between them. Mark the canopy cover in each quadrat by marking on the scale:

Broken canopy with few leaves (<30% cover)	**Low**
Some gaps in canopy (30-75% cover)	**Moderate**
Almost continuous canopy (75-100% cover)	**High**

2. Seedlings (new trees) - Healthy mangrove forests produce young trees (seedlings) to replace those that die. In environments that are impacted by people, it is often the seedlings that are small and fragile, that are damaged first or fail to grow. Mark the amount of mangrove seedlings in each quadrat by marking on the scale:

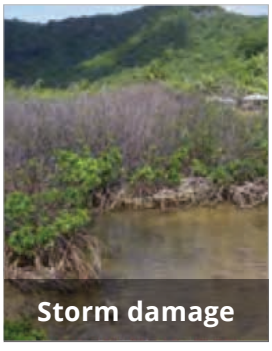
Few seedlings (<5 per quadrat)	**Low**
Many seedlings (6-10 per quadrat)	**Moderate**
Abundant seedlings (>10 per quadrat)	**High**

3. Twisted or damaged roots - Environmental conditions can damage mangrove roots, particularly if the soil or water is polluted. The health of mangrove trees is affected if roots are twisted or damaged, as mangroves 'breathe' through their roots. Mark the amount of twisted or damaged roots in each quadrat by marking on the scale:

Minor damage (<40% of roots)	**Low**
Lots of damage (40-90% of roots)	**Moderate**
Severe damage (90-100% of roots)	**High**

4. Impacts - Mangroves can be impacted by natural disturbances, like typhoons and storms, as well as human impacts from clearing, harvesting for timber, littering and digging by animals. Signs of these impacts are important to know whether management actions are needed (see photos).


Erosion around roots


Storm damage


Timber harvesting

No or Minor impacts (some cutting, digging)	**Low**
Some impacts (cut trees, clearing, bare mud)	**Moderate**
Severe impacts (clearing, bare mud, few trees)	**High**

EXAMPLE MANGROVE SURVEY

MANGROVE SURVEY SHEET

SITE DESCRIPTION			
Who	Monitor name(s): Armer, Absalom, Kalena		
Where	Atoll: Namdrik	Site name: Madmad	
When	Date: 17 June 2021	Time: 11:00 am	
Conditions	Weather: overcast, windy, 25 °C	Tide: low	
Location (number)	Seaward edge =1	Mid forest=2	Landward edge=3
Site Selection (circle)	(Random)	Marked Site	

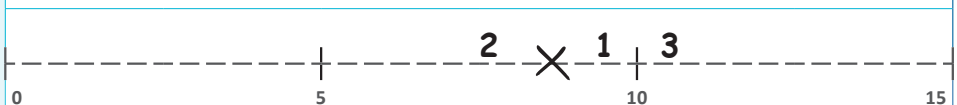
WHAT DID YOU SEE?

1. Mangrove canopy cover

Comments:

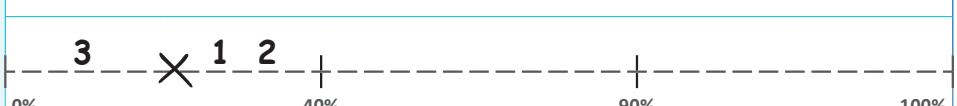
2. Seedlings (new trees)

Comments:



3. Twisted or damaged roots

Comments:



WHAT IMPACTS DID YOU SEE?

4. Impacts

Level of impact:

Comments:

Type of impact (circle all that apply):				
	Storm Damage	(Timber cutting)	Animals (eg. pigs)	
	Erosion	Development	(Litter)	Other

Photos Taken? (circle)	(Yes)	No	
Photo Notes:	Photos of cut trees and close up of seeds and flowers for ID.		

DATA REPORTING

The results from the single survey sheet are marked on the data reporting posters and monitors report back to the community about the results and discuss any potential issues and management actions that might be needed.

Differences in reporting 'mangrove health' and 'mangrove impacts'

Note that there is a difference between the data reporting posters for the mangrove health indicators and the mangrove impact indicators.

For mangrove health indicators, 'high' indicates healthy and 'low' indicates that there is an issue. Whereas with the mangrove impacts indicators, 'high' indicates an issue and 'low' indicates a healthy state. The color coding remains the same: blue indicates healthy condition, yellow indicates a potential problem (caution) with further investigation needed, and red indicates a problem (alert) and the need for immediate management action.

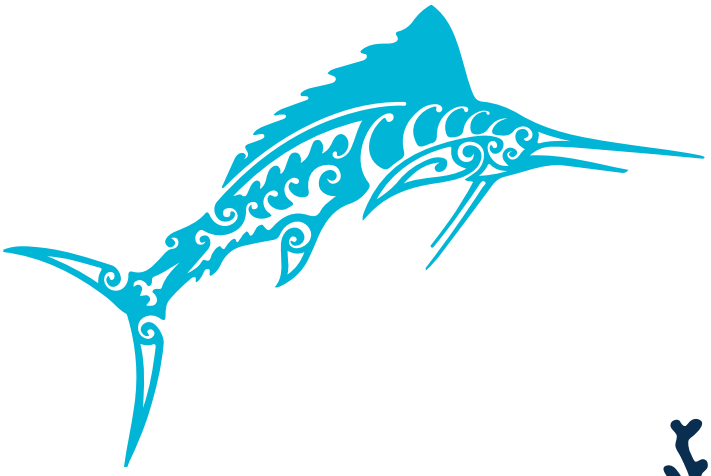
The two mangrove health indicators are marked on ONE health data reporting poster and the two impact indicators are marked on ONE data reporting poster. Considering the different mangrove impact indicators together helps to identify any concerning issues early. Even if your mangrove forest is healthy, there may be one or more impact indicators that is within the yellow (caution) zone, or the red (alert) zone. If any ONE impact is in the red zone, then immediate action is needed, even if the other impacts are in the blue zone.

MANAGEMENT OPTIONS:

The value of monitoring your mangrove area is that you can provide immediate information that can inform local management decisions. The reporting posters provide a guide on the management actions that should be considered. For the mangrove health and impact indicators:

- Results in the ***blue zone*** (healthy) would indicate healthy mangroves and should be reported to the community for raising awareness about monitoring and mangrove condition.
- Results in the ***yellow zone*** (caution) indicate a possible issue. It is recommended that monitors hold a community meeting with the local leadership and community to discuss the results, possible reasons for the results, and actions. Actions will vary between communities and should be guided by local experience, the local leadership and the management recommendations established in the local Management Plan. Compare mangrove health and impact indicators as it may help identify the cause of any declines. The discussions should also consider if the surveys should be repeated to confirm the results if they are unexpected or cannot be easily explained.
- Results in the ***red zone*** (alert) indicate that there is a serious issue, which calls for immediate management action. This could include immediate timber harvest bans, litter clean-up days, or stronger enforcement of existing rules, and should be guided by the local Management Plan.

The **Field Guide** provides a summary of the mangrove surveys, data reporting posters and photos to take in the field to assist with scoring indicators.



MARSHALL ISLANDS MANGROVE MONITORING REPORTING

MANGROVE HEALTH


Canopy Cover ✖


Seedlings ✚

HIGH → COMMUNITY UPDATE

MODERATE → COMMUNITY DISCUSS POSSIBLE ISSUES AND ACTIONS

LOW → COMMUNITY SELECT MANAGEMENT ACTIONS

JAN-MAR | APR-JUN | JUL-SEP | OCT-DEC | JAN-MAR | APR-JUN

MODERATE
EXAMPLE MANAGEMENT ACTIONS:
- Awareness raising in community
- Discuss recent trends (declines)
- Review impact results for potential causes
- Discuss possible management actions (e.g. restrict tree cutting, clean-up litter)
- Continue to monitor, perhaps more often
- Advise LRC of results and actions

LOW
EXAMPLE MANAGEMENT ACTIONS:
- Identify cause of decline (e.g. timber harvest, pigs)
- Apply appropriate management actions from management plan (e.g. ban tree clearing, fence out domestic animals)
- Discuss compliance with management plan rules
- Minimize other pressures (walking on roots, litter)
- Consider restoration/replanting of mangrove seedlings
- Continue to monitor, repeating surveys in 3-6 months
- Advise LRC of results and actions

MANGROVE IMPACTS


Damaged Roots ●


Other #

LOW → COMMUNITY UPDATE

MODERATE → COMMUNITY DISCUSS POSSIBLE ISSUES AND ACTIONS

HIGH → COMMUNITY SELECT MANAGEMENT ACTIONS

JAN-MAR | APR-JUN | JUL-SEP | OCT-DEC | JAN-MAR | APR-JUN

MODERATE
EXAMPLE MANAGEMENT ACTIONS:
- Awareness raising in community
- Discuss recent trends and impacts
- Discuss causes of impacts
- Discuss possible management actions (e.g. restrict tree cutting, clean-up litter)
- Continue to monitor, perhaps more often
- Advise LRC of results and actions

HIGH
EXAMPLE MANAGEMENT ACTIONS:
- Identify cause of impacts (e.g. timber harvest, pigs)
- Apply appropriate management actions from management plan (e.g. ban tree clearing, fence out domestic animals)
- Discuss compliance with management plan rules
- Minimize other pressures (walking on roots, litter)
- Consider restoration/replanting of mangrove seedlings
- Continue to monitor, repeating surveys in 3-6 months
- Advise LRC of results and actions

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Bell JD, Johnson JE, Hobday AJ, Ganachaud A, Gehrke P, Hoegh-Guldberg O, Le Borgne R, Lehodey P, Lough J, Pickering T, Pratchett M and Waycott M (2011) Vulnerability of tropical Pacific fisheries and aquaculture to climate change: Summary for countries and territories. Secretariat of the Pacific Community, Noumea

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MODULE 5:

SEAGRASS SURVEYS

Seagrasses are marine plants that provide nutrient-rich habitats for many animals, including those targeted by fisheries, for example, species of finfish, sea cucumbers, urchins, marine turtles, dugongs, sharks and rays. Seagrass meadows provide important ecosystem services, such as food and shelter, nutrient cycling, nursery habitat and carbon sinks. They are an important coastal habitat that is threatened by human and natural disturbances, including urban and agricultural runoff, boat damage, fishing, typhoons and storms, and dredging. Early detection of change allows local communities to adjust their practices and/or take remedial action to protect seagrass.

PURPOSE

The Seagrass Module aims to understand seagrass habitat condition and identify any impacts that can affect condition. Regular monitoring helps community monitors to become familiar with their seagrass areas, enabling them to immediately identify changes. The seagrass surveys provide a tool for:

- Regular seagrass health check-ups.
- Early warning of any impacts that damage seagrass.
- Awareness raising for local communities about their seagrass areas.

The Marshall Islands have only a small area of seagrass meadows, with 3 species of seagrass reported in shallow, sandy areas (lagoons) of some atolls – *Thalassia hemprichii, Cymodocea rotundata, and Halophila minor* (Reimaanlok National Plan 2008, SeagrassWatch). The common species are shown below, however the seagrass module does not require monitors to learn species information.

Seagrass species		Features
Thalassia hemprichii		Sickle shaped leaves Leaves 10–40 cm tall
Cymodocea rotundata		Rounded tip Narrow leaf blade (2–4 mm wide) Leaves 7–15 cm tall
Halophila minor		Oval shaped leaves Leaves 2-3 cm tall

SURVEY METHOD

Materials:

- Field survey sheet
- Pencil
- Mask and snorkel (if submerged seagrass site)
- Guide to estimating seagrass cover (in Field Guide)

Time: 5 minutes per quadrat (3 replicates). Total of 15 minutes per site.

Site Selection: Choose random sites that are easy to access (low tide is preferable), and with seagrass meadows that are typical of the local habitat. Survey one site in your community area with three 3 x 3 feet (1m x 1 m) replicates (quadrats) that are at least 30 feet (10 m) apart. Sites can be the same as the invertebrate intertidal surveys (Module 2) or the reef health surveys (Module 3) if these are typical of seagrass in your marine area.

Frequency: Once every 6–12 months, or after an impact. Monitoring can be done at the same time as other modules.

Number of monitors: At least 2 people should conduct each survey. This helps to discuss results and reach agreement, and it is also safer.

CONDUCTING THE SURVEY

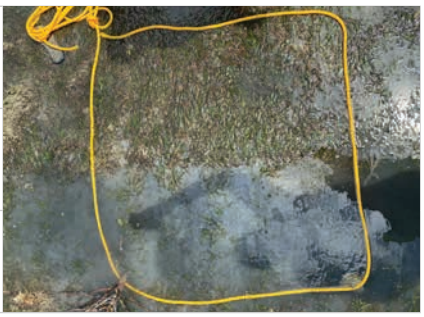
Choose the site and select 3 random 3 x 3 feet (1m x 1 m) quadrats (replicates) at each site. Each 3 x 3 ft (1m x 1 m) quadrat should be at least 30 feet (10 m) apart if the seagrass area is large enough. Monitors can use a rope to measure the quadrats or can practice estimating the 3 x 3 ft (1m x 1 m) quadrat area.

Data Collection: Monitors work together to record the site details and discuss and record what they see for the 3 indicators on the survey sheet at each quadrat (using numbers) and then score an average for all 3 quadrats (using X; see example). Once you finish the first quadrat (replicate), move 30 feet (10 m) away and repeat for the second replicate, and then again for the third. Photos of each quadrat are useful for discussing results.

The following section details each of the 3 seagrass health or impact indicators and provides a guide for recording each one.

1. Live seagrass cover - Healthy seagrass meadows can range from sparse growth to very lush growth with almost 100% cover. The amount (%) of seagrass cover is an indicator of health, and how much food and habitat it can provide.

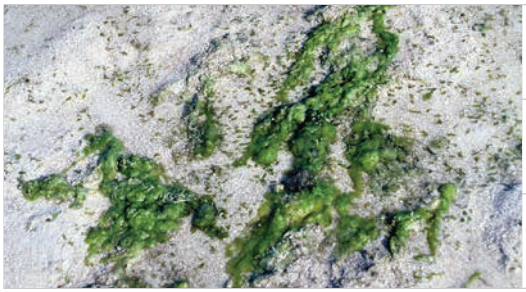
Low seagrass cover	<25%
Moderate seagrass cover	26 – 60%
High seagrass cover	>60%



IMPACT OBSERVATIONS

Seagrass can be impacted by algae overgrowth that blocks sunlight and smothers the seagrass leaves, or by physical disturbances, such as storms, land-based inputs, or boat damage, that can remove areas of seagrass, 'burn' the seagrass leaves or stress seagrass so they cannot flower or seed. Signs of these impacts are important to decide if management actions are needed.

2. Algae cover - Algae are seaweeds that can cover or overgrow seagrass and affect sunlight penetration and their ability to produce energy. High algae cover can be a sign of unhealthy seagrass while low algae cover can be a sign of a healthy meadow.



Low algae cover	<10%
Moderate algae cover	11 – 25%
High algae cover	>25 %

3. Damaged seagrass - Areas of seagrass that are damaged by storms, typhoons and boats, 'burnt' by warmer sea water or exposure to sunlight also affect the ability of seagrass to produce energy and provide habitat. Examples of damaged or stressed seagrass are provided below with a guide for estimating the extent of damage or stress.

Low damage/burnt seagrass	<25%
Moderate area of damaged/burnt seagrass	26 – 60%
High area of damaged/burnt seagrass	>60%

Stressed (burnt) seagrass

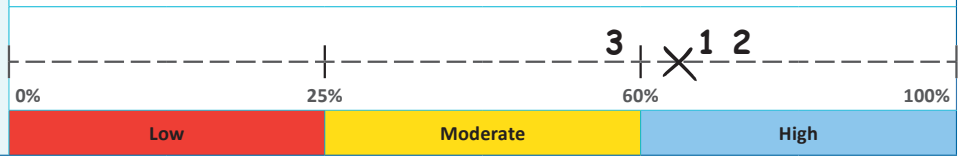
Damaged seagrass meadows

EXAMPLE SEAGRASS SURVEY

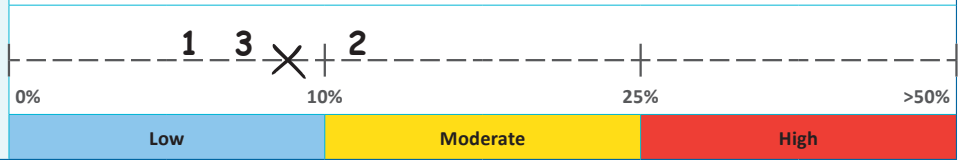
SEAGRASS SURVEY SHEET

SITE DESCRIPTION		
Who	Monitor name(s): Jessie, BJ	
Where	Atoll: Arno	Site name: Loñar
When	Date: 15 June 2021	Time: 2 pm
Conditions	Weather: Light winds, some clouds	Tide: Low, exposed
Site Selection (circle)	(Random)	Marked Site

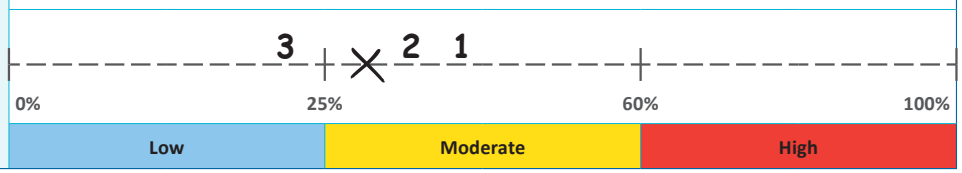
WHAT DID YOU SEE?	
1. Live Seegrass Cover	Comments: Lush meadows with strappy seagrass types



WHAT IMPACTS DID YOU SEE?	
2. Algae Cover	Comments: Not much seaweed noticed



3. Damaged or 'burnt' seagrass	Comments: Some scrapped seagrass, maybe from anchoring



Litter present? (circle)	Lots	(Some)	None
Photos Taken? (circle)	(Yes)	No	
Photo Notes:	Close up photos of seagrass for identification and algae		

DATA REPORTING

The results from the single survey sheet are marked on the data reporting posters and monitors report back to the community about the results and discuss any potential issues and management actions that might be needed.

Differences in reporting 'seagrass health' and 'seagrass impacts'

Note that there is a difference between the data reporting posters for the seagrass health indicators and the seagrass impact indicators.

For seagrass health indicators, 'high' indicates healthy and 'low' indicates that there is an issue. Whereas with the seagrass impacts indicators, 'high' indicates an issue and 'low' indicates a healthy state. The color coding remains the same: blue indicates healthy condition, yellow indicates a potential problem (caution) with further investigation needed, and red indicates a problem (alert) and the need for immediate management action.

The one seagrass health indicator (live seagrass cover) is marked on ONE health data reporting poster and the two impact indicators (algae cover and damaged/burnt seagrass) are marked on ONE data reporting poster. Considering the different seagrass impact indicators together helps to identify any concerning issues early. Even if your seagrass meadow is healthy, there may be one or more impact indicators that are within the yellow (caution) zone, or the red (alert) zone. If any ONE impact is in the red zone, then immediate action is needed, even if the other impacts are in the blue zone.

MANAGEMENT OPTIONS:

The value of monitoring your seagrass area is that you can provide immediate information that can inform local management decisions. The reporting posters provide a guide on the management actions that should be considered. For the seagrass health and impact indicators:

- Results in the ***blue zone*** (healthy) would indicate a healthy seagrass meadow and should be reported to the community for raising awareness about monitoring and seagrass condition.
- Results in the ***yellow zone*** (caution) indicate a possible issue. It is recommended that monitors hold a community meeting with the local leadership and community to discuss the results, possible reasons for the results, and actions. Actions will vary between communities and should be guided by local experience, the local leadership and the management recommendations established in the local Management Plan. Compare seagrass health and impact indicators as it may help identify the cause of any declines. The discussions should also consider if the surveys should be repeated to confirm the results if they are unexpected or cannot be easily explained.
- Results in the ***red zone*** (alert) indicate that there is a serious issue, which calls for immediate management action. This could include prohibiting anchoring on seagrass meadows or stronger enforcement of existing rules and should be guided by the local Management Plan.

The **Field Guide** provides a summary of the seagrass surveys, data reporting posters and photos to take in the field to assist with scoring indicators.

MARSHALL ISLANDS SEAGRASS MONITORING REPORTING

SEAGRASS HEALTH

Live Seagrass Cover ✖

	JAN-MAR	APR-JUN	JUL-SEP	OCT-DEC	JAN-MAR	APR-JUN	
HIGH							COMMUNITY UPDATE
MODERATE							COMMUNITY DISCUSS POSSIBLE ISSUES AND ACTIONS
LOW							COMMUNITY SELECT MANAGEMENT ACTIONS

MODERATE
EXAMPLE MANAGEMENT ACTIONS:

- Awareness raising with community
- Discuss recent trends (decline)
- Review impact results for potential causes of decline (e.g. storm, boat anchoring)
- Discuss possible management actions (e.g. ban walking on seagrass)
- Continue to monitor, perhaps more often
- Advise LRC of results and actions

LOW
EXAMPLE MANAGEMENT ACTIONS:

- Identify cause of decline (e.g. storm, boat anchoring)
- Apply appropriate management actions from management plan (e.g. protect seagrass)
- Discuss compliance with management plan rules
- Minimize other pressures (anchoring, seagrass walking, destructive fishing, runoff)
- Continue to monitor, repeating surveys in 3-6 months
- Advise LRC of results and actions

SEAGRASS IMPACTS

Algae ✖

Damaged or burnt ✚

	JAN-MAR	APR-JUN	JUL-SEP	OCT-DEC	JAN-MAR	APR-JUN	
LOW							COMMUNITY UPDATE
MODERATE							COMMUNITY DISCUSS POSSIBLE ISSUES AND ACTIONS
HIGH							COMMUNITY SELECT MANAGEMENT ACTIONS

MODERATE
EXAMPLE MANAGEMENT ACTIONS:

- Awareness raising in community
- Discuss recent trends and impacts
- Discuss causes of impacts (e.g. storm)
- Discuss possible management actions (e.g. restrict anchoring and walking on seagrass)
- Continue to monitor, perhaps more often
- Advise LRC of results and actions

HIGH
EXAMPLE MANAGEMENT ACTIONS:

- Identify cause of impacts (e.g. storm, boat anchoring)
- Apply appropriate management actions from management plan (e.g. protect seagrass)
- Discuss compliance with management plan rules
- Minimize other pressures (e.g. boat anchoring, destructive fishing, runoff)
- Continue to monitor, repeating surveys in 3-6 months
- Advise LRC of results and actions

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MODULE 5 REFERENCES

Bell JD, Johnson JE, Hobday AJ, Ganachaud A, Gehrke P, Hoegh-Guldberg O, Le Borgne R, Lehodey P, Lough J, Pickering T, Pratchett M and Waycott M (2011) Vulnerability of tropical Pacific fisheries and aquaculture to climate change: Summary for countries and territories. Secretariat of the Pacific Community, Noumea

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APPENDICES

APPENDIX 1:

FISH CATCH SURVEY: DATA INDICATOR, ANALYSIS AND REPORTING

Results from the fish catch surveys (Module 1) can be calculated manually after each survey period and/or automatically by entering data into a computer on an Excel spreadsheet. The manual calculation sheet is described in Module 1. If you wish to obtain a copy of the Excel catch survey database for automated use of the catch survey data, please contact the spreadsheet administrator (d.welch@c2o.net.au). If you only use the manual method, please share all your survey data with the LRC and MIMRA). The data will be stored and shared for regional or long-term reporting and will not report individual fisher's catches.

CRITICAL FISH SIZES

The ***critical size*** is a very important measure in the fish catch surveys because it is the basis for calculating the fish size indicator for reporting back to communities and for making management decisions. The critical size for each species group is based on information from scientific studies of the most commonly caught local species for that fish group and the size that fish become mature and can breed. Critical size estimates for some species are based on the national Fish Harvest Regulations (enacted in 2020). This is presented as the size at which 50% of populations are large enough to breed (size at 50% maturity). Data on how many small fish (that is, juveniles that are pre-breeding size) are caught is important as catching too many indicates an undesirable impact on the future breeding success of the population; this is essentially known as growth overfishing. This means that community-based management goals are based on the desire to avoid catching fish that are too small to breed.

MANUAL CATCH SURVEY DATA ANALYSIS

The sheets for manual calculation of whether catches have too many small fish include the species groups that communities have indicated a need for local management. The size indicator for each species group is the percentage of the total catch that is larger than the critical size (see Module 1).

The catch survey analysis sheet is used to summarise data collected from catch surveys, and importantly, to indicate the results for the Data Reporting posters for each species group. See Module 1 for the Analysis sheet and instructions.

REVIEW OF MONITORING

Importantly, each atoll should come together as a community early in the monitoring process to decide what management actions are appropriate, based on their management plan if there is one. These should be included on the Data Reporting posters, so decisions can be made quickly when results come in.

It is recommended that the fish catch monitoring be reviewed each year to identify challenges or opportunities to collect further information, and that the data and results are shared with MIMRA. Changes to the overall data collection approach should be carefully considered as it may result in surveys not being comparable. However, adding information, such as species or species groups and/or gear types, can be done as needed. Any changes should also consider the extra work required for data collection, data management and analysis. Finding the balance between collecting the right information and not collecting too much is important in ensuring the catch surveys will have the necessary resources to continue long term.

The results of the fish catch surveys are meant to answer the question: "Are too many juvenile (pre-breeding) fish being caught?". The results can also be used to understand if fish populations or fish sizes are changing over time. These changes, or trends, can inform whether management actions are having a positive or negative effect on fish populations. If fish populations or fish sizes are declining, management actions need to be put in place, or current management actions should be reviewed, and possibly new approaches used. The automated spreadsheet will be able to provide this information so submitting all survey data to the LRC or spreadsheet administrator is strongly encouraged.

RESOURCES AND TECHNICAL SUPPORT

For copies of the data spreadsheet and training contact the spreadsheet administrator:
d.welch@c2o.net.au

APPENDIX 2:

INVERTEBRATE DENSITIES IN THE PACIFIC

The intertidal invertebrate survey (Module 2) uses estimates of average density as the indicator of whether populations are healthy or not. Determining densities for each species that reflect healthy or unhealthy population status is challenging due to multiple factors, such as natural spatial variation in population sizes due to local habitats and oceanic influences, and historical fishing pressure, which is also variable, spatially and temporally, but not well documented. Therefore, determining healthy versus unhealthy population densities for this Toolkit has been inferred based on several Pacific regional studies, as well as local Marshall Islands data obtained by MIMRA. This local data set also provides different areas with contrasting fishing histories that greatly informed the density range for the local surveys of the survey species. As a result, local density estimates for the Marshall Islands tended to be lower for the 'healthy' population status compared to many of the regional studies (Table A1).

Table A1: *Density estimates for assessing the health of invertebrate species for the Marshall Islands Community Monitoring Toolkit (Sources: see Module 2 reference list).*

Location, date	Relative pressure	SPECIES – number per 100 m2 (area of one transect)						
		Lollyfish	Greenfish	Pinkfish	Black teatfish	Tridacna clam	Hippopus clam	Cowry shells
Marshall Islands, 1976	Likely unfished							20-68
Marshall Islands, 2008	>= moderately fished	1.5-2.6		0.01-0.14	0.03-0.7	0.13-0.48	0.01-0.46	0.03-1.35
Marshall Islands, 2008				0.01-0.46		10.8-11.3		0.01-0.47
Marshall Islands, 2008						27-29		
Marshall Islands, 2016-19	unfished	6.60	1.29	28.67		3.93	3.07	0.70
Cook Islands, 2004	Lightly fished	99						
Coral Sea, 2017	Relatively unfished	2.58	0.15		0.30			
Coral Sea, 2017	Fished	0.05	0.10		0.016			
French Polynesia, 2006	Near unfished					131-8,700		
French Polynesia, 2006	Heavily fished					3.5-14		
Great Barrier Reef, 2001	variable	1-69	11-167					
Great Barrier Reef, 2004	Unfished				0.23			
Great Barrier Reef, 2004	Fished				0.05			
Great Barrier Reef, 2010	Unfished						415	
Great Barrier Reef, 2020	Unfished				0.14-0.27			
Kiribati, 2010	Heavily fished						0.006-0.04	
New Caledonia, ~2008	Lightly fished		>1.00					
Palau, 2010	Heavily fished						0.36	
Papua New Guinea, 2010	Heavily fished						0.004	
Solomon Islands, 2006	Overfished	0.55	0.016					
Tokelau, 1998	Likely unfished	80-120						
Torres Strait, 2021	Heavily fished	7.4-16.1	0.19-0.61	0.03-0.09				
Vanuatu, 2010	Heavily fished						0.01-0.23	


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