COASTAL AND MARINE BIODIVERSITY ASSESSMENT AND MONITORING MANUAL

To provide a simple, scientific, and process-oriented guide for national biodiversity assessment and monitoring.

SEPTEMBER 2017
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1. About This Manual

1.1 At a Glance

A RICH BIODIVERSITY OFFERS MANY NATURAL AND ECONOMIC BENEFITS. IT PROVIDES COASTAL area protection, food, and livelihood. The Philippines is known for its rich coastal and marine biodiversity. However, many years of the country’s rapid unsustainable consumption of natural resources has led to the decline of its valuable biological richness.

The main threats for many species degradation are habitat destruction and ecosystem changes. Monitoring will help detect changes that significantly impact biodiversity and provide scientific basis for designing interventions that can address biodiversity loss.

1.2 Why Another Manual?

WITH THE CONSTANT CHANGES AND NEW KNOWLEDGE BROUGHT AND INTRODUCED BY THE scientific community, several updates had to be made. In this case, the Biodiversity Assessment Monitoring System (BAMS) was developed by Nordic Agency for Development and Ecology (NORDECO) and DENR back in 2001 to serve as a starting point for monitoring, thus becoming this manual’s forerunner. This was to ensure that no major change in the PA biodiversity went undetected. With the incorporation of recent advances in coastal ecosystems monitoring, this manual is an enhancement of the previous version by having included the operationalization of biodiversity monitoring in more areas in the country, with more available resources.

This How-To Guidelines are designed for use in the Philippines.

1.3 What are the Goals of this Manual?

THIS MANUAL AIMS TO:

1. set a standard assessment and monitoring guideline that is consistent across all regions in the Philippines;
2. describe the tools and methodologies employed in the monitoring process;
3. provide instruction on the methodologies concerning data generated, and
4. serve as the companion Manual in facilitating capacity development events related to the assessment and monitoring of marine biodiversity.
IN A NUTSHELL

This manual for coastal and marine biodiversity assessment and monitoring was developed based on the training module developed by a team of experts engaged by WorldFish, a nonprofit organisation dedicated to the potential of aquaculture, to serve as an attachment to the technical memo for facilitating easier and better compliance.

In order to sustain the effects of the capacity development initiatives of the PAME project, there arose a need to institutionalize an assessment and monitoring system, consistent across the regions of the country. This was to be done through the circulation of a technical memo to all DENR regional offices.

BEFORE YOU BEGIN: IS THIS MANUAL FOR YOU?

This manual is for you if you are either:

A. A technical personnel of coastal PAS under the National Integrated Protected Areas System.

B. A prospective technical service provider with knowledge and skills for the efficient and effective management of biodiversity conservation.

If yes to one or both, let’s proceed!
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2. Introduction

“FIGURE 1. OVERVIEW OF AMENDED COASTAL and Marine Biodiversity Monitoring Process” on page 11 provides an illustration of the amended coastal and marine biodiversity assessment and monitoring process overview, which recognizes that monitoring of coastal and marine biodiversity concerns not only the DENR but also the academe, local government units (LGUs) and community members, and other government agencies such as the Bureau of Fisheries and Aquatic Resources (BFAR) thus, a planning and levelling off meeting is needed to establish an effective inter-agency approach.

Each agency must take an active role in the monitoring process, however, in consideration of resources, mandate, and capacity constraints, the design of this monitoring process has different expectations on the frequency of conduct of the different methods and the outputs of monitoring from each agency.

The process includes more methods and tools than those in the BMS, which entails more time and resources.

LOGISTICS AND BUDGET

IN MAKING LOGISTICAL ARRANGEMENTS and budgeting for coastal and marine biodiversity monitoring, the following must be considered:

- Number of persons needed and required capacities for conducting assessment and monitoring
- Health and safety of personnel (i.e. access to health facilities, personal accident and life insurances)

- Need for accommodation depending on distance of monitoring site to base of monitoring team
- Appropriate gear (e.g. scuba and snorkeling gear) and equipment, and software for data collection and analysis and report making
- Sufficient supplies for personnel welfare (i.e. food, water, medicine, first aid kit)
- Enough supplies and materials for data collection proper
- Facilities for data management, analysis, and storage

THE FOLLOWING SECTIONS WILL provide information on the minimum personnel and materials needed that can guide budgeting and logistics arrangement.

DATA TO BE GENERATED BY COASTAL AND MARINE BIODIVERSITY ASSESSMENT AND MONITORING

THE AMENDED ASSESSMENT AND monitoring process for coastal and marine biodiversity aims to generate various information needed to answer the key biodiversity questions used in evaluating the effectiveness of the management interventions in the area in addressing biodiversity conservation:
## Overview of Amended Coastal and Marine Biodiversity Monitoring Process

<table>
<thead>
<tr>
<th>Partnership</th>
<th>Planning &amp; Budgeting</th>
<th>Preparation</th>
<th>Data Collection</th>
<th>Analysis &amp; Report</th>
</tr>
</thead>
</table>
| • Establishing of partnership or cooperation for monitoring and assessment among DENR, academe, BFAR, and LGUs  
  • Levelling-off on expectations of each partner | • Mapping of coastal and marine biodiversity assessment and monitoring in the schedule of activities and key target outputs of the agency  
  • Allocation of budget, staff, and other resources for the assessment and monitoring | • Strengthening capacities of personnel, if needed  
  • Preparation of map/base map for field work, survey instrument, supplies and materials, equipment, transportation needs, permissions and clearances, etc  
  • Setting and confirming schedule of data collection activity with concerned partners (e.g. LGU, fisher groups, landing site/market management) | • Protection provided by coastal habitats, coral reef, seagrass beds, seaweeds, mudflat and intertidal areas, megafauna, and fisheries  
  • Updating basemap collected data using GIS  
  • Refer to next sections of this guideline | • Analysis of data collected  
  • Looking at trends referring to previous monitoring reports and other secondary data sources  
  • Preparing of biodiversity report answering key biodiversity questions |

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**Figure 1. Overview of Amended Coastal and Marine Biodiversity Monitoring Process**
Advantages of Using a Base Map in Monitoring and Assessment

Figure 2. Advantages of using a base map

1. IT IS VITAL IN ENSURING THE RELOCATION OF POINTS OR AREAS OF INTEREST.
2. NEGATIVE CHANGES ARE ADDRESSED IN A RESPONSIVE MANNER.
3. POSITIVE CHANGES ARE PROMOTED AND MAINTAINED.
4. CONTAINS THE PA MONITORING POINTS FOR EACH OF THE THEMATIC COMPONENT.

Where are land cover, habitats, and ecosystems? And where are they being degraded/improving? (not just in PA but including buffer zones)

1. Are the populations of threatened species of plants and animals declining/increasing?
2. What are the causes of such decline/increase?
3. Has management intervention had the intended impact on the ecosystem?
4. Are there increased benefits to local communities from sustainable natural resource use?

SEE ANNEX XX, TABLE 1... (MOVE TABLE 1 to Annex)
3. Remote Sensing and GIS

**IN A NUTSHELL**

AN EFFECTIVE AND EFFICIENT assessment, monitoring, and evaluation tool for a Protected Area (PA) consists of the following:

1. A set of base maps containing the protected area (PA) site descriptors namely: location, physical, hydro-meteorology, environmental and socio-economic descriptors. For each descriptor, corresponding GIS maps are prepared (Annex 1)

2. A gridded GIS for the PA

3. A method for utilizing advanced technologies like Geographic Information Systems (GIS) and remote sensing

4. A method for data handling, processing and analysis thru GIS databasing.

**DATA AND INFORMATION FOR PAs**

THE FOLLOWING DATA AND INFORMATION should be available for the PA:

1. Administrative boundaries

2. Legal gazetttement

3. A management structure (i.e. Protected Area Management Bureau headed by a Protected Area Superintendent)

4. Updated land cover and land use data

5. Tenure (where available), e.g. Community Based Forest Management (CBFM), Certificate of Ancestral Domain Claim/Title (CADC/CADT), Mineral Production Sharing Agreement (MPSA; where applicable)

6. Biodiversity values

7. Vulnerability to impacts of climate change and hazard prone areas, among others.

**PA BASE MAP REQUIRED INFORMATION**

1. Geographic extent of the PA (e.g. technical description expressed in GIS format)

2. Current land cover and land use (e.g. land cover from 2010 or more recent data) focusing on the coastal habitats and infrastructure (e.g. settlements, commercial buildings, access roads, ports, among others)

3. Administrative boundaries (e.g. down to barangay; expressed in GIS format) focusing on coastal communities and industries

4. Bathymetry

5. Watershed drainage system (i.e. river outlets) focusing on the downstream areas

6. Location and/or extent of key coastal/marine resources (e.g. coastal habitats, fishing grounds, nesting areas, feeding grounds)

**3.1 Advantages of Using a Base Map in Monitoring and Assessment**

1. It is vital in ensuring the relocation of points or

1 A common delineation of a watershed is in terms of upstream, midstream and downstream. The downstream areas represent the most immediate impact zone for the coastal environment
2. Negative changes are addressed in a responsive manner.

3. Positive changes are promoted and maintained.

4. Contains the PA monitoring points for each of the thematic component. (See Figure 2 on page 12)

**REPRESENTATIVENESS AND REPEATABILITY**

are key to a successful monitoring.

**REPRESENTATIVENESS** To achieve this, a good base map showing the current land cover and land use vis-à-vis coastal habitat should be available. Each of the categories of the thematic component should have a monitoring point.

For example, for the coastal habitat, one monitoring station should be established at the coral reef, and one monitoring station at the seagrass, and so on. When a habitat exists at more than one location, the choice of setting up a monitoring station becomes complicated. In such a case, the accessibility of the area and the presence of a willing partner in the barangay could be used as bases.

**REPEATABILITY** This provides the opportunity to return to the monitoring point at specific periods in the future. Thus, the choice of the monitoring point should enable such point to be relocated. In this case, a base map will be critical so that the location of the monitoring point can be easily delineated. In addition, the use of landmarks and other visible ground features should be used and the location marked using a GPS unit.

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**BASE MAP MUST DOS**

- Collect relevant data such as PA boundary, coastline, bathymetry, physiography, land cover, watersheds, rivers, hazards, administrative boundaries, and land use.

- Gather the base map from authorized sources: National Mapping and Resource Information Authority, Forest Management Bureau, LGUs as shown in their Comprehensive Land Use Plans, Mines and Geosciences Bureau, Philippines Statistics Authority, and relevant agencies of the Department of Agriculture.

- Create a consistent base map to ensure repeatability of activities wherein the points of interest (POIs) or areas of interest (AOIs) (e.g. point intercept, manta tow, photo transect, visual census, seagrass watch, transect-quadrat, among others) can be relocated or revisited at future periods without much difficulty.

- Prepare the base map in consultation with the stakeholders to encourage ownership and participation e.g. construction of a gear map.

- Prepare the base map using current and available technologies like remote sensing (RS) and GIS. RS/GIS can produce the necessary visual tools to facilitate assessment and monitoring activities. The easiest and most common are OpenSource resources like GoogleEarth© RS/GIS can also be used to improve the recording (e.g. databasing) of field data and information of the thematic components.

- Organize GIS data into specific thematic components with their corresponding feature attribute tables (i.e. geodatabase).

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**MATERIALS AND EQUIPMENT**

- Preliminary base map

- Laptop/computer
• Maps and satellite imagery (e.g. NAMRIA, Google Earth©, LandSat, Sentinel2)

• GIS software (e.g. Quantum, ArcGIS)

• Reliable internet connection

• Minimum dataset (from other components of coastal and marine biodiversity assessment and monitoring)

3.2 Procedure

DEPENDING ON THE GIS SOFTWARE BEING used, executing commands may differ but the steps below describe what must be done.

Please refer to the user’s manual of the GIS software (e.g. QGIS Training Manual release 2.14 from qgis.org website) for a step-by-step guide on how to perform the following tasks. There is also a complete set of practical exercises contained in the new book on GIS by Bantayan, et al. 2015. The book contains two sets of exercises: one on QGIS and one ArcGIS.

3.2.1 Base Map Development

1. Using the GIS software, prepare the basemap considering the characteristics of the map sources in terms of datum, source scale, projection, format (analog or digital), and date of preparation (i.e. lineage).

2. Load the map from NAMRIA and/or from LGU, establish location parameters.

3. Augment and/or enhance the map with available remote sensing images, vector coverages, and other available map.

3.2.2 GIS Database Development

1. Develop the GIS database according to the thematic components of coastal and marine biodiversity assessment and monitoring. (“GIS Database Development Themes” on page 16)

Each GIS theme will have its own set of attributes (i.e. minimum datasets, see “Table 1 Minimum datasets for the different thematic components of coastal and marine biodiversity assessment and monitoring.” on page 17) and legend or symbology.

Generate attributes from the monitoring process for the different taxa or components as described in the other chapters of this guideline. Agree on the legend or symbology and make it consistent throughout different cycles of monitoring.

2. Create a 1km x 1km grid (e.g. fishnet) that encompasses the PA using a method based on the GAME model or GIS-based assessment, monitoring and evaluation (Bantayan, 2006, Bantayan, et al, 2015) based on the SUSDEV Database System.

THE SUSDEV DATABASE SYSTEM IS A comprehensive database system for sustainable development planning, field operations, and
monitoring developed by Dr. Juan Adolfo Revilla.

Each grid will have its own unique grid ID and can also be refined down to 10m X 10m granule depending on the precision of the analysis (Figure 4 on page 18 and Figure 5 on page 18).

See Annex 3 for a step-by-step guide on generating GAME Units using QGIS. It is recommended that gridded maps are used during monitoring fieldwork as this would facilitate the mapping and encoding and updating of the base map.

3. For more effective monitoring, add a unique grid code (such as coral and seagrass cover) to the usual set of location parameters (e.g. region, province, municipality, barangay, sitio, grid ID).

For example, Figure 6 on page 19 shows the GIS map and database of the Mana tow exercise conducted in Guiuan. The size of the icon indicates the condition of the coral corresponding to the protocol of the thematic component on coastal habitat assessment, i.e. larger icon means higher value.

Figure 7 on page 20 on the other hand is the manta tow database in which Figure 6 on page 19 was based on.

4. Update the base map with satellite images at 5-year intervals.
Table 1 Minimum datasets for the different thematic components of coastal and marine biodiversity assessment and monitoring.

<table>
<thead>
<tr>
<th>TAXA/COMPONENT</th>
<th>MINIMUM DATASET (MDS)</th>
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<tbody>
<tr>
<td>Coastal integrity and coastal habitat</td>
<td>x High-resolution, site-specific base maps of coastal habitats</td>
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<tr>
<td></td>
<td>x Distribution</td>
</tr>
<tr>
<td></td>
<td>x Extent</td>
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<tr>
<td></td>
<td>x Shapes</td>
</tr>
<tr>
<td></td>
<td>x Sizes</td>
</tr>
<tr>
<td></td>
<td>x Coastal landform and rock type</td>
</tr>
<tr>
<td>Corals</td>
<td>x Percent live hard coral cover per genus and life forms</td>
</tr>
<tr>
<td></td>
<td>x Percent dead coral cover and soft corals</td>
</tr>
<tr>
<td></td>
<td>x Percent cover of associated flora</td>
</tr>
<tr>
<td></td>
<td>x Coral diseases</td>
</tr>
<tr>
<td>Reef Fish</td>
<td>x Fish species and species richness</td>
</tr>
<tr>
<td></td>
<td>x Fish abundance</td>
</tr>
<tr>
<td>Seagrass</td>
<td>x Percent seagrass cover</td>
</tr>
<tr>
<td></td>
<td>x Species richness</td>
</tr>
<tr>
<td></td>
<td>x Relative abundance</td>
</tr>
<tr>
<td>Seaweed</td>
<td>x Seaweed cover focusing on dominant species</td>
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<tr>
<td></td>
<td>x Seaweed species richness</td>
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<td></td>
<td>x Relative abundance</td>
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<tr>
<td>Invertebrates</td>
<td>x Species richness</td>
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<td></td>
<td>x Species abundance</td>
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<tr>
<td>Megafauna</td>
<td>x Biological diversity</td>
</tr>
<tr>
<td></td>
<td>x Range of distribution</td>
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<tr>
<td></td>
<td>x Population abundance</td>
</tr>
<tr>
<td></td>
<td>x Species present</td>
</tr>
<tr>
<td></td>
<td>x Threats to megafauna</td>
</tr>
<tr>
<td></td>
<td>x Temporal variation (optional)</td>
</tr>
<tr>
<td>Fisheries</td>
<td>x Number of fishers per fishing village</td>
</tr>
<tr>
<td></td>
<td>x Number of fishers per km2 of fishing</td>
</tr>
<tr>
<td></td>
<td>x Total fishing effort</td>
</tr>
<tr>
<td></td>
<td>x Catch composition</td>
</tr>
<tr>
<td></td>
<td>x Catch per unit effort (CPUE)</td>
</tr>
<tr>
<td></td>
<td>x Production</td>
</tr>
</tbody>
</table>

x Bathymetry
x Slope from shoreline to 20- m elevation
x Beach forest/vegetation
x Coastal and offshore mining
x Shoreline
x Vulnerability
x Canopy height
x Shoot density (optional)
x species composition of marine mammals stranded
x Estimated number of sea turtle reproductive females, nests, and hatchlings
x Gear inventory and spatial map of fishing effort
x Sources of fish products/fishing area
x Fishing revenues and net income
x Trophic structure (optional)
Figure 4. Grid GIS database (Bantayan et al. 2015)

Figure 5. Gridded map of a portion of the Guiuan Marine Reserve Protected Landscape and Seascape.
4. Methods for Monitoring Coastal Changes

CHANGES IN THE PHYSICAL COAST MAY BE linked to the condition of the natural habitats through the Coastal Integrity Vulnerability Assessment Tool (CIVAT).

As an assessment tool, CIVAT is designed primarily for evaluating the present-day vulnerability of coastal areas to climate change hazards particularly sea-level rise and waves.

4.1 What Can the CIVAT Do?

• It considers the coastal habitats as an integral part of the coast, thus provides a means for evaluating the vulnerability of the physical coast given the current status of the natural habitats.

• It may be used across National Integrated Protected Area System (NIPAS) sites to determine the relative vulnerabilities of the different coastal areas.

• It can lead to the identification of PAs that are in need of intervention or adaptation measures in order to lessen their vulnerabilities.
It helps prioritize the measures needed to lessen the vulnerability of a coastal area. Once these measures are put in place, CIVAT may be repeated after 5 or 10 years to determine the success of the selected strategies in reducing the vulnerability of the physical coast.

The success of CIVAT depends largely on the quality of the data input and thus, beach monitoring and collection and generation of relevant data, both primary and secondary, should precede the conduct of any vulnerability assessment.

**HOW TO ESTABLISH MONITORING SITES**

1. Select coastal areas within NIPAS with human settlements and other ecologically critical sites (e.g., nesting ground for turtles) for the application of CIVAT.

2. Select the coastline directly behind the coastal habitats being monitored (i.e. coral reefs, seagrass beds, and mangrove forests) as the monitoring sites.

3. Conduct monitoring of critical coastal sites (e.g., eroding sites; important infrastructure) within NIPAS, even without habitats.

4. Include the entire littoral cell, or a continuous segment of the coast that may be bounded by cliffs and/or rivers when monitoring.

### NOTE

**WITHIN A LITTORAL CELL, THE SOURCES***

and sinks of coastal sediments are confined, and there is connectivity in coastal processes through the longshore currents, which is responsible for the redistribution of sediments along the coast. This monitoring scheme can provide a better understanding of sediment dynamics in an area, which is critical for coastal stability.

**4.2 Frequency of Monitoring**

*TABLES 3 AND 4 BELOW SHOW THE recommended frequency and duration of conduct
of CIVAT for each group and expected output from them (See “Table 2 Recommended frequencies and durations of CIVAT methodologies per monitoring group” on page 22 and “Table 3 Expected output of CIVAT from each monitoring group” on page 23).

4.3 Data Collection

4.3.1 Field Observations and Photodocumentation

> Materials needed:

- Field notebook
- Digital camera

> Procedure:

a. Observe, take note, and take photos of the following:

i. Indicators of erosion (Figure 8)
   - Exposed tree roots and leaning or fallen trees caused by wave scouring
   - Exposed cable roots of Avicennia and Sonneratia
   - Presence of continuous scarps (i.e. vertical cut created by wave scouring) on the berm.

ii. Coastal types or landforms (i.e. sandy-gravel beaches, sandy beach underlain by beachrock, mangrove-shoreline, sandy beach with fringing reefs, and sandy beach without fringing reefs) (Figure 9 on page 24).

iii. Dominant land uses in each barangay

iv. Beach vegetation (i.e. creeping variety, shrubs, and trees) and their relative

---

4.3.2 Beach Profiling

### MATERIALS

1. One (1) pair of 1.5 Emery rods (two pieces 1.5-meter polyvinyl chloride (PVC) pipes with 1-centimeter gradations)
2. 50- or 100-meter transect tape
3. One (1) pair of bubble level
4. Digital camera
5. Compass
6. Handheld GPS
7. Beach profiling worksheet or field notebook
8. Clear hose (if area to be assessed has the horizon blocked or is inside a mangrove forest)
9. Spray paint (if allowed for marking fixed points)
10. Grain size comparator
11. Cup for sediment sampling

> Procedure

Emery Method (Emery 1961)

A SIMPLE, LOW-COST METHOD OF MAPPING the cross-sectional elevation of a beach from a fixed inland point to a certain distance seaward. It involves measuring the difference in elevations between two rods (i.e. front or seaward rod and back or landward rod) with the horizon as the reference point (Figure 10 on page 25).
<table>
<thead>
<tr>
<th>METHOD</th>
<th>FREQUENCY AND DURATION*</th>
<th>EXPERTS/ACADEME</th>
<th>DENR</th>
<th>LGU/COMMUNITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Shoreline tracing</td>
<td>At least 2 times/yr; once during the wet and dry season; After a storm event to monitor beach recovery</td>
<td>At least 2 times/yr; once during the wet and dry season; After a storm event to monitor beach recovery</td>
<td>At least 2 times/yr; once during the wet and dry season; After a storm event to monitor beach recovery</td>
<td></td>
</tr>
<tr>
<td>2. Beach profiling</td>
<td>Concurrent with shoreline tracing</td>
<td>Concurrent with shoreline tracing</td>
<td>Concurrent with shoreline tracing</td>
<td></td>
</tr>
<tr>
<td>3. Sediment sampling</td>
<td>Concurrent with beach profiling</td>
<td>Concurrent with beach profiling</td>
<td>Concurrent with beach profiling</td>
<td></td>
</tr>
<tr>
<td>4. Photo documentation</td>
<td>Every fieldwork</td>
<td>Every fieldwork</td>
<td>Every fieldwork</td>
<td></td>
</tr>
<tr>
<td>5. Field observations</td>
<td>For CIVAT scoring; Note noticeable changes during monitoring</td>
<td>For CIVAT scoring; Note noticeable changes during monitoring</td>
<td>For CIVAT scoring; Note noticeable changes during monitoring</td>
<td></td>
</tr>
<tr>
<td>6. Anecdotal accounts/ interview</td>
<td>First fieldwork to fill in data gaps and to determine causes of erosion; Seasonal to determine significant events</td>
<td>For CIVAT scoring (to determine beach recovery and other human activities); Event-based</td>
<td>For CIVAT scoring (to determine beach recovery and other human activities); Event-based</td>
<td></td>
</tr>
<tr>
<td>7. Natural habitats assessment</td>
<td>For CIVAT scoring – must be done in same sites</td>
<td>For CIVAT scoring – must be done in same sites</td>
<td>For CIVAT scoring – must be done in same sites</td>
<td></td>
</tr>
<tr>
<td>Desktop analysis</td>
<td>after every fieldwork; Same as (a); For CIVAT scoring; For CIVAT scoring; For CIVAT scoring and monitoring</td>
<td>after every fieldwork; Same as (a); For CIVAT scoring; For CIVAT scoring; For CIVAT scoring and monitoring</td>
<td>Depends on the capacity of LGU/community</td>
<td></td>
</tr>
</tbody>
</table>

*Duration would depend on the length of shoreline to be covered.

**If LGU or community has no GPS, beach profiling as a monitoring method would be acceptable.
Table 3 Expected output of CIVAT from each monitoring group

<table>
<thead>
<tr>
<th>METHOD</th>
<th>OUTPUT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>METHOD</strong></td>
</tr>
<tr>
<td>Anecdotal accounts</td>
<td>Experts/Academe: Detailed; Following a questionnaire.</td>
</tr>
</tbody>
</table>
THE EMERY METHOD REQUIRES AT LEAST THREE PERSONS:

1. The reader on the landward side, who will also function as the recorder

2. Another person on the landward side who will ensure that the Emery rod is straight while the reader is making the reading.

3. A third person to hold the seaward Emery rod and draw the transect tape seaward.

The Emery Method in Nine Steps

1. Select a site to be profiled. Establish a transect perpendicular to the coast where there is an observable change in beach configuration or where there are known critical sites within the PAs.

2. Establish the fixed point. This should mark the location of the transect and should be recognizable for subsequent monitoring even without the aid of a GPS. Mark it with spray paint, if permitted.
   - Describe the fixed point in detail.
   - If the first reading cannot be made on the
Figure 10. The Emery method of beach profiling. The elevation profile of a cross-sectional portion of a beach is measured as the difference in the elevations between the two rods, with the lower rod sighted to the horizon, where the elevation readings are referenced.

Figure 11. Zones of beach profile
fixed point, note the offset from it.
- To detect changes in the fixed point, there should be a reference feature or marking of which the height is known or measured. Measured this repeatedly every time the transect is reoccupied for beach profiling.
- The fixed point including the other measurements taken should be photo-documented to ensure repeatability in subsequent monitoring.

3. Note the following on the worksheet or field notebook:
   - Name of transect (should begin with an abbreviated name of the site)
   - Date and time
   - Location (name of municipality or beach)
   - Orientation of the transect (i.e., compass reading)
   - Description of the fixed point as in (2).
   - Readings should be recorded in the table with the following columns:
     i. Point
     ii. X (distance, in m)
     iii. dz (difference in elevation, in cm)
     iv. Remarks

4. Place the back (landward) rod on or near the fixed point and the other rod several meters seaward.
   - The location of the front (seaward) rod may be dictated by fixed distances where elevation readings are to be measured.
   - A better approach is to do measurements following the natural topography of the beach, particularly on the different zones of the beach profile such as the vegetation line, beach scarp if present, berm, high-tide line, and sea level or waterline at the time of the survey (Figure 11 on page 25).
   - The distance between rods should not be more than 20m.

5. Reading should start at Point 1 which corresponds to the position of the back (landward) rod. It can be the fixed point, or a certain distance away from the fixed point if adjustments were made. At Point 1, X and dz should be 0.

6. At Point 2, note the distance (X) between two rods.
   - The difference in elevation, dz, between Point 1 and Point 2 is acquired by sighting the lower of the two rods to the horizon and projecting the intersection of the lower rod and the horizon onto the higher rod.
   - If the beach is sloping downward, reading will be made on the back (or landward) rod and shall be recorded as a negative value (see top-right image of Figure 10 on page 25).
   - If the beach slopes upward, reading will be made at the front (or seaward) rod and shall be recorded as a positive value (Figure 12 on page 27).
   - Note remarkable features or zones on the Remarks column (e.g., vegetation line, berm).

7. Move the rod seaward following the transect orientation, with the back rod occupying Point 2 and the front rod moving farther seaward to establish Point 3.
   - Repeat STEP 5 to obtain distance and elevation measurements as the rods move seaward until the waterline or sea level is reached.
   - At sea level, record the time and GPS reading on the Remarks section. DO NOT FORGET THIS AS THIS POINT WILL BE USED.
TO REFERENCE THE BEACH PROFILE TO MEAN SEA LEVEL (MSL), which is the elevation datum used by NAMRIA.

8. Repeat STEP 7 until the desired water depth is reached and then end the survey.

9. Encode and process data. (Proceed to the section on Data Processing and Desktop Analysis (Insert Page here)

   • It is important to do the survey during low tide but not too low that the entire reef flat is exposed. Remember that measurement at sea level is very important.
   • If the reef flat is exposed when you conduct beach profiling, you will have to do measurements all the way to the waterline or sea level to be able to reference the profile to mean sea level. For comparison, the same extent will have to be covered in subsequent monitoring.

Sediment Characterization

1. Use a cup in acquiring sediment samples. Sediment should be sampled on the berm, beach face, and sea-level (Figure 9).

2. Observe sediment size and composition along the beach profile. Use grain size comparator to
determine the sizes of sediments along the transect (Figure 14 on page 29).

3. **Note noticeable changes in the Remarks column.** Changes such as size and composition and accumulation of gravel on a sandy beach. For detailed grain size fractionation, subject the sediment samples to a sieve analysis.

**Photo-documentation**

1. Photo-document the vicinity of the beach to compare changes in beach configuration.
2. Take photos at the same location and from the same angle for better comparison of coastal features.
3. Shoot photos perpendicular to the coast (i.e., start and end of the beach profile) and at the sides from a seaward and landward vantage points.

### 4.3.3 Shoreline Tracing

**MATERIALS NEEDED**

1. Two (2) handheld GPS
2. Digital camera
Figure 14. Determining sediment sample size by using grain size comparator
Procedure

1. Conduct shoreline tracing concurrent with beach profiling. The two methods will provide a more accurate picture of beach sediment dynamics.

2. Walk along the shoreline while marking the GPS location every twelve steps, which approximates the ±3m positional error of the GPS. Ideally, the “true” shoreline should be located close to the Mean Sea Level (MSL) -- the elevation datum used by NAMRIA.

Since the exact MSL is not known, different approximations can be done depending on the type of beach characteristics:

> Steep Slope

**SHORELINE TRACING ALONG BEACHES WITH steep slope** is simple because the translation of shoreline positions between tidal phases can be minimal, and thus may be within the GPS positional error. On a steep coast, shoreline tracing can be done at the waterline, during high tide. During low-tide, the mid-swash area, or the mid-tide line, can approximate the shoreline.

> Gentle Coasts Adjacent to Fringing Reefs or Sand Flat

**IN THIS TYPE OF SHORELINE, THERE IS A** shoreline change reference called the beach toe, which marks the transition between the sloping beach face (Figure 15 on page 31) and the relatively flat surface of the adjacent platform. The beach toe in Figure 13 is characterized by a break in the slope and a drastic change in sediment size and composition. Shoreline tracing can be done at the crest of the beach toe, which approximates the low-water line (Genz et al., 2007).

> Gently Sloping Coasts

**ON GENTLY SLOPING COASTS, THE** translation of shoreline between tidal phases can be much larger than the GPS error. It is important to determine where the mid-tide line (MTL) is, or the midway between the low-tide line (LTL) and high-tide line (HTL) (Figure 11 on page 25). The MTL can also be approximated by the mid-swash zone. The swash zone marks the area where the waves and tides move sediments up and down the seaward sloping portion beach called the beach face (Figure 11 on page 25). Shoreline tracing should be conducted during low-tide conditions to better approximate the location of the MTL.

3. Using another GPS, map the extent of the high-water mark features such as vegetation line or continuous scarps concurrently with shoreline tracing particularly on gently sloping coasts. Together with beach profiling, simultaneous mapping of the shoreline and high-water mark features such as scarps and vegetation line can distinguish between actual beach erosion and redistribution of sediments on adjacent platform or reef flat.

4.3.4 Anecdotal Accounts

**INTERVIEW LONG-TIME COASTAL RESIDENTS** to determine the changes that cannot be captured by shoreline change analysis

**WHAT TO ASK THE COASTAL RESIDENTS**

- Shoreline changes during the intermittent years
- Possible causes of erosion
- Annual shoreline changes
- Whether the beach can recover after typhoons or strong-wave events
- Insights on how the government and local
community have responded to this hazard

4.3.5 Data Processing and Management

MATERIALS NEEDED

1. Computer with GIS software (e.g. QGIS), spreadsheet program (e.g. MS Excel), and Google Earth

2. NAMRIA topographic maps and satellite images

3. Scoring rubrics

> Beach Profiling Data

1. Encode data in MS Excel or other spreadsheet software.

2. Insert a column after the third column (dz) for the cumulative elevation (with column heading

- Affix the correct sign (i.e. either positive (+) or negative (-)) to the data under the third column (dz or change in elevation in cm) as this will indicate if the beach is sloping upward or downward.

- If the fixed point is not the first point, do not include it in the computation.

- The descriptions (e.g. height of wall relative to the rod, distance from the wall) is important for locating the same spot for the repeated surveys as part of monitoring.

- Note the time when sea level is reached. This will be used for resetting the readings to sea level and correction for tides. Tide correction will be done if the tide data is not yet referenced to mean sea level.
“Cumulative dz”).

- For the cells under this column, put in the formula for the cumulative summation of the dz (change in elevation in cm).
- For example, assuming that dz and cumulative dz are under columns C and D, respectively, then the cell D10 should have the value of C10, being the first entry in column C. For the second row of column D, D11, the formula should be “=D10+C11”, which adds column C cumulatively.
- Apply the formula to the rest of the cells for Column D (Cumulative dz; See Figure 17 on page 33).

3. Insert a column after “Cumulative dz” and label it as the “Reset to SL” column.

- The “Reset the SL” column will give you a profile that is still not yet corrected for tides. Land elevation (dz) is always referenced to sea level. Thus the entry corresponding to sea level measurement in the “Cumulative dz” column should be set to zero (0).
- This can be done by adding the negative of the last cumulative dz value to the last cumulative dz value.
- For example, if the last cumulative dz value is -229, +299 should be added to it under the Reset to SL column of the same row. Apply this formula to the rest of the cells in the “Reset to SL” column (see Figure 18 on page 33).

4. Add a column for Tide Corrected profile after the Reset to SL column. This is necessary because we still don’t know where the 0 (or sea level) is, relative to the MSL. In the Philippines, elevation data is always referred to MSL.

If Tide Data is Referenced to MSL

DIRECTLY SUBTRACT THE TIDE LEVEL TO THE

values under reset to SL column. The tide level can be obtained from tide tables or wxtide32. Refer to attached guideline on how to get data from wxtide32 (Annex 4). In using dataset from wxtide32, get the tide level at the time when sea level was reached.

If Tide Data is Not Yet Referenced to MSL (Like in the Philippines)

Follow the below guidelines on tide correction:

a. Get the tide level from Wxtide or NAMRIA predicted tide tables.
   i. Get the tide level at the time when sea level rise reached during the survey (use the incremental tide option in Wxtide to generate tide data per minute).
### Figure 17. Example of how to calculate Cumulative dz column

<table>
<thead>
<tr>
<th>Points</th>
<th>Distance in meters</th>
<th>( dz ) ([\text{change in elevation in cm}])</th>
<th>Cumulative ( dz )</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>6.7</td>
<td>34</td>
<td>34</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>16.6</td>
<td>-115</td>
<td>-81</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>25.5</td>
<td>42</td>
<td>-39</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>29</td>
<td>-79</td>
<td>-118</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>40.6</td>
<td>-40</td>
<td>-78</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>50</td>
<td>-107</td>
<td>-185</td>
<td>SL: 10:10</td>
</tr>
<tr>
<td>8</td>
<td>55</td>
<td>-44</td>
<td>-229</td>
<td></td>
</tr>
</tbody>
</table>

### Figure 18. Example of how to reset to sea level

<table>
<thead>
<tr>
<th>Points</th>
<th>Distance in meters</th>
<th>( dz ) ([\text{change in elevation in cm}])</th>
<th>Cumulative ( dz )</th>
<th>Reset to SL</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>6.7</td>
<td>34</td>
<td>34</td>
<td>SL: 10:10</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>16.6</td>
<td>-115</td>
<td>-81</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>25.5</td>
<td>42</td>
<td>-39</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>29</td>
<td>-79</td>
<td>-118</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>40.6</td>
<td>-40</td>
<td>-78</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>50</td>
<td>-107</td>
<td>-185</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>55</td>
<td>-44</td>
<td>-229</td>
<td>0</td>
<td>SL: 10:10</td>
</tr>
</tbody>
</table>
ii. Get the mean tide level (MTL) or mean sea level (MSL) using the nearest station in the NAMRIA predicted tide table. Or estimate the MSL or MTL value from the wxtide.

b. Subtract the tide level at the time of the survey (tide level) from the MSL or MTL, as follows:

\[
\text{Tidediff} = \text{MSL} - \text{tide level}
\]

c. On the “Tide Corrected” column, subtract the tidediff from each entry in the preceding column, “Reset to SL.” See Annex 5 for a detailed illustration of the tide correction procedure.

4. Using Scatterplot, plot the uncorrected data (“Reset to SL” column) vs “Tide Corrected” column.

- Assign the ‘Reset to SL’ values on the y-axis (or Legend Entries (Series)) and the ‘distance (x)’ values on the x-axis (or Horizontal (Category) Axis Labels).
- With this, the graph should already show the uncorrected elevation data based on the Reset to SL values.
- Plot in the tide corrected data by adding the values under the “Tide Corrected” column to the y-axis. The graph should now show both the uncorrected (reset to SL) and tide corrected elevation data.

- During high tide, the tide corrected data should be higher than the uncorrected profile (“Reset to SL” column) because you are lowering the sea level at the time of the survey to mean sea (tide) level. Thus land elevation would appear higher after correcting for high tide.
- On the other hand, the tide corrected data should be lower than the uncorrected profile during low tide because you are raising the sea level at the time of the survey to mean sea level. Thus land elevation would appear lower if survey was done during low tide.

> Shoreline Change Computation

This section outlines how to compute shoreline change using the Change Polygon Method applied to shoreline datasets acquired from GPS shoreline mapping and shoreline traces derived from topographic maps, and satellite images such as Google Earth and LandSat. For a more detailed and illustrated step-by-step guide, see demo of shoreline change computation using QGIS in Annex 6.
1. Process the most recent GPS shoreline trace. Download the marked coordinates from the GPS into a .csv (table) file.

2. Create a point shapefile from the .csv file by using QGIS or other GIS software.

3. Convert the resulting point shapefile into a line shapefile. This can be done by either manual or automatic tracing.

   • For manual tracing, add a new vector, selecting the type “Line” and then start creating the line to connect the series of points. Then add feature. For convenience, it is recommended that the snapping function (under settings) is enabled while creating the line. Snapping is an automatic editing operation in which points or features within a specified distance (tolerance) of other points or features are moved to match or coincide exactly with each other’s coordinates. Save edits by clicking **Save Layer Edits**

   • For automatic tracing, the plugin POINTS2ONE should be installed. Once installed, double click the tool to use it. Input the point shapefile as the input vector layer. The plugin will automatically create the line. If the newly created line is not automatically added to QGIS, double click on the shapefile to manually add it.

4. Merge the resulting line shapefile of the most recent shoreline tracing with another trace of the same shore (either from an earlier GPS shoreline trace, NAMRIA topographic map, or satellite images) during a different time for visualization of the shoreline change. In doing so, make sure that the shapefiles to be merged are both in projected coordinate systems (PCS) (e.g. UTM). If any of shoreline traces are not in PCS, re-project the shapefile first to a projected one before merging into a single line shapefile.

5. Ensure that both ends of the shoreline traces intersect each other. In cases wherein the ends do not intersect, edit the shapefile and move the end of one line to the end (or vertex) of the other. This can be done through the Node Tool under Toggle Editing. Move the other end of the line if it also does not interest with the other line. Don’t forget to save edits.

6. Create a polygon shapefile from the merged line shapefiles with intersecting ends.

7. Determine if polygons are seaward or landward of older shoreline. This can be done by adding a column in the Attribute Table of the Polygon shapefile. It is suggested that the column should be named “Trends”. The type of data under this column should be whole number (integer).

Highlight a particular polygon. Determine if the polygon is seaward or landward of the older shoreline. If the polygon is seaward, the trend on the polygon should be 1. If the polygon is landward, put -1 under Trends. Do this for all polygons created by the two shoreline traces, then save.

8. Copy the attribute table to Excel or spreadsheet program.

9. Compute net rate of change.

Go to the Excel file. In the column after Trends, put in the formula which would multiply the Area value and the Trends value of the same row. Then sum up all the values under the new column. The summation will be the **Area** in square meters.

Go back to QGIS to get the length of the shoreline from the attribute table of either shoreline traces. If there is no length, add a column and label it Length in the attribute table of one of the shorelines. The data type under this column should be decimal number (real) with precision of 2. Then calculate the length using the Field Calculator of the software. Copy the **Length** from QGIS to the Excel file.

Compute the **Magnitude** in Excel by dividing the **Area** by the **Length**.
Determine the **Time interval** between the two shoreline traces by taking the difference in the year taken (or for the case of shorelines traced from topographic maps or satellite images, the year the map or image was created) – newer minus older.

Get the **net rate of shoreline change** in meter per year by dividing the **Magnitude** by **Time Interval**.

### Vulnerability Scoring using CIVAT Rubrics

1. Use the CIVAT Scoring Rubrics (Annex 7) to determine the Exposure, Sensitivity, and Adaptive Capacity of each site. Score all the needed attributes for each site and input into the Rubrics.

#### Exposure

i. Determine the values for the following attributes indicated in the Scoring Rubrics for Exposure:

- Relative sea-level change in millimeter per year (estimated from tide gauge data or satellite altimetry data)
- Wave exposure – published Relative Exposure Index (REI) for the barangay. As a proxy to REI, orientation of the coast with respect to the winds can be used, with coasts relatively protected from predominant winds scored at 1 to 2; moderately exposed at 3 to 4; and directly exposed at 5.
- Tidal range – can be retrieved from wxtide or NAMRIA predicted table

ii. Assign the appropriate score based on the scoring guidelines shown in “Table 4 Scoring guideline for exposure indicators” on page 37.

iii. Sum up the scores for all the attributes.

iv. Rate the **Exposure** of the site, whether Low, Medium, or High, following the guide shown in “Table 5 Rating guide for exposure” on page 37.

#### Sensitivity

i. Determine the following attributes which are indicated in the scoring rubrics for Sensitivity:

- Coastal landform and rock type – based on data collected through field observations, photodocumentation, and sediment characterization (done along with beach profiling).
- Seasonal beach recovery – based on the following data collected:
  - Beach profiling and shoreline tracing during and wet and dry season (i.e. if the profile appeared higher and longer than the previous one, then it is accreting.; if the profile is much shorter and flatter than the previous one, it is eroding; if there is minimal change in the profile, then it is relatively stable.)
  - Indicators of erosion observed during field observation: presence of scarp and tees with exposed roots with fresh markings; abundance of magnetite sand and coarse-grained sediments such as gravel; and human-induced shoreline retreat reflected by structures such as seawalls and groins
  - Anecdotal accounts: If the beach continues to erode after typhoons or strong winds, the shore is therefore eroding. If the shoreline returns to its original position, then the shore is considered stable. If the beach widens, the shore is accreting.
- Coastal slope – estimated from NAMRIA topographic map or Digital Elevation Models (DEM)
- Width of reef flat or shore platform – estimated from NAMRIA map or high-resolution satellite images in Google Earth
- Lateral continuity of reef flat or shore platform
Table 4 Scoring guideline for exposure indicators

<table>
<thead>
<tr>
<th>EXPOSURE CRITERIA</th>
<th>LOW (1-2)</th>
<th>MEDIUM</th>
<th>HIGH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relative sea-level change (mm/yr)</td>
<td>≤ 0.1</td>
<td>≤ 2.4</td>
<td>&gt; 2.4</td>
</tr>
<tr>
<td>Wave exposure</td>
<td>Low</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>Tidal range (m)</td>
<td>≤ 1</td>
<td>1 - 2</td>
<td>&gt;2</td>
</tr>
</tbody>
</table>

PROXY TO WAVE EXPOSURE

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Low Protection</th>
<th>Slight Exposure</th>
<th>Directly Exposed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orientation of the coast to</td>
<td>Relatively</td>
<td>Slightly</td>
<td>Directly</td>
</tr>
<tr>
<td>predominant winds/storms</td>
<td>protected</td>
<td>exposed</td>
<td>exposed</td>
</tr>
</tbody>
</table>

Table 5 Rating guide for exposure

<table>
<thead>
<tr>
<th>RATING (TOTAL NUMBER OF CRITERIA = 3)</th>
<th>RANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low (L)</td>
<td>3 – 7</td>
</tr>
<tr>
<td>Medium (M)</td>
<td>8 – 11</td>
</tr>
<tr>
<td>High (H)</td>
<td>12 - 15</td>
</tr>
</tbody>
</table>

If habitat assessment is possible, consider the attributes listed below instead.

Information needed for this can be taken from assessment and monitoring of coastal habitats, including mangrove forests:

- Coral reef as sediment source
- Seagrasses as sediment source and stabilizers
- Mangroves as sediment trap
- Mangroves as wave buffer

- Coastal and offshore mining – from field observation and photodocumentation
- Structures on the foreshore – from field observation and photodocumentation

ii. Assign the appropriate score based on the scoring guidelines shown in “Table 6 Scoring guideline for sensitivity indicators” on page 38.

If habitat assessment is possible, use “Table 7 Scoring rubrics for habitat assessment results” on page 39 instead of presence or absence of coastal habitats: (1) Coral as sediment source, (2) Seagrass bed as sediment source and stabilizers, (3) Mangroves as sediment trap, and (4) Mangroves as wave buffer. Each of these rubrics has its own set of criteria for scoring. For each rubric, score according to the guide below. Average the scores of the criteria under the same rubric. The average will then be the final score for that specific rubric which will contribute to the assessment of sensitivity.

iii. Sum up the scores for all the attributes.
<table>
<thead>
<tr>
<th>SENSITIVITY CRITERIA</th>
<th>LOW</th>
<th>MEDIUM</th>
<th>HIGH</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1-2)</td>
<td>(3-4)</td>
<td>(5)</td>
</tr>
<tr>
<td>Coastal landform and rock type</td>
<td>Rocky, clifed coast; beach rock</td>
<td>Low cliff (&lt;5m high); Cobble/gravel beaches; alluvial plains; fringed by mangroves</td>
<td>Sandy beaches; deltas; mud/sandflat</td>
</tr>
<tr>
<td>Seasonal beach recovery</td>
<td>Net Accretion</td>
<td>Stable</td>
<td>Net Erosion</td>
</tr>
<tr>
<td>Slope from the shoreline to 20-m elevation (landward slope; rise over run)</td>
<td>&gt;1:50</td>
<td>1:50-1:200</td>
<td>&lt;1:200</td>
</tr>
<tr>
<td>Width of reef flat or shore platform</td>
<td>&gt;100</td>
<td>[50, 100]</td>
<td>&lt;50</td>
</tr>
<tr>
<td>Lateral continuity of reef flat or shore platform</td>
<td>&gt;50%</td>
<td>[10-50]</td>
<td>&lt;10%</td>
</tr>
<tr>
<td>Beach forest/vegetation</td>
<td>Continuous and thick with many creeping variety</td>
<td>Continuous and thin with few creeping variety</td>
<td>Very patchy to none</td>
</tr>
<tr>
<td>Coastal habitats</td>
<td>Coral reef, mangroves and seagrasses or coral reef and mangroves are present</td>
<td>either coral reef or mangrove is present</td>
<td>none</td>
</tr>
<tr>
<td>If habitat assessment is possible, use the following rubrics instead of presence or absence of coastal habitats (above item). See guide on scoring for each rubric on next table:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coral reef as sediment source</td>
<td>(average of criteria scores on next table)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seagrasses as sediment source and stabilizer</td>
<td>(average of criteria scores on next table)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mangroves as sediment trap</td>
<td>(average of criteria scores on next table)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mangroves as wave buffer</td>
<td>(average of criteria scores on next table)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coastal and offshore mining (includes removal of fossilized corals on the fringing reef and beach)</td>
<td>None to negligible amount of sediments being removed (i.e., sand and pebbles as souvenir items)</td>
<td>Consumption for HH use</td>
<td>Commercial scale</td>
</tr>
<tr>
<td>Structures on the foreshore</td>
<td>None; one or two short groins (i.e., &lt;5m long) and/or few properties on the easement with no apparent shoreline modification</td>
<td>Short groins &amp; short solid-based pier (5 to 10m long); seawalls and properties with aggregate length of less than 10% of the shoreline length of the barangay</td>
<td>Groins and solid-based pier &gt; 10m long; seawalls and other properties with aggregate length of more than 10% of the shoreline length of the barangay</td>
</tr>
</tbody>
</table>
### Table 7 Scoring rubrics for habitat assessment results

<table>
<thead>
<tr>
<th>SENSITIVITY CRITERIA FOR HABITATS</th>
<th>LOW (1 TO 2 PTS PER CRITERION)</th>
<th>MEDIUM (3 TO 4 PTS PER CRITERION)</th>
<th>HIGH (5 POINTS PER CRITERION)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coral as sediment source (average of the scores of the criteria below)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>living coral cover</td>
<td>over 50%</td>
<td>between 25 to 50%</td>
<td>less than 25%</td>
</tr>
<tr>
<td>coral community growth form in the shallow reef</td>
<td>at least half of the corals are hemispherical/massive and encrusting</td>
<td>at least half of the corals are tabulate</td>
<td>at least half of the corals are branching and foliose</td>
</tr>
<tr>
<td>Seagrass bed as sediment source and stabilizer (average of the scores of the criteria below)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>areal extent relative to reef flat</td>
<td>seagrasses cover more than half of the reef flat</td>
<td>seagrasses cover more than 1/8 to 1/2 of the reef flat</td>
<td>seagrasses cover less 1/8 of the reef flat</td>
</tr>
<tr>
<td>capacity to withstand storm removal and wave impacts</td>
<td>root system extensive; <em>Enhalus acoroides</em> and <em>Thalassia hemprichii</em> dominated</td>
<td><em>Thalassia</em> - <em>Cymodocea-Halodule</em> beds</td>
<td>small sized species, i.e. <em>Halophila</em> - <em>Halodule</em> meadows</td>
</tr>
<tr>
<td>seagrass meadow type</td>
<td>mixed bed with over 5 species</td>
<td>2 to 4 species</td>
<td>monospecific bed</td>
</tr>
<tr>
<td>Mangroves as sediment trap (average of the scores of the criteria below)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>forest type</td>
<td>riverine-basin-fringing type; basin-fringing type</td>
<td>riverine-fringing type; fringing</td>
<td>no mangrove; scrub type</td>
</tr>
<tr>
<td>mangrove zonation</td>
<td>3 to 4 mangrove zones (<em>Avicennia-Sonneratia</em>; <em>Rhizophora</em>; <em>Ceriops-Bruguiera-Xylocarpus</em>; <em>Nypa</em> zones)</td>
<td>2 mangrove zones</td>
<td>only 1 mangrove zone present</td>
</tr>
<tr>
<td>capacity to trap sediments</td>
<td>at least half of the mangrove area are <em>Avicennia-Sonneratia</em> dominated</td>
<td>at least half of the mangrove area are dominated by species with pneumatophore (<em>Avicennia, Sonneratia</em>) and knee root (<em>Bruguiera, Ceriops tagal</em>) system</td>
<td>area is dominated by species with prop (<em>Rhizophora</em>) or buttress/plank (<em>Xylocarpus granatum, Heritiera littoralis</em>) type of root system</td>
</tr>
<tr>
<td>Mangroves as wave buffer (average of the scores of the criteria below)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>forest type</td>
<td>riverine-basin-fringing type</td>
<td>riverine-fringing type</td>
<td>scrub-fringing type</td>
</tr>
<tr>
<td>present vs historical mangrove extent</td>
<td>0 to 25% of original mangrove area loss; at least 75% of seaward zone remaining</td>
<td>26 to 50% of original mangrove area loss</td>
<td>over 50% of original mangrove area loss</td>
</tr>
<tr>
<td>mangrove zonation</td>
<td>3 to 4 mangrove zones (<em>Avicennia-Sonneratia</em>; <em>Rhizophora</em>; <em>Ceriops-Bruguiera-Xylocarpus</em>; <em>Nypa</em> zones)</td>
<td>2 mangrove zones</td>
<td>only 1 mangrove zone present</td>
</tr>
<tr>
<td>mangrove canopy cover</td>
<td>mangrove area with over 50% canopy cover</td>
<td>mangrove area with canopy cover that is between 25% to 50%</td>
<td>mangrove area with less than 25% canopy cover</td>
</tr>
<tr>
<td>mangrove basal area</td>
<td>more than 50 m² per ha</td>
<td>between 25 to 50 m² per ha</td>
<td>less than 25 m² per ha</td>
</tr>
</tbody>
</table>
### Table 8 Rating guide for sensitivity

<table>
<thead>
<tr>
<th>WITHOUT HABITAT ASSESSMENT (TOTAL NUMBER OF CRITERIA = 9)</th>
<th>WITH HABITAT ASSESSMENT (TOTAL NUMBER OF CRITERIA = 12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rating</td>
<td>Range</td>
</tr>
<tr>
<td>Low (L)</td>
<td>9 – 21</td>
</tr>
<tr>
<td>Medium (M)</td>
<td>22 – 33</td>
</tr>
<tr>
<td>High (H)</td>
<td>34 – 45</td>
</tr>
</tbody>
</table>

### Table 9 Scoring guideline for adaptive capacity indicators

<table>
<thead>
<tr>
<th>ADAPTIVE CAPACITY CRITERIA</th>
<th>LOW</th>
<th>MEDIUM</th>
<th>HIGH</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1 to 2 points per criterion)</td>
<td>(3 to 4 points per criterion)</td>
<td>(5 points per criterion)</td>
</tr>
<tr>
<td>Long-term shoreline trends (m/year)</td>
<td>≤ -1 (eroding)</td>
<td>(-1,0)</td>
<td>&gt;0 (accreting)</td>
</tr>
<tr>
<td>Continuity of sediment supply</td>
<td>if interruption in sediment supply is regional</td>
<td>if interruption in sediment supply is localized</td>
<td>If sediment supply is uninterrupted</td>
</tr>
<tr>
<td>Guidelines regarding the easement (setback zone)</td>
<td>No provision for easement (setback zone) in the CLUP and zoning guidelines</td>
<td>Setback policy is clearly stated in the CLUP and zoning guidelines; with &lt;50% implementation</td>
<td>Implementation of setback policy is at least 50%</td>
</tr>
<tr>
<td>Guidelines on coastal structures</td>
<td>CLUP and zoning guidelines promotes the construction of permanent and solid-based structures along the coast</td>
<td>Clearly states the preference for semi-permanent or temporary structures to be built along the coast (e.g., made of light materials and on stilts) is in the CLUP and zoning guidelines</td>
<td>Prohibits construction of solid-based structures; For those already erected, CLUP/zoning guidelines has provision to remove or modify any structure causing obstruction and coastal modification</td>
</tr>
<tr>
<td>Type of coastal development</td>
<td>Industrial, Commercial, Highways, Large institutional facility</td>
<td>Residential</td>
<td>Agricultural, Fishpond, Open space, Greenbelt</td>
</tr>
<tr>
<td>Viability of coral reef as sediment source</td>
<td>Use AC matrix for coastal habitats (next table)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Viability of seagrasses as sediment source</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Viability of mangroves as sediment trap</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Viability of mangroves as wave buffer</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
iv. Rate the Sensitivity of the site, whether Low, Medium, or High, following “Table 8 Rating guide for sensitivity” on page 40.

Adaptive Capacity

i. Determine the following attributes which are indicated in the scoring rubrics for Adaptive Capacity (AC):

- Long-term shoreline trends (m/year) – from comparison of latest shoreline position (shoreline tracing from GPS survey or from latest Google Earth or satellite images) and shoreline traces from old maps and satellite images or from previous GPS survey; anecdotal accounts
- Continuity of sediment supply – from field observation or high-resolution images in Google Earth©
- Guidelines on setback zones – from Coastal Land Use Plan (CLUP)
- Guidelines on coastal structures – from CLUP and zoning guidelines for the site.
- Type of coastal development – CLUP and field observation and photodocumentation
- Viability of coral reef as sediment source – can be taken from assessment and monitoring of coral reefs
- Viability of seagrasses as sediment source - can be taken from assessment and monitoring of seagrass beds
- Viability of mangroves as sediment trap - can be taken from assessment and monitoring of mangrove forests
- Viability of mangroves as wave buffer - can be taken from assessment and monitoring of mangrove forests

ii. Assign the appropriate score based on the scoring guidelines shown in “Table 9 Scoring guideline for adaptive capacity indicators” on page 40.

“Table 10 Adaptive capacity matrix for coastal habitats” on page 42 is the AC matrix for coastal habitats. To get the score of the Viability of mangroves as wave buffer, get the average of the scores of the two criteria under it.

iii. Sum up the scores for all the attributes.

iv. Rate the Adaptive Capacity of the site, whether Low, Medium, or High, following the guide in “Table 11 Rating guide for adaptive capacity” on page 42.

v. Determine the Potential Impact (PI) of each site. This is done by cross-tabulating Exposure and Sensitivity. Rank the PI of each site as Low, Medium, or High based on the cross-tabulation guide in “Table 12 Scoring guideline for adaptive capacity indicators”.

Therefore:

- LL, LM, or ML combination equates to Low
- LH, MM, or HL combination equates to Medium
- MH, HM, or HH combination equate to High

vi. Determine the Vulnerability (V). This is done by comparing Adaptive Capacity (AC) to Potential Impact (PI) of each site:

<table>
<thead>
<tr>
<th>EXPOSURE (E)</th>
<th>SENSITIVITY (S)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>L</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>M</td>
<td>L</td>
</tr>
<tr>
<td>H</td>
<td>M</td>
</tr>
</tbody>
</table>
### Table 10 Adaptive capacity matrix for coastal habitats

<table>
<thead>
<tr>
<th>ADAPTIVE CAPACITY CRITERIA FOR COASTAL HABITATS</th>
<th>LOW</th>
<th>MEDIUM</th>
<th>HIGH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viability of coral reef as sediment source</td>
<td>living coral cover less than 25%</td>
<td>between 25 to 50%</td>
<td>over 50%</td>
</tr>
<tr>
<td>Viability of seagrasses as sediment source</td>
<td>capacity to recover from storm blow-outs</td>
<td>Enhalus- Thalassia dominated</td>
<td>Thalassia - Cymodocea- Halodule dominated</td>
</tr>
<tr>
<td>Viability of mangroves as sediment source</td>
<td>capacity to trap sediments</td>
<td>area is dominated by species with prop (Rhizophora) or buttress/plank (Xylocarpus granatum, Heritiera littoralis) type of root system</td>
<td>at least half of the mangrove area are dominated by species with pneumatophore (Avicennia, Sonneratia) and knee root (Bruguiera, Ceriops tagal) system</td>
</tr>
<tr>
<td>Viability of mangroves as wave buffer</td>
<td>canopy cover</td>
<td>mangrove area with less than 25% canopy cover</td>
<td>mangrove area with canopy cover that is between 25% to 50%</td>
</tr>
<tr>
<td></td>
<td>mangrove basal area</td>
<td>less than 25 m² per ha</td>
<td>between 25 to 50 m² per ha</td>
</tr>
</tbody>
</table>

### Table 11 Rating guide for adaptive capacity

<table>
<thead>
<tr>
<th>WITHOUT HABITAT ASSESSMENT (TOTAL NUMBER OF CRITERIA = 5)</th>
<th>WITH HABITAT ASSESSMENT (TOTAL NUMBER OF CRITERIA = 9)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rating</td>
<td>Range</td>
</tr>
<tr>
<td>Low (L)</td>
<td>5 – 11</td>
</tr>
<tr>
<td>Medium (M)</td>
<td>12 – 18</td>
</tr>
<tr>
<td>High (H)</td>
<td>19 – 25</td>
</tr>
</tbody>
</table>

- **x** If AC > PI, then the site has Low V
- **x** If AC = PI, then the site has Medium V
- **x** If AC < PI, then the site has High V

### 5. Coral Reef Biodiversity

**CORAL REEFS, MADE OF LIMESTONE**

(Calculator carbonate) represent some of the most biologically diverse ecosystems on earth, providing critical habitats to marine organisms.

They support fisheries and their structure provides natural breakwaters that protect shorelines, other ecosystems, and human settlements from waves and storms.
Methods for Assessing and Monitoring Coral Reef Biodiversity (Figure 20 on page 44)

5.1 Establishing Monitoring Stations

1. In establishing permanent monitoring stations, choose sites that are representative of the coral condition in the area and can be reached during all weather conditions.

2. Identify at least four stations for deployment of two 50m transects each: Two stations inside, and two stations outside Marine Protected Areas (MPAs).

3. To determine suitable sites for monitoring purposes, conduct a general survey using Manta Tow (See section on Data Collection). The survey will give an overview of the coral reef which will reveal which sites best represent the area.

4. For biodiversity monitoring purposes, the permanent monitoring sites should be established in areas of the coral reef with the best coral cover.

5. For small islands, choose one site representing the windward (front-reef) zone and another representing the leeward (back-reef) zone.

6. In regions where reversing monsoon winds prevail, select sites in reef areas exposed to the different monsoon winds.

7. The actual location of the transect (i.e. monitoring station) should be recorded using a GPS (i.e. recording the coordinates of both ends of the transect), noting landmarks or unique features that may help locate the site in future monitoring.

8. Mark the position of the transect location by hammering a one-meter bar with loop at the upper end, and provided with a subsurface buoy for easy location in future monitoring activities.

5.2 Frequency of Monitoring and Expected Data Output

TABLES 12 AND 13 SHOW THE RECOMMENDED frequency, duration, and expected output of assessment and monitoring of coral reef biodiversity for each group. (See “Table 13 Recommended frequency and duration for coral reef biodiversity assessment and monitoring per monitoring group.” on page 45 and “Table 14 Expected output of coral reef biodiversity assessment and monitoring for each monitoring group” on page 46)

5.3 Data Collection

5.3.1 Manta Tow

Materials Needed:

1. Mask and snorkel
2. Small boat
3. GPS
4. Manta board with rope (Figure 21 on page 45)
5. Writing slate and pencil (aside from the one attached to the manta board) or field notebook for above sea note taking

Procedure

IN TERMS OF HUMAN RESOURCES, THE Manta Tow Method requires at least four persons:

- A boat operator
- An observer who knows how to use mask and snorkel and must be physically fit to undergo long hours of sea and sun exposure
- A time tracker
- A navigator.

1. Attach manta board to boat with 17m length of rope.
2. Observer geared with mask and snorkel grip on
METHODS FOR ASSESSING AND MONITORING CORAL REEF BIODIVERSITY

The Manta Tow Technique
- A point intercept technique complemented by photo-transect, day time fish visual census, and belt transect for associated macro- invertebrates.
- Requires relatively clear water for good visibility.
- Used for wide area survey to get a broader picture of the reef conditions.
- Used to guide the selection of monitoring stations, to detect large scale changes due to storm or siltation, and to detect occurrence of disturbances such as bleaching and infestation of crown of thorns (COT).

The Point Intercept Technique (PIT)
- Provides a quick assessment of the coral reef area by providing estimates of the relative abundance of living and non- living things.
- The indicators for PIT are percent live hard coral cover per genus and lifeforms, percent dead coral cover, soft coral, macro-algae, sand, and rocks.
- PIT is best done by scuba diving, however snorkel survey can also be done in shallow areas (Uychiaoco et al 2001).

The Daytime Fish Visual Census (FVC)
- Identifies and counts fish in a given area.
- A non-destructive method of estimating fish variety and abundance in a given area and uses the following parameters: species richness, fish abundance, and fish sizes. Fish count and size estimation can provide information on fish biomass and abundance.
- More detailed ecological work such as determining trophic structures and ratio of the reef fish can provide information on reef health conditions. Trophic level values of fish species can be obtained from Fish-Base®.

The Belt Transect Method
- Used to estimate population and variety of invertebrates associated with the coral reef.
Table 13 Recommended frequency and duration for coral reef biodiversity assessment and monitoring per monitoring group.

<table>
<thead>
<tr>
<th>METHOD</th>
<th>FREQUENCY AND DURATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manta tow technique for wide area survey of coral reef areas</td>
<td>Once every 5 years; 2-3 days per survey</td>
</tr>
<tr>
<td></td>
<td>Quarterly; 2-3 days per survey</td>
</tr>
<tr>
<td></td>
<td>Quarterly; 2-3 days per survey</td>
</tr>
<tr>
<td>Coral survey (PIT) complemented with photo-transect</td>
<td>Once every 2 years; 4-5 days per survey</td>
</tr>
<tr>
<td></td>
<td>Twice a year; 4-5 days per survey</td>
</tr>
<tr>
<td></td>
<td>Twice a year; 3-4 days per survey</td>
</tr>
<tr>
<td>Daytime FVC for reef fish</td>
<td>Once every 2 years; 4-5 days per survey</td>
</tr>
<tr>
<td></td>
<td>Twice a year; 4-5 days per survey</td>
</tr>
<tr>
<td></td>
<td>Twice a year; 3-4 days per survey</td>
</tr>
<tr>
<td>Belt transect for macro-invertebrates</td>
<td>Once every 2 years; 4-5 days per survey</td>
</tr>
<tr>
<td></td>
<td>Twice a year; 4-5 days per survey</td>
</tr>
<tr>
<td></td>
<td>Twice a year; 3-4 days per survey</td>
</tr>
</tbody>
</table>

Figure 21. Schematic diagram of the manta board redrawn from English et al (1997)
Table 14 Expected output of coral reef biodiversity assessment and monitoring for each monitoring group

<table>
<thead>
<tr>
<th>ECOSYSTEM/RESOURCE AND METHOD</th>
<th>OUTPUT/INDICATORS</th>
<th>EXPERTS/ACADEME</th>
<th>DENR</th>
<th>LGU/COMMUNITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manta tow technique</td>
<td>Live coral cover</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Dead coral cover</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Soft corals</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Coral bleaching</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>COT</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Other observations:</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>blasting, storm/anchor damage</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Point-intercept technique (PIT) complemented with photo-transect</td>
<td>Coral ID up to species level whenever possible and lifeform</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Percent live hard coral</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Percent dead coral cover, soft corals</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Associated invertebrates e.g. crown of thorns, giant clams, sea cucumbers identified up to species level</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Coral diseases</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Coral bleaching</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Coral ID genus</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Percent live hard coral cover, soft coral</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Associated invertebrates e.g. crown of thorns, giant clams, sea cucumbers identified up to general level or major groups</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Percent live hard coral cover per lifeforms</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Percent dead coral cover, soft coral</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Associated invertebrates e.g. crown of thorns, giant clams, sea cucumbers identified by their local name</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Categories classification using minimal number of codes</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Daytime FVC for reef fish</td>
<td>Fish ID up to species level</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Species richness</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Fish count per species</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Fish abundance</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Fish sizes (actual size estimates in cm)</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Fish ID as major groups or genera,</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Species richness</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Fish count per major group or genera</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Fish abundance</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Fish sizes (3 size class)</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Belt transect for macro-invertebrates</td>
<td>Macro-invertebrates counted and identified up to species level</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Trophic structures/ratio class</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Macro-invertebrates counted and identified up to genera level</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Macro-invertebrates counted and identified using local names</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>
3. Run the boat along the reef crest at speed of three to five kilometers per hour, towing the Observers (Figure 22 on page 48) Navigator may take note of activities along the shoreline such as number of fishing boats and structures like fish pens, floating cages, etc.

4. The time tracker should keep track of every run and signal the boat operator to reduce speed every two minutes for recording. At the same time, pull and jerk the rope to give signal to the observer to record.

5. The Navigator, on the other hand, should mark or record the coordinates of each stop using a GPS together with a map sketch.

6. The Observer will follow a tow sequence for each stop in sync with the Navigator (Figure 23 on page 48). At each stop, the Observer will write down his/her rating of the percent live hard coral cover on the waterproof data sheet or writing slate attached to the manta board. Rating will be guided by "Table 15 Percent cover index for manta tow"

The Observer will also take note of any occurrence of disturbances such as coral bleaching and COT infestation.

### NOTE

- Need to ensure that all data sheets or writing slates are labelled with the location, date of tow, and observer’s name for data management.

- The time tracker must be in constant watch of the observers for signals or directions.

- Synchronization of tow number is critical and this must be communicated properly to the observer using hand signals.

#### 5.3.2 Point-intercept Technique with Photo-transect Method

<table>
<thead>
<tr>
<th>MATERIALS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mask, snorkel, and fins</td>
</tr>
<tr>
<td>2. Scuba gear</td>
</tr>
<tr>
<td>3. Writing slates with pencil</td>
</tr>
<tr>
<td>4. GPS</td>
</tr>
<tr>
<td>5. Laminated field guides</td>
</tr>
<tr>
<td>6. Data sheet</td>
</tr>
<tr>
<td>7. Lead sinker with line or a plumb line</td>
</tr>
<tr>
<td>8. Photo-kit for quadrat</td>
</tr>
<tr>
<td>9. Transect tape (at least 50m)</td>
</tr>
<tr>
<td>10. Underwater digital camera (preferably wide angle cameras)</td>
</tr>
<tr>
<td>11. Monopod (preferably rust proof)</td>
</tr>
</tbody>
</table>

### Procedure

<table>
<thead>
<tr>
<th>PERSONNEL QUALIFICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Must be a certified scuba diver, strong</td>
</tr>
</tbody>
</table>
2. Should be adept in using the computer for encoding and processing data.

3. Must possess basic knowledge on taxonomy and be willing to undergo training on taxonomy.

4. Representatives of the LGU and community need not be certified scuba divers but they should be strong swimmers, know how to snorkel, and should have good eyesight to write underwater using slates and pencils.

1. Calibrate the camera.

- Before going out to the field, calibrate the camera for the photo-transect. Photos for this method should cover 1x1m quadrat using the highest resolution possible.
The calibration must adjust the distance of the camera to achieve a 1x1m-quadrat coverage in the resulting image. For camera with wide angles, distance may vary from 60 to 80cm. For camera with no wide angles, distance may be longer than 1m, thus wide angle cameras are recommended.

You may attach the camera to a rust-proof monopod with the stand already adjusted and fixed with the length equivalent to the distance determined in the calibration. By doing this, taking photos will be easier as the observer would not need to repeatedly determine the height from which he/she should take the picture since the monopod is already fixed on the right distance.

Set the camera to take pictures in the highest resolution possible, set the right date, and turn on geo-tagging function, if available.

2. Lay the transect.

- Lay two 50-meter transects along reef slope at three- to six- meter depth level, or along the established permanent monitoring station for coral reef.

- The transect tape should be stretched snugly to follow depth contours. For reefs with deeper areas, such as reef a wall, additional transects may be deployed at 10m depth level.

3. Determine and record the coordinates at the start and end of each transect using a GPS.

4. Record categories.

- Using the plumb line as a guide, record categories such as coral genera and lifeform, dead coral algae, recently dead corals, sand/
silt/rocks/rubbles, macro-algae, and coralline algae for every 0.25m, starting at point 0.

- It would be helpful if the transect tape is marked at 5 meter interval (e.g. with pink or yellow electric tape) prior to laying the transect for easier sighting of recording points.

- For recording convenience, follow a standard coding system for the different lifeform categories. “Table 16 Recommended coding system for coral and other lifeforms using point-intercept technique” on page 49 is the suggested coding system for the different categories.

- Bring a laminated field guide on lifeform identification (Annex 9) during transect reading as an on-hand reference. (Figure 24)

- Ensure that the data written down in on the writing slates are labelled with the site name and transect number. (Figure 25 on page 51)

5.3.3 Daytime Fish Visual Census (FVC)

### MATERIALS

<table>
<thead>
<tr>
<th>Number</th>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mask, snorkel, and fins</td>
</tr>
<tr>
<td>2</td>
<td>Scuba gear</td>
</tr>
<tr>
<td>3</td>
<td>Writing slates with pencil</td>
</tr>
<tr>
<td>4</td>
<td>Transect tape (at least 50 meters)</td>
</tr>
<tr>
<td>5</td>
<td>GPS</td>
</tr>
<tr>
<td>6</td>
<td>Laminated fish guides</td>
</tr>
</tbody>
</table>

### Procedure

1. Survey can be done anytime during daylight hours and should be done in
2. The same transect lines established for the point-intercept technique will be used for the FVC.

3. Personnel who will do the FVC must be certified scuba divers physically fit to undergo long hours in the sea and sun, and should have basic training on fish identification.

4. Representatives from the LGUs must know how to use the mask and snorkel; must be willing to learn basic taxonomy and field protocols for recording data and information underwater.

1. Before doing the survey, swim and get acquainted with the fish species found in the area. Make a preliminary checklist of reef fish before doing the FVC.

2. After the transect is laid, wait for about 10 to 15 minutes to allow the fish to return after the disturbance.

3. Take note of the time of survey, visibility, and conditions of the coastal waters.

4. The fish census can be done either by snorkel survey for shallow stations and/or scuba diving for deeper stations.

**FISH CENSUS MUST DOS**

- The Observer must read and record fish ID and count within 2.5m on the right side, 2.5m on the left side, and 5m above the transect (Figure 26).

- A laminated reef fish guide (Annex 10) can be used underwater as a handy reference.

- Obtain counts for each fish identified should per size class (i.e. size ranges 1-10cm, 11-20cm, and 21-30cm). If fish identified is...
longer than 30 cm, the estimated length of the fish should be recorded.

• In poor visibility, reduce the observation distance by half (1.25 m both sides and 2.5m above the transect).

• Survey transect as a complete 50 x 5m belt and do not break it down into smaller units.

5.3.4 Belt Transect for Macro-invertebrates in Coral Reefs

MATERIALS

1. Mask, snorkel, and fins

2. Scuba gear

3. Transect tape (at least 50 meters)

4. Laminated field guides

5. Writing slates with pencil

6. Pegs

HOW TO DO THIS SURVEY AND PERSONNEL QUALIFICATIONS

1. This method will be done using the same transect laid out for coral survey.

2. Identify and count macro-invertebrates at 5m interval along the 50m transect, starting at point 0. Observation distance from the transect line at these intervals should be 2.5 meters to the left and 2.5 meters to the right.

4. Personnel must know how to use the mask and snorkel in shallow areas and certified scuba divers for deep transects.

5. They must be physically fit to undergo long hours of work in the sea and sun, and must be able to identify species of invertebrates (or are willing to learn the basic taxonomy and field protocols) while recording data or information underwater.

5.3.5 Data Processing and Management

THE SPREADSHEETS ON ANNEX 12 AND 13 are designed to organize data collected for assessment and monitoring of coral reef biodiversity and facilitate processing, storage, and management. Encode the collected data onto these spreadsheets.

Data Processing Techniques:

1. Point Intercept Technique

THE ANNEX 12 AND 13 SPREADSHEETS contain the formula to automatically compute the percent cover of live hard coral, dead coral, other animals, plants and algae, and abiotics with the entry of the PIT data collected. But in the absence of these files, the percent cover of each lifeform and benthic category considered in the survey can be computed by dividing the frequency of the lifeform intercepted by the transect at 0.25m interval) by 200 (i.e. the total number of recordings made for the whole transect), then finally multiplying by 100 to convert the value into percentage (see below). Therefore, if ACB (Acropora branching) coral was recorded 100 times in the transect, the percent cover for that particular transect is 50%.

\[
\text{Percent Cover} = \left( \frac{\text{Frequency of Lifeform}}{200} \right) \times 100
\]

The data can be summarized by collapsing the lifeforms into five groups:

a. **Live coral** – sum of percent cover of all Acropora, non-Acropora, and soft coral
b. **Dead coral** – sum of percent cover of dead coral and dead coral with algae
c. **Flora** – sum of percent cover of all algae and seagrass
d. **Abiotic** – sum of percent cover of rubble, rock, sand, silt, and water

The data summary can be presented in graphical form either as pie or bar chart.

2. Photo- Transect

DIGITAL IMAGES OBTAINED FROM THE REEF survey will be processed using the Coral Point Count with Excel Extension (CPCe) Version 4.1, a Windows-based software that provides a tool for the determination of coral cover using transect photographs (Kohler & Gill 2006).

The photo-transect method with CPCe for image analyses are the same method used by the Coral Reef Visualization and Assessment (CoRVA) and the National Assessment of Coral Reef Environments (NACRE) projects. There may be slight modifications but results are comparable.

A quick start guide for using CPCe can be accessed through the link [http://cnso.nova.edu/forms/cpce_quickstart_guide.pdf](http://cnso.nova.edu/forms/cpce_quickstart_guide.pdf)

6. Seagrass Biodiversity

SEAGRASSES ARE SUBMERGED FLOWERING plants that form extensive vegetation in shallow waters. Seagrass beds are often called nursery habitat because they provide shelter for small invertebrates, small fish, and juveniles of large organisms that support nearshore fisheries. Seagrass
beds are also good indicators of coastal ecosystem changes because their loss signals a deterioration of ecological conditions (e.g. water quality).

At least 12 seagrass species has been identified in the Philippines out of the 50 species worldwide (Fortes 1989).

The Transect-Quadrat Method is used to estimate seagrass cover and relative abundance of the different seagrass species in a given area.

- It is a popular method being adopted globally for comparative assessment of the state of seagrass ecosystems.
- It yields data on percent seagrass cover, species richness, canopy height, and associated invertebrates (e.g. sea cucumbers, sea urchins, and shellfish).

The Belt Transect Method is also employed to estimate variety and population size of invertebrates associated with the seagrass beds.

6.1 Establishing Monitoring Stations

1. Visit seagrass beds within the area of concern during low tide to determine the extent of the seagrass meadow when locating suitable sites for monitoring.

2. Estimate the extent of the seagrass using GPS and plotted in maps, if possible.

3. Choose an area that is relatively evenly shaped with no sandbanks, mud ridges, or changes in the meadow.

4. Select a site that is representative of the seagrass in the area and is easy to revisit in future monitoring.

5. Place the first 50m transect parallel to the shore and mark the start and end of the transect using a GPS.

6. Set the second transect 50m apart from the first transect going seaward and likewise mark the coordinates. These transects will represent the nearshore and middle portion of the seagrass bed.

7. To permanently mark the transect locations, drive a 1m iron bar with a loop at the top end, and attach a subsurface buoy. Permanent markers may be set at the start and end of every transect.

8. Record the position of the iron bar using a GPS.

6.2 Frequency of Monitoring and Expected Data Output

"Table 17 Recommended frequency and duration for seagrass biodiversity assessment and monitoring per monitoring group" on page 55 and "Table 18 Expected output of seagrass biodiversity assessment and monitoring per monitoring group" on page 55 show the recommended frequency, duration, and expected output of seagrass biodiversity assessment and monitoring for each group.

6.3 Data Collection

6.3.1 Transect-Quadrat Method for Seagrass Assessment

<table>
<thead>
<tr>
<th>MATERIALS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mask and snorkel</td>
</tr>
<tr>
<td>2. Transect tape (at least 50m)</td>
</tr>
<tr>
<td>3. Writing slates with pencil</td>
</tr>
<tr>
<td>4. GPS</td>
</tr>
<tr>
<td>5. Pegs</td>
</tr>
<tr>
<td>6. 0.5m x 0.5m quadrats (without grids)</td>
</tr>
<tr>
<td>7. Ruler</td>
</tr>
<tr>
<td>8. Underwater digital camera</td>
</tr>
<tr>
<td>9. ID guides</td>
</tr>
</tbody>
</table>
Table 17 Recommended frequency and duration for seagrass biodiversity assessment and monitoring per monitoring group

<table>
<thead>
<tr>
<th>METHOD</th>
<th>FREQUENCY AND DURATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experts/Academe</td>
<td>Denr</td>
</tr>
<tr>
<td>Transect-quadrat for seagrass</td>
<td>Once every 2 years; 4-5 days per survey</td>
</tr>
<tr>
<td>Belt transect for macro-invertebrates</td>
<td>Once every 2 years; 4-5 days per survey</td>
</tr>
</tbody>
</table>

Table 18 Expected output of seagrass biodiversity assessment and monitoring per monitoring group

<table>
<thead>
<tr>
<th>ECOSYSTEM/RESOURCE AND METHOD</th>
<th>OUTPUT/INDICATORS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experts/Academe</td>
<td>Denr</td>
</tr>
<tr>
<td>Transect-quadrat for seagrass</td>
<td>x Seagrass ID species level x Percent seagrass cover x Species richness x Species dominance and category x Canopy height x Associated invertebrates counted and identified up to species level</td>
</tr>
<tr>
<td>Belt transect for macro-invertebrates</td>
<td>x Macro-invertebrates counted and identified up to species level</td>
</tr>
</tbody>
</table>

Procedure

TheRecommended Transect-Quadrat

Method for seagrass that will go into the BMS is modified based on the SeagrassNet Protocol (Short et al 2001) and Seagrass Watch (McKenzie et al 2003).

Transect tapes are laid parallel to the shoreline (SeagrassNet) instead of perpendicular to the shoreline. The quadrats will be placed regularly at 5m interval (Seagrass Watch) instead of random pre-set quadrats. Random quadrats may cause confusion if there are many sites to monitor.

Step by Step Guide for the Transect-Quadrat Method for Seagrass
1. Lay two 50m transects along the seagrass area parallel to the shoreline. Transects should be set at 50 meters apart to represent the nearshore and middle portion of the seagrass meadow. Record the coordinates of the beginning and end of each transect.

2. Set the quadrats at 5m interval, starting at point 5. Each transect should have a total of 10 readings or recordings. In setting down the quadrat, always place the quadrats on the right side of the transect line and walk on the left side to avoid trampling on the seagrass.

3. Inside each quadrat, record the seagrass species found and the percent cover of each species. For example, in one quadrat, a 20% cover of *Cymodocea rotundata* and 5% *Thalassia hemprichii* may be recorded. When no other seagrass species occur in that quadrat, then the remaining 75% of the quadrat is composed of substrate (Figure 27).

4. Refer to Annex 14 for the seagrass species identification and percent cover estimation guides.

### 6.3.2 Belt Transect for Macro-invertebrates in Seagrass Beds

#### MATERIALS

1. Mask, snorkel, and fins
2. Scuba gear (optional)
3. Transect tape (at least 50 meters)
4. Laminated field guides
5. Pegs

#### HOW TO DO THIS SURVEY AND PERSONNEL QUALIFICATIONS

1. Assessment of macroinvertebrates will be done using the same transect laid for the seagrass survey.
2. Identify and count invertebrates at 5m interval along the 50m transect, beginning at
point 0 (1 x 5m). The observation corridor along the transect is 0.5 meters to the left and right of the line. A field guide to common invertebrates (Annex 11) can be helpful in field identification of macroinvertebrate.

3. Survey personnel must know how to use the mask and snorkel, or must be certified scuba divers for deep transects, and must be physically fit for long hours of work under the heat of the sun. (Make this a consistent phrase for all where it is mentioned)

4. Observer must be able to identify species of invertebrates and must be willing to learn basic taxonomy and field protocols.

**NOTE**

If invertebrates are too many to count along the transect, such as gastropods, quadrat sampling may be used to quantify them. The quadrat size is 1x1m and set at 5m interval along the transect. However, the belt transect should also be done for other invertebrates.

6.4 Data Processing and Management

The spreadsheets on Annex 13 are designed to help the organization of seagrass data and formulas are provided for the computation of percent seagrass cover.

**How To Compute Percent Cover of Seagrass**

**COMPUTE THE PERCENT COVER OF EACH**

seagrass species for one whole transect by getting the average of all its recorded percent cover within the transect. Summing up the averages for all seagrass species will yield the percent seagrass cover for that specific transect.

**How To Estimate Percent Seagrass Cover**

**ESTIMATE THE PERCENT SEAGRASS COVER**

of the whole site as represented by the transects established by getting the average of the total percent seagrass cover of all transects. The same is done in estimating the percent cover of each seagrass species within the site.

7. Mudflat and Intertidal Areas Biodiversity

Mudflats or tidal flats, are important areas particularly for migratory birds due to the abundance of large food items such as small invertebrates (e.g. crabs and mollusks) and fish.
They are usually found in sheltered areas such as bays, lagoons, and along mangrove areas. The Belt Transect Method is the recommended tool to estimate population and variety of invertebrates associated with mudflat and intertidal areas.

7.1 Establishing Monitoring Stations

**MUDFLATS ARE GENERALLY FOUND BETWEEN** mangrove areas and seagrass beds. It is best to locate monitoring stations in mudflats and intertidal areas near the locations of the seagrass monitoring stations.

7.2 Frequency of Monitoring and Expected Data Output

**TABLES 20 AND 21 SHOW THE RECOMMENDED** frequency, duration, and expected output of mudflat and intertidal areas biodiversity assessment and monitoring for each group (See “Table 19 Recommended frequency and duration for mudflat and intertidal area biodiversity assessment and monitoring per monitoring group” on page 59 and “Table 20 Expected output for mudflat and intertidal area biodiversity assessment and monitoring per monitoring group” on page 59).

7.3 Data Collection

**MATERIALS**

1. Transect tape (at least 50 meters)
2. Laminated field guides

> Procedure

**AS IN THE CORAL AND SEAGRASS** assessments, the observers must be physically fit and must be able to identify species of invertebrates or are willing to learn the basic taxonomy and field protocols to obtain accurate data or information.

**STEP BY STEP GUIDE FOR THE BELT-TRANSECT METHOD FOR MUDFLATS**

1. Biodiversity assessment of mudflats and intertidal areas is generally carried out during low tide when the area is exposed to air, otherwise a mask and snorkel may be used.
2. Lay two 50m transects parallel to the shoreline along mudflats.
3. Identify and count invertebrates at 5m interval along the 50m transect, starting at point 0. (Figure 29 on page 59)
4. Annex 13 datasheet is recommended for data collection.
5. Observation distance from the transect line at these intervals should be 0.5 meters to the left and 0.5 meters to the right.
6. The field guide to common invertebrates (Annex 11) can be helpful in the invertebrate identification

8. Seaweed Biodiversity

**SEAWEEDS ARE ALSO KNOWN AS** macroscopic benthic algae and are mostly associated with the rocky shores. They are non-flowering plants and usually do not form extensive beds as
Table 19 Recommended frequency and duration for mudflat and intertidal area biodiversity assessment and monitoring per monitoring group

<table>
<thead>
<tr>
<th>METHOD</th>
<th>FREQUENCY AND DURATION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EXPERTS/ACADEME</td>
</tr>
<tr>
<td>Belt transect for macro-invertebrates</td>
<td>Once every 2 years; 4-5 days per survey</td>
</tr>
</tbody>
</table>

Table 20 Expected output for mudflat and intertidal area biodiversity assessment and monitoring per monitoring group

<table>
<thead>
<tr>
<th>ECOSYSTEM/RESOURCE AND METHOD</th>
<th>OUTPUT/INDICATORS</th>
<th>EXPERTS/ACADEME</th>
<th>DENR</th>
<th>LGU/COMMUNITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belt transect for macro-invertebrates</td>
<td>x Macro-invertebrates counted and identified up to species level</td>
<td>x Macro-invertebrates counted and identified up to genera level</td>
<td>x Macro-invertebrates counted and identified using local names</td>
<td></td>
</tr>
</tbody>
</table>

Figure 29. Belt transect on mudflats and some macro-invertebrates found within the transect
seagrasses do.

The Transect-Quadrat and Belt-Transect methods are the assessment and monitoring tools for seaweed biodiversity.

The indicator considered in this method is seaweed cover focusing on dominant species e.g. *Sargassum sp.*, *Gracilaria sp.*, *Chaetomorpha sp.*, and *Ulva sp.* (common species in green algal bloom). Other species of seaweeds may be included depending on the level of expertise of the observer.

### 8.1 Establishing Monitoring Stations

1. To locate suitable sites for monitoring stations, visit the area during low tide to determine the extent of seaweed forming meadows such as Sargassum.
2. Estimate the extent of the Sargassum beds using GPS and plotted in maps, if possible.
3. Select a site that is representative of the seaweeds in the area and is easy to revisit in future monitoring, ideally close to the coral reef monitoring stations.
4. To permanently mark the transect locations, drive a 1m iron bar with a loop at the top end, and attach a subsurface buoy. Permanent markers may be set at the start and end of every transects.
5. Record the position of the iron bar using a GPS.

### 8.2 Frequency of Monitoring and Expected Data Output

**TABLES 22 AND 23 BELOW SHOW THE recommended frequency and duration seaweed areas biodiversity assessment and monitoring for each group and expected output from them.**

### 8.3 Data Collection

#### 8.3.1 Transect-Quadrat Method for Seaweed

**MATERIALS**

1. Mask and snorkel
2. Transect tape (at least 50m)
3. Writing slates with pencil
4. GPS
5. Pegs
6. 0.5m x 0.5m quadrats with 0.1 m grids
7. Ruler
8. Underwater digital camera

> Procedure

**PERSONNEL QUALIFICATIONS**

- Must know how to use the mask and snorkel.
- Must be physically fit to endure long hours in the sea and sun.
- Must be able to identify species of xx,xx,xx.
- For LGUs, personnel must be willing to learn the basic taxonomy and field protocols while recording data underwater.

**NOTE**

SUGGESTED REFERENCES FOR SEAWEED identification are the following: Calumpong & Meñez.1997, and Trono 1997

**STEP BY STEP GUIDE FOR TRANSECT-QUADRAT METHOD FOR SEAWEEDS**

1. Lay two 50m transects parallel to the shoreline along shallow rocky areas.
2. Set the quadrats at 5m interval, starting at point 5. Thus, each transect should have a
### Table 21 Recommended frequency and duration of seaweed biodiversity assessment and monitoring per monitoring group

<table>
<thead>
<tr>
<th>METHOD</th>
<th>FREQUENCY AND DURATION</th>
<th>EXPERTS/ACADEME</th>
<th>DENR</th>
<th>LGU/COMMUNITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transect-quadrat for seaweed</td>
<td>Once every 2 years; 4-5 days per survey</td>
<td>Twice a year; 4-5 days per survey</td>
<td>Twice a year; 3-4 days per survey</td>
<td></td>
</tr>
<tr>
<td>Belt transect for macro- invertebrates</td>
<td>Once every 2 years; 4-5 days per survey</td>
<td>Twice a year; 4-5 days per survey</td>
<td>Twice a year; 3-4 days per survey</td>
<td></td>
</tr>
</tbody>
</table>

### Table 22 Expected output for seaweeds assessment and monitoring per monitoring group

<table>
<thead>
<tr>
<th>ECOSYSTEM/RESOURCE AND METHOD</th>
<th>OUTPUT/INDICATORS</th>
<th>EXPERTS/ACADEME</th>
<th>DENR</th>
<th>LGU/COMMUNITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transect-quadrat for seaweeds</td>
<td>x Seaweed ID up to species level&lt;br&gt;x Seaweed cover (focus on dominant species e.g. <em>Sargassum</em>, <em>Gracilaria</em>, <em>Ulva</em> (green algal bloom))&lt;br&gt;x Associated invertebrates counted and identified up to species level</td>
<td>x Seaweed ID up to genera level&lt;br&gt;x Seaweed cover (focus on dominant species e.g. <em>Sargassum</em>, <em>Gracilaria</em>, <em>Ulva</em> (green algal bloom))&lt;br&gt;x Associated invertebrates counted and identified up to genera level</td>
<td>x Seaweed ID using local names&lt;br&gt;x Seaweed cover (focus on dominant species e.g. <em>Sargassum</em>, <em>Gracilaria</em>, <em>Ulva</em> (green algal bloom))&lt;br&gt;x Associated invertebrates counted and identified using local names</td>
<td></td>
</tr>
<tr>
<td>Belt transect for macro- invertebrates</td>
<td>x Macro-invertebrates counted and identified up to species level</td>
<td>x Macro-invertebrates counted and identified up to genera level</td>
<td>x Macro-invertebrates counted and identified using local names</td>
<td></td>
</tr>
</tbody>
</table>

### Table 23 Species cover code after Saito and Atobe (1970)

<table>
<thead>
<tr>
<th>SCORE</th>
<th>AMOUNT OF SUBSTRATUM COVERED</th>
<th>% SUBSTRATUM COVERED</th>
<th>MID POINT % EQUIVALENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>More than ½</td>
<td>50 – 100</td>
<td>75</td>
</tr>
<tr>
<td>4</td>
<td>¼ to ½</td>
<td>25 – 50</td>
<td>37.5</td>
</tr>
<tr>
<td>3</td>
<td>1/8 to ¼</td>
<td>12.5 – 25</td>
<td>18.75</td>
</tr>
<tr>
<td>2</td>
<td>1/16 to 1/8</td>
<td>6.25 – 12.5</td>
<td>9.38</td>
</tr>
<tr>
<td>1</td>
<td>Less than 1/16</td>
<td>&lt; 6.25</td>
<td>3.13</td>
</tr>
<tr>
<td>0</td>
<td>Absent</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
total of 10 readings or recordings.

3. In each quadrat, record seaweed species and percent cover. Optional data are shoot density and photographs per quadrat.

4. Reading is done per 0.1 x 0.1m grid using the categories by Saito & Atobe (1970) (“Table 23 Species cover code after Saito and Atobe (1970)” on page 61).

5. The actual cover per species is the average of the 25 small grids in every quadrat.

6. To calculate the percent cover of every species per quadrat, use the midpoint equivalent of every score and get the sum of all the grids and divide by 25.

7. See further details to calculate in English et al (1997).

8.3.2 Belt Transect for Macro-invertebrates in Seaweed Areas

**MATERIALS**

1. Mask, snorkel, and fins
2. Scuba gear (optional)
3. Transect tape (at least 50 meters)
4. Laminated field guides
5. Pegs

**Procedure**

THIS ASSESSMENT WILL BE CARRIED OUT using the same transect laid out for seaweed survey.

**STEP BY STEP**

1. Use masks and snorkels in assessing macroinvertebrate species associated with seaweed communities.

2. Observers must be physically fit to work long hours in the sea and sun, and must be able to identify species of invertebrates, otherwise he/she should be willing to learn the basic taxonomy and field protocols in faunal assessment in seaweed areas for accurate recording of data.

3. Identify and count invertebrates at 5m interval along the 50m transect, beginning at point 0.

4. Annex 13 datasheet is recommended for data collection.

5. Observation distance from the transect line at these intervals should be 0.5 meters to the left and 0.5 meters to the right.

6. The field guide to common invertebrates (Annex 11) can be helpful in the invertebrate identification.

**NOTE**

IF INVERTEBRATES ARE TOO MANY TO count along the transect, such as gastropods, quadrat sampling may be used to quantify them. The quadrat size is 1x1m and set at 5 m interval along the transect. However, the belt transect should also be done for other invertebrates such as sea cucumbers and crabs. Be cautious of the different sizes of quadrats used in the calculation – the values should be expressed as individuals/m2 then converted to number individual/hectare.

8.3.3 Data Processing and Management
How to Compute Percent Cover of Seaweed

**COMPUTE THE PERCENT COVER OF EACH** seaweed species for one whole transect by getting the average of all its recorded percent cover within the transect. Summing up the averages for all seaweed species will yield the percent seaweed cover for that specific transect.

How to Estimate Percent Seaweed Cover

**ESTIMATE THE PERCENT SEAWEED COVER OF** the whole site as represented by the transects established by getting the average of the total percent seaweed cover of all transects. The same is done in estimating the percent cover of each seaweed species within the site.

9. Megafauna Biodiversity

**MEGAFAUNA IN THE PHILIPPINE BIODIVERSITY** context pertain to marine mammals such as cetaceans and dugongs, sea turtles, and sharks and rays. The common feature of these animals is that they are mostly long-lived, have low reproductive potential, and are considered threatened, vulnerable and endangered. Globally, a few marine mammal species have already been declared extinct.

9.1 Constraints in Assessing and Monitoring Megafauna

1. Their elusive nature (i.e. barely surfacing for respiration, or even not surfacing at all in the case of sharks and rays) makes it hard for them to be sighted.

2. Identifying megafauna species is difficult. Oceanic habitats where they can be located are vast and defining meaning boundaries to distribution is challenging.

3. The state of knowledge regarding their habitats and habitat use, and the range of their populations and sub-populations are poor.

Considering these constraints, “Table 24 Recommended methods for megafauna biodiversity assessment and monitoring” on page 64 shows the recommended methods to be used for megafauna biodiversity assessment and monitoring.

Prior to the conduct of these methods, a Focus Group Discussion (FGD) or key informant interviews should be done to build the “big picture” of megafauna biodiversity within the area of concern.

9.2 What is an FGD?
• A simple research tool used for gathering (baseline) information from an assemblage of people of similar backgrounds or experiences.

• Provides broad scale information on the distribution and species diversity of marine mammals, sea turtles, and even sharks and rays, which can be used to identify areas where the more specific methods maybe employed.

**NOTE**

**IF THE INFORMATION GENERATED FROM**

the FGD appear to be not consensual, structure interviews can be done

### 9.3 Establishing Monitoring Stations

> **Criteria for Selecting Monitoring Sites**

1. The uniqueness of assemblage of reported/sighted/stranded megafauna based on the PMMSN Database
2. Limited literature and archived media reports
3. Results of the FGD (See next section on how to conduct FGDs).
4. The marine biogeographical zones of the Philippines (See Figure 30 on page 65)
   • The Babuyan and Balintang Channels: Important waters in the northern section of Luzon
   • The Eastern Philippine Sea: The most challenging area to assess and monitor megafauna
   • The Tañon Strait Protected Seascpe (TSPS): The only marine protected area allocated for cetaceans in recognition of the abundance and diversity of cetaceans in the area
   • The Sulu Sea: One of the most important basins in the Philippines

<table>
<thead>
<tr>
<th>MEGAFANA</th>
<th>METHOD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cetaceans</td>
<td>x Opportunistic survey</td>
</tr>
<tr>
<td></td>
<td>x Photo-identification (boat-based surveys)</td>
</tr>
<tr>
<td></td>
<td>x Gathering of stranding and bycatch data</td>
</tr>
<tr>
<td>Dugong</td>
<td>x Feeding trail survey</td>
</tr>
<tr>
<td></td>
<td>x Opportunistic sightings</td>
</tr>
<tr>
<td></td>
<td>x Gathering of stranding and bycatch data</td>
</tr>
<tr>
<td>Sea Turtle</td>
<td>x Nesting beach survey</td>
</tr>
<tr>
<td></td>
<td>x Opportunistic sightings</td>
</tr>
<tr>
<td></td>
<td>x Gathering of stranding and bycatch data</td>
</tr>
<tr>
<td>Sharks and Rays</td>
<td>x Market surveys or inspections</td>
</tr>
<tr>
<td></td>
<td>x Photo-identification (e.g. whale sharks)</td>
</tr>
<tr>
<td></td>
<td>x Fish landing surveys</td>
</tr>
<tr>
<td></td>
<td>x Gathering of bycatch data</td>
</tr>
</tbody>
</table>

Table 24: Recommended methods for megafauna biodiversity assessment and monitoring
Figure 30. The marine biogeographical zones of the Philippines

- The Sarangani Bay: One of the most important embayment in southwestern section of Mindanao
- The Western Philippines Sea: One of the most under-rated seas in terms of productivity and diversity. But this area has one of the stranding hotspots for cetaceans in the entire Philippines.

9.4 Frequency of Monitoring and Expected Data Output

“TABLE 25 RECOMMENDED FREQUENCY AND duration for megafauna biodiversity assessment and monitoring per monitoring group” on page 66
### Table 25 Recommended frequency and duration for megafauna biodiversity assessment and monitoring per monitoring group

<table>
<thead>
<tr>
<th>METHOD</th>
<th>FREQUENCY AND DURATION EXPERTS/ACADEME</th>
<th>FREQUENCY AND DURATION DENR</th>
<th>FREQUENCY AND DURATION LGU/COMMUNITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>FGD</td>
<td>1/year, 3 days per monitoring</td>
<td>2/year, 5 days per monitoring</td>
<td>4/year, 5 days per monitoring</td>
</tr>
<tr>
<td>Photo ID (Cetaceans)</td>
<td>2/year, 5-7 days per monitoring</td>
<td>2/year, 7-10 days per monitoring</td>
<td>Optional</td>
</tr>
<tr>
<td>Nesting beach survey (sea turtles)</td>
<td>2/year, 5 days per monitoring</td>
<td>2/year, 5-7 days per monitoring</td>
<td>2/year, 10 days per monitoring</td>
</tr>
<tr>
<td>Opportunistic survey</td>
<td>2/year, 3 days per monitoring</td>
<td>2/year, 3-5 days per monitoring</td>
<td>2/month, 2 days per monitoring</td>
</tr>
<tr>
<td>Feeding scars (Dugong)</td>
<td>2/year, 3-5 days per monitoring</td>
<td>2/year, 3-5 days per monitoring</td>
<td>1/month, 2 days per monitoring</td>
</tr>
<tr>
<td>Fish landing monitoring (sharks, rays etc)</td>
<td>2/year, 3-5 days per monitoring</td>
<td>2/year, 5 days per monitoring</td>
<td>1/week, 2 days per monitoring</td>
</tr>
<tr>
<td>Market inspection (sharks, rays etc)</td>
<td>2/year, 3 days per monitoring</td>
<td>2/year, 5 days per monitoring</td>
<td>Every day</td>
</tr>
<tr>
<td>Distance sampling (Transect)*</td>
<td>1/year, 10-15 days per monitoring</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interview (structured)**</td>
<td>1/year, 3 days per monitoring</td>
<td>1/year, 3 days per monitoring</td>
<td>2/year, 5 days per monitoring</td>
</tr>
<tr>
<td>Stranding Data***</td>
<td>Coordinate with Philippine Marine Mammal Stranding Network (PMMSN)</td>
<td>Coordinate with PMMSN</td>
<td>Coordinate with PMMSN</td>
</tr>
</tbody>
</table>

and “Table 26 Expected output for megafauna biodiversity monitoring per monitoring group” on page 67 show the recommended frequency and duration megafauna biodiversity assessment and monitoring for each group and the expected outputs.

### 9.5 Data Collection

1. Focus Group Discussion
2. Opportunistic Survey
3. Photo-Identification
4. Stranding Data

5. Dugong Feeding Trail Monitoring
6. Nesting Beach Survey
7. Market Survey
8. Fish Landing Survey

### 9.5.1 Focus Group Discussion

**MATERIALS**

1. Pens
2. Notebooks
## Table 26 Expected output for megafauna biodiversity monitoring per monitoring group

<table>
<thead>
<tr>
<th>ECOSYSTEM/RESOURCE AND METHOD</th>
<th>OUTPUT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FGD</strong></td>
<td>Range of distribution and (if possible) biological diversity of associated megafauna at Order of Family or up to Genera levels; and possible context of temporal variations.</td>
</tr>
<tr>
<td></td>
<td>Range of distribution and (if possible) biological diversity of associated megafauna at Order of Family levels; and possible context of temporal variations.</td>
</tr>
<tr>
<td></td>
<td>Range of distribution and (if possible) species composition of associated megafauna at Class or Order levels; and possible context of temporal variations.</td>
</tr>
<tr>
<td><strong>Photo-ID</strong></td>
<td>Range of distribution and biological diversity of cetaceans at species level; and calculate population abundance in the context of temporal variations.</td>
</tr>
<tr>
<td></td>
<td>Range of distribution and biological diversity of cetaceans at species level; and calculate population abundance in the context of temporal variations.</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Nesting Beach Survey</strong></td>
<td>Estimate number of reproductive females, nests, hatchlings, and identify species of sea turtle; and (if possible) capture temporal variation through time (e.g. inter-annual).</td>
</tr>
<tr>
<td></td>
<td>Estimate number of reproductive females, nests, hatchlings, and identify species of sea turtle; and (if possible) capture temporal variation through time (e.g. inter-annual)</td>
</tr>
<tr>
<td></td>
<td>Estimate number of reproductive females, nests, hatchlings, and identify species of sea turtle.</td>
</tr>
<tr>
<td><strong>Opportunistic Survey</strong></td>
<td>Presence or absence of species of megafauna; and (if possible) identify species of sighted megafauna. Can give information regarding possible extent of range of distribution and even threats to megafauna.</td>
</tr>
<tr>
<td></td>
<td>Presence or absence of species of megafauna; and (if possible) possibly identify species of sighted megafauna. Can give information regarding possible extent of range of distribution and even threats to megafauna.</td>
</tr>
<tr>
<td></td>
<td>Presence or absence of species of megafauna.</td>
</tr>
<tr>
<td><strong>Dugong Feeding Trail Monitoring/ Survey</strong></td>
<td>Presence or absence of important dugong population; and (if possible) develop some index of relative abundance through time. Can give information regarding possible extent of range of distribution and even threats to dugongs.</td>
</tr>
<tr>
<td></td>
<td>Presence or absence of important dugong population. Can give information regarding possible extent of range of distribution and even threats to dugongs.</td>
</tr>
<tr>
<td></td>
<td>Presence or absence of important dugong population. Can give information regarding possible extent of range of distribution and even threats to dugongs.</td>
</tr>
<tr>
<td>ECOSYSTEM/ RESOURCE AND METHOD</td>
<td>OUTPUT</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>--------</td>
</tr>
<tr>
<td>Fish Landing Survey</td>
<td>Identify important species of sharks and rays found within the area. Possibly determine relative abundance through catch per unit effort (CPUE) of the more commonly caught (or bycaught) sharks and rays. Can give information regarding possible extent of range of distribution and even threats to sharks and rays.</td>
</tr>
<tr>
<td></td>
<td>Identify important species of sharks and rays found within the area. Can give information regarding possible extent of range of distribution and even threats to sharks and rays.</td>
</tr>
<tr>
<td></td>
<td>Identify important species of sharks and rays found within the area. Can give information regarding possible extent of range of distribution and even threats to sharks and rays.</td>
</tr>
<tr>
<td>Market Inspection</td>
<td>Identify important species of sharks and rays found within the area and preferably being traded. If possible, determine relative abundance through size estimation and/or amount being sold of the more commonly caught (or bycaught) sharks and rays. Can provide information regarding possible extent of range of distribution and even threats to sharks and rays.</td>
</tr>
<tr>
<td></td>
<td>Identify important species of sharks and rays found within the area and preferably being traded. Can provide information regarding possible extent of range of distribution and even threats to sharks and rays.</td>
</tr>
<tr>
<td></td>
<td>Identify important species of sharks and rays found within the area. Can provide information regarding possible extent of range of distribution and even threats to sharks and rays.</td>
</tr>
<tr>
<td>Distance Sampling</td>
<td>Density and abundance of various species of cetaceans that will be sighted within the boat transects. This technique can also describe the spatial extent and temporal variation in the species distribution.</td>
</tr>
<tr>
<td>Interview Survey</td>
<td>Range of distribution and possibly biological diversity of associated megafauna at Order of Family or even Genera levels; and possible context of temporal variations.</td>
</tr>
<tr>
<td></td>
<td>Range of distribution and possibly biological diversity of associated megafauna at Order of Family levels; and possible context of temporal variations.</td>
</tr>
<tr>
<td></td>
<td>Range of distribution and possibly species composition of associated megafauna at Class or Order levels; and possible context of temporal variations.</td>
</tr>
<tr>
<td>Stranding data</td>
<td>The species composition of marine mammals that strand in various regions and provinces of the Philippines are being recorded through the efforts of the PMMSN and MMRSL. The national stranding database has the potentials to generate information regarding the most common species that strand to identification of stranding hotspots.</td>
</tr>
</tbody>
</table>
3. Visual aids such as photos, posters, and maps

4. Snacks for participants

## WHO SHOULD CONDUCT THE FGD AND HOW SHOULD IT BE CONDUCTED?

1. Staff members who are not involved in enforcement activities in the same area so as to encourage open discussion with local people.

2. A well-trained moderator to facilitate discussions and another person to record the minutes.

3. Get a good proportion of key informants to participate.

4. In the context of megafauna biodiversity monitoring, recruit as participants experienced fishers living within various areas of concern.

5. Do the FGD for megafauna biodiversity monitoring and the FGD for the fisheries biodiversity monitoring at the same time, ensuring that there will be enough time to collect the data needed for both topics.

6. Establish permanent FGD groups for monitoring purposes. For this, the barangay captains and other community leaders should be met to explain the objectives and activities of the monitoring system.

7. Emphasize the common interest of monitoring staff and local people in conservation and the sustained use of local natural resources (DENR & NORDECO 2001).

8. Give at least one week notice to the FGD participants to allow them to set aside time to attend. Make sure that the time set for the meeting is convenient for the participants.

9. Ask questions about species diversity and distribution of marine mammals, sea turtles, and even sharks and rays.

10. Sample questions include: Examples: What marine mammals/sea turtles/shark and rays have you seen in the area? Where and when did you see them, and how many? Can you show us in the maps the locations of these animals?

11. Keep participants honest by asking validation questions.

12. (Call out/balloon) Validation questions are those that would require them to describe the particular group of animals that they claim they saw or have sighted in the area and the like.

13. When all needed information has been collected, thank the participants and end the meeting.

14. Evaluate the information collected. The more specific megafauna biodiversity assessment methods to be employed and where these would be conducted should be determined with the guidance of the FGD results. If information generated is not consensual, plan for an Interview Survey.

15. Lastly, feed your participants. It is the moderator’s call when the snacks will be given based on the FGD timing.
9.5.2 Opportunistic Survey

**MATERIALS**

1. Regular maritime vessel
2. Binoculars
3. GPS
4. Camera and video camera
5. Datasheets

**Procedure**

The Opportunistic Survey in Four Steps

1. Be adept at detection and identification of megafauna from a distance.
2. Board a maritime vessel traversing predetermined navigational routes within the area of concern.
3. Record species and relative abundance (group size) sighted, including the location and time of sighting.
4. Use the field guide developed by the Philippine Marine Mammal Stranding Network (Annex 16) in identifying cetacean species.

9.5.3 Photo-Identification

**MATERIALS**

1. Single Lens Reflex (SLR) camera with zoom lens appropriate for wildlife photography (i.e. 300-600 mm)
2. Binoculars (preferably with embedded reticle for distance estimation)
3. Large memory cards for the camera
4. GPS
5. Good laptop or desktop with huge hard drive space or with extra external drive and should have the following programs installed: Photo editing software (e.g. Adobe Photoshop, Picassa), Darwin, and Mark
6. A good size boat with a reasonable engine (avoid those with water pump engines and pump boats), elevated platforms, and trained crew
7. Data survey sheets
8. Pens or pencils

**Procedure**

**THIS METHOD REQUIRES THE FOLLOWING personnel:**

1. A skilled boat crew and operator
2. An observer who is skilled and trained in photography.
3. A recorder.

However, if there are more people taking photos, the chances of getting more photos with good unique marks for various individuals, increases

**HOW TO DO PHOTO-DOCUMENTATION**

1. This technique is applicable in areas where the animals’ habitat use of the area is more or less known or predictable (e.g. roosting or nursery areas, or migratory pathway).
2. Boat surveys for capturing photos should be done on fair weather for better quality of photos taken and in consideration of the safety of the monitoring team and boat crew.
3. Prior to actual survey conduct, fill in the following information in the preformatted data sheets:
4. Before the actual survey, orient the boat captain on the Cetacean Watching Protocol to make sure that the animals will not be harassed during the survey keeping in mind the no approach zone, no follow zone and the right distances from the group (see Annex 17). The protocol also allows the boat to maintain a perpendicular angle towards the dorsal fin/s or group from the photographer’s perspective (Figure 31).

5. Observers should take photographs of cetaceans sighted during the boat survey. Observers should aim to capture quality photo of distinctive body parts of cetaceans sighted: dorsal fin for most dolphins and flukes for those that fluke up (a behavior when the whale brings up its tail flukes out of the water just before diving).

6. The Recorder should write down the following information in the data sheets (Annex 18) for every sighting of marine mammal or other megafauna species:

- Initial time of sampling
- Sighting distance
- Time
- Track
- Sequence Number
- Coordinates of the boat location

Figure 31. Diagram of the Cetacean Watching Protocol (Aragones et al., 2013)
# Beaufort Sea State (BSS) using the Modern Beaufort Scale

<table>
<thead>
<tr>
<th>BEAUFORT NUMBER</th>
<th>WIND DESCRIPTION</th>
<th>WIND SPEED</th>
<th>WAVE HEIGHT</th>
<th>VISUAL CLUES</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Calm</td>
<td>0 knots</td>
<td>0 ft</td>
<td>Sea like a mirror. Smoke rises vertically.</td>
</tr>
<tr>
<td>1</td>
<td>Light Air</td>
<td>1–3 knots</td>
<td>&lt; ½ ft</td>
<td>Ripples with appearance of scales are formed, but without foam crests. Smoke drifts from funnel.</td>
</tr>
<tr>
<td>2</td>
<td>Light Breeze</td>
<td>4–6 knots</td>
<td>½ ft (max 1)</td>
<td>Small wavelets still short but more pronounced; crests have a glassy appearance and do not break. Wind felt on face. Smoke rises at about 80 degrees.</td>
</tr>
<tr>
<td>3</td>
<td>Gentle Breeze</td>
<td>7–10 knots</td>
<td>2 ft (max 3)</td>
<td>Large wavelets; crests begin to break. Foam of glassy appearance. Perhaps scattered white horses (white caps). Wind extends light flags and pennants. Smoke rises at about 70 deg.</td>
</tr>
<tr>
<td>4</td>
<td>Moderate Breeze</td>
<td>11–16 knots</td>
<td>3 ft (max 5)</td>
<td>Small waves, becoming longer. Fairly frequent white horses (white caps). Wind raises dust and loose paper on deck. Smoke rises at about 50 deg. No noticeable sound in the rigging. Slack halyards curve and sway. Heavy flag flaps limply.</td>
</tr>
<tr>
<td>5</td>
<td>Fresh Breeze</td>
<td>17–21 knots</td>
<td>6 ft (max 8)</td>
<td>Moderate waves, taking a more pronounced long form. Many white horses are formed (chance of some spray). Wind felt strongly on face. Smoke rises at about 30 deg. Slack halyards whip while bending continuously to leeward. Taut halyards maintain slightly bent position. Low moaning, rather than whistle, in the rigging. Heavy flag doesn't extend but flaps over entire length.</td>
</tr>
<tr>
<td>6</td>
<td>Strong Breeze</td>
<td>22–27 knots</td>
<td>9 ft (max 12)</td>
<td>Large waves begin to form. The white foam crests are more extensive everywhere (probably some spray). Wind stings face in temperatures below 35 deg F (2C). Slight effort in maintaining balance against wind. Smoke rises at about 15 deg. Both slack and taut halyards whip slightly in bent position. Low moaning, rather than whistle, in the rigging. Heavy flag extends and flaps more vigorous.</td>
</tr>
<tr>
<td>7</td>
<td>Near Gale</td>
<td>28–33 knots</td>
<td>13 ft (max 19)</td>
<td>Sea heaps up and white foam from breaking waves begins to be blown in streaks along the direction of the wind. Necessary to lean slightly into the wind to maintain balance. Smoke rises at about 5 to 10 deg. Higher pitched moaning and whistling head from rigging. Halyards still whip slightly. Heavy flag extends fully and flaps only at the end. Oilskins and loose clothing inflate and pull against the body.</td>
</tr>
<tr>
<td>8</td>
<td>Gale</td>
<td>34–40 knots</td>
<td>18 ft (max 25)</td>
<td>Moderately high waves of greater length. Edges of crests break into spindrift; foam is blown in well-marked streaks along the direction of the wind. Head pushed back by the force of the wind if allowed to relax. Oilskins and loose clothing inflate and pull strongly. Halyards rigidly bent. Loud whistle from the rigging. Heavy flag straight out and whipping.</td>
</tr>
</tbody>
</table>
## Table 27 (cont.) Beaufort Sea State (BSS) using the Modern Beaufort Scale

<table>
<thead>
<tr>
<th>BEAUFORT NUMBER</th>
<th>WIND DESCRIPTION</th>
<th>WIND SPEED</th>
<th>WAVE HEIGHT</th>
<th>VISUAL CLUES</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>Strong Gale</td>
<td>41–47 knots</td>
<td>23 ft (max 32)</td>
<td>High waves. Dense streaks of foam along the direction of the wind. Crests of waves begin to topple, tumble and roll over. Spray may affect visibility.</td>
</tr>
<tr>
<td>10</td>
<td>Storm</td>
<td>48–55 knots</td>
<td>29 (max 41)</td>
<td>Very high waves with long overhanging crests. The resulting foam, in great patches, is blown in dense white streaks along the direction of the wind. On the whole, the surface of the sea takes on a whitish appearance. Tumbling of the sea becomes heavy and shock-like. Visibility affected.</td>
</tr>
<tr>
<td>11</td>
<td>Violent Storm</td>
<td>56–63 knots</td>
<td>37 ft (max 52)</td>
<td>Exceptionally high waves (small- and medium-sized ships might, be for a time, lost to view behind the waves). The sea is covered with long white patches of foam lying along the direction of the wind. Everywhere, the edges of the wave crests are blown into froth. Visibility affected.</td>
</tr>
<tr>
<td>12</td>
<td>Hurricane</td>
<td>64+ knots</td>
<td>45+ ft</td>
<td>The air is filled with foam and spray. The sea is completely white with driving spray. Visibility is seriously affected.</td>
</tr>
</tbody>
</table>

---

**Figure 32. Cloud cover using Oktas**

0 Oktas (no cloud) 5 Oktas
1 Oktas 6 Oktas
2 Oktas 7 Oktas
3 Oktas 8 Oktas (no blue sky)
4 Oktas Sky obscured

https://greenfieldgeography
» Number of boats present at the time and its/their type
» Distance/angle of the group sighted and boat
» Species identification of sighted marine mammal (Refer to Annex 16)
» Group structure
» Beaufort Sea State
» Cloud cover
» Glare

7. Estimate the distance of the group sighted simply with experience. However, for less experienced observers, using binoculurs with embedded reticle is recommended for estimating distance based on platform height.

8. The angle of the boat towards the group is recorded in terms of hours of a clock, with the bow serving as the 12 o’clock reference (e.g. when the group is sighted on the right side of the boat, then the angle of the boat to be recorded is 3 o’clock). These could later be converted to angles with respect to the GPS since the track or heading is also recorded.

9. For the Beaufort Sea State and Cloud Cover, “Table 27 Beaufort Sea State (BSS) using the Modern Beaufort Scale” on page 72 and Figure 32 on page 73 respectively. For Glare, rate it as either High Medium or Low.

10. At the end of the boat survey, record the end time on the data sheet. Figure 33 shows an example of a filled up survey datasheet.

11. After the boat survey, process photos taken. See section on Date Processing and Management.

9.5.4 Stranding Data

THE RESPONSE PROTOCOL FOR STRANDING events is in Annex 19.

This technique requires the supervision of trained
personnel with experience in several coastal places throughout the Philippines, in close coordination with the PMMSN, and through the UP Institute of Environmental Science and Meteorology (UP IESM) Marine Mammal Research and Stranding Laboratory (MMRSL).

The PMMSN has a national database of stranding events of marine mammals in the Philippines. The PMMSN is composed of several organizations, from the academe (UP IESM), national government agencies (NGAs) (i.e. Bureau of Fisheries and Aquatic Resources or BFAR), LGUs to private industry. Collaboration between BMB and PMMSN must be encouraged.

9.5.5 Dugong Feeding Trail Monitoring

**MATERIALS**

1. Scuba gear
2. Tape measure
3. Ruler
4. Slateboard
5. Underwater camera

> Procedure

**PERSONNEL WHO ARE CERTIFIED SCUBA DIVERS WHO CAN IDENTIFY DUGONG FEEDING SCARS OR FEEDING TRAILS ARE NEEDED FOR THIS METHOD.** Conduct the survey on known dugong feeding areas (deep seagrass areas) revealed during FGDs and structured interviews.

1. Dive down the identified dugong feeding area and search for feeding scars or trails (Figure 34).
2. Assess the freshness of the feeding scar by indicating whether it is new or old. Light colored cuts indicate a fresh or new feeding scar.
3. Measure and record the dimensions (length, width, and depth).

**NOTE**

VARIATION IN SIZES OF DIMENSIONS OF...
feeding trails suggests presence of several dugongs feeding in the area. However, without actually seeing the dugongs, the monitoring team should take caution in declaring a specific number of dugongs present since variation of feeding scar dimensions is only suggestive of presence of more than one dugong and is not definitive.

4. Take photos or video of the feeding trail.

9.5.6 Nesting Beach Survey

**MATERIALS**

1. Flashlight
2. Camera
3. Tape measure
4. Data Sheets

**Procedure**

TRAINED PEOPLE WHO WILL REGULARLY traverse or walk the known nesting beaches are required for this survey.

1. Visit areas where sea turtles are known to nest identified during FGDs and structured interviews.
2. Map the nesting site using GPS to get the area (in hectares) utilized by sea turtles. This would define the nesting site.
3. Observe along the latest high tide line.
4. Record all crawls per species observed and indicate if the crawl is fresh or not. Also record presence and frequency of false crawls.
5. Fill out the data sheet (Annex 20) accordingly.
6. Differentiation of nesting crawls and false crawls, identification of tracks per species, and sample filling out of data sheets are described in Annex 21.
7. Mark traversed track to avoid duplication.

9.5.7 Market Survey

**MATERIALS**

1. Camera and/or video-recorder
2. Data sheets

**Procedure**

1. Coordinate with the Market supervisor. If it is a roadside stall, ask permission from the fish vendors prior to conducting to survey.
2. For every stalls seen selling sharks or rays, intercept the fish komprador/fish broker, if present. Ask where the sharks were caught. In these stalls, with the permission of the vendor, estimate the total volume of shark and ray catch per species.
3. Take a sample of the total shark and ray catch per species and measure the total length and estimate the weight of sampled individuals.
5. Take photos of the sharks of the shark or ray. Make sure to include a reference scale (ruler) in the photo.
6. At the minimum, make sure to take photos of the following parts of the shark and rays sampled: Lateral and ventral side, Head, Caudal fin, and Dorsal fin.

9.5.8 Fish Landing Survey

**MATERIALS**

1. Large fish board
2. Weighing scale
3. Data sheets
4. Camera

   > Procedure

   1. Coordinate with the LGU/Barangay/Fisherfolk Association. Inquire the best time to do the survey.

   2. Intercept only the fishers who caught sharks or rays. With their permission, estimate the total volume of sharks and rays catch.

   3. Enumerate species composition and detail abundance or volume per species.

   4. Sample the total catch per species and measure the total length and estimate weight of sampled individuals

   5. Ask and record the type of gear used and the location of the catch

   6. Fill out the data sheet (Annex 23) accordingly.

   7. Take photos of the sharks of the shark or ray. Include a reference scale (ruler) in the photo.

   8. Take photos of the following parts of the shark and rays sampled: Lateral and ventral side, Head, Caudal fin, Dorsal fin.

9.6 Data Processing and Management

9.6.1 Photo-Identification

   IN PROCESSING THE PHOTOGRAPHS, MAKE sure to refer to the datasheet for guidance. – Which datasheet?

   DORSAL FIN CROPPING, GRADING, TRACING AND MARKING
1. Crop raw images using a photo editing software (Adobe Photoshop or Picasa) to zoom in on distinctive body part (i.e. dorsal fin for most dolphins, flukes for those who fluke up, and left side above the pectoral fin for whale sharks). Make sure the leading edge and trailing edge (Figure 35 on page 77) is included in the cropped photo. The orientation of the dorsal fin in the cropped image should be have the leading edge on the left and the tailing edge at the right side of the photo. Flip the photo horizontally if needed.

2. Level the photo if needed by arbitrarily rotating the cropping tool so that the leading edge levels with the tailing edge. Displaying the grids is useful in aligning the leading edge and trailing edge.

3. Save the cropped photo as a JPEG file. Make sure the filename contains the date and image number. If multiple fins are cropped from one photo, the cropped photos must be labelled in order (in sequence) from left to right.

4. Save raw and cropped photos in separate folders by date taken.

5. Grade cropped images following methods of Urian et. al (1999) to create a folder of valid fins. Use a spreadsheet for grading.

6. Compute the proportion of valid and invalid fins. Figure 36 shows a sample of a filled out spreadsheet used for grading cropped images. Create a folder for valid fins. The images in this folder are those ready to be traced using Darwin software.

7. Trace, and marking the images in the folder using Darwin software. “DARWIN” on page 80.

8. Match and mark valid fins with Darwin. Click Match to directly match a traced fin or create queues for matching by batch of traced fins. Queues can be created by adding the saved traced fins. Matching fins must have the same name/acronym. Mark new fins by properly (i.e. fins without a match in the

Figure 37. Sample spreadsheet for building encounter histories
database) by properly naming the fins based on marking codes.

9. Build Encounter Histories (EH) by creating a spreadsheet of the marked fins (use the marking codes) and the daily encounter dates as shown in Figure 37. Save the EH generated as .inp file in notepad.

10. Analyze EH using Mark software. Enter the EH by clicking Select File and uploading the .inp file. Provide title for the set of data.
   • Select POPAN data type.
   • Enter the number of encounter occasions and set Time Intervals (default value of 1 is equal to one year or one month).
   • Set Attribute groups to 1.
   • In the POPAN interface, specify POPAN parameters per model (capture $\rho$; survival $\phi$; and entry $P_{Ent}$).

Models to be tested are:
$$\rho_t, \phi_t, P_{Entt} \text{ or } \{\rho_t, \phi_t, bt\}$$
$$\rho, \phi_t, P_{Entt} \text{ or } \{\rho, \phi_t, bt\}$$
$$\rho, \phi, P_{Entt} \text{ or } \{\rho, \phi, bt\}$$
$$\rho_t, \phi, P_{Ent} \text{ or } \{\rho_t, \phi, bt\}$$
$$\rho, \phi, P_{Ent} \text{ or } \{\rho, \phi, b.\}$$

   • Run MARK to generate AICs.
   • Refer to Program MARK manual (Cooch & White 2014) for more information.

11. Analyze the EH. Take note of the model with the lowest AIC for abundance and survival estimate. Open or retrieve MARK results with Notepad in .FPT format. Get the results from the chosen model with the lowest AIC. Generate the abundance by adjusting the population (N-hat) using the proportion computed previously (marked vs unmarked).

12. Graph the results.

CRITERIA FOR RATING PHOTOGRAPHIC QUALITY

SCORES SHOULD BE GIVEN FOR EACH of these elements for the estimation of the overall photographic quality:

1. Focus or clarity: The crispness or sharpness of the photo. For this specific element, a score of 2 should be given to the photo if it has excellent focus; 4 for moderate focus, and 9 for poor focus and very blurry photo.

2. Contrast: The range of tones in the image. A score of 1 means the photo has ideal contrast while the score of 3 has excessive or minimal contrast.

3. Angle: The angle of fine (What?) to the camera. A score of 1 refers to perpendicular angle; 2 to slight angle; and 8 for oblique angle.

4. Partial: The fin visibility wherein 1 means the fin, including the leading and trailing edges fully visible and 8 means that the fin is partially obscured in the image.

5. Proportion of the Frame: Filled by the Fin: The measured by the percent area the fin occupies relative to the frame. A score of 1 means that the percent area is greater than 5% while the score of 5 means it is less than 1%.

6. Distinctiveness: The amount of information contained on the fin. An image is given the rating of D1 if it is very distinctive with features evident even in distant or poor quality photograph; D2 if it has an average
amount of information content with at least two features or one major feature visible on the fin; and D3 if the image is not distinctive with very little information content in pattern, markings, or leading and trailing edge features.

7. For each image, add all the score given for the first five elements to rate its overall photographic quality.

<table>
<thead>
<tr>
<th>SCORE TOTAL</th>
<th>QUALITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 to 9</td>
<td>Excellent</td>
</tr>
<tr>
<td>10 to 12</td>
<td>Average</td>
</tr>
<tr>
<td>&gt; 12</td>
<td>Poor</td>
</tr>
</tbody>
</table>

In the spreadsheet, input Q1, Q2, or Q3 for excellent, average, and poor quality, respectively under Photographic Quality.

8. Get the image grade by combining the Photographic Quality and Distinctiveness. Determine if the image is valid for Darwin base on its grade: Q1D1, Q1D2, Q2D1, and Q2D2 images are considered valid while Q1D3, Q2D3, and Q3D3 are considered not valid.

The necessary fields are the following:

- **ID Code = Acronym + filename**
- **Name = Acronym** (can be derived from description, e.g. UMNO which stands for upper middle with notch)
- **Damage category = location of the mark/s (refer to Annex 24)**
- **Short description of the marking/s = e.g. upper middle with notch**

5. Trace the fin by clicking **Trace Outline**. Click start of fin (Leading Edge) and then the end of fin (Trailing Edge) for automatic/quick tracing of fin. Make any necessary corrections to outline trace using the displayed tools.

6. Click **Save** then click **Add to Database**. Choosing only Add to Database will just add the fin to the database without attempting to match it. Open other images of the same species in the Valid for Darwin folder and repeat these steps for tracing, marking, and matching.

---

1. **DARWIN**

   1. Launch Darwin and create New Survey Area and New Database. Include the species name in the database name. The database created must contain fins of the same species.

   2. For other species in the same survey area, click New Database within the Selected Survey Area.

   3. Open image files of the indicated species from the created Valid for Darwin folder.

   4. Modify the image if needed. Enter known information.
10. Fisheries Biodiversity

A RELIABLE FISHERIES PROFILE OR database is a critical component of fisheries management around a marine KBA.

Since interviews serve as the principal source of information for fisheries profiles, there are limitations to the accuracy of estimates. A detailed fisheries monitoring schedule will provide a comprehensive assessment of the state of the fishery within the KBAs, however, this approach is costly and requires a large amount of time and manpower that are often not readily available.

The use of participatory methods is an alternative means of obtaining vital information that can guide the policy for the conservation of fisheries biodiversity. There are several methods to monitor fisheries biodiversity which will be discussed in the following sections.

10.1 Establishing Monitoring Stations

FISHERIES DIVERSITY MONITORING SHOULD be done around marine Key Biodiversity Areas.

- Conduct monitoring of fisheries diversity and status in each KBA in at least three coastal fishing villages or barangays.
- Conduct at least one FGD session is conducted in each barangay or cluster around the KBA.
- A Stratified Sampling approach is recommended to cover municipal and commercial fishing gear/vessels and should cover at least 10% of the total number of households in each site. This approach, however, may be modified in case the fisher population size is too prohibitive (in terms of manpower, time and other logistics).

10.2 Criteria for Selecting Monitoring Areas

1. Number of fishers
2. Presence of a designated fish landing area
3. Presence of both municipal and commercial fishing fleet.
4. Availability and willingness of a local academic institution with technical staff who can partner with and build the capacity of local government and DENR staff to undertake fisheries monitoring work.

10.3 Frequency of Monitoring and Expected Data Output

“TABLE 28 RECOMMENDED FREQUENCY AND duration for fisheries biodiversity assessment and monitoring per monitoring group” on page 82 presents the recommended frequency and duration of fisheries assessment and monitoring by each group while “Table 29 Expected output for fisheries biodiversity monitoring per monitoring group” on page 83 lists the expected output of these activities.

10.4 Data Collection

10.4.1 Focus Group Discussion

MATERIALS

1. Attendance sheets
2. FGD guide tables
3. Manila paper
4. Markers (different colors)
5. Blackboard and chalk (or white board and whiteboard markers)
6. Masking tape
### Table 28 Recommended frequency and duration for fisheries biodiversity assessment and monitoring per monitoring group

<table>
<thead>
<tr>
<th>METHOD</th>
<th>FREQUENCY AND DURATION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EXPERTS/ACADEME</td>
</tr>
<tr>
<td></td>
<td>DENR AND BFAR</td>
</tr>
<tr>
<td></td>
<td>LGU/COMMUNITY</td>
</tr>
<tr>
<td>FGD</td>
<td>Once a year</td>
</tr>
<tr>
<td></td>
<td>Once a year</td>
</tr>
<tr>
<td></td>
<td>Once a year</td>
</tr>
<tr>
<td>Fishing Effort Inventory</td>
<td>Once a year</td>
</tr>
<tr>
<td></td>
<td>Once a year</td>
</tr>
<tr>
<td></td>
<td>Once a year</td>
</tr>
<tr>
<td>Fish Landing/Dockside Survey (includes census of species caught by various gears)</td>
<td>Quarterly 1 month per quarter; at least 15 days (spread over the month)</td>
</tr>
<tr>
<td>On Board Vessel Fish Catch Monitoring*</td>
<td>Quarterly</td>
</tr>
<tr>
<td></td>
<td>Twice a year</td>
</tr>
<tr>
<td></td>
<td>Quarterly</td>
</tr>
<tr>
<td>Market Survey</td>
<td>Quarterly</td>
</tr>
<tr>
<td></td>
<td>Twice a year</td>
</tr>
<tr>
<td></td>
<td>Quarterly</td>
</tr>
<tr>
<td>Key Informant/ Household Interview</td>
<td>Once a year</td>
</tr>
<tr>
<td></td>
<td>Once a year</td>
</tr>
<tr>
<td></td>
<td>Once a year</td>
</tr>
</tbody>
</table>

#### Procedure

**1. Scissors**

**8. Snacks for participants**

> **HOW TO CONDUCT THE FGD**

1. The FGD should be conducted by staff who are not involved in enforcement activities in the same area so as to encourage open discussion with local people.

2. The FGD requires a well-trained moderator to facilitate discussions and another person to record the minutes.

3. The FGD can be done with the members of fishers association, preferably 10-15 fishers who are using a variety of major fishing gear and who have sufficient fishing experience. Establish permanent FGD groups for monitoring purposes.

4. The barangay captains and other community leaders should be met to explain the objectives and activities of the monitoring system.

5. The common interest of monitoring staff and local people in conservation should be stressed and the possible use of the monitoring data in a more sustained use of local natural resources should be mentioned (DENR & NORDECO 2001).

6. Give at least one week notice to target FGD participants to allow participants to allot time to attend. Make sure that the time set for the meeting is convenient for the participants.
Table 29 Expected output for fisheries biodiversity monitoring per monitoring group

<table>
<thead>
<tr>
<th>Method/Tool</th>
<th>Output Data/Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Focus Group Discussion (FGD)</td>
<td><em>Fishing effort, fishing intensity, and fish biodiversity</em></td>
</tr>
<tr>
<td>Fishing Effort Inventory and Mapping with GPS*</td>
<td>Number of fishers per fishing village</td>
</tr>
<tr>
<td>Fish landing or dockside survey</td>
<td>Changes in fish diversity/species composition</td>
</tr>
<tr>
<td>Fish landing or dockside survey</td>
<td>Number of fishers per km2 of fishing ground</td>
</tr>
<tr>
<td>Fishing gear types and number of users/units</td>
<td>Fishing gear types and number of users/units</td>
</tr>
<tr>
<td>Boat type and number</td>
<td>Number of fishing trips and number of hours/trip</td>
</tr>
<tr>
<td>Fish landing or dockside survey</td>
<td><em>Fisheries diversity</em></td>
</tr>
<tr>
<td>Catch composition</td>
<td>Landed weight per group/species</td>
</tr>
<tr>
<td>Trophic structure analysis*</td>
<td></td>
</tr>
<tr>
<td>Fish landing or dockside survey</td>
<td>Production estimates and fishing revenues</td>
</tr>
<tr>
<td>Catch rates or catch-per unit-effort (CPUE)</td>
<td>Estimates of fish production (daily, monthly, annual)</td>
</tr>
<tr>
<td>Fishing revenues and net incomes</td>
<td>Price changes (by type of fish)</td>
</tr>
<tr>
<td>Price changes (by type of fish)</td>
<td>Sources of fish products</td>
</tr>
<tr>
<td>Destination of fish products</td>
<td></td>
</tr>
<tr>
<td>Focus Group Discussion (FGD)</td>
<td>Changes in fish production and diversity thru time (temporal)</td>
</tr>
<tr>
<td>Semi-structured interviews</td>
<td>Changes in fish composition</td>
</tr>
<tr>
<td>Changes in fishing effort changes</td>
<td>Historical trends in CPUE</td>
</tr>
<tr>
<td>Seasonality of fishery resources</td>
<td>Environmental impacts</td>
</tr>
<tr>
<td>Biodiversity loss or fish extirpation studies</td>
<td></td>
</tr>
</tbody>
</table>

7. The moderator should lead the discussion based on a set of questions designed to obtain the optimum amount of data to establish a profile of the local fishery. These include questions about fishing practices, fishing effort and intensity, seasonal fishing calendars and catch trends, as well as the resource and fisheries issues.

8. The recorder should note down the information shared in the discussions. The goal is to gather information to completely fill out the FGD Guide Tables (Annex 25).

9. The facilitating team can choose to enlarge these tables in manila papers so that these can be filled together with the FGD participants (Figure 38 on page 84). A map of the area can be used to plot fishing grounds and map out gear use.

10. When all needed information have been collected, thank the participants and end the meeting.

11. Lastly, feed your participants. It is the moderator’s call when the snacks will be given during the FGD.
10.4.2 Fish Landing/Dockside Survey

**MATERIALS**

1. Fish landing survey data forms
2. Grid map
3. Weighing scale
4. Measuring tape, ruler, Vernier caliper, fish board
5. Kitchen or digital weighing scale
6. Plastic slates and pencils
7. Specimen jars or resealable bags
8. Money for buying fish samples, if needed
9. Knife or scissors
10. Field Guide to common fin fish families
11. Field Guide to identification of commonly gathered invertebrate resources

**Procedure**

1. Record the boat type, gear type, number of fishers, fishing time, landed weight, species composition, and weight by species (refer to Annexes 26 and 11) in the standard fish landing (FL) survey data sheet (Annex 27, Form 1). Engage a representative number of boats (i.e. at least 20%) that landed at the time of the survey.

2. Take note of the total number of boats and gear operating in the area. Fill out one data sheet per boat.

3. Interview the boat operator about the cost of operation per trip (i.e. cost and volume of fuel, number and cost of labor, cost of supplies, and other expenses). Also ask about their revenues (gross income) from fish sold and where they sell their fish (either the name of the market or the town/city). Take note of
Figure 39. Visual assessment of sex and gonadal maturity of dissected fish

theses information on the datasheet.

4. Borrow or buy samples of the most abundant or major fish species per boat. Measure and record the total length (i.e. length from tip of the snout to the end of the longest part of the tail) and weight of each fish. In measuring the total length, make sure that the measuring instrument remains horizontally straight and does not bend according to the curvature of the fish.

5. Dissect each fish on the “belly” part to expose the gonads. Assess if the sex and maturity of the fish based on gonads using a 5-point gonadal maturity scale (Annex 28).

6. Fill out the preformatted datasheet for morphometrics and gonadal maturity (Annex 27, Form 2)

10.4.3 Market Survey

<table>
<thead>
<tr>
<th>MATERIALS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Market survey data form</td>
</tr>
</tbody>
</table>

2. Field Guide to common fin fish families

3. Field Guide to identification of commonly gathered invertebrate resources

> Procedure

HOW TO CONDUCT A MARKET SURVEY

COORDINATE WITH THE MARKET supervisor prior to conducting the survey. If the market is a roadside fish stall, ask permission from the fish vendors. Preferably at least 10% of the market stalls should be surveyed at each monitoring period. In conducting the survey, inquire about the following:

Source

IDENTIFY the fishing ground or landing of the fish or invertebrate products whenever possible. This information is usually known to the market stall owner or middleman.

Buying price

OBTAIN the buying price from the fisher or
middleman and selling price of each fish/invertebrate species from each market stall owner

**Standard Weight Units**

USE standard units (kg) to compare unit prices across species. Appropriate weight conversions of bulk volume (e.g. banyera or styrofoam box) should be made.

**FILL OUT MARKET SURVEY FORM WITH**
the collected data (Annex 29).

### 10.4.4 Household Survey or Semi-structured Key Informant Interview

**MATERIALS**

1. Guide questions for key informant interview (KII)
2. Household survey on fisheries and socioeconomics

**Procedure**

**HOW TO CONDUCT HOUSEHOLD SURVEY**

1. Explain clearly the objective of the interview and ask the fisher if he/she is willing to participate.

2. With the fisher’s approval, conduct the interview following the prepared questionnaire (Annex 30). This instrument may be modified in case more detailed information is needed.

### 10.5 Data Processing and Management

**LONG-TERM MONITORING OF LOCAL fisheries** is important to show changes in production levels and patterns through time as affected by seasonal wind patterns, changes in fishing effort levels or fishing area, and even climate change-related events. Relevant parameters or measures to describe the state of the local fisheries and simple mathematical tools to obtain estimates are described in the following:

#### 10.5.1 Estimates of Fishing Effort

- The amount of effort involved in fishing operations in a fishing ground (bay or gulf).
- In municipal or artisanal fisheries, effort can be expressed as either number of fishers, hours per day fishing, days per month, or number of gear units.
- In commercial or industrial scale fishing, effort can be expressed as number of days at sea per fishing trip, horse power of the fishing vessel, or number of boats per fishing fleet (Sparre 2000).
- Estimates of total effort can also be derived from information gathered from interviews or FGDs, from each LGU’s municipal fisherfolk registration, and from BFAR’s commercial fishing vessel annual registration.
- Fishing time (or duration of fishing) often expressed as number of hours, can be understood as total time away from the harbor or shore, divided into:
  - time steaming to the fishing grounds
  - time searching for fish
  - actual fishing time (Gulland 1966)
- In municipal (or artisanal) fisheries where most fishing is conducted nearshore (can be reached after a short trip), the travel time to and from the fishing ground and search hours can be minimal.
- In commercial fisheries, on the other hand, travel time and search time can cover several
hours.

• In stationary or passive gear operations, active fishing time is also called “soak time” or the amount of time a gear is actively in the water (and actually catching fish).

• Soak time is considered a more suitable indicator for measuring fishing activity and is useful in standardization of fishing effort (EUR-Lex 2011; www.fao.org/fishery).

10.5.2 Catch per unit Effort (CPUE)

• Also known as catch rates, or the amount of catch one fisher obtains from a single fishing operation during a fixed duration (i.e., hour, day or trip) for each gear type:

\[
CPUE = \frac{\text{Total catch (in kg)}}{\text{No. of fisher – hours, or fisher – days, or gear units}}
\]

• Estimates of mean CPUE of all fishers sampled can be compared among gear types, landing areas, or municipalities and across months or years. Where the goal of monitoring is to provide an updated status of the fishery system, CPUE is considered an important management tool for long-term sustainability of fisheries (van Hoof & Salz, 2001).

Three Ways to Express CPUE

1. Catch per gear unit per trip (kg/g/trip)
The amount of catch of one unit of gear in a single trip (a day or over a number of days, depending on the gear). This allows for an estimate of the total amount of catch landed by one gear type when the total number of gear units is known.

2. Catch per fisher per trip (kg/f/trip)
The amount of catch a fisher obtains from operating a gear type in one trip; derived by dividing the kg/g/trip by the number of crew members. This metric is useful in estimating the gross revenues a fisher earns from a fishing day or trip by multiplying this CPUE measure with the average unit price of fish.

3. Catch per gear unit per hour
The amount of catch of one gear unit per hour of fishing, derived by dividing kg/g/trip by the fishing duration (number of hours of one fishing operation). This metric allows for the comparison of catching efficiency of one gear with other types.

• Fishing duration here refers to the actual fishing hours per operation or ‘soak time’ (e.g. setting the net, handline or trap) and should not include travel time.

10.5.3 Landed Catch

• This is the amount of fish landed in a given area (village, municipality/city, province or bay) by all fishers and all gears, and can be estimated from recorded catch of a sample of fishers or gears through the use of raising factors (Sparre, 2000).

• Sampling the catch of a number of fishers, boats or gears is fundamental to fisheries monitoring since it is virtually impossible to census the fisheries of an entire barangay, municipality or bay.

• Estimating total catch from samples is a basic use of data, a procedure known as ‘raising the catch’ to the total landed per unit area (Gulland 1966).

• The methodology of raising is closely linked to the hierarchy of stratification, also known
as multi-level raising.

- The stratification at each level, from the single trip interview to the estimate of total landings of the country, should be well-defined to make the raising from one level to the next level possible and dependable (Sparre 2000).

**EXAMPLE OF STRATIFICATION IN FISHERIES SURVEY**

1. Sampling the catch of the number of boats or gear type in a given day. This needs data on total number of boats or gears landing that day.

2. Sampling the landed catch of a number of fish landing sites or coastal barangays in one municipality. This needs data on total number of coastal barangays in the respective municipality.

3. Sampling the landed catch of few municipalities in a bay or gulf. This needs data on number of municipalities/cities surrounding the bay.

4. Sampling the number of days within a month or for a whole year

- Stratification can also be done with municipal (artisanal) and commercial (industrial) fishing boats or gear, or major and minor fish landing area.

**Principles of Raising**

**THE BASIC PRINCIPLE OF RAISING INTERVIEW** samples is illustrated in Figure 38 (Sparre 2000). Interviews with individual fishers in a landing center (i.e. fish landing survey) would be the most practical means of getting catch data. Interviews containing information about the catch (or landings) per day can be combined with information on total effort and activity, involving a simple multiplication to obtain an estimate of the total catch (or landings).

If other effort measures (number of gear units, boats, horsepower, etc.) are available, these may replace the “fishing days”, which may improve the estimation of total landings.

**IF FISHING VESSELS OR BOATS ARE VERY similar (i.e. vessels belonging to the same fleet) then it is assumed that all vessels have approximately the same catch. If the number of vessels in the fleet is already identified, then the catch of the fleet can be estimated using the following formula:**

\[
\text{Catch of fleet/month} = \left( \text{catch of one vessel in a month} \right) \times \left( \frac{\text{Number of vessels in a fleet}}{\text{Fleet}} \right)
\]

**Estimating Total Landed Catch**

**WHEN AN ESTIMATE OF THE TOTAL EFFORT** involved in a fishery is available, it is easy to obtain an estimate of the total amount of fish caught and landed in a given area within a specified period (day, month, year). To raise the sampled catch monitored over a number of days to the total landed catch in a month from a sample of landing areas (e.g. in a bay) or gears, use the following raising factor:

\[
\text{Raising Factor } (RF) = \frac{NT}{nt}
\]

Where: \( N = \) total number of fish landing areas (FLA) or units of each gear type; \( n = \) number of landing sites (or gear units) sampled or monitored; \( T = \) total number of days fishing in a month; \( t = \) number of days sampled

The calculated RF will then be multiplied by the total recorded catch (TRC) from the sampled fish landing areas (FLAs) or gear units to obtain an estimate of the total landed catch (TLC) for the month.

**Example 1:** Raising the sampled catch of a gear to TLC in each month, if \( N = 15, n = 5, T = 20 \) days
and \( t = 5 \) days, and \( TRC = 15 \) kg.

\[
TLC = \frac{(15 \times 20)}{(5 \times 5)} \times 15 = 180 \text{ kg landed in a month by a gear type}
\]

**Example 2:** Raising the sampled catch from all gear types of a landing area to TLC of a municipality, if \( N = 3 \), \( n = 1 \), \( T = 20 \) and \( t = 5 \), and \( TRC \) (total catch in a day recorded in FLA) = 120 kg.

\[
TLC = \frac{(3 \times 20)}{(1 \times 5)} = 12.0 \times 120 = 1,440 \text{ kg landed catch in a month in 1 municipality (or city)}
\]

To obtain the TLC of the entire bay (i.e. of all municipalities), the TLC per month of the sampled municipalities will be multiplied by the RF derived as follows:

\[
RF = \frac{\text{Number of municipalities around the bay (N)}}{\text{Number of monitored municipalities (n)}}
\]

Thus, TLC for the entire bay can be computed as follows:

\[
TLC \text{ of Entire Bay} = \left( \frac{N}{n} \right) \times TLC
\]

The annual landed catch can then be obtained by simply adding up the monthly TLC in a given year.

### 10.6 Data Analysis

**DATA GENERATED BY OTHER COOPERATING agencies** (i.e. academe, LGU, BFAR) and secondary data sources such as baseline/previous biodiversity monitoring reports, CLUPs, CRMPs, etc. need to be integrated into the analysis.

1. Consolidate data generated from all monitoring sites/stations using data summary matrices for coastal vulnerability (Annex 7) coastal habitats biodiversity (Annex 31), megafauna biodiversity (Annex 32), and fisheries biodiversity (Annex 33).

2. Update the base map of the concerned area using the data generated from the different monitoring methodologies conducted within the year.

3. Write a biodiversity synthesis report following the outline below.

   - The different sections of the report should provide answers to the key monitoring questions substantiated by the data and information consolidated in the matrices and base map, and by trends observed by comparing the latest data with the baseline or previous biodiversity reports.

   - The regional offices can provide insights on the methodologies used for monitoring to identify any further improvements that need to be made to the monitoring system or any constraints that must be addressed in order to comply to it more effectively.

   - Regional offices are also encouraged to give recommendations on addressing threats to biodiversity or improving management of the MKBAs as they are the ones who know more about the area and the users of information on the coastal and marine natural resources.

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### ❗️ KEY MONITORING QUESTIONS

1. Where are the land covers, habitats, and ecosystems? And where are they being degraded/improved? (not just in PA but including buffer zones)

2. Are the populations of threatened species of plants and animals declining or increasing?

3. What are the causes of of decline or increase?

4. Has the management intervention achieved the intended impact on the ecosystem?

5. Are there increased benefits to local communities from sustainable natural resource use?
SUGGESTED OUTLINE FOR BIODIVERSITY SYNTHESIS REPORT FOR EACH MARINE KEY BIODIVERSITY AREA:

I. Introduction - short relevant background on the marine KBA, e.g. establishment history

II. Biophysical Setting - geographical location & description- with base maps showing habitat/resources; areal estimates of coastal ecosystems

III. Socio-economic Setting - short statement on resource uses, economic status of coastal communities surrounding the mKBA – livelihood options, average HH income;

IV. Status of and Trends in Coastal Habitats & Resources (including GIS maps integrating habitat/resource information and areal estimates of coastal ecosystems)
   A. Reef Status and associated fauna (trends in hard coral cover and fish diversity, abundance, and biomass)
   B. Seagrass and associated fauna (trends seagrass cover and invertebrate diversity and abundance)
   C. Mudflats and seaweed areas (trends in seaweed cover and diversity and invertebrate diversity and abundance)
   D. Coastal Integrity with focus on contribution of coastal habitats to it
   E. Megafauna diversity and distribution
   F. Capture fisheries (biodiversity, fishing effort and catch, CPUE trends, economic benefits)

VII. Status of threatened species - trends in relative abundance or populations of threatened species of plants and animals to see if they are increasing or declining, including causes of these increases or decline.

VIII. Impact of Management – has management intervention had the intended impact on the ecosystem?

IX. Benefits to local communities from sustainable natural resource use – are there increased benefits to local communities from sustainable natural resource use? How much ecosystem services benefits are the PAs providing to the local communities? Where are the major ecosystem services being generated and where are they being used?

X. Monitoring Approaches/Methodology and Gaps

XI. Recommendations

XII. References

Figure 40. Suggested outline for Biodiversity Synthesis Report for Each Marine Key Biodiversity Area
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Figure 29 Gary John B. Cabinta
Figure 30 Gary John B. Cabinta
Figure 34 Gary John B. Cabinta
Figure 38 Sarah S. Esguerra
Figure 39 Sarah S. Esguerra