

POLICY BRIEF

New Scales to Guide the Assessment of Hard Coral Cover and Diversity in the Philippines

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KEY POINTS

- Coral reefs supply vital ecosystem services to the Philippines.
- Safeguarding these services requires the rapid identification of reefs that provide most services, and identification is best made by measuring hard coral cover and diversity and using updated and locally relevant assessment scales on these measurements.
- The use of these assessment scales has advantages and is recommended to update and improve Philippine laws.

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1. CORAL REEF ECOSYSTEM SERVICES

Coral reefs and the vital ecosystem services they supply are already severely threatened in the Philippines (Licuanan et al. 2019; Muallil et al. 2019). Safeguarding them requires the rapid identification of the reefs that provide the most services and are resistant, if not resilient, to climate change and direct human impacts. Reef ecosystem services include the provision of spawning, nursery, and feeding areas for commercially important fishes and invertebrates, ensuring food security for millions of Filipinos living near the country's coastlines (Cabral and Geronimo 2018). Coral reefs are also important habitats for many other marine organisms that make up the biodiversity that the country's waters are known for (Carpenter and Springer 2005; Sanciangco et al. 2013; DeVantier and Turak 2017). Further, coral reefs shelter our coastlines from erosion, storm surges, and tsunamis (Villanoy et al. 2011; Licuanan et al. 2015).

Healthy reefs generate 1 to 5 kg per sq m per year of carbonate rock (Sheppard et al. 2009), contributing significantly to the white sand that is so valuable to tourism. The total economic value of reef ecosystem services in the Philippines was recently estimated to be USD 4 billion per year (Tamayo et al. 2018).

2. HARD CORAL COVER

Since hard (stony) corals are essential building blocks of coral reefs, the more corals there are in reefs, the better coral reefs' ability to build and maintain these ecosystem services. The skeletons left behind by hard corals accumulate and are cemented by coralline algae to form coral reefs (Riegl and Piller 1999; Sheppard et al. 2009). The more corals there are, the faster the reefs can grow, and the larger the area of reef growth there will be (Shen et al. 2010; Villanoy et al. 2011). A study of a now-dead reef in Currimaog, Ilocos Norte, showed that it accreted at a vertical rate

of 10-13 m every thousand years, among the fastest known in the western Pacific and Indian Ocean fossil record (Shen et al. 2010). More corals allow the reefs to keep up with rising sea levels and protect coastlines from waves and currents (Villanoy et al. 2011). Thus, reefs with high potential ecosystem services may be readily recognized by their high hard coral cover. It should be noted that current technologies remain inadequate to produce the millions of corals needed for the restoration of hard coral cover at the scale of entire reefs (see Reyes et al. 2017; Feliciano et al. 2018). These technologies must only be used for research purposes and with the proper Department of Agriculture-Bureau of Fisheries and Aquatic Resources (BFAR) permits.

3. HARD CORAL DIVERSITY

In addition to a large number of individual corals (and higher coral cover), having many coral species is also essential in maintaining coral reef ecosystem services. Consider, for example, the dozen or so species of arborescent or branching “staghorn” *Acropora* (Wallace 1999), which are important contributors in providing the architectural complexity that attracts and supports more fish and invertebrates in a reef (Graham and Nash 2013). These corals are prone to bleach (Hughes et al. 2018) and are sensitive to sedimentation (Dikou and van Woesik 2006; Hennige et al. 2010). But some of these arborescent corals, like *Acropora pulchra*, are observed to resist bleaching when in very turbid, nearshore waters where they could be very abundant (Morgan et al. 2016). Hence, the more species of arborescent coral there are in a reef, the greater the level of redundancy in maintaining reef ecosystem services, and the greater the variety of environmental stressors that the reef can endure. Thus, reefs with greater ability to resist or recover from stressors and disturbances may be recognized by their having many coral species, i.e., higher coral diversity. Reduction in coral diversity and changes in coral species composition indicate the degradation of the reefs’ ability to sustain their vital ecosystem services (Wilson et al. 2012). This is one reason why coral diversity, not just coral cover, must also be monitored (see Licuanan 2020). Such monitoring also allows the tracking of the populations of coral species threatened with extinction.

4. PAST AND PRESENT STATUS OF PHILIPPINE REEFS

In the late 1970s, the Philippines was one of the first countries to undertake a nationwide assessment of coral reefs (Licuanan and Aliño 2014). National Scientists E.D. Gomez and A.C. Alcala, who led this massive effort that covered more than 600 reef stations, also introduced an assessment scale to allow for the interpretation of their survey results. They arbitrarily classified reef stations by “living coral cover,” which is the sum of hard and soft coral covers, into poor (0-24.9%), fair (25-49.9%), good (50-74.9%), and excellent (75-100%) categories (Gomez et al. 1981). They found that 5.5% of the stations then were in the excellent category (Gomez et al. 1981). Their use of soft coral cover in their scale has led to some confusion (i.e., some used the same assessment scale on the cover of hard corals alone) and is no longer justified based on newer information. Soft corals do not contribute much to reef formation and growth, though there are exceptions (Cornish and DiDonato 2004; Jeng et al. 2011). Unlike hard corals, experimental removal of soft corals did not lead to changes in the associated reef fish assemblage (Syms and Jones 2001). The cover and diversity of hard corals alone are thus better measures of coral reefs’ capacity to build and maintain their ecosystem services (Licuanan and Aliño 2014).

The National Assessment of Coral Reef Environments (NACRE) Program undertook the latest nationwide assessment of reefs with funding from the Department of Science and Technology – Philippine Council for Agriculture, Aquatic, and Natural Resources Research and Development (DOST-PCAARRD). NACRE Project 1 revealed the loss of one-third of the hard coral cover (HCC) in Philippine reefs over the last decade (Licuanan et al. 2019). No fringing reefs in the excellent category were found (Licuanan et al. 2019). NACRE also provided statistically robust estimates of average HCC and coral diversity (as taxonomic amalgamation units) in the country and in each of its six biogeographic regions (Figure 1). These estimates now serve as new baselines for future national and sub-national assessments of fringing reefs in the country. In the absence of site-specific information, these numbers can also be used as bases for estimating the loss of coral cover and the damage (and costs) to reefs caused by ship groundings, reclamation, and other impacts to reefs, provided that the sampling design and site selection criteria used are compatible (see Licuanan and Aliño 2014).

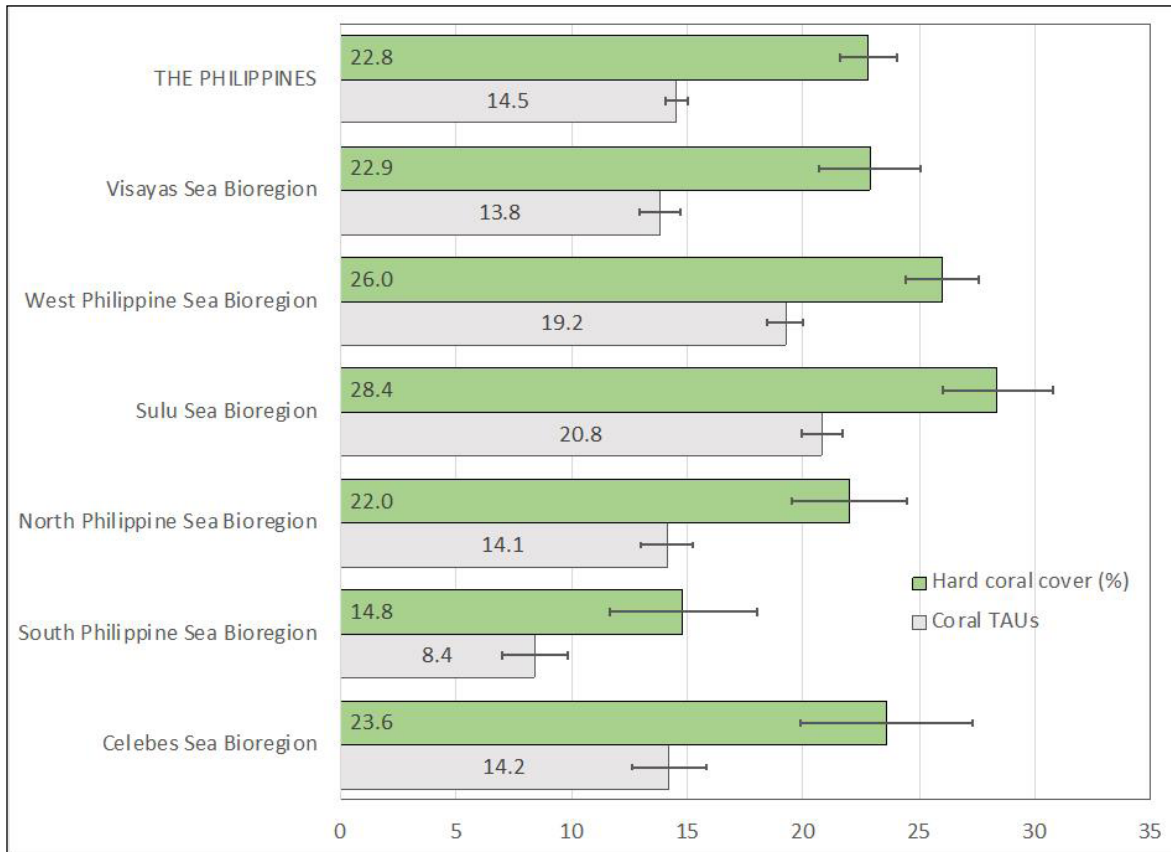


Figure 1. Baseline numbers for average hard coral cover and coral diversity (as taxonomic amalgamation units or TAUs) in the Philippines and its six marine biogeographic regions. See Licuanan et al. (2019) for details. Error bars represent +/- 1 standard error.

5. SCALES FOR ASSESSING HARD CORAL COVER AND DIVERSITY

Aside from the new baselines, NACRE allowed for the development of more locally relevant scales (Licuanan et al. 2019; Table 1) to guide the interpretation of HCC and diversity in the Philippines. These new assessment scales are based on the baselines and average HCC and diversity in the Indo-Pacific and Tubbataha Reefs Marine Natural Park (Licuanan et al. 2017; Licuanan et al. 2019). They are thus easier to explain to non-specialists. HCC Category A, B, and C reefs all have higher than average HCC for reefs; HCC Category A and B reefs have higher HCC than the Tubbataha average; and HCC Category A reefs have higher than double the average HCC. These new scales encourage the use of letter “grades.” The use of letter “grades” in these scales avoids the use of (potentially) value-laden terms such as “poor” and “fair.” Such

terms should not be applied to reefs because even “poor” reefs provide significant ecosystem services. As examples, Perry et al. (2013) show a reef with 10% coral cover is still able to accrete (i.e., grow) and a reef in Bolinao, Pangasinan with 12% HCC still had over 100 species of hard corals (Licuanan, unpublished data). Because the new scales have finer increments, small differences in HCC and diversity among reefs can be discerned and highlight improvements in reef condition because of effective management. The new scales are also part of a broader scorecard developed to guide the interpretation of data collected by citizen scientists monitoring reefs. The advantages of using the new scales require improvements in selecting reefs to survey and monitor, where the survey and monitoring are done, and the field and analytical methods used to do these. These are described in detail in a protocol handbook (Luzon et al. 2019) being distributed by DOST-PCAARRD.

Table 1. Assessment scales to guide the interpretation of hard coral cover and coral diversity (as taxonomic amalgamation units or TAUs) in the Philippines. See Licuanan et al. (2019) for details.

Hard coral cover (HCC)		Hard Coral Diversity	
HCC Category A	>44%	Diversity Category A	>26 TAUs
HCC Category B	>33% – 44%	Diversity Category B	>22 – 26 TAUs
HCC Category C	>22% – 33%	Diversity Category C	>18 – 22 TAUs
HCC Category D	0 – 22%	Diversity Category D	0 – 18 TAUs

The scales for assessing hard coral cover and diversity have already been adopted by the Biodiversity Management Bureau of the Department of Environment and Natural Resources (Technical Bulletins 2017-05 and 2019-04). More scientists at BFAR, the National Fisheries Research and Development Institute, and several higher education institutions have also been trained in the site selection criteria, reef assessment and monitoring methodology, and data summarization relevant to the application of these scales. Their greater use would allow us to recognize better the most important coral reef areas in the country.

6. POLICY RECOMMENDATION

The National Fisheries and Aquatic Resources Management Council recently passed a resolution recommending that the president amend Proclamation No. 2146, Series of 1981, “Proclaiming Certain Areas and Types of Projects as Environmentally Critical and Within the Scope of the Environmental Impact Statement System Established Under PD 1586.” This Presidential Proclamation specifies, among others, the criteria to be used in identifying environmentally critical reefs. In its original form, the Proclamation defined a coral reef as environmentally critical if it is “...characterized by one or any combinations of the following conditions:

- a. With 50% and above live coralline cover;
- b. Spawning and nursery grounds for fish;
- c. Which act as natural breakwater of coastlines.”

Criterion (a) essentially referred to “excellent” and “good” category reefs, which meant around 30% of the reef stations in the early 1980s qualified as environmentally critical (see Gomez et al. 1981). However, given the current state of Philippine reefs as

revealed by NACRE, only around 7% of the reefs will qualify as environmentally critical under Criterion (a) (AM Licuanan et al. 2017). The country’s average hard coral cover is now only 22.8% (± 1.2 SE; Licuanan et al. 2019). Amending Criterion (a) to read “With 23% and above hard coral cover” will mean that about 50% of our coral reefs will qualify as environmentally critical. An “environmentally critical” classification potentially affords greater protection for reefs and their ecosystem services from the impacts of heavy industries, resource extractive industries (e.g., fishpond development projects), and infrastructure projects such as coastal reclamation, road and bridge building, as specified in the Proclamation 2146. Hopefully, the amendment will, at least, demonstrate how the outcomes of properly designed and implemented scientific research (in this case, an updated baseline for HCC) can help improve laws and regulations to benefit society and the state of the Philippine environment.

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