SOLOMON ISLANDS
COMMUNITY MARINE MONITORING TOOLKIT

A FACILITATOR'S GUIDE TO IMPLEMENTING LOCAL MONITORING TO SUPPORT LOCAL MANAGEMENT

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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 and improving technology. 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 tailored 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 Solomon Islands is supported by observed declines in coastal marine resources throughout Melanesia. Solomon Islands has committed to global and regional policies and declarations to ensure transformative ocean management. This includes a voluntary commitment to contribute to the implementation of UN Sustainable Development Goal (SDG) 14, and the sustainable use of oceans, seas, and marine resources for sustainable development (2017 and 2022)[1]. In 2019, the Solomon Islands National Ocean Policy[2] was developed as a governance framework to ensure a consistent and coordinated approach to managing ocean ecosystems in order to achieve "a healthy, resilient, secure and productive ocean, that supports sustainable use and development for the benefit of the people of the Solomon Islands now and into the future". As part of the Ocean Policy, Solomon Islands is now in the process of finalizing its Marine Spatial Plan, with a conservation target of 15% of Marine Protected Areas and locally managed areas. As part of the SDG 14, the Solomon Islands Government has also committed to strengthen Community Based Resource Management (CBRM) initiatives, as recognised within its 10-year National Fisheries Policy (2019)[3]. Under these policies, establishing community-based marine resource management, building capacity and community monitoring are all key actions.

This Solomon Islands Community Marine Monitoring Toolkit has been developed to support locally managed marine areas in the Solomon Islands and provide guidance and tools for community-based marine monitoring. It includes locally appropriate monitoring methods that help to inform community decision-making and can support national management decisions. The development of this Toolkit also recognises that marine 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 Wildlife Conservation Society and international marine specialists from C_2O Pacific, with input from community members of Vurana Community in the Western Province. 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. 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.

1 https://solomons.gov.sb/si-participates-in-the-united-nations-ocean-conference/
2 https://solomonislands-data.sprep.org/dataset/solomon-islands-national-ocean-policy
3 https://www.fisheries.gov.sb/mfmr-docs/mfmr-national-fisheries-policy-2019.pdf

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 resources 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 local decision-making. Monitoring can also be used to assess if existing management actions are effective. A key benefit of the Toolkit is that it provides an early warning system that prompts communities to act (e.g. limit some fishing gear), or for communities to share results with government (e.g. national Ministry of Fisheries and Marine Resources) 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 take charge in the management of 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 a simple process for community members to be part of the process. There is an implied responsibility of community members trained to conduct monitoring to communicate regularly in their communities, particularly with local leaders and environmental committees, and across men's, women's and youth groups, to share results. To achieve this, it is recommended that community leaders are included throughout the process and that communities meet 1–2 times each year to discuss monitoring results and actions, including enforcement, that are needed to manage their marine environment.

The people of Solomon 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 Solomon Islands' coastal resources. Many marine species are subject to national harvest restrictions or bans, such as sharks, sea cucumbers, baitfish, coral, clams, giant snails[4]. Community 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.

4 https://www.fisheries.gov.sb/mfmr-docs/mfmr-national-fisheries-policy-2019.pdf

HOW TO USE THIS TOOLKIT

This Toolkit includes survey methods for monitoring local marine habitats and animals that are important to communities in the Solomon Islands 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. Invertebrate surveys
3. Coral reef surveys
4. Mangrove surveys
5. Seagrass meadow surveys

Each module is independent, and communities can select one or more module, 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 their 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 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 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 Solomon 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 Solomon Islands of isolated areas assumed to represent relatively natural populations. For Module 3, the scale for hard coral cover is based on scientific survey data from Solomon 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.

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 and then transfer these 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?

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).

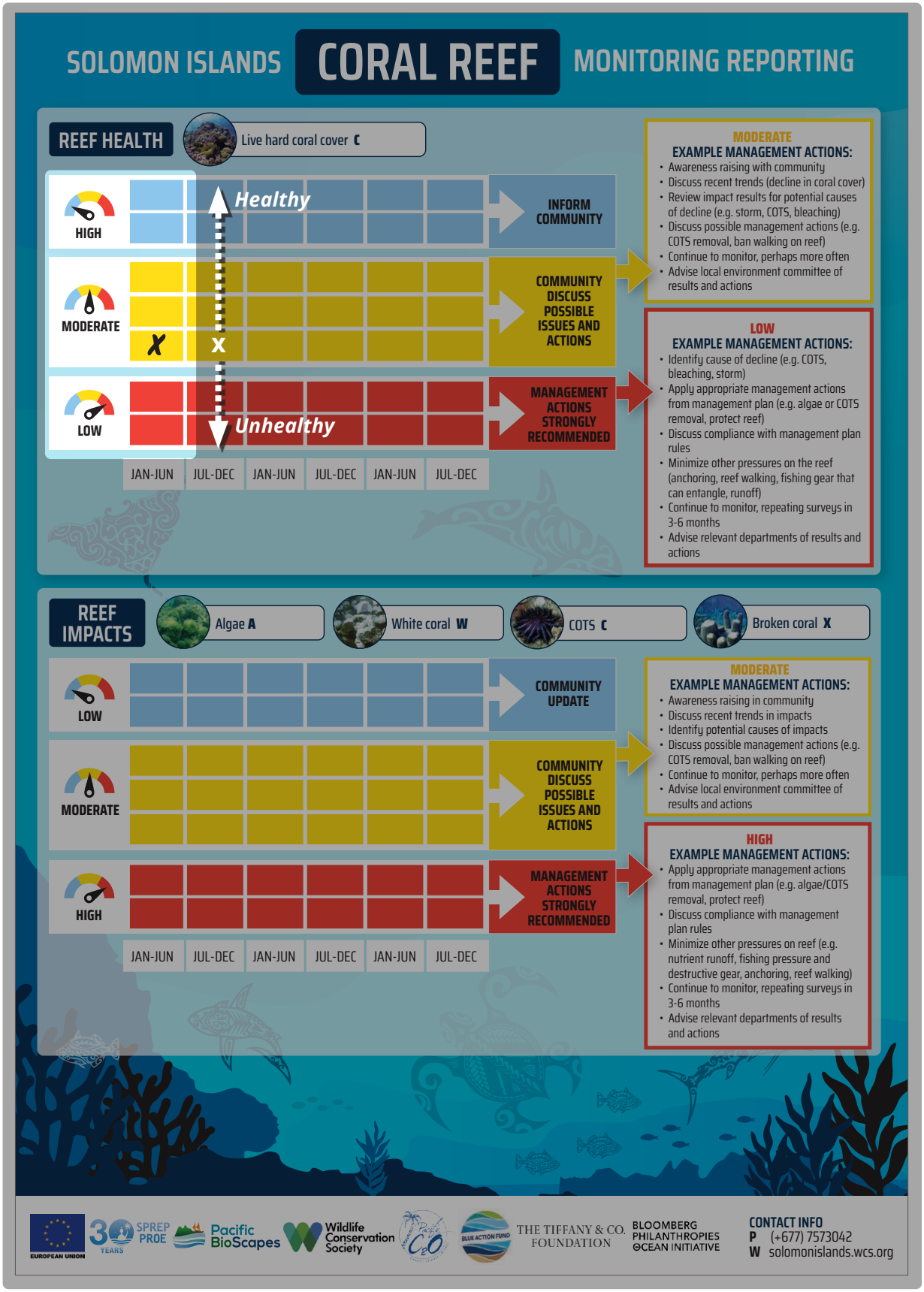


Figure 1: *Transferring survey results to the reporting posters is important for discussing results with communities and identifying relevant management responses.*

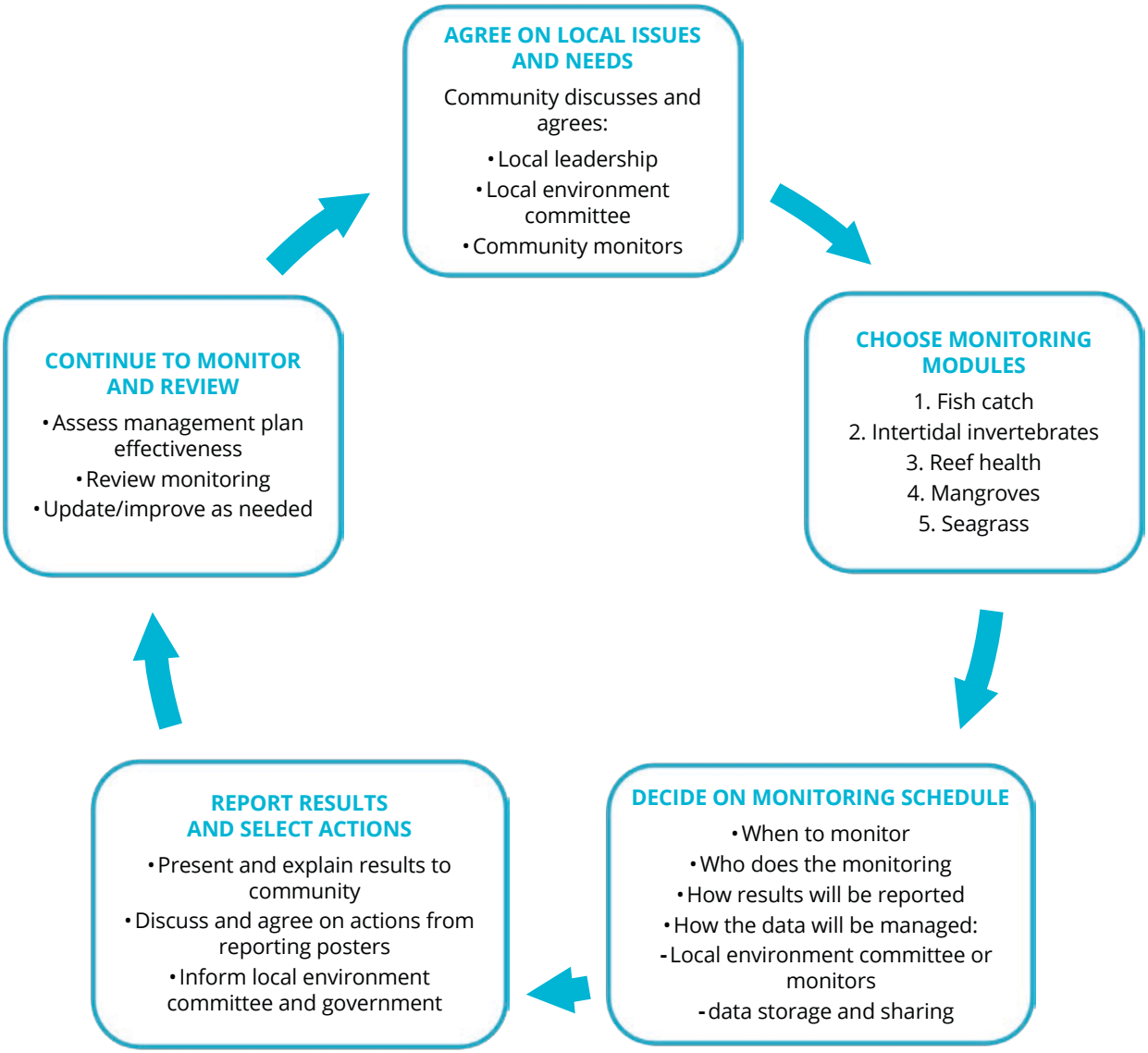


Figure 2: *Process to guide the use of the Solomon Islands Toolkit and engage communities in the process from commencement to review and improvement.*

MODULE 1:

FISH CATCH SURVEYS

PURPOSE

The purpose of the fish catch surveys for the Solomon Islands is to assess the likelihood that local fishing practices are overfishing target coastal reef fish species. Further, given the national intention to implement fish size limits under the National Fisheries Policy 2019-2029, the fish catch surveys also have the potential in the future to assess the level of compliance with these regulations once implemented. 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 grown large enough to reach 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. This is what is known as overfishing and is unsustainable. Therefore, fish need to be allowed to grow to a minimum size so they can breed before they are caught. Because different species start breeding at different sizes (known as the size at maturity; see Table A1 in Appendix 2), the recommended minimum size 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 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. Surveys also collect information about gender of fishers because men and women often target different species, use different gears and fish in different habitats. Therefore, understanding fishing by everyone in the community will help to ensure that any management rules will benefit the whole community.

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., Solomon Islands Ministry of Fisheries and Marine Resources). Further, catch rate data is most useful when used as a time series (that is, data is collected at different points in time – at least 2 years). The coastal reef species included in the fish catch surveys were identified in consultation with local experts and represent target species across all of Solomon Islands, and species may vary regionally.

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

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 (that is, less fish).

Issue 2: Too many small fish are being caught

If a part of the catch is made up of too many small fish that have not grown large enough to breed at least once, 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, reduced catches and smaller sized fish on average.

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 6-12 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** – This provides 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/location.
2. **FISHING DETAILS** – This provides 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 gears to record in the survey form include:
  - Spearguns
  - Gillnets
  - 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 ***'Other 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 belonging to the target **fish family groups** 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 beside.

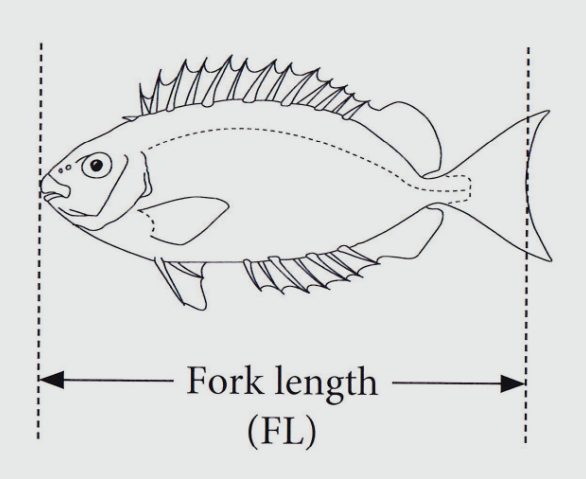
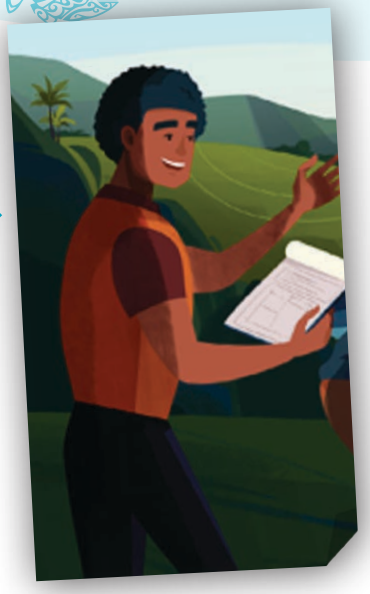


Figure 3: *Distance for measuring fork length (FL) of fish during catch surveys. Source: Moore and Colas (2016).*

Table 1: *Main target species groups (families) to be included in fish catch monitoring surveys. A full identification guide is included in the field guide.*

Fish Group	Family Name
Surgeonfish	*Acanthuridae*
Sweetlip/Grunt	*Haemulidae*
Soldierfish & Squirrelfish	*Holocentridae*
Wrasse	*Labridae*
Emperor	*Lethrinidae*
Snapper	*Lutjanidae*
Goatfish	*Mullidae*
Parrotfish	*Scaridae*
Grouper	*Serranidae*
Rabbitfish	*Siganidae*

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?

ıction: This survey aims to collect fishing catch information to better understand local fishing activity and management for sustainable fishing and to maximise community benefits. The questions ask details abo tch from your recent fishing trip, including measuring the fish you caught. The more fishers we survey, th he information will be. The survey is voluntary, and no fisher's name will be associated with results whe ted publicly. **Are you willing to participate?**

VEY DETAILS

	Fisher name (confidential):	Male / Female (ci
Munda	Survey time: John	Monitor name:
19/07/22	0615	Peter

ING DETAILS

of people fishing: 2	Time spent fishing (hours): 3.5		Day / Night (circle one)
hing method (circle one):	Speargun	Trolling	Gillnet
hook and line	Other methods (please list):		
shing method/s (circle which ones):	Speargun	Trolling	Gillnet
hook and line	Other methods (please list):		
used, what was the mesh size:			

CH DETAILS

pecies group		Fish sizes – fork length (centimetres)
ne	Common name	(if not all individual fish are measured write ~ next to the species group name)
	Surgeonfish	34 32 42 33 28 34
	Sweetlip/Grunt	16
	Soldierfish / Squirrelfish	
	Wrasse	23 21 27 29 22 19 29 23 33 27 32 31 26 22 18 17 28
	Emperor	26 28 25 27 25
	Snapper	
	Goatfish	14 24 19 27
	Parrotfish	22 17 21 25 27 26 24 29 26

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. The critical size estimated for each family group approximates the size at maturity for the most (2-3 species) commonly caught species in the Solomon Islands for each family group. This is based on scientific size at maturity studies which provide information on the size that each species become mature and can begin to breed. While a 'composite' estimate of size at maturity at the family level is not as accurate as species level information, it provides a compromise that facilitates community-level monitoring (see critical size derivation in Table A1, Appendix 2).

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

CONVERTING DATA INTO RESULTS

There is a fully automated Excel spreadsheet and database that can be adapted for Solomon Islands and provided 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 a relevant agency (e.g., government or NGO) that enters and stores data on behalf of communities. In acknowledging that reliable access to computers in communities is not always possible, we have also 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 group. The key indicator used to assess local fishing practices is the percentage (or proportion) of individual fish in each target species group captured that are larger than the critical size. This indicator acts as a proxy of whether overfishing is likely to be occurring on the particular group of species. 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 6-12 month survey period separately – make sure to follow the recommended number of surveys (at least 10 per 6-month period). Do one species group at a time and include data from **ALL** the surveys for the survey period being assessed.

For each species:

1. Count the number of individual fish caught that are larger than (or the same as) the critical size shown for that species group. Write this number in the box labelled **A** shown on the Catch Survey Analysis Sheet;
2. Count the total number of fish caught of that species group. Write this number down in the box labelled **B** shown on the sheet;
3. Use a calculator or your phone to divide the number in **A** by the number in **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 Parrotfish in total are caught, and 10 are larger than 25 cm (the critical size for parrotfish), then we calculate 10/30 = 0.33. Multiply by 100: 0.33 x 100 = 33 %. That is, 33 % of the catch of Parrotfish for the survey period is greater than the critical size. Write this down in the box labelled **C** shown on the sheet;
4. Using the percentage ranges in the column labelled "%" circle the appropriate **Status** in the final column.
5. 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 critical size for each species group for each survey period; recommend using 10-20 surveys per survey period (~6 monthly).

FISH SPECIES GROUP	CRITICAL SIZE (cm)	TOTAL NUMBER OF FISH			%	STATUS
		Larger or equal to the critical size	Caught	% larger than the size limit		
		A	B	C = (A/B) X 100		
Surgeonfish	20	𝍸 = 3	𝍸 𝍸 = 12	= (3/12) x 100 = 25%	0-80	Overfished
					81-95	Declining
					>95	☺
Sweetlip/Grunt	40	I = 1	𝍸 I = 6	=(1/6) x 100 = 17%	0-80	Overfished
					81-95	Declining
					>95	☺
Soldierfish / Squirrelfish	20		I = 1	=(0/1) x 100 = 0%	0-80	Overfished
					81-95	Declining
					>95	☺
Wrasse	25				0-80	Overfished
					81-95	Declining
					>95	☺
Emperor	25	𝍸 III = 8	𝍸 𝍸 III = 13	=(8/13) x 100 = 62%	0-80	Overfished
					81-95	Declining
					>95	☺
Snapper	20	III = 3	𝍸 = 4	(1/4) x 100 = 25%	0-80	Overfished
					81-95	Declining
					>95	☺
Goatfish	25	𝍸 = 5	𝍸 = 5	(5/5) x 100 = 100%	0-80	Overfished
					81-95	Declining
					>95	☺
Parrotfish	25				0-80	Overfished
					81-95	Declining
					>95	☺
Grouper	25		𝍸 = 4	=(0/4) x 100 = 0%	0-80	Overfished
					81-95	Declining
					>95	☺
Rabbitfish	20	𝍸 III = 8	𝍸 𝍸 = 9	=(8/9) x 100 = 89%	0-80	Overfished
					81-95	Declining
					>95	☺

DATA REPORTING

It is important to include the whole community in reporting information about monitoring, the results of monitoring, and decisions about managing local coastal resources. A useful approach is to also consult community views while in the process of making management decisions. 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 of the species groups monitored to be readily transferred from the Data Analysis sheet and provide an easy-to-understand visual display of the survey results. The poster allows for up to three years of reporting in 6-monthly time periods, or longer. 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 letter coded for each species group 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. Also, the Data Reporting poster is designed to allow results for all the species groups monitored to be presented together.

All monitoring results, even those showing species groups to be in 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; for example, a copy of the poster can be put on a community noticeboard. A copy of the Data Reporting poster is 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 coloured zones where the indicator from the survey results is plotted as a proxy to indicate the likely status of target fish groups under current fishing practices, and to inform the types of management actions that can be taken that may mitigate problems where the results indicate.

Different status levels given on the Data reporting poster for species group are:

- The target is for the indicator to be above 95% (ideally the target level is 100%) to ensure that very few juvenile (small) fish are caught which suggest that the population for that species group is likely to be healthy (***blue zone***).
- If the indicator is in the ***yellow zone*** (declining; 81-95%), this is a sign that the species group is likely to be declining, and it is recommended that management actions are considered by the community.
- If the indicator is in the ***red zone*** (stocks overfished; 0-80%), this is a sign that the species group is likely to be overfished and immediate action is strongly recommended, and a range of potential, and appropriate, management actions are provided.

Where possible, it is strongly encouraged that the management options provided in the Data Reporting poster are considered by the community before monitoring commences.

SOLOMON ISLANDS FISH CATCH MONITORING REPORTING

FISH SPECIES GROUPS

 Emperor **E**

 Goatfish **G**

 Grouper **GR**

 Parrotfish **P**

 Rabbitfish **R**

95 - 100%

INFORM COMMUNITY

90 - 95%

COMMUNITY DISCUSS POSSIBLE ISSUES AND ACTIONS

80%

60%

40%

20%

MANAGEMENT ACTIONS STRONGLY RECOMMENDED

JAN-JUN | JUL-DEC | JAN-JUN | JUL-DEC | JAN-JUN | JUL-DEC

DECLINING
EXAMPLE MANAGEMENT ACTIONS:
consider management options listed below

OVERFISHED
EXAMPLE MANAGEMENT ACTIONS:

- Ban harvest of fish smaller than the critical size relevant to the species group (introduce a size limit)
- Ban the use of small-mesh gillnets (minimum mesh size should avoid catching fish smaller than the critical size relevant to the species group)
- Introduce a temporary/permanent ban of harvest in some areas or times (e.g. known spawning times)
- Ban spearfishing at night
- Ensure tabu areas are effective: closed, respected, large enough (seek technical advice)

FISH SPECIES GROUPS

 Snapper **SN**

 Surgeonfish **S**

 Sweetlip **SW**

 Soldierfish/Squirrelfish **SQ**

 Wrasse **W**

95 - 100%

INFORM COMMUNITY

90 - 95%

COMMUNITY DISCUSS POSSIBLE ISSUES AND ACTIONS

80%

60%

40%

20%

MANAGEMENT ACTIONS STRONGLY RECOMMENDED

JAN-JUN | JUL-DEC | JAN-JUN | JUL-DEC | JAN-JUN | JUL-DEC

DECLINING
EXAMPLE MANAGEMENT ACTIONS:
consider management options listed below

OVERFISHED
EXAMPLE MANAGEMENT ACTIONS:

- Ban harvest of fish smaller than the critical size relevant to the species group (introduce a size limit)
- Ban the use of small-mesh gillnets (minimum mesh size should avoid catching fish smaller than the critical size relevant to the species group)
- Introduce a temporary/permanent ban of harvest in some areas or times (e.g. known spawning times)
- Ban spearfishing at night
- Ensure tabu areas are effective: closed, respected, large enough (seek technical advice)

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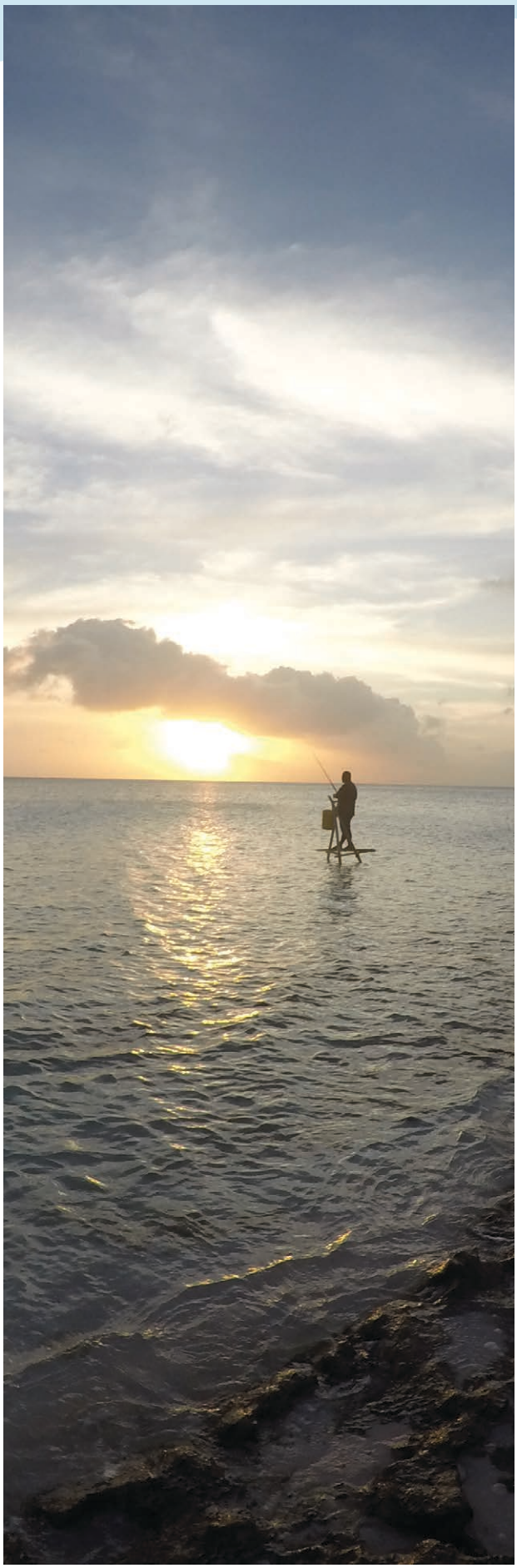
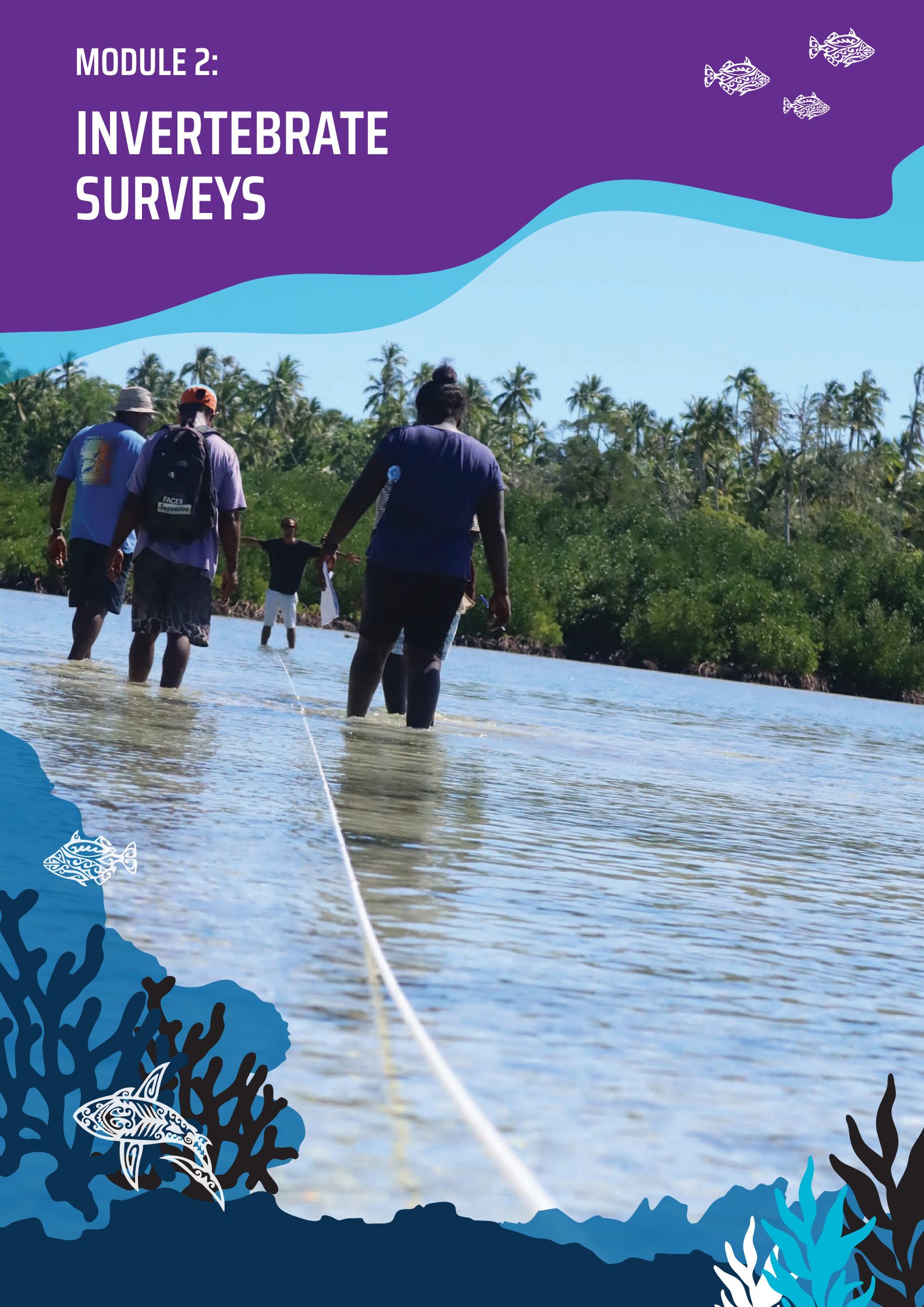


MODULE 2:

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 invertebrate surveys for Solomon Islands is to enable communities to assess whether locally important invertebrates are in a healthy or unhealthy condition, thereby providing a strong basis to take action if necessary. The survey method also provides choices of valid and proven management actions depending on the health of the surveyed populations.

This module focuses on counting the number of selected invertebrate species and provides two different survey methods depending on the species of interest. Some species are found mainly in intertidal reef flat areas, where it is safer and more feasible for communities to access (Intertidal method), while other important species are found mainly on reef slope areas and require snorkelling equipment for surveys (Reef slope method). The key indicator used is the **average density** (number per area) of each species, which is a useful measure of population health since invertebrates need to be close to one another for successful breeding, as they can't move very far (or at all). Thresholds for inferring the level of health (overfished, declining or healthy or sustainable) of the target species are derived from a review published scientific surveys conducted for the relevant species, locally and/or in the Pacific, and from local data provided by the local monitoring toolkit development team (see Appendix 3).

Invertebrate surveys can be done to assess the status of populations in a community area, or to assess the effectiveness of marine protected areas (tambu) by conducting surveys inside and outside fished and unfished areas. 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.

SURVEY METHOD

There are two methods provided to survey invertebrate species, each targeting different species based on their preferred habitats. The methods are I) the **Intertidal method**, and II) the **Reef slope method**. The common approach for both methods is that two separate areas, or sites, are chosen, and several transects, or survey lines, are conducted within each site following a standard protocol. When monitoring animal populations there can be very high levels of variability in numbers from one area to another. If only one of these areas is surveyed, then the data collected may be inaccurate and not representative of the real situation. To reduce this variability and increase the accuracy of the data collection during surveys, each time a survey is conducted data are collected from two sites and up to 4 transects within each site.

The major differences between the two survey methods are the species counted, the areas surveyed, and equipment required. Otherwise, the methods are almost identical, including the basic materials required to conduct surveys, site selection, transects, data analysis and reporting back to communities.

Basic Materials:

Regardless of the method used you will need:

- Field survey sheet
- Slate (or similar)
- Pencil
- Mask and snorkel (if the intertidal site is under water, or doing the Reef slope method)
- Calculator, e.g., on a phone (for data analysis)

Site selection: Sites are simply different survey areas in the same region of interest, preferably separated by a distance of at least 50 m. This may vary depending on your location. Select two sites where you would expect to see the invertebrate species being monitored: for the Intertidal method, preferably an area with some hard substrate areas mixed with sand patches, and to survey sand fish focus on soft, muddy bottom areas; for the Reef slope method, choose typical reef slopes for your region. Sites need to be large enough to be able to conduct 3-4 transect lines that are 50 m in length and choosing survey sites that are easy to access in most conditions makes it safer and simpler to resurvey the same sites in the future.

Transects: Within each site four transects (or 3 if the area isn't big enough) are chosen randomly with at least 10 metres between each transect (see site images for each method below). A transect is a straight line chosen in the survey site, that is 50 metres long and 2 metres wide (i.e., 1m either side of the middle line; Figure 4). Measure out the 50 metres using a measuring tape or a piece of rope marked at 50 metres.

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

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

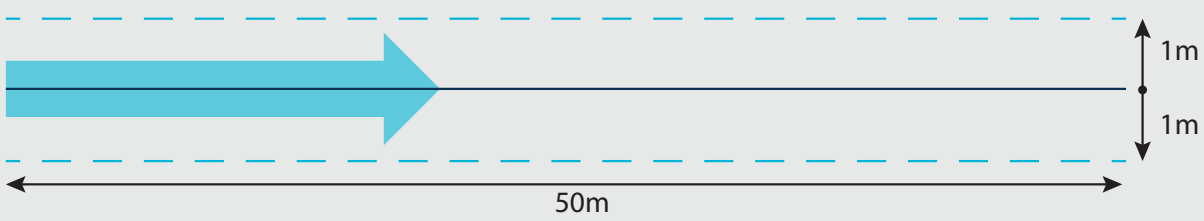


Figure 4: *Representation of a typical transect showing the area that invertebrates are counted in.*

Data collection: Data collected during the surveys should be recorded using the relevant invertebrate survey sheet (see Field Guide). Using a pencil, count and record the number of each target species while walking or swimming the transect line, by marking it on the survey sheet (see example survey sheet below; Figure 7). Each survey sheet contains space for recording data for up to four transects in each of the two chosen sites. If you are snorkelling to conduct the survey, you will need to use something that can be marked to count the target species while in the water. While waterproof paper and slates may not be readily available, using a section of the main stalk of a palm leaf with a sharp object (e.g., a nail) has been proven to work well in communities.

Number of monitors: Invertebrate surveys are best done by a minimum of 2 people to help with the counts, particularly the Reef slope method, to assist in laying down the transect line and because it is safer and more accurate.

CONDUCTING THE SURVEY

INTERTIDAL SURVEY METHOD

Target species: The target species chosen for the Intertidal method were based on feedback from the Solomon Islands Toolkit development team and includes giant clam species and sea cucumber species (see below).

Site selection: Choose an area as the first site where you would expect to see the invertebrate species being monitored, preferably with some hard substrate areas mixed with sand patches (not all sand). Also, choose a survey site that is easy to access in most tides. Select the starting point of the first transect path. The transect line can be walked if the site is exposed or in very shallow water, or it can be surveyed using mask and snorkel if the water depth is too deep to walk. As you walk/snorkel the 50 metre transect (approximately 70-80 paces), count and write down on the survey sheet the number of each of the monitored species types that you see in an area that is 1 metre either side of the line (approximately one arm length each side; see Figure 4). Within each site you should aim to conduct 4 transects, or if there isn't enough area, three transects (Figure 5).

Frequency: Survey once every 6-12 months, as these species are slow growing, and populations are unlikely to change in shorter timeframes.

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

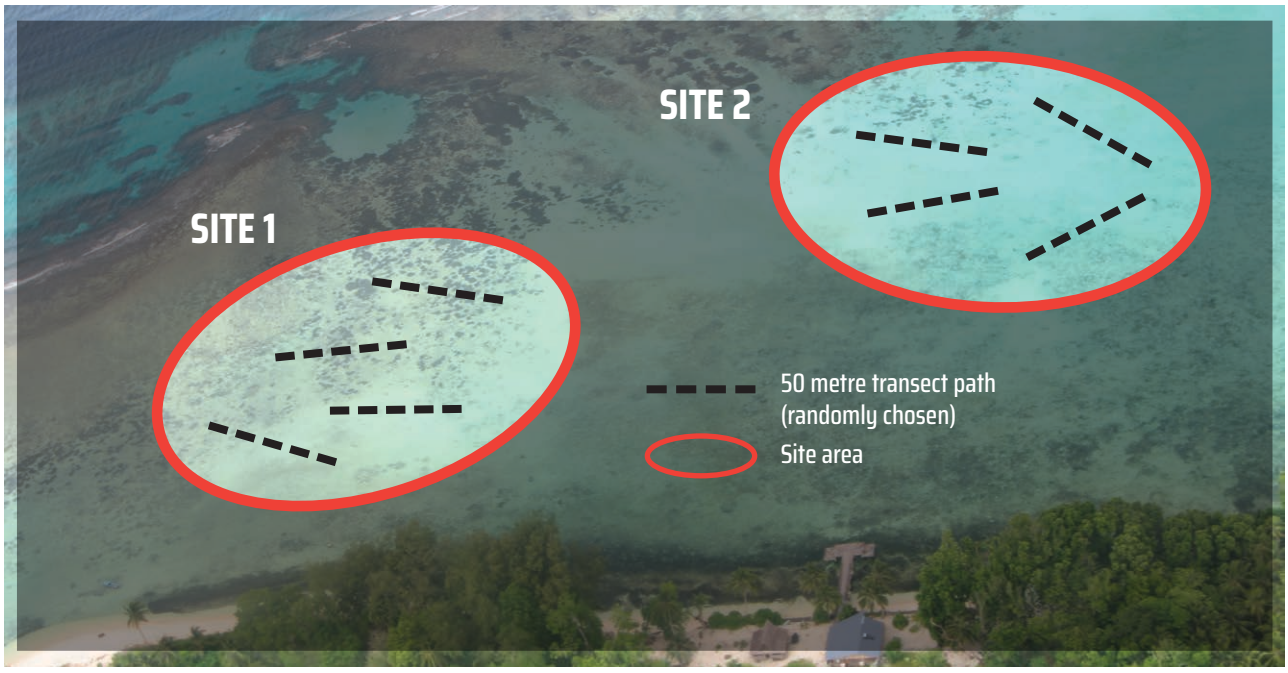


Figure 5. *Example of suitable invertebrate survey sites and transects for the intertidal method.*

REEF SLOPE SURVEY METHOD

Target species: The target species chosen for the reef slope method were based on feedback from Solomon Islands development team and includes trochus shells and giant clams.

Site selection: When choosing areas as survey sites on the reef slope and crest you need to pay particular attention to areas that are accessible and safe as these areas may be exposed to wave action, as well as where you would expect to see the invertebrate species being monitored. For this method transects are best done running approximately parallel to the reef crest to ensure water depth doesn't get too deep, and similar habitat is consistently surveyed (Figure 6). This is particularly important for surveying trochus since they have been shown to preferentially occupy depths less than approximately 8 m. The transect should try and include portions of the reef crest area itself. The transect line will need to be surveyed using mask and snorkel, with target species counted and recorded one metre either side of the line until you reach the end of the 50 m line. Within each site you should aim to conduct 4 transects, or if there isn't enough area, three transects (Figure 6). A safe and efficient way to conduct these surveys is for one person to lay out the tape or rope to measure out the 50 m line, while the second person conducts the survey counts.

Frequency: Once every 6-12 months, as these species are slow growing, and populations are unlikely to change in shorter timeframes.

Time: Approximately 15-20 minutes per transect. Total of 60-80 minutes for each site.

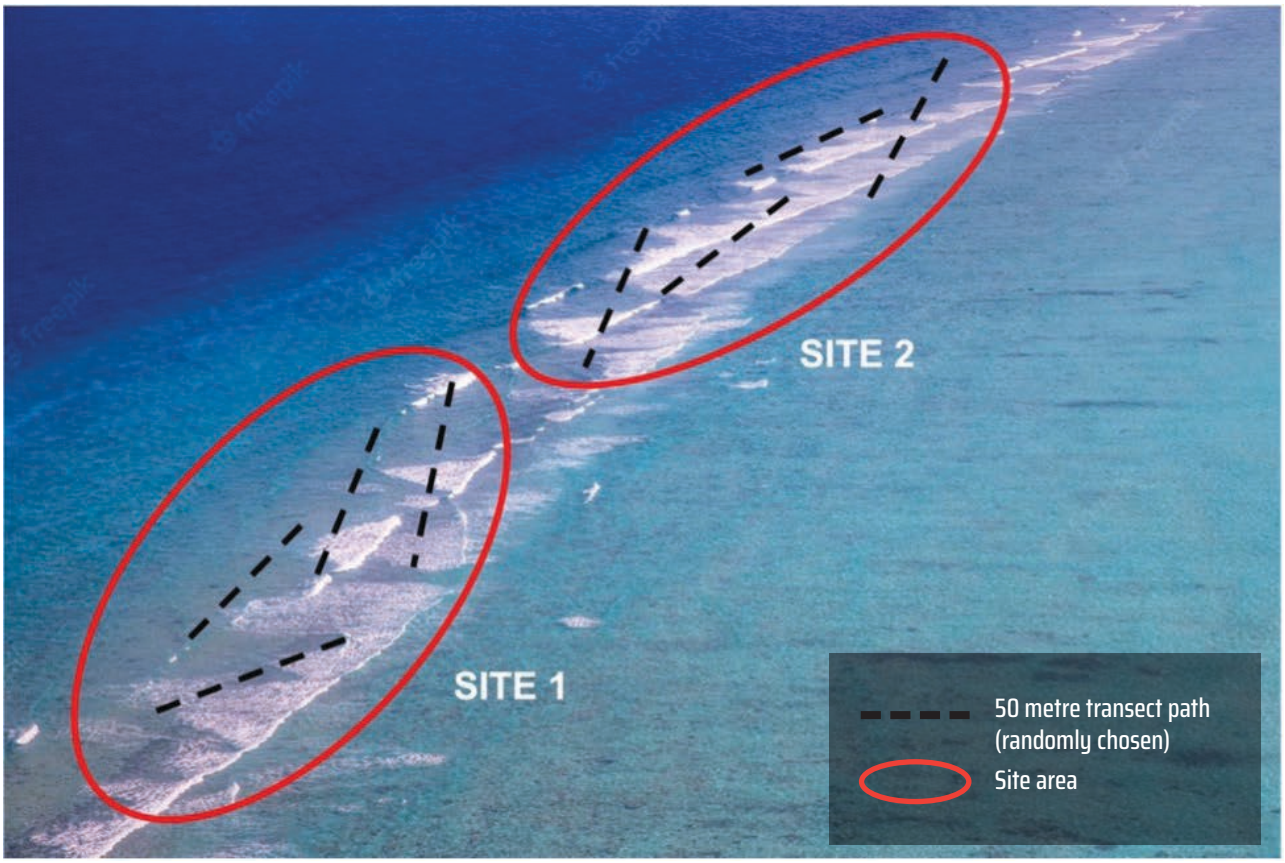


Figure 6. *Example of suitable invertebrate survey sites and transects for the reef slope method.*

INVERTEBRATE SPECIES IDENTIFICATION:

Giant clams

Tridacna clam species

Hippopus clam species

Sea cucumbers

Greenfish, ***Stichopus chloronotus***

Sandfish, ***Holothuria scabra***

Pinkfish, ***Holothuria edulis***

Lollyfish, ***Holothuria atra***

Flowerfish, ***Holothuria edulis***

Cowrie shells

Trochus, ***Trochus spp.***

EXAMPLE INVERTEBRATE SURVEY

INVERTEBRATE SURVEY SHEET (PAGE 1 OF 2)

SURVEY TYPE (CIRCLE ONE):	INTERTIDAL	REEF SLOPE

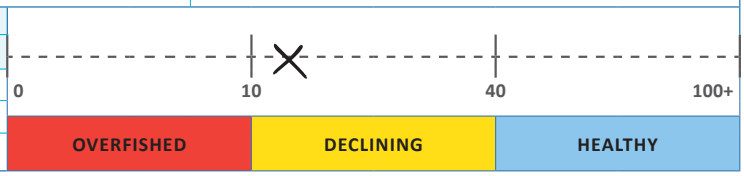
SITE DESCRIPTION

Monitor names: Alec, Romalynn			Village : Munda			2:30pm
Site #1 name: West		Date : 28/07/22		Method (circle one)	Reef Walk	Swim
Main habitat site #1 (circle on or more)	Seagrass	Sand	Hard substrate	Algae	Other:	
Site #2 name: East		Date : 28/07/22		Method (circle one)	Reef Walk	Swim
Main habitat site #2 (circle on or more)	Seagrass	Sand	Hard substrate	Algae	Other:	

GIANT CLAM SPECIES

	SITE 1	SITE 2
T1	17	4
T2	12	7
T3	11	2
T4	14	16

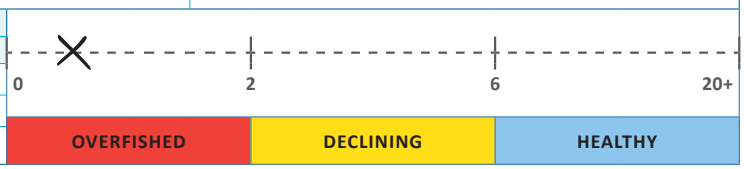
	Total number counted				
	T1	T2	T3	T4	Average
Site 1	27	17	11	14	17.25
Site 2	4	7	2	16	7.25
Overall average					12.5



PINKFISH

	SITE 1	SITE 2
T1		1
T2		
T3	1	
T4		2

	Total number counted				
	T1	T2	T3	T4	Average
Site 1	0	0	1	0	0.25
Site 2	1	0	0	2	0.75
Overall average					0.5



GREENFISH

	SITE 1	SITE 2
T1		
T2		
T3		
T4		

	Total number counted				
	T1	T2	T3	T4	Average
Site 1					
Site 2					
Overall average					

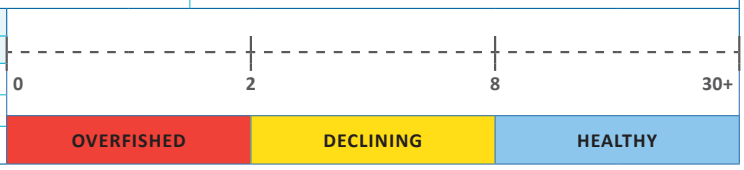


Figure 7. *Example intertidal survey form for giant clam species (above) and sandfish (below) including example calculations of the average number counted per transect (density) with the overall average plotted on the health scale for each.*

DATA ANALYSIS

Once all transects are completed at each site, the invertebrate health indicator is calculated to assess the status of each species population. This is calculated as the average of all the transect counts. This can be done using a calculator on a phone, by adding together the counts for all transects and dividing by the number of transects conducted (Figure 8). For assessing the population health If you are monitoring to assess the effectiveness of a locally managed tambu area, sites can be selected inside and outside the tambu area and the health indicator for each site compared. If your sites are both in a fished area, then data from both sites are combined to provide the final health indicator value. This is done simply by taking an average of the health indicator from each site:

$$\textit{Final health indicator value} = \frac{\textit{(Site 1 average + Site 2 average)}}{2}$$

The indicator values provide an estimate of the density of each species, which is then plotted directly onto the health scale on the survey sheet as an estimate of the status of the population (see Figures 7 and 8).

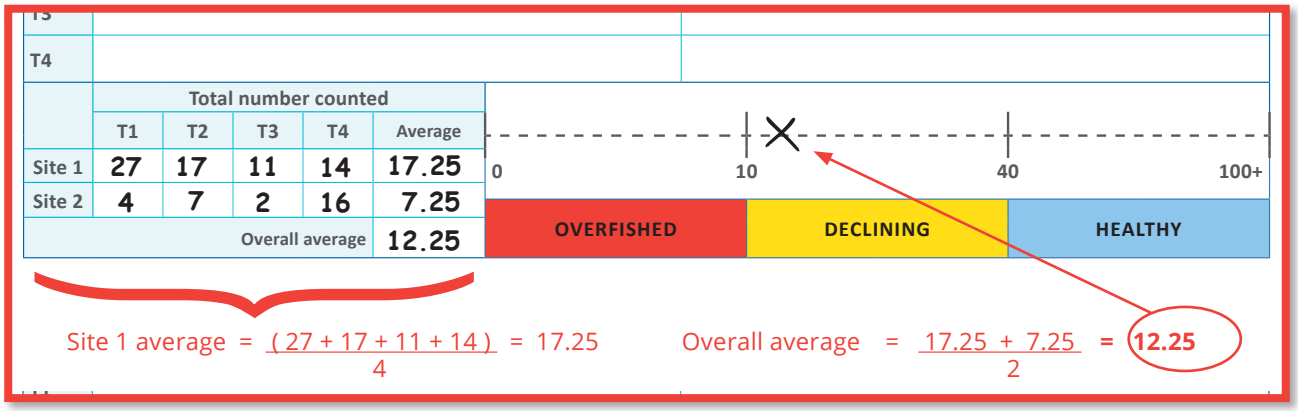


Figure 8. *Details of the data analysis calculations using the example data for giant clam shown in Figure 7.*

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 period (recommend 6-12 monthly) that the survey was conducted. For example, from the example survey sheet with example data for Giant clam and Sandfish shown in Figure 7, the results from the stock health scale is transferred to the Data Reporting poster using the species codes shown at the top of the poster. For example, the status for Sandfish was shown to be 'declining', and just above 'overfished' status, while Giant clams were assessed as 'overfished'. How these results are marked down on the Data Reporting poster is shown in Figure 9 (below). Depending on the zone (status) on the Data Reporting poster, different recommended actions are provided including a range of management options for declining or overfished stocks (see below and Figure 9). Survey results for each individual species can be presented on a single poster or individual Data Reporting posters. Community monitors or a nominated village representative should keep all reporting posters as a long-term record of surveys. Data Reporting posters are provided in the Invertebrate module field guide.

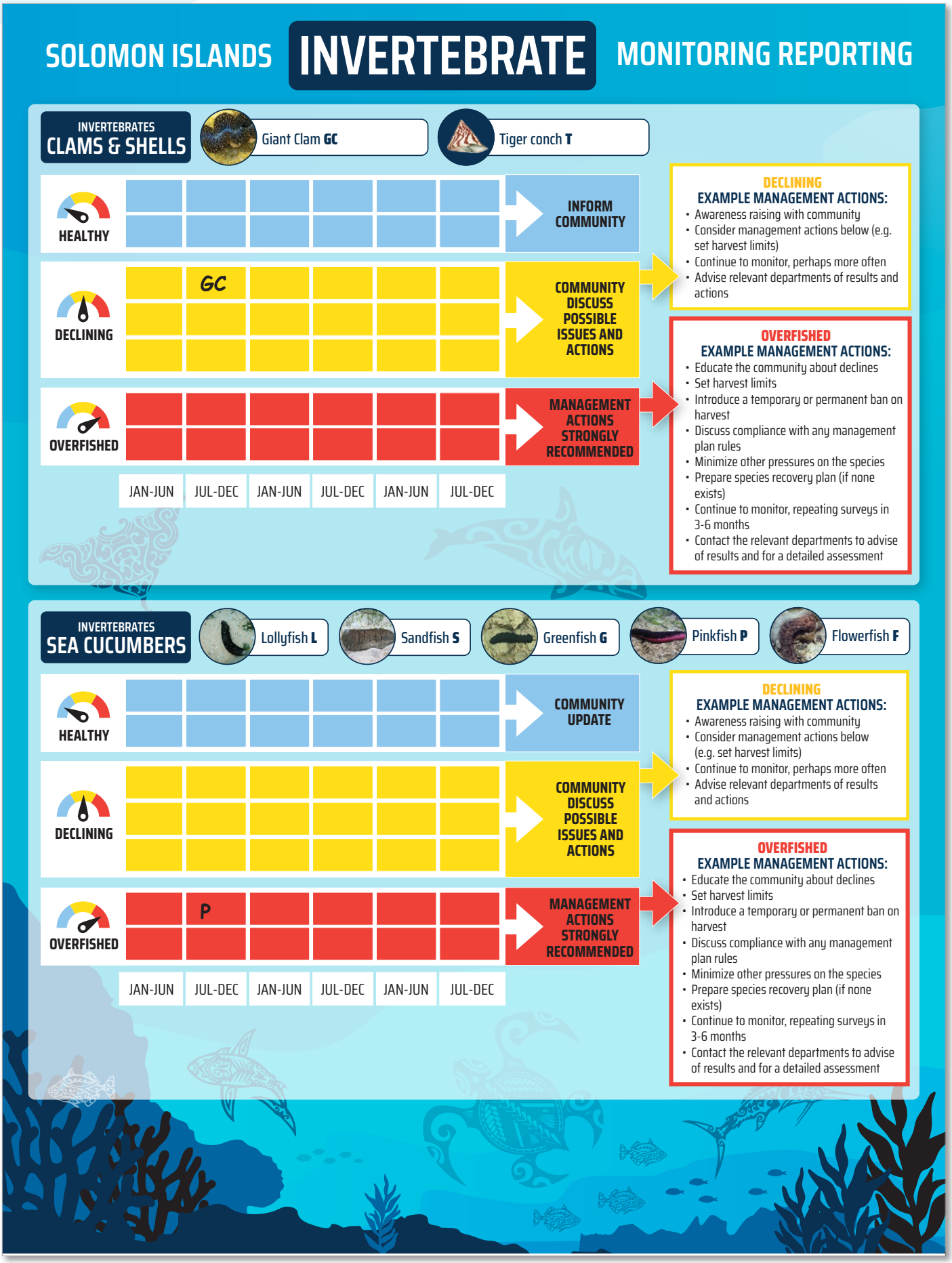


Figure 9. *Example completed Data Reporting poster showing results from example data given in Figure 7 for giant clams and pinkfish, denoted by the codes GC and P respectively. The colour coded zones that the data results fall into provide different levels and choices of recommended actions.*

MANAGEMENT OPTIONS:

The monitoring is designed so that results from surveys can inform immediate management decisions based on the survey results. The colour of the zone where the indicator from the survey results is plotted, informs of 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 status.
- Results in the ***yellow zone*** (declining) indicate that populations for the species are likely to be declining. Monitors should have a community meeting with local leaders and community to discuss the results, possible reasons for the results, and possible actions. Example management actions include: community awareness raising (such as information on notice boards), discussion with the national fisheries department 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*** (overfished) indicate that the population for the particular species is likely to be overfished and should follow the recommendations for the yellow zone, as well as 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 invertebrate surveys, data reporting sheets and species identification.

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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. Solomon Islands has over 490 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 cyclones and storms, eco-tourism opportunities, and resilience to climate change and other impacts. Coral reefs are under pressure from land-based pollution, direct damage from reef walking and boat anchoring, storms, and climate change that is changing ocean temperatures and chemistry.

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
- Mask and snorkel (fins are optional)
- 100 m rope (optional)
- Field survey sheet and pencil
- Guide for estimating benthic cover (see Field Guide)

Time: 10 minute timed-swim per site or use a 100 m rope or transect tape to mark the transect line. Total of 20 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 (see Figure 10), but not necessarily the healthiest. Survey 2 random sites in the local area. If the aim of monitoring is to determine whether the MPA is meeting community objectives, choose one site inside the MPA and one outside the MPA.

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.

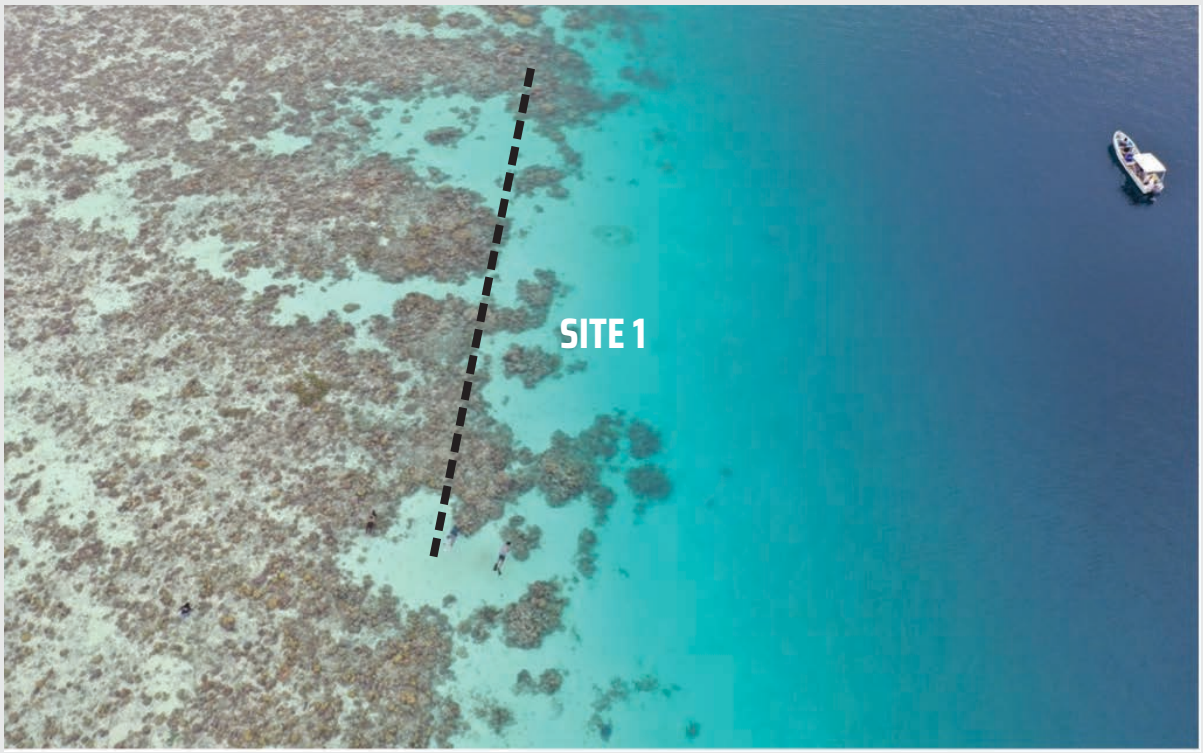


Figure 10: *Different types of coral reefs are found in Solomon Islands, such as reef flats and reef slopes shown here with example transect line for monitors to conduct the survey (Source: Alec Hughes).*

Choose sites less than 8 m deep so the reef can be seen clearly when snorkelling at the surface. All sites should be similar depth and habitat type (e.g. fringing reef) and should be about 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 discussion afterwards. If more monitors are available, then more can conduct the survey at the same time. More monitors provide more observations to improve accuracy of survey results.

Knowing your coral reefs

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

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 10-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 colourful (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 can move and are often seen to 'sway' in the water or appear like fans, whips or trees. 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 Solomon Islands that documented hard coral cover of 40–60% in 2003/04 (Lovell et al. 2004) and 29.4–47.5% in 2006 (Turak 2006), and regional Pacific coral cover of 21–26% (Moritz et al. 2018). For healthy reef ecosystem services, live coral cover close to 30% or more is recommended and fish biomass has been shown to decline considerably at sites with live coral cover below 25% (McClanahan et al. 2011).

Low live hard coral cover	0-10%	**Low**
Moderate live hard coral cover	11-30%	**Moderate**
High live hard coral cover	>30%	**High**

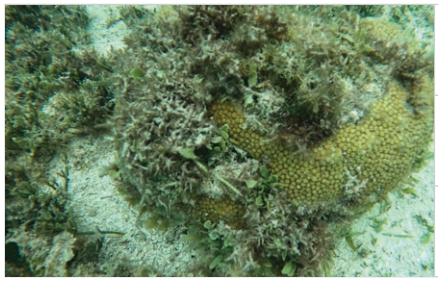
REEF IMPACT INDICATORS

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. Macroalgae cover – Macroalgae (fleshy 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. Macroalgae is different from turf algae, that is a fine algae that grows only 1-2 cm high. Turf algae are not recorded. When macroalgae overgrow live hard coral, it blocks sunlight and makes it hard for the coral to grow. When macroalgae cover bare rock, new corals can't settle.

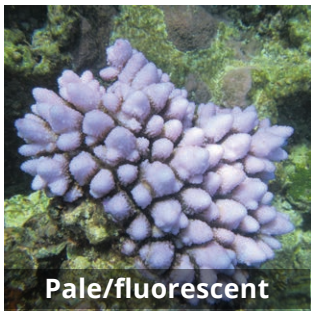
A healthy reef has only a small percentage of macroalgae, much less than the amount of live coral. An unhealthy reef has a lot of macroalgae often growing over the coral, in between coral and on bare rock.

Monitors need to estimate the percentage of area covered in macroalgae and mark it on the scale (see table below). The scale is based on scientific monitoring results from sites around the Solomon Islands that documented macroalgae cover of less than 10% in surveys conducted between 2003 and 2006 (Lovell et al. 2004, Turak 2006), and region Pacific algae cover of 10% (Moritz et al. 2018).



Low macroalgae cover	0–10%	**Low**
Moderate macroalgae cover	11–25%	**Moderate**
High macroalgae cover	>25%	**High**

3. White coral – Corals turn white as a stress response when exposed to above-average water temperature, below-average water temperature, disease, predation, or freshwater. The coral loses its colour 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 white or 'bleached' coral is especially important during periods of stress (e.g. during hot summers or cold winters, or after heavy rainfall).


Pale/fluorescent


Heat stress

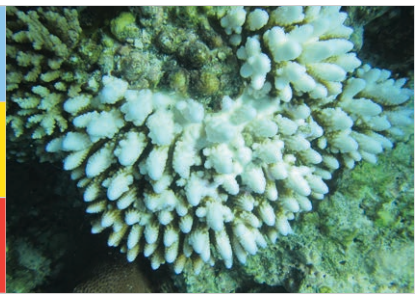

Disease


Predation (snails)

Importantly, bleached corals are not dead and can recover when the stress conditions end. However, bleached corals do represent a stressed reef, and recovery will benefit from immediate management actions that reduce any 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 white coral, 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 (m2). Monitors need to estimate the percentage of coral area that is white and mark it on the scale (see table below).

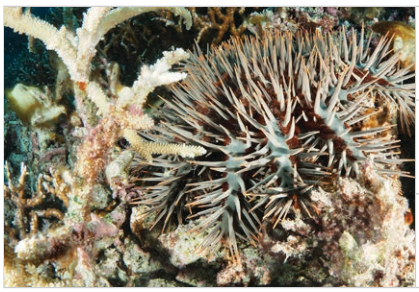
Low white coral cover	0-10%	**Low**
Moderate white coral cover	11–25%	**Moderate**
High white coral cover	>25%	**High**



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, which appear white (see photos below). If lots of white coral has been recorded in indicator #3, then monitors should look for COTS.

Monitors need to count the number of COTS seen during each 10-minute survey and mark it on the scale (see table below).



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

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 cyclones, 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/cyclone, 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%	**Low**
Moderate coral damaged	11–25%	**Moderate**
High coral damaged	>25%	**High**

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 take 1–5 years, plastic bags take 10–20 years, aluminium cans take 80 years and plastic bottles take at least 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 (none, some, lots) 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 (no more than 2 m apart), so that you all survey the same site and for safety. Monitors can swim side-by-side or in a line.

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 discussion when a single field survey sheet is filled in for each site.

EXAMPLE CORAL REEF SURVEY

CORAL REEF SURVEY SHEET

SITE DESCRIPTION (ONE FORM PER SITE)		
Who	Monitor names: Emma, Lyla, Phillipe	
Where	Village: Fulo	Site: Stony Pass
When	Date: 10 Jan 2023	Time: 10:20 am
Conditions	Weather: calm, clear, 28°C (sea temp)	Tide: ebbing
Habitat (circle one or more)	Reef lagoon	Reef front
	(Reef flat)	Reef slope

WHAT DID YOU SEE?

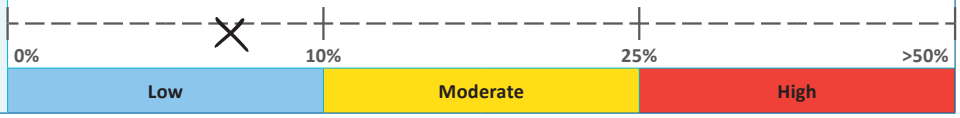
1. Hard coral cover

Comments:

WHAT IMPACTS DID YOU SEE?

1. Algae Cover

Comments:



2. White Coral

Comments:

3. Crown-of-thorn starfish (COTS)

Comments:
1 seen by 1 monitor only

4. Broken coral:

Comments (note type of damage):

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 for each site.

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 field 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. There will be 2 survey sheets completed – one for each site – so a letter or shape can be used to show the different results on the data reporting poster.

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 colour 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.

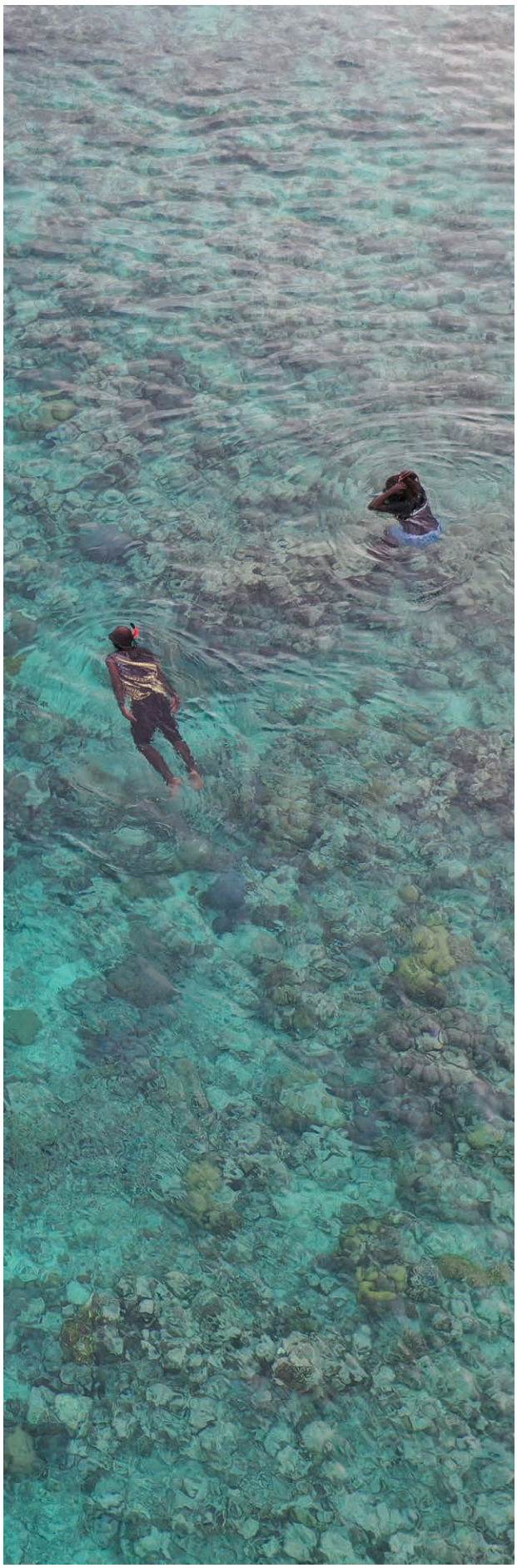
The reef impact indicators are marked on the same reporting poster. Since coral reefs are complex, it is important to consider the different reef impact indicators together to identify any concerning issues early. Even if your reef is in a healthy state, there may be one or more impact indicators that 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.



SOLOMON ISLANDS CORAL REEF MONITORING REPORTING

REEF HEALTH

Live hard coral cover **C**

HIGH	JAN-JUN, JUL-DEC, JAN-JUN, JUL-DEC, JAN-JUN, JUL-DEC	INFORM COMMUNITY
MODERATE	JAN-JUN, JUL-DEC, JAN-JUN, JUL-DEC, JAN-JUN, JUL-DEC	COMMUNITY DISCUSS POSSIBLE ISSUES AND ACTIONS
LOW	JAN-JUN, JUL-DEC, JAN-JUN, JUL-DEC, JAN-JUN, JUL-DEC	MANAGEMENT ACTIONS STRONGLY RECOMMENDED

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 local environment committee 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 relevant departments of results and actions

REEF IMPACTS

Algae **A**

White coral **W**

COTS **C**

Broken coral **X**

LOW	JAN-JUN, JUL-DEC, JAN-JUN, JUL-DEC, JAN-JUN, JUL-DEC	COMMUNITY UPDATE
MODERATE	JAN-JUN, JUL-DEC, JAN-JUN, JUL-DEC, JAN-JUN, JUL-DEC	COMMUNITY DISCUSS POSSIBLE ISSUES AND ACTIONS
HIGH	JAN-JUN, JUL-DEC, JAN-JUN, JUL-DEC, JAN-JUN, JUL-DEC	MANAGEMENT ACTIONS STRONGLY RECOMMENDED

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 local environment committee 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 relevant departments of results and actions

EUROPEAN UNION
30 YEARS SPREP PROE
Pacific BioScapes
Wildlife Conservation Society
C2O
BLUE ACTION FUND
THE TIFFANY & CO. FOUNDATION
BLOOMBERG PHILANTHROPIES OCEAN INITIATIVE

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MODULE 3 REFERENCES

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MODULE 4:

MANGROVE SURVEYS

Mangroves are tidal marine plants immersed at high tide. 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, cyclones 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.

Solomon Islands have an estimated 470 km^2 of mangrove forests (2% of total land area), with 20 species and 2 hybrid species of mangroves documented (Ellison 2009). The common species are shown below (with Rhizophora stylosa being the most common and widely distributed), 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 at least one permanent marked site in your community area, with 3 replicate quadrats 5 m x 5 m at least 50 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 seaward (close to the sea) (C) (Figure 11), if possible. If the mangrove forest is small or narrow, then replicate quadrats can be closer together or all near the land or sea.

Make sure to mark or identify the 3 replicate quadrats in some way (e.g. tying a cloth around a tree) to help find them for each survey, and compare results.

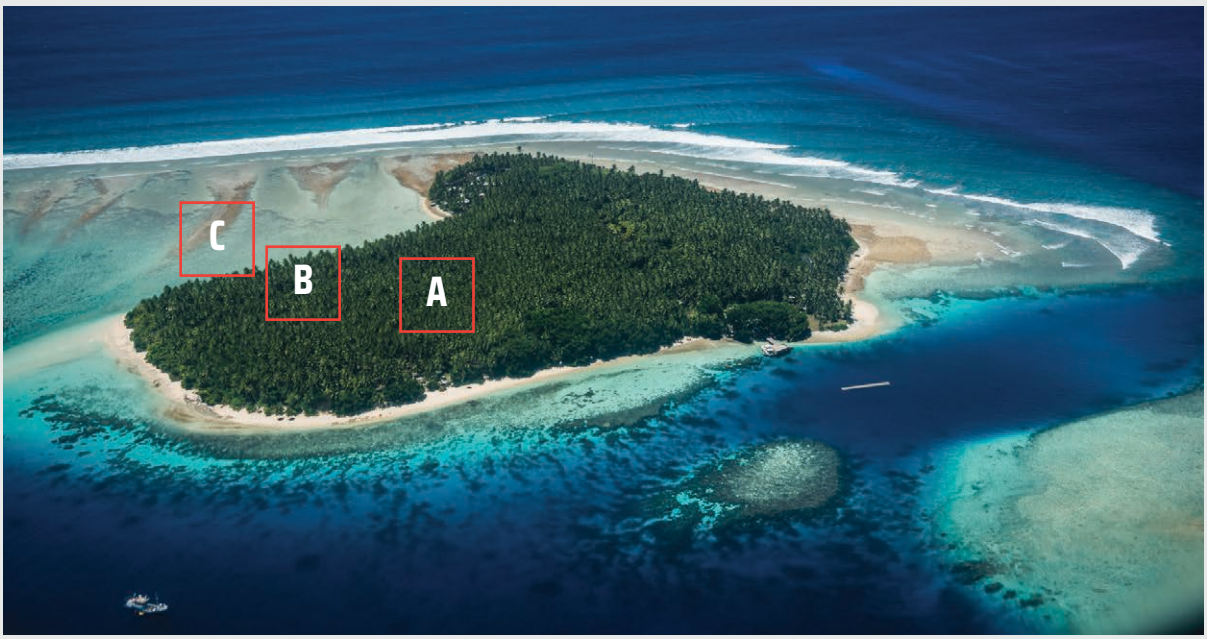


Figure 11: *Example of suitable mangrove replicates within one survey site, showing landward (A), mid-forest (B) and seaward (C) replicate quadrats.*

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.

Mangroves and crocodiles

Crocodiles are a natural part of mangrove forests in Solomon Islands. Often communities know of resident crocodiles that can be protective of their 'home' and males can be mobile and more aggressive during breeding season.

It is important that monitors consider their safety first and avoid mangrove sites that have known resident crocodiles. And/or don't monitor during breeding season, especially if there has been a recent sighting of a crocodile.

It is also recommended that an extra person is taken along as a look-out to watch for crocodiles while monitors survey the mangroves.

CONDUCTING THE SURVEY

Choose the site and select three replicates (5 m x 5 m quadrats) at each site (Figure 7). Each 5 m x 5 m quadrat should be about 50 m apart (Figure 12) if the mangrove forest is large enough. Monitors can use a rope to measure out the quadrats or can practice walking the 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 (e.g. mangrove roots or mud can be difficult to walk through, resident crocodiles),
- the height of the tide (preferably surveys should be done at low tide), and
- weather conditions.

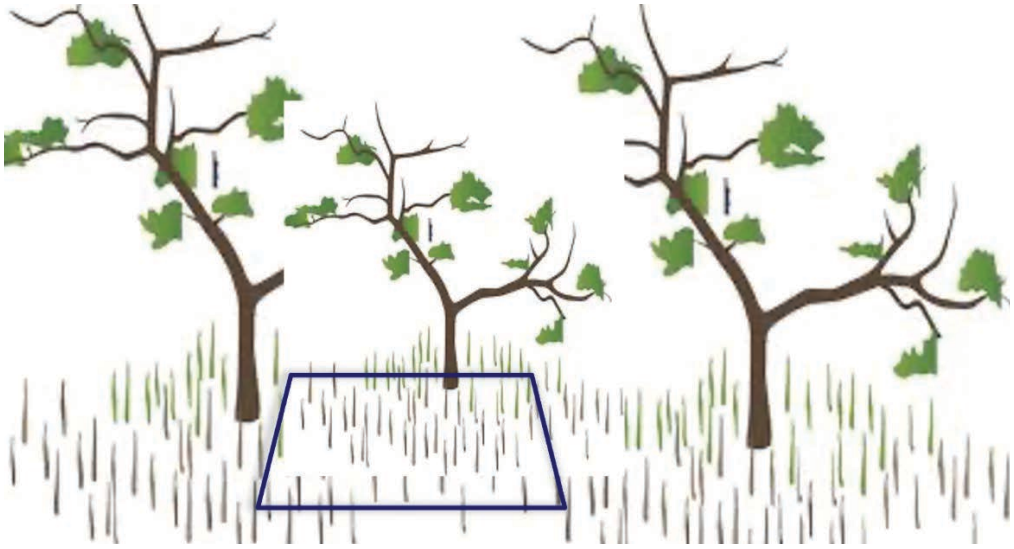


Figure 12: *Select three replicates (5 m x 5 m quadrats) at each site at least 50 m apart.*

DATA COLLECTION

Monitors work together to record site details and discuss and record what they see for the indicators on the survey sheet at each quadrat (using numbers) and then score a final average for all 3 quadrats (using an **X**).

Once you finish the first quadrat (replicate), move 50 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 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**

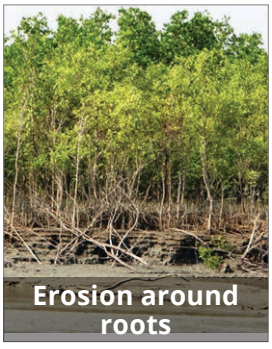
2. Seedlings (new trees) - Healthy mangrove forests produce young trees (seedlings) to replace those that die. In environments that are impacted by people, it is often the seedlings that are small and fragile, that are damaged first or fail to grow. Mark the amount of mangrove seedlings in each quadrat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

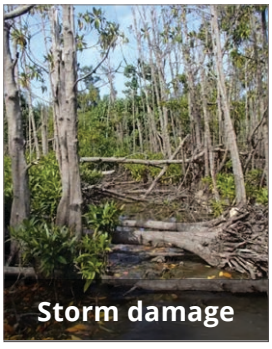
Few seedlings (<5 per quadrat)	**Low**
Many seedlings (6-10 per quadrat)	**Moderate**
Abundant seedlings (>10 per quadrat)	**High**

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): Marie, Jean, Malia		
Where	Village: Tulagi	Site: East windward coast	
When	Date: 17 January 2023	Time: 8:45 am	
Conditions	Weather: Overcast, windy, 32°C (air)	Tide: low 0.53m	
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: 1 3 2 0% 30% 75% 100% Low Moderate High
2. Seedlings (new trees)	Comments: 2 1 3 0 5 10 15 Low Moderate High

WHAT IMPACTS DID YOU SEE?				
3. Twisted or damaged roots	Comments: 3 1 2 0% 40% 90% 100% Low Moderate High			
4. Impacts **Level of impact:**	Comments: 1 3 2 Low Moderate High			
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 colour 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.

SOLOMON ISLANDS MANGROVE MONITORING REPORTING

MANGROVE HEALTH


Canopy Cover **C**


Seedlings **S**


HIGH → INFORM COMMUNITY


MODERATE → COMMUNITY DISCUSS POSSIBLE ISSUES AND ACTIONS


LOW → COMMUNITY SELECT MANGROVE ACTIONS

JAN-JUN | JUL-DEC | JAN-JUN | JUL-DEC | JAN-JUN | JUL-DEC

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 local environment committee 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 local environment committee of results and actions

MANGROVE IMPACTS


Damaged Roots **X**


Other **#**


LOW → COMMUNITY UPDATE


MODERATE → COMMUNITY DISCUSS POSSIBLE ISSUES AND ACTIONS


HIGH → MANAGEMENT ACTIONS STRONGLY RECOMMENDED

JAN-JUN | JUL-DEC | JAN-JUN | JUL-DEC | JAN-JUN | JUL-DEC

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 local environment committee 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 relevant departments of results and actions

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MODULE 4 REFERENCES

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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, cyclones 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 Solomon Islands have approximately 6,633 hectares (ha) of mapped intertidal and shallow subtidal seagrass meadows (in 2004), with over half recorded from Malaita Province (McKenzie et al. 2006). The Solomon Islands have 10 documented species of seagrass in intertidal, shallow subtidal, and reef habitats less than 10 m depth (McKenzie et al. 2021a). The dominant species recorded are Enhalus acoroides and Thalassia hemprichii (McKenzie et al. 2006, 2021a). The common large species are shown below, however the seagrass module does not require monitors to learn species information.

Seagrass species		Features
Enhalus acoroides		Flat strap-like leaves Aerial surface (dry) pollination Leaves 30–150 cm tall
Thalassia hemprichii		Sickle shaped leaves Leaves 10–40 cm tall

SURVEY METHOD

Materials:

- Field survey sheet
- Pencil
- Rope or plastic/metal square to mark 1m x 1m quadrat (optional)
- 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 1 m x 1 m replicates (quadrats) that are at least 10 m apart. Seagrass surveys can be conducted at the same sites as the invertebrate surveys (Module 2) or the reef health surveys (Module 3) if these include typical seagrass habitats in your marine area.

Frequency: Once every 6 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

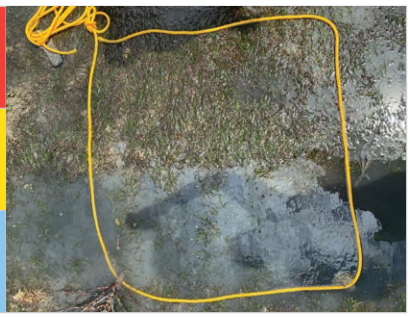
Choose the site and select 3 random 1 m x 1 m quadrats (replicates) at each site. Each quadrat should be at least 10 m apart if the seagrass area is large enough. Monitors can use a rope to measure the quadrats, or a prepared plastic or metal square to mark the 1 m x 1 m quadrat area.

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 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.

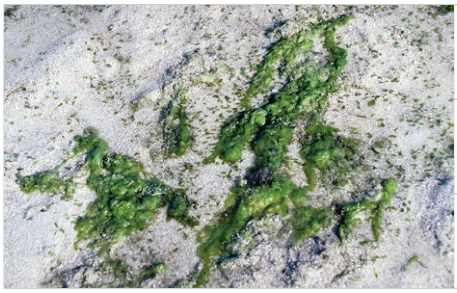
Low seagrass cover	<25%	**Low**
Moderate seagrass cover	25 – 60%	**Moderate**
High seagrass cover	>60%	**High**



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%	**Low**
Moderate algae cover	10 – 25%	**Moderate**
High algae cover	>25 %	**High**

3. Damaged seagrass - Areas of seagrass that are damaged by storms, cyclones 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%	**Low**
Moderate area of damaged/burnt seagrass	25 – 60%	**Moderate**
High area of damaged/burnt seagrass	>60%	**High**

Stressed (burnt) seagrass

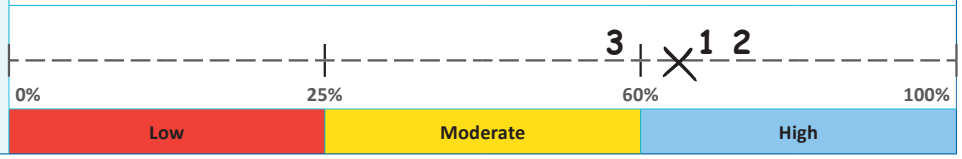
Damaged seagrass meadows

EXAMPLE SEAGRASS SURVEY

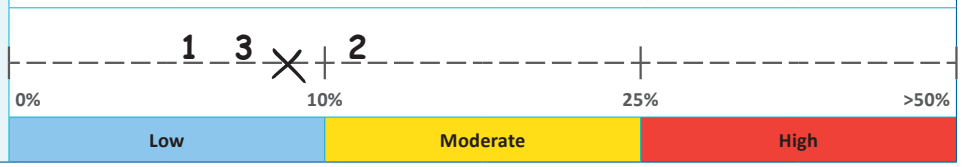
SEAGRASS SURVEY SHEET

SITE DESCRIPTION		
Who	Monitor names: Petelo, Bruno	
Where	Village: Hapai	Site: Village Bay
When	Date: 15 February 2023	Time: 2:10 pm
Conditions	Weather: Light winds, some clouds, 29°C	Tide: Low, exposed flat
Site Selection (circle)	(Random)	Marked Site

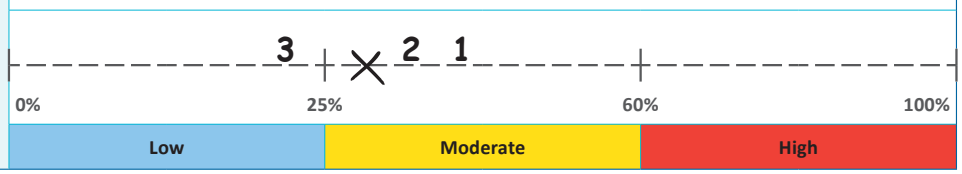
WHAT DID YOU SEE?	
1. Live Seegrass Cover	Comments: Lush meadows with strappy seagrass types



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.

SOLOMON ISLANDS SEAGRASS MONITORING REPORTING

SEAGRASS HEALTH

Live Seagrass Cover **C**

INFORM COMMUNITY

COMMUNITY DISCUSS POSSIBLE ISSUES AND ACTIONS

MANAGEMENT ACTIONS STRONGLY RECOMMENDED

JAN-JUN | JUL-DEC | JAN-JUN | JUL-DEC | JAN-JUN | JUL-DEC

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 local environment committee 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 relevant departments of results and actions

SEAGRASS IMPACTS

Algae **A**

Damaged or burnt **X**

COMMUNITY UPDATE

COMMUNITY DISCUSS POSSIBLE ISSUES AND ACTIONS

MANAGEMENT ACTIONS STRONGLY RECOMMENDED

JAN-JUN | JUL-DEC | JAN-JUN | JUL-DEC | JAN-JUN | JUL-DEC

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 local environment committee 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 relevant departments 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 store your data sheets securely and preferably share all your survey data with local partners for safe storage and backup.

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.

RESOURCES AND TECHNICAL SUPPORT

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

APPENDIX 2:

FISH CATCH SURVEY: CRITICAL SIZE ESTIMATION

Table A1. Species size at maturity estimates to inform critical sizes for each of the priority fish family group1,2. Species were chosen as the most common for each family based on several Solomon Islands catch composition data sets (WCS; Prince et al., 2020), although some common species were omitted due to lack of regional studies of maturity. Locally based studies were used where possible, otherwise studies from the nearest latitude in the Pacific region were used. The species shown in each family grouping are those that were the most common across the three catch composition data sets analysed, with the average % composition shown for each species (the number of data sets they were present in is given in parentheses). Composition % is based on the entire catch data set in each case as raw data wasn't available for all sets.

FAMILY	SPECIES	AVERAGE % IN CATCHES	SIZE AT MATURITY (CM, FL)[3]	SOURCE	PROPOSED CRITICAL SIZE FL
Acanthuridae	*Acanthurus nigricauda*	3.02 (3)	18.0	Prince et al., 2020	20 cm
	Acanthurus lineatus	2.68 (2)	16.2	Prince et al., 2020	
	Ctenochaetus striatus	1.54 (2)	14.0 (F)	Longenecker et al., 2014 (PNG)	
	Acanthurus xanthopterus	1.05 (3)	32.2	Prince et al., 2020	
Haemulidae	*Diagramma pictum*	0.53 (2)	36.0 (F)	Longenecker et al., 2013 (PNG)	40 cm
	Plectorhinchus chaetodonoides	0.13 (1)	38.0 TL (F)	Longenecker et al., 2013 (PNG)	
			43.7 (35.4)	Prince et al., 2019	
	Plectorhinchus gibbosus	0.13 (1)	38.0 (F)	Longenecker et al., 2014 (PNG)	
Holocentridae	*Myripristis pralinia*	0.92 (1)	12.0 (F)	Longenecker et al., 2013 (PNG)	20 cm
	Myripristis adusta	0.61 (2)	17.0 (F)	Longenecker et al., 2013 (PNG)	
	Myripristis berndti	0.51 (1)	18.0 (F)	Longenecker et al., 2013 (PNG)	
	Sargocentron spiniferum	0.49 (2)	?		
Labridae	*Choerodon anchorago*	0.51 (3)	24.7	Prince et al., 2020	25 cm
Lethrinidae	*Lethrinus obsoletus*	7.26 (3)	22.4	Prince et al., 2020	25 cm
	Lethrinus lentjan	3.98 (3)	22.0	Prince et al., 2020	
	Lethrinus erythropterus	2.89 (3)	17.1	Prince et al., 2020	
	Lethrinus xanthochilus	1.58 (3)	35.8	Prince et al., 2020	
Lutjanidae	*Lutjanus gibbus*	8.42 (3)	20.9	Prince et al., 2020	20 cm
	Aphareus furca	2.20 (2)	?		
	Lutjanus carponotatus	2.12 (2)	19.0 (F)	Longenecker et al., 2013 (PNG)	
	Lutjanus fulvus	1.51 (3)	18.2	Prince et al., 2020	
Mullidae	*Parupeneus barberinus*	3.27 (3)	17.6	Prince et al., 2020	25 cm
	Parupeneus indicus	0.69 (2)	32.5 (26.3)	Prince et al., 2019	

Scaridae	*Hipposcarus longiceps*	3.06 (3)	25.0	Prince et al., 2020	25 cm
	Scarus dimidiatus	1.28 (2)	19.0	Prince et al., 2020	
Serranidae	*Epinephelus merra*	3.71 (1)	11.0	Longenecker et al., 2013 (PNG)	25 cm
	Cephalopholis boenak	2.18 (2)	15.0 (F)	Longenecker et al., 2013 (PNG)	
	Cephalopholis polyspila	0.91 (1)	?		
	Cephalopholis miniata	0.69 (2)	?		
	Plectropomus oligacanthus	0.61 (2)	27.0 (F)	Longenecker et al., 2013 (PNG)	
Siganidae	*Siganus doliatus*	1.49 (3)	15.8	Prince et al., 2020	20 cm
	Siganus canaliculatus	1.40 (2)	19.7	Prince et al., 2020	
	Siganus lineatus	1.28 (1)	21.3	Prince et al., 2020	
	Siganus argenteus	1.11 (3)	19.3	Prince et al., 2020	

APPENDIX 3:

INVERTEBRATE DENSITIES IN THE PACIFIC

The 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 including data provided by the local Wildlife Conservation Society team (see Tables A2 and A3).

Table A1: Density estimates from a range of studies across the Pacific used to identify the indicator values for assessing the status (health) of invertebrate species for the Solomon Islands Community Monitoring Toolkit (Sources: see Module 2 reference list). N.B. As the Toolkit strongly recommends daytime surveys for this module, only data from daytime surveys were used in this table. Value ranges are indicative of regional variation for each region/study.

LOCATION, DATE	RELATIVE PRESSURE	SPECIES – NUMBER PER 100 M2 (AREA OF ONE TRANSECT)							
		LOLLYFISH	GREENFISH	PINKFISH	SANDFISH#	FLOWER FISH	GIANT CLAM	TROCHUS	TIGER CONCH
Solomon Islands, 2006	Overfished	0.55	0.016					0.1	
Solomon Islands, 2020	Heavily overfished	0.006-0.014					0.006-0.014		
Solomon Islands, 2016*	Open (heavily fished)	0.008		0.078		0.275	0.580		
Solomon Islands, 2016*	Tambu (some fishing?)			0.444		0.400	0.667		
Solomon Islands, 2018*	Open (heavily fished)			0.027		0.027	0.533		
Cook Islands, 2004	Lightly fished	99							
Coral Sea, 2017	Relatively unfished	2.58	0.15						
Coral Sea, 2017	Fished	0.05	0.10						

Fiji, 1993	Moderately fished				0.63-7.0				
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								
Great Barrier Reef, 2004	Fished								
Great Barrier Reef, 2010	Unfished						415		
Great Barrier Reef, 2020	Unfished								
Kiribati, 2010	Heavily fished						0.006-0.04		
Marshall Islands, 2008	>= moderately fished	1.5-2.6		0.01-0.14			0.14-0.94		
Marshall Islands, 2008				0.01-0.46			10.8-11.3		
Marshall Islands, 2008							27-29		
Marshall Islands, 2016-19	unfished	6.60	1.29	28.67			7.00		
New Caledonia, ~2008	Lightly fished		>1.00						
Pacific wide (review), ~2003-09	Lightly fished				~20-30				
Pacific wide (review), ~2003-09	Heavily fished				1-3				
Palau, 1984	Moderate-heavily fished							1-2.5	
Palau, 2010	Heavily fished						0.36		
Papua New Guinea, 1988	Unfished								23.39
Papua New Guinea, 1988	Lightly fished								12.20
Papua New Guinea, 1988	Moderately fished								11.11
Papua New Guinea, 1988	Heavily fished								8.35
Papua New Guinea, 2014	Heavily fished				0.47-0.79				
Papua New Guinea, 2010	Heavily fished						0.004		
Samoa, 2018	~light-moderately fished							2-10	
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		

*Estimates derived from local raw data of intertidal reef flat invertebrate surveys provided by Wildlife Conservation Society (WCS).
#Sandfish prefer muddier substrates and are usually found in very shallow turbid waters. Consideration of these ecological characteristics should be made in interpreting survey results based on the location surveyed. See training manual for guidance.

Table A2. *Derived thresholds for the health scale for each invertebrate species based on the literature and expert judgement. Due to the high variability among regions greater weighting was given to studies in or closest to Solomon Islands.*

SPECIES	OVERFISHED	DECLINING	HEALTHY
Lollyfish	0 – 6	6 – 20	20 – 50+
Greenfish	0 – 2	2 – 8	8 – 30+
Pinkfish	0 – 2	2 – 6	6 – 20+
Sandfish	0 – 1	1 – 4	4 – 8+
Flower fish	0 – 0.5	0.5 – 4	4 – 7+
Giant clam	0 – 10	10 – 40	40 – 100+
Trochus	0 – 2	2 – 6	6 – 15+
Tiger conch	0 – 8	8 – 15	15 – 20+