Photo: Johanna Johnson

# Vanuatu Community Marine Monitoring Toolkit

Pacific Community
Communauté du Pacifique

RESCCUE

Pacific C2O

www.oceanswatch.org

**Key contributors:**
**Johanna Johnson**, $C_2O$ Pacific, Cairns, Australia and Vanuatu
**David Welch**, $C_2O$ Pacific, Cairns, Australia and Vanuatu
**Eryn Hooper**, OceansWatch New Zealand
**Bradley Moore**, SPC Division of Fisheries, Aquaculture and Marine Ecosystems, Noumea, New Caledonia
**Glenn Edney**, OceansWatch New Zealand
**Jane Waterhouse**, $C_2O$ Consulting, Townsville, Australia

**Citation**: Johnson, J.E., Welch, D.J., Hooper, E., Moore, B., Edney, G., Waterhouse, J. (2018) *Community Marine Monitoring Toolkit: Vanuatu.* Prepared under the Restoration of Ecosystem Services and Adaptation to Climate Change (RESCCUE) Vanuatu project for the Pacific Community (SPC), Noumea, New Caledonia (104pp).

Funding for this project was provided by the French Global Environment Facility (FFEM) and French Development Agency (ADF) under the RESCCUE program.



Cover photograph: Havannah Harbour, North Efate, Vanuatu. Johanna Johnson

**Acknowledgements:**
This monitoring Toolkit was developed based on requests from members of the Nguna-Pele Marine and Land Protected Area and Tasi-Vanua environmental networks in North Efate, Vanuatu and their desire to make better and more informed decisions about managing their local marine resources. Its successful development and field trials was due to the support of these Networks and Resource Monitors from local villages as well as the Vanuatu Fisheries Department. Integral to its development was the commitment of the Network Marine Champions who dedicated their time to provide critical input and deliver training. The Vanuatu Fisheries Department, in particular Jeremie Kaltavara, also provided valuable support and input to the Toolkit. The authors also appreciate the expert input of: Chris Bone (OceansWatch), the SPC Division of Fisheries, Aquaculture and Marine Ecosystems, Christopher Bartlett (SPC-GIZ Coping with Climate Change in the Pacific Island Region), Steve Newman (WA Fisheries, Australia) and Paul Marshall (Reef Ecologic). Additional financial support and resources were also provided by $C_2O$ Consulting, $C_2O$ Fisheries, OceansWatch and *Experiment* crowd-funding.

# CONTENTS

# INTRODUCTION

Community-based management of coastal marine resources has a long history throughout the Pacific with varying degrees of success, made even more challenging by rapidly growing human populations. An integral part of management is monitoring marine resources to assess status and trends to actively inform management decisions by communities and to assess the effectiveness of management. 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

Resource Monitoring Networks (the Networks) in the North Efate region of Vanuatu have a strong history of applying community-based coastal management, especially the use of marine protected areas. However, their sustainability and effectiveness has been questionable. Communities identified that a key reason for this was that previous monitoring approaches were not designed to inform local decisions.

This Community Marine Monitoring Toolkit has been developed to address this need in partnership with environmental Networks in North Efate, local NGOs, the Vanuatu Government, in particular the Fisheries Department, and international marine specialists. The aim is to provide a series of monitoring modules that directly inform community-based decisions to 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.

### Why is monitoring important?

Monitoring the health of marine environments helps to detect changes caused by human activities and natural events. Community monitoring is important as it provides regular information from many locations collected by people familiar with their environment, and has the ability to support national initiatives. Community 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 the *impacts of fishing* methods and gears.
- Raise awareness about the *range of management* actions appropriate for local issues.
- *Empower communities* to take control of local marine resource management through an inclusive and informed process.
- Determine if local management actions are effective and *facilitate adaptive management.*

This Toolkit includes survey methods for monitoring marine habitats and animals, and provides a simple guide for making appropriate village-based decisions to manage these resources. Effective management relies on the support of the whole village and the Toolkit modules have been developed to make it a simple process to inform village members to be part of the process. There is an implied responsibility of resource monitors (community members trained to conduct monitoring) to communicate regularly in their villages, particularly with Chiefs, and to use the education materials provided. This might involve communities meeting 1–2 times each year to discuss monitoring results, and actions including enforcement, that are needed by all villages to manage their shared marine environment.

[1]Vanuatu Fisheries Act and Regulations 2009; National Fisheries Policy 2016–2031; Sea Cucumber Management Plan 2015; National Plan of Action on Sharks 2015–2018; National green snail, triton shell and trochus restrictions.
[2]http://www.msgsec.info

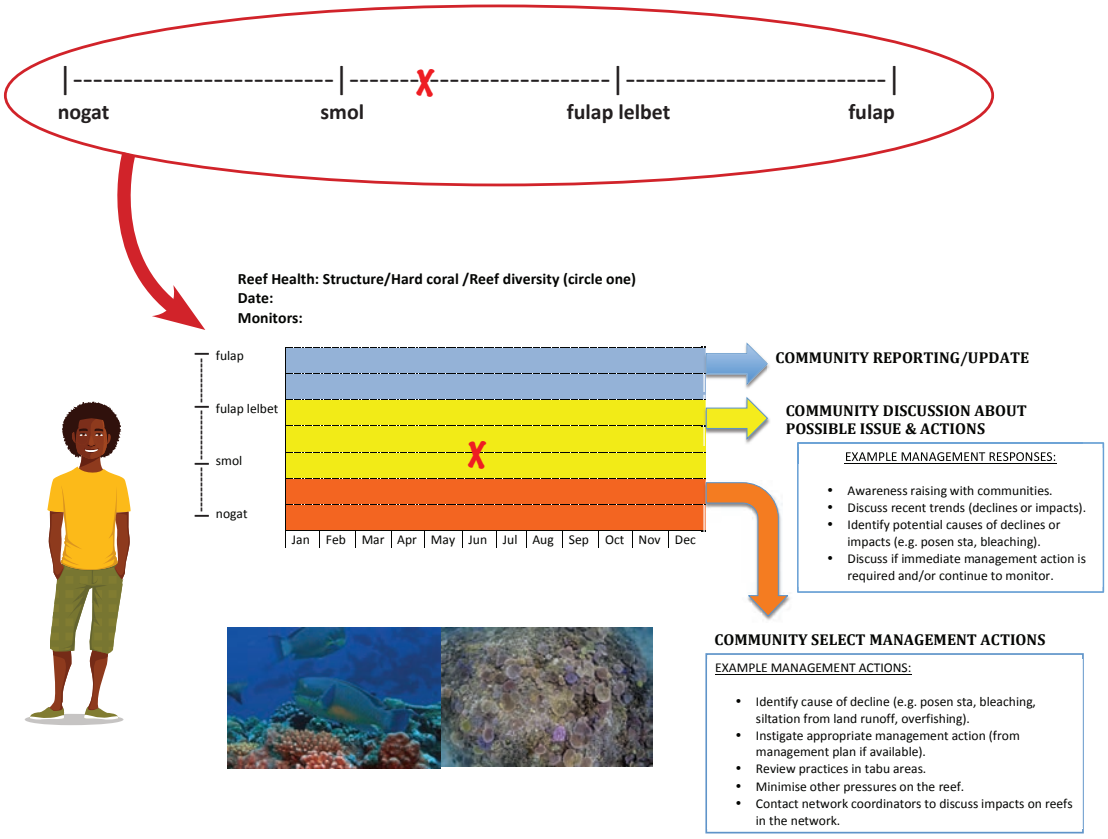
Villages use marine habitats and animals that are connected and shared among adjacent villages. To some extent they are also protected by national Regulations, Policies and Plans that aim to safeguard and revive Vanuatu's coastal resources. Many marine species in Vanuatu are subject to national harvest restrictions or bans. Resource monitors should be familiar with these regulations and the Networks play a role in ensuring the wider community is also aware of the regulations. This will enable the use of the Toolkit to complement relevant national regulations and effectively work in partnership with government agencies. The *Vanuatu National Fisheries Policy 2016 – 2031* was developed in part to meet national actions recommended in *A new song for coastal fisheries - pathways to change: The Noumea strategy* (2015) and by the *Melanesian Spearhead Group*[2] for coastal fisheries. It focuses on fisheries resources and the habitats that support them. Monitoring of fish, invertebrates, coral reefs, seagrass and mangroves is coordinated at a national scale, with the directive to secure food and nutrition, provide environmental protection in the face of climate change and natural disasters, improve fisheries compliance and build partnerships. Community-based monitoring can provide early warning and condition information to the national program, and request formal support from Vanuatu Fisheries if impacts are observed.

## HOW TO USE THIS TOOLKIT

This Toolkit has six (6) modules that can be used for community-based monitoring:

1. Fish catch
2. Intertidal invertebrates
3. Reef health
4. Mangroves
5. Seagrass
6. Crown-of-thorns starfish

Each module is independent of the others, and communities can select one or more modules, depending on their local needs, issues and resources. The Toolkit provides all the steps to establish and conduct community monitoring for each of the six modules, and how to interpret the results to inform local decisions. Each module collects standardised data that is plotted onto a scale from 'nogat' (none/unhealthy) to 'fulap' (many/healthy). The Toolkit has standardised methods for communities to use monitoring results instantly, translating information from their surveys into management actions that target key issues. This is achieved by transferring the survey data directly onto Data Reporting Sheets (provided as posters) that are colour-coded: blue indicates no concern, yellow indicates there is a possible issue, and red indicates there is an immediate issue. One of the key features of the Toolkit is that each colour directly provides management responses appropriate to the local context.




The monitoring results can therefore immediately identify if there is an issue, and inform village discussions about what management actions will be used to address the issue (Figure 1). Resource monitors are responsible for the safekeeping of monitoring data and at regular intervals should provide copies to be stored in a central folder, such as at the Emua Resource Centre. While monitoring is a key part of sustainable marine resource management, it should be part of planned local resource management, and this monitoring Toolkit is accompanied by the booklet *RESCCUE Community Based Marine Management: A guide for effective tabu areas.*

### The science behind the Toolkit

The Toolkit has been designed to align with national policy, and provides information that can be used by government. Importantly, the scientific basis of the data reporting outputs means that community-based monitoring can complement more technical scientific and regional monitoring that is conducted less frequently, for example, once every three years.

The Toolkit has drawn on established survey methods and known species and ecosystem thresholds to apply standardised interpretation of monitoring results. The *nogat* to *fulap* scale provides a relative measure of the condition of the indicator being monitored. For each indicator, the *nogat* to *fulap* scale is based on available scientific information from Vanuatu or comparable regions. For example, green fish sea cucumber density estimates from unfished areas around the Pacific provide an estimate for *fulap* (healthy) population status, while *fulap* (healthy) for hard coral cover is based on data from North Efate. For some modules, the measures of healthy or unhealthy are derived. For example, the fish catch survey uses 'size at maturity' estimates from the scientific literature. For simplicity in the community surveys, identification of fish is to the family level, which has applied a process to derive a composite family-level critical fish size. 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 of *nogat* to *fulap* to record survey results and then transfers these directly onto community data reporting sheets (as shown below).

### Toolkit resources:

The Toolkit includes all instructions for setting up and conducting monitoring, field sheets for collecting survey data, data reporting sheets, the Fish Catch Data Management section (Appendix 1), quick field guides for each module (Appendix 2), and a resource list and educational materials about marine monitoring and how results can help inform local management (Appendix 3). The educational materials can be used anytime, and monitors are strongly encouraged to share them with all community members so they can be involved in and support local sustainable marine management.

The educational resources include:

1. Fish and People DVD series
2. *Hard to catch a fish* poster
3. Vanuatu Fisheries Department – key species national fishery regulations
4. Indicators of Reef Health fact sheet

## REVIEW AND IMPROVEMENT

It is recommended that each village review their monitoring data at least annually. First, to see if there have been changes in the condition of the resources they are monitoring (e.g. fish catch, reef health) and to determine if and what actions are required. Second, to identify any issues with the methods or the modules that have been used. For example, a review would 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 better enforced. It is also recommended that Resource Networks review the monitoring results for their joint resources together each year. This provides an opportunity for community monitors to get together and share their experiences and results, identify challenges, and look for ways to work together to improve monitoring and management.

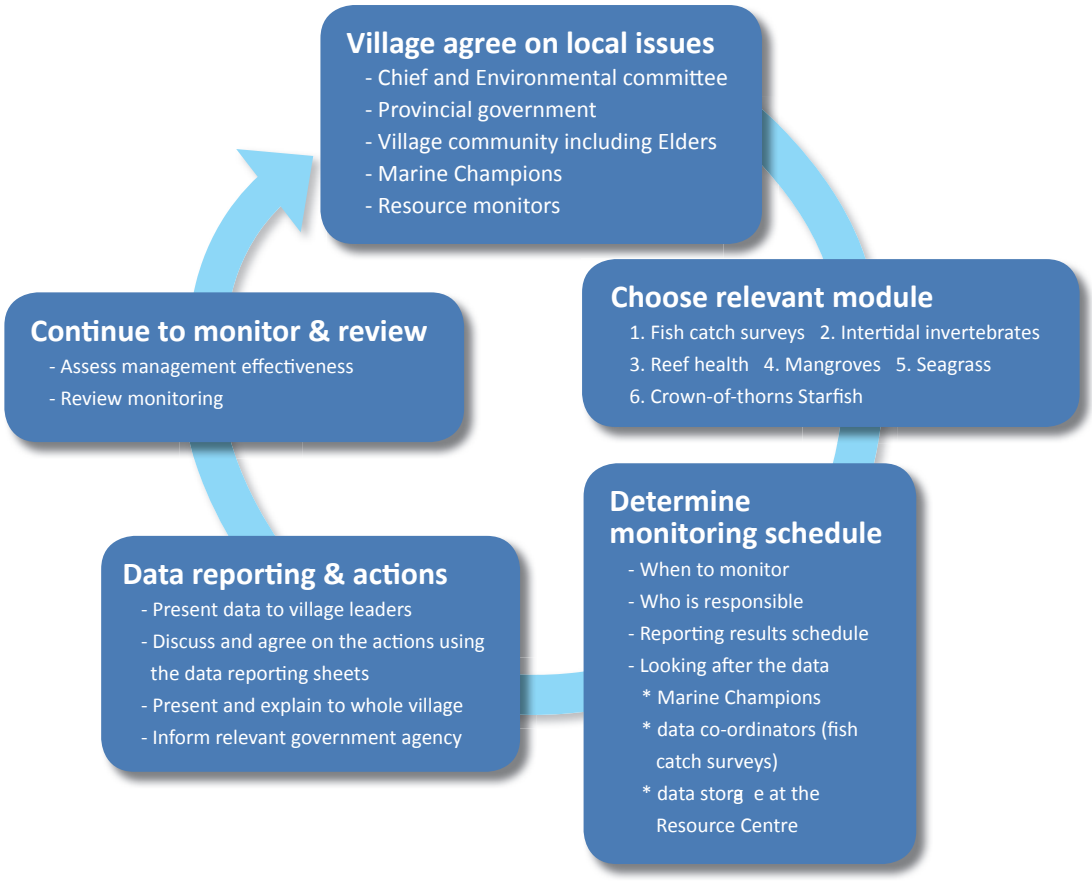



**Figure 1. Process to guide the use of the monitoring toolkit and engage communities in the process.**

# MODULE 1

# Fish Catch Surveys

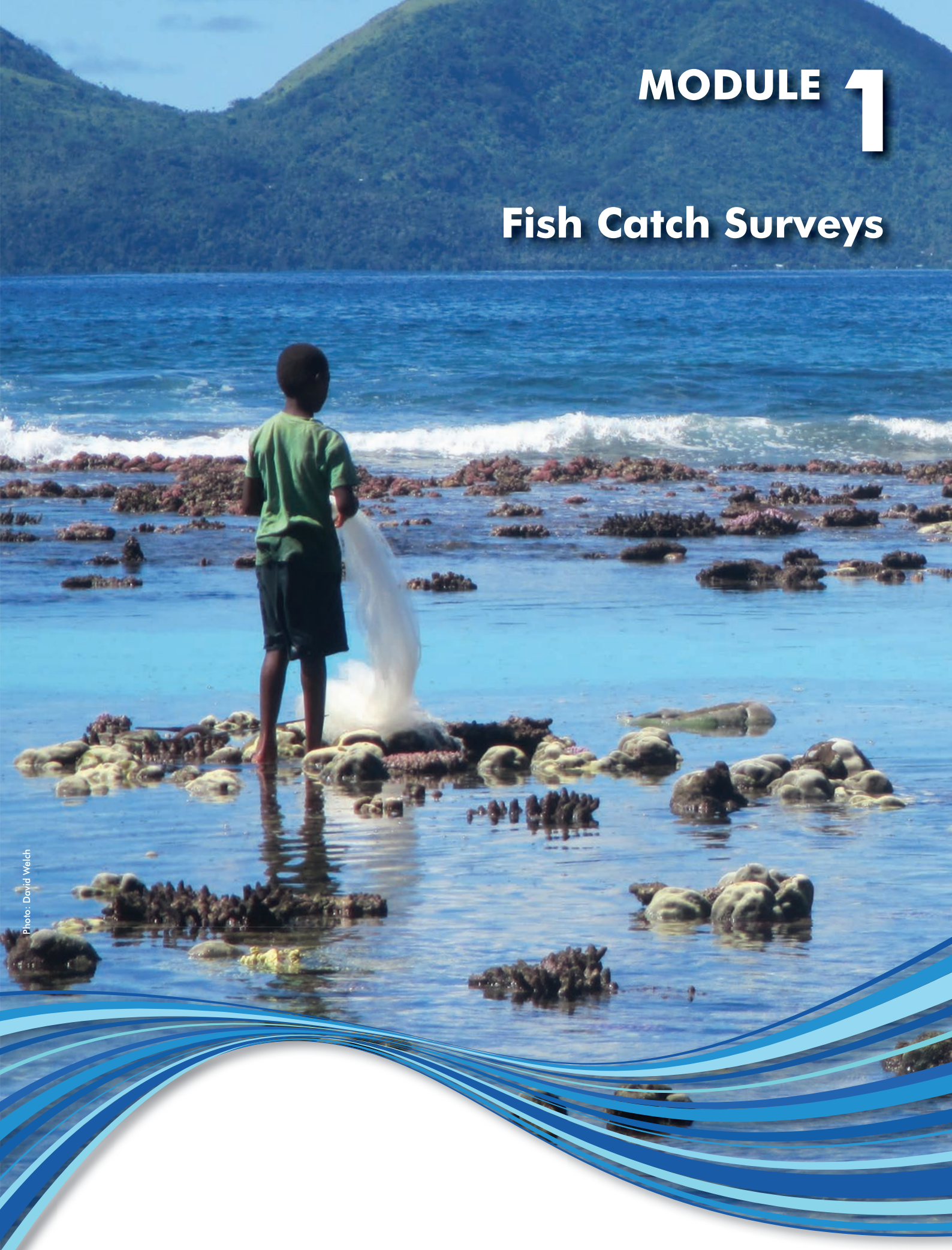


Photo: David Welch

## MODULE 1: FISH CATCH SURVEYS

### Relevant laws and rules:

Vanuatu Fisheries Act and Regulations (2009); National Fisheries Policy (2016–2031); Melanesian Spearhead Group Coastal Fisheries Roadmap (2015-2024); Forum Fisheries Agency Regional MCS Strategy (2010- 2015); Noumea Strategy: A new song for coastal fisheries – pathways to change (2015); Pacific Regional Roadmap on Fisheries (2010); Samoa Pathway (2014).

### Purpose:

The purpose of the fish catch surveys is to collect data on *subsistence* fish catches in Vanuatu at the community level. Monitoring fish catches can inform and raise awareness of the types of fish being caught, their sizes, what fishing gears are used and can detect changes in fish populations. For example, if catches are made up of too many small fish (before they have reached breeding size), then the fish population will produce less fish each year. Without new juvenile fish to replace those caught each year, the population will decline, and there will be fewer fish to catch. Also, catching several small fish often provides less food than one large fish. Different species start breeding at different sizes (size at maturity; see Table A1 in Appendix 1), so to avoid catching juvenile (pre-breeding) fish, monitoring needs to consider when different species become mature.

The fish catch surveys have been developed to directly inform local management actions regarding targeting of reef fish species, and in particular to minimise the capture of fish before they have grown large enough to breed. This addresses a key issue identified by local communities ("catching too many small fish") partly due to the common local use of small mesh gillnets. The key species groups to monitor were determined by feedback from the local communities and the Vanuatu Fisheries Department. The data also informs about the impacts of different fishing gears based on the size of fish they catch and on the time it takes to catch fish (catch rates). This can identify if fish populations are decreasing (becoming harder to catch) and which fishing gears may be damaging fish populations the most, also helping to inform which management actions are needed. Knowing this is important for resource monitors to be able to explain to fishers and community members the importance of the catch surveys and management. Below are two key issues that catch monitoring information can help address and were agreed as a high priority by community members.

***Issue 1: Fish are harder to catch***

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

***Issue 2: Too many small fish are being caught***

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

## METHOD

### Materials:

- Fish measuring ruler
- Field survey sheet
- Pencil
- Fish identification sheet (Table 1)

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

**Frequency:** Aim to conduct a minimum of 20 fisher surveys every 3-6 months.

### Conducting the survey:

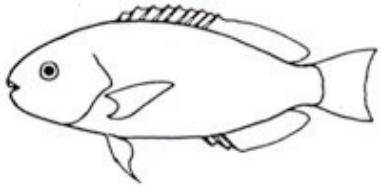
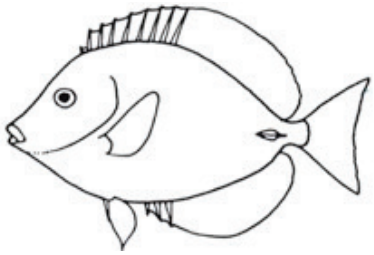
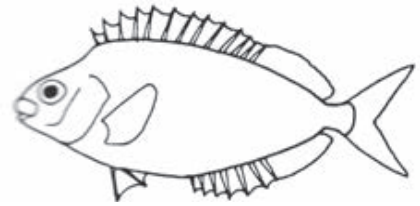
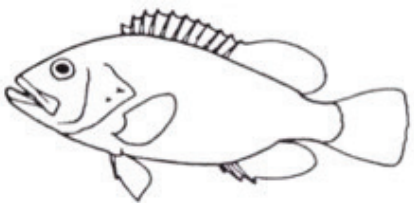
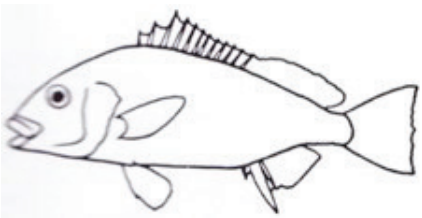
Each resource monitor should carry out surveys in their local village by meeting fishermen AND women when they return to shore from fishing with their catch. Using the survey form, monitors collect information about the fishing trip each fisher just completed. This will include information on what species were caught and their sizes. Fish catch surveys are the only method in this Toolkit that requires data to be entered into a database for analysis and completed surveys need to be given to the data coordinator for each region. **Survey as many *different* fishers (men and women) as possible. The more surveys conducted the stronger the results.**

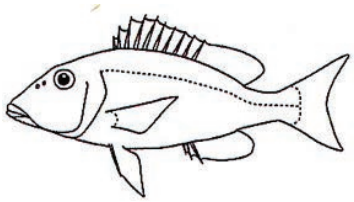
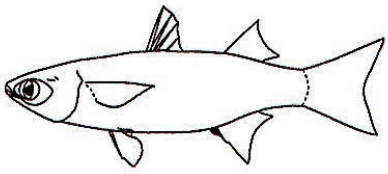
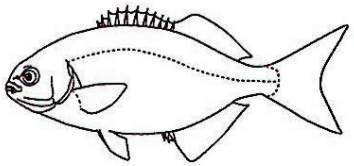
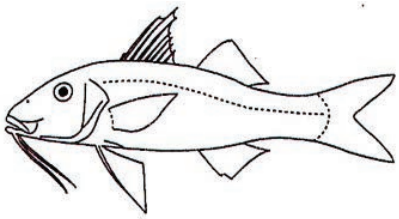
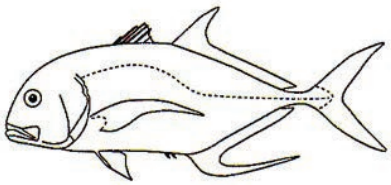
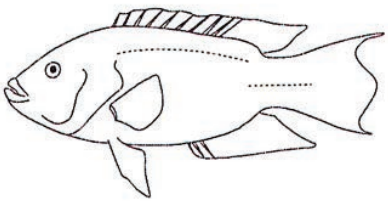
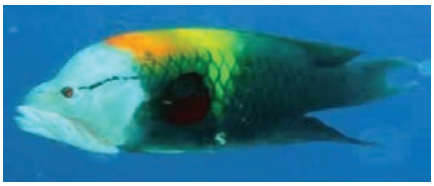
At the start of each survey it should be explained to fishers:

- 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 favourite fishing spots.

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

**Table 1. Guide for the identification of fish species groups**

| Name | Illustration | Example |
|---|---|---|
| **Blu Fis (Parrotfish)** |  |  |
| **Strong Skin (Surgeonfish / Unicorns)** |  |  |
| **Pico (Rabbitfish)** |  |  |
| **Siko (Snapper)** |  |  |
| **Los (Grouper)** |  |  |
| **Sua Sua (Sweetlip)** |  |  |

| Name | Illustration | Example |
|---|---|---|
| Red Mouth (Emperor) |  |  |
| Malet (Mullet) |  |  |
| Bigbel (Drummer) |  |  |
| Mustafis (Goatfish) |  |  |
| Karong (Trevally) |  |  |
| Klis Fis (Wrasse) |  |  |

### Data collection:

Catch survey information should be collected using the catch survey form provided below. Resource monitors need to read the form carefully and be sure to accurately collect ALL the information on the survey sheet. There are three main sections of the survey form:

1. SURVEY DETAILS – Basic information about where and when the survey was conducted: date and time of survey, fisher's name and gender, and the fisher's village.

2. FISHING DETAILS – Basic information about the fishing trip being surveyed.

- Whether fishing was done during the day or night
- The total number of people fishing
- The **main** fishing method/gear used during the fishing trip. Fishing method choices are given and only the method used most of the time during the latest fishing trip should be circled in this section. This information helps to understand the catch taken with each gear type, which can inform specific management actions if issues are identified. For example, a common problem throughout the Pacific is the rapid decline of large parrotfish (blu fis) due to spearfishing at night with torches. Another example is small gillnet mesh sizes used in the Pacific that mostly catch small juvenile fish. Fishing gear types to record in the survey form are:
  - Speargun
  - Traditional spear
  - Pana hute net
  - Gillnet
  - Hook and line
  - Other – if the method/gear is not listed then write it down here

- **ONLY** if an other fishing method/gear was used during the trip then the ***'Secondary fishing methods used'*** section should be filled in. If applicable, more than one 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 key species groups listed in **Table 2**. Community members and the Vanuatu Fisheries Department identified these species groups as the most important for local subsistence catches.

- For the key fish species groups in the catch, the fork length (FL) for each individual fish should be measured using the ruler provided (see Figure 2) and in centimetres (cm). Where possible **ALL** fish should be measured.
- In the catch survey form, for each species group write down the size of each individual fish measured in one of the boxes on the form. An example of a completed survey is shown below.

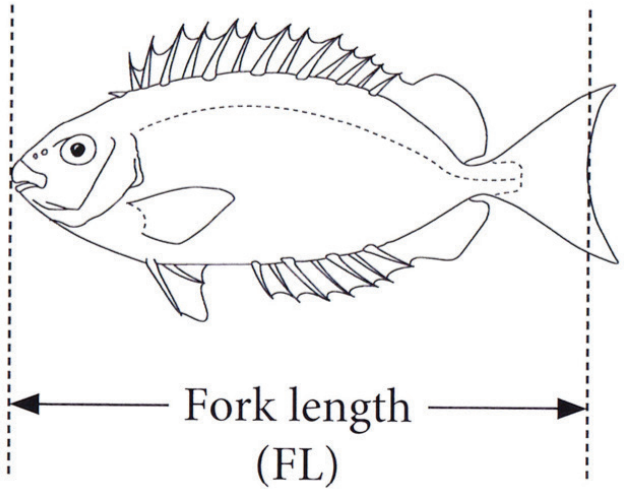



**Figure 2. Distance for measuring fork length (FL) of fish during catch surveys. Source: Moore and Colas (2016).**

**Table 2. Main target species group to be included in subsistence fish catch monitoring.**

| Local Name | Common Name | Family Name |
|---|---|---|
| Blu fis | Parrotfish | Scaridae |
| Strong sing/Pocket knife fish | Surgeon fish | Acə thuridə |
| Pico | Rabbit fish | Siganidae |
| Siko | Snappers | Lutjanidae |
| Los | Groupers | Serranidae |
| Sua sua | Thicklips/Sweetlips | Hə mulidə |
| Red mouth | Emperor | Lethrinidə |
| Mə et | Mullet | Mugilidə |
| Bigbel | Drummer | Kyphosidae |
| Mustafis | Goat fish | Mullidə |
| Karong | Trevally | Cə ə gidə |
| Klisfis | Wrasse | Lə ridə |

## EXAMPLE FISH CATCH SURVEY

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

**1. SURVEY DETAILS**

| | | |
|---|---|---|
| Village: Emua | Fisher name (confidential): | Male/Female (circle) |
| Date: 21/05/2017 | Time: 3.15pm | Monitor name: John |

**2. FISHING DETAILS**

| | |
|---|---|
| Day/Night (circle one) | Number of people fishing: 1 |
| Main fishing method (circle one): Speargun Traditional spear Hook and line Parachute net Gillnet Other…… | |
| Secondary fishing method/s used (circle): Speargun Traditional spear Hook and line Parachute net Gillnet Other…… | |
| If gillnet used, what was the mesh size: 2 cm | Time spent fishing: 3.5 hrs |

**3. CATCH DETAILS**

| ***Species group*** | | ***Fish sizes (cm) (if not all individual fish are measured write * next to the species name)*** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| National name | Local name | | | | | | | | | |
| Parrot fish | Blu fis | 5.4 | 6.5 | 14.2 | 8.5 | 20.1 | 4.8 | 14.4 | 8.6 | 12.1 |
| | | 11.7 | 15.8 | 5.7 | | | | | | |
| | | | | | | | | | | |
| Surgeon fish | Strong skin | 5.7 | 11.1 | 12.6 | 6.8 | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| Rabbit fish | Pico | | | | | | | | | |
| | | | | | | | | | | |
| Snapper | Siko | 14.6 | 20.1 | | | | | | | |
| | | | | | | | | | | |
| Grouper | Los | 7.8 | | | | | | | | |
| | | | | | | | | | | |
| Sweetlip | Sua sua | 27.9 | | | | | | | | |
| | | | | | | | | | | |
| Emperor | Redmouth | | | | | | | | | |
| | | | | | | | | | | |
| Mullet | Malet | | | | | | | | | |
| Drummer | Bigbel | | | | | | | | | |
| Goatfish | Mustasfis | 15.2 | 13.5 | | | | | | | |
| Trevally | Karong | 27.6 | | | | | | | | |
| Wrasse | Klisfis | | | | | | | | | |

## DATA REPORTING

All catch survey data will be maintained by a team of *Data Coordinators* from TasiVanua and Nguna-Pele Marine and Land Resource Networks using the prepared and automated catch survey spreadsheet provided. The role of Data Coordinators is key to the provision of data results to villages and those selected in this role will need to be well organised, disciplined and motivated people. Data Coordinators also need basic training in using the spreadsheet data entry and reporting system. The Data Coordinators will need to collect completed catch survey data forms from resource monitors at regular intervals (2–3 times per year). The original survey data forms should be stored in a central folder in the Resource Centre after the data is entered.

Data will need to be entered by the coordinators into the fish catch spreadsheet. All data analysis and results to inform management decisions are generated automatically. The *Instructions* sheet in the spreadsheet provides a summary of information for data coordinators including details on how to enter and analyse the catch data. It is very important that data coordinators are familiar with this information.

### Critical fish size estimate

The size distribution of fish caught is used to present the results of the catch surveys. Data on how many small fish (pre-breeding size) are caught is important as this result indicates an undesirable impact on the future breeding success of the population. The key indicator generated in this module is the proportion of the total catch that are larger than a ***critical size***. This critical size estimate is derived separately for each of the 6 key fish species groups that communities have indicated a need for local management (blu fis, strong skin, piko, siko, los and sua sua) (see Table A2).

For each species group the *critical size* is based on the size fish become mature and can breed. This means that community-based management goals are based on the desire to avoid catching fish that are too small to breed. The critical sizes are a composite size based on information from scientific studies of the most commonly caught local species for each species group and of similar species where necessary (Table A2). The critical sizes have also been reviewed against draft fisheries size limits under consideration by the Vanuatu Fisheries Department to ensure a level of consistency.

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

### Results

The data spreadsheet automatically generates all data outputs including a graph that mimics the key output on the Data Reporting Sheet making it a simple step to copy data points exactly as they appear in the spreadsheet species group graphs onto the printed copy of the Data Reporting Sheet. This can then be taken directly to the relevant community for discussion of results and possible management responses.

Key statistics of the data are automatically generated and summarised in the spreadsheet. For all species group the statistics generated are: *average size and proportion of the total catch*. Also, for each of the 6 community target species groups, the results calculate the percentage (%) of the catch that are the larger than the critical size. The *% of each species larger than the critical size* is automatically plotted into a graph for that species group. These graphs are shown in a separate worksheet for each species group (*e.g. Blu fis size, Strong skin size, etc.*).

### Community meetings

The results indicate how much of the catch of each species group are likely to be juvenile fish and are therefore caught before they can breed. Although the goal should be to catch no juvenile fish (100% of the catch are larger than the critical size), this may significantly impact fishing in the short-term. Therefore, we have set the initial target of having no more than 30 % of juveniles in the catch (70% of the catch are larger than the critical size). This means that management actions are required for a species group when the data show that less than 70% of the catches are larger than the critical size.

Data coordinators need to manually copy the data points from each species group's worksheet onto a printed *Data reporting sheet* for that species group. This sheet provides the basis for discussing the results with communities and gives clear guidance on management actions in response to the results.

### Management options and decision-making

The monitoring is designed so that results from any single catch survey can inform immediate management decisions based on the *critical size*. Results for each species group are marked on the *Data Reporting Sheet* either in the blue (fulap), yellow (smol) or red (nogat) zone. The coloured zones indicate the percentage of the catch that are *larger than the critical size*, where red = 0 – 70 % (70 – 100 % are juvenile), yellow = 70 – 90 % (10 – 30 % are juvenile), and blue = 90 – 100 % (0 – 10 % are juvenile).

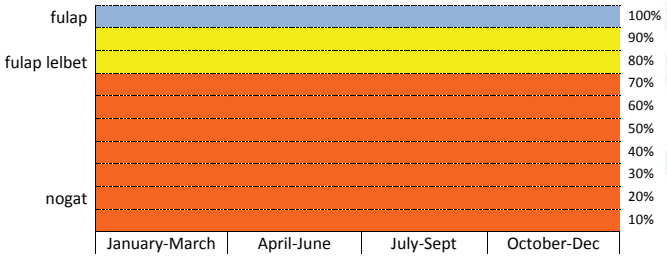
Results provide a guide to possible management actions for each zone (blue, yellow or red). It is very important that the list of possible management actions be discussed in each village prior to monitoring. For instance:

- Results in the ***blue zone*** (fulap) would suggest a healthy fishery that is not catching too many small fish and having negative impacts on fish populations. Results should be reported to the community for raising awareness about monitoring and fish populations.
- Results in the ***yellow zone*** (smol fulap lelbet) indicate a possible issue. It is recommended that Monitors have a community meeting with the Chief and village to discuss the results, possible reasons for the results, and what actions should be taken. Example management actions include: community awareness raising (such as information on notice boards), particularly with buyers/restaurants and Chiefs, and harvest restrictions to prevent further declines, such as size limits or gear bans. The discussions should also consider if the surveys should be repeated to confirm the results if they are unexpected or are being used to inform tabu area management.
- Results in the ***red zone*** (nogat) indicate that there are too many small fish in the catches and should follow the recommendations for the yellow zone, with more immediate actions needed. These may include: introduce a size limit, limit some fishing gears (e.g. night spearfishing, small mesh gillnets), and temporary or permanent bans on harvest. Other options include rules and fines for disrespecting local management, seasonal closures, accessing sources of alternative food, and review of tabu area management. Results in the red zone may also require meetings with neighbouring villages to discuss and agree on actions for everyone, since many villages will share the same fish populations. The use of coloured floats (blue, yellow, red) to indicate the status of catch survey results may also help to make community members more aware.

These actions will vary between villages and should be guided by local experience. Where possible, the village Chief should use the management recommendations already established in local village management plans, however the use of the suggested management options in the *Data Reporting Sheets* is encouraged.

A field quick guide is provided in Appendix 2. Information sheets for awareness raising activities are provided in Appendix 3.

FINFISH SPECIES: **Blu fis/Parrotfish**




**COMMUNITY REPORTING/UPDATE**

**COMMUNITY DISCUSSION ABOUT POSSIBLE ISSUE & ACTIONS**

EXAMPLE MANAGEMENT RESPONSES:

- Put signs up
- Inform Vanuatu Fisheries Department

**COMMUNITY SELECTION OF MANAGEMENT ACTIONS**

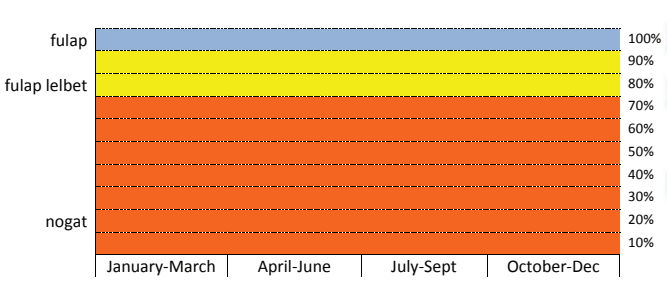
EXAMPLE MANAGEMENT ACTIONS:

- Ban harvest of fish smaller than 20 cm (introduce size limit)
- Ban the use of small-mesh gillnets
- Temporary/permanent ban of harvest in some areas or times (e.g. known spawning times)
- Ban spearfishing at night (protects larger breeding fish)
- Ensure tabu areas are effective: closed, respected, large enough

1. Plot the portion (%) of blu fis **20 cm** or bigger in the total catch for the survey period
2. Depending on which coloured zone the data point is in follow the arrow to the suggested actions

*The initial target is that at least 70% of blu fis caught are larger than the critical size. Long term target should be ~100%

FINFISH SPECIES: **Los/Groupers**




**COMMUNITY REPORTING/UPDATE**

**COMMUNITY DISCUSSION ABOUT POSSIBLE ISSUE & ACTIONS**

EXAMPLE MANAGEMENT RESPONSES:

- Put signs up
- Inform Vanuatu Fisheries Department

**COMMUNITY SELECTION OF MANAGEMENT ACTIONS**

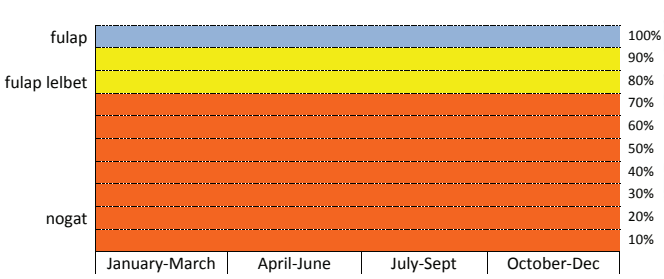
EXAMPLE MANAGEMENT ACTIONS:

- Ban harvest of fish smaller than 25 cm (introduce size limit)
- Ban the harvest using spearfishing at night
- Ban the use of small-mesh gillnets
- Temporary/permanent ban of harvest in some areas or times (e.g. known spawning locations/months)
- Ensure tabu areas are effective: closed, respected, large enough

1. Plot the portion (%) of los **25 cm** or bigger in the total catch for the survey period
2. Depending on which coloured zone the data point is in follow the arrow to the suggested actions

*The initial target is that at least 70% of los caught are larger than the critical size. Long term target should be ~100%

FINFISH SPECIES: **Pico/Rabbitfish**




**COMMUNITY REPORTING/UPDATE**

**COMMUNITY DISCUSSION ABOUT POSSIBLE ISSUE & ACTIONS**

EXAMPLE MANAGEMENT RESPONSES:

- Put signs up
- Inform Vanuatu Fisheries Department

**COMMUNITY SELECTION OF MANAGEMENT ACTIONS**

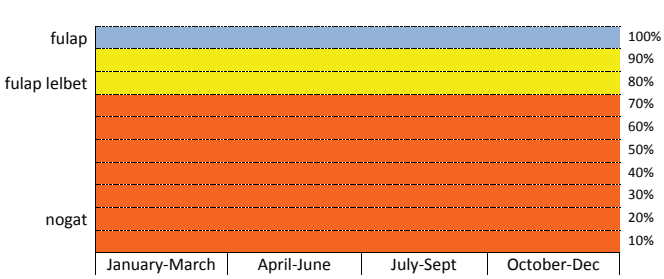
EXAMPLE MANAGEMENT ACTIONS:

- Ban harvest of fish smaller than 20 cm (introduce size limit)
- Ban the use of small-mesh gillnets
- Temporary/permanent ban of harvest in some areas or times (e.g. known spawning locations/months)
- Protection of local seagrass beds
- Ensure tabu areas are effective: closed, respected, large enough

1. Plot the portion (%) of pico **20 cm** or bigger in the total catch for the survey period
2. Depending on which coloured zone the data point is in follow the arrow to the suggested actions

*The initial target is that at least 70% of pico caught are larger than the critical size. Long term target should be ~100%

FINFISH SPECIES: **Siko/Snappers**




**COMMUNITY REPORTING/UPDATE**

**COMMUNITY DISCUSSION ABOUT POSSIBLE ISSUE & ACTIONS**

EXAMPLE MANAGEMENT RESPONSES:

- Put signs up
- Inform Vanuatu Fisheries Department

**COMMUNITY SELECTION OF MANAGEMENT ACTIONS**

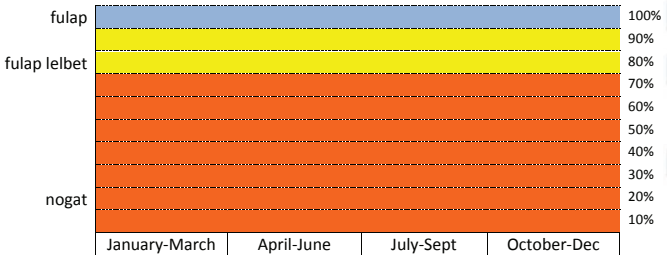
EXAMPLE MANAGEMENT ACTIONS:

- Ban harvest of fish smaller than 20 cm (***small*** siko species, e.g. species pictured left)
- Ban harvest of fish smaller than 35 cm (***large*** siko species)
- Ban the use of small-mesh gillnets
- Temporary/permanent ban of harvest in some areas or times (e.g. known spawning locations/months)
- Ensure tabu areas are effective: closed, respected, large enough

1. Plot the portion (%) of siko **20 cm** and bigger (small species) or **35 cm** and bigger (large species) in the total catch for the survey period
2. Depending on which coloured zone the data point is in follow the arrow to the suggested actions

*The initial target is that at least 70% of siko caught are larger than the critical size. Long term target should be ~100%

FINFISH SPECIES: **Strong skin/Pocket knife fish/Surgeonfish**




**COMMUNITY REPORTING/UPDATE**

**COMMUNITY DISCUSSION ABOUT POSSIBLE ISSUE & ACTIONS**

EXAMPLE MANAGEMENT RESPONSES:

- Put signs up
- Inform Vanuatu Fisheries Department

**COMMUNITY SELECTION OF MANAGEMENT ACTIONS**

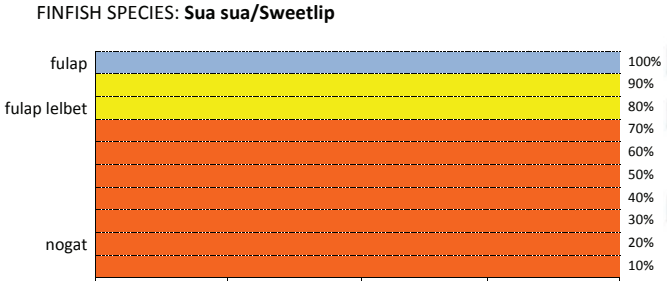
EXAMPLE MANAGEMENT ACTIONS:

- Ban harvest of fish smaller than 20 cm (introduce size limit)
- Ban the use of small-mesh gillnets
- Temporary/permanent ban of harvest in some areas or times (e.g. known spawning locations/months)
- Ensure tabu areas are effective: closed, respected, large enough

1. Plot the portion (%) of strong skin **20 cm** or bigger in the total catch for the survey period
2. Depending on which coloured zone the data point is in follow the arrow to the suggested actions

*The initial target is that at least 70% of strong skin caught are larger than the critical size. Long term target should be ~100%

FINFISH SPECIES: **Sua sua/Sweetlip**




**COMMUNITY REPORTING/UPDATE**

**COMMUNITY DISCUSSION ABOUT POSSIBLE ISSUE & ACTIONS**

EXAMPLE MANAGEMENT RESPONSES:

- Put signs up
- Inform Vanuatu Fisheries Department

**COMMUNITY SELECTION OF MANAGEMENT ACTIONS**

EXAMPLE MANAGEMENT ACTIONS:

- Ban harvest of fish smaller than 30 cm (introduce size limit)
- Ban the use of small-mesh gillnets
- Ban spearfishing at night (protects larger breeding fish)
- Ensure tabu areas are effective: closed, respected, large enough

1. Plot the portion (%) of sua sua **30 cm** or bigger in the total catch for the survey period
2. Depending on which coloured zone the data point is in follow the arrow to the suggested actions

*The initial target is that at least 70% of sua sua caught are larger than the critical size. Long term target should be ~100%

## Module 1 References:


Adams, S., Mapstone, B.D., Russ, G.R., Davies, C.R. (2000) Geographic variation in the sex ratio, sex specific size, and age structure of Plectropomus leopardus (Serranidae) between reefs open and closed to fishing on the Great Barrier Reef. Can J Fish Aquat Sci, 57: 1448–1458.

Anand, P.E.V., Pillai, N.G.K. (2002) Reproductive biology of some common coral reef fishes of the Indian EEZ. Journal of the Marine Biological Association of India 44(1&2): 122-135.

Barba, J. (2010) Demography of parrotfish: age, size and reproductive variables. Masters (Research) thesis, James Cook University, Townsville, Australia.

Chan, T.T.C., Sadovy, Y. (2002) Reproductive biology, age and growth in the chocolate hind, Cephalopholis boenak (Bloch, 1790), in Hong Kong. Marine and Freshwater Research 53: 791-803.

Craig, P.C., Choat, J.H., Axe, L.M., Saucerman, S. (1997) Population biology and harvest of the coral reef surgeonfish Acanuthurus lineatus in American Samoa. Fishery Bulletin 95(4):680-693.

Ferreira, B.P. (1995) Reproduction of the common coral trout Plectropomus leopardus (Serranidae: Epinephelinae) from the central and northern Great Barrier Reef. Bull Mar Sci, 56: 653–669.

Forum Fisheries Agency Regional MCS Strategy (2010- 2015)

Friedlander, A.M., Parrish, J.D., DeFelice, R.C. (2002) Ecology of the introduced snapper Lutjanus kasmira (Forsskal) in the reef fish assemblage of a Hawaiian Bay. Journal of Fish Biology 60: 28-48.

Gillett, R.D. (2016) Fisheries in the Economies of Pacific Island Countries and Territories. Pacific Community (SPC) 2016 (2nd edition), Noumea, New Caledonia, 688p.

Grandcourt E.M., Al Abdessalaam, T.S., Francis, F., Al Shamsi, A.T. (2011) Reproductive biology and implications for management of the painted sweetlips Diagramma pictum in the southern Arabian Gulf. Journal of Fish Biology 79:615-632.

Heupel, M.R., Penny, A., Williams, A.J., Kritzer, J.P., Welch, D.J., Marriott, R.J., Davies, C.R., Mapstone, B.D. (2010) Demographic characteristics of exploited tropical lutjanids: a comparative analysis. Fishery Bulletin 108:420-432.

Longenecker, K., Langston, R., Bolick, H., Kondio, U. (2011) Reproduction, Catch, and Size Structure of Exploited Reef-Fishes at Kamiali Wildlife Management Area, Papua New Guinea. Bishop Museum Technical Report 57. 169 pp.

Longenecker, K., Langston, R., Bolick, H., Kondio, U. (2013a) Rapid reproductive analysis and length-weight relation for red-bellied fusilier, Caesio cuning, and longfin emperor, Lethrinus erythropterus (Actinopterygii: Perciformes: Caesionidae and Lethrinidae) from a remote village in Papua New Guinea. Acta Ichthyologica et Piscatoria 43(1):51-55.

Longenecker, K., Langston, R., Bolick, H., Kondio, U. (2013b) Size and Reproduction of Exploited Reef Fishes at Kamiali Wildlife Management Area, Papua New Guinea. Contribution No. 2013-008 to the Pacific Biological Survey, Honolulu, Hawaii.

Melanesian Spearhead Group Coastal Fisheries Roadmap (2015-2024)

Mishina, H., Gonzares, B., Pagaliawan, H., Moteki, M., Kohno, H. (2006) Reproductive biology of blacktip grouper, Epinephelus fasciatus, in Sulu Sea, Philippines. La Mer 44: 23-31.

Moore, B., Colas, B. (2016) Identification guide to the common coastal food fishes of the Pacific Islands region. Pacific Community (SPC), Noumea, New Caledonia. 140p.

Noumea Strategy: A new song for coastal fisheries – pathways to change (2015)

Pacific Regional Roadmap on Fisheries (2010)

Samoa Pathway (2014)

Vanuatu Fisheries Act and Regulations (2009)

Vanuatu National Fisheries Policy (2016–2031)

Welch, D. (2016) Broadscale assessment of the status of coastal finfish in North Efate, Vanuatu. Report to the Pacific Community (SPC), Noumea, New Caledonia, and Agence Francaise de Developpement, Paris, France. Vanuatu RESCCUE project, 31p.

# NOTES

# MODULE 2

# Intertidal Invertebrate Surveys

Photo: David Welch

## MODULE 2: INTERTIDAL INVERTEBRATE SURVEYS

### Relevant laws and rules:

Vanuatu Fisheries Act and Regulations 2009; National Fisheries Policy 2016–2031; Sea Cucumber Management Plan 2015; National green snail, triton shell and trochus restrictions.

### Purpose:

Invertebrates play important roles in marine environments. Some eat algae (e.g. green snail), others 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.

This module aims to enable communities to assess the status and detect changes in intertidal invertebrates that are locally important. This will help to raise community awareness of these species and enable them to take appropriate action to ensure that populations are healthy to maintain local fisheries as well as their ecological functions. Key invertebrate species of interest to local communities are: giant clam, sea cucumbers, green snail and trochus. Because green snail and trochus live in less accessible areas (e.g. reef crests) and are monitored by a national fisheries program, this module focuses on counting the number of giant clam and sea cucumbers as they live in the more accessible intertidal areas.

Some of these intertidal species are monitored by the Vanuatu Fisheries Department (https://fisheries.gov.vu/index.php/sea-cucumbers) and are subject to national harvest restrictions or bans (see table below). Resource monitors should be familiar with these regulations and the Networks should play a role in ensuring the wider community is also aware of the regulations.

| Invertebrate | | Restrictions and limits |
|---|---|---|
| **Giant Clam** |  | No specific national measures in place but covered by the Convention of International Trade in Endangered Species (CITES) to manage over-exploitation for trade. |
| **Sea Cucumber (beche-de-mer)** |  | Catch limits defined for specific areas in North Efate for some species. Harvest is managed under a 5-year national management plan 2015–2020. Complete ban on collecting, possessing, selling or purchasing any beche-de-mer from Ja ua y 2008 to January 2013 was continued until the national management plan was la nched in 2015. |
| **Green Snail** |  | A person must not, take, have in his/her possession, sell or purchase any green snail in the period 1 October 2005 to 1 October 2020. |
| **Trochus** |  | Minimum size across the base 90mm dia n eter.<br>Export permit required.<br>National catch quota: 500 tonnes per year. |

## METHOD

### Materials:

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

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

### Site selection:

Choose a survey site that is easy to access, and where you would expect to see the invertebrates being monitored. This could be a reef flat or seagrass meadow. Survey at least 2 sites in your marine area, so you can compare results and decide if management actions are working.


**Figure 3. Example of suitable invertebrate survey sites and transects for surveys.**

It is recommended that the same sites are resurveyed each time so they can be compared. Naming or mapping the sites can help find them each time. At each site, aim to survey along 4 straight paths (transects) chosen randomly with at least 50 m between each transect (Figure 3). Each transect should be 50 m long and 2 m wide. If tabu areas are being monitored, there should be at least 1 site within the tabu area and at least 1 site outside to compare invertebrate populations.

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

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

**Conducting the survey:** Before starting, spend 5 minutes checking your site and note:

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

Choose your site and select the starting point of the first transect path. It is recommended that you choose each transect randomly and return to the same starting point for resurveys. You can either walk the transect if the site is exposed at low tide or snorkel if it is in shallow water. As you walk/snorkel the 50 m transect path (approximately 70-80 paces or 50 fin kicks), write down what you see in an area as wide as your arm span, which represents approx. 2 m wide.

**Data collection:**

Survey information should be collected using the data sheet below. This sheet can be modified to add further information over time, however keeping it consistent is important.

You will need to fill in **one form for each site**. Using your slate and pencil, count and record the number of each target species that you see along the transect path but only those inside 2 m width of the transect. Once you have completed all 4 surveys at your site, calculate the average. You do this by adding the counts for all transects in that site together and dividing by the number of transects you conduct (see example below). This will provide an estimate of the density of each species, which can then be plotted on a scale from *nogat* (likely overfished) to *fulap* (healthy population). The density is simply the average number of each species in the area you counted them but expressed as the number for each square metre (m2; 1 x 1 m area).

Using lollyfish as an example where four transects are counted:

| T1 | T2 | T3 | T4 |
|---|---|---|---|
| 4 | 8 | 7 | 5 |

| Average (total ÷ 4) |
|---|
| 6 |

Based on the 'health status' scale lollyfish would be assessed as smol:

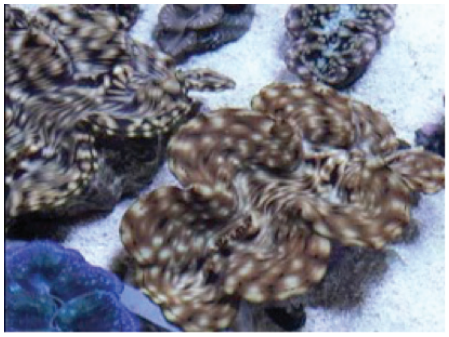
|----------|-X----------|----------|

| nogat (0) | smol (5) | fulap lelbet (30) | fulap (51+) |
|---|---|---|---|

### Giant clam:

There are many species of giant clam found in North Efate, but the most common are the maxima clam and the fluted giant clam (see photos below). For both species, the juvenile matures to an adult after 2–3 years, and is 12–15 cm long (Van Wynsberge et al. 2013).

**Maxima clam *(Tricdacna maxima)***



**Fluted giant clam *(Tridacna squamosa)***

The density of giant clams can vary between locations, due to sea conditions such as temperature, depth, tides, and water quality, as well as harvesting (Table 3).

**Table 3. Density estimates from published Pacific studies used to assess the health of giant clams for the areas surveyed.**

| | Density | Number over 50m transect |
|---|---|---|
| **nogat** | <0.5 per m2 | 0 – 50 |
| **smol** | 0.5 - 2 per m2 | 51 – 200 |
| **fulap lelbet** | 2 - 5 per m2 | 201 – 500 |
| **fulap** | 5 per m2 | 500 or more |

### Sea cucumber:

There are more than 20 species of sea cucumber in Vanuatu harvested for export, and most local populations are depleted (Pakoa 2014). Some slow-growing species, e.g. black teatfish, can take up to 10 years or more to recover (Uthicke et al. 2004). The Vanuatu Fisheries Department has introduced a new Total Allowable Catch system in some areas that aims to promote recovery. Minimum sizes have been defined for the commercial species, and range from 20–25 cm for most species (Vanuatu Fisheries Regulations).

Defining a healthy density for sea cucumbers is difficult and will vary between species and habitats. Our estimates of density for each species that correspond to the different levels of the *nogat* (unhealthy, overfished) to *fulap* (healthy) scale were derived from a review of available scientific information throughout the Pacific (see Table 4). Because of previous overfishing, the population of some species are so low that they may not be seen during surveys. The three indicator species for this survey are found in shallow intertidal reef areas although sandfish prefer sandy/muddy substrates often near seagrass beds (Mercier et al. 2000).

The three reef flat sea cucumber species included in this monitoring module are:

**Table 4. Density estimates for assessing the health of the 3 sea cucumber species for the areas surveyed (Toral-Grande et al. 2008; Anon 2003; Drumm 2004; Chambers 1990; Purcell, S. unpublished data; Stewart 1993; Friedman, K. unpublished data; Purcell et al. 2009).**

**LOLLYFISH** *(Holothuria atra)* Lolifis:

| | Density | Count of Lollyfish per 50m transect |
|---|---|---|
| **nogat** | <0.05 per m2 | 0 – 4 |
| **smol** | 0.05-0.3 per m2 | 5 – 30 |
| **fulap lelbet** | 0.3 – 0.5 per m2 | 31 – 50 |
| **fulap** | >0.5 per m2 | 51 or more |

**SANDFISH:** *(Holothuria scabra)* Sanfis:

| | Density | Count of Sandfish per 50m transect |
|---|---|---|
| **nogat** | <0.003 per m2 | 0 – 0.3 |
| **smol** | 0.003-0.029 per m2 | 0.3 – 2 |
| **fulap lelbet** | 0.03 – 0.06 per m2 | 3 – 5 |
| **fulap** | >0.06 per m2 | 6 or more |

**GREENFISH:** *(Stichopus chloronotus)* Krinfis:

| | Density | Count of Greenfish per 50m transect |
|---|---|---|
| **nogat** | <0.01 per m2 | 0 – 1 |
| **smol** | 0.01 – 0.15 per m2 | 2 – 15 |
| **fulap lelbet** | 0.15 – 0.3 per m2 | 16 – 30 |
| **fulap** | >0.3 per m2 | 31 or more |

# EXAMPLE INTERTIDAL INVERTEBRATE SURVEY

**Site description (ONE form per site)**

Resource monitor names: *Julie, Leisavi* | Village: *Sunae*

Site name: *Main beach* | Date: *30 June 2018* | Time: *9:10 am*

Weather: *Overcast, cool* | Tide height: *Low tide (0.2 m)*

**Habitat (circle)** Reef flat Seagrass Sand flat (Rocky shore) Other

**GIANT CLAM**

| | |
|---|---|
| Transect | // |
| Transect | ///// |
| Transect | / |
| Transect | /// |

**Total number counted:**

| T1 | T2 | T3 | T4 | Average |
|---|---|---|---|---|
| 2 | 5 | 1 | 3 | 3 |

|-X----------|----------|----------|
nogat (0) | smol (50) | fulap lelbet (200) | fulap (500+)

**LOLLY FISH**

| Transect 1: | Transect 2: | Transect 3: | Transect 4: |
|---|---|---|---|
| //// | ///// //// | ///// ///// // | ///// / |

**Total number counted:**

| T1 | T2 | T3 | T4 | Average |
|---|---|---|---|---|
| 4 | 9 | 12 | 6 | 8 |

|----------|-X----------|----------|
nogat (0) | smol (5) | fulap lelbet (30) | fulap (51+)

**SANDFISH**

| Transect 1: | Transect 2: | Transect 3: | Transect 4: |
|---|---|---|---|
| / | | | / |

**Total number counted:**

| T1 | T2 | T3 | T4 | Average |
|---|---|---|---|---|
| 1 | 0 | 0 | 1 | 0.25 |

|----------X-----|----------|----------|
nogat (0) | smol (0.3) | fulap lelbet (3) | fulap (6+)

**GREENFISH**

| Transect 1: | Transect 2: | Transect 3: | Transect 4: |
|---|---|---|---|
| //// | // | ///// / | ///// /// |

**Total number counted:**

| T1 | T2 | T3 | T4 | Average |
|---|---|---|---|---|
| 4 | 2 | 6 | 8 | 5 |

|----------|---------X----------|----------|
nogat (0) | smol (2) | fulap lelbet (16) | fulap (30+)

## DATA REPORTING

Data analysis for the Invertebrate module is simple and involves marking the results directly on the data reporting sheet (shown below) for the month the information was collected. The data reporting graph will show whether the results are in the blue, yellow or red zone. This should be completed for each species and each survey, as shown on the following page. The Community Monitors should keep all reporting sheets in a folder, stored in a central Resource Centre.

### Management options:

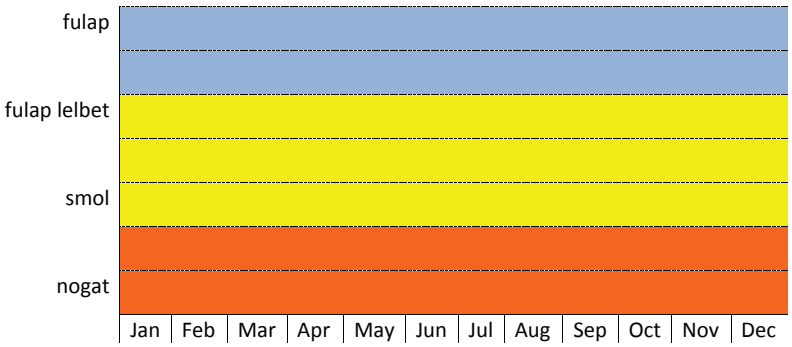
The reporting sheet provides a guide on the management actions that might be suitable given where the survey results are marked (e.g. in the blue, yellow or red zone). For instance:

- Results in the ***blue zone*** (fulap) would indicate a healthy population and should be reported to the community for raising awareness about monitoring and the species.
- Results in the ***yellow zone*** (smol or fulap lelbet) indicate a possible issue. Monitors should have a community meeting with the Chief and village to discuss the results, possible reasons for the results, and actions. Example management actions include: community awareness raising (such as information on notice boards), discussion with the Vanuatu Fisheries De partment to request formal monitoring, and 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*** (nogat) indicate that there is an issue and should follow the recom mendations for the yellow zone, with more immediate management actions suggested. This could include further restrictions on harvest or stronger enforcement of existing rules.

These actions will vary between villages and should be guided by local experience, the village Chief and the management recommendations already established in local village management plans.

A field quick guide is provided in Appendix 2. Information sheets for awareness raising activities are provided in Appendix 3.

INVERTEBRATE SPECIES: _____




**COMMUNITY REPORTING/UPDATE**

**COMMUNITY DISCUSSION ABOUT POSSIBLE ISSUE & ACTIONS**

EXAMPLE MANAGEMENT RESPONSES:

- Awareness raising (information signs) in communities
- Inform/discuss with Vanuatu Fisheries

**COMMUNITY SELECT MANAGEMENT ACTIONS**

EXAMPLE MANAGEMENT ACTIONS:

- Set catch limits on declining species
- Limit gear for harvesting declining species
- Temporary/permanent ban of harvest
- Contact Vanuatu Fisheries for detailed assessment
- Minimise other pressures on the declining species
- Prepare species recovery plan (if none exists)

## Module 2 References:

Anon. (2003) Invertebrate Survey for Airai State. Report prepared for The Environment Inc., Koror, Republic of Palau.

Drumm, D. (2004) Habitats and Macroinvertebrate Fauna of the Reef-top of Raratonga, Cook Islands: Implications for Fisheries and Conservation Management. Unpublished Ph.D. Thesis, University of Otagao, Dunedin, New Zealand.

Chambers, M.R. (1990) A survey of beche-de-mer of Vanuatu. pp. 86–91. In: T.J. Done and K.F. Navin (eds). Vanuatu marine resources. Australian Institute of Marine Science, Townsville. 272 p.

Toral-Granda, V., Lovatelli, A. and Vasconcellos, M. (eds). (2008) Sea cucumbers: A global review of fisheries and trade. FAO Fisheries and Aquaculture Technical Paper. No. 516. Rome, FAO. 2008. 317p.

Gilbert, A., Andréfouët, S., Yan, L., Remoissenet, G. (2006) The giant clam Tridacna maxima populations of three French Polynesia islands: comparison of their population sizes and structures at early stages of their exploitation. e ICES Journal of Marine Science, 63: 1573e1589.

Jameson, S. (1976) Early Life History of the giant Clams Tridacna crocea Lamarck, Tridacna maxima (Röding), and Hippopus hippopus (Linnaeus). Pacific Science 30: 219–233

Mercier, A., Battaglene, S.C., and Hamel, J.F. (2000). Settlement preferences and early migration of the tropical sea cucumber, Holothuria scabra. Journal of Experimental Marine Biology and Ecology, 249(1): 89-110.

National green snail, triton shell and trochus restrictions

Pakoa, K., Raubani, J., Siaosi, F., Amos, G., Ham, J. (2014) The status of sea cucumber fisheries and resources in Vanuatu: November 2013. Secretariat of the Pacific Community (SPC), Noumea, New Caledonia, 2014.

Purcell, S.W., Gossuin, H. and Agudo, N.N. (2009) Status and management of the sea cucumber fishery of la Grande Terre, New Caledonia. Programme ZoNéCo. WorldFish Center Studies and Reviews No. 1901. The WorldFish Center, Penang, Malaysia. 138 p.

Sea Cucumber Management Plan 2015

Stewart, B. (1993) Evidence for a Marked Decline of Beche-de-Mer Populations in the Suva and Beqa Areas of Fiji, and a Preliminary Description of a Method of Identifying Beche- de-Mer Individuals based on Characteristic Body Wrinkles. University of the South Pacific Marine Studies Technical Report, No.1. Suva, USP.

Uthicke, S. (2001) Interactions between sediment-feeders and microalgae on coral reefs: grazing losses versus production enhancement. Marine Ecology Progress Series, 210: 125–138.

Uthicke, S., Benzie, J. (2001) Effect of bêche-de-mer fishing on densities and size structure of Holothuria nobilis (Echinodermata: Holothuroidea) populations on the Great Barrier Reef. Coral reefs, 19(3), 271-276.

Uthicke, S. and D.W. Klumpp. (1998) Microbenthos community production in sediments of a near shore coral reef: seasonal variation and response to ammonium recycled by holothurians. Marine Ecology Progress Series, 169: 1–11.

Uthicke, S., Welch, D.J., Benzie, J.A.H. (2004) Slow growth and lack of recovery in overfished holothurians on the Great Barrier Reef: Evidence from DNA fingerprints and repeated large-scale surveys. Conservation Biology, 18(5): 1395-1404.

Vanuatu Fisheries Act and Regulations 2009

Vanuatu National Fisheries Policy 2016–2031

Van Wynsberge, S., Andréfouët, S., Gilbert, A., Stein, A., Remoissenet, G. (2013) Best Management Strategies for Sustainable Giant Clam Fishery in French Polynesia Islands: Answers from a Spatial Modeling Approach. PLoS ONE, 8(5), e64641.

# MODULE 3

# Reef Surveys

Photo: Johanna Johnson

## MODULE 3: REEF HEALTH SURVEYS

### Relevant laws and rules:

Vanuatu Fisheries Act and Regulations 2009; Vanuatu National Sustainable Development Program and Policy 2016–2030.

### Purpose:

Coral reefs are complex and changing ecosystems that are usually dominated by corals and support hundreds of species of plants and animals. Diverse habitats and species are important in ensuring coral reefs are healthy. This Reef Health Module aims to understand reef habitat condition and the impacts that can affect reefs.

The Reef health surveys provide a tool for:

- regular reef health check-ups, and
- early warning of any impacts that damage the reef.

Regular monitoring also helps monitors to become familiar with their reefs, enabling them to immediately identify changes.

## METHOD

### Materials:

- Underwater slate with reef indicators written on it
- Pencil
- Mask and snorkel (fins are optional)

**Time:** 20 minutes per site. Total of 40 minutes for 2 sites plus time for consensus discussion.

### Site Selection:

Choose a site that is typical of the main reef type in your marine area (Figure 4). Survey at least 2 sites in your village area, so you can compare results and decide if management actions are working.

It is recommended that the same sites are resurveyed each time so they can be compared. Marking or mapping the sites can help find them each time (see box below). Include at least 1 site in the village tabu area and 1 site in an open area, so that you can compare results and decide if your tabu area is meeting your community objectives.

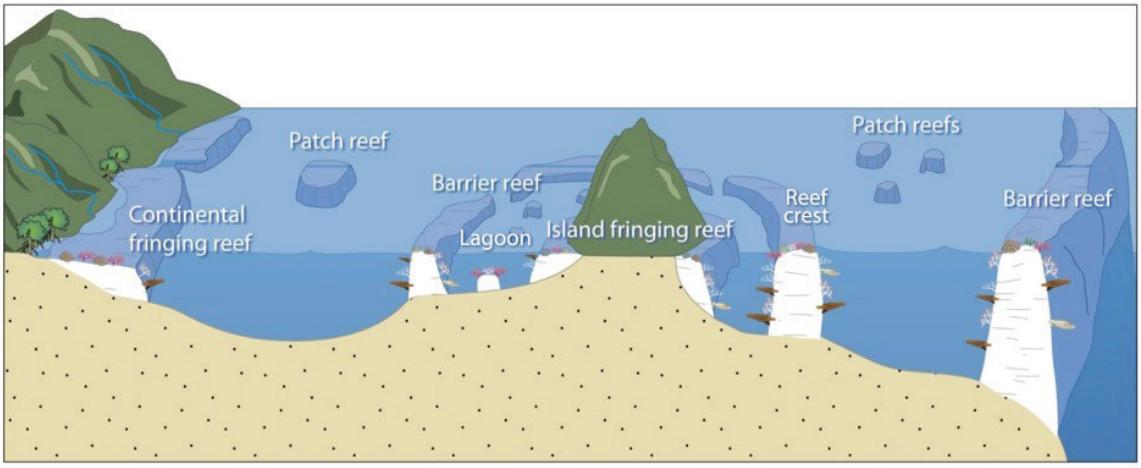



**Figure 4. Different types and locations of tropical coral reefs (Source: Hoegh-Guldberg et al. 2011).**

Choose sites 2–6 m deep so you can see the reef clearly when snorkelling. All sites should be similar depth and habitat type (e.g. fringing reef), and should be at least 100 m apart to get a good overview of the whole reef area. It is important that each monitor surveys the same area. Having prominent landmarks at the start and end of your survey area is a good idea.

Starting at one end swim steadily and record information on general indicators (reef structure, live coral). Once you reach the end of your survey area (marked by your land mark) swim back to the start point taking time to investigate the smaller details of the reef, including indicators that need a detailed look (e.g. bleaching, crown-of-thorns starfish).

**Frequency:** How often you do a reef health survey will depend on your community, and each village can decide together (see table below).

| Monitoring type | Frequency (once every) |
|---|---|
| Routine monitoring | 3 months |
| Tabu area effectiveness | 6 months |
| Impact risk monitoring | High risk period (e.g. summer season for coral bleaching) |
| Impact response monitoring | Within 1 month of impact occurring |

**Number of monitors:** This module uses a consensus (or agreement) process (see box below). If possible 4 monitors should survey the reef at the same time and then compare their results. If 4 monitors aren't available either postpone the survey until they are available or carry out the survey with 3 monitors. This way, there is less chance of any one person affecting the results.

### *Discuss your coral reef before monitoring*

Each coral reef is different and over time condition changes due to natural events (e.g. tropical cyclones) and human uses (e.g. overfishing). Resource monitors and communities who use local reefs are usually the first to notice these changes, and many remember the history of their reef. Discussing your local reef will be a process that each village goes through with their Chiefs and Elders who remember how the reefs used to be. That way, the monitoring can measure reef condition now and implement management actions based on how it used to be when it was considered healthy and had lots of fish and invertebrates.

This is a consensus process for the whole village to decide what is a "healthy" reef for their local marine area, and in what condition they want their reefs to be. It could be that local reefs are recovering from a tropical cyclone, in which case, the goal would be to measure the improvement in condition. Or reefs could be the same as village Elders remember from 40 years ago when they were children, so monitoring would check that it stays fulap.

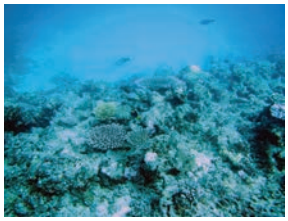
**Conducting the survey:** Snorkel the reef site and record what you see for the indicators of coral reef health or impact using a slate and pencil (or nail and coconut palm frond) to write on the data sheet provided.

The following sections detail each of the 7 reef health or impact indicators and provide a guide for recording each one on a scale of nogat to fulap. Each community should discuss their reefs before monitoring begins (see box above).

**Reef Health Indicators:**

The 7 reef health indicators are important for reef habitat condition and signs of impacts. You may decide to use them all, or choose only the ones that best suit your reef or management needs. Detailed information on each indicator is in Appendix 3.

**1. Reef Structure (habitat complexity)** – Coral provides the structure of reefs, and the habitat that supports fish and invertebrates. The more complex the reef is, with different sizes and types of corals, the more space it provides for fish and invertebrates to live in and use. Record the general habitat complexity over the whole site, on a scale of nogat to fulap.

| | | |
|---|---|---|
| Smooth, low profile, small or encrusting corals (or sand areas) | **nogat** |  |
| A little complex, few holes and cracks, small corals | **smol** |  |
| Medium complexity, some holes and cracks, plate corals | **fulap lelbet** |  |
| High complexity, lots of holes and cracks, old la ge corals | **fulap** |  |

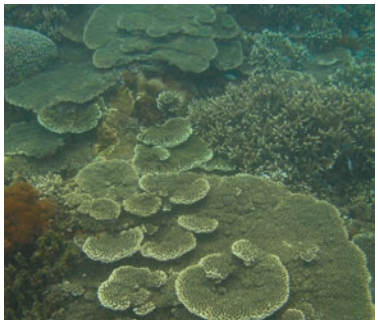
**2. Live Hard Coral** – Record cover of living hard coral. It's easy to tell the difference between live and dead coral as live coral is colourful and doesn't have algae growing on it. There are many different types of hard coral but monitors don't need to learn coral types.

Monitors needs to estimate how much of the reef is covered in live coral, and mark it on the scale based on the table below. The scale is based on work done on the Great Barrier Reef (Thompson et al. 2017), recent monitoring in North Efate that documented coral cover ranging from 3% to 78% (Johnson et al. 2016)[3], and Pacific regional data for average coral cover in 2015-2016 of 26% (GCRMN 2018).

| | |
|---|---|
| No or very low live hard corel cover (0-5%) | nogat |
| Low live hard coral cover (6-10%) | smol |
| Moderate live hard coral cover (11-30%) | fulap lelbet |
| High live hard coral cover (>30%) | fulap |

**3. Reef diversity** – Record how many different types of coral, fish and invertebrates there are on the reef. As you snorkel through the survey site ask yourself: does the reef have lots of different kinds of corals, fish and invertebrates? Look for lots of different shapes, sizes and colours in the coral. Do you see many different types of shells (e.g. giant clam, coral clams, trochus)? How many different types of fish do you see? Are there many different shapes, colours and sizes of fish? Below is a guide for recording reef diversity on the scale of nogat to fulap. A fulap reef will have many species of coral fish and invertebrates while a nogat reef would have very few.

| | |
|---|---|
| Very few different types of corals, fish & invertebrates | nogat |
| Some different types of corals, fish & invertebrates | smol |
| Many different types of corals, fish & invertebrates | fulap lelbet |
| Very many different types of corals, fish & invertebrates | fulap |



**Healthy reefs (fulap) with plenty of diversity**

[3]Reef Check surveys in 2009–2011; RESCCUE reef surveys in 2015–2017.

### Reef Impact Indicators:

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

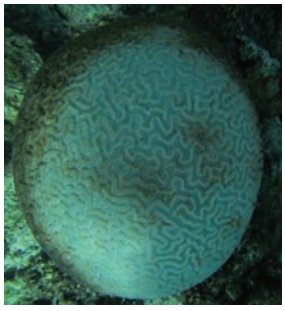
**1. Algae cover** – Algae and seaweeds are a natural part of the reef but if there is too much it can be a sign that the reef is unhealthy. When algae covers live coral it blocks out sunlight and makes it hard for the coral to grow. When the algae covers bare rocks, new corals can't settle.
A healthy reef has only a small amount of algae growing, much less than the amount of live coral. An unhealthy reef has a lot of algae and it will be growing over the coral, in-between coral and on bare rock.

Monitors need to estimate how much of the reef is covered in algae or seaweeds, and mark it on the scale based on the table below. The scale is based on recent monitoring in North Efate that documented algae cover ranging from 2% to 66% (Johnson et al. 2016)[4], and average algae cover in 2015-2016 of 25% (GCRMN 2018).

| | |
|---|---|
| No or very low algae cover (0-5%) | nogat |
| Low algae cover (6-10%) | smol |
| Moderate algae cover (11-25%) | fulap lelbet |
| High algae cover (>25%) | fulap |

**2. Coral bleaching** – Coral bleaching occurs when the ocean water gets too warm. 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 water cools. Monitoring for coral bleaching is especially important in the summer months when the water is likely to be warmest.

**Bleached Pale/Fluoro**



**Bleached Upper**

**Bleached White**

[4]Reef Check surveys in 2009–2011; RESCCUE reef surveys in 2015–2017.

Bleaching can affect individual corals or sometimes, entire sections of the reef. During each survey, take note of even a small amount of bleaching, as this may be an early warning that more severe bleaching may happen soon. Also note the overall amount of bleaching in the whole survey area. Try to estimate the amount of live coral that is showing signs of bleaching or that has recently died and mark your scale accordingly. Use the following table as a guide:

| | |
|---|---|
| No bleaching seen | nogat |
| Some corals bleached (1-10%) | smol |
| Many corals bleached (11-50%) | fulap lelbet |
| Lots to almost all of the corals bleached (>50%) | fulap |

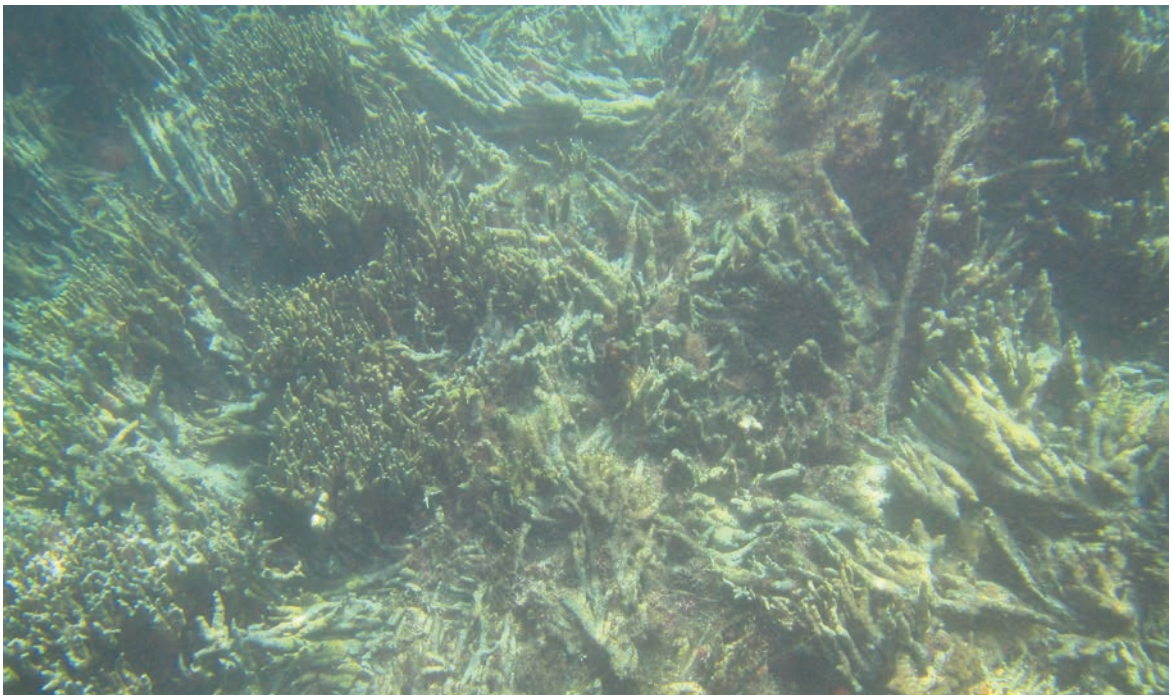
Importantly, bleached corals are not dead and can recover if conditions cool and there are no other pressures. However, bleached corals do represent a stressed reef, and coral recovery benefits from management actions that reduce other pressures.

**3. Crown-of-thorns starfish (COTS)** – It can be difficult to know what a normal population of COTS should be on a reef, but for the Reef Module the most important thing is to record all COTS seen or any signs of their activity. You may see the starfish itself or areas of coral that have been eaten by COTS. If you notice this while monitoring, make a note on the reef survey form and then go to Module 6 to report your observations using the Vanuatu Fisheries COTS reporting system.

| | |
|---|---|
| No COTS or COTS scars seen | nogat |
| Some COTS/scars on the reef (<2 per $10m^2$) | smol |
| Many COTS/scars on the reef (2-3 per $10m^2$) (beginning of outbreak) | fulap lelbet |
| Lots of COTS/scars on the reef (>3 per $10m^2$) (active outbreak) | fulap |

**4. Broken coral** – Recording the amount of coral damage and how much area is damaged provides information to help understand how long it takes the reef to recover, and if human caused, what management actions are needed. If you can recognise and record what is likely to have caused the damage (e.g. storm/cyclone, anchoring), it will help decide on 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.

| | |
|---|---|
| No reef dan g e | nogat |
| Some broken corals (1-10% coral damaged) | smol |
| Many broken corals (11-50% coral damaged) | fulap lelbet |
| Lots of broken corals (>50% coral damaged) | fulap |



***Things to remember while monitoring***

Swim in a slow and relaxed way so you do not disturb the fish and do not stand on or break coral.

Stay close together while swimming, so that you all survey the same area. It's important that each monitor marks their slates separately and do not share your results while you are in the water. You will share your results afterwards during the consensus process.

## EXAMPLE REEF HEALTH SURVEY

| **Site description (ONE form per site)** | | | |
|---|---|---|---|
| **Who** | Monitoring team: *John, Salome, Willie* | | |
| **Where** | Village: *Emao* | Site name: *Devil's point* | |
| **When** | Date: *10 October 2018* | | Time: *11:10 am* |
| **Conditions** | Weather: *Clear, calm* | | Tide: *High* |
| **Habitat (circle)** | Fringing reef | Lagoon | Reef flat |
| | Reef crest | Reef slope | Patch reef |
| **What did you see…** | | | |
| **1. Reef structure**<br>Comments: *Very complex, overhangs etc.* | \|----------\|----------\|---------X----------\|<br>nogat smol fulap lelbet fulap | | |
| **2. Coral cover**<br>Comments: *Agreed estimate of all monitors* | \|----------\|----------\|----------X-----\|<br>nogat (0) smol (10%) fulap lelbet (30%) fulap (>30%) | | |
| **3. Reef diversity**<br>Comments: *Many different types of corals and animals* | \|----------\|----------\|----------X-----\|<br>nogat (1) smol (5) fulap lelbet (10) fulap (>10) | | |
| **What impacts did you see…** | | | |
| **1. Algae cover**<br>Comments: *Mostly fleshy algae/seaweed* | \|----------X-----\|----------\|----------\|<br>nogat (0) smol (10%) fulap lelbet (25%) fulap (>25%) | | |
| **2. Coral bleaching**<br>Comments: *None seen* | \|X----------\|----------\|----------\|<br>nogat (0) smol (10%) fulap lelbet (50%) fulap (>50%) | | |
| **3. Crown-of-thorn starfish (COTS)**<br>Comments: *2 COTS seen by 1 monitor* | \|----------X\|----------\|----------\|<br>nogat (0) smol (<2/m²) fulap lelbet (2–3/m²) fulap (>3/m²) | | |
| **4. Broken coral**<br>Comments (note if storm damage or human): *Some old cyclone damage* | \|----------\|---X----------\|----------\|<br>nogat (0) smol (10%) fulap lelbet (50%) fulap (>50%) | | |

## 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 data reporting sheet to report back to community.

### The consensus process:

Reaching consensus is an important step and simply means everybody agrees about the state of the reef using the following steps:

1. Share your results and compare where you each marked all the reef health indicators.
2. Every monitor should have a chance to explain the reasons for their scores on the scale of nogat to fulap. 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 marks on each of the reef health indicator data sheets. 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 records on their slate. For example, if only one person sees a crown-of-thorns starfish in the survey area, that person will mark COTS as smol, whereas other monitors who didn't see any might mark them as nogat. 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 results 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 results and it will be easier to 'average' what each monitor records into a single score for the survey.

The data analysis and reporting are what informs your management decisions. There is one data reporting sheet for each reef health indicator. The blue section represents a good level of health. The yellow section indicates that there may be an issues and management actions should be discussed. The red zone indicates an issue and the need for immediate management actions.

### *Different data sheets for 'reef health' and 'reef impacts'*

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

For reef health indicators, 'fulap' indicates healthly and 'nogat' indicates that there is an issue. Whereas with the reef impacts indicators, 'fulap' indicates an issue and 'nogat' indicates a healthy state. The colour coding remains the same: blue indicates healthy conditions, yellow indicates potential problems with further investigation needed, and red indicates a problem and immediate management action.

Since coral reefs are complex, it is important to consider the different reef health indicators together to get an overall reef health assessment. Even if your reef is in a healthy state there may be some indicators that are within the yellow (caution) zone, or possibly even the red zone. In the case of reef impacts, if any one impact is in the red zone (e.g. coral bleaching) then immediate action is needed, even if the other impacts are in the blue zone.

Once results are marked on the data reporting sheets, monitors report back to the community about the findings and discuss any potential issues and management actions that might be needed.

**Management options for reef health indicators:**

The value of monitoring your reef area is that you can provide immediate information that can inform local management decisions. The reporting sheets provide a guide on the management actions that might be suitable given where the survey results are marked (e.g. in the blue, yellow or red zone). For instance, for the reef health indicators:

- Results in the ***blue zone*** (fulap) 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*** (smol or fulap lelbet) indicate a possible issue. It is recommended that Monitors hold a community meeting with the Chief and village to discuss the results, possible reasons for the results, and actions. Example management actions include community awareness raising (such as information on notice boards). Compare reef impact results and fish catch surveys as it may help identify the cause of any declines, and/or introducing fishing restrictions for blu fis and pico. During these fishing restrictions, monitors should re-survey the reef to record any change and report back to the community. 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*** (nogat) indicate that there is a serious issue, which calls for immediate management actions. This could include further restrictions on harvest or stronger enforcement of existing rules.

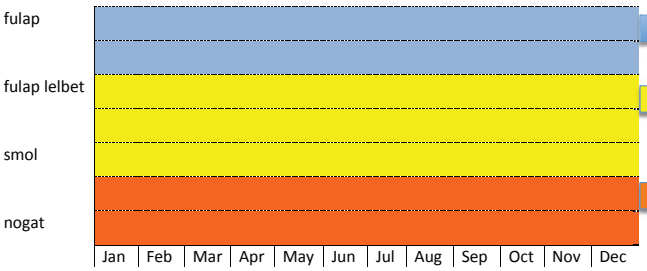
These actions will vary between villages and should be guided by local experience, the village Chief and the management recommendations already established in local village management plans.

**Management options for reef impact indicators:**

- Results in the ***blue zone*** (nogat) 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*** (smol or fulap lelbet) indicate a possible issue. It is recommended that monitors have a community meeting with the Chief 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), discussions to identify the cause of the impacts, and/or immediate management actions. Such actions would depend on the impact and could include posen sta removal, changing anchoring practices or land-based nutrient reductions. During the period following action, monitors should resurvey the reef to record any change and report back to the community. The discussions should also include review of the information, and if necessary, repeat the survey to confirm the results if they were not expected or cannot be easily explained.
- Results in the ***red zone*** (fulap) should follow the recommendations for the yellow zone, with more immediate management actions suggested. This could include further restrictions on harvest, land-based actions, stronger enforcement of existing rules, or identifying a new tb u a ea

A field quick guide is provided in Appendix 2. Information sheets for awareness raising activities are provided in Appendix 3.

**Reef Health: Structure/Hard coral /Reef diversity (circle one)**
**Date:**
**Monitors:**




**COMMUNITY REPORTING/UPDATE**

**COMMUNITY DISCUSSION ABOUT POSSIBLE ISSUE & ACTIONS**

EXAMPLE MANAGEMENT RESPONSES:

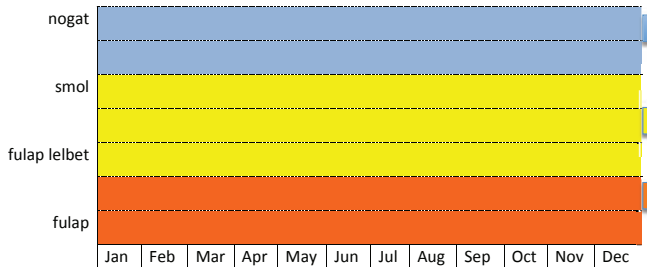
- Awareness raising with communities.
- Discuss recent trends (declines or impacts).
- Identify potential causes of declines or impacts (e.g. posen sta, bleaching).
- Discuss if immediate management action is required and/or continue to monitor.

**COMMUNITY SELECT MANAGEMENT ACTIONS**

EXAMPLE MANAGEMENT ACTIONS:

- Identify cause of decline (e.g. posen sta, bleaching, siltation from land runoff, overfishing).
- Instigate appropriate management action (from management plan if available).
- Review practices in tabu areas.
- Minimise other pressures on the reef.
- Contact network coordinators to discuss impacts on reefs in the network.

**Reef Impacts:Algae/Coral bleaching/COTS/Broken coral (circle)**
**Date:**
**Monitors:**

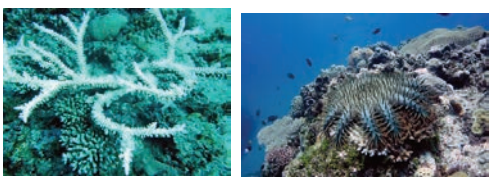



**COMMUNITY REPORTING/UPDATE**

**COMMUNITY DISCUSSION ABOUT POSSIBLE ISSUE & ACTIONS**

EXAMPLE MANAGEMENT RESPONSES:

- Awareness raising in communities.
- Discuss recent trends in impacts.
- Identify potential causes of impacts.
- Advise network coordinators of trends.
- Discuss possible management actions (e.g. posen sta removal) and continue to monitor



**COMMUNITY SELECT MANAGEMENT ACTIONS**

EXAMPLE MANAGEMENT ACTIONS:

- Instigate appropriate management action from management plan (e.g. posen sta removal).
- Minimise other pressures on reef area (e.g. eliminate/reduce nutrient runoff, fishing pressure).
- Review practices that can impact reefs (e.g. anchoring, reef walking, fishing gear that can entangled).
- Contact network coordinators for assessment and advice.

## Module 3 References:

Dumas, P., Leopold, M., Kaltavara, J., Williams, A., Kaku, R., Ham, J. (2012) Efficiency of tabu areas in Vanuatu (EFITAV project) Report.

Fraser, N., Crawford, B., Kusen, J. (2000) Best practices Guide for Crown-of-thorns starfish clean-ups. Proyek Pesisir Special Publication. Coastal Resources Center Coastal Management Report #2225. Coastal Resources Center, University of Rhode Island, Narragansett, Rhode Island. 38 pages.

Global Coral Reef Monitoring Network [GCRMN] (2018) Status and Trends of Coral Reefs of the Pacific. Edited by: Moritz C, Vii J, Tamelander J, Thomassin A, Anderson P, Lee Long W, Planes S.

Great Barrier Reef Eye on the Reef program: http://www.gbrmpa.gov.au/managing-the-reef/how-the-reefs-managed/eye-on-the-reef

Johnson, J.E., Hooper, E., Waterhouse, J., Dwyer, S., Kaltavara, J. (2018) Republic of Vanuatu Chapter. In: Global Coral Reef Monitoring Network – Status and trends of coral reefs of the Pacific. Moritz C, Vii J, Tamelander J, Thomassin A, Anderson P, Lee Long W, Planes S. (editors).

Johnson, J.E., Waterhouse, J., Devlin, M.J., Hooper, E. (2016) Marine Ecosystem Assessment: North Efate, Vanuatu. Report to the Pacific Community (SPC), Noumea, New Caledonia, and Agence Francaise de Developpement, Paris, France. Vanuatu RESCCUE project

Leopold, M., Beckensteiner, J, Kaltavara, J., Raubani, J., Caillon, S. (2013) Community-based management of near-shore fisheries in Vanuatu: What works? Marine Policy, 42, 167-176.

Monitoring Matters Network: http://www.monitoringmatters.org

Rambay, J. (2015) Sanma TVET Workshop: Crown-of-thorns and coral planting training. Report, Sanma Province

Thompson, A., Costello, P., Davidson, J., Logan, M., Coleman, G., Gunn, K., Schaffelke, B. (2017) Marine Monitoring Program. Annual Report for inshore coral reef monitoring: 2015 to 2016. Report for the Great Barrier Reef Marine Park Authority, Great Barrier Reef Marine Park Authority, Townsville, 133pp.

Vanuatu Fisheries Act and Regulations 2009.

Vanuatu National Sustainable Development Program and Policy 2016–2030.

# MODULE 4

# Mangrove Surveys

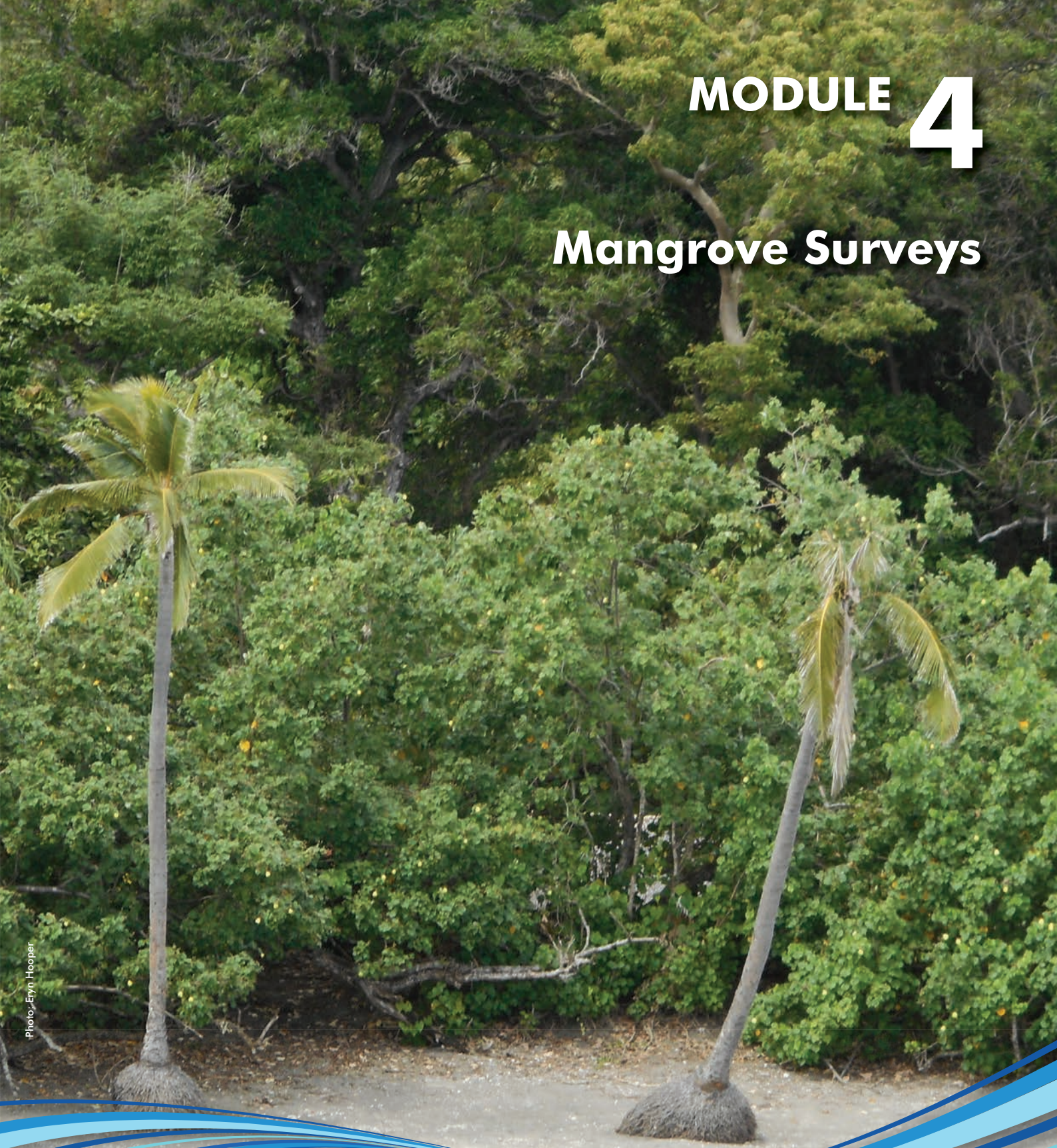


Photo: Eryn Hooper

## MODULE 4: MANGROVE SURVEYS

### Relevant laws and rules:

Vanuatu Fisheries Act and Regulations 2009; Vanuatu National Sustainable Development Program and Policy 2016–2030.

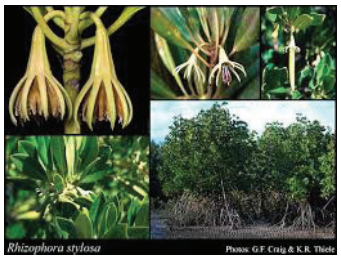
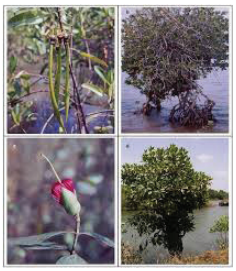
### Purpose:

Monitoring mangroves provides information that can be used to:

- Record if mangrove condition is stable, improving or declining, and
- Inform and improve local management of mangroves.

Mangroves are tidal marine plants that are covered by the tide twice a day. They provide a nutrient-rich habitat for lots of animals, including those targeted by fisheries such as crabs, fish, molluscs, marine turtles, and sharks and rays. Mangrove forests provide important ecosystem services, such as providing humans with food, trapping sediment and nutrient, filtering the 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 the 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/or take action sooner to protect mangroves.

Vanuatu has 23 species of mangroves (MESCAL 2013), and some of the more common species are shown below, however the mangrove module does not require monitors to learn species information.

| Mangrove Species | | Common Name |
|---|---|---|
| *Rhizophora stylosa* |  | Stilted mangrove, spotted mangrove |
| *Heriteria littoralis* |  | Looking-glass mangrove |
| *Brugiera gymnorhiza* |  | Black mangrove |
| *Ceriops tagal* |  | Yellow mangrove |
| *Sonneratia caseolaris* |  | Crabapple mangrove |
| *Avicennia marina* |  | Grey mangrove |

## METHOD

### Materials:

- Field survey sheet
- Pencil

**Time:** 10 minutes per quadrat. Total of 30 minutes per site.

**Figure 5. Example of suitable mangrove survey sites**

### Site selection:

Choose sites that are easy to access, and with mangroves that are typical of the local habitat. Survey at least 2 sites in your village area, so you can compare results and decide if management actions are working. Include at least 1 site in the tabu area and 1 site in an open area, to compare results and decide if the tabu area is meeting village objectives.

Alternatively, monitors can select 3 sites in the mangrove area based on distance from the ocean (Figure 5): 1 towards the sea (blue dot), 1 in the middle of the mangrove forest (red dot), and 1 on the closer to land (green dot).

At each site, 3 random 10 x 10 m areas (quadrats) are surveyed. It is recommended that the same sites are resurveyed each time so they can be compared.

**Frequency:** Once every 6 months as 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 compare results and reach agreement, and it is also safer.

**Conducting the survey:** Before starting, spend 5 minutes checking your site and record:

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

Choose the sites with your survey partner and select 3 random 10 x 10 m areas (quadrats) at each site (Figure 6). Use a natural feature or landmark to identify each site, so that the same site is resurveyed each time. Each 10 x 10 m area (quadrat) should be at least 25 m apart. Monitors should practice walking a 10 x 10 m area so the same quadrat area is surveyed each time.

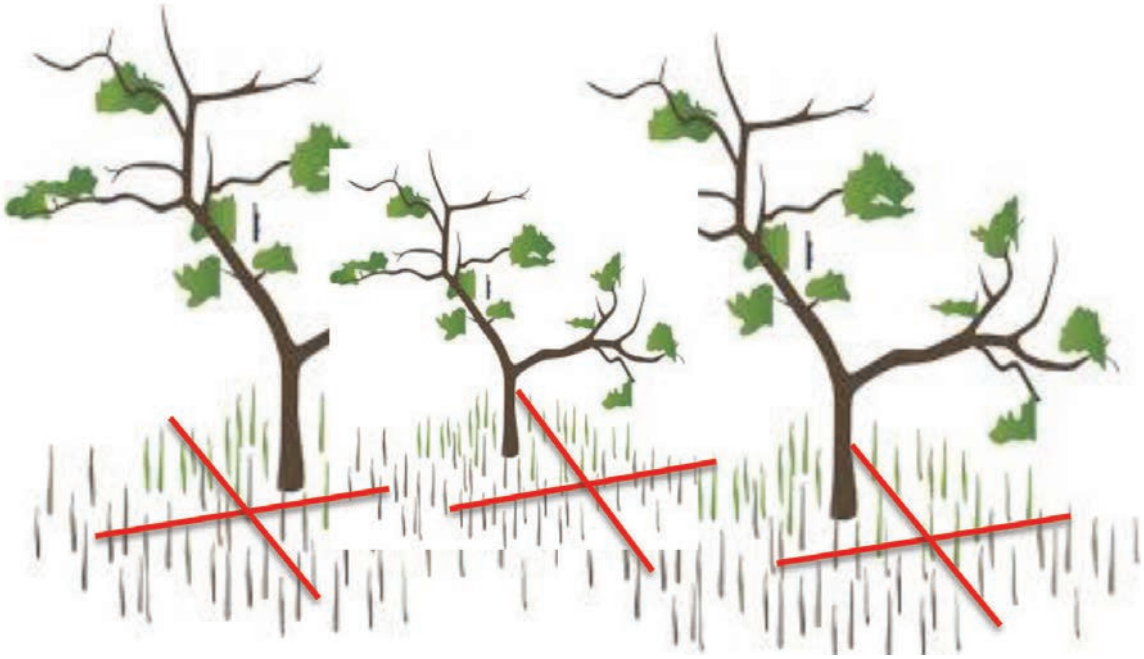


**Figure 6. Selecting 3 random 10 x 10 m survey areas (quadrats) at each site at least 25m apart.**

### Data collection:

Each monitor will have a field survey sheet and pencil so they can record the date and time of survey, the location, and what they see for each of the 6 indicators of mangrove condition. The following provides a guide for recording each indicator on a scale of nogat to fulap.

### 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 braches 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 tree (<30% cover) | nogat |
| Lots of gaps in canopy (30-75% cover) | smol |
| Some gaps in canopy (75-95% cover) | fulap lelbet |
| Continuous canopy (95-100% cover) | fulap |

## 2. Leaf colour:

Mangrove leaf colour can be a natural process of shedding old leaves, or a sign of stress, particularly if most of the leaves on a tree are turning yellow to brown. Lots of green leaves indicate healthy mangrove trees. Lots of yellow and brown leaves can be a sign of stress. Mark the amount of yellow and/or brown leaves for the mangrove trees in each quadrat by marking on the scale:

| | |
|---|---|
| All green leaves | nogat |
| Some yellow leaves (1-40% of leaves) | smol |
| Lots of yellow-brown leaves (40-90% of leaves) | fulap lelbet |
| Mostly yellow-brown leaves (90-100% of leaves) | fulap |

## 3. Insect damage to leaves:

Insects eat mangrove leaves naturally, however mangroves that have many leaves or leaf buds eaten and/or damaged by insects may be stressed or unhealthy. Mark the amount of insect damage for the mangrove trees in each quadrat by marking on the scale:

| | |
|---|---|
| No insect damage | nogat |
| Minor insect damage (1-40% of leaves) | smol |
| Lots of insect damage (40-90% of leaves) | fulap lelbet |
| Severe insect damage (90-100% of leaves) | fulap |

### 4. 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 'breath' through their roots. Mark the amount of twisted or damaged roots in each quadrat by marking on the scale:

| | |
|---|---|
| No damage or twisting | nogat |
| Minor damage (1-40% of roots) | smol |
| Lots of damage (40-90% of roots) | fulap lelbet |
| Severe damage (90-100% of roots) | fulap |

### 5. 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:

| | |
|---|---|
| No seedlings | nogat |
| Few seedlings (1-5 per quadrat) | smol |
| Many seedlings (6-10 per quadrat) | fulap lelbet |
| Abundant seedlings (more than 10 per quadrat) | fulap |

## 6. Impacts:

Mangroves can be impacted by natural disturbances, likes cyclones and storms, as well as human impacts from clearing, harvesting for timber, sand mining, and digging by animals. Signs of these impacts are important to know whether management actions are needed (example photos are below).

**Erosion around roots**

**Storm damage**

**Timber harvesting**

| | |
|---|---|
| No impacts seen | nogat |
| Minor impacts (some cutting, digging by pigs) | smol |
| High impacts (cut trees, clearing, bare mud) | fulap lelbet |
| Severe impacts (clearing, bare mud, few trees) | fulap |

## EXAMPLE MANGROVE SURVEY

| **Site description (ONE form per site)** | | | |
|---|---|---|---|
| **Who** | Monitoring team: *Minnie, Rebecca* | | |
| **Where** | Village: *Siviri* | Site name: *Headland* | |
| **When** | Date: *28 February 2018* | | Time: *2:45 pm* |
| **Conditions** | Weather: *Overcast and light rain* | | Tide: *mid-range* |
| **Location (circle)** | Seaward edge | (Mid-forest) | Landward edge |
| **What did you see?** | | | |
| **1. Mangrove canopy cover**<br>**Comments:** *Thick canopy with not much sunlight seen* | \|----------\|----------\|----------X----------\|<br>**nogat** (0-30%) **smol** (75%) **fulap lelbet** (95%) **fulap** (>95%) | | |
| **2. Leaf colour**<br>**Comments:** *Mostly green leaves with few yellow or brown* | \|----------\|----------\|-------X----------\|<br>**nogat** **smol** **fulap lelbet** **fulap** | | |
| **3. Insect damage to leaves**<br>**Comments:** *Only 1-2 leaves with holes* | \|----X----------\|----------\|----------\|<br>**nogat** (0) **smol** (40%) **fulap lelbet** (90%) **fulap** (>90%) | | |
| **4. Twisted or damaged roots**<br>**Comments:** *None seen* | \|-X----------\|----------\|----------\|<br>**nogat** (0) **smol** (40%) **fulap lelbet** (90%) **fulap** (>90%) | | |
| **5. Seedlings (new trees)**<br>**Comments:** *8 seedlings* | \|----------\|----------X-----\|----------\|<br>**nogat** (0) **smol** (5) **fulap lelbet** (10) **fulap** (>10) | | |
| **6. Impacts**<br>**Degree of impact:** | \|----------\|--X----------\|----------\|<br>**nogat** **smol** **fulap lelbet** **fulap** | | |
| **Type of impacts:** | **Circle all that apply:**<br>Storm damage (Timber harvesting) Erosion Clear & building<br>Sand mining Animals (e.g. pigs) Other | | |

## DATA REPORTING

Data analysis for the Mangrove module is simple and involves marking the results on the data reporting sheet shown below for the month the information was collected. This will show whether the results are in the blue, yellow or red zone. This should be completed for each indicator in each survey. The Community Monitors should keep all reporting sheets in a central folder.

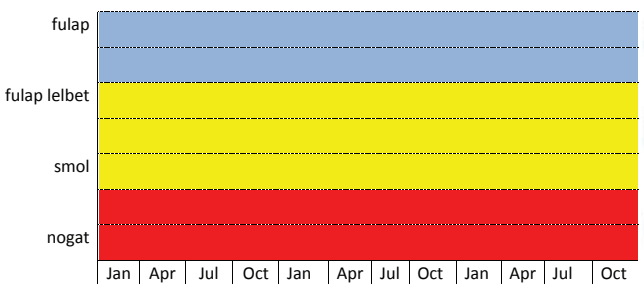
The reporting sheet provides a guide on management actions that might be suitable given where the survey results are marked (blue, yellow or red zone). For instance:

- Results in the ***blue zone*** (fulap) indicate healthy mangroves and would be reported to the community for raising awareness about the monitoring and mangrove habitats.
- Results in the ***yellow zone*** (smol or fulap lelbet) indicate a possible issue, and it is recommended that resource monitors have a village meeting with the Chief to discuss the results, possible reasons for the results, and actions. Example management actions include: community awareness raising (such as information on notice boards), discussions to identify the cause of declines or impacts including clearing, land-based runoff or recent storms or cyclones, and immediate management actions. Such actions would depend on the impact and could include changing timber harvesting or clearing practices.
  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*** (nogat) indicate there is an issue and should follow the recommendations for the yellow zone, with more immediate management actions needed. This could include immediate timber harvest bans or stronger enforcement of existing rules.

These actions will vary between villages and should be guided by local experience, the village Chief and the management already established in village management plans.

A field quick guide is provided in Appendix 2. Information sheets for awareness raising activities are provided in Appendix 3.

**MANGROVES: CANOPY COVER / SEEDLINGS (circle one)**




**COMMUNITY REPORTING/UPDATE**

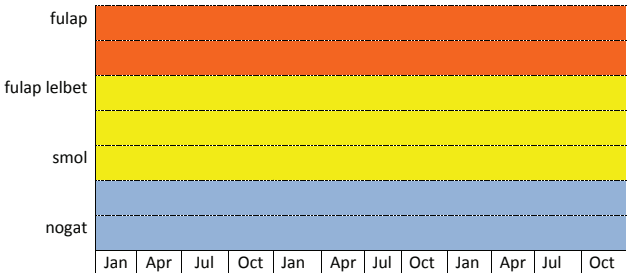
**COMMUNITY DISCUSSION ABOUT POSSIBLE ISSUE & ACTIONS**

EXAMPLE MANAGEMENT ACTIONS:
- Awareness raising (information signs) in communities
- Identify cause of decline or impacts

**COMMUNITY SELECT MANAGEMENT ACTIONS**

EXAMPLE MANAGEMENT ACTIONS:
- Review and restrict clearing and/or timber harvesting practices
- Restrict domestic animal access to mangrove area
- Limit destructive fishing gear in mangrove area
- Minimise other pressures on the mangrove area
- Include mangrove area in management plan (if not already done)

**MANGROVE IMPACTS: LEAVES/ROOTS/OTHER:_____**




**COMMUNITY SELECTION OF MANAGEMENT ACTIONS**

**COMMUNITY DISCUSSION ABOUT POSSIBLE ISSUE & ACTIONS**

**COMMUNITY REPORTING/UPDATE**

EXAMPLE MANAGEMENT RESPONSES:
- Awareness raising (information signs) in communities
- Identify cause of decline or impacts

EXAMPLE MANAGEMENT ACTIONS:
- Review and restrict clearing and/or timber harvesting practices
- Restrict domestic animal access to mangrove area
- Limit destructive fishing gear in mangrove area
- Minimise other pressures on the mangrove area
- Include mangrove area in management plan (if not already done)

## Module 4 References:

Ellison, J.C., Jungblut, V., Anderson, P., Slaven, C. (2012) Manual for mangrove monitoring in the Pacific Islands region. Secretariat of the Pacific Regional Environment Programme (SPREP), Apia, Samoa.

MESCAL [Mangrove Ecosystems for Climate Change Adaptation] Biodiversity Assessments and Technical Reports (2013).

# MODULE 5

# Seagrass Surveys

Photo: David Welch

## MODULE 5: SEAGRASS SURVEYS

### Relevant laws and rules:

Vanuatu Fisheries Act and Regulations 2009; Vanuatu National Sustainable Development Program and Policy 2016–2030.

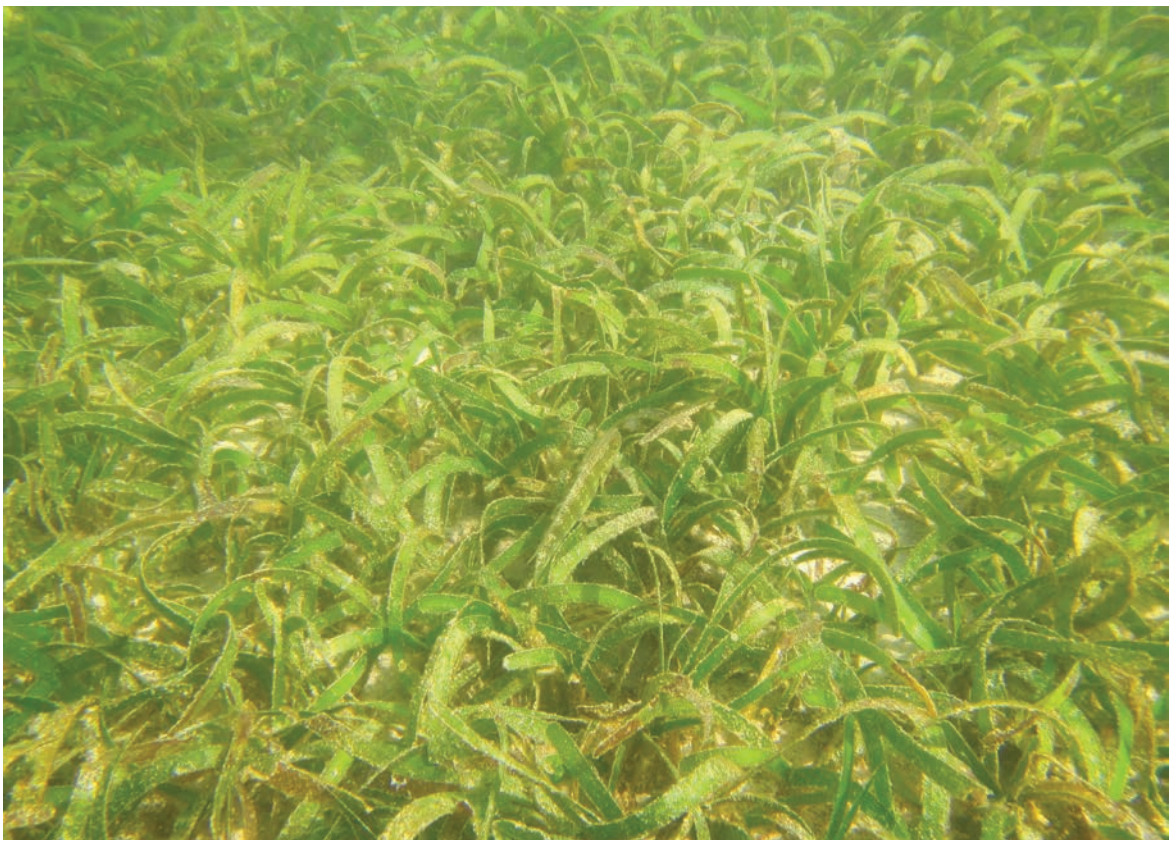
### Purpose:

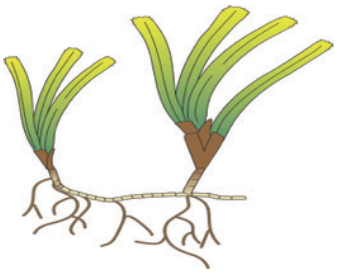
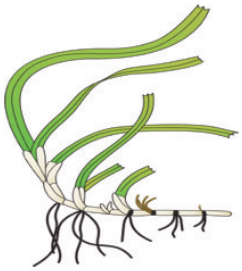
Monitoring seagrass meadows provides information that can be used to:

- Record if seagrass status and condition is stable, improving or declining, and
- Inform and improve local management of seagrass.

Seagrasses are marine plants that provide nutrient-rich habitats for a many animals, including those targeted by fisheries. For example, sea cucumbers, fish, urchins, marine turtles, dugongs, and 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.

Vanuatu has several species of seagrass, some of the more common species are shown below in photos, however the seagrass modules does not require monitors to learn species information.



| Seagrass Species | | Features |
|---|---|---|
| *Cymodocea rotundata* |  | Rounded leaf tip<br><br>Narrow leaf blade (2–4 mm wide)<br><br>Leaves 7–15 cm tall |
| *Cymodocea serulata* |  | Serrated leaf tip<br><br>Wide leaf blade (5–9 mm wide)<br><br>Leaves 6–15 cm tall |
| *Enhalus acoroides* |  | Very long ribbon-like leaves<br><br>Leaves 30–150 cm tall |
| *Halodule uninervis* |  | Trident leaf tip<br><br>Narrow leaf (0.2–4 mm)<br><br>Leaves 5–25 cm tall |
| *Halophila ovalis* |  | Oval leaves<br><br>Leaves 1–15 cm tall (< 2 cm more common)<br><br>Obvious cross veins on leaves |
| *Thalassia hemprichii* |  | Sickle shaped leaves<br><br>Leaves 10–40 cm tall |

## METHOD

### Materials:

- Field survey sheet
- Pencil
- Mask and snorkel (if submerged seagrass site)

**Time:** 15 minutes per quadrat. Total of 45 minutes per site.

**Site Selection:** Choose sites that are easy to access, and with seagrass meadows that are typical of the local habitat. Survey at least 2 sites in your village area, so you can compare results and decide if management actions are working. Sites can be the same as the invertebrate intertidal surveys (Module 2) or the reef health surveys (Module 3) if these are typical of seagrass in your ma ine a ea

**Frequency:** Once every 6 months or 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 compare results and reach agreement, and it is also safer. If impacts or changes are noticed and the community is concerned, a more detailed survey can be requested by contacting the Vanuatu Fisheries Department.

### Conducting the survey:

Choose the sites with your survey partner and select 3 random 50 x 50 cm areas (quadrats) at each site. Use a natural feature or landmark to identify each site, so that the same site is resurveyed each time. Each 50 x 50 cm area (quadrat) should be at least 25 m apart. Monitors should practice estimating a 50 x 50 cm area so the same quadrat area is surveyed each time.
If changes in seagrass health are observed (e.g. live seagrass cover declines or there is lots of damage), or if there are plans to do new activities in seagrass meadows monitors should conduct a survey using a field survey sheet. Make sure to write down the date, time and location of the seagrass observations on your data sheet (see Data Collection).
The following provides a guide to the type of impacts that might be seen in seagrass meadows and how to record them when monitoring.

### Data Collection:

Each monitor will have a field survey sheet and pencil so they can record the date and time of survey, the location, and what they see for each of the seagrass indicators. Taking a photo of each quadrat is also useful for checking and discussing results before reporting. The following provides a guide for recording each indicator on a scale of nogat to fulap.
If the village is planning to start activities that might impact on seagrass, such as more boat anchoring, or making a boat landing, resource monitors should begin monitoring and discussions with Vanuatu Fisheries before the activity starts. The results can be discussed with Vanuatu Fisheries to decide if formal surveys are needed. If observers can take photos (on phones or camera) these are also useful.

### 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 how healthy the meadow is, and how much food and habitat it can provide.


**nogat**


**smol**


**fulap lelbet**


**fulap**

| | |
|---|---|
| No or very low seagrass cover | nogat |
| Low seagrass cover | smol |
| Moderate seagrass cover | fulap lelbet |
| High seagrass cover | fulap |

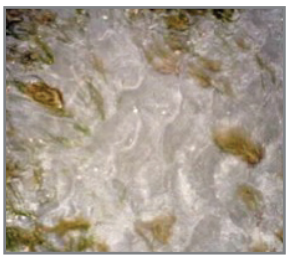
### Impact observations:

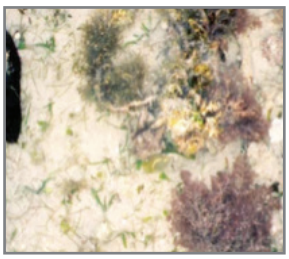
Seagrass can be impacted by too much algae growth that blocks sunlight and smothers the seagrass leaves. Or by physical disturbances, such as storms, land-based inputs or boat damage, that can remove areas of seagrass, 'burn' the seagrass leaves or stress seagrass so they cannot flower or seed. Signs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

### 1. Algae cover:

Algae are seaweeds that can cover or overgrow seagrass leaves and affect their ability to produce energy. High algae cover is often a sign of unhealthy seagrass while low algae cover is a sign of a healthy meadow.


**nogat**


**smol**


**fulap lelbet**


**fulap**

| | |
|---|---|
| No or very low algae cover (0-5%) | nogat |
| Low algae cover (6-10%) | smol |
| Moderate algae cover (11-25%) | fulap lelbet |
| High algae cover (>25%) | fulap |

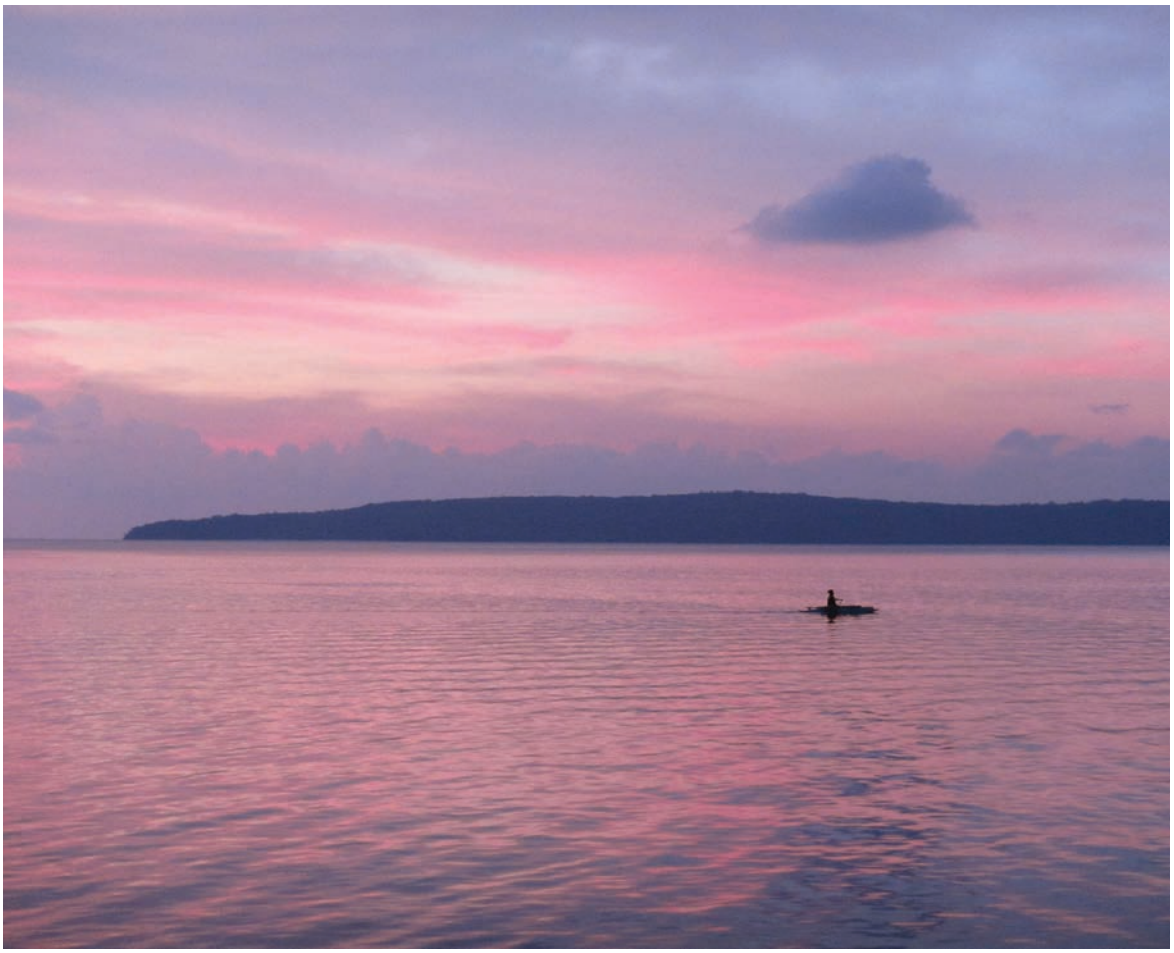
## 2. Damaged seagrass:

Areas of seagrass that are pulled up 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 dam g e or stress.


**Stressed (burnt) seagrass**


**Damaged seagrass meadows**

| | |
|---|---|
| No damage/burnt seagrass | nogat |
| Small seagrass area damaged/burnt | smol |
| About half of seagrass area damaged/burnt | fulap lelbet |
| Most of seagrass area damaged/burnt | fulap |



## EXAMPLE SEAGRASS SURVEY

| **Site description** | | | |
|---|---|---|---|
| **Who** | Observer name: *Mary, John* | | |
| **Where** | Village: *Tanoliu* | Site location/name: *Phil's point* | |
| **When** | Date: *16 October 2017* | | Time: *4:35 pm* |
| **Conditions** | Weather: *Clear, warm, little wind* | | Tide: *High (2.3 m)* |
| **Photos taken?** | (Yes) | No | |
| **What did you see?** | | | |
| **1. Live seagrass cover** | **Comments:** *High seagrass cover (approx. 50%) with new seeds* | | |
| | \|----------\|----------\|----------X-------\|<br>**nogat smol smol lelbet fulap** | | |
| **2. Impacts:** | **Comments:** *Not much algae, all small types. No damage seen* | | |
| **Algae cover** | \|---X----------\|----------\|----------\|<br>**nogat smol smol lelbet fulap** | | |
| **Damaged or 'burnt' seagrass** | \|X----------\|----------\|----------\|<br>**nogat smol smol lelbet fulap** | | |

## DATA REPORTING

Data analysis for the Seagrass module is simple and involves marking the results on the data reporting sheet shown below for the month the information was collected. This will show whether the results are in the blue, yellow or red zone. This should be completed for each indicator in each survey. The Community Monitors should keep all reporting sheets in a central folder.

The reporting sheet provides a guide on management actions that might be suitable given where the survey results are marked (blue, yellow or red zone). For instance:

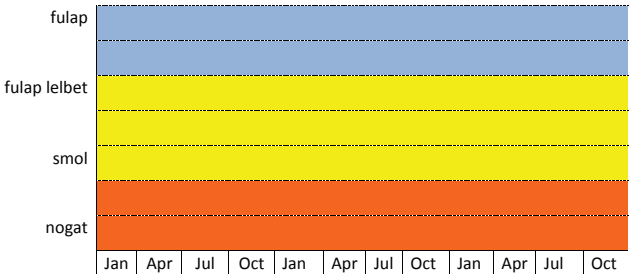
- Results in the ***blue zone*** (fulap) indicate healthy seagrass and would be reported to the community for raising awareness about the monitoring and mangrove habitats.
- Results in the ***yellow zone*** (smol or fulap lelbet) indicate a possible issue, and it is recommended that Monitors have a village meeting with the Chief to discuss the results, possible reasons for the results, and actions. Example management actions include: community awareness raising (such as information on notice boards), discussions to identify the cause of declines or impacts including boat anchoring, land-based runoff or recent storms or cyclones, and immediate management actions. Such actions would depend on the impact and could include changing anchoring practices. The discussions should also consider if Vanuatu Fisheries should be contacted to conduct formal surveys.
- Results in the ***red zone*** (nogat) indicate there is an issue and should follow the recommendations for the yellow zone, with more immediate management actions needed This could include immediate anchoring bans or stronger enforcement of existing rules.

These actions will vary between villages and should be guided by local experience, the village Chief and the management already established in village management plans.

If seagrass meadows have declined or been impacted, this information should be communicated to the community for raising awareness about the seagrass habitats and the possible issues, and the village should also be involved in discussions with Vanuatu Fisheries. This will be particularly important if the village is planning to start activities that might impact on seagrass, such as making a boat landing, and formal monitoring is needed before starting new activities.

A field quick guide is provided in Appendix 2. Information sheets for awareness raising activities are provided in Appendix 3.

**SEAGRASS SURVEYS: COVER**

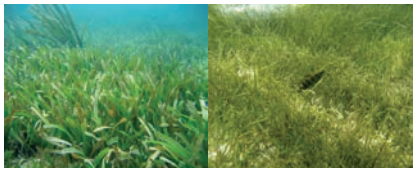



**COMMUNITY REPORTING/UPDATE**

**COMMUNITY DISCUSSION ABOUT POSSIBLE ISSUE & ACTIONS**

EXAMPLE MANAGEMENT RESPONSES:

- Awareness raising (information signs) in communities
- Identify cause of decline or impacts

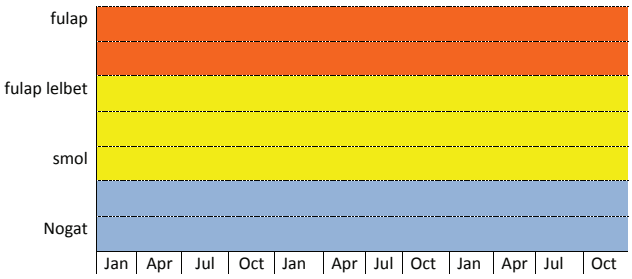


**COMMUNITY SELECT MANAGEMENT ACTIONS**

EXAMPLE MANAGEMENT ACTIONS:

- Review boating and anchoring practices
- Restrict boating and anchoring activities in seagrass meadows
- Limit destructive fishing gear in seagrass meadows
- Minimise other pressures on the seagrass meadows
- Include seagrass meadows in management plan (if not already done)
- Contact Vanuatu Fisheries Department

**SEAGRASS SURVEYS: IMPACTS**




**COMMUNITY SELECTION OF MANAGEMENT ACTIONS**

**COMMUNITY DISCUSSION ABOUT POSSIBLE ISSUE & ACTIONS**

**COMMUNITY REPORTING/UPDATE**

EXAMPLE MANAGEMENT RESPONSES:

- Awareness raising (information signs) in communities
- Identify cause of decline or impacts

EXAMPLE MANAGEMENT ACTIONS:

- Review boating and anchoring practices
- Restrict boating and anchoring activities in declining seagrass meadows
- Limit destructive fishing gear in seagrass meadows
- Minimise other pressures on the seagrass meadows
- Include seagrass meadows in management plan (if not already done)
- Contact Vanuatu Fisheries Department

## Module 5 References:

DMcKenzie, L.J. and Campbell, S.J. (2002) Seagrass-Watch: Manual for Community (citizen) Monitoring of Seagrass Habitat. Western Pacific Edition, Queensland Fisheries Service, Cairns, Australia.

SPC/ Vanuatu Fisheries Department (2016) Vanuatu monitoring method

Vanuatu Fisheries Act and Regulations 2009

Vanuatu National Sustainable Development Program and Policy 2016–2030.

Waycott, M., McMahon, K., Mellors, J., Calladine, A., and Kleine, D. (2004) A Guide to Tropical Seagrasses of the Indo-West Pacific. James Cook University, Townsville, Australia.

# MODULE 6

# Crown of thorns starfish (COTS) Surveys

Photo: David Westcott

## MODULE 6: CROWN-OF-THORNS STARFISH

### Relevant laws and rules:

Vanuatu Fisheries Act and Regulations 2009; Vanuatu National Sustainable Development Program and Policy 2016–2030.

### Purpose:

Monitoring crown-of-thorns starfish (COTS), also known locally as posen sta, can be an early warning of increasing numbers and that there might be a problem with too many eating corals. Knowing if there are more COTS can:

- Locate where and when there is a problem, and
- Inform and improve local control and removal of COTS.

### What are Crown-of-thorns starfish?

The large, coral-eating starfish is a major cause of coral reef disturbance, whose impact has been compared to cyclones. These starfish are a natural part of reefs and contribute to reef diversity by eating a small amount of fast-growing corals, and creating space for slower growing corals. Generally, COTS occur at very low numbers (typically < 1 individual / hectare). However, populations can dramatically increase during certain times called “outbreaks” to reach thousands of individuals / ha, and then cause severe reef damage.

Overfishing of their natural predators – giant triton snail, humphead maori wrasse, starry pufferfish and titan triggerfish – are one of the main reasons there are COTS outbreaks.

Over a third of Pacific reefs (including Vanuatu, Fiji, New Caledonia, French Polynesia, Australia, Palau, Guam, Samoa, Japan) are being affected by COTS outbreaks, which can lead to the almost total destruction of corals in the area.

**Figure 7. Adult crown-of-thorns starfish (COTS)**

### *A major threat to marine life*

In Vanuatu, the current situation is alarming. Very high densities of COTS (e.g. 7,000/ ha) have recently been recorded. Intact and healthy corals reefs are necessary for and provide critical habitat to many fish and invertebrates harvested by the local communities. A drastic reduction in living coral due to COTS predation raises serious concerns for food security in areas where people rely on their coa tb resources.

**Monitoring and Reporting COTS:**

It is especially important to notice any increase in the number of small COTS (plate size or less) in reef areas. The number of COTS you should expect to see will depend on the size of your survey area, but if you notice any while doing the Reef Surveys (Module 3) or just fishing or swimming on the reef, please report this on the Vanuatu Fisheries website *(https://fisheries.gov.vu/index.php/crowns-of-thorns/reports-cot)* by filling in the online form on the "REPORT" webpage.

You can also download the mobile application for Android and Windows phones and send reports from your mobile phone:

*https://build.phonegap.com/apps/2314895/install/HrsHXDhrkj2XxehMzBSm*

Your reports will be processed and stored at the Vanuatu Fisheries Department. The information will be displayed on the interactive map. Your contribution will really help to develop the best management strategy for COTS in Vanuatu.

# APPENDICES

Photo: David Welch

# FISH CATCH SURVEY DATA MANAGEMENT, ANALYSIS AND REPORTING:
## INSTRUCTIONS FOR DATA COORDINATORS

The fish catch surveys are an important part of the Community Marine Monitoring Toolkit. Using results from the fish catch surveys (Module 1) requires data to be entered into a computer on an Excel spreadsheet. To help make this simple a fully automated spreadsheet has been developed that minimises data entry and calculates results for immediate use by communities. The current version of the catch surveys are for North Efate but can be adapted and used anywhere in Vanuatu. The spreadsheet also automatically produces data useful for national fisheries departments and other agencies and therefore maximises the use of the data collected using the catch surveys.

Data will need to be maintained by trained **Data Coordinators** from the TasiVanua and Nguna-Pele Marine and Land Resource Networks. The data coordinators will need to collect completed catch survey forms from resource monitors at regular intervals (at least 2-3 times each year). The original survey forms should be stored in a folder in the Resource Centre after the data is entered into the computer. Data coordinators will need to make sure that there is a well-organised system for: collecting survey forms, entering data, reporting results back to communities, and maintaining the data securely.

It is the responsibility of data coordinators to enter data into the spreadsheets, and to check the data is correct. All data and results used to inform management decision-making will be generated automatically.

This document has three sections:

1. Instructions for data coordinators to help with the collection and use of fish catch surveys;
2. Details about the Excel spreadsheet, the data it calculates and its uses; and
3. Guidelines for reviewing the use of catch surveys. An overview of these instructions is also given in the *Instructions* worksheet in the data spreadsheet.

### SECTION 1. INSTRUCTIONS FOR DATA COORDINATORS

The role of data coordinators is very important, as they will be the source of information for decision-making in communities using the fish catch results. Figure A1 shows the role data coordinators play. The steps for doing this role are described below.

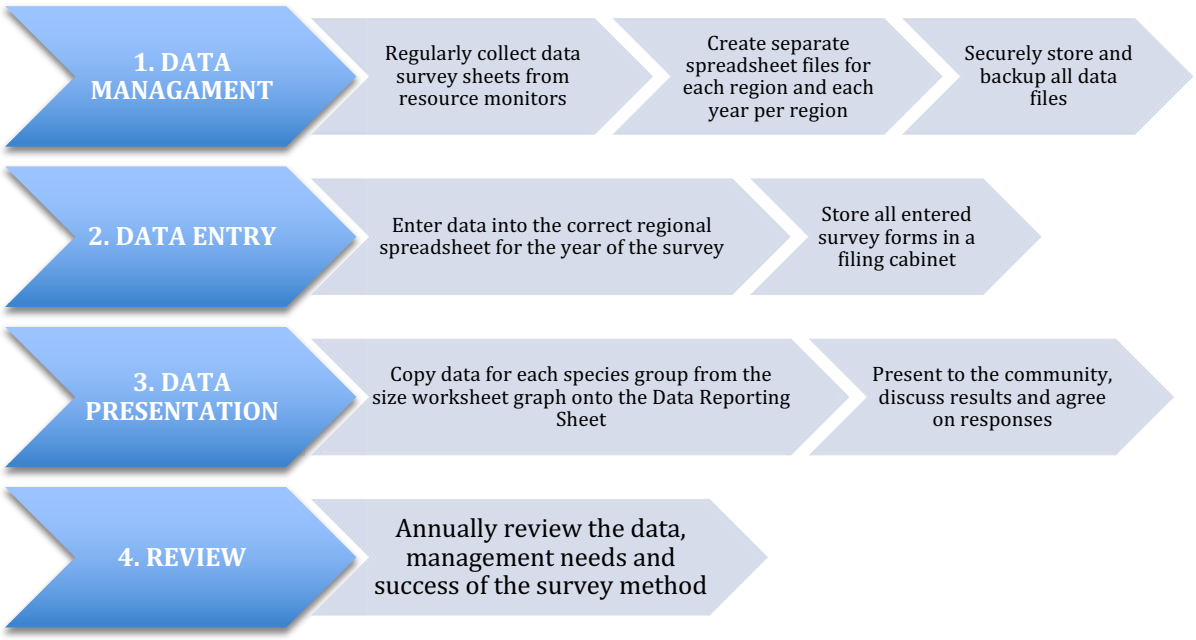



**Figure A1.** A summary of the role of Fish Catch Survey Data Coordinators.

**Data management**

*Data collection*

Fish catch surveys are conducted in each village by local ***Resource Monitors*** trained in the Module 1 monitoring method. ***Data Coordinators*** should make sure that there is a system for completed catch survey forms to be regularly collected from Resource Monitors and stored in a secure place, such as a filing cabinet at the Emua resource centre.

*Master file*

A MASTER data spreadsheet file is provided which includes all worksheets, data fields, formulas and graphs. **The MASTER file should NOT be used to enter and store data**; it is to be used as a backup copy for creating NEW data files. The following will guide the creation and management of data files and it is the role of Data Coordinators to ensure the data is securely stored.

*Data regions*

Separate files should be maintained for each of the four (4) sub-regions in North Efate. The four regions and their villages are:

**1. Havannah** – Mangaliliu, Natapau, Tanoliu, Tassariki, Sunai and Port Havannah.
**2. Undine Bay** – Siviri, Lakenasua, Saama, Emua, Paonangisu and Napara.
**3. Nguna-Pele** – all villages on Nguna Island and Pele Island.
**4. North-east Efate** – Quoin Hill, Bauvatu, Onesua, Matarisu, Ekipe, Epao and Emao Island.

Having smaller data regions mean that the large amount of data collected over time are easier to manage. The sub-regions are also chosen based on: the location of the different monitoring Networks; proximity of villages; and natural geographic boundaries and habitat differences that affect fish population connectivity (Figure A2). This means that the regions are ***ecologically practical*** and will help ensure that any trends in fish catch data are accurate and meaningful.

**The importance of sub-regions**

*There may be a high number of very small Pico in the catch for Nguna and Pele Islands (this is undesirable), while fishers on Emao Island may be catching a high number of large Pico (desirable). Since the islands are separated by deep water and the reef fish populations are likely to be separate, combining the catch data from all three islands would hide the problem of too many small Pico being caught from Nguna and Pele Islands.*

*Data files*

Using the MASTER spreadsheet file, make a copy for each region and year. For example, for Undine Bay there needs to be a file for each year: 'Undine Bay 2018.xls', 'Undine Bay 2019.xls', 'Undine Bay 2020.xls', etc.

At the start of each year make a copy of the MASTER file and rename it to the region and year. So, all catch survey data collected from villages in a particular region must be entered into a spreadsheet file for that region AND for the year the data are collected.

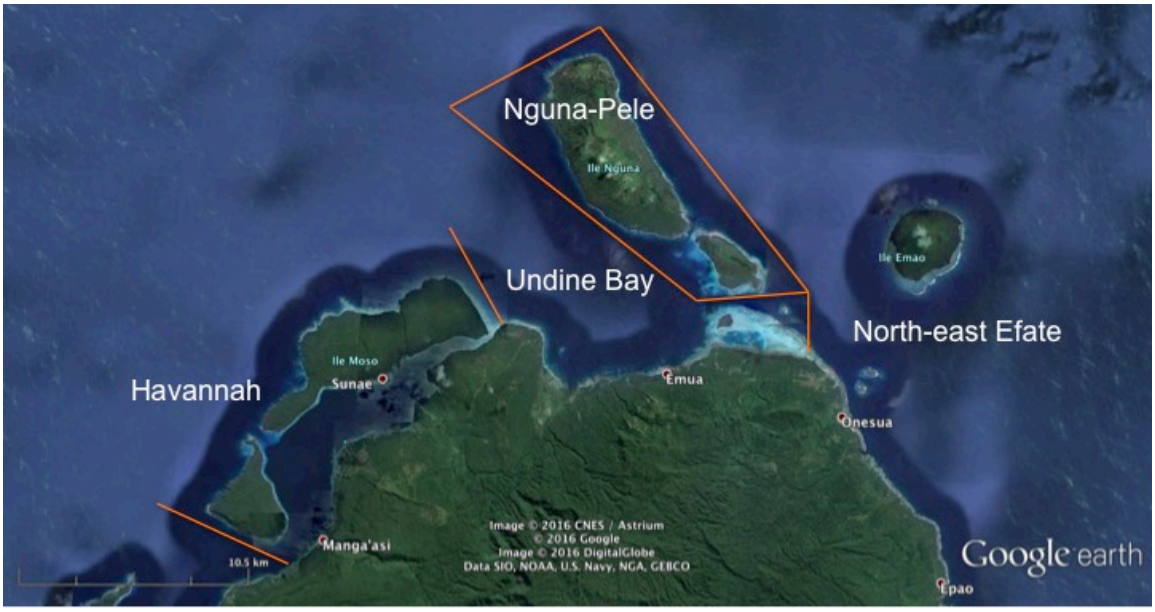



**Figure A2.** Map of North Efate showing suggested catch survey monitoring sub-regions. Catch monitoring data should be grouped and analysed based on the villages within each sub-region (Havannah, Undine Bay, Nguna-Pele and North-east Efate). That is, there should be a separate spreadsheet used for each sub-region.

*File management*

All catch survey module data and resources should be stored on the resource centre computer in a folder called 'CATCH SURVEYS'. Separate folders can then be created to store relevant files so that data and resources are readily found when needed. For example, in the CATCH SURVEY folder, create two folders: 'Data' and 'Resources'. In the 'Data' folder create a folder for each of the four regions. In each of the region folders create a copy of the MASTER spreadsheet file for each year and rename it (for example, 'Havannah 2019.xls', 'North-east Efate 2020.xls', etc.) (Figure A3). Files such as Data Reporting Sheets and catch survey forms should be stored in the 'Resources' folder.

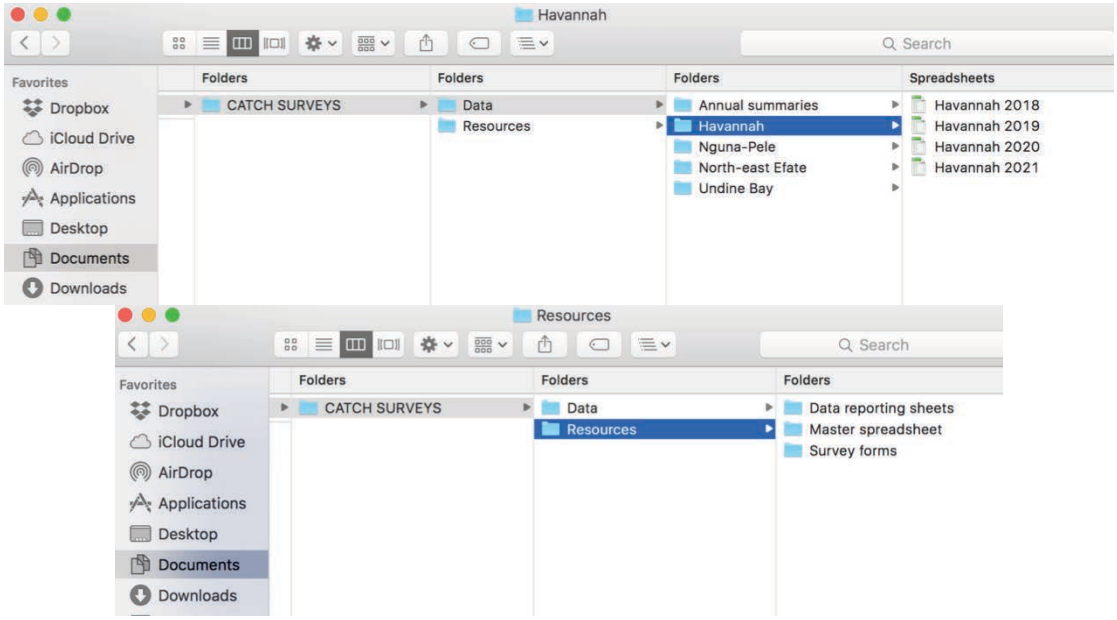



**Figure A3.** Examples of how to set up folders on the computer to organise and manage catch survey data files.

There is also a separate file that automatically calculates summaries of all data each year. This data can be useful for informing communities about the status of fisheries stocks and on appropriate management options, and will be of interest to local, national and regional agencies. The annual summary file should be kept in a separate folder within the 'Data' folder, and called 'Annual summaries' (Figure A2). Because this summary file is linked to all data files, they should **NOT BE MOVED** from their respective folders.

Remember to also save all data files on a different backup computer or separate hard drive.

## SECTION 2. DATA SPREADSHEET DETAILS

**'Instructions' worksheet**

The 'Instructions' worksheet provides a ***summary*** of instructions for Data Coordinators for managing the data files, data entry, and for using data outputs for reporting results back to communities. It also summarises the data automatically calculated in the spreadsheet (for example, average size of los).

**'Source sheet' worksheet**

This worksheet is ***hidden*** so cannot be seen in the spreadsheet file. It contains information that is used by other worksheets in the file (for example, dropdown menus). It also stores data on the ***critical sizes*** of fish species groups.

*Critical sizes*

The ***critical size*** is a very important measure in the use of the catch surveys because it is the basis for calculating the 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 also took into account draft national fish size limit regulations. This is presented as the size at which 50% of the population are large enough to breed (size at 50% maturity; Table A1). Data on how many small fish (that is, pre-breeding size) are caught is important as too many indicates an undesirable impact on the future breeding success of the population. This means that community-based management goals are based on the desire to avoid catching fish that are too small to breed.

For the species groups that communities have indicated a need for local management (blu fis, strong skin, piko, siko, los and sua sua), the size indicator (% of the catch >= the critical size) is automatically calculated and plotted. The critical size is pre-entered into the 'Source sheet' worksheet. The critical size estimates can therefore be reviewed and changed if necessary in the future. Further, critical sizes can also be added for the additional 6 species groups included at the request of VFD (into the 'Source sheet' worksheet) and the spreadsheet will automatically calculate the size indicator for these species groups. Other species groups can also be added (contact the *Spreadsheet administrator*).

**'Sample' worksheet**

The 'Sample' worksheet simply shows an example of the 'Data entry' worksheet with example data entered. It shows how the different rows (survey) and columns (individual fish caught) appear with data entered.

**Table A1.** Estimates of size at maturity for key local species in each species group to determine the critical size (length) for determining community management responses. Where possible common local Vanuatu species are used, otherwise published information on similar species are used.

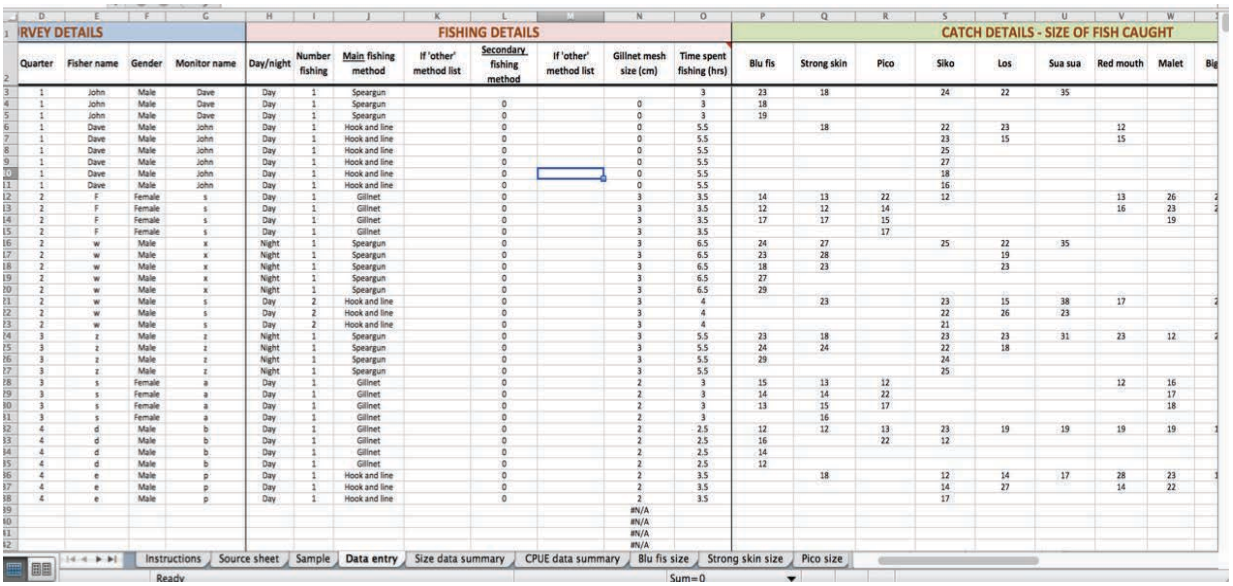
| Species group | Species | Size at 50% maturity estimates* | Critical size: fork length, cm | Reference |
|---|---|---|---|---|
| **Blu fis** | *Chlorurus bleekeri* | PNG: 20 cm** | **20 cm** | Longenecker et al. (2012) |
| | *Chlorurus sordidus* | GBR: 12-16 cm FL; Guam: 15 -16 cm FL | | Barba (2010) |
| | *Scarus psittacus* | GBR: 12-13 cm FL; Guam: 10.5-15 cm FL | | Barba (2010), Taylor and Choat (2014) |
| | *Cetoscarus ocellatus* | GBR: 30 cm FL | | Fishbase.org |
| | *Scarus niger* | 17 cm | | Longenecker et al. (2013) |
| | *Cetoscarus bicolor* | 32.3 cm | | Taylor and Choat (2014) |
| | *Scarus altipinnis* | 25.1 cm | | Taylor and Choat (2014) |
| | *Scarus ghobban* | 25 cm | | Armagan (2010) |
| **Strong skin** | *Ctenochaetus striatus* | 13.5 cm | **20 cm** | Choat and Robertson (2002) |
| | *Acanthurus triostegus* | Hawaii: 16.4 cm | | Longenecker et al (2008) |
| | *Acanthurus lineatus* | 17-18 cm | | Craig et al (1997) |
| | *Naso lituratus* | | | |
| | *Naso unicornis* | | | |
| **Piko** | *Siganus lineatus* | 19-24 cm | **20 cm** | Longenecker et al. (2012) |
| **Siko**** | *Lutjanus fulvus* | 14-19 cm | **20 cm** | Longenecker et al. (2013a) |
| | *Lutjanus fulviflamma* | | | Anand and Pillai (2002), |
| | *Lutjanus kasmira* | 12-14 cm | | Friedlander et al. (2002) |
| | *Lutjanus gibbus* | 18-23 cm | | Anand and Pillai (2002), Longenecker et al. (2013b), Heupel et al. (2010) |
| **Los** | *Cephalopholis urodeta* | | **25 cm** | Chan & Sadovy (2002) |
| | *Cephaloppholis boenak* | 18 cm | | Longenecker et al. (2013) |
| | *Cephalopholis cyanostigma* | 15-16 cm<br>20-23 cm | | Mishina et al. (2006) |
| | *Epinephelus fasciatus* | 14-18 cm | | Longenecker et al (2013) |
| | *Variola louti* | | | |
| | *Pectropomus leopardus* | 33 cm FL | | Ferreira (1995), Adams et al (2000) |
| **Sua sua** | *Diagramma pictum* | 27-36 cm | **30 cm** | Grandcourt et al (2011) |
| | *Plectorhincus vittatus* | 23-29 cm | | Anand and Pillai (2002), Longenecker et al. (2013b) |

* Estimates are for females unless otherwise stated. Also, note some estimates are given in fork length (FL).
* Whether an estimate is length at FIRST maturity or 50% maturity is not always given in the literature.

**‘Data entry’ worksheet**

This is the *only* worksheet where Data Coordinators are required to enter the information collected from each catch survey. All other worksheets are instructional or fully automated. ***Therefore, the ‘Data entry’ worksheet is the most important for Data Coordinators to become familiar with.***

Data from each survey should be entered into a *single row*. For multiple fish of the same species group caught in a survey, the sizes are entered in a *single column* for the group. As you enter new fish sizes in the species group column, the survey information will automatically fill each row, for the survey and fishing details, that a fish is entered (Figure A4). Each new survey data needs to be entered into the NEXT AVAILABLE row in the spreadsheet.



| RVEY DETAILS | | | | FISHING DETAILS | | | | | | | | CATCH DETAILS - SIZE OF FISH CAUGHT | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Quarter | Fisher name | Gender | Monitor name | Day/night | Number fishing | Main fishing method | If 'other' method list | Secondary fishing method | If 'other' method list | Gillnet mesh size (cm) | Time spent fishing (hrs) | Blu fis | Strong skin | Pico | Siko | Los | Sua sua | Red mouth | Malet |
| 1 | John | Male | Dave | Day | 1 | Speargun | | 0 | | 0 | 3 | 23 | 18 | | 24 | 22 | 35 | | |
| 1 | John | Male | Dave | Day | 1 | Speargun | | 0 | | 0 | 3 | 18 | | | | | | | |
| 1 | John | Male | Dave | Day | 1 | Speargun | | 0 | | 0 | 3 | 19 | | | | | | | |
| 1 | Dave | Male | John | Day | 1 | Hook and line | | 0 | | 0 | 5.5 | | 18 | | 22 | 23 | | 12 | |
| 1 | Dave | Male | John | Day | 1 | Hook and line | | 0 | | 0 | 5.5 | | | | 23 | 15 | | 15 | |
| 1 | Dave | Male | John | Day | 1 | Hook and line | | 0 | | 0 | 5.5 | | | | 25 | | | | |
| 1 | Dave | Male | John | Day | 1 | Hook and line | | 0 | | 0 | 5.5 | | | | 27 | | | | |
| 1 | Dave | Male | John | Day | 1 | Hook and line | | 0 | | 0 | 5.5 | | | | 18 | | | | |
| 1 | Dave | Male | John | Day | 1 | Hook and line | | 0 | | 0 | 5.5 | | | | 16 | | | | |
| 2 | F | Female | s | Day | 1 | Gillnet | | 0 | | 3 | 3.5 | 14 | 13 | 22 | 12 | | | 13 | 26 |
| 2 | F | Female | s | Day | 1 | Gillnet | | 0 | | 3 | 3.5 | 12 | 12 | 14 | | | | 16 | 23 |
| 2 | F | Female | s | Day | 1 | Gillnet | | 0 | | 3 | 3.5 | 17 | 17 | 15 | | | | | 19 |
| 2 | F | Female | s | Day | 1 | Gillnet | | 0 | | 3 | 3.5 | | | 17 | | | | | |
| 2 | w | Male | x | Night | 1 | Speargun | | 0 | | 3 | 6.5 | 24 | 27 | | 25 | 22 | 35 | | |
| 2 | w | Male | x | Night | 1 | Speargun | | 0 | | 3 | 6.5 | 23 | 28 | | | 19 | | | |
| 2 | w | Male | x | Night | 1 | Speargun | | 0 | | 3 | 6.5 | 18 | 23 | | | 23 | | | |
| 2 | w | Male | x | Night | 1 | Speargun | | 0 | | 3 | 6.5 | 27 | | | | | | | |
| 2 | w | Male | x | Night | 1 | Speargun | | 0 | | 3 | 6.5 | 29 | | | | | | | |
| 2 | w | Male | s | Day | 2 | Hook and line | | 0 | | 3 | 4 | | 23 | | 23 | 15 | 38 | 17 | |
| 2 | w | Male | s | Day | 2 | Hook and line | | 0 | | 3 | 4 | | | | 22 | 26 | 23 | | |
| 2 | w | Male | s | Day | 2 | Hook and line | | 0 | | 3 | 4 | | | | 21 | | | | |
| 3 | z | Male | z | Night | 1 | Speargun | | 0 | | 3 | 5.5 | 23 | 18 | | 23 | 23 | 31 | 23 | 12 |
| 3 | z | Male | z | Night | 1 | Speargun | | 0 | | 3 | 5.5 | 24 | 24 | | 22 | 18 | | | |
| 3 | z | Male | z | Night | 1 | Speargun | | 0 | | 3 | 5.5 | 29 | | | 24 | | | | |
| 3 | z | Male | z | Night | 1 | Speargun | | 0 | | 3 | 5.5 | | | | 25 | | | | |
| 3 | s | Female | a | Day | 1 | Gillnet | | 0 | | 2 | 3 | 15 | 13 | 12 | | | | 12 | 16 |
| 3 | s | Female | a | Day | 1 | Gillnet | | 0 | | 2 | 3 | 14 | 14 | 22 | | | | | 17 |
| 3 | s | Female | a | Day | 1 | Gillnet | | 0 | | 2 | 3 | 13 | 15 | 17 | | | | | 18 |
| 3 | s | Female | a | Day | 1 | Gillnet | | 0 | | 2 | 3 | | 16 | | | | | | |
| 4 | d | Male | b | Day | 1 | Gillnet | | 0 | | 2 | 2.5 | 12 | 12 | 13 | 23 | 19 | 19 | 19 | 19 |
| 4 | d | Male | b | Day | 1 | Gillnet | | 0 | | 2 | 2.5 | 16 | | 22 | 12 | | | | |
| 4 | d | Male | b | Day | 1 | Gillnet | | 0 | | 2 | 2.5 | 14 | | | | | | | |
| 4 | d | Male | b | Day | 1 | Gillnet | | 0 | | 2 | 2.5 | 12 | | | | | | | |
| 4 | e | Male | p | Day | 1 | Hook and line | | 0 | | 2 | 3.5 | | 18 | | 12 | 14 | 17 | 28 | 23 |
| 4 | e | Male | p | Day | 1 | Hook and line | | 0 | | 2 | 3.5 | | | | 14 | 27 | | 14 | 22 |
| 4 | e | Male | p | Day | 1 | Hook and line | | 0 | | 2 | 3.5 | | | | 17 | | | | |
| | | | | | | | | | | #N/A | | | | | | | | | |
| | | | | | | | | | | #N/A | | | | | | | | | |
| | | | | | | | | | | #N/A | | | | | | | | | |
| | | | | | | | | | | #N/A | | | | | | | | | |

Instructions | Source sheet | Sample | Data entry | Size data summary | CPUE data summary | Blu fis size | Strong skin size | Pico size

Ready Sum=0

**Figure A4.** Example of entered data in the ‘Data entry’ worksheet. For each survey ‘Survey detail’ and ‘Fishing detail’ information is entered into a **single row**. Where more than one fish of a species group is caught in a survey, the fish size is entered downwards in each **column** and the information for each survey is copied into rows automatically.

**‘Size data summary’ worksheet**

Key measures about the size of fish in the catches surveyed are automatically calculated and summarised in the ‘*Size data summary’* worksheet. For each species group the measures calculated are: *average size,* the *proportion of the total catch* (catch composition) and the *percentage (%) caught that are equal to or larger than the critical size*. These are calculated for each quarter during each year as well as annually. The number of surveys done during each quarter is also calculated.

The *% of each species larger than the critical size* is calculated only for the 6 key species groups prioritised by local communities, and is automatically plotted into a graph for that species group. These graphs are shown in separate worksheets for each group (e.g. ‘*Blu fis size’*, ‘*Strong skin size’*, etc.).

**‘CPUE data summary’ worksheet**

This worksheet calculates the (unstandardised) annual catch rates for each species group by fishing gear, and for night and day fishing. Catch rate is simply the nominal Catch per Unit of Effort (CPUE) expressed as the **number of fish caught per hour of fishing**. CPUE data is often used as an indicator of the abundance of the fish populations and is best used over long periods (e.g. years) based on trends

in the data. For example, if the trend is that CPUE is declining then it is assumed that the fish population that it relates to is also declining. Because CPUE data is difficult to interpret accurately, due to the potential for many other factors that can affect the data (for example, changes in the fishers behaviour), it is NOT used as an indicator for the catch survey module. However, it is calculated here because fisheries and regional agencies may be interested in catch rate data.

**Species group size worksheets**

There are 6 species group size worksheets corresponding to the 6 species groups identified by the communities of North Efate for improved management. These worksheets are: '*Blu fis size*', '*Strong skin size*', '*Pico size*', '*Siko size*', '*Los size*' and '*Sua sua size*'. Each of these worksheets has a graph that is exactly the same as what appears on the Data Reporting Sheet for each species group. The spreadsheet automatically plots the size indicator data (*percentage (%) caught that are equal to or larger than the critical size*) for each quarter onto the graph. This makes the job for Data Coordinators very simple as all they have to do is *copy the data points on the graph onto the Data Reporting Sheet for that species group* for presenting back to communities for discussion.

## SECTION 3. REVIEW

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 see 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. Importantly, each village should come together as a community early in the monitoring process to decide what management actions are appropriate for them. These can then be included in the *Data Reporting Sheets*, so decisions can be made quickly when results come in.

It is recommended that the catch monitoring be reviewed by the Nguna-Pele and TasiVanua Networks each year to identify challenges or opportunities to collect further information, and that the data and results are shared with VFD. 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 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 right 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 into the future.

It is also recommended that **annual reviews of data analyses** for each of the major catch survey regions are done and presented to the Tasi Vanua and Nguna-Pele Networks. This will: (1) share experiences about monitoring; (2) share information to identify data trends; and (3) inform discussions to identify management actions as needed. This may best be done in an annual workshop with the two Networks or at a regular AGM. These reviews should be done in consultation with VFD to ensure that, where possible, data collected may also be helpful in achieving government policy and goals.

**RESOURCES AND TECHNICAL SUPPORT**

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

# Quick guide to the Fish Catch Survey

**Site selection**

- Surveys should be carried out in your local village by meeting fishermen and women when they come back from catching fish

**Method**

- Carry out surveys once every 3 to 6 months. At least 20 surveys should be carried out during the survey period (can be over different days).

- One person is needed to ask the fishermen and women about their fish catch

- Only one site is needed for this survey – your village

- Fill in the survey sheet – make sure you fill in every section
    - Survey details
    - Fishing details
    - Catch details
- Give your completed data sheets to your local data coordinator within your monitoring network

- Once the data has been entered into the main database the size distribution of the fish caught can be plotted on the graph and will show you what management actions need to be followed

# Quick guide to the Intertidal Invertebrate Survey

**Site selection**

- Choose sites that you would expect to see the invertebrates you are monitoring. This could be a reef flat or seagrass meadow

**Method**

- Carry out the surveys once every 6 months. Better to be carried out at low tide
- Two people needed
- 4 straight paths (transects) **at least 50 m apart** at the 2 sites. (8 paths in total). Each path should be 50 m long and 2 m wide, see the example below


- Count the number of invertebrates you see
- Once you have counted them from all the paths you have walked, take the average by adding up the species you saw in all the paths. E.g. 4+8+7+5= 24 then 24÷4= **6**

| T1 | T2 | T3 | T4 | Average (total ÷ 4) |
|---|---|---|---|---|
| 4 | 8 | 7 | 5 | 6 |

Based on the 'health status' scale lollyfish would be assessed as igat smol:

|----------|-X----------|----------|

| nogat | igat smol | igat fulap smol | fulap |
|---|---|---|---|
| (0) | (5) | (30) | (51+) |

- Use your mark on the scale to plot it on the reporting sheet graph for all the species you counted

# Quick guide to the Reef Health Survey

**Site selection**

- Choose a site that is typical of the main reef type in your marine area
- Using clear land marks can help you find your site again when you come back to survey the site again
- Choose sites that are 2-6m deep
- Include at least 1 site in the village tabu area and 1 site in an open area so you can compare results and decide if your tabu area is meeting you community objectives.

**Method**

- Carry out the surveys once every 3 to 6 months for regular monitoring.
- If you are monitoring impact response monitor within 1 month of the impact e.g. cyclone or prolonged high water temperatures

- A minimum of 4 people are needed but up to 6 people can do the survey at the same time

- Survey at least 2 sites near your village. Include one inside and one outside of your tabu area if you are monitoring the effects of your tabu area

- Starting at one end swim steadily over the reef and record information on general indicators (reef structure, live coral)
- Once you reach the end of your survey area (marked by your land mark) swim back to the start point taking time to record the smaller details of the reef, including indicators that need a detailed look (e.g. bleaching, posen sta)

- Use your mark on the scale to plot it on the graph for all the species you counted

# Quick guide to the Mangrove Survey

**Site selection**

Find an area with mangroves that are typical for the area. Survey at least 2 sites in your area. It is suggested that you survey areas at different distances from the sea.

1. Green dot – one survey close to land
2. Orange dot – one survey in the middle of the mangrove forest
3. Blue dot – one survey close to sea

If you want to monitor if your tabu area is meeting village objectives include at least 1 site in the tabu area and one site in the open area.

**Method**

- Carry out the surveys once every 6 months. Better carried out at low tide. Spend about 10 minutes observing each quadrat, 30 minutes at each site
- Two people needed
- 3 random 10 x 10 m areas (quadrats) at each site **at least 25 m apart.** Try to survey the same area each time
- Record what you see on the nogat to fulap scale for each category on the survey sheet for:
    - Mangrove canopy cover
    - Leaf colour (e.g. green, yellow, brown)
    - Insect damage to leaves
    - Twisting or damaged areal roots
    - Seedlings (new trees)
    - Impacts (e.g. damaged or stressed trees)
- Use your mark on the scale to plot your results on the data reporting graph for all the observations you made

# Quick guide to the Seagrass Survey

**Site selection**

- Choose an area of seagrass that is near your village which is typical of the local habitat

**Method**

- Carry out the surveys once every 6 months for regular monitoring.
- 15 minutes should be spent observing each quadrat, with a total of 45 minutes per site. Allow 1.5 hours to complete the surveys at 2 sites.

- At least 2 people should carry out the survey. This helps to compare results and reach an agreement

- Survey at least 2 sites in your village area. Try to survey the same area every 6 months by using landmarks to identify the site. Select 3 random 50cm x 50cm areas (quadrats) at each site **at least 25 m apart**

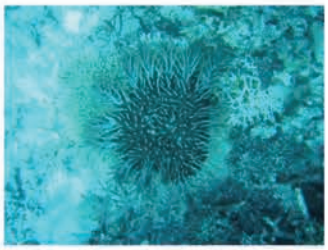
- Make your observations and fill in the survey sheet to record:
  - Site information
  - Live seagrass cover
  - Impacts
- Record what you see on the nogat to fualp scale for each category on the survey sheet

- Use your mark on the scale to plot it on the data reporting graph for all the observations you made
- If seagrass meadows have changed or been impacted, this information should be communicated to the community for raising awareness about the seagrass habitats and the possible issues

# Quick guide to Crown-of-thorns starfish Survey

**Site selection**

- Any site that you are monitoring for Reef Health or happen to be at



**Method**

- Anytime you see lots of crown-of-thorns starfish you should report it
- Helpts to locate where and when there is a problem
- Reports inform local control and removal of COTS

- Ideally 2 people are needed but 1 person can report COTS

- Any number of sites, and when you notice lots of COTS you should check a larger area

- Report COTS on the Vanuatu Fisheries (VFD) website (https://fisheries.gov.vu/index.php/crowns-of-thorns/reports-cot) by filling in the online form on the "REPORT" webpage
- You can also download the mobile App for Android and Windows phones and send reports from your mobile phone:

- https://build.phonegap.com/apps/2314895/install/HrsHXDhrkj2XxehMzBSm

- Your reports will be processed and stored at VFD and the information will be used to inform control and displayed on the interactive map

# Are we finding it hard to catch fish?

## Is there a problem with our marine resources?

**Our marine resources provide our homes with food and money. Many communities have overharvested their marine resources. What about us?**

Are we catching less?

Are we catching only smaller sizes because the bigger ones have disappeared?

Are commercially important marine animals hard to find?

## Major causes of reduced catches include:

- More people fishing and catching too many fish
- Using modern or illegal fishing gear that catch small fish or make it too easy
- Catching fish before they have had time to breed
- Destroying areas that are important to fish such as coral reefs, seagrass beds and mangroves
- Activities on land such as logging or farming that can affect the sea through rivers and runoff

## How can we start?

We should discuss in our communities whether we can see signs of overfishing. If so are there things we can DO NOW? What about the management rules to the right?

We must get everyone in the community involved.

We also need to make other people aware of the need to manage and protect our marine resources and important marine habitats. We can distribute this poster and other information in clinics, schools, churches and other places where people congregate. We can discuss common problems – say in radio interviews and at public meetings. We can also seek assistance from national authorities or NGOs.

**The most effective management of our marine resources (including mangroves, lagoons and coral reefs) will need us to all work together and take action!**

## We must act now before it is too late

Most of the reductions in fish catch are caused by humans – that is why we have to manage our marine resources. We have to have rules or regulations to protect our marine life and the places in which they live. National fisheries authorities and departments impose rules to help keep this important food and income coming in and we must support them. A marine ecosystem that collapses is difficult to revive again.

### Some rules can be made by our local communities. We can:

- **Protect plant-eating fish**
  Some fish, such as parrotfish, unicornfish and surgeonfish eat seaweeds that would otherwise over grow coral reefs.
- **Protect watershed areas**
  Seek government support to reduce sediments and nutrients running off the land; these cause damage to many marine habitats.
- **Protect habitats**
  All species need places to eat, live and grow. Some species use different habitats in different parts of their lives. Important habitats include coral reefs, seagrass beds and mangroves.
- **Leave sleeping fish**
  Ban underwater torches and spears at night when fish are sleeping.

- **Leave small fish & shellfish**
  Allow individuals to breed at least once before they can be caught.
- **Leave some big fish & shellfish**
  Larger individuals produce many more eggs. Protect or leave some of the large fish so they can continue to reproduce and provide fish for us to catch.
- **Establish no-take areas**
  Set up areas to protect fish habitat (coral reefs, seagrass beds and mangroves). No-take areas may allow fish catches in nearby areas to eventually improve.


- **Ban damaging fishing methods**
  People using poisons and explosives are destroying our coral reefs and the marine life which depends on them.
- **Ban or reduce fishing on spawning fish**
  Ban fishing at times and in areas where fish are known to gather to spawn.
- **Ban small mesh net fishing**
  Restrict the length of gill nets used. Limit the number of fish traps or fish fences.

There are many other actions we can take. Not all of the above measures are appropriate for all species. A series information sheets produced by SPC (www.spc.int) and LMMA (www.lmmanetwork.org) is available. Each individual information sheet should be consulted for the management options that are appropriate for specific species.


For further information, or to obtain copies of this poster and the *SPC/LMMA Information kit for fishing communities*, contact:

European Union

SPC Secretariat of the Pacific Community

SPREP

# PROHIBITION

## Green Snail Le Burgau Grin Snel

### *Turbo marmaratus*

A person must not:

- take,
- harm,
- have in his or her possession,
- sell; or
- purchase any Green Snail during the period starting on **1 OCTOBER 2005** and ending on **1 OCTOBER 2020.**

***Penalty:*** *Individual:* ***- VT 200,000***
*Company, Association, body of persons corporate or incorporate:* ***- VT 1,000,000***

Une personne ne doit pas :

- Prendre
- Endommager
- Detenir
- Vendre; ou
- Acheter des Burgaus entre le **1er OCTOBRE 2005** et **1er OCTOBRE 2020.**

***Infraction et peine:*** *Dans le cas d'une personne physique:* ***- une amende d'un montant maximum de VT 200,000***
*Dans le cas d'une société, association ou personne morale –* ***une amende d'un montant maximum de VT 1,000,000***

Man or woman ino mas:

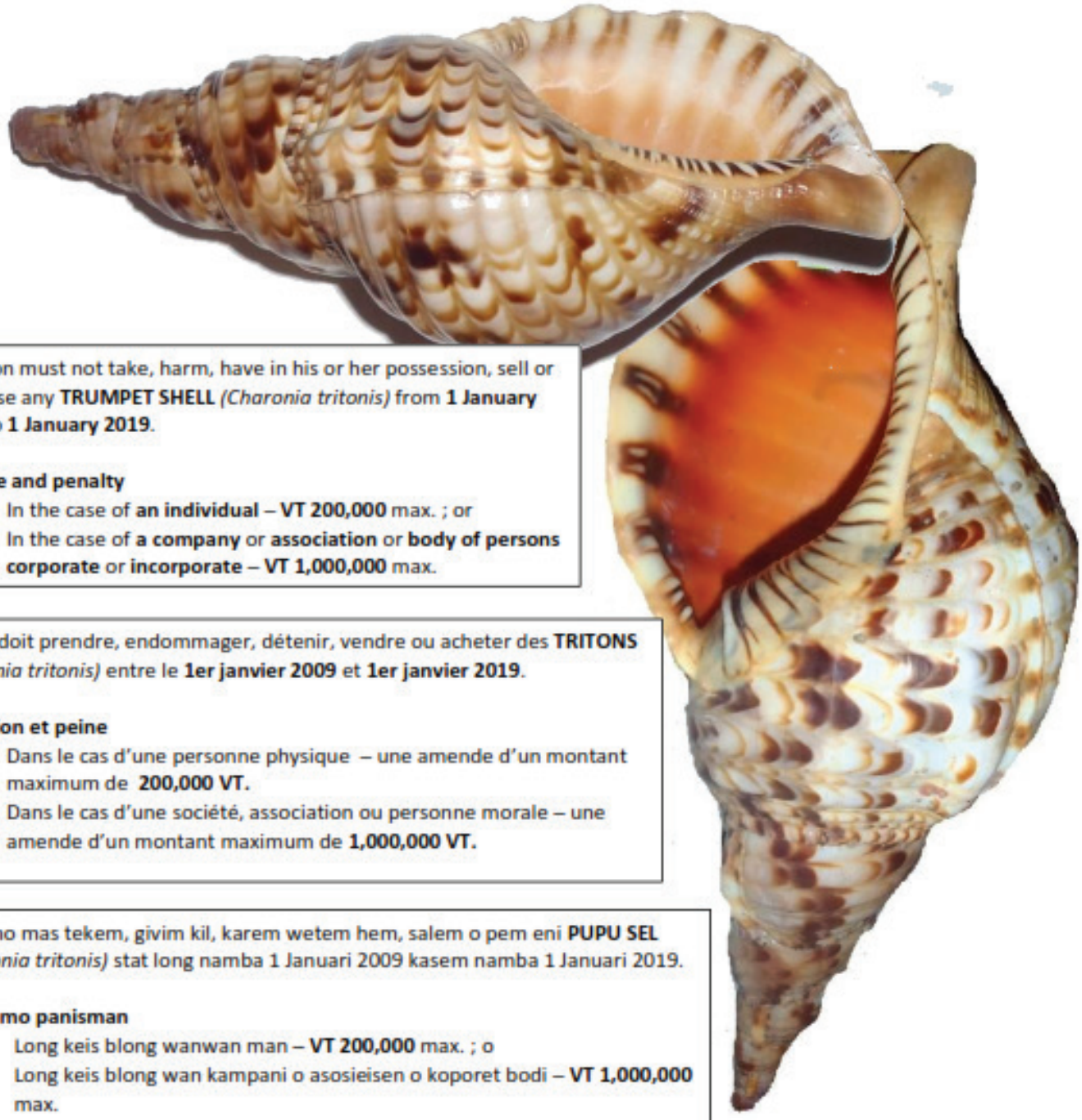
- tekem,
- givim kil,
- karem wetem hem,
- salem; o
- pem eni grin snel long taem we I stat long namba **1st OKTOBA 2005** mo finis long namba **1st OKTOBA 2020.**

***Infraction et peine:*** *long keis blong wanwan man* ***VT 200,000***
*long keis blong wan kampanio asosiasen o koporet bodi* ***VT 1,000,000*** *max.*

FISHERIES DEPARTMENT
SERVICE DES PECHES

Private Mail Bag 9045
Sac Postale Privé No. 9045
Port Vila,
VANUATU

# ATTENTION



A person must not take, harm, have in his or her possession, sell or purchase any **TRUMPET SHELL** *(Charonia tritonis)* from **1 January 2009** to **1 January 2019**.

**Offence and penalty**

- In the case of **an individual** – **VT 200,000** max. ; or
- In the case of **a company** or **association** or **body of persons corporate** or **incorporate** – **VT 1,000,000** max.

Nul ne doit prendre, endommager, détenir, vendre ou acheter des **TRITONS** *(Charonia tritonis)* entre le **1er janvier 2009** et **1er janvier 2019**.

**Infraction et peine**

- Dans le cas d'une personne physique – une amende d'un montant maximum de **200,000 VT.**
- Dans le cas d'une société, association ou personne morale – une amende d'un montant maximum de **1,000,000 VT.**

Man ino mas tekem, givim kil, karem wetem hem, salem o pem eni **PUPU SEL** *(Charonia tritonis)* stat long namba 1 Januari 2009 kasem namba 1 Januari 2019.

**Ofens mo panisman**

- Long keis blong wanwan man – **VT 200,000** max. ; o
- Long keis blong wan kampani o asosieisen o koporet bodi – **VT 1,000,000** max.

**FISHERIES DEPARTMENT**
**SERVICE DES PECHES**
**Private Mail Bag 9045**
**Sac Postale Privé No. 9045 Port Vila, Vanuatu**

# Rock Lobster

A person must not take, harm, have in his or her possession, sell or purchase any rock lobster *(Panulirus spp.)*:

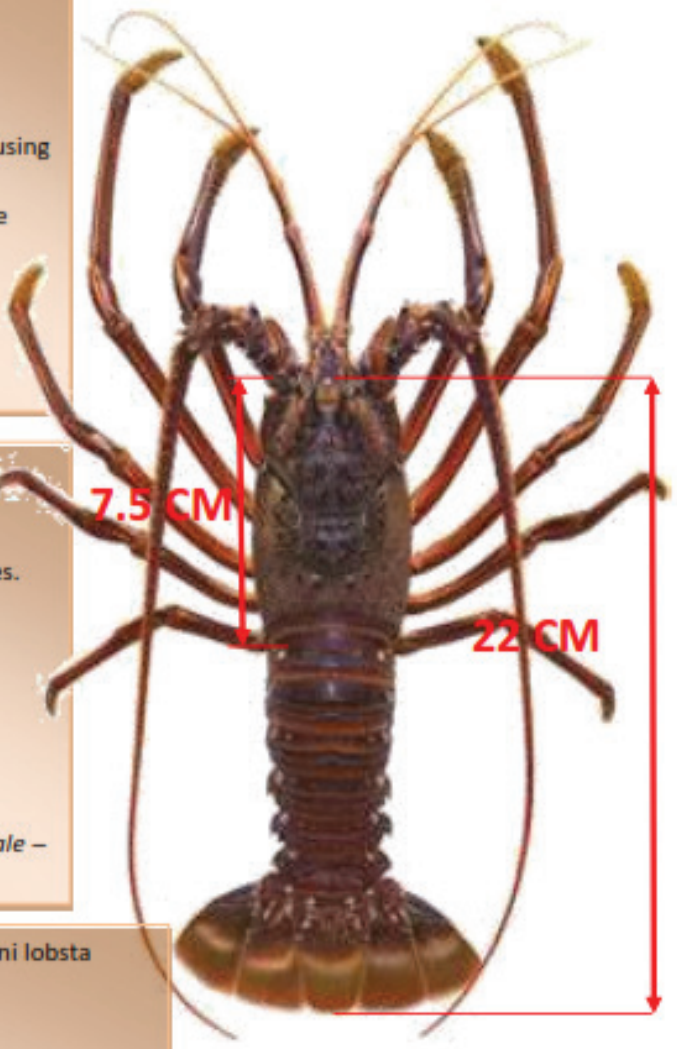
- carrying eggs;
- less than 22 centimeters in length;
- whose carapace is less than 7.5 centimeters.

A person must not: capture or attempt to kill any rock lobster by using spears or any sharp objects;

- export any crustacean (including rock lobsters) without the authorization of the Director.

**Offence and penalty**

- *In the case of an individual – **VT 200,000 max.**; or*
- *In the case of company or association or body of persons corporate incorporate – **VT 1,000,000 max**.*




Nul ne doit prendre, endommager, détenir, vendre ou acheter des langoutes (Panulirus ssp) portant des oeufs;

- ayant une taille inférieure à 22 centimètres;
- dont la carapace est d'une taille inférieure à 7,5 centimètres.

Nul ne doit: blesser, capturer ou tenter de tuer une langouste au moyen d'un harpoon ou d'un objet pointu;

- exporter des crustacés (y compris des langoustes) sans l'autorisation du Directeur.

**Infraction et peine**

- *Dans le cas d'un individu – une ammende d'un montant maximum de **200 000 VT**; ou*
- *Dans le cas d'une société,association ou une personne morale – une ammende d'un montant maximum de **1 000 000 VT**.*

Wan man ino mas tekem, kivim kil, kat wetem hem, salem o pem eni lobsta blong rif *(Panulirus spp.)*we:

- I karem ek;
- ino kasem 22 sentimeta;
- sel blong baksaed blong hem ino kasem 7.5 sentimeta.

Wan man ino mas: karem o traem blong kilim eni lobsta blong rif wetem ol spia or samting we I shap;

- expotem eni 'crustacean' (inkludim lobsta blong rif) witaot otoraeseisen blong Daerekta.

**Ofens mo Panisman**

- *long keis blong wanwan man – **VT 200,000** max.; o*
- *long keis blong wan kampani o asosieisen o koporet bodi – **VT 1,000,000** max.*

**Fisheries Department, Service des Peches, PMB 9045, Sac Postale Privé No. 9045 Port Vila, Vanuatu**

# Slipper Lobster

A person must not take, harm, have in his or her possession, sell or purchase any Slipper lobster *(Parrabacus caledonicus)*:

- carrying eggs;
- less than 15 centimeters in length;

A person must not: capture or attempt to kill any Slipper lobster by using spears or any sharp objects;

- export any crustacean (including Slipper lobsters) without the authorization of the Director.

**Offence and penalty**

- *In the case of an individual – **VT 200,000 max.**; or*
- *In the case of company or association or body of persons corporate incorporate – **VT 1,000,000 max**.*


Nul ne doit prendre, endommager, détenir, vendre ou acheter des Cigales (*Parrabacus caledonicus*) portant des oeufs;

- ayant une taille inférieure à 15 centimètres;

Nul ne doit: blesser, capturer ou tenter de tuer une Cigale au moyen d'un harpoon ou d'un objet pointu;

- exporter des crustacés (y compris des Cigales) sans l'autorisation du Directeur.

**Infraction et peine**

- *Dans le cas d'un individu – une ammende d'un montant maximum de **200 000 VT**; ou*
- *Dans le cas d'une société,association ou une personne morale – une ammende d'un montant maximum de **1 000 000 VT**.*

Wan man ino mas tekem, kivim kil, kat wetem hem, salem o pem eni Slipa lobsta *(Parrabacus caledonicus)we:*

- I karem ek;
- ino kasem 15 sentimeta;

Wan man ino mas: karem o traem blong kilim eni Slipa lobsta wetem ol spia or samting we I shap;

- expotem eni 'crustacean' (inkludim Slipa lobsta) witaot otoraeseisen blong Daerekta.

**Ofens mo Panisman**

- *long keis blong wanwan man – **VT 200,000** max.; o*
- *long keis blong wan kampani o asosieisen o koporet bodi – **VT 1,000,000** max.*

**Fisheries Department, Service des Peches, PMB 9045, Sac Postale Privé No. 9045 Port Vila, Vanuatu**

# Indicators of REEF HEALTH

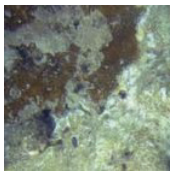
## Reef community

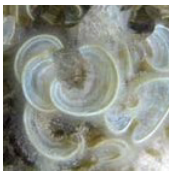
The make-up of communities on coral reefs can serve as an indicator of the general habitat condition of the area. Reefs made up of mostly hard corals are quick to recover from disturbances and high coral cover ensures that if some corals die there are others to re-seed the reefs in the years that follow. Also, most corals grow very slowly so high coral cover indicates that the site has either tolerated and/or recovered from past impacts, or that the site is rarely impacted. Coral reefs are dynamic and the make-up of reef communities varies over time with local environmental conditions. Monitoring reef communities helps understand trends in habitat condition, and indicates how well an area will tolerate and recover from future impacts. At some sites there are impacts on reefs related to human activities and management can work to reduce these impacts, and can use data from monitoring to check the effectiveness of these actions. Knowing the make-up of reef communities can also work as a baseline, enabling scientists and managers to better assess impacts when they occur.

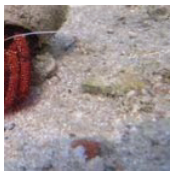

hard coral


soft coral


dead coral


rock


seaweed


sand

## Coral types

Many different coral types occur on reefs, from branching and plate corals to massive, encrusting and solitary or 'mushroom' corals. The type of corals found on reefs varies with local environmental conditions, like currents, shading, and water quality and clarity. Coral reefs that have many different coral types are considered healthy, as they are more likely to tolerate and recover from impacts. For example, not all corals are equally affected by bleaching. Fast-growing branching and plate corals are often the first to bleach, and are more likely to die from bleaching. Slower-growing massive corals usually take longer to bleach, and tend to be able to survive for longer in a bleached state. Similarly, branching and plate corals have a more fragile structure and are therefore more susceptible to physical damage from storms or anchoring. Information on which coral types are most common at a particular reef site can help determine how susceptible the reef is to impacts like storms and bleaching, both of which are predicted to occur more frequently and be more severe in the future.


branching


plate


massive


soft coral


encrusting


mushroom

# Seaweed and seagrass

Competition between corals and seaweed, or algae, is key in determining the abundance of corals on reefs. Seaweed can overgrow coral tissue, reduce the amount of light available to corals for photosynthesis, damage tissue, or produce chemicals that damage or kill coral tissue. Recovery of corals following impacts also requires that bare space is available for new corals to settle on and grow, and extensive growth of seaweeds can limit the available bare space. The amount of seaweed on a coral reef is indicative of the reef's health, with more seaweed generally meaning a lower abundance of corals. On some reefs, especially those near shore, water quality can affect the balance between coral and seaweed, as the growth rates of seaweed increase in waters that are rich in nutrients.

Seagrass meadows are important habitats that have high biodiversity, and are important breeding and feeding grounds for many marine animals. For example, fish, dugongs, green turtles and sea cucumbers all use seagrass meadows to feed, breed or as a nursery ground. Seagrass meadows also help to keep coastal environments stable, they cycle nutrients and often provide a rich source of seafood. They are often found growing among corals on reefs.


brown algae


green algae


red algae

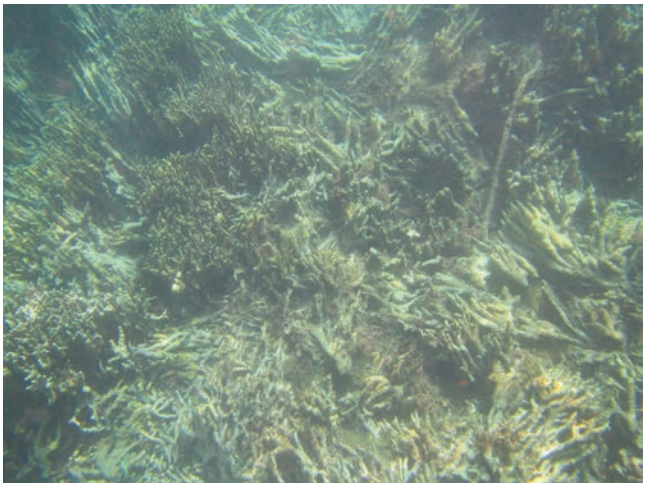

turf algae


seagrass


seagrass

# Recent coral breakage

Branching and plate coral types are the most likely to be damaged by storms, waves, and impacts related to human activities like anchoring due to their fragile structure. Other coral types, like massive, encrusting and solitary corals have a lower profile and are much less prone to physical damage. Wave action produced by storms, carelessly placed anchors, as well as the fins of snorkelers and divers can break fragile corals, resulting in injuries that corals must use their energy to repair. In corals, a loss of energy increases the chances of the coral being affected by disease and bleaching. Simple changes to anchoring locations, snorkeler and diver awareness and boating practices can work to reduce the number of damaged corals and increase the chances reefs have of tolerating future impacts. Information on recent coral breakage provides insight into human pressures at a site and/or the frequency of severe storms in the area.



# Predation and disease

Some marine invertebrates are natural predators of corals, primarily crown-of-thorns starfish (posen sta) and a marine snail (Drupella). These animals prefer fast-growing corals, like plate and branching corals, and will live on and within a coral colony while they feed on the coral tissue. Their feeding leaves telltale signs as they leave behind a bare skeleton, making the areas where tissue has been eaten appear bleached. Although posen sta rarely consume an entire colony, the areas of dead coral leave the coral with a high chance of acquiring disease or being overgrown by seaweed. Posen sta and Drupella can be found on reefs throughout the Indo-Pacific and outbreaks occur when the density of animals is high enough that they end up consuming coral tissue on a reef faster than it can grow. Entire reefs can be damaged during outbreaks leaving the reef framework exposed to impacts like severe storms.

Coral disease takes many forms, but the effects of disease can be recognised by a strong line separating live and dead parts of a coral colony. Coral diseases are most commonly caused by a pathogen (e.g. bacteria, fungi) and some types of coral diseases can advance quickly killing entire colonies. All diseases increase the chances of corals being damaged by other impacts. There are 30 documented coral diseases worldwide, with some of the most common types being white syndrome, black band syndrome, brown band syndrome and growth anomalies.


Posen sta


*Drupella* snails


white syndrome


black band disease


brown band disease


tumours

# Coral bleaching

Coral bleaching is a stress response in corals that results in the breakdown of the relationship between the coral animal and the symbiotic algae that live inside them – known as 'zooxanthellae'. The loss of the algae results in the coral losing its colour making it easy to see the white limestone skeleton beneath, hence the term 'bleaching'. The algae provide the coral with its main food source, so bleached corals can only survive for a few weeks before they die. A lot of different types of stress can cause bleaching on reefs but large-scale bleaching events that affect many reefs are caused by unusually warm sea temperatures. Corals can regain their algae and survive bleaching if sea temperatures decrease. However, exposure to unusually warm temperatures for longer than a few weeks when bleached causes corals to starve and die. Coral bleaching events have now affected every major coral reef system worldwide, most recently in 2015/16. As climate change continues to cause unusually warm sea temperatures, bleaching will occur more frequently resulting in reefs with less coral.


Partial bleaching


Partial bleaching


Bleached colony


Mass bleaching


Dead coral


Damaged reef

# Rubbish

Rubbish, such as plastic bags, bottles, packaging, cigarette butts and discarded household goods, are often transported through urban drains and waterways and end up in coastal marine environments. Most urban rubbish takes years to decades to break down. For example, cigarette butts take 1 -5 years, plastic bags 10 – 20 years, aluminium cans 80 years and plastic bottles 450 years. Plastics in particular break down very slowly and are the most common man-made objects in the sea. Plastic bags are often mistaken for food – such as jellyfish – by marine animals such as turtles, dolphins and seabirds, which try and eat the bags and end up choking. Plastic bags, packaging material and discarded fishing line and nets can also entangle marine animals and in the worse cases, fatally injure them. Worldwide, 100,000 turtles, dolphins, whales and seals are killed by plastic marine litter every year.

# Vanuatu Marine Mammal Sanctuary

## Le Sanctuaire des Mammifères Marins du Vanuatu

## Vanuatu Marin Mamol Sanktuari

The Vanuatu Marine Mammal Sanctuary comprises all Vanuatu waters. In the Vanuatu Marine Mammal Sanctuary, a person must not:

- *Kill, harm, harass, take or move any marine mammal;*
- *Possess, hold in captivity or restrict the movement of any marine mammal;*
- *Possess a part of a marine mammal, or product produced from a marine mammal*
- *Export from or import into Vanuatu or facilitate the exportation from or the importation into Vanuatu of any marine mammal, marine mammal or marine mammal product.*

Le sanctuaire des baleines de Vanuatu comprend l'ensemble des eaux de Vanuatu.
Dans le sanctuaire des baleines de Vanuatu, nul ne doit:

- *Tuer, blesser harceler, capturer ou déplacer un mammifère marin;*
- *Détenir ou retenir en captivité un mammifère marin ou restreindre ses déplacements;*
- *Avoir en sa possession une partie d'un mammifére marin, ou des produits derives d'un mammifère marin;*
- *Exporter de Vanuatu, importer à Vanuatu ou faciliter l'exportation de Vanuatu ou l'importation à Vanuatu d'un mammifère marin, d'une partie d'un mammifére marin ou de produits derives d'un mammifére marin.*

Sanktuari blong marin mamol long Vanuatu hemi tekem evri solwora blong Vanuatu.

Insaed long sanktuari blong welfish long Vanuatu, man ino mas:

- *Kilim, givim kil, harasem, tekem o muvum eni marin mamol;*
- *Karem wetem hem, holem taet o restriktim muvmen blong eni marin mamol;*
- *Karem wan pat blong wan marin mamol, o wan prodak we oli prodiusim wetem wan marin mammol;*
- *Ekspotem i aot o impotem kam long Vanuatu o fasilitatem ekspoteisen o impoteisen i kam insaed Vanuatu blong eni marin mamol , wan pat blong marin mamol o wan prodak blong marin mamol.*

*Blue Whale*
*Baleine bleue*
*Blu Weil*
*藍鯨*
*ブルーホエール*

*Manatee*
*Lamantin*
*Buluk blong solwota*
*馬納蒂*
*マナティー*

*Dolphins*
*Les dauphins*
*Ol Dolfin*
*海豚*
*イルカ*

*Dugong*
*Buluk blong solwota*
*杜*
*ジュゴン*

*Killer Whale*
*Orque*
*Kila Weil*
*虎鯨*
*キラーホエール*

**Penalty/Peine/Panisman**

*VT 50,000,000 max. Or a term of imprisonment not exceeding 2 years or both.*
*Une amende d'un montant maximum de 50 millions VT, une peine de prison d'une durée maximale de deux ans ou un cumul des deux peines.*
*VT 50,000,000 max. o wan taem blong go long kalabus we ino bitim 2 yia o tugeta Panisman.*

FISHERIES DEPARTMENT
SERVICE DES PECHES

Private Mail Bag 9045
Sac Postale Privé No. 9045
Port Vila, VANUATU

# Marine Turtles Of Vanuatu

A person must not:

- Take;
- Capture;
- have in his or her possession;
- Harm
- Kill;
- Consume;
- Destroy;
- Export;
- Sell or purchase any hatchlings, juveniles or adults, eggs, parts or shells of any of the following turtle species:
  - *Leatherback Turtle (Dermocheyles coriacea)*
  - *Hawksbill Turtle (Eretmochelys imbricate)*
  - *Green Turtle (Chelonia mydas)*


- Une personne ne doit pas:
  - Prendre;
  - Capturer;
  - avoir en sa possession;
  - Endommager
  - Tuer;
  - Consommer;
  - Détruire;
  - Exporter;
  - vendre ou acheter des jeunes faucons, des jeunes ou des adultes, des œufs, des pièces ou des coquilles de toutes les espèces de tortues suivantes:
    - o la tortue luth (Dermocheyles coriacea)
    - o la tortue imbriquée (Eretmochelys imbricate)
    - o la tortue Verte (Chelonia mydas)


Wan man o woman ino mas:

- Tekem;
- Kapjarem;
- Kat long posesen blong hem;
- Hamem;
- Kilim;
- Kakae;
- Distroem;
- Ekspotem;
- Salem o pem eni smol yang totel, or bigfala totel, ek, pat o sel blong eni long ol totel spesis ia:
  - *Letabak Totel (Dermocheyles coriacea)*
  - *Hoksbill Totel (Eretmochelys imbricate)*
  - *Grin Totel (Chelonia mydas)*


FISHERIES DEPARTMENT
SERVICE DES PECHES
PRIVATE MAIL BAG / SAC POSTALE PRIVÉ NO. 9045
PORT VILA, VANUATU

# NOTES