STATE OF THE CORAL TRIANGLE: **Philippines**

STATE OF THE CORAL TRIANGLE:
Philippines

ADB

CORAL TRIANGLE INITIATIVE
ON CORAL REEFS, FISHERIES AND FOOD SECURITY

gef

ISBN 978-92-9254-518-5 (Print), 978-92-9254-519-2 (PDF)
Publication Stock No. RPT146480-3

Cataloging-in-Publication Data

Asian Development Bank.
State of the Coral Triangle: Philippines.
Mandaluyong City, Philippines: Asian Development Bank, 2014

1. Coral Triangle. 2. Marine environment. 3. Marine fisheries. 4. Philippines.
I. Asian Development Bank.

Note:
In this publication, "$" refers to US dollars, unless otherwise stated.

Photo credit
Front cover (*from left to right*): Vangie White and Raul Roldan
Back cover: Aileen Maypa

6 ADB Avenue, Mandaluyong City
1550 Metro Manila, Philippines
Tel +63 2 632 4444
Fax +63 2 636 2444
www.adb.org

For orders, please contact:
Public Information Center
Fax +63 2 636 2584
adbpub@adb.org

Printed on recycled paper

Contents

Tables and Figures

Tables

Figures

Foreword

The Coral Triangle Initiative on Coral Reefs, Fisheries, and Food Security (referred to in this report as Coral Triangle Initiative [CTI]) was launched in 2007 as a multilateral partnership of the governments of Indonesia, Malaysia, Papua New Guinea, the Philippines, Solomon Islands, and Timor-Leste. The CTI recognizes the need to safeguard the coastal and marine resources of the seas that surround these countries, which together constitute a uniquely diverse and economically important region often referred to as the Coral Triangle. In 2009, these six countries—now often referred to as the CT6—adopted a 10-year, five-point regional plan of action for improving management of the region's coastal and marine resources. The ultimate objectives of this plan are to ensure food security and sustainable livelihoods for all residents of the Coral Triangle, and to protect the region's unique ecosystems and the marine species that inhabit them in perpetuity.

The Asian Development Bank (ADB) has a long-term commitment to sustainable development of coastal and marine resources, and decades of experience in coastal and marine resource management in Southeast Asia and the Pacific. As an implementing agency of the Global Environment Facility, ADB manages a broad array of technical and financial support programs both within the Coral Triangle and beyond. It is thus rewarding that ADB is a key development partner of the CT6 countries, both collectively and individually. ADB has undertaken a number of loan, grant, and technical assistance initiatives that directly support and complement the CTI, as well as the national and regional action plans that are central to it. These initiatives help strengthen regional policy dialogue, facilitate CTI-wide exchange of data and information, build institutional capacity, and encourage policy and program development based on global best practice.

Other ongoing ADB-sponsored projects that support the CTI include Regional Cooperation on Knowledge Management, Policy, and Institutional Support to the CTI and Strengthening Sound Environmental Management in the Brunei Darussalam–Indonesia–Malaysia–Philippines East ASEAN Growth Area. Further, ADB supports the CTI's technical and financial working groups, and has set up a business development unit to liaise with and support the CT6 countries, its development partners, and the CTI regional secretariat. This unit coordinates inputs to knowledge and project management, facilitates project assessment and feasibility studies, and provides assistance to CTI monitoring and evaluation systems.

ADB's support to the CTI includes the publication of several CTI knowledge products. These include a State of the Coral Triangle (SCT) report for each member country, as well as a regional SCT report that promotes regional and international understanding of current ecological, political, and socioeconomic issues in the Coral Triangle. These SCT reports describe the current condition of coastal ecosystems—particularly their exploited resources—in each of the CT6, as well as the entire Coral Triangle region. They likewise document these countries' current biophysical and socioeconomic characteristics, the environmental vulnerabilities of their coastal and marine ecosystems, and the aspects of governance currently in place for addressing these vulnerabilities.

As these SCT reports are the first to be published, they provide a baseline against which future progress in improving management of the Coral Triangle's marine resources can be measured. They likewise memorialize the commitment of these six countries to the CTI through elaboration of goals and the creation of a national plan of action for each country to achieve sustainable use of marine resources within the Coral Triangle.

Through publication of these national and regional SCT reports—and the *Economics of Fisheries and Aquaculture in the Coral Triangle*—we hope to promote a more complete regional and international understanding of current ecological, political, and socioeconomic issues in the Coral Triangle. Similarly, we hope that future updates of these SCT reports will enable the CT6 countries to monitor their progress, evaluate projects, refine their action plans as necessary over time, and thus create a sustainable development trajectory for both the communities and the marine ecosystems that inhabit the Coral Triangle.

James A. Nugent
Director General
Southeast Asia Department
Asian Development Bank

Messages

In 2007, the six countries that launched the Coral Triangle Initiative (CTI) adopted a set of principles that formed the foundation of this complex, yet vital, regional initiative. They then used these principles to outline a road map for conserving and sustainably managing the Coral Triangle coastal and marine resources, and ultimately to create the CTI Regional Plan of Action (RPOA), which was adopted at the CTI Leaders' Summit in 2009.

Formal adoption of the RPOA was a key step in operationalizing the CTI, as it encouraged numerous development aid agencies and international nongovernment organizations (NGOs) to support this important initiative not only with financial resources but also with their expertise as well. This expertise was in turn a key in formulating the national plans of action (NPOAs) for each of the Coral Triangle countries. These national plans form the very core of the CTI, as it is at the national level that appropriate shifts in policy, legislation, and enforcement can most easily be brought about. However, such shifts in policy, legislation, and enforcement can only be appropriate if they are based on information that is as accurate, complete, and timely as possible.

Ultimately, the country State of the Coral Triangle (SCT) reports are critical to sustainable development of the Coral Triangle coastal and marine resources in two ways. First, they provide policy makers with the information necessary for formulating changes in policies and legislations for achieving sustainable development of our marine resources as quickly and efficiently as possible. Second, they serve as baseline information for (i) determining the extent to which additional shifts in policies and legislations are required, and (ii) measuring the progress achieved in implementing each country's NPOA.

As with the other Coral Triangle countries, in the Philippines, a significant amount of research regarding the state of the marine environment had already been performed when the CTI was launched. However, despite the value of all of this information to policy makers, until publication of this report, the information was widely diffused, spread across the databases of numerous government agencies, the archives of environment-related initiatives, and the libraries of environmental NGO partners.

The chief value of the Philippines SCT report is in bringing together for the first time all available information concerning the state of the country's coastal and marine resources into a single volume. The value of this undertaking to policy makers cannot be overstated, as it makes the task of accessing the information far easier. The Philippines SCT report is thus key to putting the Philippines—and ultimately all of the Coral Triangle countries—onto a development trajectory that will ensure the sustainability of the productivity of its coastal and marine resources in perpetuity for the populations that depend on them as a source of food and income.

I call on all agencies and organizations concerned with sustainable development of the Philippines' coastal and marine resources to build on the foundation that this SCT report provides, and to make full use of it in bringing about changes necessary for implementing our NPOA and, ultimately, for sustainably managing the Coral Triangle's marine resources.

Finally, I would like to personally extend my thanks to all of the experts who contributed to the production of this report. It is their example of true partnership and cooperation that we must strive to emulate if we are to succeed in sustainably managing the Philippines' coastal and marine resources, both for present and future generations.

Ramon J.P. Paje
Secretary
Department of Environment and Natural Resources
Republic of the Philippines

Warmest greetings to our partner countries, policy makers, and program implementers of the Coral Triangle Initiative—protecting a source of sustenance for over 120 million people and billions of dollars for small and medium businesses.

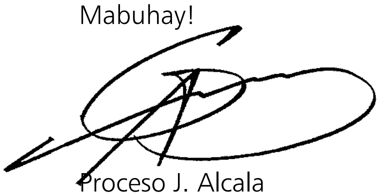
Preserving corals and marine habitat and allowing the same to flourish are among the thrusts of the Philippines' Department of Agriculture. In 2010, our local fishing industry contributed 2% to the gross domestic product at current prices and 2.4% at constant prices.

Consequently, the fisheries sector is one of the major sources of employment. The industry employed more than 1.6 million fishing operators nationwide in 2002, with the municipal fisheries sector having more than one million operators while the commercial and aquaculture sectors added more than 16,000 and more than 222,000 operators, respectively.

With this in mind, the Department of Agriculture has focused on addressing the biggest threat to the fisheries sector—climate change. Climate change adaption plans were developed and are ready for implementation in Taytay, Palawan as well as for Sibutu and Tawi-Tawi.

We reiterate our commitment of keeping fisheries sustainable and promoting inclusive growth for our fishers. Let us continue our collaboration for the development of coral reefs, fisheries, and food security in the Philippine and in the region for the years to come.

Mabuhay!



Proceso J. Alcala
Secretary
Department of Agriculture
Republic of the Philippines

Acknowledgments

The Philippines State of the Coral Triangle (SCT) report was prepared at the request of the National Coordination Committee for the Coral Triangle Initiative. Jointly chaired by the Department of Environment and Natural Resources (DENR) and the Department of Agriculture, the committee's membership is representative of a wide range of government agencies, academic institutions, and NGOs, all of which provided essential inputs to the report's preparation. These include the following:

(i) Department of Finance,
(ii) Department of Foreign Affairs,
(iii) Department of Interior and Local Government,
(iv) National Economic and Development Authority,
(v) League of Municipalities of the Philippines,
(vi) Marine Science Institute of the University of the Philippines (UPMSI),
(vii) Conservation International–Philippines, and
(viii) WWF–Philippines.

In addition, this report would not have been possible without the contribution of many other individuals, government agencies, and organizations, all of which are committed to sustainable development of the Philippines' coastal and marine resources. The assistance of the following is therefore particularly acknowledged:

(i) Bureau of Fisheries and Aquatic Resources;
(ii) National Fisheries Research and Development Institute;
(iii) Department of Energy;
(iv) Philippine Council for Agriculture, Aquatic, and Natural Resources Research and Development in the Department of Science and Technology;
(v) Department of Tourism;
(vi) Maritime Industry Authority;
(vii) Philippine Tourism Authority;
(viii) Marine Protected Area Support Network;
(ix) ASEAN Centre for Biodiversity;
(x) FishBase Information and Research Group;
(xi) Resources, Environment and Economics Center for Studies;
(xii) Environmental Management Bureau of the DENR;
(xiii) National Mapping and Resource Information Agency of the DENR; and
(xiv) Protected Areas and Wildlife Bureau of the DENR.

Finally, several international donor agencies provided valuable assistance to the report's preparation. In addition to financial resources, their assistance included substantive support by participating in numerous workshops and meetings, drafting of the report, and providing substantive contributions to it. These agencies particularly include the

(i) United States Agency for International Development, through the Coral Triangle Support Partnership;
(ii) Asian Development Bank, through its Regional Cooperation Knowledge Management, Policy, and Institutional Support to the Coral Triangle Initiative Project; and
(iii) German Technical Cooperation Agency, through its Adaptation to Climate Change in Coastal Areas project.

Executive Summary

The Philippines is geographically located at the apex of the Coral Triangle, an area recognized by marine ecologists the world over as a global center of marine biodiversity. The coastal waters of this vast marine expanse contain a wider range of species of corals, reef fishes, seagrasses, and mangroves than anywhere else in the world. The other marine vertebrates, invertebrates, and plant species, as well as their terrestrial counterparts, in the Coral Triangle are also reported to be richly diverse.

Millions of Filipinos depend on coral reefs and their associated ecosystems for both food and income. This includes small-scale and subsistence fishers and commercial fishers alike. Similarly, the recreational, educational, and aesthetic values of these coastal ecosystems contribute significantly to the country's tourism sector. Damage to these ecosystems beyond restoration would entail significant adverse consequences for all Filipinos. Sustainable development of these marine ecosystems is thus critical to the long-term future of the Philippines, as 78% of its 80 provinces and 56% of its 1,634 cities and municipalities are located along the country's coastline.

However, degradation of these coastal ecosystems is already apparent, in part because of the high-profile nature of the activities that cause it. These include overfishing; use of destructive fishing practices; unsustainable development along the country's coastline; pollution originating in the agriculture, industry, transport, and domestic sectors; and elevated sediment loads caused by unsustainable removal of forest cover. Population growth in the country's coastal areas has amplified these threats; thus, compromising food security and socioeconomic stability in coastal communities. Climate change has further exacerbated these impacts. In sum, the factors referred to above have together made the Philippines one of the most environmentally vulnerable countries in Southeast Asia.

As a signatory to the Convention of Biological Diversity (CBD), the Philippines promotes conservation of biodiversity. The Protected Areas and Wildlife Bureau of the Department of Environment and Natural Resources (DENR) regularly reports loss of biodiversity to the CBD, as well as gains in protecting it, in promoting sustainable use of these living resources, and addressing threats to biodiversity in general.

The Coral Triangle Initiative (CTI) on Coral Reefs, Fisheries, and Food Security addresses the threats to sustainability referred to above through a multilateral partnership that includes the six CTI member countries: Indonesia, Malaysia, Papua New Guinea, the Philippines, Solomon Islands, and Timor-Leste. The CTI's primary objective is safeguarding Coral Triangle coastal and marine resources for future generations. The Philippines' National Coordinating Committee

(NCC) for the CTI is co-chaired by DENR and the Bureau of Fisheries and Aquatic Resources (BFAR) in the Department of Agriculture.

Rationale

This State of the Coral Triangle (SCT) report documents the Philippines' commitment to sustainable development of Coral Triangle marine resources, as contained in its national plan of action (NPOA) for the CTI. It likewise documents the current status of these resources; and, thus, provides baseline data and information against which future progress in implementing the country's NPOA can be assessed. The NPOA likewise summarizes the policies and programs currently in force at all levels of governance for addressing conservation and sustainable development of the country's coastal and marine resources.

The Philippines NPOA embodies the five overall goals of the CTI, which are as follows:

Goal 1: Designation and effective management of priority seascapes
Goal 2: Application of an ecosystem approach to management of fisheries and other marine resources
Goal 3: Establishment and effective management of marine protected areas (MPAs)
Goal 4: Application of climate change–adaptation measures
Goal 5: Improvement of the status of threatened species

All aspects of the Philippines' NPOA are consistent with the CTI principles and guidelines. Further, each of the five goals set out above includes appropriate strategies and quantitative targets.

For example, the priority seascapes identified under Goal 1 comprise large-scale geographies that have been prioritized for both investment and action. Under these investments and actions, best practices are to be applied and their use expanded. Goal 2 specifies that the ecosystem approach to fisheries and marine resource management is to be fully applied under the NPOA. Likewise, the effective management of MPAs included under Goal 3 is to include community-based resource utilization and management.

The quantitative targets to be used for measuring progress in NPOA implementation are consistent with the set of measurable indicators formulated by the CTI's NCC Technical Working Group at the series of workshops convened for that purpose. As collection of these data will continue throughout implementation of the NPOA, this report presents data relating to these indicators that were available at the time of report preparation.

Physical and Socioeconomic Characteristics

The dominant wind system over the Philippines is the Asian monsoon, which blows from the northeast (December–March), and from the southwest (June–October). This monsoonal wind system affects the country's temperature, wind, and rainfall patterns; and produces four distinct dry and wet seasons along a north–south, east–west gradient. Oceanic circulation around the Philippines archipelago is a product of complex factors that relate to bathymetry, seasonally reversing monsoons, and tidal and nontidal circulation between the West Philippine Sea (also known as South China Sea)[1] and the Western Pacific Ocean. Winds blowing through gaps between islands can induce upwelling and downwelling along the leeward sides of the islands. Climate change variation is influenced by the Pacific Decadal Oscillation, which affects sea surface temperature and produces thermal anomalies that result in coral bleaching.

The Philippines' coral reef area is estimated at 26,000 square kilometers (km^2), which is the second largest in Southeast Asia. Approximately 500 species of scleractinian or "stony" corals are known to exist in the area, 12 species of which are considered endemic. Similarly, these coral reefs are home to 3,053 species of fish, of which 2,724 are marine-based. Pelagic fish species number about 177, while demersal species total 2,351 (1,658 of these are reef-associated and 693 are associated with other nearshore habitats). There are 277 deep-sea fish species and 173 freshwater species. Similarly, the Philippines has 16 species of seagrass known to occur over an area of 978 km^2. The country is home to 42 mangrove species representing 18 families. Natural mangrove cover has declined from approximately 500,000 hectares (ha) to 247,268 ha, while planted mangroves cover more than 44,000 ha. Several animal species are considered threatened. These include cetaceans, dugongs, manta rays, marine turtles, whale sharks, and other sharks.

A wide range of Philippine laws and policies address the food security, livelihood, and socioeconomic condition of the population; the country's environment and natural resource base; its habitats in need of protection, conservation, and sustainable management; security, safety, and territorial boundaries; and law enforcement. Other laws and government policies have created and improved the organizational and institutional mechanisms that address marine sector issues. These laws and government policies particularly relate to fisheries, biodiversity conservation, and integrated coastal management.

The country's population was 92.1 million in 2009. Population growth rate averaged 2% annually over the period 2000–2007, but had fallen to an annual rate of 1.9% by 2011. In 2009, population density was estimated at 307 persons per km^2, about 10% higher than in 2003. An estimated 60% or more of the total population lives in coastal areas. Population increase is a serious problem as it puts additional environmental pressure on the country's limited natural resource base, and results in overexploitation of coastal and marine resources. Fish remains the population's principal source of animal protein, as it accounts for 70% of total animal protein intake and 30% of protein intake overall.

Status of Fisheries

In 2009, the fisheries sector accounted for 2.2% of the country's gross domestic product (GDP) as expressed in current prices and 4.4% in constant prices. Recent data indicate that this sector's contribution to GDP declined in 2011 as a result of decreases in production in both the commercial and small-scale subsectors. The incomes of fishers are generally below the official poverty threshold, which in 2002 was P11,906 per capita per year, but by 2009 had risen to P16,841. The country's overall density of fishers is 4.4–6.5 per km^2.

[1] In the context of the State of the Coral Triangle: Philippines, West Philippine Sea (also known as South China Sea) shall be used analogously and coterminously throughout this report.

The country's capture fisheries output ranked ninth in the world in 2008. In 2010, capture fisheries produced 2.6 million tons (51% of total Philippine fish production) valued at P138.4 billion. Of this, the small-scale sector accounted for 1.4 million tons valued at P77.6 billion, and the commercial sector accounted for 1.2 million tons valued at P60.7 billion. Approximately 1 million people work in the fisheries sector, which include fishers, entrepreneurs, traders, fish processors, and transport as it relates to fisheries. Total annual tuna landings were estimated at 400,000 tons in 2009, of which 120,000 tons (30%) were caught in Philippine waters and 280,000 tons (70%) in adjacent international waters.

Small pelagic fish—anchovies, fusiliers, mackerels, round herrings, round scads, and sardines—are the main sources of cheap protein for the country's lower-income groups. These fishes, which comprised about 60% of total capture fisheries production in 2003, have an estimated maximum sustainable yield of 550,000 tons. However, the catch per unit of effort for these small pelagic fishes has continued to decline since the 1950s. Of these small pelagic species, sardines comprise one of the major species targeted commercially. In 2003, the sardine harvest totaled 442,045 tons, with an approximate value of P10.5 billion. The country's sardine stocks are showing signs of depletion.

Over the past several decades, the biomass of demersal stocks has declined. Further, the species composition of these stocks has changed. This shift includes an increase in the share of squids, shrimps, and small pelagic species; and a substantial decline in the share of large, commercially valuable species, such as groupers, sea catfishes, and snappers. The present exploitation rates of demersal species are reported to exceed maximum sustainable yield. Further, the current level of output requires a higher level of fishing effort than previously. This indicates overcapitalization of the fishing industry, which suggests overexploitation of the country's fisheries resource. Other recent data relating to small-scale fisheries indicate a predominance of species of small size and low market value.

The value of sustainable production from capture fisheries (excluding invertebrates and aquatic plants) is estimated at P128 billion per year (based on 2006 data). However, due to the country's open-access regime, the net value of production from capture fisheries is only about P13 billion. Based on a coral reef area of 26,000 km^2 (initially reported as 33,000 km^2), the annual potential yield from coral reef fish species is 351,000–429,000 tons. Assuming a coral reef area of 26,000 km^2, the estimated current yield is more than 169,000 tons, with potential net value of P2.0 billion–P2.5 billion, and actual net value of less than P1.0 billion. These values are slightly lower than the estimates for previous years. The gross annual value of the potential production from mangrove fisheries was P1.5 billion–P6.1 billion in 2006. The estimated actual contribution of mangrove ecosystems to fisheries production in 2006 was 23,269 tons.

The Philippines' live reef fish trade mainly targets groupers. This trade generates significant export revenue and income for fishers and cagers. Catches of live reef fish nationwide peaked in the mid-1990s, and have gradually declined since then, particularly in Palawan Province, which is a major source of live reef fish.

Aquaculture contributes 38% to total annual fisheries production and is currently the largest fisheries subsector. This activity is growing at 10.2% per year. In 2010, aquaculture produced 2.5 million tons of output valued at P82 billion. In that year, the country's output level was second only to that of Indonesia, which produced 3 million tons.

Coastal tourism brings substantial economic benefits to the Philippines, as it is a source of foreign exchange, and a significant contributor to the economy, both at the national and local levels. Tourism generated $16.3 billion in the mid-2000s, accounting for 9.1% of GDP. As in other CTI countries, tourism is one of the fastest-growing economic sectors.

Domestic oil production began in the Philippines in 1979, but has been very limited. In all subsequent years up to 2010, the country produced 61,860,820 billion barrels (bbl) of oil, 1,011,267 million cubic feet of natural gas, and 45,312,937 bbl of condensate. The country holds an estimated 3.5 trillion cubic feet (Tcf) of natural gas reserves, most of which are found in the Malampaya gas field in Palawan, which contains an estimated 2.6 Tcf of natural gas. According to the British Petroleum Statistical Energy Survey performed in 2008, annual natural gas consumption in the Philippines was 3.4 billion cubic meters (m^3). As of January 2008, the country had two crude oil-refining facilities, with a total capacity of 282,000 bbl per day.

An archipelagic country, the Philippines relies heavily on domestic and international shipping to transport both people and goods. In 2009, the gross revenue of the Philippine Ports Authority (PPA) was P7.1 billion.

The value of traditional knowledge is increasingly being recognized in the Philippines, particularly with regard to its ability to complement scientific findings, and to contribute insights that science tends to overlook. For example, customary marine tenure systems and traditional practices are now seen as viable alternative fisheries management regimes for addressing overexploitation. Similarly, using traditional fisheries management strategies in the context of national fisheries policy often benefits human communities and marine biodiversity alike. Traditional knowledge is likewise increasingly seen as a valuable input into both national and international conservation efforts and climate change–adaptation initiatives.

Gender equality is actively promoted in the Philippines in government, nongovernment agencies, and throughout the private sector through targeted policies and legislations.

Threats to Biodiversity

In 2000–2004, areas of reef with poor coral cover in the Philippines accounted for 40% of the total. Conversely, areas with excellent coral cover comprised less than 1%. This outcome can be attributed to the negative impacts of coastal development, marine-based pollution, sedimentation, overfishing, and destructive fishing practices. In 2002, overfishing was the largest threat (about 40%) to the coral reefs in the country, followed by destructive fishing practices (36%). However, by 2012, the threat posed by destructive fishing practices had decreased, though the intensity of the other threats had increased considerably.

The negative impact of sedimentation and pollution on the country's coral reefs has grown significantly in recent decades. This suggests that the activities that drive both sedimentation and pollution have increased in scale. These include inappropriate land use, irresponsible mining practices, deforestation (including illegal logging), and improper waste disposal. The pace of coastal development has likewise been significant in recent decades, as manifested by increases in the country's coastal population, expansion of built-up areas, and the rate of urbanization. In contrast, the use of destructive fishing practices appears to be declining in many locales, thus indicating partial success on the part of marine protected areas (MPAs) and fishery management regimes in some municipalities.

Nevertheless, the impacts of overfishing and, to some extent, destructive fishing practices on coral reefs are evident in the declining biomass of reef-associated fish. More than 50% of the reef sites in the Philippines assessed between 1991 and 2004 are overfished. Overfishing also occurs in the live reef fish fishery, particularly in Palawan. Given the moderate-to-heavy fishing pressure on groupers in recent years, depletion of this species has advanced to a point at which current harvests are no longer sustainable.

Some 2.2 million tons of organic pollutants are released into the country's marine environment annually. The sources of this pollution include terrestrial-based domestic, agricultural, and industrial activities.

A major threat to marine turtles—which number among the Philippines' most threatened species—is large-scale illegal harvesting of eggs and collection of adults for the curio trade. Marine turtles are also threatened by coastal development and unsustainable fishing practices. Poaching by foreign fishers targeting marine turtles has likewise caused the country's marine turtle populations to decline.

Inappropriate aquaculture practices negatively impact both the environment and the stocks of farmed fish. Negative outcomes of these practices, such as massive fish kills, also result in financial losses.

Coral reef restoration can rehabilitate damaged habitats and conserve biodiversity. As a result, reef restoration activities are being undertaken in the Philippines to conserve local coral diversity and the productivity of these ecosystems. Restocking also helps maintain the output of target species at sustainable levels. Giant clams, sea cucumbers, sea urchins, and scallops are some of the species targeted by restocking initiatives in the Philippines.

Progress Achieved in Fulfilling the Five CTI Goals Embodied in the Philippines National Plan of Action

For Goal 1 (priority seascapes), two seascapes have been designated. These include the Sulu–Sulawesi Marine Ecoregion and the West Philippine Sea (or South China Sea). With regard to Goal 2, application of the ecosystem-based approach to fisheries management (EAFM), national EAFM policies are being drafted for management of tuna, and for the live reef food fish trade.

For Goal 3 (MPAs), 270,000 ha (2,700 km^2) or 0.1% of the Philippines' coral reefs are under some form of protection. The target is for 2% of coral reefs to be protected by 2015, and 10% of each coral reef and mangrove habitat to be protected by 2020. An assessment performed by the Marine Protected Area Support Network in 2011 showed that 1,620 MPAs have been established, and are managed locally. The MPA Management Effectiveness Assessment Tool was used to assess 110 MPAs that together cover 7% (31,520 ha) of the Philippines' total MPA area of 393,994 ha. For mangroves, 57% (80,000 ha) of the remaining mangroves are under some form of protection, and mangrove replanting activities continue in many municipalities.

There are some mangrove areas with 100% (full) protection. There has been an increase in the number of Marine Key Biodiversity Areas in the Philippines' marine biogeographic regions in the past 2 years, except in the southeastern Philippine Sea. About two-thirds of the Marine Key Biodiversity Areas are located in the Visayan Sea (Visayas region), with smaller numbers located in the Sulu Sea and West Philippine Sea (or South China Sea).

To address Goal 4 (climate change adaptation), climate change vulnerabilities relating to marine and coastal environments have been identified. The RESILIENT SEAS Program of the Department of Science and Technology and the Marine Science Institute of the University of the Philippines (UPMSI) established the framework and initial activities relating to vulnerability assessments of coastal areas, nearshore habitats, fisheries, and fishing communities. This initiative also identified climate typologies in the Philippines that complement existing climatological classifications. Research has also established oceanographic, biophysical, fisheries, and socioeconomic indicators that are integral to climate change vulnerability assessments. This program engages national and local governments, as well as academic institutions in various activities, in the formulation of adaptation strategies in particular.

Under Goal 5 (status of threatened species), action plans have been prepared for conserving and monitoring the status of threatened species, such as sharks. Action plans are likewise being formulated for other species under the auspices of the Turtle National Action Plan and the Marine Mammal Action Plan. The Philippines NPOA calls for completion of species action plans for seabirds, wrasses, and other reef fishes by 2015. Threatened species being considered for restocking efforts include giant clams, scallops, and top shells.

Other initiatives listed in the Philippines' NPOA relate to capacity building, sustainable financing schemes, and public awareness. One innovative initiative is the university mentoring program, which aims to transfer knowledge and skills from centers of excellence to institutions of higher education. This makes the latter better equipped to assist local government units (LGUs), particularly on the technical aspects of coastal resource management and NPOA implementation. On sustainable financing, a range of mechanisms (e.g., payments for ecosystem services [PES]) for generating additional funding for government agencies at both the national and local levels have been identified. Such additional funding will enable these governmental units to undertake activities that help fulfill the goals of the Philippines' NPOA.

Abbreviations

ArcDev	–	Archipelagic Development Framework
BFAR	–	Bureau of Fisheries and Aquatic Resources
CITES	–	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CTI	–	Coral Triangle Initiative on Coral Reefs, Fisheries, and Food Security (also referred to as Coral Triangle Initiative)
DENR	–	Department of Environment and Natural Resources
EAFM	–	ecosystem approach to fisheries management
EEZ	–	exclusive economic zone
GDP	–	gross domestic product
ha	–	hectare
IEC	–	information, education, and communication
IUCN	–	International Union for Conservation of Nature
kg	–	kilogram
km	–	kilometer
km^2	–	square kilometer
LGU	–	local government unit
m^3	–	cubic meter
MEAT	–	Management Effectiveness Assessment Tool
MKBA	–	marine key biodiversity area
MPA	–	marine protected area
MSY	–	maximum sustainable yield
NGO	–	nongovernment organization
NIPAS	–	National Integrated Protected Areas System
NMP	–	National Marine Policy
NPOA	–	National Plan of Action (for the Coral Triangle Initiative)
PAWB	–	Protected Areas and Wildlife Bureau
PCSD	–	Palawan Council for Sustainable Development
PES	–	payment for ecosystem services
PPA	–	Philippine Ports Authority
RPOA	–	Regional Plan of Action (for the Coral Triangle Initiative)
SSH	–	sea surface height
SSME	–	Sulu–Sulawesi Marine Ecoregion
SST	–	sea surface temperature
Tcf	–	trillion cubic feet
UPMSI	–	University of the Philippines Marine Science Institute

Introduction

The Coral Triangle describes a marine expanse that straddles the Indian and Pacific oceans. This area is known to environmentalists to be one of extreme abundance of marine life and significant biodiversity. The Coral Triangle includes some or all of the land and oceanic areas of six countries: Indonesia, Malaysia, Papua New Guinea, the Philippines, Solomon Islands, and Timor-Leste. While it comprises only 1.6% of the total area of the earth's oceans, the Coral Triangle is home to 76% of all known coral species; 37% of all known coral-reef fish species; 53% of the world's coral reefs; and the most extensive mangrove forests in the world, the latter being spawning and juvenile growth areas for tuna and other commercial fish species of global importance. These rich marine and coastal resources provide significant economic and social benefits to 360 million residents of the Coral Triangle particularly the 120 million residents who live on or near its coastlines. For example, these resources are a source of food, income, recreation, and culture. They also protect both the coastline and its residents from the damaging impacts of extreme weather events.

This report describes the biophysical characteristics of the Philippines' marine and coastal ecosystems, their governance as per the terms of the prevailing legal and policy framework, and the institutional arrangements for ensuring compliance with the provisions of that framework. It also describes the socioeconomic characteristics of the population these ecosystems serve, and the pattern of resource use of the population. In addition, the report summarizes the threats to and vulnerabilities of these coastal and marine ecosystems, and how the country proposes to address these to ensure sustainable use of these ecosystems in the future. From an operational perspective, the future sustainable use of these ecosystems is to occur through implementation of a national plan of action (NPOA), which aims at improved governance and management of marine resources. Notably, the latter is to include an ecosystem-based marine resource management regime as well as adaptation to the negative impacts of climate change.

Biophysical Characteristics

Physical Characteristics

Location

Geographically located at the apex of the Coral Triangle, the Philippine archipelago lies between 4°25' and 21°7' north of the equator (NAMRIA 2011). One of the world's largest island groups, the Philippines is composed of 7,597 islands and extends 1,880 kilometers (km) from north to south. While the country's total land area is approximately 300,000 square kilometers (km^2) and its coastline is 37,008 km, its complete territory, including its exclusive economic zone (EEZ), is about 2 million km^2. The Philippines faces the Luzon Strait (Bashi Channel) to the north, the Celebes Sea to the south, the West Philippines Sea (or South China Sea)[1] to the west, and the broad expanse of the Pacific Ocean to the east.

Geography

For purposes of administration, the country's 7,597 islands are divided into three major groups: Luzon in the north, the Visayas in the central part of the country, and Mindanao in the south. In terms of geographic area, the country's three largest islands include Luzon (104,687 km^2), Mindanao (94,631 km^2), and Samar (13,271 km^2). Administratively, the country has 13 regular and 4 special administrative regions. These are divided into 80 provinces, 138 cities, 1,496 municipalities, and 42,026 villages (*barangays*) (NSCB 2011). Of the 80 provinces, 62 (78%) have coastlines, while 17 are landlocked. Of its cities and municipalities, 832 (56%) are located on the coast (CRMP 2001).

Geology

Virtually all of the country's islands are of volcanic origin. As a result, the larger islands are traversed by mountain ranges, the most significant of these being the Caraballo Mountains, the Central Cordillera, the Sierra Madre, and the Zambales Mountains. Both the Diwata Mountain and Mount Apo—the latter being the country's highest peak at 2,954 meters—are located in Mindanao. Due to the country's numerous active volcanoes, seismic activity is a relatively common occurrence.

---

[1] In the context of the State of the Coral Triangle: Philippines, West Philippine Sea (also known as South China Sea) shall be used analogously and coterminously throughout this report.

Climate

Due to its archipelagic nature, the Philippines experiences significant climatic variability as a result of (i) the Pacific Decadal Oscillation, and (ii) interannual variations in the monsoons that occur at least every 2 decades. The dominant wind system over the Philippines is the (*amihan*) monsoon that blows from the northeast (December–March), and the (*habagat*) monsoon that blows from the southwest (June–October) (Wang et al. 2001). These systems affect the temperature, wind, and rainfall patterns of the Philippines. The north–south and east–west trends are classified into four Corona classifications (Types I–IV).

The Remote Sensing Information for Living Environments and Nationwide Tools for Sentinel Ecosystems in our Archipelagic Seas Program for Climate Change (RESILIENT SEAS Program, 2009–2012) has created a system of classification for the seas surrounding the Philippines archipelago. Knowledge of this classification system—which includes 10–11 categories—is critical to understanding land–sea interactions in coastal marine environments (see further discussion in Chapter 5 on Threats and Vulnerabilities). Notably, this classification system takes into account data relating to precipitation, sea surface temperature, and sea surface height. Knowledge of how this classification system complements other sources of data and information is critical to appropriately adapting to climate change.

The coastal and marine climate classification system of David et al. (n.d.) highlighted variability in sea surface temperature in the Philippines. The system consisted of 11 clusters. Cluster I exhibits the greatest increase in observed sea surface temperature (SST). Together with Clusters II, III, VI, VII, and X, it also exhibits greater sea surface height (SSH) during negative Pacific Decadal Oscillations. Cluster II exhibits anomalous negative changes in SST during El Niño events, and anomalous positive changes in SST during La Niña events. Together with Clusters III and IV, Cluster II exhibits pronounced rainfall during the southwest monsoon. Except for Clusters V, VI, and VII, most clusters exhibit cooler SST during the northeast monsoon, with the smallest increase in SST occurring in Cluster VI. Winds are highly monsoonal in Clusters I, VIII, IX, and X, with strong winds occurring during the northeast monsoon.

Clusters I–V extend from north to south, and are mainly exposed to the southwest monsoon, with Clusters I–III closely corresponding to the Type I climate of the modified Philippine Coronas Classification. Cluster III overlaps with Clusters IV and V, and some parts of Cluster VI nearly coincide with Type III of the Corona Classification. Type IV of the Corona Classification is comparable to Clusters VI–VIII, as well as some parts of Cluster IV. Predominantly exposed to the northeast monsoon, Clusters VIII–X are similar to the Type II climate of the Corona Classification.

Hydrology

On average, the Philippines receives 2,500 millimeters (mm) of rainfall per year (Magdaraog 1998). When all factors, including the uneven distribution of rainfall, that influence water availability are taken into account, the average annual supply of surface runoff is an estimated 125,790 million cubic meters (cm^3). Based on estimates of surface runoff and ground infiltration, the amount of water available for consumption is approximately 431 million cm^3 per day. This contrasts with the Philippines' estimated total daily demand for water, which is 77 million cm^3 per day. Of this latter volume, 84% is used by the agriculture sector for irrigating the country's

1.5 million hectares (ha) of cropland. Domestic consumption accounts for 4.6 million cm^3 per day, while the remaining 8% is used for commercial and industrial purposes.

The Philippines' primary sources of surface freshwater are rivers, lakes, and marshes (Magdaraog 1998). It has more than 70 lakes. Laguna Lake located southeast of Manila is Southeast Asia's second largest.

The Philippines is home to 421 principal river basins, which together account for 66% of the country's total land area. River basins with a total area of 990 km^2 or more are categorized as major river basins. More than 400 watersheds feed these major river basins.

The total area of the country's watersheds is approximately 21 million ha equivalent to 70% of its total land area. Some are exposed to human activity that produces pollution. Activity of this type includes logging, upland farming, and agricultural runoff. As a result of pollution, 17 of the country's major watersheds are in critical condition.

Groundwater drawn from aquifers comprises 14% of the Philippines' total water resource potential (Philippine Environment Monitor 2003). The estimated annual sustainable yield of these aquifers is 31,554 million cm^3 (Magdaraog 1998). The total area covered by shallow wells is 57,787 ha, while deep wells cover 123,064 km^2 (PSDN n. d.). Groundwater is the source of drinking water for about 50% of the population. The agriculture sector places the greatest demand on the country's groundwater resources.

Oceanography

Oceanic circulation around the Philippine archipelago is a product of complex dynamics relating to bathymetry, seasonally reversing monsoons, and tidal and nontidal circulation between the West Philippine Sea (also known as South China Sea) and the Western Pacific (Wang et al. 2008; Han et al. 2009; Gordon et al. 2011, as cited in Villanoy et al. 2011).

The direct connection of the Philippine seas to the Western Pacific is through the San Bernardino Strait and the Surigao Strait. The North Equatorial Current bifurcation near 14ºN (Nitani 1972; Toole et al. 1990; Qiu and Lukas 1996, 2003) forms the western boundary of the equatorward-flowing Mindanao Current and the nascent poleward-flowing Kuroshio. Pacific water seeps into the Sibuyan and Bohol seas by way of the shallow San Bernardino and Surigao straits, respectively; and in greater volume through the 2,200 meter-deep Luzon Strait into the West Philippine Sea (or South China Sea) (Metzger and Hurlburt 1996, 2001; Centurioni et al. 2004; Qu et al. 2006). On the western side of the archipelago, water flows from the West Philippine Sea (or South China Sea) through the Mindoro and Panay straits. The Mindoro–Panay throughflow extends into the Sulu Sea and the adjacent Bohol and Sibuyan seas via the Verde Island Passage and the Tablas and Dipolog straits. The West Philippine Sea (or South China Sea) also connects to the southern Sulu Sea via the Balabac Strait. The Sibutu Passage links the southern Sulu Sea to the Sulawesi Sea (also known as the Celebes Sea).

Once within the confines of the Philippines archipelago, circulation and stratification are subjected to monsoonal winds that are influenced by (i) island land forms (Pullen et al. 2008, 2011; May et al. 2011), (ii) sea–air heat and freshwater fluxes including river outflow, and

(iii) regions with strong tidal currents. Overflow across sills shallower than 500 meters ventilates the depths of isolated basins, the Sulu Sea, and the smaller Bohol and Sibuyan seas.

Monsoonal winds (northeast and southwest) forced through the Philippines' complex topography can give rise to lee eddies and wind-stress curl zones, particularly during monsoon surges (Pullen et al. 2008, 2011). Winds blowing through gaps between islands can induce upwelling (e.g., off the northern coast of the Zamboanga Peninsula) and downwelling along the leeward sides of islands (Chavanne et al. 2002).

Biodiversity of Coastal and Marine Ecosystems

Coral Reefs

The Philippines lies within the Indo–Malayan Triangle, a global center of marine biodiversity (Burke et al. 2002). Its total oceanic area is approximately 2 million km^2, while its continental shelf area is 184,600 km^2. The country's coastline includes 246,063 ha of swamplands and 253,854 ha of fishponds.

Estimates of the Philippines' total coral reef area ranges from 10,750 km^2 (Table 1) to 33,500 km^2, depending on the maximum depth at which corals are assumed to be found (Swedish Space Corporation; Carpenter 1977; Gomez et al. 1994; Bryant et al. 1998; Burke et al. 2002, 2011). The total coral reef area used in this report is 26,000 km^2, which is that estimated by Burke et al. (2002). The country's coral reefs are home to 500 species of scleractinian (i.e., "stony") corals. Of these, 12 species endemic to the Philippines have been identified (Veron 1995). Appendix 1 lists the number of species per family of corals identified at several sites in the Philippines.[2]

Based on the biophysical attributes of the Philippines' coral reef communities, six biogeographic regions have been identified. These include the (i) West Philippine Sea (or South China Sea), (ii) Sulu Sea, (iii) Celebes Sea, (iv) Visayas region, (v) Northeastern Philippine Sea, and (vi) Southeastern Philippine Sea (Nañola et al. 2002).

The Philippines has declared two priority seascapes under the Coral Triangle Initiative (CTI). The first of these is the Sulu–Sulawesi Marine Ecoregion (SSME). The Philippines has a formal cooperation agreement on the SSME with Indonesia and Malaysia. The second priority seascape is the West Philippine Sea (or South China Sea). The SSME encompasses the Sulu Sea, Celebes Sea, Visayan Sea, and a small part of the West Philippine Sea (or South China Sea) biogeographic region. The West Philippine Sea (or South China Sea) covers only the West Philippine Sea (or South China Sea) biogeographic region.

These six biogeographic regions are divided into 17 sections, based on the extent of their coral reef cover. The SSME seascape includes 11 of these sections, while the West Philippine Sea (or South China Sea) seascape includes 7.

[2] As per the collection in the Coral Laboratory of the Marine Science Institute, University of the Philippines (UPMSI).

Coral reefs account for 41.5% of the total area of the Palawan group of islands, which includes the Kalayaan Islands group. The corresponding percentage share for the Visayas region is 29.1%, that for Mindanao is 18.1%, and for Luzon and Mindoro, 11.3% (Table 1).

The Philippines is home to 3,053 species of fish (Herre 1953, Allen et al. 2003, Allen and Erdmann 2009, FishBase 2009), of which 2,724 are marine-based. There are 177 pelagic fish species and 2,351 demersal species. Of these demersal species, 1,658 are associated with coral reefs, and 693 are associated with other nearshore habitats. The Philippines has 277 deep-sea fish species and 173 freshwater species.

Nañola et al. (2011) identified 721 species of reef-associated fishes in 205 genera belonging to 52 families, and 4 species of cartilaginous fishes in 3 genera belonging to 2 families (Table 2).

Table 1 **Estimated Coral Reef Cover in the Philippines' Six Biogeographic Regions**

Region	Area (square kilometers)	% of Total Area
West Philippine Sea (or South China Sea)		
West Philippine Sea (or South China Sea)	306.5	2.85
Kalayaan Islands	3,257.7	30.30
Western Palawan (northwest Palawan Shelf)	147.9	1.38
Sulu Sea		
Sulu Sea	468.8	4.36
Calamianes/Balabac transition	222.7	2.07
	108.2	1.01
Visayas transition	143.4	1.33
Sulu archipelago transition	114.6	1.07
Celebes Sea		
Mindanao	811.3	7.55
Visayas Region		
South Luzon facing Visayas Region	229.3	2.13
Western Visayas	298.7	2.78
Central Visayas	1,750.8	16.29
Eastern Visayas	1,075.1	10.00
Northern Mindanao (including Southern Bohol)	317.3	2.95
Northeastern Philippine Sea		
Eastern Luzon	20.4	0.19
	655.5	6.10
Southeastern Philippine Sea		
Eastern Mindanao	821.6	7.64
Total	**10,749.8**	**100.00**

Source: Ong et al. (2002), Nañola et al. (2011).

The most speciose families were *Pomacentridae* (125 species), *Labridae* (105), *Serranidae* (48), *Chaetodontidae* (41), *Acanthuridae* (36), *Scaridae* (36), and *Apogonidae* (30). These families comprised 58% of the total number of species observed.

Other important families observed with considerable numbers of species include *Lutjanidae* (21), *Blenniidae* (21), *Pomacanthidae* (18), *Holocentridae* (18), *Balistidae* (17), *Nemipteridae* (17), *Carangidae* (15), and *Gobiidae* (15) (Table 2). Allen et al. (2011) identified at least 800 reef fish species in Calamianes Islands, Palawan, alone.

As a result of the limited number of sampling sites, the statistics presented do not necessarily represent the actual total number of species found in the Philippines. Thus, these statistics should be interpreted as the lower bound of the total number of fish species in the Philippines. Table 2 reports the total number of reef fish species observed in the Philippines' six biogeographic regions by family. Table 2 is based on Nañola et al. (2011), which excludes 16 families in which only one species was observed.

Table 2 Species of Reef Fish in the Philippines' Six Biogeographic Regions, by Family

Number	Family	Celebes Sea	Northeastern Phillipine Sea	West Philippine Sea (or South China Sea)	Southeastern Philippine Sea	Sulu Sea	Visayan Region	All Regions
Class Osteichthys								
1.	*Acanthuridae*	26	28	27	21	24	18	36
2.	*Apogonidae*	14	16	15	11	13	21	30
3.	*Balistidae*	13	7	10	5	11	6	17
4.	*Blenniidae*	8	9	15	7	9	7	21
5.	*Caesionidae*	7	11	10	5	11	7	12
6.	*Carangidae*	5	5	6	1	11	3	15
7.	*Chaetodontidae*	32	35	30	34	34	27	41
8.	*Cirrhitidae*	3	3	4	3	4	3	5
9.	*Diodontidae*	2	1	1	0	1	1	3
10.	*Ephippidae*	2	1	1	0	3	2	3
11.	*Gobiidae*	2	6	9	1	3	6	15
12.	*Haemulidae*	5	5	7	6	8	6	9
13.	*Holocentridae*	8	10	8	9	13	2	18
14.	*Labridae*	75	70	82	57	84	69	105
15.	*Lethrinidae*	3	3	6	3	5	2	7
16.	*Lutjanidae*	14	11	12	9	14	7	21
17.	*Microdesmidae*	2	3	4	2	3	3	6
18.	*Monacanthidae*	11	8	9	6	5	8	13
19.	*Mullidae*	9	9	8	7	11	7	12
20.	*Muraenidae*	2	0	1	1	2	0	4
21.	*Nemipteridae*	11	8	14	5	13	12	17

continued on next page

Table 2 *continued*

Number	Family	Celebes Sea	Northeastern Phillipine Sea	West Philippine Sea (or South China Sea)	Southeastern Philippine Sea	Sulu Sea	Visayan Region	All Regions
22.	*Ostraciidae*	4	3	4	3	3	4	4
23.	*Pempheridae*	1	1	1	1	1	2	2
24.	*Pinguipedidae*	5	4	5	2	6	3	6
25.	*Pomacanthidae*	11	15	14	11	13	10	18
26.	*Pomacentridae*	83	85	79	64	87	72	125
27.	*Priacanthidae*	0	1	1	0	2	1	3
28.	*Pseudochromidae*	2	3	4	3	2	2	5
29.	*Scaridae*	23	27	29	19	28	23	36
30.	*Scombridae*	1	1	2	0	0	0	3
31.	*Scorpaenidae*	3	3	3	1	3	3	7
32.	*Serranidae*	26	16	31	12	33	19	48
33.	*Siganidae*	9	10	8	9	10	8	11
34.	*Sphyraenidae*	2	1	2	0	3	2	3
35.	*Syngnathidae*	1	2	2	1	0	2	3
36.	*Synodontidae*	3	4	4	2	3	3	5
37.	*Tetraodontidae*	9	9	10	5	6	8	13
	Other families	8	7	6	5	9	7	16
Class Chondrichthys								
1.	*Dasyatidae*	0	0	0	0	3	0	3
	Total Species	445	441	484	331	494	386	721

Source: Nañola et al. (2011).

Biannual surveys of the Philippines' coral reefs have been performed since 2002. These surveys show declines in the species diversity of reef fish at some sites (Reefs Through Time, 2003, 2004, 2006, 2008, 2010).

Seagrass

The Philippines is home to 16 species of seagrass (Table 3) (Fortes, n.d.; Burke et al. 2002; PNSC 2004).

Based on data collected at 96 sites, Fortes and Santos (2004) reported the total estimated area of the Philippines' seagrass beds as 978 km^2. A combination of satellite images and ground-truthing surveys were used to identify 36% (or 343 km^2) of this total area, while satellite imagery alone was used to identify the remainder (Appendix 2).

The Seaweed Laboratory of the Marine Science Institute in the University of the Philippines (UPMSI) is assessing the state of the country's seagrass beds. In the Philippines, seagrasses have alternatively been used as packing material, children's toys, compost for fertilizers, and animal feeds. However, the importance of seagrass beds to the livelihood of coastal populations lies in

Table 3 **Seagrass Species in the Philippines, by Family**

Family	Species
Cymodoceaceae	*Cymodocea rotundata*
	Cymodocea serrulata
	Halodule pinifolia
	Halodule uninervis
	Syringodium isoetifolium
	Thalassodendron ciliatum
Ruppiceae	*Ruppia maritima*
Hydrochariticeace	*Halophila becarii*
	Halophila decipiens
	Halophila minor
	Halophila minor var nov.
	Halophila ovalis
	Halophila spinulosa
	Halophila sp.
	Enhalus acoroides
	Thalassia hemprichii

Source: Fortes (n. d.).

their ecological functions and support to fisheries, and, to a certain extent, tourism. Seagrass beds are habitats for juvenile and small adult fishes (e.g., rabbitfish), invertebrates, reptiles (turtles), and mammals (dugong). They also buffer the shoreline from the damaging effects of large waves and storm surges. By keeping the amount of sediment present in the water relatively constant, they protect adjacent mangroves and coral reefs. Further, seagrass beds produce a significant amount of organic matter that is a source of nutrients for the ecosystems adjacent to them.

Mangroves

The Philippines is home to 42 mangrove species representing 18 families, making it one of the most species-rich mangrove areas in Southeast Asia (Table 4) (Polidoro et al. 2010, Spalding et al. 2010, Samson and Rollon 2011).

The country's mangrove forests provide a habitat for at least 54 species of crustaceans; 63 species of mollusks; and 110 species of fish, some of which are commercially important (De la Paz and Aragones 1985, PNMC 1987). In addition, mangroves are used for aquaculture, salt production, and construction materials (e.g., timber); as a source of fishery products (e.g., fishes, crabs, shrimps, and mollusks); and even as a venue for human settlement (Jacinto et al. 2000). The Philippines' mangroves produce an estimated 1–2 grams of carbon per square meter per day (Jacinto et al. 2000).

The above benefits of mangroves notwithstanding, their intensive use has caused a significant decline in their total area. In the early 1900s, the Philippines' mangrove forests totaled 400,000–500,000 ha (Brown and Fischer 1998). However, an estimated 337,000 ha of mangroves have

Table 4 Mangrove Species in the Philippines, by Family

Family	Species
Acanthaceae	*Acanthus ebracteatus*
	Acanthus ilicifolius
Arecaceae	*Nypa fruticans*
Avicenniaceae	*Avicennia alba*
	Avicennia marina
	Avicennia officinalis
	Avicennia rumphiana
Bignoniaceae	*Dolichandrone spathacea*
Bombacaceae	*Compostemon philippinense*
	Campostemon schultzii
Caesalpiniaceae	*Cynometra iripa*
Combretaceae	*Lumnitzera littorea*
	Lumnitzera racemosa
Euphorbiaceae	*Excoecaria agallocha*
Lythraceae	*Pemphis acidula*
Meliaceae	*Xylocarpus granatum*
	Xylocarpus moluccensis
Myrsinaceae	*Aegiceras corniculatum*
	Aegiceras floridum
Myrtaceae	*Osbornia octodonta*
Plumbaginaceae	*Aegialitis annulata*
Pteridaceae	*Acrostichum aureum*
	Acrostichum speciosum
Rhizophoraceae	*Bruguiera cylindrical*
	Bruguiera exaristata
	Bruguiera gymnorhiza
	Bruguiera hainessi
	Bruguiera parviflora
	Bruguiera sexangula
	Ceriops decandra
	Ceriops tagal
	Kandelia obovata
	Rhizophora apiculata
	Rhizophora mucronata
	Rhizophora stylosa
	Rhizophora x lamarckii
Rubiaceae	*Scyphiphora hydrophylaceae*
Sonneratiaceae	*Sonneratia alba*
	Sonneratia caseolaris
	Sonneratia ovate
	Sonneratia x gulngai
Sterculiaceae	*Heritiera littoralis*

Source: Spalding et al. (2010), Polidoro et al. (2010), Samson and Rollon (2011).

been lost, which equates to approximately 75% of the country's original mangrove forest cover. Of this area, 278,657 ha (66%) was lost over the period 1950–1990 (Samson and Rollon 2008).

During the mid-1980s, the highest rate of mangrove exploitation was recorded in the Visayas at 72%, followed by Luzon at 64%. Utilization rates were significantly lower in Palawan (21%) and Mindanao (10%). Thus, by 2005, the country's natural mangrove cover had declined to 247,268 ha, while planted mangroves covered more than 44,000 ha (Primavera, Rollon, and Samson 2011).

As for the country's remaining mangrove forest cover, satellite imagery shows that 29% is found in Mindanao. Old growth mangrove forests are only found in Mindanao (4,582 ha) and Palawan (5,317 ha) (Zamora 1990), while the remaining stands comprise secondary growth. Table 5 lists the Philippines' most extensive and diverse mangrove sites.

Table 5 **Estimated Total Area and Number of Species Present at Significant Mangrove Sites in the Philippines**

Site	Present Area (square kilometers)	Number of Species
Pagbilao, Quezon	19.39	32
Busuanga, Palawan	12.98	24
Coron, Palawan	12.96	26
Ulugan, Palawan	7.90	16
San Jose	4.83	25
Subic, Zambales	1.48	23
San Vicente, Palawan	1.33	14

Source: UNEP (2004).

Other Coastal Wetlands

As defined by the Ramsar Convention, wetlands encompass both inland (e.g., lakes, marshes, rivers, swamps, and other inland bodies of water) and coastal wetlands (coastal lagoons, coral reefs, estuaries, mangroves, seagrass beds, tidal flats, and other coastal bodies of water).[3] The Philippines has extensive areas of both types of wetlands, four examples of which are now designated as Wetlands of International Importance (or "Ramsar sites"). These include Agusan Marsh Wildlife Sanctuary, Naujan Lake National Park, Olango Island Wildlife Sanctuary, and Tubbataha Reefs Natural Park. Scott (1993) reported an overall loss of wetlands of 78% for the Philippines, which is one of the highest in Southeast Asia. The proposed National Wetland Action Plan of the Philippines, 2011–2016, identifies priority wetlands based on agreed criteria. The purpose of designating these sites as priority wetlands is to ensure their optimal use as resources, and to achieve the maximum positive environmental impact possible from the initiatives included in the action plan. Appendix 3 lists the Philippines' coastal and marine wetlands designated as priority wetlands.

[3] Concluded in Ramsar, Iran, in 1971, the Convention on Wetlands is often referred to as the "Ramsar Convention." Signatories to this convention commit to sustainable use of wetlands of international importance that are located within their respective jurisdictions. Though not affiliated with the United Nations System of multilateral environmental agreements, the Ramsar Convention works closely with the administrations of other multilateral environmental agreements.

Threatened and Endangered Species

A necessary first step in planning for, managing, and monitoring investments in species conservation and protection is the compilation of a formal list of species that are either threatened or at risk of extinction. In the Philippines, such investments are guided by the Red List published by the International Union for Conservation of Nature (IUCN), which identifies a number of marine species as being threatened, endangered, or already extinct (IUCN Red List 2004). Threats to these species must be prioritized if conservation investment is to be guided appropriately.

Appendix 4 shows the species in the Philippines that are categorized as endangered or threatened by the edition of the IUCN Red List published in 2011, and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). These species include cetaceans, dugongs, manta rays, and whale sharks, which are mainly killed for their high-quality but inexpensive meat (Alava and Cantos 2004).[4] While they ecologically form the very top-most portion of the reef food chain, sharks have been decimated; and, thus, are now rarely observed in the Philippines' coral reef ecosystems (Aliño et al. 2004).

Five species of marine turtles are found in the Philippines: green, hawksbill, leatherback, loggerhead, and olive ridley turtles. However, only green, hawksbill, and olive ridley turtles nest in the Philippines, though leatherback and loggerhead turtles forage in Philippine waters. While green and hawksbill turtles nest throughout the Philippines year-round, olive ridley turtles mainly nest from August to September, particularly in Bataan, Batangas, and Zambales provinces. Marine turtles are hunted or killed for their eggs, bones, fat, leather, oil, and skin, these being either consumed as food or used as bait in catching other species. Some of the body parts of marine turtles are also believed to have medicinal properties. Issues relating to threatened and endangered species in the Philippines are discussed in detail in Chapter 5.

[4] The dugong is a large herbivorous mammal that inhabits Philippine waters and feeds mainly on seagrass.

Governance

A number of issues that relate to both the Coral Triangle Initiative (CTI) and the Philippines national plan of action (NPOA) are addressed by either government policy or national legislation. These issues include

(i) food security;
(ii) the livelihood strategy and socioeconomic status of the country's population;
(iii) the protection, conservation, and sustainable management of the country's natural resource base; and
(iv) issues relating to law enforcement, safety, security, and the protection of territorial claims.

Several laws and policies have either created or upgraded agencies or other institutional mechanisms for governing the use of coastal and marine resources. Similarly, sector-specific laws and policies have been developed, revised, or implemented. These in particular include laws and policies that address the use of air and water, conservation of biodiversity, management of the country's fisheries, mining, pollution control, and solid waste management.

Policies that address management of the natural resource base focus heavily on management of fisheries and coastal resources in general, as these resources are a vital source of both food and income to the population at large. In general, policies that address the protection, preservation, and sustainable use of marine resources tend to be both multisector and participatory in orientation.

Their existence and legal status notwithstanding, implementation of laws and policies is often constrained by conflicts between policies, lack of interagency coordination, and lack of either the institutional capacity or the financial resources necessary for their full implementation. Similarly, the implementation of existing laws and policies is often constrained by gaps in the provision of particular policies. Such gaps in particular include

(i) lack of provisions that clarify the territorial limits of municipal waters,
(ii) jurisdictional conflicts and overlaps between national and local authorities, and
(iii) lack of clarification of access to the marine resource by commercial fishing interests.

Overall Governance

The 1987 Constitution of the Philippines contains numerous legal instruments that address management of the country's coastal and marine resources. Article I recognizes the archipelagic character of the country, and describes the territorial jurisdiction of the Philippines as comprising

> … the Philippine archipelago, with all the islands and waters embraced therein and all other territories over which the Philippines has sovereignty or jurisdiction, consisting of its terrestrial, fluvial and aerial domains, including its territorial seas, the seabed, the subsoil, the insular shelves and other submarine areas. The waters around, between and connecting the islands of the archipelago, regardless of their breadth and dimensions, form part of the internal waters of the Philippines.

The Constitution also declares as state policy the protection and advancement of the right to the health of the people and their right to a balanced and healthful ecology in accordance with the rhythm and harmony of nature (Article II, Sections 15–16). In terms of governance, the Constitution recognizes the right of the people and their organizations "to effective and reasonable participation at all levels of social, political, and economic decision-making" (Article XIII).

National and Local Governance

The National Integrated Protected Areas System Act of 1992 (Republic Act No. 7586) sets out a national framework for establishing national parks and protected areas. Under this law, 10 sites have been declared as high-priority protected areas. These include Apo Reef Marine Natural Park, Batanes Protected Landscapes and Seascapes, Siargao Island Protected Landscapes and Seascapes, and Turtle Island Wildlife Sanctuary.

The Philippine Constitution guarantees the autonomy of local governments as it makes specific reference to decentralization of governmental authority (Article II, Section 25; Article X, Sections 2 and 3). Similarly, the Local Government Code of 1991 (Republic Act No. 7160) provides for the decentralization and devolution to LGUs of the delivery of services and other functions related to local development. The functions devolved to LGUs include promotion of health and safety, and enhancement of the right of the people to a balanced ecology (Section 16, Republic Act No. 7160).

Toward Integrated Management

In 1994, the Philippines adopted the National Marine Policy (NMP) that provides an integrated policy planning and management framework for addressing the country's entire marine, coastal, and ocean-related interests (ArcDev 2004). Although the 1994 NMP was far more comprehensive in scope than previous marine-related policies, some gaps in its agenda still remain. For example, it is silent on the treatment of major economic sectors, such as shipping and tourism. Further, it proposes a sector rather than an integrated management framework. As a result, governance of the marine sector for the most part remains fragmented and uncoordinated.

The government formulated a draft document entitled ArcDev: A Framework for Sustainable Philippine Archipelagic Development. Revaluing Our Maritime Heritage and Affirming the Unity of Land and Sea (DENR 2004). This framework aimed to

(i) facilitate ways of improving the implementation of mechanisms for harmonizing the various uses of resources and access arrangements,

(ii) provide an enabling environment in which the synergistic benefits of an integrated archipelagic policy can be harnessed, and
(iii) enhance appreciation and awareness of the significance of a holistic approach to address the various needs of the archipelago.

ArcDev focused on coastal and marine areas in an attempt to rebalance the disproportionate terrestrial focus of the existing planning and management framework.

Large-Scale Biodiversity Conservation

Proclamation No. 1028 of 28 June 1997 declared the entire Sulu Sea and Celebes Sea as an integrated conservation and development zone. The Presidential Commission for the Integrated Conservation and Development of the Sulu–Celebes Seas was created to formulate, review, and implement programs that would ensure conservation of the marine biodiversity contained in these seascapes. It likewise promotes sustainable development in coastal communities within these areas through income-generating economic activity.

Issued by the President in 2006, Executive Order No. 578 established the national policy on biological diversity, and prescribed its implementation throughout the country, particularly in the Sulu–Sulawesi Marine Ecoregion (SSME) and the Verde Island Passage Marine Corridor. This policy also provided for the (i) review and updating of the Ecological Conservation Plan, (ii) creation of the Task Force on the Verde Island Passage to ensure sustainable use of the resources it contains, and (iii) identification of other marine biodiversity corridors within the SSME that urgently require appropriate conservation and management strategies.

Locally Managed Marine Protected Areas

The Local Government Code of 1991 empowers LGUs to establish marine protected areas (MPAs) within their respective jurisdictions through municipal ordinances. The Philippine Fisheries Code of 1998 (Republic Act No. 8550) also designates at least 15% of municipal waters as fish refuges or sanctuaries, and 25%–40% of fishing grounds as mangrove reserves.

In the Philippines, MPAs began as a community-based effort, but have since advanced to a strategy adopted by local governments that is memorialized in legal instruments. For example, alliances between municipalities and towns that manage their respective MPAs through an MPA network are for the most part governed by the terms of memorandums of agreement concluded by the mayors and governors concerned.

Overall, the Philippines has achieved significant progress with regard to its MPAs. Of the country's 1,208 MPAs (MSN Report 2009), 117 (10%) were assessed in 2011. This assessment reported that 44% of those assessed were effectively managed (CTSP Report 2011). These results suggest that MPAs may be an effective way of meeting the objective of protecting at least 20% of municipal waters by 2020, which is an explicit goal of the Philippines NPOA under the CTI.

That said, Bleakley and Wells (1995) reported that the level of MPA management expertise in the Philippines is generally "low." Aliño et al. (2004) mainly attributed this outcome to

(i) lack of public understanding and support of MPA objectives,
(ii) lack of a transparent hierarchy relating those objectives,
(iii) weak enforcement arrangements,
(iv) lack of sustainable financing,
(v) unclear jurisdictional boundaries,
(vi) poorly specified roles and accountability arrangements relating to implementation, and
(vii) unrealistic expectations regarding the rate of biomass buildup.

Sector Laws and Policies

Environment and Natural Resources

The broad policy framework for managing the country's coastal and marine environment can be understood from several documents taken together. These include the

(i) Philippine National Marine Policy;
(ii) Philippine Development Plan;
(iii) Philippine Strategy for Sustainable Development;
(iv) Philippine Action Plan for Agenda 21;
(v) 1997 Philippine Environment Code; and
(vi) various administrative orders, proclamations, letters of instruction, and related documents issued by the Department of Environment and Natural Resources (DENR).

The major goals of the NMP as these relate to coastal management and education are the following:

(i) Explore, develop, and manage offshore and/or oceanic resources on the basis of sustainable development principles.
(ii) Develop and manage coastal resources within an integrated coastal zone management framework.
(iii) Develop and expand national marine consciousness through a comprehensive information program.
(iv) Encourage development of a marine research program.
(v) Use the "polluters pay" principle to protect the marine environment.
(vi) Ensure high quality maritime professional schools and other related institutions for training experts in maritime-related issues.

The 1992 Declaration of the United Nations Conference on Environment and Development (UNCED) caused the protection, preservation, and conservation of the environment to assume significant importance in national development plans. Subsequently, Agenda 21, Chapter 17 was formulated, which calls for protection of the oceans, all types of seas, and coastal areas; and for the protection, rational use, and development of living resources. The Philippines responded to Agenda 21 by formulating Philippine Agenda 21 that called for a national marine policy; enactment of a fisheries code; and preparation of coastal zone management plans at the national, regional, and local levels.

The major goal of Philippine Agenda 21 is "harmonious integration of a sound and viable economy, responsible governance, social cohesion and harmony, and ecological integrity to ensure that development is human development now and through future generations." This implies a mandate for ensuring sustainable rural development that benefits all stakeholders.

As early as the 1970s, the Philippines recognized pollution as a serious problem. This is reflected in the enactment of several presidential decrees such as Nos. 600, 979, and 984 that provide a mandate for the control of marine pollution. Pollution has been addressed by Philippine Agenda 21, the Philippine Clean Air Act of 1999, and various provisions of the Philippine Environment Code.

The Code on Sanitation of the Philippines (Presidential Decree No. 856) addresses health problems caused by environmental factors, particularly those relating to the supply and quality of water. The Ecological Solid Waste Management Act of 2000 (Republic Act No. 9003) not only prohibits land-based environmental degradation but also addresses illegal dumping of wastes that cause water pollution. Other similar legislation includes Proclamation No. 2146, Proclaiming Certain Areas and Types of Projects as Environmentally Critical and Within the Scope of the Environmental Impact Statement System Established under Presidential Decree No. 1586.

Legislations that address coastal resource management include the following:

(i) Local Government Code of 1991 (Republic Act No. 7160), which mandates development of medium-term community resource management plans;
(ii) Fisheries Code of 1998 (Republic Act No. 8550), which addresses coastal management as it relates to fisheries and other marine resources;
(iii) NIPAS Act of 1992 (Republic Act No. 7586), which enforces national and local environmental protection ordinances; and
(iv) Agriculture and Fisheries Modernization Act of 1997 (Republic Act No. 8435), which establishes co-management systems; intergovernmental relations; links between people's organizations, nongovernment organizations (NGOs), and cooperatives; and provides for technical and extension services.

With regard to mangroves, issuance of fishpond permits and/or leases on public forestland is regulated by Fisheries Administrative Order No. 60, which prohibits wide-scale conversion of mangroves into fishponds. Similarly, DENR Administrative Order No. 30 (1994) sets out the implementation guidelines for DENR-sponsored community-based mangrove forest management projects that are assisted by NGOs. Likewise, Joint Memorandum Circular No. 98-01, which was jointly issued by the DENR and the Department of the Interior and Local Government, declared the Pagbilao Mangrove Swamp Forest to be a genetic resources area and a national mangrove training site. The Wildlife Resources Conservation and Protection Act (Republic Act No. 9147) provides for species-specific protection measures at both the national and local government levels.

The Writ of *Kalikasan* derives from a provision of the Philippine Constitution (Article II, Section 16 on the Declaration of Principles and State Policies) that specifically addresses resource conservation. This writ protects the rights of persons whose constitutional right to a balanced and healthful ecology has been violated or threatened with violation through environmental damage of such a magnitude that it prejudices the life, health, or property of inhabitants in two or more cities or provinces.

The National Climate Change Action Plan (NCCAP) was adopted in November 2011. The objective of this plan is to create a country-driven program of action for adapting to climate change and mitigating its negative impacts. The plan's time horizon is 18 years following the date of adoption. The NCCAP includes seven priorities:

(i) food security,
(ii) water sufficiency,
(iii) environmental and ecological stability,
(iv) human security,
(v) sustainable energy,
(vi) climate-smart industries, and
(vii) knowledge and capacity development.

Specific objectives include

(i) making fisheries production and distribution systems, as well as fishing communities, more resilient to climate change than they were at the plan's adoption;
(ii) formulating, implementing, and sustaining climate change mitigation and adaptation strategies for key ecosystems;
(iii) expanding conservation and sustainable management of key biodiversity areas;
(iv) ensuring enforcement of environmental laws; and
(v) promoting and sustaining the ecosystem-based approach to management of protected areas and key biodiversity areas.

The Indigenous Peoples Rights Act of 1997 (Republic Act No. 8371) requires that development programs, projects, and activities be formulated in a manner that recognizes and protects ancestral domain and land rights, self-governance by and empowerment of indigenous peoples, as well as their cultural integrity and human rights, and social justice as it relates to these peoples.

On 6 June 2006, Executive Order No. 533 adopted integrated coastal management (ICM) as a national strategy for developing the country's coastal and marine environment and resources. This order promotes food security, sustainable livelihoods, poverty alleviation, and reduction of vulnerability to natural hazards, while preserving ecological integrity. In addition, it specifies a framework and operational approach to improving coastal management through ICM programs at both the national and local levels. Several national government agencies, LGUs, and civil society organizations are to participate in the implementation of these programs. Further, initiatives are to be undertaken that support ICM to include

(i) ICM education;
(ii) ICM training for LGUs;
(iii) environmental and natural resource accounting and valuation for ICM planning; and
(iv) implementation of a coastal and marine environment information management system.

Together with other national policies and laws, Executive Order No. 533 supports the achievement of the goals of the CTI, particularly as these are outlined in the CTI Regional Plan of Action and NPOA. Executive Order No. 797 of 6 May 2009 formally adopted the Philippines NPOA, which specifies that DENR and the Department of Agriculture are to coordinate NPOA implementation, and are to jointly act as the national coordinating body for NPOA implementation. Under the NPOA, all LGUs—particularly those located in coastal areas—are to prepare and implement local development plans and associated budgets.

Fisheries

The Philippine Constitution of 1987 acknowledges fish as the country's most vital marine living resource. Further, it specifies that the state is to protect the rights of subsistence fishers and local communities, and is to ensure their preferential use of communal marine and fishing resources, regardless of whether these are located inland or offshore.

Philippine Fisheries Code of 1998. Republic Act No. 8550, also known as the Fisheries Code of 1998, specifically addresses micro- and operational-level issues as these relate to fishing and related activities. In particular, this code (i) limits access to fisheries resources through the use of scientifically determined procedures, (ii) integrates management systems through cooperation of governments at the local level, and (iii) institutionalizes participation by community residents. It also clarifies the extent of LGU jurisdiction in municipal waters, and the degree to which commercial fishing operations have access to such areas (Republic Act No. 8550, Sections 2, 4, 16, 23, and 91).

Sections 4 and 91 of Republic Act No. 8550 prohibit any person or corporation from gathering, possessing, selling, or exporting ordinary, precious, or semiprecious corals, whether in raw or processed form, except for scientific or research purposes.

Comprehensive National Fisheries Industry Development Plan. The plan was adopted through Department of Agriculture fishery administrative order, whose objective is to create a framework to promote optimal development and long-term sustainability of the Philippines' fisheries. The law identifies the priorities of the fisheries sector over the period 2006–2025. Further, the plan addresses two development aspects of the Philippines' fisheries over this period. The first of these is the development aspect (e.g., physical infrastructure, expansion of fishing activity, and assistance to marketing), while the second aspect relates to conservation (e.g., rehabilitation of fisheries and restoration of habitats). The plan also specifies that "six critical actions" be undertaken for improving the management and output of the country's capture fisheries. These actions, which support both the development and conservation aspects of fisheries development, include

(i) reduction and rationalization of fishing effort,
(ii) protection and rehabilitation of fisheries habitats,
(iii) improved utilization of harvests,
(iv) improved local stewardship and management of resources,
(v) provision of supplemental and/or alternative livelihoods for fishers, and
(vi) capacity building and institutional strengthening.

Philippine Development Plan. Formerly known as Medium-Term Philippine Development Plan, the Philippine Development Plan 2011–2016 guides the formulation of policy and implementation of development programs over its 6-year time horizon. The plan notably includes a strategy for increasing fisheries output, which is to be implemented through the Agriculture and Fisheries Modernization Act of 1997. The plan's vision is a competitive, sustainable, and technology-based agriculture and fisheries sector that is driven by productive and progressive farmers and fishers, supported by efficient value chains, and well integrated into domestic and international markets. The plan also includes strategies for adapting to climate change and reducing the risks posed by natural disasters.

Energy and Mining

Executive Order No. 462 enables private sector participation in exploring, developing, utilizing, and commercializing ocean, solar, and wind energy resources for power generation. Other legislations address issues relating to specific energy sources such as oil, gas, petroleum, and geothermal energy—Presidential Decree No. 87; Presidential Proclamation Nos. 72, 1412, and 1413; and Republic Act No. 5092. The Electric Power Industry Reform Act of 2001 (Republic Act No. 9136) ensures social and environmental compatibility of energy sources and infrastructure; and promotes the use of indigenous, new, and renewable energy resources in power generation as a means of reducing dependence on imported energy. The Renewable Energy Act of 2008 (Republic Act No. 9513) accelerates the exploration and development of renewable energy resources, such as ocean energy sources.

Issues relating to the mining of seabed minerals, including the mining of sand, are addressed by the People's Small-Scale Mining Act of 1991 (Republic Act No. 7076), the Philippine Mining Act of 1995 (Republic Act No. 7942), Presidential Proclamation No. 370, and specific DENR administrative orders. The Philippines also complies with the provisions of the (i) International Maritime Organization Code for the Construction and Equipment of Mobile Offshore Drilling Units, (ii) United Nations Environment Programme's 1982 Guidelines Concerning the Environment Related to Offshore Mining and Drilling within the Limits of National Jurisdiction, and (iii) Global Guidelines on Environmental Protection Measures of Offshore Mining and Drilling Operations.

Republic Act No. 8550 criminalizes the gathering, sale, or export of white sand, silica, pebbles, or any other substance that makes up any marine habitat.

Marine Transport

To date, there exists no comprehensive law or policy document that addresses shipping and maritime transport in the Philippines. This is likely due to the fragmented nature of the sector, and conflicts between the interests of owners of vessels of various sizes. However, several initiatives relating to shipping have been undertaken. These either respond to recognition of the need for development of a comprehensive shipping policy, or to make the country compliant with international standards.

In the absence of detailed laws relating to shipping, the Maritime Industry Authority (MARINA) has provided guidelines through administrative circulars. A number of Marcos-era presidential decrees also addressed various aspects of the shipping industry. These include Presidential Decrees (i) 666 and 667-A, which provided incentives for the shipbuilding industry; (ii) 760 and 761, which addressed foreign vessel registration; and (iii) 857 and 1284, which organized the MARINA, the Philippine Ports Authority, and other agencies concerned with marine transport.

Issues that relate to the growing traffic of both Philippine and foreign ships in the waters surrounding the country need to be addressed. These include

(i) hazards arising from normal shipping operations (oil spill, red tide contamination, and toxic materials);
(ii) regulation of foreign military movements in nearby waters;
(iii) interisland shipping;

(iv) shipbuilding;
(v) construction of tunnels, bridges, causeways, and passenger routes; (vi) oil tankers;
(vi) bulk cargo; and
(vii) waste disposal.

For ports, the existing legislation appears to be sufficient to address all current issues. The only exception to this relates to instances in which the community adjacent to a proposed port opposed its construction.

Maritime Safety and Security

The Maritime Industry Decree of 1974 (Presidential Decree No. 474) and the Domestic Shipping Development Act of 2004 (Republic Act No. 9295) make maritime security a concern of the state in instances in which the country's marine assets, maritime practices, territorial integrity, and coastal peace and order are to be protected, conserved, and enhanced (see National Marine Policy of 1994). The term "maritime safety" relates to shipping, navigation, and transport with respect to freedom from natural hazards, unforeseen accidents, and acts of piracy or related crimes. Nevertheless, taking maritime safety and security together requires a combination of preventive, law enforcement, and defense-related activities.

The Philippines; the People's Republic of China; Hong Kong, China; Japan; Singapore; and the United States are all among 15 economies that control nearly three-quarters of shipping globally. As the volume of ocean traffic increases, the Philippines is confronted with many issues. These include

(i) pollution from exchange of ballast water;
(ii) trafficking hazardous cargo;
(iii) air pollution;
(iv) oil spills;
(v) training and qualification of inspectors;
(vi) equipment; and
(vii) rising number of accidents at sea, and related matters such as the reporting of accidents and compliance with international standards.

The Philippine Merchant Marine Officers Act of 1998 (Republic Act No. 8544) declares that it is the policy of the state "to promote and ensure the safety of life and property at sea, to protect and serve the marine environment and ecology, and to prevent marine pollution and accidents at sea." However, the act only addresses the examination, registration, and certification of competency of merchant marine officers, and compliance with the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (see STCW 1978, as amended), to which the Philippines is a signatory.

The Philippines needs to address three major maritime safety issues. First, the various functions of government are poorly delineated. Numerous agencies are tasked with the administration of maritime safety, resulting in overlapping duties and responsibilities and inevitable jurisdictional conflicts. Second, the current maritime safety regulations are outdated and inapplicable. Third, navigational safety is jeopardized by

(i) inadequate navigational aids, such as lighthouses;
(ii) insufficient search and rescue capabilities;

(iii) lack of vessel traffic control system; and
(iv) poor weather forecasting and dissemination of related information.

The Armed Forces of the Philippines Modernization Act of 1995 (Republic Act No. 7898) enables the Philippine Navy and Air Force to develop their respective surveillance, reconnaissance, and electronic capabilities. These are vital to the protection of the country's extensive maritime areas; and for addressing the growing transnational threats posed by piracy, smuggling, poaching, and illegal fishing. However, procurement and acquisition procedures have hampered implementation of Republic Act No. 7898.

The Philippines Coast Guard Law of 2009 (Republic Act No. 9993) established the Philippine Coast Guard, which is mandated to enforce laws, rules, and regulations that protect the marine environment and resources from offshore sources of pollution within the Philippines maritime jurisdiction.

Jurisdictional Issues

The Philippines maritime jurisdiction is defined by the following national legislations:

(i) Article 1, National Territory, Constitution of the Republic of the Philippines, 1987;
(ii) Republic Act No. 9522 of 10 March 2009, An Act to Amend Certain Provisions of Republic Act No. 3046, as Amended by Republic Act No. 5446, to Define the Archipelagic Baseline of the Philippines and for Other Purposes; where the act defines the borders around the country's major archipelago, and declares a "Regime of Islands" under the Republic of the Philippines, which is consistent with Article 121 of the United Nations Convention on the Law of the Sea (UNCLOS); and this jurisdiction includes the Kalayaan Islands Group, which is defined by Presidential Decree No. 1596; and the Bajo de Masinloc, also known as Scarborough Shoal;
(iii) Presidential Decree No. 1596 of 11 June 1978, Declaring Certain Areas as Part of the Philippine Territory and Providing for Their Government and Administration, which identifies the Kalayaan Islands Group;
(iv) Presidential Decree No. 1599 of 11 June 1978, Establishing an Exclusive Economic Zone and Other Purposes; and
(v) Presidential Proclamation No. 370 of 20 March 1968, Declaring as Subject to the Jurisdiction and Control of the Republic of the Philippines All Mineral and Other Natural Resources in the Continental Shelf.

Climate Change Initiatives

The Climate Change Act of 2009 (Republic Act No. 9729) created the Climate Change Commission, which is a policy-making body attached to the Office of the President. This commission coordinates, monitors, and evaluates both short-term and long-term programs and action plans that relate to climate change, as well as disaster reduction and risk management.

Socioeconomic Characteristics

Capture fisheries and aquaculture are vital to virtually all coastal communities. In the Philippines, these communities represent a wide spectrum of society, and even include a substantial number of indigenous groups. This chapter discusses the roles of these types of fisheries in coastal communities within the context of declining food security. Such a context requires that the discussion acknowledges the short-term monetary value that the communities necessarily place on fisheries, as well as the value of services the ecosystems are capable of providing over the long term. Due to their significant social, economic, and ecological impacts on both types of fisheries, other sectors—such as coastal tourism; marine transport; and mineral, oil, and gas exploration—are also included in the discussion that follows.

Demography

The islands that comprise the Philippines are divided into 17 regions. These regions are further divided into smaller administrative units including provinces, cities, municipalities, and *barangays* (villages). The country is composed of 80 provinces; 138 cities; 1,496 municipalities; and 42,026 *barangays*. Of the country's provinces, coastal provinces comprise 78%, and 22% are landlocked. Of the cities, 62% are coastal in nature, while the corresponding figure for municipalities is 56%.

The Framework for Sustainable Philippine Archipelagic Development (ArcDev 2004) defines coastal areas as those falling under the administrative jurisdiction of coastal municipalities or municipal administrative zones. The importance of coastal cities and towns to the national economy is significant, as these areas are home to 60% of the national population.

Population size, density, and growth rate. As of mid-2011, the country's population was 95.7 million (PRB 2011 World Population Data Sheet). In 2003, the country's estimated overall population density was 282 persons per square kilometers (km^2). By 2009, this figure had grown to 307 and, by 2011, to 339. While the national population growth rate averaged 2.0% annually over the period 2000–2007, by 2011 this had fallen to 1.9%. As for the country's growth in overall population, in mid-2025, this is projected to be 120 million and, by mid-2050, 150 million. In 2011, the estimated number of births per 1,000 population was 25, and the number of deaths, 6.

Average household size. In 2007, the average household size was 4.8 persons. However, there is significant variation in average household size, the highest figure of 5.8 persons occurring in the Autonomous Region in Muslim Mindanao (ARMM), and the lowest figure of 4.4 persons in the National Capital Region (NCR).

Gender ratio. The 2007 census indicated that 50.5% of the country's population is composed of males, with females making up the remaining 49.5%. This translates into 102 males for every 100 females, a ratio slightly greater than 101 males for every 100 females reported in 2000.

Age composition of the population. In 2011, an estimated 34.6% of the country's total population was less than 14 years old, while 61.1% were aged 15–64 years, and only 4.3% were 65 years old or above. In that year, the median age for the overall population was 22.9 years, while that of males was 22.4 years and 23 years for females.

Life expectancy at birth. Life expectancy at birth for the national population was estimated at 71.7 years in 2011. In that year, males had an estimated life expectancy of 68.7 years, while that of females was 74.0 years.

Literacy. Estimates place the percentage of the total population aged 15 years or above who are literate was 92.6% in 2011. The estimated literacy rate for males in that year was 92.5% and for females, 92.7%.

Coastal population. At 37,008 km, the Philippines' coastline is one of the longest in the world. Approximately 36 million persons (60% of the country's total population) resided in coastal areas in 1990. This figure had increased to 49 million (60%) in 2004. The overall population density of the coastline was 2,467 persons per square kilometers in 2000.

Poverty. Approximately 45% of the country's population lives on an income of less than $2 per day, as measured at purchasing power parity at 2005 international prices.

Income and poverty levels. The agriculture, fisheries, and forestry sectors together accounted for 13% of gross domestic product (GDP) in 2006–2010. However, the percentage share of these sectors in GDP has been on the decline since the late 1990s (NSCB 2011). In 2009, fisheries accounted for 4.4% in constant prices. Recent data indicate that the output of the fisheries sector shrank by 3.8% in 2011 due to a fall in the output of the commercial and small-scale fishing subsectors. In 2011, the output of the commercial fishing subsector alone fell by 16%.

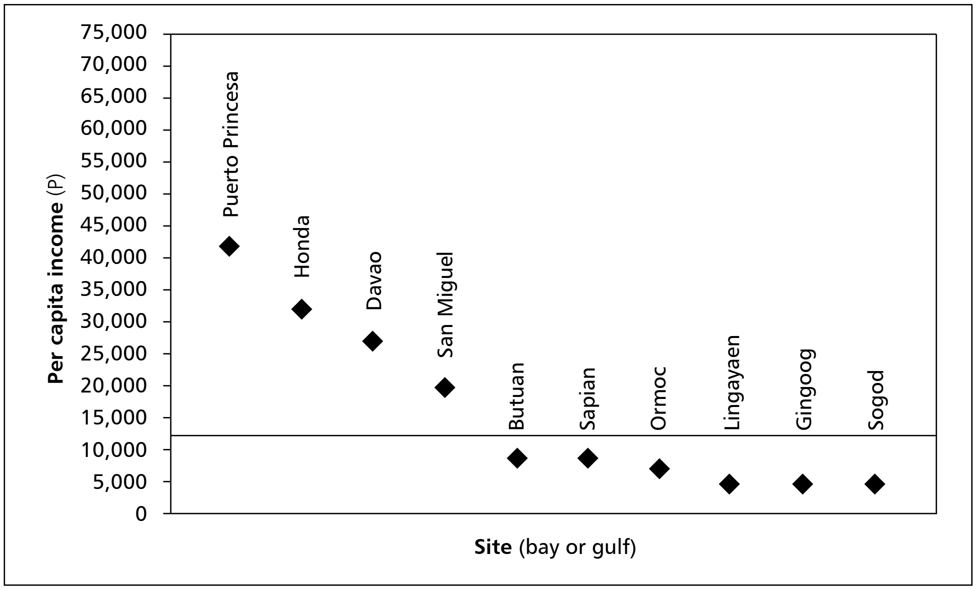
Virola et al. (2009) analyzed the Philippines' maritime sector from a holistic perspective that encompasses all maritime-related economic activity. In addition to fisheries—which is a significant component of the maritime sector as they defined it—the sector also includes maritime-related communication and storage, financial intermediation, forestry, manufacturing, mining and quarrying, and transport. Further, it likewise includes maritime-related private education and public administration, as well as tourism. Their analysis showed that of total gross value added (gross output less intermediate consumption) generated by the maritime sector, fishery and forestry contributed nearly 50%, while tourism-related activity contributed 19%, and transport, 15%. Each of the maritime sector's remaining components accounted for less than 5% of total gross value added generated by the sector.

A study performed by the Sustainable Philippine Fisheries Agenda under the Fisheries Resources Management Project compared the incomes of fishers operating out of 10 bays in various geographic areas of the Philippines (Figure 1). The results of this study provide some indication of the income level of fishers in the Philippines relative to the national poverty threshold. In 2002, the national poverty threshold was annual per capita income of P11,906, which was the estimated income level required to purchase a basket of essential food and nonfood commodities in that year. This analysis revealed that only in four bays did the average income level of fishers exceed the national poverty threshold. The study cited three factors as accounting for the relatively higher incomes of fishers in these four higher-income bays:

(i) higher productivity levels,
(ii) higher per capita incomes from both fishing- and nonfishing-related sources, and
(iii) relatively low density of fishers.

In the other six bays, incomes were below the national poverty threshold. Fishers operating out of these latter bays had low daily catch rates, and per capita incomes of less than P10,000 per year. Further, they faced competition resulting from relatively higher densities of fishers. Income opportunities in one bay (Lingayen Gulf) were limited to farming, raising livestock, employment, and aquaculture, which contributed only P400–P500 to monthly incomes.

Figure 1 **Per Capita Incomes of Fishers in 10 Bays Surveyed**



Note: The 10 bays surveyed include Butuan Bay, Davao Gulf, Gingoog Bay, Honda Bay, Lingayen Gulf, Ormoc Bay, Puerto Princesa Bay, Sapian Bay, San Miguel Bay, and Sogod Bay.

[a] Survey conducted by the Sustainable Philippine Fisheries Agenda under the Fisheries Resources Management Project. Also, modified from the Sustainable Philippines Fisheries Agenda (SUPFA) Report, where the national per capita poverty income threshold was P11,000.

Source: SUPFA Fisheries Resources Management Project Final Report.

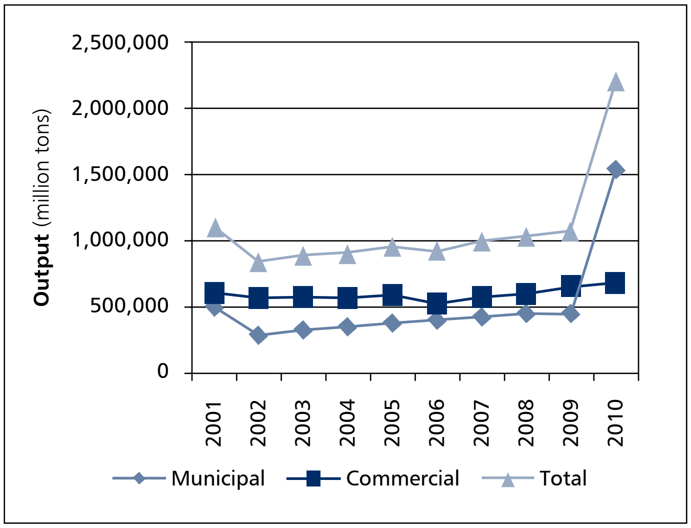
Fisheries

Subsector Composition of the Fisheries Sector

Fish is the primary source of protein in the Filipino diet, as it accounts for 70% of total animal protein intake and 30% of total protein intake. Given this importance of fish in the national diet, fisheries provide direct and indirect employment for more than 1 million people, or about 5% of the national labor force.

In the Philippines, the fisheries sector is composed of three subsectors: (i) commercial, (ii) small-scale (or municipal), and (iii) aquaculture. The commercial subsector uses boats of more than 3 tons gross, while the small-scale (municipal) subsector uses boats of smaller size. Figure 2 depicts the annual output of the commercial and small-scale subsectors from 2001 to 2010.

Figure 2 **Output of Philippine Capture Fisheries by Subsector, 2001–2010** (million tons)



Source: BFAR (2010).

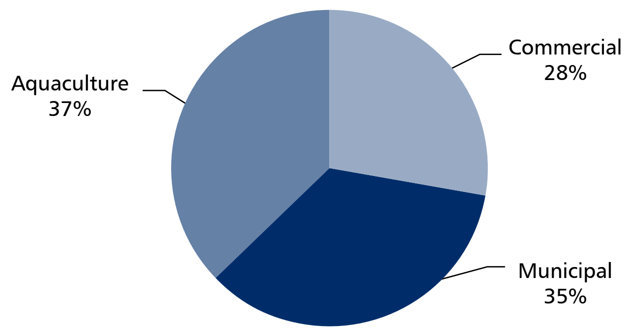
Over the period 2001–2009, output in both the commercial and small-scale subsectors remained relatively constant. However, 2009 and 2010 saw a large increase in output from the small-scale subsector, which in turn caused a relatively steep increase in total output. Rapid expansion in seaweed production largely accounted for this rise.

Annual Output of the Fisheries Sector

By international standards, the output of the Philippines capture fisheries is significant. In 2008, it was the world's ninth largest (FAO 2008). In 2010, the total output of the country's capture fisheries was 2.2 million tons, or 51% of total fish output, with a value of P138.4 million (BAS 2010). Of this, the small-scale sector accounted for 1.5 million tons valued at P77.6 million, while the commercial subsector produced 1.3 million tons valued at P60.7 million (Figure 3) (BAS 2010). In all, capture fisheries directly employed 675,700 persons. In addition, 56,700 fishers derived additional income from ancillary activities, such as fish processing, marketing, and boatbuilding (BFAR 2003).

Aquaculture contributed considerably to fisheries output, both in volume and value terms. Seaweed production comprised the bulk of output from the aquaculture subsector.

Figure 3 Subsector Percentage Shares in Total Value of Catch, 2010



Source: BAS (2010).

Species Composition of Output

The major groups of species of commercial importance to the Philippines fisheries sector include tuna, small pelagic species, and demersal species.

Tuna

The Philippines' output of tuna and tuna-like fish is the second largest among the 10 member countries of the Association of Southeast Asian Nations (ASEAN). Similarly, the Philippines' output of seaweed is the world's third-largest after the People's Republic of China and Japan.

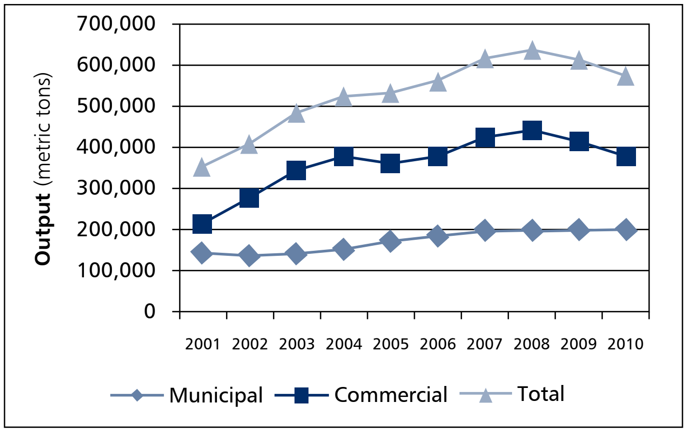
While tuna is harvested throughout the Philippines, four of the country's tuna fishing grounds are the most productive. These include the

(i) Sulu Sea,
(ii) Moro Gulf,
(iii) waters that extend southward to the North Celebes Sea, and
(iv) deep-water fishing grounds off the northeast coast of Luzon Island. Other viable fisheries include those that lie off western Negros Island, and those that lie off the northwestern and southern coasts of Luzon Island.

Figure 4 depicts changes in national tuna output from 2001 to 2010. The increase in the output of tuna—particularly by the commercial fleet—over the period 2001–2008 is the most striking feature of Figure 4. Similarly notable is the decline in the catch by the commercial tuna fleet in 2009 and 2010. In all likelihood, closure of small pockets of fishing grounds in the Western and Central Pacific Ocean accounted for this decline.

Roughly speaking, tuna accounts for 12% of the Philippines total fisheries output. Total tuna annual landings were estimated at 400,000 tons in 2009, of which 120,000 tons (30%) were caught in Philippine waters, the remainder caught in adjacent international waters. Approximately 80% of the country's tuna output is caught by fleets based in Mindanao, General Santos City in particular.

Figure 4 **Output of Commercial and Small-Scale Tuna Fisheries, 2001–2010** (metric tons)



Source: BAS, 2001–2010.

Three tuna species comprise the bulk of the country's tuna catch. These include yellowfin (*Thunnus albacares*), bigeye (*Thunnus obesus*), and skipjack (*Katsuwonus pelamis*). While these species are known to spawn extensively, currently, the standing biomass (and catch) is mainly composed of juveniles. The results of tagging experiments reveal that these fishes are part of the regional stock found in the Western and Central Pacific Ocean.

The size of the country's tuna catch exhibits little seasonality, other than that resulting from monsoonal events and migration into and out of the country's fishing grounds. Neritic (continental shelf) tunas, such as eastern little tuna (*Euthynnus affinis*), frigate tuna (*Auxis thazard*), bullet tuna (*Auxis rochei*), and longtail tuna (*Thunnus tonggol*), are abundant in inshore waters and, as a result, support domestic fisheries of significant size. Billfishes, scads, rainbow runners, dolphinfishes, and sharks tend to be associated with these oceanic tuna species.

The equipment used to harvest most of the commercial tuna catch include purse seine, ringnet, and handline gear. In all, the commercial sector accounts for approximately 70% of the total catch. This is primarily taken by large purse-seine vessels that target skipjack and yellowfin tunas.

In contrast, the small-scale subsector uses a relatively wide variety of artisanal equipment, including gill net, troll line, multiple handline, and mini-longline fishing gear. For the most part, the small-scale subsector primarily uses handline gear, which accounts for an estimated 70% of the total small-scale tuna catch. The percentage share of oceanic and neritic tunas caught by the small-scale sector roughly parallels that of the major tuna species.

Small Pelagic Species

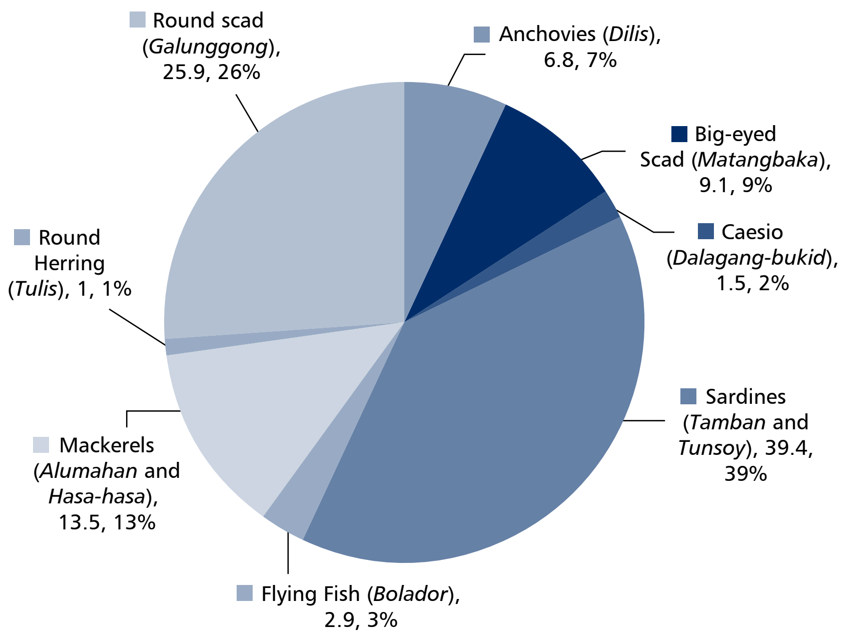
Small pelagic fish comprises the major source of animal protein for lower-income Filipinos. These species, which include anchovies, fusiliers, mackerel, round herring, round scads, and sardines, are caught both by the small-scale subsector using gill net, hook and line, ring net, beach seine, and purse seine gear; and by the commercial subsector using purse seine, ring net, and bag net fishing gear. The country's major fishing grounds for these species include Cuyo Pass, Guimaras Strait, Lamon Bay, Manila Bay, Moro Gulf, Sulu Sea, Visayan Sea, and waters that lie off the west coast of Palawan Island.

Historically, small pelagic species have dominated coastal fisheries output in volumetric terms. For example, they comprised approximately 60% of the total output of the Philippines capture fisheries in 2003 (FAO 2010). However, the estimated maximum sustainable yield for these species is 550,000 tons (Dalzell et al. 1987). As a result, the catch per unit of effort for small pelagic fishes began decreasing in 1956, and has continued to decrease ever since (Barut et al. 2003).

Due to their availability throughout the year, round scads are one of the most commercially important small pelagic fish species. However, in 2010, sardines replaced round scads as the dominant small pelagic species in terms of total output. In that year, the sardine catch totaled 1,532 tons, an amount that accounted for 38% of total small pelagic fish output (Figure 5).

Sardines comprise the major commercial group of small pelagic fish species. The output of fimbriated sardines (*S. fimbriata*) and Bali sardines (*S. lemuru*) together accounted for 442,045 tons, valued at approximately P10.5 billion (BAS 2011). However, the country's sardine stocks are apparently declining in size. Data from the National Stock Assessment Project of the Bureau of Fisheries and Aquatic Resources (BFAR) reveal that sardines in the western and central Visayas are reportedly under heavy threat of overexploitation. In particular, the stocks of *S. gibbosa, S. fimbriata*, and *S. lemuru* (reported as *S. longiceps*) are reported to be overexploited (Guanco et al. 2009). Similarly, in Sorsogon Bay, which is located southeast of

Figure 5 Percentage Shares of the Commercial and Small-Scale Subsectors in Small Pelagic Fish Output, 2001–2010



Source: BAS, 2001–2010.

the Bicol Peninsula on Luzon Island, the dominant sardine *Escualosa thoracata* appears to be overfished, as the size of catch there is decreasing in the face of increasing fishing effort (Olaño et al. 2009a). Likewise, in Honda Bay, Palawan, *Amblygaster sirm* is likewise overexploited (Ramos et al. 2009). However, other sardine species that inhabit Palawan waters appear not overexploited as, on average, the length of these fish captured there exceeds the total length of such fish at first maturity (Ramos et al. 2009).

Demersal Species

The unfavorable changes in the species composition of the demersal fish catch that has been reported indicate a decline in the stock of commercially important demersal species (Armada 2004). Conversely, squids, shrimps, and other small pelagic species account for an increasing percentage share of the total demersal species catch in volume terms while the percentage share of large, commercially valuable species—such as grouper, snapper, and sea catfish in the total demersal species catch volume—has declined substantially in recent decades. Similarly, the biomass of demersal species caught in the Philippines is declining. While in the 1950s, the demersal fish biomass was estimated at 5–17 tons per km^2, by the 1980s, the corresponding figure was only 2–3 tons per km^2.

According to Armada (2004), the country's demersal fisheries needed time to fully recover. As a result, the rate at which these fisheries are exploited needs to be managed. Recent studies indicate poor catch levels to as low as 1–2 kilograms (kg) per fisher per day, as well as catches that predominantly comprise small species of fish of lower market value (Maypa et al. 2004, Mamauag et al. 2009).

Value of Fisheries Output

Economic valuation of the potential annual output of a country's fisheries is an important exercise, as it provides an estimate of the net benefit of these fisheries to society. However, the question is whether fisheries are well managed and integrated into an overall marine resource management regime (Cesar et al. 2004).

Capture Fisheries

Table 6 reports the maximum sustainable yield (MSY) for the Philippines' conventional fisheries on which national fisheries policies have been based (Barut et al. 1997).[5] Subsequent estimations for the country's demersal and pelagic fisheries are consistent with those that appear in Table 6. For example, the estimated MSY for demersal fisheries is 340,000–390,000 tons (Silvestre and Pauly 1987). When the MSY estimate for unexploited and lightly fished hard-bottom areas[6] of 200,000 tons is included, the total becomes 540,000–590,000 tons (Barut et al. 1997). For exploited pelagic fisheries, the MSY estimate is 550,000 tons (Dalzell et al. 1987). When combined with MSY estimates of 250,000 tons for lightly fished small pelagic resources or fishing grounds,[7] the result approximates the estimates presented earlier (Barut et al. 1997).

5 The results from the economic valuation of the Philippines fisheries sector cited in this section are those that appear in the Country Environmental Analysis performed by Padilla (2009).

6 Offshore hard-bottom areas include the areas adjacent to Palawan, southern Sulu Sea, and central portion of the country's Pacific coast.

7 This includes the waters off Palawan, portions of the country's Pacific coast, and some portions of Mindanao Island.

Table 6 **Estimated Potential Annual Fish Output from the Philippines Marine Fisheries** (tons)

Area	Annual Potential Output		
	Pelagic	Demersal	Total
Coastal areas (up to 200 meters)	**800,000 ± 200,000**	**600,000 ± 200,000**	**1,400,000 ± 200,000**
Region 1: Tayabas Sea, Camotes Sea, Visayan Sea, Sibuyan Sea, Ragay Gulf, Samar Sea, and related bays	120,000 ± 30,000	90,000 ± 30,000	210,000 ± 30,000
Region 2: South Sulu Sea, East Sulu Sea, Bohol Sea, Guimaras Strait, and related bays	112,000 ± 30,000	84,000 ± 30,000	196,000 ± 30,000
Region 3: Moro Gulf, Davao Gulf, and Southeast Mindanao Coast	80,000 ± 20,000	60,000 ± 20,000	140,000 ± 20,000
Region 4: East Sulu Sea, Palawan, and Mindoro (West Palawan, Cuyo Pass, West Sulu Sea, and Batangas Coast)	264,000 ± 70,000	198 ,000 ± 70,000	462,000 ± 70,000
Region 5: North and Northwest Luzon (Lingayen Gulf, Manila Bay, Babuyan Channel, Palawan Bay)	64,000 ± 30,000	48,000 ± 20,000	112,000 ± 30,000
Region 6: Pacific Coast except Southeast Mindanao (Leyte Gulf, Lagonoy Gulf, Lamon Bay, and Casiguran Sound)	160,000 +/– 30,000	120,000 ± 40,000	280,000 ± 40,000
Oceanic areas	**250,000 ± 50,000**	**0**	**250,000 ± 50,000**
Total			**1,650,000 ± 200,000**

Source: Padilla (2009).

Unfortunately, the actual rates of exploitation exceed the MSY (Dalzell et al. 1987, Silvestre and Pauly 1987, Padilla and de Guzman 1994, NSCB 1999). In fact, the latter studies confirm considerable depletion of the country's fisheries.

Further, these studies show that the current level of fishing effort is high relative to MSY, which indicates that the Philippines fishing industry is overcapitalized. The potential economic rents (i.e., excess profits) from fishing have been fully dissipated by the industry's high average operating costs. This implies that, in the long run, inefficient fishing vessels will be driven out of the industry, as revenues fall to a point at which they just cover the costs of operation.

Nevertheless, economic rents are likely to remain over the long run in the subsectors where operational efficiency is relatively high and fish stocks remain relatively large. This report assumes that this will be true for 10% of the gross value of all of the Philippines fisheries taken together.

Data from BFAR and the Bureau of Agricultural Statistics were used to disaggregate production and value data into species grouping and attribution by ecosystem. This disaggregation was based on information from FishBase[8] and consultations with experts at the UPMSI. The production from resident species within each ecosystem was attributed fully to that ecosystem; while for transient species, a conservative 10% attribution was made. Table 7 presents the total output of species groups that use various ecosystems throughout their life cycles in 2006. This table likewise disaggregates the total output of each species by ecosystem.

In 2006, the total of the Philippines fisheries was 2.2 million tons. This represents a significant increase over 2002, when total output was 1.8 million tons. When averaged over the period 2002–2006, the annual increase in total fisheries output exceeded 5%. However, in 2006, more than half of the total country's fish catch comprised small pelagic species, with large pelagic and demersal species accounting for the remainder. Further, the non-finfish catch in 2006 exceeded 146,000 tons, primarily comprising invertebrates. The largest share of the 2006 catch was harvested in nearshore areas, which exclude mangrove forests, seagrass beds, and coral reefs.

For purposes of determining how the Philippines current annual fish output compares with MSY, let us assume that oceanic pelagic species primarily comprise large pelagic species, and that coastal pelagic species primarily comprise small pelagic species. The catches of large pelagic fish total approximately 605,000 tons. This is more than twice the annual potential yield of 250,000 (±50,000 tons). Similarly, the catch of small pelagic species is 1.0 million tons, which is 15% larger than the annual potential yield of 800,000 (±100,000) tons. However, for the demersal

Table 7 **Total Output of Various Species Groups by Ecosystem Utilized throughout the Life Cycle of Each Species Group Concerned, 2006** (tons)

	Ecosystem						
	Coastal						
Species Group	Mangrove	Seagrass	Coral Reef	Other Coastal	Subtotal	Oceanic	Total
Small pelagic	10,100	–	83,272	950,743	1,044,115	–	1,044,115
Large pelagic	178	–	1,355	–	1,532	603,372	604,904
Demersal	12,991	3,089	34,272	299,097	349,448	–	349,448
Other fish	–	–	–	9,883	9,883	–	9,883
Subtotal	23,269	3,089	118,898	1,259,723	1,404,978	603,372	2,008,350
% of row total	1.16	0.15	5.92	62.72	69.96	30.04	100.00
Invertebrates	6,833	5,292	75,851	52,805	140,781	–	140,781
Mammals	–	–	536	4,822	5,357	–	5,357
Aquatic plants	–	29	285	–	314	–	314
Subtotal	6,833	5,320	76,672	57,626	146,452	–	146,452
Total	30,102	8,410	195,570	1,317,349	1,551,430	603,372	2,154,802
% of row total	1.40	0.39	9.08	61.14	72.00	28.00	100.00

Source: Padilla (2009).

8 FishBase. http://www.fishbase.org.

species, the actual output of approximately 350,000 tons is just half the potential output of 600,000 (±100,000) tons.

In short, the figures in the paragraph immediately above suggest that the country's total annual fish output is more than 2.0 million tons, which exceeds the estimated maximum potential yield of 1.9 million tons. This is relatively consistent with the findings of other studies (Dalzell et al. 1987, Silvestre and Pauly 1987, Padilla and de Guzman 1994) that show considerable depletion and degradation of the Philippines' fisheries.

Table 8 reports the estimated gross and net value of potential capture fisheries output, as measured in 2006 wholesale prices.[9] The estimates presented indicate that the potential gross value that can be sustainably derived from the Philippines capture fisheries (excluding invertebrates and aquatic plants) is about P128 billion per year. However, the Philippines does not restrict access to its fisheries in any way. As a result, large numbers of fishing operators enter the industry, driving down the net value that can be obtained from the country's capture fisheries to only about 10% of the gross value figure of P128 billion. As a result, the net potential value that can be sustainably derived from the Philippines capture fisheries is only about P13 billion.

Table 8 **Gross and Net Value of Potential Output from the Philippines' Capture Fisheries** (in 2006 wholesale prices)

Item	Average Price (P/ton)	Potential Annual Output (ton)	Total Gross Value (P million)	Net Value (P million)
I. Coastal (small pelagic species)				
Low estimate	55,574	600,000	33,344	3,334.42
High estimate		1,000,000	55,574	5,557.36
Average		800,000	44,459	4,445.89
II. Coastal (demersal species)				
Low estimate	65,822	400,000	26,329	2,632.88
High estimate		800,000	52,658	5,265.76
Average		600,000	39,493	3,949.32
III. Oceanic (large pelagic species only)				
Low estimate	65,173	200,000	13,035	1,303.46
High estimate		300,000	19,552	1,955.19
Average		250,000	16,293	1,629.33
Total				
Low estimate		1,200,000	72,708	7,270.76
High estimate		2,100,000	127,783	12,778.32
Average		1,650,000	100,245	10,024.54

Notes:
1. Output from coastal areas (pelagic and demersal species) includes fish harvests from mangrove, seagrass, and coral reef areas.
2. The prices in the table are derived from the Philippine Fisheries Statistics.
3. "Net value" refers to economic rents from fishing. These are assumed to equal 10% of the gross value of fisheries output.

Source: Padilla (2009).

[9] All price data in this chapter refer to wholesale prices, except when otherwise stated.

Table 9 reports the value of actual fisheries production in 2006, measured both in gross and net terms. The actual value exceeds P100 billion, while the net value of 10% of that amount is only P10 billion.

Fish Harvested from Coral Reefs

Table 10 reports the percentage of the total area of selected coral reefs that was covered by hard coral over the period 1981–2004. The data in Table 10 are those reported by on-site surveys of a number of coral reef sites, all of which were conducted by Philippine academic institutions. The percentage of the total area of these sites with poor coral cover has increased, while that with excellent coral cover has steadily declined from more than 5% in 1981 to less than 1% in 2000–2004. Relatively better reef cover may be found at sites in the Celebes Sea, southern Philippine Sea, Sulu Sea, and the Visayas (Nañola et al. 2002).

Table 9 Gross and Net Value of Actual Output from the Philippines Fisheries in 2006, by Ecosystem (P million)

Species Group	Gross Value					
	Coastal					
	Mangrove	Seagrass	Coral Reef	Coastal	Oceanic	Total
Small pelagic	248.2	–	2,947.9	37,114.5	–	40,310.6
Large pelagic	12.4	–	77.7	–	31,769.0	31,859.0
Demersal	650.9	183.8	1,952.5	17,231.5	–	20,018.7
Other fish	–	–	–	650.2	–	650.2
Subtotal	911.4	183.8	4,978.2	54,996.1	31,769.0	92,838.5
% to row total	1.0	0.2	5.4	59.2	34.2	100.0
Invertebrates	520.0	380.5	4,566.0	3,775.7	–	9,242.2
Mammals	–	–	39.2	352.4	–	391.5
Aquatic plants	–	2.1	21.3	–	–	23.5
Subtotal	520.0	382.7	4,626.4	4,128.1	–	9,657.2
Total, All Species	**1,431.5**	**566.5**	**9,604.6**	**59,124.2**	**31,769.0**	**102,495.7**
% of row total	**1.4**	**0.6**	**9.4**	**57.7**	**31.0**	**100.0**
	Net Value					
Small pelagic	24.8	–	294.8	3,711.5	–	4,031.1
Large pelagic	1.2	–	7.8	–	3,176.9	3,185.9
Demersal	65.1	18.4	195.3	1,723.1	–	2,001.9
Other fish	–	–	–	65.0	–	65.0
Subtotal	91.1	18.4	497.8	5,499.6	3,176.9	9,283.8
Invertebrates	52.0	38.1	456.6	377.6	–	924.2
Mammals	–	–	3.9	35.2	–	39.2
Aquatic plants	–	0.2	2.1	–	–	2.3
Subtotal	52.0	38.3	462.6	412.8	–	965.7
Total, All Species	**143.1**	**56.7**	**960.5**	**5,912.4**	**3,176.9**	**10,249.6**

Source: Padilla (2009).

Table 10 **Coral Cover in Selected Philippine Coral Reef Ecosystems, Various Years** (hard coral cover as a percentage of total area)

Location	Category			
	Poor (0%–24.9%)	Fair (25%–49.9%)	Good (50%–74.9%)	Excellent (75%–100%)
1981 (Gomez et al. 1981)				
Luzon	31.4	42.8	22.3	3.5
Visayas	29.6	36.9	26.1	7.3
Mindanao	48.8	30.2	14.0	7.0
All	31.8	38.8	23.6	5.7
1997 (Licuanan and Gomez 2000)				
All	27.0	42.0	28.0	4.0
2000–2004 (Nañola et al. 2002, Nañola et al. 2006)				
West Philippine Sea (or South China Sea)	46.0	54.0	0	0
Northeastern Philippine Sea	48.1	51.9	0	0
Southeastern Philippine Sea	31.0	60.2	8.8	0
Visayas Region	47.6	50.0	2.4	0
Sulu Sea	56.0	36.0	8.0	0
Celebes Sea	20.5	48.7	28.2	2.6
All	40.8	53.3	5.7	0.2

Source: Padilla (2009).

The amount of fish that can be harvested from coral reefs largely depends on three factors:

(i) the ecological health of the coral reef ecosystem concerned,
(ii) the physical size of the coral reef concerned, and
(iii) the degree of biodiversity associated with the coral reef in question.

McAllister (1988) used the following four categories of coral reef health to estimate the annual output of fish that may be sustainably harvested per km^2 of coral reefs:

(i) excellent condition, 18 tons;
(ii) good condition, 13 tons;
(iii) fair condition, 8 tons; and
(iv) poor condition, 3 tons.

Based on the estimates above, Table 11 presents estimates of the potential volume and value of fish output from the Philippines coral reef systems. The estimates presented are based on

(i) the degree of coral reef health as reported by recent surveys,
(ii) the area of selected coral reef sites in the Philippines,
(iii) the volume and value of potential fish yields from these coral reefs, and
(iv) the volume and value of actual fish yields from these coral reefs.

These estimates indicate that based on a total coral reef area of 33,000 km^2, the annual potential output of all coral reef fish species is 351,000–429,000 tons/year. This contrasts with the estimated current yield of 169,000 tons/year that is harvested from a coral reef area of 27,000 km^2.

Padilla (2009) uses an area of 27,000 km^2 to estimate the potential net value of fish output from the Philippines coral reefs, which is P2.0 billion–P2.5 billion (Table 11). This contrasts sharply with the actual net value of less than P1 billion (using the average 2006 price for coral reef fish of P57 per kg).

This estimated potential net value of coral reef fish output becomes slightly lower when coral reef conditions from previous years are used to perform the calculation. This result may be due to the loss of coral reef cover that occurred between 2000–2004 and 2006, since this would cause coral reef fish output to decline.

The Philippines' live reef fish export industry generates significant export revenue and income for fishers and cagers. However, this activity mainly targets groupers (Mamauag 2004), the abundance of which likewise depends on coral reef health. The national catch of live reef fish peaked in the mid-1990s, and gradually declined thereafter (Figure 6). As a result, this industry has increasingly focused on Palawan Island. Most recent assessments of the abundance of live reef fish have therefore focused on Palawan (Figure 7).

Ornamental Coral Reef Fish

The ornamental fish industry is extensive; it accounts for a relatively large share of the total value of fish harvested from the country's coral reefs. Table 12 reports the volume and value of ornamental fish exports from the Philippines in 2006.

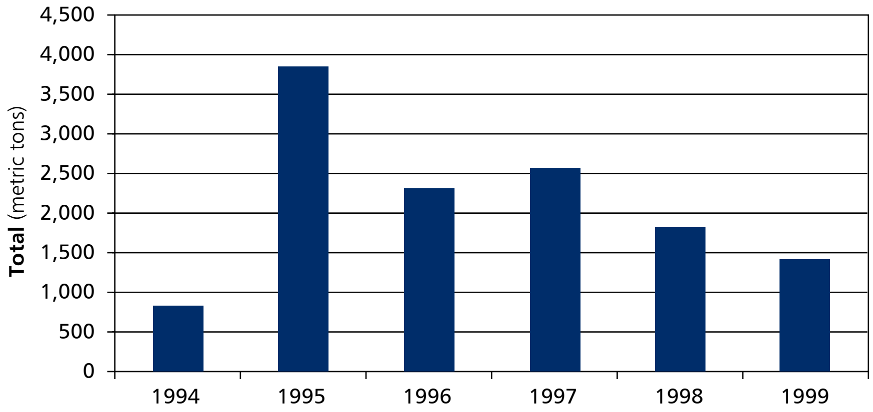
Table 11 **Potential Volume and Value of Coral Reef Fish Output**

Reef Condition		Total Reef Area (km^2)		Sustainable Production (ton/km^2/year)	Potential Yield if Reefs are in Good Condition (ton/year)	Present Calculated Yield Using Current Area and Reef Conditions (ton/year)
Condition	% Area	Maximum Possible Area	Current Area			
Poor	40.8			3	429,000	33,048
Fair	53.3			8	(using maximum area)	115,128
Good	5.7	33,000	27,000	13	351,000	20,007
Excellent	0.2			18	(using current area)	972
Total	100.0					169,155
Gross value of potential production (P million/year, in 2006 wholesale pries)		**Using maximum area**			**24,449**	**9,640**
		Using current area			**20,003**	
Net value of potential production (P million/year, in 2006 wholesale prices)		**Using maximum area**			**2,445**	**964**
		Using current area			**2,000**	

km^2 = square kilometers.

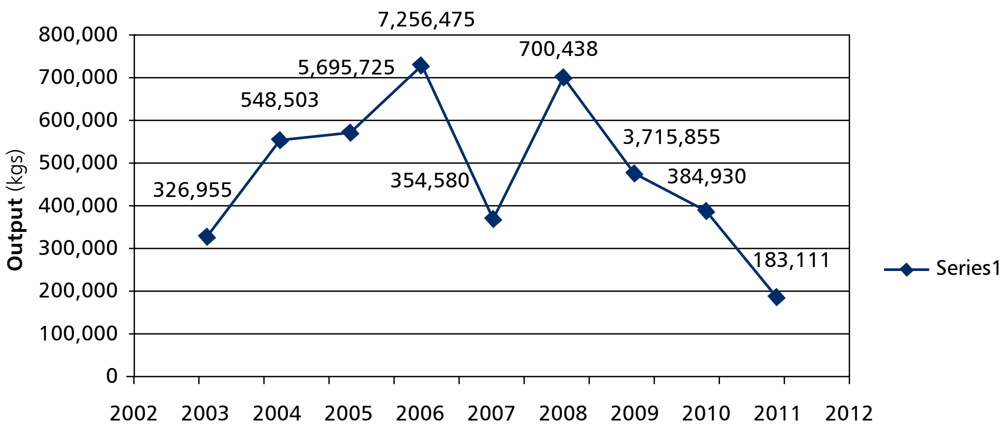
Source: Padilla (2009).

Figure 6 Volume of Live Reef Fish Exported from the Philippines, 1994–1999 (tons)



Source: Mamauag (2004).

Figure 7 Output of Live Reef Fish in Palawan, 2003–2011



Source: PCSD (2011).

Fish Harvested from Mangroves

Table 9 presents estimates of the output of fish harvested from mangroves in 2006. Fisheries output[10] covers a wide range (142–578 kg/ha/year). It is also site dependent, while the influence of the quality of mangrove stands is not definitive.

The value of mangrove fisheries estimated below uses the extent of mangrove cover reported for 3 separate years: (i) 1918; (ii) 1980, which corresponds to the time of estimation of potential

[10] The higher figure of Walton et al. (2005) is not considered, as it assumes a very high level of dependence (80%) of coastal fisheries on mangrove ecosystems.

Table 12 Volume and Value of Live Ornamental Fish Exports from the Philippines, 2006

Year	Quantity (ton)	FOB Value (P million)	Net Value (P million)
2002	5,632	333.13	33.31
2003	5,912	348.17	34.82
2004	6,941	380.05	38.01
2005	6,698	368.91	36.89
2006	6,660	371.14	37.11

FOB = free-on-board.
Note: Net value (i.e., economic rent) is assumed to be 10% of the gross value reported in the table.
Source: BFAR, 2002–2006 (various years).

fisheries yields by the Fishery Industry Development Council–Natural Resources Management Center report; and (iii) 2006 (Table 13).

With the original mangrove cover of 5,000 km^2 (500,000 ha) in 1918, the gross value of potential output from mangrove fisheries ranges from P3.6 billion to P14.6 billion per year in 2006 prices (Table 13). By 1980, the total area of the Philippines mangroves had declined to an estimated 215,793 ha. Assuming the latter extent of mangrove cover, the potential value of the country's mangrove fisheries output would be P1.5 billion–P6.3 billion per year in 2006 prices. The corresponding gross value range for 2006 is P1.5 billion–P6.1 billion per year. Net values are based on 10% of gross value. The estimated contribution of mangrove ecosystems to actual fisheries

Table 13 Gross and Net Value of Output of Mangrove Fisheries in 1918, 1980, and 2006 (in 2006 wholesale prices)

Author	Schatz (1991)	PIDS (1997)	Janssen and Padilla (1999)	Walton et al. (2005)
Reference year	1990	1992–1995	1995	2004
Location	Central Visayas	Pagbilao Bay and Ulugan Bay	Pagbilao Bay	Aklan
Type of vegetation	Managed and Unmanaged Mangroves	Old Growth (Ulugan) and Secondary growth (Pagbilao)	Secondary Growth	Mangrove Reforestation
Fisheries production (kg/ha/year)	667.0	175.4	141.9	578.0–2.6
Gross value (P/ha/year) for reference year	13,450	6,743	1,940	25,307–121,072
Gross value (P/ha/year) for 2006: Average price = P50.37/kg	33,597	8,835	7,149	29,114–129,350
Mangrove area in 1918 (ha)		500,000		
Fish production (ton)		70,969–289,000		

continued on next page

Table 13 *continued*

Gross value in 2006 (P million/year)	3,575–14,557
Net value in 2006 (P million/year)	358–1,456
Mangrove area in 1980 (ha)	215,793
Fish production (ton)	30,629–124,728
Gross value in 2006 (P million/year)	1,543–6,283
Net value in 2006 (P million/year)	154–628
Mangrove area in 2006 (ha)	209,109
Fish production (ton)	29,681–120,865
Gross value in 2006 (P million/year)	1,495–6,088
Net value in 2006 (P million/year)	150–609

ha = hectare, kg = kilogram, PIDS = Philippine Institute for Development Studies.

Notes: Upper bound value of production per year is the lower bound value from Walton et al. (2005) study. Net values are estimated at 10% of gross values.

Source: Padilla (2009).

production in 2006 was 23,269 tons. With the inclusion of invertebrates, total fish output would be an estimated 30,102 tons. This estimate approximates the 29,681 tons of estimated potential output in the same year when the lower end of the range shown in Table 13 is used.

Fish Harvested from Seagrass and Algal Beds

Seagrass beds are habitats for numerous fish species, and serve as food for sea turtles, hundreds of fish species, several species of waterfowl, manatees, and dugongs (Short et al. 2004). Indeed, the endangered dugong feeds almost entirely on seagrass (Spalding et al. 2003). Seagrass also supports complex food webs as a result of its physical structure and primary production characteristics. Seagrasses are an important part of the detrital food chain that they filter nutrients and contaminants from water, stabilize sediments, and dampen water currents.

Data on potential fisheries output from seagrass beds are not available. Thus, calculation of the estimated contribution of seagrass and algal beds to fisheries output in the Philippines requires attributing the total fisheries catch to various coastal and marine ecosystems. For 2006, the contribution of seagrass and algal beds to fisheries output is estimated at 3,089 tons for finfishes, and an additional 8,410 tons for invertebrates and aquatic plants taken together. The total value of the contribution of seagrass and algal beds to fisheries output is thus estimated at P379 million for 2006, of which finfish accounts for 29%.

Mangroves

Table 14 summarizes the results of some studies of timber output from Philippine mangrove forests. These data are calculated either potential sustainable harvests or actual harvests, based on the degree to which adjacent communities depend on timber from the mangrove forest in question for house construction, fencing, or fuelwood. The number of cubic meters per hectare that can be sustainably harvested per year ranges from 1.2 to 13.5. Using this range of sustainable yield, the 2006 sustainable timber output from all mangrove stands in the

Table 14 Volume and Value of Timber Output from Philippine Mangrove Forests, Various Years (in 2006 wholesale prices)

Author	Schatz (1991)			PIDS (1997)		Janssen and Padilla (1999)	Walton et al. (2005)
Reference year	1990			1992–1995		1995	2004
Location	Central Visayas			Pagbilao Bay and Ulugan Bay		Pagbilao Bay	Aklan
Type of vegetation	Mangrove Plantation	Managed, Naturally Regenerated Stands	Unmanaged, Understocked Stands	Old Growth (Ulugan Bay)	Secondary Growth (Pagbilao Bay)	Secondary Growth	Mangrove Reforestation
Timber production (m^3/ha/year)	13.0	7.5	3.5	3.1	2.6	2.4	13.4
Net value (P/ha/year) for reference year	1,950	1,125	525	1,283	1,182	971	1,638
Average price in reference year	300	300	300	834	918	819	244
Average price in 2006 (P/kg)	908	908	908	1,836	2,021	1,540	265
Net value (P/ha/year) for 2006	5,903	3,406	1,589	2,823	2,602	1,825	1,776
Philippine mangrove area (ha)	209,109	209,109	209,109	209,109	209,109	209,109	209,109
Total net value (P million/year)	1,234	712	332	590	544	382	371

ha = hectare, kg = kilogram, m^3 = cubic meter, PIDS = Philippine Institute for Development Studies.

Notes:

1. Timber production corresponds to degrees of dependence of households to the mangroves: 30%, 50%, 75%, and 100%. Gross value is based on shadow prices of next best alternative to the mangrove timber products.
2. Timber production is based from subsistence forestry extraction. Gross value is based on shadow prices of the next best alternative to the actual use of mangrove timber products.
3. Based from thinnings used apparently for fuelwood.
4. Values depend on uses of mangrove timber products, such as fuelwood, construction, fencing, etc. Net value is assumed 50% of gross value.

Philippines in both volume and value terms can be calculated from the (i) results summarized in Table 14, (ii) degree of mangrove forest cover in 2006, and (iii) relevant prices.

The results presented in Table 14 include the value of nonmarketed mangrove forest products. The manner in which the value of these nonmarketed products was estimated depends on their use, as well as relevant shadow prices adjusted to 2006 levels. Note that the gross value per unit volume for the mangrove forests in Pagbilao Bay and Ulugan Bay are higher than in Aklan. This result is due to the fact that timber harvested from mangroves in Pagbilao Bay and Ulugan Bay is used for house construction, while in Aklan it is used as fuelwood, which has a much lower gross value. The production costs associated with alternative timber products are assumed to be 50% of those associated with timber used for house construction and fuelwood. As a result, their net values are estimated as half of their gross values. In sum, the results presented in Table 14 indicate that the net value of mangrove timber output for the entire Philippines in 2006 ranged from P332 million to P1.2 billion. The average (mean) of all of these estimates is about P596 million.

Aquaculture

The Philippines aquaculture subsector, which includes both inland farms and coastal marine aquaculture, produces at least 18 species of fish. The output of this subsector is significant, as it accounts for 37% of the total annual volume of fish output, and 49% in value terms, making it the largest fisheries subsector (BAS 2010). Further, aquaculture output is growing rapidly—at 10.2% per year. This fisheries subsector is thus recognized as having the greatest potential to alleviate poverty, since it includes both primary production and processing activities. In 2010, the total output of the aquaculture sector reached 2.5 million tons with a value of P82 billion. While seaweed accounted for most of this output, the sector is likewise a major producer of milkfish, tilapia, and black tiger shrimp. Aquaculture production is carried out in freshwater, brackishwater, and saltwater fishponds. Similarly, fish pens and fish cages are employed in both fresh and saltwater environments (Table 15).

Marine Aquaculture

In addition to fish, the Philippines marine aquaculture subsector produces significant quantities of seaweed and sea cucumber. Due to technological advances, the country's marine aquaculture industry is increasingly competitive (DOST–PCAMRD Report 2010). This has led to significant gains in food security, employment, product quality, and profit from exports.

Table 15 **Philippine Aquaculture Output by Culture Environment** (ton)

Item	Brackishwater	Freshwater	Marine Water	Oyster, Mussel, and Seaweed	Total
Fishpond	302,850	144,724			447,574
Fish cages	2,241	101,611	59,026		162,878
Fish pens	3,350	62,002	21,574		86,926
Oyster, mussel, and seaweed				1,779,862	1,779,862
Total	**308,440**	**308,337**	**80,600**	**1,779,862**	**2,477,239**

Source: DOST–PCAMRD Report (2010).

Seaweed. Research and development (R&D) relating to seaweed has ranged from improvements in culture technology, which increase production capacity to new, improved strains of seaweed that use branch and spore culture technologies, micropropagation, and cryopreservation. Future improvements are likely to improve the following:

(i) postharvest activities, carrageenan extraction, and recombinant production of carrageenase and agarase;
(ii) output of oligocarragenan and oligoagar; and
(iii) output of novel red algal poly- and oligo-saccharides for various applications. In 2010, the Philippines aquaculture output of 1,799 tons was surpassed only by Indonesia.

Mariculture parks. The objective of these parks is to promote sea farming as a major livelihood opportunity for coastal fishers, as well as ancilliary services that provide employment opportunities for residents of adjacent communities. To date, 51 marine parks covering 49,553 hectares (ha) have been established, and 11 additional parks covering 876 ha began operations in 2011. For example, Panabo marine park in Davao has approximately 5,000 cages. These were financed by a total investment of P950 million. This mariculture park produces rabbitfish together with milkfish in a polyculture environment. Other major species produced by marine parks include groupers, jacks, and pompanos (NAST 2011).

Aquaculture Research and Development

Over the period 2011–2016, aquaculture research and development is to focus on superfarms that produce milkfish, tilapia, and shrimp. For milkfish, the focus of research and development is on improving broodstock management, milkfish hatchery technology, and grow-out technology. For shrimp, research and development is to focus on developing high-quality *Penaeus monodon* broodstock and spawners; environment-friendly production techniques; and handling protocols and value chain analysis for fresh, chilled, and frozen shrimps reared in commercial and organic culture. For tilapia, research and development is to focus on hatchery and grow-out management techniques, use of prebiotics and probiotics, environment-friendly feeding strategies, and culture schemes for the fillet market. Red tilapia production will also be improved through breeding.

Coastal Tourism

The Philippines' tropical climate and diverse coastal environment are ideal for the development of coastal tourism. Coral reefs, sandy beaches, clear water, and resorts continue to draw tourists. The coastal environment provides for a wide array of tourist activities that includes watching whales, birds, and turtles, and fish spotting. Coral reefs are likewise popular with scuba divers and snorkelers.

The economic benefits of coastal tourism development can be substantial, the most important of these being generation of foreign exchange earnings and the financial stimulus the sector provides to both adjacent communities and the national economy. In fact, with $16.3 billion in annual tourism revenues, this sector already accounts for 9.1% of the country's GDP. As with other Coral Triangle countries, tourism is one of the fastest-growing economic sectors (Crabtree and Douglas 2007). Table 16 reports the number of foreign tourist arrivals visiting the Philippines in 2009–2011.

Table 16 **Foreign Tourist Arrivals, 2009–2011**

Year	Foreign Tourist Arrivals
2009	3,017,099
2010	3,520,471
2011 (Jan–Sep)	2,887,715

Note: Excludes arrivals of Filipino residents in countries other than the Philippines.
Source: DOT (2011).

Minerals, Oil, and Gas

Including its EEZ, the Philippines' offshore area occupies an estimated 2.0 million km^2. The country's offshore mineral resources that are potentially viable for extraction include chromites, decorative stones, gold, magnetite, manganese nodules, sand and gravel, and silica, as well as minerals encrusted with cobalt, copper, gold, and zinc.

Exploration, mining, and production of iron ore are ongoing in the Philippines. The northern portion of Luzon Island is home to 36,000 ha of offshore magnetite iron ore sites, particularly in the provinces of Cagayan, Ilocos Norte, and Ilocos Sur. The country also has the potential to produce petrochemical oil and petroleum.

The total area under Philippine jurisdiction includes 16 sedimentary basins, 13 of which are located offshore (Department of Energy). Geologically formed through various chemical and physical processes, sedimentary basins worldwide have accounted for a number of economically viable oil reserves. The Philippines' sedimentary basins include those located in the Sulu Sea and on the Eastern Shelf of Palawan, the largest of these areas being 200 km^2. Sedimentary basins are also located in southwest and northwest Palawan Island, the Mindoro–Cuyo Platform, Bicol Shelf, and southeast Luzon. Current estimates indicate that the Philippines has undiscovered petroleum resources of 7.9 billion barrels (bbl) of oil equivalent, while discovered petroleum resources include 972.9 million bbl of oil equivalent. Of the 34 petroleum service contracts operational in 2010, most were primarily engaged in exploration. Before the service contract system was established under Presidential Decree No. 87 in 1972, 302 wells have been drilled while 261 wells were drilled under the system.

While domestic petroleum production began in 1979, the level of output produced thus far has been modest. As of 2010, the country had produced 61.9 million bbl of oil, 1.0 million cubic feet of natural gas, and 45.3 million bbl of condensate. All five producing petroleum fields are located offshore in the Northwest Palawan Basin. These fields include Galoc, Malampaya, Matinloc, North Matinloc, and Nido. According to the Statistical Energy Survey performed by British Petroleum in 2008, the Philippines consumed an average of 298,000 bbl of oil per day in 2007 (BP, n.d.).

The *Oil and Gas Journal* reported that as of January 2008, the country's natural gas reserves were estimated at 3.5 trillion cubic feet (Tcf), most of this being found in the Malampaya gas field. According to the Statistical Energy Survey carried out by British Petroleum in 2008 (BP), in 2007, natural gas consumption in the Philippines totaled 3.4 billion m^3. The country has two crude oil-refining facilities—in Limay, Bataan, of Petron Corporation and in Tabangao, Batangas, of Shell Oil. The refining capacity of the latter facility was 282,000 billion bbl per day as of January 2008.

In 2009, consumption of natural gas totaled 3.3 billion m^3, which equaled 0.11% of world consumption during that year (BP). The Philippines has 3.2 Tcf in proven natural gas reserves, exploitation of which began in 2001. Natural gas is mainly used for producing electricity; it used to produce a third of the total power requirement of the Luzon grid. However, the government is continually promoting other uses of natural gas, such as in the transport sector where it is primarily used to power public utility buses.

Malampaya is the country's largest natural gas development project, one of the largest foreign investments ever undertaken in the country. A 504-kilometer pipeline links the field to three power plants in Batangas. This pipeline is one of the longest deep-water pipelines in the world, with half its length located 600 feet below the ocean's surface.

Transport and Shipping

Due to its archipelagic nature, the Philippines relies heavily on both domestic and international shipping to transport both people and goods. Shipping contributes to the national economy in many ways. For example, it generates significant foreign exchange earnings and revenues through taxes and fees paid on bareboat chartered vessels. Shipping is likewise a significant source of employment. In addition, the industry involves a significant amount of technology transfer in fields that range shipping operations to ship management.[11]

In 2010, the Philippine Ports Authority (PPA) reported that the country had 25 port management offices (5 in Manila and northern Luzon, 4 in southern Luzon, 6 in the Visayas, 5 in northern Mindanao, and 5 in southern Mindanao). These ports contribute significantly to national economic growth as they are a significant source of revenue that originates in fees for wharfage, dockage, port use, storage, pilotage, terminal use, equipment rental, arrastre and/or stevedoring, management, and other ancillary services. In 2009, the gross revenue of the PPA totaled P7.1 billion, one-third of which was derived from the International Container Terminal Services, which serves as the operator of Manila International Container Terminal (Table 17).

Traditional Knowledge of Indigenous Peoples in Coastal Areas

Knowledge specific to residents of indigenous or aboriginal communities is derived from long-standing practices that have developed through trial and error. Such knowledge is generally

(i) locally bound, or native to a specific geographic area;
(ii) culture and context specific;
(iii) nonformal in nature;

[11] Maritime Industry Authority. http://www.marina.gov.ph

Table 17 **10 Busiest Philippine Port Management Offices, 2009 (in terms of traffic volume)**

Rank	Category			
	Cargo	Container	Passenger	Ship Call
1	Batangas	MICT	Batangas	Batangas
2	North Harbor	South Harbor	Calapan	Dumaguete
3	MICT	North Harbor	Zamboanga	Pulupandan
4	Limay	Davao	Tagbilaran	Davao
5	Surigao	Cagayan de Oro	Pulupandan	Calapan
6	South Harbor	General Santos	Dumaguete	Legazpi
7	Davao	Pulupandan	Legazpi	Iloilo
8	Pulupandan	Iloilo	Ozamiz	Tagbilaran
9	Iloilo	Zamboanga	Iloilo	Iligan
10	Cagayan de Oro	Nasipit	Iligan	Ozamiz

MICT = Manila International Container Terminal.
Source: Philippine Ports Authority.

(iv) orally transmitted and generally not documented;
(v) dynamic and adaptive;
(vi) holistic in nature; and
(vii) closely related to the survival and subsistence of many people.

In recent decades, the value of this type of knowledge in complementing scientific findings has begun to be appreciated. For example, customary marine tenure systems and traditional practices can be viable alternatives to modern approaches to managing fisheries.

The Philippines possesses two types of traditional knowledge: (i) the practices of aboriginal groups, and (ii) the practices of coastal populations that may or may not be marginalized from mainstream Philippine society. Enacted in 1997, the purpose of the Indigenous Peoples Rights Act (Republic Act No. 8371) is to protect and promote the rights of these peoples.

The best practices of indigenous cultural communities can significantly contribute to modern Philippine society. For example, the greatest challenge facing conservation of marine biological diversity and sustainable use of the country's marine resources is understanding the behavior of users of these resources. Understanding the reasons for cultural and spiritual beliefs and their motivations is key to Influencing the behavior of users of resources. Such understanding is thus imperative if the resources contained in a particular management area are to be used in a sustainable manner. This relates to fisheries in particular.

Understanding both modern property rights and indigenous rights is vital to achieving sustainable management of fisheries in the Philippines. Of these, perhaps the most important principle is recognizing the potential viability of indigenous peoples managing the resources over which they have stewardship. For example, many island communities have traditionally used area-based restrictions to facilitate recovery of depleted marine resources. In this regard, the experience of fishers has traditionally been taken into account when establishing procedures for ensuring sustainable resource use. This knowledge includes the circulation of water around a particular island, the rationale behind traditional fish-harvesting techniques, and the behavior of particular types of fish. Such factors can be of paramount importance in determining the location of MPAs) (Flores 1994).

While the value of these traditional resource management systems to modern conservation programs is increasingly being recognized, existing government legislation sometimes conflict with such traditional resource allocation systems. Further, the potential contribution of traditional knowledge to national and international protected area networks, and even development strategies and targets, may be sufficiently recognized to produce optimal outcomes. There are many reasons for this oversight. First, modern environment planners and decision makers may be suspicious of indigenous ecological management systems. Second, government-sponsored fisheries management regimes to date have narrowly focused on relieving symptoms rather than addressing causes, being the focus of traditional resource management regimes (Magos 1994).

Of the 85 million Filipinos that comprised the country's population in 2005, 12 million were categorized as indigenous, in that they were associated with approximately 110 different ethnolinguistic or cultural groups (Corazon 2005, Colchester and Ferrari 2007). Three examples of the numerous indigenous groups and the potential contribution each might make to sustainable management of the country's fisheries are presented below.

Calamian Tagbanwa

The Calamian Tagbanwa inhabit Coron Island, which sits off the northern portion of Palawan. Ethnoichthyological studies demonstrate that traditional fishers possess a significant amount of knowledge as regards both fish and fishing (Sampang 2005). The Tagbanwa classify fishes according to their habitat, schooling behavior, morphological appearance, and market value. Their knowledge of fish habitats and diets could potentially make a significant contribution to management of adjacent fisheries. For example, the gear these fishers use varies with the season: hook and line are used during the southwest monsoon, and spear gun and gill net are commonly used during the northeast monsoon. The sacred beliefs and conservation practices of this group include protecting certain areas as sanctuaries, and avoiding certain fish species as they are thought to pose a risk to human populations.

Prior to mid-20th century, the Tagbanwa's population was relatively small compared to the size of the resource base to which they had access. As a result, this group enjoyed a sustainable subsistence economy. Their cultural taboos prohibited indiscriminate exploitation of forest and coastal resources. All of this changed during the early 1970s when the municipal government sequestered many of the areas the Tagbanwa inhabited as a result of their failure to pay the taxes imposed by the municipal government. Ultimately, their lands were auctioned off to tourist resort developers and real estate agents. During the 1980s, degradation of the fisheries in the Visayas Island and off the southern coast of Luzon Island triggered migration of fishers into the area formerly inhabited by the Tagbanwa. As a result, by the mid-1980s, this area was rapidly being degraded by dynamite and cyanide fishing, as well as other destructive and illegal fishing methods introduced by the immigrant fishers.

In response to this ecological assault, in 1985, the Tagbanwa established the Tagbanwa Foundation of Coron Island. This foundation then applied to the DENR for the approval of the Community Forest Stewardship Agreement, which provided the Tagbanwa people with legal tenure over a 25–year time horizon and allowed them to manage the natural resources over which they had stewardship through a community forest management plan (Ferrari and de Vera 2004).

Ivatan

The Ivatans are a Filipino ethnolinguistic group that predominate in the Batanes islands, which are located off the north coast of Luzon Island. As these islands sit in a strait that separates the Philippines from Taipei,China, the culture of this ethnolinguistic group has been largely influenced by the area's relatively harsh climate. The sea is thus vital to the Ivatan's way of life (Rowthorn 2003). The Ivatans particularly depend on the flying fish (*dibang*) and dolphinfish (*arayu*) for their survival. These species are abundant along the shores of the Batanes islands from March to May (Datar 2008).

The beliefs and traditional practices of Batanes fishers are known as *mataws.* These beliefs and traditional practices integrate the

- (i) traditional ecological knowledge of fishers,
- (ii) observance of taboos and performance of rituals as vehicles for sustainable resource management,
- (iii) establishment of sacred sites that naturally become protected areas,
- (iv) reciprocity and mutual help arrangements that protect the environment, and
- (v) enforcement of rules and taboos through penalties formulated and levied by the *mataw's* association.

Visayan Fishers

Of special importance to this group is the belief that there exist *mari-it* (dangerous) sites on the island of Panay (Magos 1994). As such areas are considered to be sacred, native people would never dare ravage them. As a result, their overexploitation is permanently prevented. By tradition, the fishing, farming, and hunting practices of these people use implements sustainably derived from their environment. As a result, neither marine nor forest resources are threatened with depletion. Because these people believe that spirit beings inhabit the sea and forest, these resources are permanently protected. In their view, using the earth's resources in a discourteous or greedy way incurs the ire of these spirits. Thus, fishing and farming rites are necessarily performed regularly to gain the favor of these spirits. For example, fishers in Antique consider the entire sea to be very dangerous. In contrast, those from Capiz, Guimaras, and Gigantes Sur consider the waters around them friendly, safe, and a blessing of nature. To them, it is the land that is *mari-it*. Western ideas have slowly eroded the beliefs and values of such traditional societies, and the loss of these beliefs and values is greatly responsible for the overexploitation and destruction of natural resources that occur today.

Gender-Related Issues

Gender equality is actively promoted in the Philippines both in the public and private sectors. Enabling policies and mechanisms support gender equality in the country, with the most important of these included as follows:

- The 1987 Philippine Constitution, which upholds equality before the law of men and women, and recognizes the role of women in nation building;
- Establishment of the National Commission on the Role of Filipino Women in 1975, and its transformation into the Philippine Commission on Women in 2009, which acts as
  - (i) catalyst for mainstreaming gender issues into many aspects of Philippine society,
  - (ii) the leading authority on the concerns of women, and
  - (iii) the lead advocate of empowerment of women and gender equality in the Philippines;
- The 1981 signing and ratification by the Philippines of the International Convention on the Elimination of all Forms of Discrimination against Women;
- Republic Act No. 7192, otherwise cited as the Women in Development and Nation Building Act, which provides guidance and measures for mobilizing and expanding the participation of women in the development process in ways equal to those of men; and
- Incorporation of the gender and development budget into the annual General Appropriations Act.

A study of links between reproductive health and integrated coastal management performed by the PATH Foundation Philippines revealed two major gender issues in the coastal areas of Bohol and Palawan: (i) lack of access to credit by women, as well as lack of training for alternative livelihoods; and (ii) a lower level of educational attainment in men with regard to secondary education. The latter is a concern because it limits employment opportunities other than fishing to men (Castro et al. 2004).

Threats and Vulnerabilities

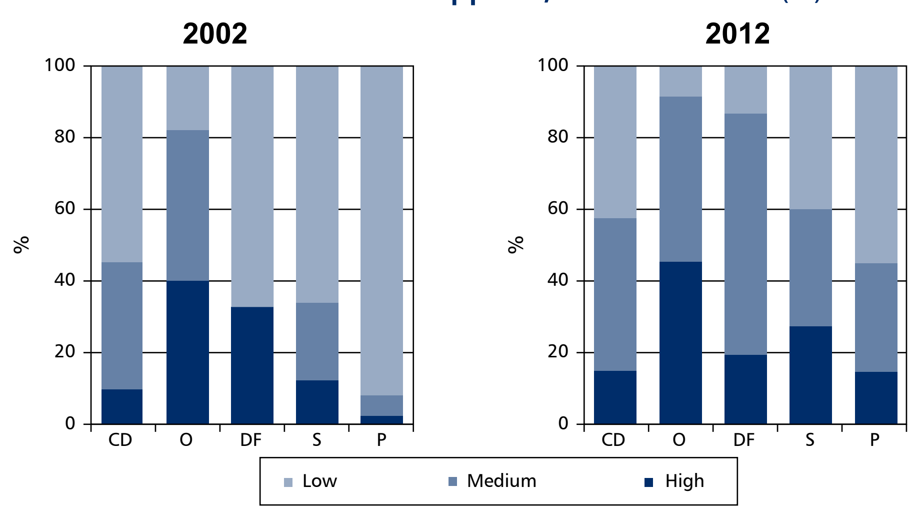
Current Issues in Marine Resource Management

Degradation of Fisheries and Food Insecurity

The status report on Philippine coral reefs (Licuanan and Gomez 2002, Tun et al. 2004) reveals that live hard coral cover has decreased by 3%–5% relative to the total estimated cover in the 1980s. Similarly, the percentage of coral reefs in "poor condition" has increased from 33% in the 1980s to 40%, while reefs in "excellent condition" account for only 1% of the country's total coral reefs (Nañola et al. 2004). This decline results from continuing coastal development, marine-based pollution, sedimentation, overfishing, and use of destructive fishing practices (Burke et al. 2002, 2011).

Based on the most recent assessment, the types of environmental threats these coral reefs face have changed. In 2002, overfishing was the greatest threat (about 40%) faced by the country's coral reefs, followed by destructive fishing practices (36%) (Figure 8). By 2012, except for destructive fishing practices, the impact of most major threats to the country's coral reefs had intensified (MSN 2012). High- and medium-level threats—sedimentation and pollution in particular—had increased markedly. These threats include inappropriate land use, irresponsible mining practices,

Figure 8 **Change in Estimated Intensity of Major Environmental Threats to Coral Reefs in the Philippines, 2002 and 2012** (%)



CD = coastal development, DF = destructive fishing, O = overfishing, P = pollution, S = sedimentation.
Source: Burke et al. (2002), MSN (2012).

deforestation or illegal logging, and improper waste disposal. Coastal development also considerably grew as a result of increases in coastal populations, built-up areas, and urbanization. At many sites, the environmental threat posed by destructive fishing practices appears to have decreased over time, indicating some improvement in the management of fisheries and enforcement in MPAs, as well as several municipalities.

Overfishing

Overfishing remains a significant problem in many areas. Nañola et al. (2011) reported low abundance of species, especially in the Visayas region, which is characteristic of intense fishing and habitat degradation that subsequently lead to declines in species stocks. Continued high levels of exploitation are thought to have a cumulative effect on overall species richness in the Visayas region.

The impacts on coral reefs of overfishing—and to some extent, destructive fishing practices—appear in the level of biomass of reef-associated fish. The data reported in Table 18 indicate that more than 50% of the reef sites in the Philippines surveyed between 1991 and 2004 were overfished. High levels of fish biomass were more common in the Visayas and Sulu Sea areas, as these were present in 25.9% and 32.9% of coral reefs, respectively. Very high fish biomass levels were observed where species diversity was also high, such as in the West Philippine Sea (or South China Sea) and the Sulu Sea. In each of these cases, very high fish biomass levels occurred in 15% of the total reef area. These biogeographic regions contain large MPAs, including Tubbataha Reef National Marine Park and many expansive reefs, such as in the Kalayaan Islands Group in the West Philippine Sea (or South China Sea). Thus, the only reefs with considerable fish populations are either located in MPAs that have been protected for at least 5 years, or those located in remote areas inaccessible to most small-scale fishers.

Table 18 **Level of Exploitation and Fish Biomass in Coral Reefs in the Philippines**

Reef Fish Biomass (tons per km^2)	Fish Biomass Level	Fishing Intensity
1.0–5	Very low	Overfished
5.1–10	Low	Overfished
11.0–20	Medium	Moderate
21.0–40	High	Minimal
>40	Very high	Minimal

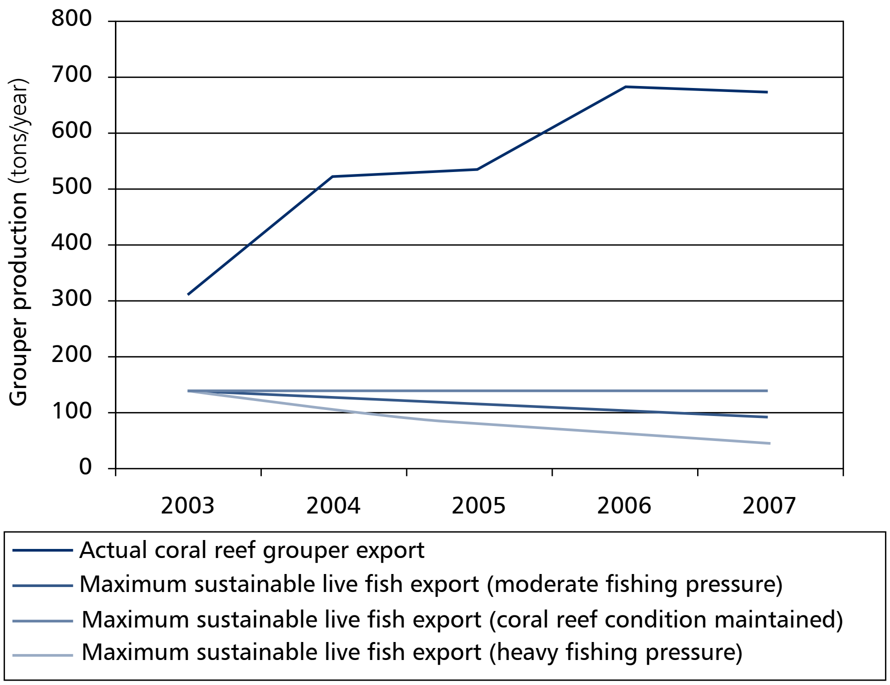
km^2 = square kilometer.
Source: Nañola et al. (2002).

Overfishing in Palawan's Live Reef Food Fish Fishery. Palawan's live reef food fish fishery is an excellent case study of overfishing of reef fishes, as several assessments have confirmed stock depletion and overfishing since this fishery was established. Based on the current report of the Palawan Council for Sustainable Development, the province-wide maximum sustainable yield for grouper[12] is 186 tons per year under the best of conditions (i.e., a complete lack of overfishing and use of cyanide or other destructive fishing practices for 1 year). Conversely, this study estimates the

[12] The maximum grouper productivity of a reef in an area in a year; measured in tons or kilograms of grouper fish per square kilometer or hectare of a reef per year.

maximum sustainable level of exports for grouper[13] at 139.5 tons per year. These levels contrast sharply with the actual volume of live groupers exported from Palawan in 2003, which was 309.2 tons, a level that steadily increased to 669.1 tons in 2007. Further, these data should be interpreted as representing the lower bound for exports, given the relatively high rate of mortality associated with the live fish trade. Given the moderate to heavy fishing pressure on groupers, their rate of depletion has accelerated. As a result, current harvest levels are unsustainable (Figure 9).

Figure 9 Actual Live Grouper Exports from Palawan Compared to Maximum Sustainable Export Levels, 2003–2007
(under various assumptions of fishing intensity)



Source: PCSD Report (2011).

At the provincial level, the amount of depletion estimated for 2007 was 624.9 tons for heavy fishing pressure, 577.5 tons for moderate fishing pressure, and 529.5 tons for negligible fishing pressure. A parallel depletion scenario was shown to be applicable on a per-area cluster basis. Table 19 depicts the estimated level of depletion for 2007 compared with the estimated maximum sustainable export volume, both for the whole province and by cluster. The rate of depletion is caused by the generally poor condition of coral reefs. This in turn results from the following:

(i) use of illegal fishing practices such as cyanide and dynamite fishing,
(ii) siltation from land-based sources,
(iii) sea water temperature increase due to global warming, and
(iv) overfishing sustained over many years.

[13] The maximum volume of live grouper in a year that can be shipped out of Palawan; and assumed to be 75% of the maximum sustainable yield.

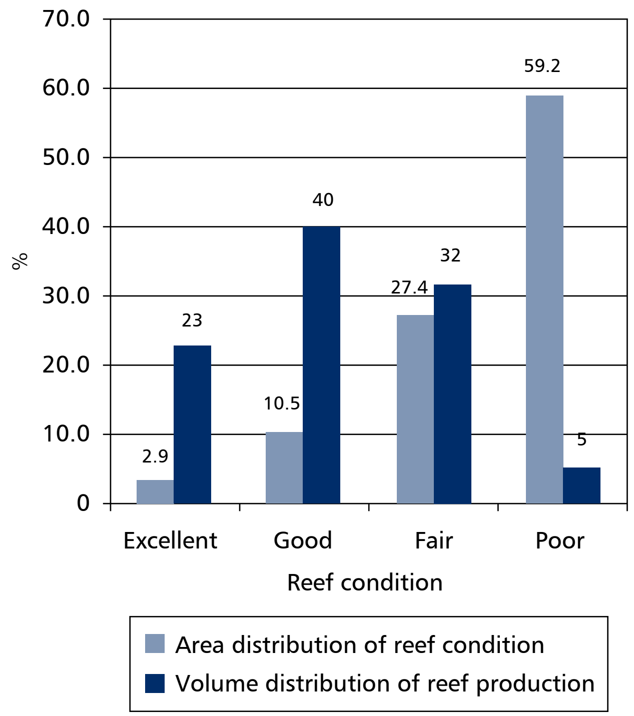
Table 19 Actual Live Exports of Groupers from Palawan Compared to Estimated Depletion of Palawan Grouper Stocks, 2007
(Under alternative assumptions on fishing pressure) (tons)

Area	Actual Live Exports	MSEG under Heavy Fishing Pressure	Depletion	MSEG under Moderate Fishing Pressure	Depletion	MSEG under Negligible Fishing Pressure	Depletion
Province-wide	669.08	44.16	624.93	91.57	577.52	139.56	529.52
Calamianes Group of Islands	233.71	6.80	226.90	14.10	219.60	21.50	212.21
Mainland and nearby island municipalities	308.15	33.20	274.95	68.84	239.31	104.93	203.22
Cuyo Group of Islands	127.23	4.16	123.07	8.62	118.61	13.14	114.09

Notes: MSEG = maximum sustainable export for grouper.
Source: PCSD Report (2011).

Only 13.4% (109.2 square kilometers [km^2]) of Palawan's reefs are in excellent to good condition. The remaining 86.6% are in fair to poor condition. This causes overall reef productivity to be poor (Figure 10).

Figure 10 Percentage Shares in Total Live Reef Fish Output of Reefs in Excellent, Good, Fair, and Poor Conditions in Palawan (%)



Source: PCSD Report (2011).

Impacts on Adjacent Habitats

Despite the ecological and economic value of seagrasses, in the last 50 years, 30%–50% of the Philippines seagrass beds have been lost due to economic activity associated with industry development, ports, and recreation (Fortes 1995). Seagrass ecosystems are threatened by the loss of mangroves, as the latter filter and remove some of the sediment deposited by rivers. Seagrass beds also protect coral reefs by buffering them from the damaging impacts of large waves and storm surges (PNSC 2004).

Harvesting mangrove timber for use as construction material, fuelwood, and charcoal largely contributed to the destruction of this resource. Subsequent illegal cutting and overharvesting then degraded these mangrove habitats and the ecosystems associated with them (White and de Leon 2004). However, converting mangroves into fishponds accounted for the bulk of mangrove loss (66%). Over the period 1951–1988, 279,000 ha of mangrove forests were converted into aquaculture ponds. Despite a government ban on further conversion of mangroves into fishponds that came into effect in 1980, the rate at which mangroves have been lost has accelerated (White and de Leon 2004).

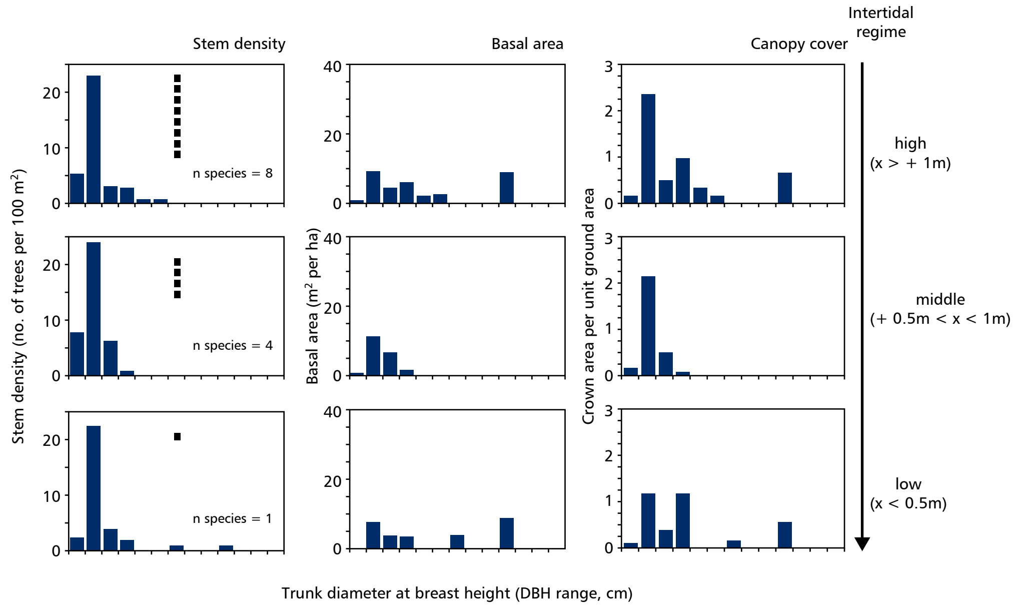
Primavera (2000) showed that mangrove-friendly sustainable aquaculture technologies that do not require the cutting of mangroves exist. In 1987, a project of the BFAR established 1.6–2.6 ha of milkfish ponds in Ubay, Bohol, where *Rhizophora* mangroves occupied approximately 80% of the area concerned (Aypa and Bacongis 1999). This area yielded about 1 ton of milkfish/ha/year for the first 5 years. Further, these milkfish ponds became a habitat for a number of wild fish and invertebrates, as well as wild ducks and birds. However, the mangrove roots hampered assessment and harvest of fish stocks. Similarly, prolonged flooding was detrimental to these mangroves, and overgrowth of filamentous algae led to fish kills.

The planting of mangrove trees has become standard coastal resource management practice in the Philippines. However, Samson and Rollon (2008) reported a tendency to plant mangroves in large areas (44,000 ha) that are not natural mangrove habitats. This in turn often resulted in conversion of mudflats, sandflats, and seagrass meadows into monospecific *Rhizophora* mangrove forests (Figure 11). This study argued that a more rational approach would be to plant mangroves in brackishwater aquaculture ponds, such areas being the original habitat of mangroves. This study explored a number of management options, the implementation of which ultimately depended on the political will of both local and national governments.

Excessive Nutrients and Other Sources of Pollution

Major sources of marine pollution include improper disposal of domestic and industrial waste, agrochemical runoff, siltation and sedimentation, inappropriate disposal of toxic and hazardous materials (including heavy metals and mine tailings), and oil spills. DENR Administrative Order No. 34 (Series 1990) established the basis for assessing water quality by means of specific physicochemical indicators, such as the presence of dissolved oxygen, fecal coliform, heavy metals, and pesticides, as well as pH (McGlone et al. 2004).

Figure 11 Growth Parameters of Mangroves Planted in Unnatural Habitats

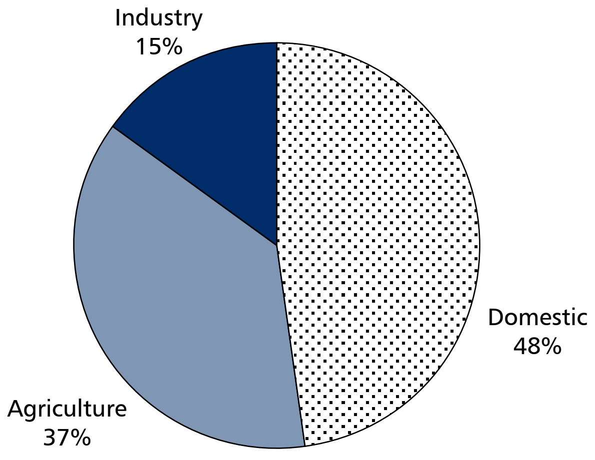


cm = centimer, ha = hectare, m = meter, m^2 = square meter.

Source: Samson and Rollon (2008).

The Brown Report (2009) estimated that 2.2 million tons of organic pollutants are released into the Philippines' overall environment annually. The source of these pollutants is domestic, agricultural, and industrial activities (Figure 12). With regard to water quality and quantity, the country's four critical regions include the National Capital Region (Metro Manila), Central Luzon, Southern Tagalog provinces, and Central Visayas islands. In these regions, the primary contributors to water pollution are the domestic and industry sectors.

Figure 12 Percentage Shares in Total Organic Waste Pollution Contributed by Agriculture, Domestic, and Industry Sectors (%)



Sources: Philippine Environment Monitor (2003), Brown Report (2009).

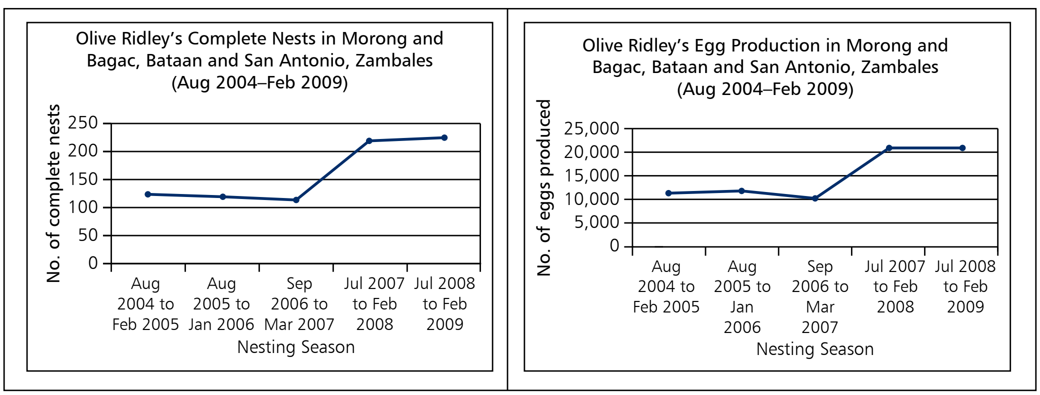
Numerous laws currently in place in the Philippines are meant to protect water quality. However, protecting the country's water resources from pollution is hampered by weak enforcement, inadequate resources, poor databases, and lack of cooperation among national and local government agencies. As a result, the Philippine Clean Water Act of 2004 (Republic Act No. 9275) was enacted to address the existing inadequacies on water quality management.

Threatened and Endangered Species

Marine Turtles

Both the size of the nesting population and the volume of eggs produced are indicators of the status and degree of abundance of marine turtles. Data gathered by the Protected Areas and Wildlife Bureau-Pawikan Conservation Project (PAWB-PCP) in collaboration with DENR's regional office, LGUs, NGOs, and resort owners showed an increase in the number of olive ridley nests and eggs produced in Morong and Bagac (Bataan), and in San Antonio (Zambales) from August 2004 to February 2009 (Figure 13).

Figure 13 **Number of Complete Nests and Eggs Produced by Olive Ridley Marine Turtles in Bataan and Zambales Provinces, August 2004–February 2009**

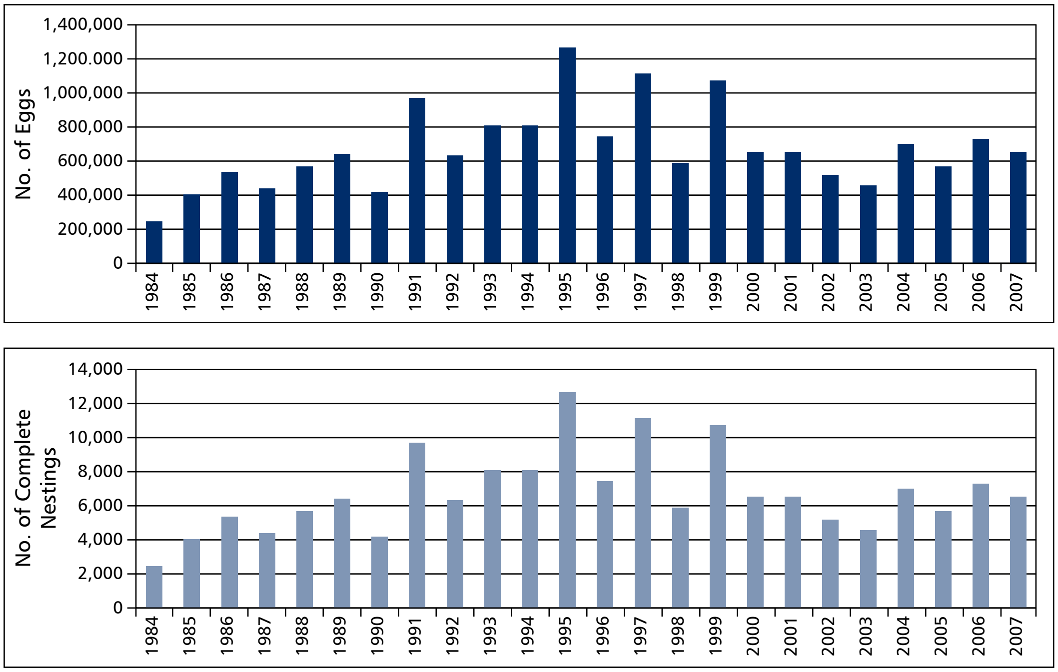


Source: PAWB-PCP (2009).

Another well-known marine turtle–nesting area is the Turtle Islands, which have been declared the Turtle Islands Heritage Protected Area. The first transboundary protected area for marine turtles in the world, this reserve includes six islands administered by the Philippines, and three islands administered by the Malaysian state of Sabah. The six islands under the Philippines' jurisdiction are referred to as the Turtle Islands Wildlife Sanctuary, while the three islands under Malaysian jurisdiction are referred to as the Sabah Turtle Islands.

These islands are major nesting areas for green turtles in Southeast Asia. Hawksbill turtles also nest in the area, although in relatively small numbers. From 1984 to 2007, PAWB-PCP recorded the number of complete nestings and the total number of eggs produced in Baguan Island. Fluctuations in these two variables occurred as a result of changes in weather patterns brought about by El Niño and La Niña, as well as predation by monitor lizards (e.g., *Varanus* sp.) (Figure 14).

Figure 14 **Number of Eggs and Complete Nestings Produced per Year in the Philippines Baguan Island Marine Turtle Sanctuary, 1984–2007**



Source: PAWB-PCP (2007).

Large-scale illegal harvesting of eggs and collection of turtles for the ornamental trade are the major threats these protected animals face. Of all turtle eggs produced in the Turtle Islands Wildlife Sanctuary (except Baguan Island, which produces more than 50%), 60% end up being collected to support the illegal trade in eggs. Prior to passage of the Wildlife Resources Conservation and Protection Act of 2001 (Republic Act No. 9147), collection of turtle eggs in some portions of the Turtle Islands was regulated under a DENR permit system that allowed collection during an open season from April to December. Under this permit system, only 60% of the eggs were allowed to be collected, the remainder being required to be left for conservation purposes. After passage of Republic Act No. 9147, collection of sea turtles or any of their derivative products—including eggs—was prohibited. This prohibition resulted in conflicts within and among stakeholder groups, since the sale of marine turtle eggs accounts for approximately 35% of the total annual income of area residents (BFAR-NFRDI 2005, DENR-PAWB 2009). A memorandum of agreement signed by stakeholders that would phase out collection of turtle eggs and phase in alternative livelihood projects in the Turtle Islands Wildlife Sanctuary has been finalized and is pending approval.

In addition to illegal collection of eggs and entire animals, marine turtles face threats from coastal development and poaching by foreign fishers illegally operating in Philippines waters. As a result, the foraging habitats of marine turtles are also being proposed for declaration as critical habitats under the provisions of Republic Act No. 9147.

Marine turtles also face threats from conventional fishing practices. The results of a perception survey performed by BFAR indicated that gill net, fish corral, and setnet fishing gear are the types of gear most likely to trap marine turtles (DA-BFAR 2007). However, reports gathered by PAWB-PCP nationwide through its marine turtle tagging program reveal that fish corral, gill net, and hook and line gear are those most likely to inadvertently capture marine turtles.

The Sulu Sea is a favorite poaching area for foreign fishers targeting marine turtles. Over the past decade, more than 1,000 foreigners have been arrested and charged with poaching in the waters off Palawan alone (WWF-Philippines 2008).

Other Indicator Species

Other indicator species used to assess the status of marine and coastal biodiversity include whale sharks, humpback whales, and Irrawaddy dolphins. However, the data available regarding these species are insufficient for this purpose. The whale shark (*Rhincodon typus*) is one of two protected species in the Philippines, and is listed as vulnerable in the Red List of Threatened Species published by the International Union for Conservation of Nature (IUCN), and in Appendix II of the Convention in International Trade on Endangered Species (CITES). Whale sharks (and manta rays) are also protected by Department of Agriculture Fisheries Administrative Order (FAO) 193, S. 1998, which bans the taking or catching, selling, purchasing and possessing, transporting, and exporting of whale sharks and manta rays. No assessment of the population of these or any other species of sharks in the Philippines exists. In the 1990s, the whale shark population in Donsol, Sorsogon was reported to be composed of 50–100 individuals. WWF-Philippines has initiated participatory research for identifying individuals of the whale shark population in Donsol. This research uses distinguishing marks, gender, behavior, and photo documentation to determine the extent of the whale shark population in the study area.

Humpback whales *(Megaptera novaeangliae)* have been observed off the Babuyan Islands, which are located off the northernmost tip of Luzon. The Babuyan Islands are a significant marine conservation area, as these islands comprise the only known breeding ground for humpback whales that migrate to the Philippines annually. Surveys conducted since the year 2000 have photo-identified more than 100 individuals of this species (Acebes et al. 2007).

Irrawaddy dolphins (*Orcaella brevirostris*) are found in estuaries and semi-enclosed water bodies, such as bays and sounds. They are listed in Appendix 1 of the Convention on Migratory Species, to which the Philippines is a party. Only one population of less than 100 individuals is known to exist in the Philippines. This is located in Palawan's Malampaya Sound. The major threats this population faces include accidental killing as a result of conventional fishing, habitat degradation, possible depletion of prey as a result of overfishing, and destruction of spawning grounds (Dolar et al. 2002). Approximately four mortalities per year are recorded on average. Minimizing the contact these dolphins have with conventional fishing gear is the solution to Irrawaddy dolphin mortality, most often proposed by experts familiar with this species.

Emerging Issues in Marine Resource Management

Aquaculture

Overstocking

Overstocking, overfeeding, and short (5–6 months) production cycles are common in the Philippines fish cage aquaculture. Ultimately, all fishes compete for space, food, and oxygen. Oxygen depletion occurs when decomposing feed wastes and fecal matters are deposited at the bottom of lakes and cage environments. These become fertilizer that trigger algal blooms, the subsequent decay of which uses up oxygen and releases toxic compounds that kill fish in large numbers. However, fish kills can result from either natural causes (such as lake overturn) or human intervention (such as pollution from aquaculture).

Of the 192 documented cases of fish kills in the Philippines, aquaculture was the cause in nearly half of all cases (PHILMINAQ 2007). In the Philippines, most fish kills occur in freshwater lakes.

In 1999, a fish kill occurred in Murcieliagos Bay, Zamboanga del Norte as a result of mercury and cyanide contamination. Another occurred in Lingayen Gulf in 1999 as a result of an oil spill from an oil tanker. From 2003 to 2005, fish kills of significant scale occurred as a result of overfeeding and overstocking not only in perennial areas, such as Taal Lake, but also in Cebu, Bohol, and Isabela, and included tilapia, milkfish, shrimp, and grouper. Aside from the widely publicized Bolinao–Anda fish kill of 2009, five other fish kills occurred in Bais, Camotes, Cotabato, and Davao del Sur. These affected broodstock, milkfish siganids, and various freshwater species. While some of these fish kills caused the loss of only a few thousand pesos, others resulted in the loss of hundreds of millions. The Bolinao fish kill of 2002 was reported to have caused the loss of P200 million, while that in June 2007 caused a loss of P40 million–P100 million (PHILMINAQ 2007).

The inability of local and national government agencies to regulate fish stocking densities has led to overcrowding of fish cages and overstocking. This has in turn reduced water quality, which has subsequently resulted in fish kills. At least some of these kills can be prevented by educating fish farmers. In particular, the physical, chemical, and biological attributes of the water used for aquaculture must be properly monitored if fish kills are to be avoided. Similarly, farmers must be warned to harvest their fish in a manner that avoids losses from overstocking.

Toxic Chemicals

While antibiotics used to treat diseased fish may likewise impact wild fish populations and other organisms, it is difficult to quantify the magnitude of these effects on the environment adjacent to aquaculture ponds. At the height of disease outbreaks, the Philippines' shrimp farmers apply antibiotics (e.g., chloramphenicol and nitrofuran) to cultured shrimp. Formerly, farmers used toxic organophosphate and tin-based chemicals to control snail pests (e.g., *Cerithidea cingulata*) and fish predators in brackishwater fishponds. This practice is now banned. However, agricultural runoff of pesticides used for agricultural purposes—mainly organochlorines, which are harmful to both fish and humans—still pollute the aquatic environment. As a result, indiscriminate use of such chemicals has become a major concern not only because of the potential hazard they pose to human health but also because of the potential for bacterial resistance to these chemicals.

Increasing Demand for Trash Fish

To a significant degree, cultured fishes are dependent on wild-caught fish. Fish oil and fish meal, both of which are essential ingredients of fish feed, are usually sourced from wild fish stocks. On average, producing 1 kilogram (kg) of finfish, such as grouper, snapper, or seabass, requires 5–12 kg of feed. Based on estimates provided by the PHILMINAQ Report (2007), about 160,000 tons of wildfish and/or feed are wasted in tilapia pens, cages, and ponds. Further, more than 160,000 tons of these materials are wasted in milkfish culture. In countries with a per capita income roughly equal to that of the Philippines, trash fishes are widely eaten by the human population. Unfortunately, these species are vital to the health of the overall ecosystem, as they are the major source of food for larger fishes.

Alteration of Physical Environment

Nets, cages, pens, and associated moorings modify the aquatic environment by preventing efficient water exchange and altering the patterns of currents. Similarly, friction from nets can alter the residence time of water in bays. On occasion, nets also obstruct the migration paths of various fish species.

Environmental Impacts of Culture of Particular Species

The impacts of seaweed culture include changes in the composition of the marine ecosystem, modifications to the paths of aquatic currents, and increasing shading of bottom environments. Nutrient stress, perhaps caused by excessive seaweed culture within a confined area, has also been implicated in "ice-ice" disease. Both the shading referred to above, as well as use of mangrove poles for stakes, may adversely affect biological productivity in coral reefs and other nearshore environments.

Similarly, mussel and oyster farming results in increased biodeposition of waste on the seabed. The resulting organic enrichment induces changes in sediment chemistry and biodiversity. Effluents from shrimp ponds are high in both dissolved and particulate nitrogen and phosphorus. These effluents elevate nutrient levels in receiving waters and promote eutrophication. In brackishwater ponds, intensification of production can increase the rate at which wastes are produced. Unless this additional waste is intercepted and treated through filter traps, settlement ponds, and biofiltration beds, it is discharged into the coastal environment, where it causes eutrophication and pollution. These problems have occurred in some areas of the Philippines, such as in Bolinao.

Harmful Algal Blooms

The occurrence of harmful algal blooms ("red tide") is an important indicator of the degree to which water has become polluted. This seasonal phenomenon is caused by high organic loadings in rivers that drain into bays. From 1983 to 2001, red tide occurred in 20 coastal areas in the Philippines, causing 42 outbreaks of red tide to be reported.

Recognized as a catastrophic phenomenon that has affected public health and the national economy since 1983, the first recorded blooms of *Pyrodinium bahamense* var. *compressum*, a toxin-producing *dinoflagellate*, occurred in central Philippines. As this was the country's first experience with red tide, its public health and economic impacts were considerable. Harmful algal blooms in the Philippines, particularly of *Pyrodinium*, have become more frequent over time, and more extensive in terms of total area affected. The incidence of paralytic shellfish poisoning due to *Pyrodinium* has likewise increased considerably over the past 2 decades, as the country experienced 540 outbreaks that included subsequent shellfish poisoning episodes over the period 1983–2002. Some species that cause shellfish poisoning appear in the same geographic regions each year. However, other outbreaks are episodic in nature, which cause unexpected death of local fish, shellfish, mammals, and birds. In 2002, Azanza (2005) observed the first occurrence of a *Prorocentrum minimum* bloom in Bolinao, an area where milkfish aquaculture in pens and cages has been practiced for years. The subsequent fish kill—which lasted almost as long as the *Prorocentrum* bloom—peaked just as the bloom began declining. Lack of oxygen in cages and pens was the principal cause of the resulting fish kill (PHILMINAQ 2007).

Invasive Species

A number of marine organisms (mostly phytoplankton) have been identified as invasive species in the country's waters, which include the following:

(i) ***Pyrodinium bahamense* var. *compressum*.** This is a paralytic shellfish toxin-producing species that has caused poisoning in Brunei Darussalam, Indonesia, Malaysia, and the Philippines. The species may have entered the country naturally through migration, or may have been transported by ships. This organism's life cycle includes a cyst stage, during which it can remain viable for years. It thus only appears in future blooms once conditions become favorable.

(ii) ***Alexandrium* spp.** This species was reported in Bolinao, Pangasinan in 2003. Often transported in the ballast water of ships, its life cycle likewise includes a cyst stage during which it can remain viable for years.

(iii) ***Cochlodinium polykrikoides.*** This species bloomed on a regional scale in Southeast Asia during the period 2004–2005. The bloom began in Brunei Darussalam in November 2004, and then appeared in Sabah in December 2004 to January 2005. In February 2005, the bloom appeared in Palawan. The source of *Cochlodinium* blooms in Southeast Asia is unknown. The mode of transport may be natural, i.e., ocean currents, or anthropogenic in nature, such as through discharge of ship's ballast water or transport of infected seafood.

The Philippines coastline is one of the longest in the world. As a result, many cities are served by five ports on average. Unfortunately, this makes the country vulnerable to invasion by exotic aquatic species as a result of discharge of ballast water by foreign vessels (Azanza et al. 2006). To date, no research has been performed on the biological content of the tons of ballast water discharged annually in the country's waters, and no substantial regulatory measures have been imposed. Research on the flora and fauna content of ballast water and possible treatments are required if the impacts of invasive species on the marine environment are to be mitigated.

Coastal Tourism

Although coastal tourism brings with it numerous economic benefits, it also has numerous negative impacts on coastal resources. These include beach erosion, deterioration of coastal water quality, dumping of solid waste on beaches or in nearby beach areas, coral reef degradation caused by anchorage and landing of tourist boats, saltwater intrusion, and increased noise pollution and traffic congestion (White, Huttche, and Flores 2002).

Recent Developments in Marine Resource Use

Coral Reef Restoration

A coral reef restoration program is currently being funded by the Department of Science and Technology. The objectives of this program are

(i) biodiversity conservation;
(ii) restoration of damaged reefs through initiatives that involve residents of local communities;
(iii) development of both sexual and asexual coral propagation techniques that help conserve the diversity of local coral species;
(iv) identification of materials that can be used in coral restoration; and
(v) development of cost-effective coral restoration techniques.

Community-based coral restoration techniques sponsored by the UPMSI are ongoing in Bolinao, Pangasinan Province. These include cost-efficient transplant techniques for rearing of fragments of staghorn corals (*Acropora pulchra* and *A. intermedia*) in coastal communities. An offshoot of the program will pilot-test reef restoration techniques in partnership with resort owners at three demonstration sites located in Batangas, Bohol, and Boracay, as well as with LGUs as partners at three additional sites in Leyte, Masbate, and Tawi-Tawi.

Restocking

The possible aquaculture, sea ranching, and restocking of marine invertebrates, such as sea cucumber, scallop, paphia, and trochus, are currently under study.

Sea Cucumber

The Philippines is the world's second largest exporter of sea cucumber. In fact, export of this invertebrate has become a multibillion dollar industry (Ferdouse 2004), with an estimated annual volume of 708,207 tons in global trade valued at $7.8 billion (BAS). For the Philippines, sea cucumber is the eighth most important fisheries exports in terms of volume. These invertebrates are (i) exported dried or salted in brine; or (ii) traded in live, fresh, chilled, or frozen form. However, sea cucumbers are threatened by overexploitation. This is largely due to lack of policies for maintaining output at sustainable levels. Currently, the UPMSI has an ongoing restocking initiative that includes training of participants from academic and research institutions.

Scallops

Both scallop aquaculture and harvesting of wild scallops are ongoing in Asid Gulf, Masbate. Five species of scallops are commercially exploited in this area: *Decatopecten striatus*, *Chlamys senatoria nobilis*, *Chlamys macassarensis*, *Chlamys funebris*, and *Chlamys gloriosus*. All of these are fast-growing tropical species. *D. striatus* is also being studied as a possible indicator of climate change.

Giant Clams

Giant clams have significant cultural, commercial, and ecological value in Filipino culture. In the mid-1980s, together with Silliman University, the UPMSI assessed the extent of the country's stock of giant clams. The results of this assessment indicated overexploitation of the country's natural population of giant clams. As a result, three large species—*Tridacna gigas, T. derasa, and Hippopus porcellanus*—have become either virtually or nearly extirpated (Juinio et al. 1989). In response to this, UPMSI has undertaken long-term restocking of *T. gigas* using cultured seed (Gomez and Mingoa-Licuanan 2006, Mingoa-Licuanan and Gomez 2007, Hazel et al. 2009). Considered a responsible program for restoring stocks of *T. gigas* (Bell et al. 2005), UPMSI's giant clam restocking program that began in 1990 has continued to the present day. This program consists of transplanting cultured juveniles, subadults, and broodstock, largely of *T. gigas* (Mingoa-Licuanan and Gomez 2007 at 64 sites (Mingoa-Licuanan, unpublished data). All transplantation is conducted in protected areas. Stewards are appointed to oversee these programs as a means of reducing clam poaching.

Natural recruitment of *T. gigas* has already been reported in Bolinao and Alaminos in Pangasinan Province (Mingoa-Licuanan and Gomez 2009a) and in Guinsiliban, Camiguin (Roa-Quioait, unpublished data). Surveys at these sites show generally low levels of recruitment, except for one site at Hundred Islands, Alaminos in Pangasinan Province. Observations of three distinct year-classes in the recruitment of Bolinao clams reported the presence of local gyres at the Hundred Islands site that allowed repeated settlement of recruits. However, it is important to protect sites where repeated recruitment occurs, since this allows establishment of *T. gigas* following natural hydrographic patterns. In the absence of protection, these sites would be open to fishing and other extractive activities.

One ecological benefit accruing to areas where giant clams are transplanted is increased marine biodiversity. Feeding aggregations of *Spratelloides delicatulus,* or blue sprat, on giant clam spawn have been observed during in-situ spawning induction of *T. gigas* in the ocean nursery (Maboloc and Mingoa-Licuanan 2011). Further, as giant clam shells are composed of calcium carbonate, they become a substrate for recruiting sessile marine organisms, including seaweeds, worms, sea squirts, boring and sessile bivalves, hard corals, soft corals, and boring and sessile sponges. Experts in restoration ecology have used giant clam shells in developing methods for transplanting coral fragments (Guest et al. 2011).

Oil and Gas

Seismic blasting reportedly damages the reproductive organs and air bladders of marine organisms, and generally causes physiological stress. It can also modify the behavior of marine organisms, alter the geographic distribution of fish, and damage planktonic eggs and larvae. Fishers in Taňon Strait in the Visayas report that the seismic blasting carried out during exploration for oil and gas may have affected their fisheries.

Mining

The country's mining industry faces a number of operational issues that range from the environmental to the political. However, most of these are based on anecdotal reports. The environmental impacts of mining reportedly include disturbance of the habitats of dugong and whale sharks, while the political issues mining faces thus far have included the killing of a local official by a security personnel of a mining company during a protest demonstration.

Aside from the dugong, whale sharks (commonly known as *butanding*) are present at Rapu-Rapu Island in Sorsogon. As a result, the LGU there opposed a large-scale mining project because of its potential negative impact on the province's multimillion whale-watching industry.

Similarly, residents of Pamplona, Cagayan conducted information and education campaigns that opposed the operations of a mining company that mined magnetite sand. Drilling vessels had reportedly transported significant quantities of the black sand that contains magnetite before residents forced them to halt such operations. These activities were investigated by the Mines and Geosciences Bureau. Ultimately, if government protocols such as securing an ore transportation permit are not complied with, transport of these sands could be considered smuggling of minerals.

Most mining projects claim to provide benefits to local residents. However, given the risks of environmental damage from irresponsible mining practices as reported by communities where mining projects have been implemented, many residents want to avoid such risks by completely banning such projects.

One negative impact of mining is loss of farmland near coastal areas as a result of flooding in the wake of coastal erosion or deforestation. Mining may also impact coastal habitats directly, as tailings are often dumped into rivers and thereby transported to the coast. As this could degrade the habitat of coastal organisms that form the foundation of local fisheries, such negative impacts would likewise adversely impact local livelihoods.

A new mining code that does not favor the interests of large transnational mining corporations and local elites is required. Instead, such a code should introduce policies and practices that promote industrialization and cater to the needs of local residents. Strategies for promoting responsible mining that include protection of coastal habitats are likewise required if sustainable development of the Philippines coastal areas is to be achieved. One effective way of promoting this objective is through sustained information, education, and public awareness activities. The objectives of these activities should include raising the awareness of local residents on the long-term impact of mining on their livelihoods and environment.

One strategy for strengthening solidarity among local residents is by creating people's organizations capable of increasing the level of participation of community residents in local governance. Another strategy is to broaden the network of advocacy groups capable of raising awareness of such issues at both the national and international levels. Ultimately, supporting the promulgation of responsible mining practices in local government circles should be given high priority. At the national level, support of policy recommendations and actions that promulgate responsible mining practices should be provided to all members of legislative bodies.

National Plan of Action Initiatives and Future Plans

The Philippines National Coordinating Committee for the Coral Triangle Initiative (CTI) envisioned a national plan of action (NPOA) that addresses the issues faced by the country's coastal and marine resources. The country's NPOA for coastal and marine resources therefore includes five goals:

Goal 1: Priority seascapes designated and effectively managed
Goal 2: Ecosystem approach to management of fisheries and other marine resources fully applied
Goal 3: Marine protected areas established and effectively managed
Goal 4: Climate change adaptation measures achieved
Goal 5: Threatened species status improving

All aspects of the Philippines NPOA are consistent with the CTI principles and guidelines. Further, each of the five goals set out above includes appropriate strategies and quantitative targets.

For example, the priority seascapes identified under **Goal 1** comprise large-scale geographies that have been prioritized for both investment and action. Under these investments and actions, best practices are to be applied and their use expanded. **Goal 2** specifies that the ecosystem approach to fisheries and marine resource management is to be fully applied under the NPOA. Likewise, the effective management of MPAs included under **Goal 3** is to include community-based resource utilization and management.

These quantitative targets to be used for measuring progress in NPOA implementation are consistent with the set of measurable indicators formulated by the NCC Technical Working Group at the series of workshops convened for that purpose. As collection of these data will continue throughout implementation of the NPOA, this report presents data relating to these indicators that were available at the time of report preparation. Further details regarding the Philippines' NPOA may be found in NPOA (DENR 2011).

Goal 1: Priority Seascapes Designated and Effectively Managed

Goal 1 includes two measurable targets: (i) designation of priority seascapes, with corresponding investment plans completed and sequenced by 2012; and (ii) sustainable management of marine and coastal resources within all priority seascapes.

With regard to target (i), the Philippines has achieved significant progress in designating two priority seascapes. The first of these is the Sulu–Sulawesi Marine Ecoregion (SSME), which the country has jointly designated as a priority seascape together with Indonesia and Malaysia. The SSME, totaling 1 million square kilometers (km^2), was designated as a priority seascape through ratification of a memorandum of understanding with Indonesia and Malaysia. In addition to these three ratifying countries, the SSME is also recognized as a priority seascape by the CTI. The West Philippine Sea (or South China Sea) is identified as a priority seascape by the Philippines NPOA. Numerous stakeholder consultations have been conducted in advance of formal designation of the West Philippine Sea (or South China Sea) as a priority seascape.

Investment plans for both of these priority seascapes are at varying stages of formulation and implementation. Three comprehensive action plans have been produced for the SSME, one for each area of priority focus, which together includes MPAs, fisheries, and threatened and endangered species. All three of these action plans contain operational frameworks that are made up of specific initiatives that will be implemented over a 5-year period.

Excellent progress has likewise been achieved in formulating the policy and institutional framework, as well as an investment plan for the West Philippine Sea (or South China Sea) priority seascape. Formulation of the vision for the overall initiative has been completed, and the geographic limits of the seascape are being finalized based on stakeholder consultations. Scoping of a coastal resource management framework for this seascape is ongoing.

With regard to target (ii) above, capacity building initiatives for ensuring sustainable management of these two priority seascapes are being formulated. The Philippines NPOA identifies five elements that must be strengthened if sustainable management of marine and coastal resources within all priority seascapes is to be achieved. These include

(i) establishment of a management body;
(ii) formulation of relevant policies and legislations;
(iii) conduct of institutional capacity building programs necessary for achieving sustainable marine resource management;
(iv) availability of sufficient financial resources for full implementation of the investment plan, which are to be leveraged through sustainable financing schemes and partnerships with the private sector; and
(v) monitoring and evaluation system for tracking the progress achieved in fulfilling the four other goals identified above.

A guidebook on the selection, development, and implementation of seascapes has been completed and published (Atkinson et al. 2011). Full sustainable management of the coastal and marine resources that comprise the two priority seascapes referred above has yet to be achieved.

Projects, programs, and initiatives in support of Goal 1. The SSME action plans relating to sustainable fisheries, MPAs, and networks, as well as the protection of threatened, charismatic, and migratory species, were published and launched in 2009. These were further developed into comprehensive action plans that include the

(i) costs of implementing the plans;
(ii) relevant indicators;

(iii) lessons learned; and
(iv) achievements in fisheries as these relate to the SSME, MPAs, and species conservation.

The West Philippine Sea (or South China Sea) was selected from three possible priority seascapes for potential development under the CTI through stakeholder consultations and a particular set of criteria. In 2009, the vision for this initiative was formulated, and delineation of the West Philippine Sea (or South China Sea) as a priority seascape was proposed. Currently, scoping, processing of information, and site-based consultations are proceeding. These will all form inputs into the formulation of an institutional and policy framework for the seascape, as well as a site-based business plan. Finally, the Coastal and Marine Management Office of the PAWB was designated as the focal point for the DENR regarding matters relating to the SSME and CTI.

Under the CTI, the designation and implementation of priority seascapes involve three steps:

(i) designation,
(ii) formulation of an appropriate strategy, and
(iii) implementation of the strategy and monitoring of results achieved.

The West Philippine Sea (or South China Sea) priority seascape is in Step 2 of this three-step process (i.e., strategy development), while the SSME is in Step 3 (i.e., strategy implementation and monitoring). As a result, the SSME is already addressing most of the nine essential elements of a functioning seascape (Atkinson et al. 2011).

Goal 2: Ecosystem Approach to Management of Fisheries and Other Marine Resources Fully Applied

Goal 2 includes four targets, the first two of which have been met. Target 2.1 is the formulation of a national ecosystem approach to fisheries management (EAFM) policy, for which there are two indicators. The first indicator is the degree to which there exists a national EAFM policy that harmonizes current laws, and a policy framework that supports EAFM. The second indicator is the area (in km^2) of management units with operational and effective (fisheries) law enforcement units.

The other three targets have yet to be fully met. Target 2.2 is improved income, livelihood, and food security for residents of coastal communities. Target 2.3 is measures put into place for ensuring sustainable exploitation of shared tuna stocks. Target 2.4 is improvement in the effectiveness of management and sustainability of trade in live reef fish and reef-based ornamental fish.

Projects, programs, and initiatives in support of Goal 2. A major ongoing activity in support of Target 2.1 is the review of amendments to national and local fisheries policies and further amendment of these as appropriate. Review and amendment of the following legislations are ongoing:

(i) the Philippine Fisheries Code of 1998 or Republic Act No. 8550;
(ii) the National Integrated Protected Areas System Act of 1992 (NIPAS) or Republic Act No. 7586;

(iii) the Local Government Code of 1991 or Republic Act No. 7160; and
(iv) the National Marine Policy of 1994.

This review is consistent with achieving EAFM in harmony with the provisions of the Archipelagic Development Framework (ArcDev) and integrated coastal management principles.

Further, EAFM-related activities are ongoing at four sites. These include the formulation of a policy framework for EAFM implementation (Armada et al. 2009). These activities are being carried out under the auspices of the Fisheries Improved for Sustainable Harvest (FISH) Project of the Department of Agriculture–BFAR. Funding for this project was provided by the United States Agency for International Development (USAID) for the period 2008–2010. A major output of this project is a draft fishery administrative order submitted to BFAR.

An additional project assessed the *dulong (*a local species) fishery in Batangas on Luzon Island. The results of the studies carried out under this project comprise inputs into national and local discussions regarding policy toward management of this resource. These studies likewise identified potential sustainable livelihood options for local residents. A further initiative, the project on Sulu–Celebes (Sulawesi) Seas Sustainable Fisheries Management, is under implementation by the SSME Sub-Committee on Sustainable Fisheries. Funded by the Global Environment Facility and the United Nations Development Programme (UNDP), a major output of this project is an analysis that will form an input into formulation of a strategic plan for this area.

Another initiative that relates to Target 2.1 is the preparation of a management plan for fish-aggregating devices for large pelagic fish (e.g., tuna). The legal aspects of the plan are also under review, as are all relevant institutional frameworks. Further, a National Stock Assessment Project implemented by BFAR formed the basis of draft legislation for rationalizing issuance of commercial fishing vessel licenses throughout the Philippines. This draft legislation will be subject to national consultation.

A further initiative relating to Target 2.1 is the preparation of a comprehensive national fisheries industry development plan that has been completed by BFAR. Subsequent steps relating to this initiative include formulation of an operational programming budget and a review of implementation by BFAR.

The Small-Scale Fisheries Governance Project funded by the WorldFish Center reviewed governance and fisheries management strategies. The output of this review was a set of policy recommendations relevant to both the national and local levels. This project also included a capacity building component relating to both the national and local levels at several pilot sites. Based on a sustainability assessment of mariculture practices in Mindanao and Palawan carried out under this project, a fishery and environmental policy for marine aquaculture has been formulated.

Strategies for achieving EAFM require all stakeholders to work together. Targeting relevant areas of Luzon, the Visayas, and Mindanao, the Integrated Coastal Resource Management Program (2009–2013) was successful in this regard, as it achieved close collaboration by stakeholders at all levels, including DENR-PAWB and Department of Agriculture-BFAR.

Finally, local field enumerators in Mindanao's Zamboanga del Norte Province received training in performing fish landing surveys. The results of these surveys will be used to formulate policy recommendations for the local sardine fishery.

Initiatives in support of Target 2.2 focus on improving the income, livelihood, and food security of fishing communities. The Regional Fisheries Livelihood Programme performed resource and social assessments for coastal fisheries in Zamboanga del Norte in 2010–2011. This initiative was supported by Spain's Agency for International Development Cooperation (*Agencia Española del Cooperación Internacional para el Desarrollo*).

Target 2.3 mainly addresses management of tuna fisheries. A number of projects supported fulfillment of Target 2.3 through formulation of a management plan for exploited tuna species in the Philippines. For example, the National Tuna Management Plan was updated in 2010 under the auspices of the West Pacific East Asia Oceanic Fisheries Management Project that was completed in 2013. The primary objective of this project was to promote conservation, management, and equitable use of tuna resources in the context of sustainable development of the whole industry. As a result of this update, the plan now applies to all commercial and small-scale tuna fishing up to the limit of the country's EEZ. Specific management measures under the plan also address operation of Philippine-flagged vessels in waters outside Philippine jurisdiction, as well as trade in products derived from tuna caught outside Philippine jurisdiction but which are transshipped through the Philippines.

Initiatives in support of fulfillment of Target 2.4 include formulation and implementation of management plans for the live reef fish trade as it specifically relates to Palawan, Surigao, and Tawi-Tawi provinces. Formulated in consultation with stakeholders, these management plans include provisions specific to the live reef fish trade at particular sites. Partnerships for supporting implementation of these management plans are being established. These partnerships include local and international traders' associations, academic institutions, relevant government agencies, and international buyers. One of the expected outputs of this exercise is improvement in the management capacity of local government units in applying EAFM principles to the live reef fish trade in the areas to which these plans relate.

Finally, a major output of the USAID-funded FISH Project was a set of policy recommendations relating to Palawan's live reef fish trade. This project also funded a study of spawning aggregation sites of target species. The results of this study will then inform establishment of protected areas (i.e., seasonal closures relevant to the target species). Strict enforcement of laws relating to the live reef fish trade, creation of a live reef fish trade council, and formulation of management plans for reef-based ornamental fish are ongoing.

Goal 3: Marine Protected Areas Established and Effectively Managed

Goal 3 includes three targets. The first is a regionwide Coral Triangle MPA system in place and fully functional by 2020. The other two targets include protection of specific habitats and their effective management.

To date, the Philippines has legally established 439 MPAs, while many others have been proposed (Table 20). Most of these MPAs are located in waters under municipal jurisdiction. Some have been declared under the NIPAS Act, while others have been established under various national laws and municipal ordinances. One of the most important of the Philippines MPAs is Tubbataha Reefs Natural Park, which has also been designated a World Heritage Site by the United Nations Educational, Scientific, and Cultural Organization (UNESCO).

Table 20 **Declared Marine Protected Areas in the Philippines**

Code	Marine Protected Area Designation Status/Category	Number
AR	Artificial Reef	10
ECA	Environmentally Critical Area	1
RSP	Reserve, Sanctuary, Park	800
MTS	Marine Turtle Sanctuary	7
MSFR	Mangrove Swamp Forest Reserve	120
PLS	Protected Landscape and Seascape	10
SP	Seashore Park	1
TZMR	Tourist Zone Marine Reserve	65
WA	Wilderness Area	52
WT	Wetland	10
M	Multiple (more than 1 category)	50
U	Undetermined	50

Sources: Tun et al. (2004); Arceo et al. (2008).

The Philippines has forged partnerships with academic institutions, conservation organizations, people's organizations, government agencies, and development partners to monitor its hundreds of MPAs. As a result, the monitoring tools currently in use are the result of a relatively long process of formulation, application, reassessment, and refinement.

Using 2008 data, Weeks et al. (2010) (Table 21) reported 985 MPAs as having been established in the Philippines. Together, these MPAs comprised a total area of 14,943 km^2. Of these 985 MPAs, 942 included no-take areas, the area of which together totaled 1,459 km^2. Thus, 4.9% of coastal municipal waters (within 15 km of the coastline) were protected by formal MPAs, with 0.5% of coastal municipal waters being no-take areas. Although this report used the total coral reef area of 26,000 km^2 estimated by Burke et al. (2002), the country's total coral reef area reported by other studies ranged from 20,000 km^2 (Weeks et al. 2010) to 22,484 km^2 (Burke et al. 2011).

Using the range of the total extent of the Philippines coral reef area referred to above results in 2.7%–3.4% of this total area being protected by no-take MPAs. Weeks et al. (2010) found that community-based MPAs comprised 95% of the total area of MPAs in the country. Together, these community-based MPAs had a combined area estimated at 628 km^2, of which 206 km^2 comprising no-take areas.

The Visayan Sea bioregion (the Visayas region) was home to the greatest number of MPAs (67%). Although the Sulu Sea and West Philippine Sea (or South China Sea) biogeographic

Table 21 **Number and Size of Marine Protected Areas, by Biogeographic Region**

Marine Biogeographic Region[a]	Number of MPAs	MPA Coverage (km^2)		Municipal Waters[b]	
		All	No-Take	All	No-Take
Celebes Sea	50	2,345.13	7.37	6.77	0.02
Northern Philippine Sea	35	2,469.60	7.54	6.52	0.02
Southern Philippine Sea	102	3,500.02	33.16	12.67	0.12
Sulu Sea	90	3,573.35	991.29	4.52	1.25
West Philippine Sea (or South China Sea)	51	1,836.93	283.71	4.26	0.66
Visayan Seas (Visayas Region)	663	1,219.50	136.50	1.50	0.17

km2 = square kilometer, MPA = marine protected area.

[a] These are the marine biogeographic regions identified by Ong et al. (2002).

[b] Municipal water boundaries (15 km offshore) calculated as per DENR (2001).

Source: Weeks et al. (2010).

regions were home to fewer MPAs, these latter areas were the best protected, as 1.25% and 0.66% of their respective municipal water areas were located in no-take MPAs. The Philippines biogeographic regions include the large no-take areas of Tubbataha Reef National Park and Apo Reef Natural Park. Overall, the size of individual MPAs ranges from 0.01 km^2 to 2,789.14 km^2, the latter comprising Siargao Protected Landscape and Seascape. The (mean) average area of all MPAs taken together is thus 23.60 km^2.

In 2010, the MPA Support Network (MSN) formulated the Management Effectiveness Assessment Tool (MEAT). The purpose of this tool was assessment of the performance of MPA management. The results of this assessment were then used to decide the winners of the 2011 Best MPA Awards. MSN is a group composed of national government agencies, academic institutions, NGOs, and other institutions that focus on MPA management in the Philippines. As this tool is a means of determining how well Goal 3 of the Philippines NPOA is addressed, it forms a significant contribution to managing the progress achieved in implementing the NPOA over time.

Dizon et al. (2011) reported that of the Philippines 1,208 MPAs, MEAT was used to assess the management performance of 110 MPAs in the run-up to the 2011 Best MPA Awards. These 110 MPAs together comprise 9% of the total area of locally managed MPAs. This assessment revealed that 70 (64%) of these 110 MPAs were effectively managed (i.e., the effectiveness of their management was rated at levels 2–4 as described in Table 22). However, the total area of these 70 effectively managed MPAs taken together comprised only 14% of the total area of the 110 MPAs assessed.

Most of the larger MPAs are located in Luzon and, to a lesser extent, Mindanao. Conversely, the Visayas region is home to the greatest number of small MPAs. An analysis of current MPA management status performed in 2011 revealed that 1,072 MPAs (89%) had formal status as established MPAs (Table 23). This represents an increase in the number of MPAs over the 985 MPAs reported by Weeks et al. (2010). However, this increase was not evenly distributed over the country. Over the period 2008–2011, the number of MPAs in the North Philippine

Table 22 Number of Local Marine Protected Areas in the Philippines that Met MEAT Criteria

Management Effectiveness	Number of MPAs (locally managed)	Total Area (hectares)
Level 0: MPA needs to satisfy the requirements of Level 1	26	24,590.44
Level 1: MPA is established	14	956.84
Level 2: MPA is strengthened	48	2,922.11
Level 3: MPA is effectively sustained	21	1,361.39
Level 4: MPA is effectively institutionalized	1	22.91
Total	**110**	**29,853.69**

MEAT = Management Effectiveness Assessment Tool, MPA = marine protected area.
Source: MSN-CI-CTSP Report (2011).

Table 23 Number and Percentage Share of Marine Protected Areas in the Philippines Evaluated using MEAT

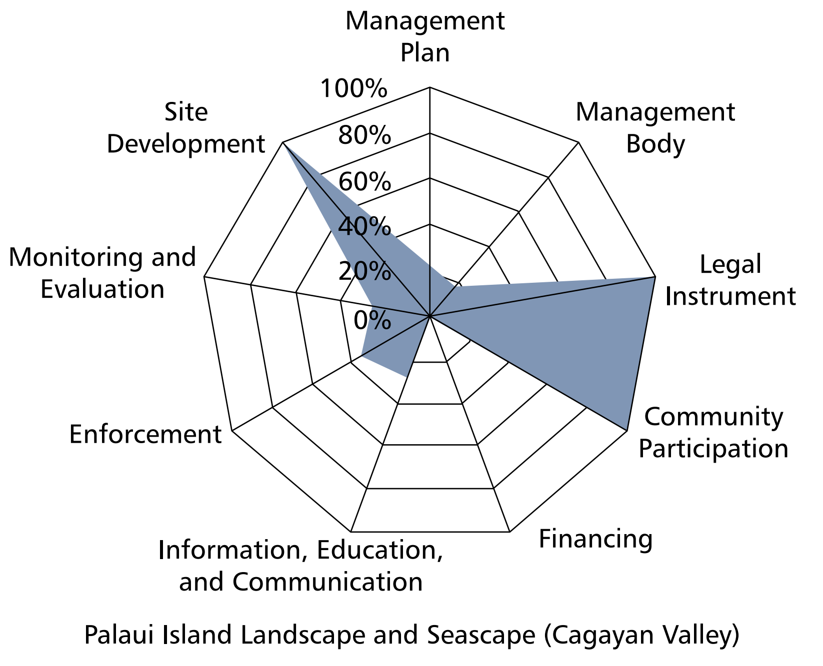
Description	Number of MPAs	MPAs Evaluated with MEAT	% MPAs Evaluated with MEAT
Total number of MPAs recorded in the database	1,208	117	9.6
Established MPAs	1,072	113	10.5
Proposed MPAs	136	3	2.2
Biogeographic zones			
Northeastern Philippine Sea	122	1	0.8
Southeastern Philippine Sea	48	2	4.2
West Philippine Sea (or South China Sea)	107	18	16.8
Sulu Sea	85	28	32.9
Visayan Seas (Visayas Region)	740	41	5.5
Celebes Sea	104	26	25.0

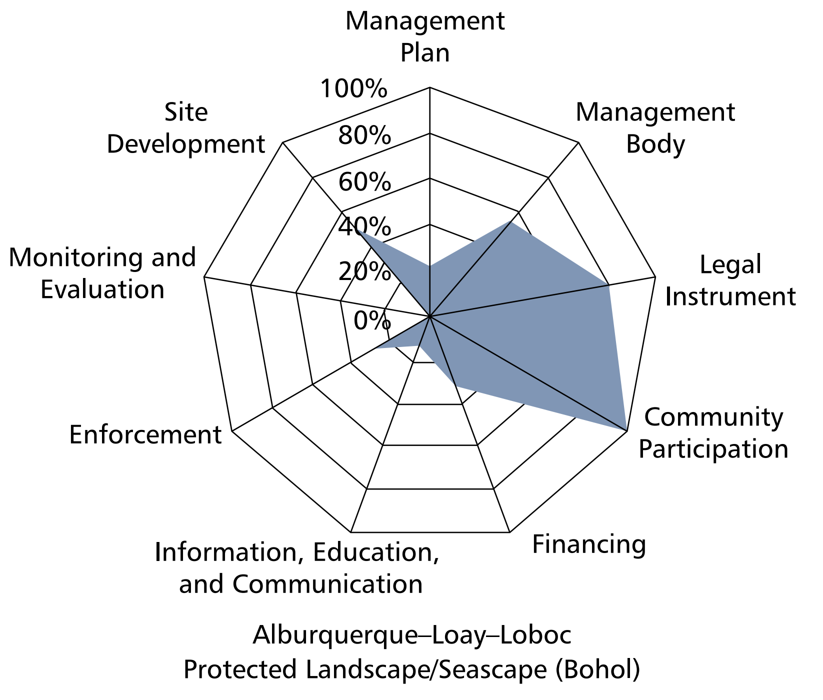
MEAT = Management Effectiveness Assessment Tool, MPA = marine protected area.
Source: MSN-CI-CTSP Report (2011).

Sea (Northeastern Philippine Sea) had increased by a factor of four, and those in the West Philippine Sea (or South China Sea) and Celebes Sea had increased by a factor of two. The number of MPAs in the Visayan Sea showed a slight increase, while no increase in the number of MPAs in the Sulu Sea was recorded. Finally, at this writing, the number of MPAs located in the South Philippine Sea (Southeastern Philippine Sea) appears to have decreased by 50% over the period, but this requires verification.

As of September 2011, MEAT had been used to assess the management of 9 of 33 MPAs that comprise the NIPAS. The total area of these 9 MPAs was 700,018 hectares (ha), or 41% of the 1.7 million ha of MPAs that comprise the NIPAS. Three of these nine MPAs (Figure 15) were found to be effectively managed (Table 24). These three NPAs thus represent 47% of the national MPAs that are effectively managed (Table 25).

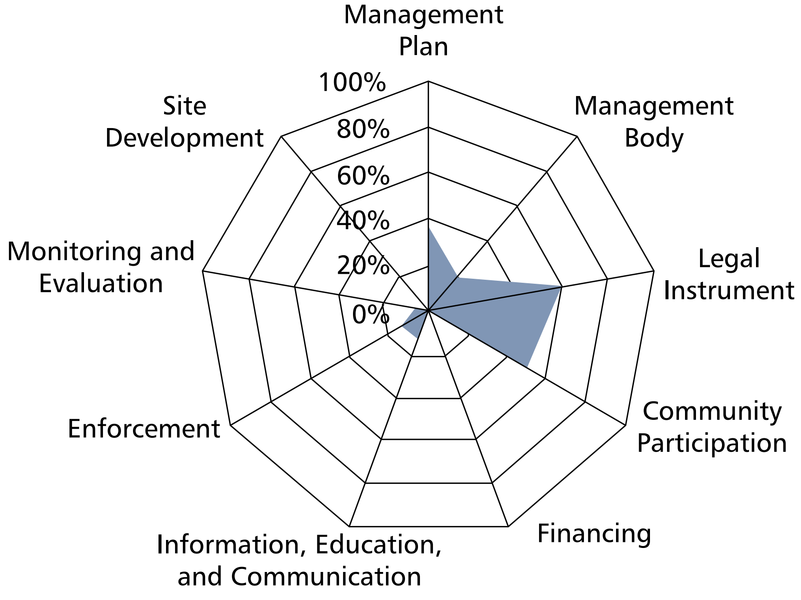
Figure 15 **Results of Assessment of Management Status of Nine Marine Protected Areas that are Members of the National Integrated Protected Areas System**



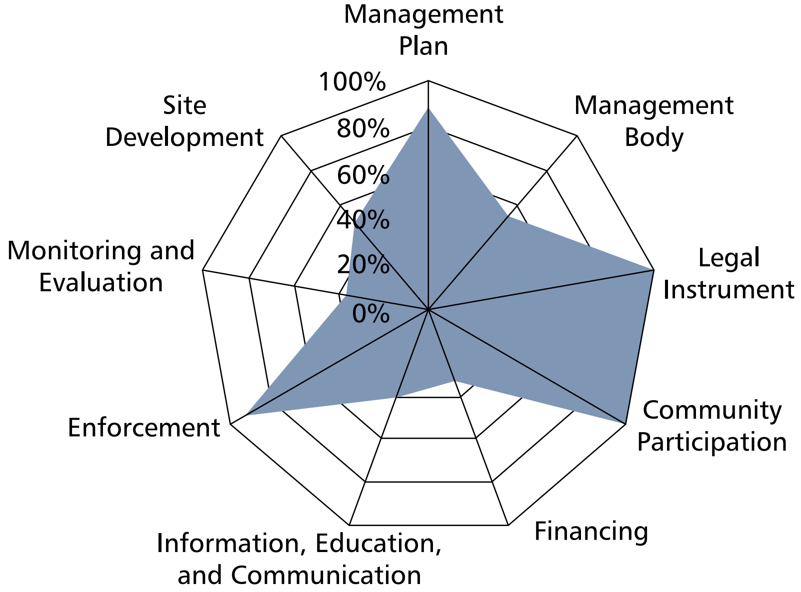


continued on next page

Figure 15 *continued*



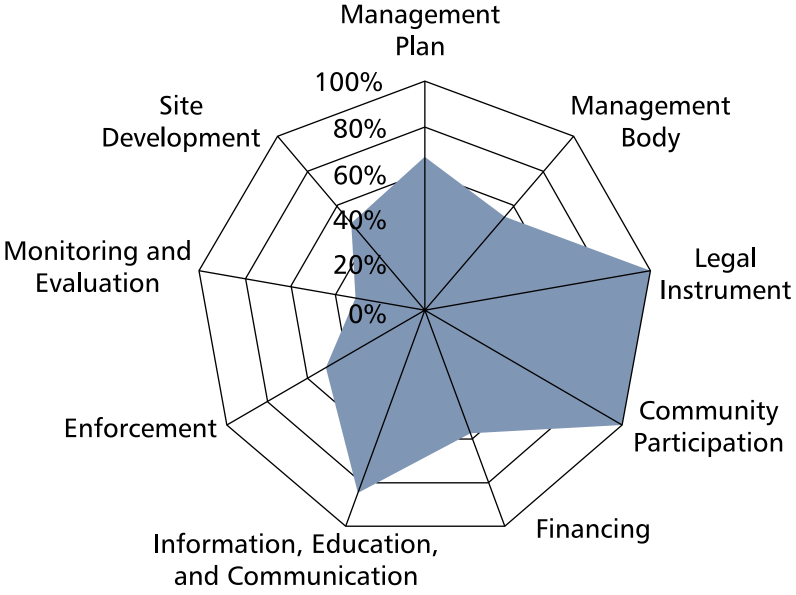
Masinloc and Oyon Bays Marine Reserve (Zambales)



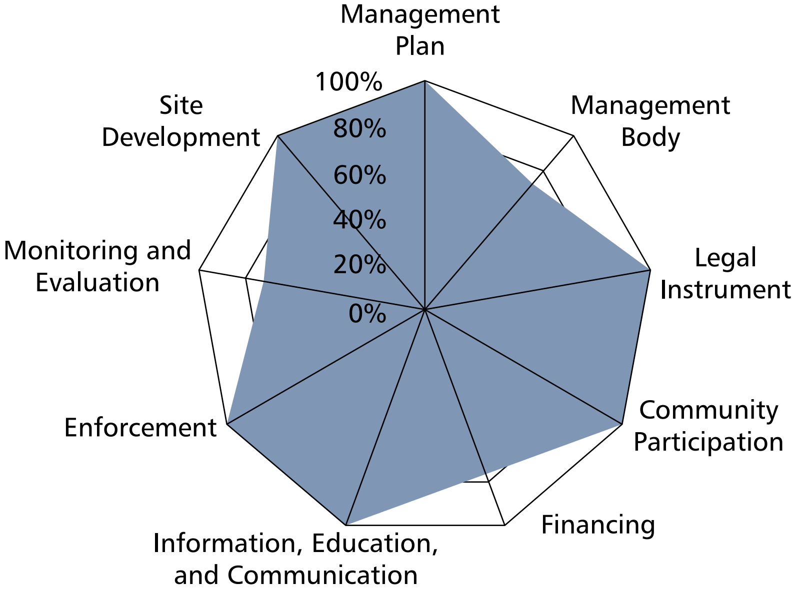
Sarangani Bay Protected Seascape

continued on next page

Figure 15 *continued*



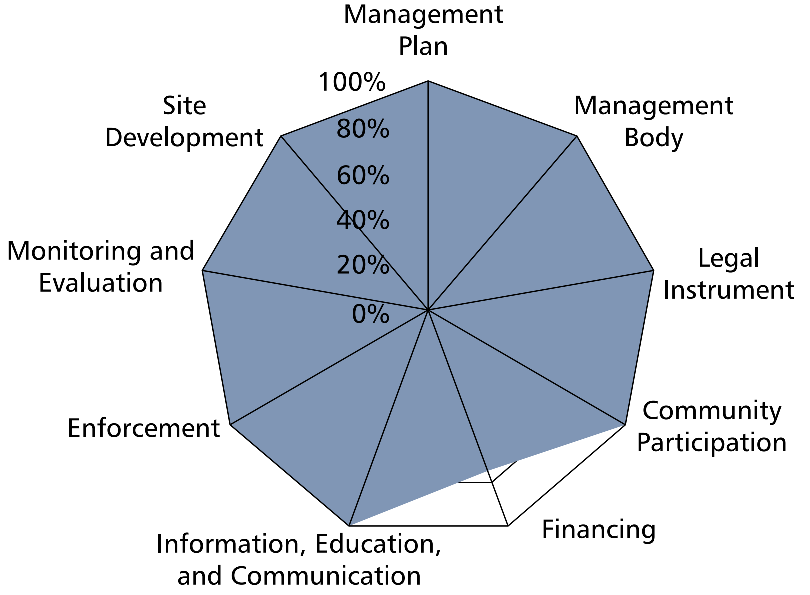
Turtle Islands Wildlife Sanctuary (Tawi-Tawi)



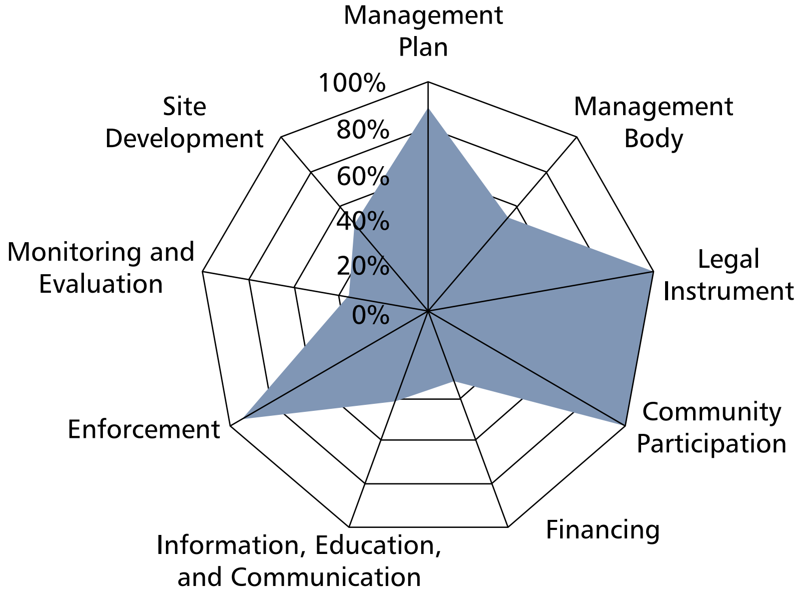
Apo Reef Natural Park (Occidental Mindoro)

continued on next page

Figure 15 *continued*



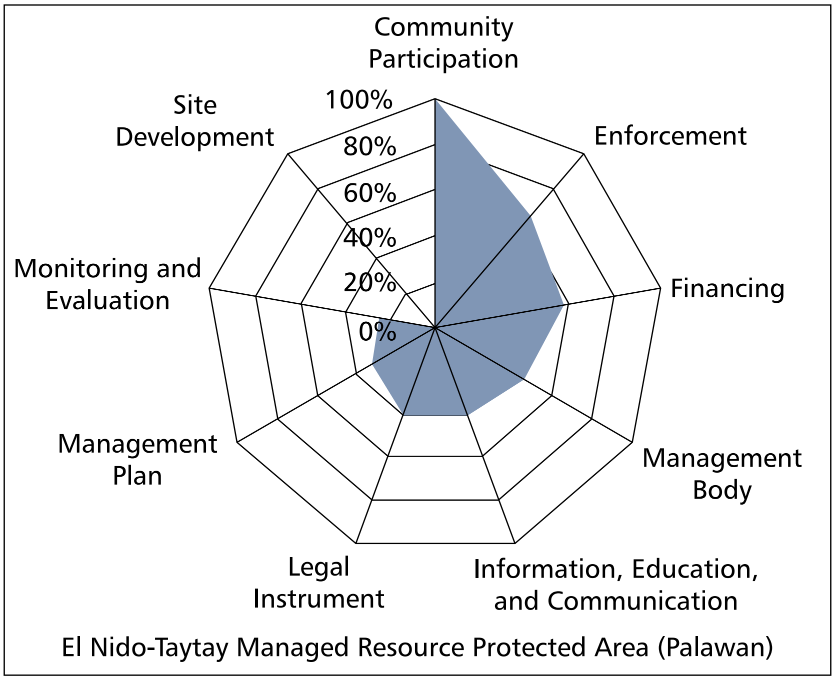
Tubbataha Reefs Natural Park (Palawan)



Pujada Bay Protected Landscape/Seascape (Davao Oriental)

continued on next page

Figure 15 *continued*



Source: Dizon et al. (2011).

In addition to the effectiveness of NPA management, MEAT was used to evaluate the focus of management. This relates to particular aspects that include the

(i) management plan;
(ii) management body;
(iii) existence or absence of a legal instrument declaring the MPA;
(iv) degree of community participation in MPA activities;
(v) availability and sustainability of financing;
(vi) number, size, breadth, and scope of information, education, and communication programs;
(vii) effectiveness of enforcement;
(viii) degree to which monitoring and evaluation tools are used; and
(ix) degree of development of the MPA site in question.

The scores resulting from application of MEAT include the degree to which particular criteria relating to (i)–(ix) above are met.

The largest MPA in the Philippines, Tubbataha Reefs Natural Park scored the highest with regard to management. Its capacity in all criteria was rated as high except for the MPA's financial aspect, which scored only slightly less than 80%. Such scores reflect the excellent conditions at the site (e.g., high fish biomass, large average fish size, high degree of species richness, extensive and only slightly degraded reef habitat). Apo Reef Natural Park also showed relatively high levels of management effectiveness, indicating similarly remarkable conditions compared to Masinloc and Oyon bays, Albuquerque–Loay–Loboc, and Palaui Island protected sites, all of

Table 24 Level of Effectiveness Achieved in Managing Marine Protected Areas that are Members of the Philippines National Integrated Protected Areas System

Region	Name of Marine Protected Area		Province where MPA is Located	Area (hectares)	Level of Management Effectiveness
2	1	Palaui Island Marine Reserve	Cagayan	7,415	Level 0: No management plan adopted
3	2	Masinloc and Oyon Bays Marine Reserve	Zambales	7,568	Level 0: No management plan adopted
4B	3	Apo Reef Natural Park	Occidental Mindoro	15,792	Level 2: MPA management strengthened
4B	4	El Nido Managed Resource Protected Area	Palawan	89,134	Level 1: MPA established
4B	5	Tubbataha Reefs Natural Park	Palawan	98,828	Level 3: MPA is effectively sustained
7	6	Alburquerque–Loay–Loboc Protected Landscape and Seascape	Bohol	1,164	Level 0: No management plan adopted; no baseline assessment conducted
ARMM	7	Turtle Island Wildlife Sanctuary	Tawi-Tawi	242,967	Level 1: MPA established
11	8	Pujada Bay Protected Landscape/Seascape	Davao Oriental	21,200	Level 1: MPA established
12	9	Sarangani Bay Protected Seascape	Sarangani and General Santos City	215,950	Level 2: MPA management strengthened
TOTAL				700,018	

ARMM = Autonomous Region in Muslim Mindanao, MPA = marine protected area.
Source: Dizon et al. (2011).

Table 25 Number of National Marine Protected Areas in the Philippines Meeting MEAT Criteria in 2011

Management Effectiveness	Number of MPAs	Total Area (hectares)
Level 0: MPAs need to satisfy the requirements of Level 1	3	16,147
Level 1: MPA is established	3	353,301
Level 2: MPA is strengthened	2	231,742
Level 3: MPA is effectively sustained	1	98,828
Level 4: MPA is effectively institutionalized	0	0
Total	**9**	**700,018**

Source: Dizon et al. (2011).

the latter MPAs being found to require significant effort if the scores of these sites relating to a number of criteria are to be raised.

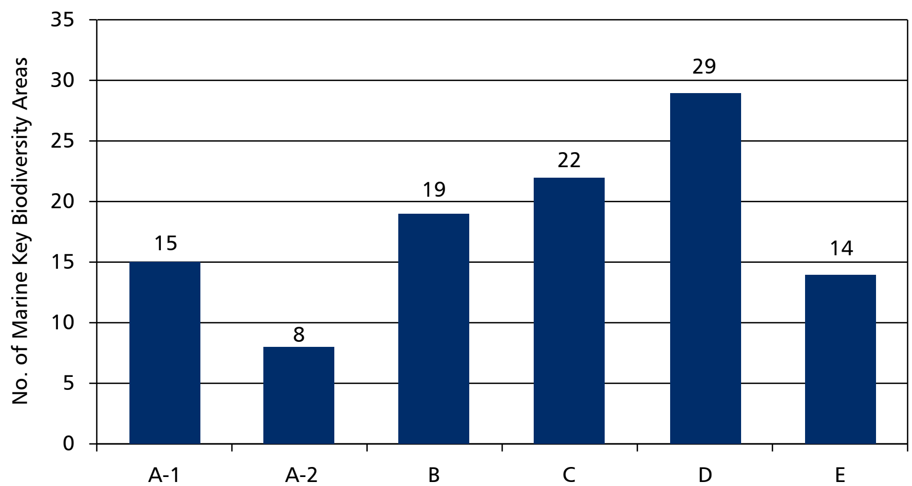
Using examples specific to the Philippines, the short review conducted by Panga (2011) highlighted the importance of MPA networks. Similarly, Laffoley et al. (2008) found that MPA networks facilitate the creation, connection, and optimal management of individual MPAs. The MPA networks allow economies of scale that facilitate conservation, ecological protection, risk reduction, and goals other than conservation to be pursued. It is the economies of scale that derive from MPA networks that allow individual MPAs to focus on the economic and sociocultural aspects of the communities living adjacent to them in addition to pursuing ecological goals (Laffoley et al. 2008).

Guided by these principles, Panga (2011) showed that differences in the level of MPA management effectiveness in the Philippines reflect differences in the structure of MPA networks. For example, the Masinloc Marine Sanctuary Association in Zambales, western Luzon, is a municipality-based fishers' federation. This MPA has a single-level structure. Several fishers formed this federation, which in turn is made up of committees. Each committee in turn is composed of fisher-members drawn from the four MPAs located in the municipality (Ebue 2011). The organizational structures of MPAs in other municipalities were quite different. Some had multilevel structures, and exhibited organizational characteristics unique to themselves (Panga 2011).

The more recent list of marine key biodiversity areas (MKBAs) in the Philippines published by Conservation International Philippines in 2009 includes sites in addition to those enumerated by the surveys referenced above. This latter list shows an increase in the number of MKBAs over that reported by Ong et al. (2000). However, this increase is not distributed equally across the country.

For example, most (66%) of the MKBAs identified were located in the Visayan Seas, the Sulu Sea, and the West Philippine Sea (or South China Sea), whereas the number of MKBAs located in the Southeastern Philippine Sea remained unchanged (Figure 16). Overall, the Visayas region

Figure 16 **Number of Marine Key Biodiversity Areas Located in the Philippines' Six Marine Biogeographic Regions**



Notes:
A-1 = Northeastern Philippine Sea
A-2 = Southeastern Philippine Sea
B = West Philippine Sea (or South China Sea)
C = Sulu Sea
D = Visayas Region
E = Celebes Sea
Source: Conservation International Philippines (2009).

was home to the greatest number of MKBAs; and the Sulu Sea, the second greatest number. The Visayas region and the Celebes Sea showed the greatest increase in the number of MPAs. However, little information was available concerning a number of localities, such as Romblon (east of Mindoro Island) and the eastern shores of the Moro Gulf (southwest of Mindanao).

Table 26 reports the total extent of coral reef areas located within the MKBAs. However, due to data constraints, in some cases, estimates of the extent of coral reef area drawn from previous surveys were used to supplement the estimates derived from the more recent Conservation International Philippines data set referred to above.

Table 26 **Estimates of Total Coral Reef Area in Marine Key Biodiversity Areas, by Biogeographic Region**

Biogeographic Zone	Name of Marine Biogeographic Region	Coral Reef Area within MKBA (hectare)
A-1	Northeastern Philippine Sea	3,323,649.78
A-2	Southeastern Philippine Sea	505,111.81
B	West Philippine Sea (or South China Sea) (Kalayaan Islands Group = 22,846,585.81)	24,623,758.80
C	Sulu Sea (Tubbataha Reefs National Marine Park = 90,419.67)	8,302,064.16
D	Visayan Seas (Visayas Region)	3,216,427.78
E	Celebes Sea	875,642.18

MKBA = marine key biodiversity area.
Notes:
A-1 = Northeastern Philippine Sea
A-2 = Southeastern Philippine Sea
B = West Philippine Sea (or South China Sea)
C = Sulu Sea
D = Visayas Region
E = Celebes Sea
Sources: Ong et al. (2000), MERF (2009). Satellite imagery was used to derive the data in the table.

Goal 4: Climate Change Adaptation Measures Achieved

This goal includes two targets: (i) formulation and implementation of a region-wide, early-action, climate change adaptation plan for the nearshore marine and coastal environment and small island ecosystems; and (ii) establishment and full operation of a network of national centers of excellence pertaining to climate change adaptation for marine and coastal environments.

Programs and initiatives in support of Goal 4. The Sulu–Sulawesi Seascape Program sponsored by the Global Marine Division of Conservation International supported formulation of a climate-resilient MPA strategy by the Verde Island Passage MPA Network. This program facilitated the establishment of the first climate resilient MPA in Lubang Island. The program also assisted formulation of a climate-resilient MPA strategy for Calatagan. Two initiatives supported the climate change component of the Sulu–Sulawesi Seascape. These included USAID's Coral Triangle Support Partnership and International Climate Initiative Ecosystem-Based Adaptation.

The Philippines' Department of Science and Technology is supporting the Remote Sensing Information for Living Environments and Nationwide Tools for Sentinel Ecosystems in our Archipelagic Seas (RESILIENT SEAS) Program. This program is administered by the Philippine Council for Agriculture, Aquatic, and Natural Resources Research and Development and is being implemented by six partner institutions led by UPMSI. This program aims to formulate a climate change vulnerability assessment framework, which identifies appropriate criteria for assessing vulnerability to the negative impacts of climate change. The framework also describes the specific attributes of these criteria, as well as how they interrelate, the process to be used for identifying climate change adaptation strategies, and the mechanisms that must be in place to support these strategies.

The following climate change-related projects assess the exposure, sensitivity, adaptive capacity, and vulnerability of the Philippines to the negative impacts of climate change.

Project 1: Climate Change and the Coast: Vulnerability of Bentho-Pelagic Productivity. This project identified sites that represent the Philippines' various climate typologies. Automatic weather stations were installed at 10 sites across the various environmental gradients in the country. The climate typology of each gradient was derived from modeling and simulation of oceanographic processes (i.e., seasonal weather residence and material residence). The simulation showed highly monsoonal weather in the Philippines. The sensitivity of rainfall anomalies in the southern parts of the country to the Southern Oscillation Index was highlighted. The sensitivity of sea surface height (SSH) anomalies of the entire country to the Southern Oscillation Index was also observed. In addition, types I, II, III, IV, VII, and X were sensitive to the state of the Pacific Decadal Oscillation.

Project 2: Retrospective Analyses of Climate Change from Coastal Erosion Trends and Uplifted Coral Reef Assemblages (RetroCET). This research assessed sea-level changes over the period 1992–2008 using altimetry-derived SSH. The SSH data were compared with tide gauge data to extract the non-oceanographic signal in the data sets. The vulnerability of coastal villages in Davao and Iloilo to erosion and marine inundation was assessed. Seasonal monitoring of shoreline changes through Global Positioning System surveys and beach profiling were also performed in Batangas and Zambales.

Project 3: Monitoring and Impact Research on Resilience of Reefs (MIRROR). This study used high resolution techniques of transect and permanent quadrant monitoring to document changes in coral reefs brought about by anomalously high sea surface temperatures (SSTs). Results included identification of coral genera susceptible to climate-related bleaching, and the effects of temperature on coral cover and diversity (loss of 50% coral cover in one site associated with a drastic increase in SST). Further projections of reef health under various scenarios of climate change and human impacts will aid local governments and other constituents in making informed policy and management decisions. This research complements other efforts carried out under the RESILIENT SEAS program that use vulnerability assessments in the formulation of adaptation strategies for reducing climate change-related risks through timely action.

Project 4: Fisheries Ecosystem Connectivity and Monitoring (Fish EConnect). Performed by the University of the Philippines in the Visayas, this project focuses on the early life history of target species of selected fisheries. Together with Projects 6 and 7 below, this project demonstrates the comparative seasonal variability of target fisheries.

MERF-UPMSI

Regional Coastal Climate Change Adaptation Initiative Workshops organized by the Coastal Learning Adaptation Network

Project 5: Invertebrate Fisheries Populations as Response Indicators for Climate (INVERTS). This project found the interaction of local site attributes, such as the extent of reef habitat, wave exposure, and degree of fisheries exploitation to be critical to the relative vulnerability of the collector sea urchin vis-à-vis storminess and SST variability and climate-related variation.

Project 6: Monitoring of Potentially Vulnerable Coastal Fisheries in Northwestern Mindanao (CoastFish). Coastal fisheries in the four bays of Northern Mindanao were studied to determine sustainability amid high fishing pressure. The sardine fishery in Sindangan, Zamboanga del Norte was observed to exhibit a variation (strong seasonality) linked to changes in monsoons. There appeared some relationship between fisheries and oceanographic patterns that showed the linkages that can relate to climate change variability. Sardine stock variability was influenced by periodic changes in oceanographic processes (temperature-driven upwelling zones).

Project 7: Climate Impact and Adaptation in the Coastal Environment (CLIMACE). Together with the other fisheries project components, this project provided value-added insights regarding the social and ecological aspects on the *siganid a*nd scallop fisheries in the Bicol region.

Project 8: Research and Development for Adaptive Management and Feedback Monitoring Networks (ADAPT). This project of the RESILIENT SEAS Program (2009–2011) provided enabling activities for determining adaptation strategies among the constituents of the sites. Training, monitoring, and participation of local partners in climate-related impacts were demonstrated at six sites. Sensitivity of species, habitats, ecosystems, and coastal communities to the potential impacts of climate change variability, such as siltation related to increased precipitation, storm surge buffering of ecosystems, and thermal anomalies that lead to coral bleaching and mortality, were highlighted. These comprised important contributions to the vulnerability assessment and climate change simulation scenarios. The following activities were also undertaken:

(i) One of the mechanisms of building reef resilience included initial engagement of a broader network of coral bleaching watch partners. This stimulated widespread reports of bleaching in the country. An internet-based system was set up that resulted in nationwide reporting. This system elicited more than 500 reports of coral bleaching around the country.

(ii) Publication of *The State of the Coasts Report* (2010) was a critical output of the study, which reported the status of resources and habitats as benchmark indices vis-à-vis climate change impacts. This research also focused on vulnerability assessments and identification of adaptation strategies.

Another project focusing on climate change was Initiating the CTI Coastal Learning Adaptation Network (CLAN). Implemented by the Marine Environment and Resources Foundation (MERF) of UPMSI, this project was financed by USAID. The primary objective of this project was to initiate institutional learning partnerships among Coral Triangle regional and in-country partners, and to build the capacity of member countries to adapt to change in the coastal context. Regional meetings and training will facilitate knowledge and information exchange relating to vulnerability assessment, formulation and implementation of coastal adaptation strategies, and monitoring and evaluation.

Goal 5: Threatened Species Status Improving

Goal 5 includes three targets:

(i) improving the status of sharks, sea turtles, marine mammals, and other threatened species;
(ii) protecting spawning aggregation sites of vulnerable fishes and the nesting sites of turtles and birds; and
(iii) assessing the status of key bony fishes to establish baseline data for priority taxa.

The NPOA includes plans for producing a number of species action plans. To date, a species action plan relating to sharks has been completed, and corresponding action plans for turtles and marine mammals are being formulated. The formulation of species action plans for seabirds, wrasses, and reef fishes is to be completed by 2015. Further, estimation of the total area of the country's protected marine habitat that contributes to conservation of threatened species is ongoing.

Programs and initiatives in support of Goal 5. Some studies regarding recovery of marine turtle populations have been performed. Nesting of critically endangered hawksbill turtles have been observed at several sites in Region XI (Davao region). A memorandum of agreement has been ratified by DENR, the mayor of Davao City, and the Davao Light and Power Company. Covering the period 2004–2009, this memorandum of agreement addresses conservation of both marine turtles and dugongs (*Dugong dugon*). This joint initiative was formulated in a way that facilitates its replication elsewhere in the Philippines.

A sea cucumber research and development program is being implemented by UPMSI. The objective of this research is to improve management of natural populations and promote sustainable harvesting practices. The Commission on Higher Education has supported several research institutions in performing inventory and resource assessments of sea cucumbers in the country's key marine biogeographic areas. This program improves the resource assessment, data handling, processing, and analytical capacity of these institutions.

Bicol University is providing scientific data to the government of Cauayan, Masbate (Visayas Region) that will facilitate formulation of policies and ordinances for managing the scallops in the Asid Gulf. These ordinances will address numerous aspects of scallop harvesting, including minimum size, closures, and zoning of scallop beds.

A study of the short-necked clam *Paphia undulata* fishery in Negros Occidental facilitated formulation of guidelines for managing paphia clam fisheries. These guidelines only allow harvesting of clams of sexually mature size, and impose seasonal closures during spawning periods.

Community-based stock enhancement of top shell *Trochus niloticus* is expanding the trochus population through restocking of reefs with juvenile and adult top shells. This initiative will thus help restore Palawan's severely exploited trochus populations. The local community's Fish Sanctuary Management Plan includes public awareness activities, such as training and seminars relating to both management and biology.

Capacity Building

Under the University Mentoring Program, recognized centers of excellence in marine science and related disciplines serve as mentors to institutions of higher education. The beneficiaries of this program assist LGUs implement the technical aspects of sustainable coastal resource management, which in turn assists implementation of the Philippines NPOA. Under this program, five centers of excellence have mentored six universities. This assistance includes a short course in science as it pertains to coastal resource management on particular aspects of physical and chemical oceanography, biology, coastal habitats, fisheries, and climate change that relates to coastal resource management.

Capacity building activities undertaken by the Coastal and Marine Management Office of PAWB improve the biodiversity conservation and integrated coastal management skills of its technical staff. These trained technical staff members then conduct seminars and training for the staff of provincial offices and LGUs.

PAWB's capacity building initiatives likewise include training relating to ecotourism that addresses issues, such as ecotourism principles, planning and development, full-site diagnostic analysis, and business planning. Participants include enterprise development assistants, DENR technical staff, and members of people's organizations.

Financial Considerations

This section reviews the financing mechanisms that directly or indirectly contribute to enforcement in, and maintenance of, the country's numerous MPAs.

User Fees

Recreational visitors are mainly assessed user fees by marine reserves or MPAs. Imposition of user fees began in the Visayas region under Silliman University initiatives at Apo Island. User fees were likewise assessed at MPAs located at Sumilon, Gilutongan and Olango, these schemes being initiated under the USAID-funded Coastal Resources Management Project. Imposition of user fees has since spread to other MPAs, particularly those offering recreational diving. Similarly, user fees are now levied on a wide range of activities that take place either within, or adjacent to, the boundaries of MPAs. For example, user fees on aquaculture activities, resorts, and large-scale economic development projects are now assessed. Some LGUs likewise charge fees for using recreational areas, particularly those that enable enjoyment of environmental amenities.

Registration and Licensing Fees

Registration and licensing fees are common revenue-generating mechanisms in coastal resource management. Registration and licensing of fishers are common in the commercial sector, and are now being implemented by BFAR. The USAID-funded Philippine Environmental Governance project also established such schemes. UPMSI has similarly recommended registration and licensing schemes at coastal management project sites in Northern Luzon. In most cases, the revenues thus generated partly fund enforcement activities by the coast guard teams that monitor local MPAs or guard municipal waters against fishing violations.

Trust Funds

The largest endowment trust fund established for conservation purposes is the Foundation for the Philippine Environment, which was funded by a debt-for-nature swap in 1992. Since then, trust funds have been used by Puerto Princesa Subterranean River National Park and Tubbataha Reefs National Park.

Public–Private Partnerships

The objectives of these partnerships are varied. They range from unilateral articulation of corporate social responsibility imperatives to articulation of ecological values by nonprofit conservation-oriented groups and profit-driven organizations. Two such partnerships have been formed in the Verde Island Passage. The first of these is the Batangas Bay Coastal Resources Management Foundation, the membership of which includes industrial enterprises in Batangas Bay. Similarly, First Gen (a power-generation company) and Conservation International Philippines formed First Philippine Conservation. This entity is the primary implementing agency for conservation work at Verde Island Passage. Formed in El Nido, Palawan, the El Nido Foundation is a partnership of the tourism industry, local community residents, and LGUs.

Payment for Ecosystem Services

Payment for ecosystem services (PES) schemes assign a monetary value to ecosystem stewardship services. Such schemes are attractive in that they (i) generate new financing, (ii) are sustainable, and (iii) are efficient.

While PES schemes have been successfully implemented in several contexts in the Philippines, including watershed management, none that relates to management of coastal and marine resources have been implemented. While strictly not a PES scheme, an attempt was made at establishing a wastewater pollution permit system at Verde Island Passage that approximates a PES scheme. However, this attempt was not successful due to the (i) lack of wastewater management infrastructure on the part of the municipalities concerned, and (ii) sheer volume of domestic pollution the area generates. In the fisheries sector, it may be possible to establish a tradable quota system that would allow individuals to trade rights to harvest fish of a particular size, though such schemes may not be feasible in light of the multispecies character of the country's fisheries. Similarly, PES schemes may be feasible in the ecotourism sector, given some means of establishing the tenure of residents of the coastal communities concerned. Finally, PES schemes may well be a viable means of maintaining the ecological integrity of the Philippines mangrove forests.

Government Budgetary Allocations for Coastal Resource Management

The traditional source of funding for management of coastal resources has been allocations from local or national government budgets. Some LGUs—particularly those that have received assistance from donor agencies—have set aside funds for financing enforcement and other management activities on an ongoing basis. Overall, by 2003, government budgetary allocations had increased by nearly 200% over their 1999 level of P122,000. The annual budgetary allocation of Mindanao LGUs averages P750,000, while such units in the Visayas average P250,000.

In the absence of alternative sources of revenue, some LGUs have proposed inclusion of coastal waters in the total area over which they have jurisdiction in an attempt to increase the size of their budgetary allocations. In other cases, such as those at FISH Project sites, accessing the special activity funds of LGU budgets has proven successful. Similarly, MPA networks have been formed in areas where MPAs have been established and coastal resource management regimes have been institutionalized, as in the case of Surigao del Sur and Zamboanga del Sur (Mindanao). MPA networks are sustained by annual contributions of member municipalities and enforcement efforts are coordinated. This allows scale economies in enforcement to be reaped, thus reducing average unit costs. Taxes, penalties, and fines have also been used as sources of financing for conservation-related activities.

Public Awareness

In addition to capacity building initiatives, PAWB presents workshops and seminars that raise public awareness of the importance of sustainable management of marine resources. PAWB's information, education, and communication strategy includes three components:

(i) advocacy,
(ii) social mobilization, and
(iii) public information and communication for purposes of behavior modification.

Advocacy-related initiatives provide support to biodiversity-related organizations, such as the National Ecotourism Congress. Similarly, PAWB's social mobilization strategy targets societal groups including students and local constituents. Such activities take the form of celebrations such as *Dalaw-Turo,* a nontraditional, informal, and participatory event that raises student awareness of the need for biodiversity conservation and sustainable development. Events such as World Wetlands Day and the International Day for Biological Diversity showcase the work of wetlands management and conservation-oriented organizations.

Public information and communication platforms that seek to modify public behavior as it relates to the environment include materials, such as posters, coffee table books, brochures, flyers, primers, calendars, bookmarks, button pins, and stickers.

Appendix 1

Table A1 Number of Coral Species (Per Family Level) Identified in the Philippines

Family	Number of species	Locality	Source
Acroporidae	157	Oriental Mindoro: Puerto Galera; Palawan: Calamian Islands, Malampaya Sound, Malotamban, Tuluran Island; Bohol: Talibon; Cebu: Liloan, Mactan Island, Sumilon Island Pinamungajan, Tuyan, Naga; Samar: Guiuan; Pangasinan: Hundred Islands	Nemenzo 1967, Nemenzo 1971, Veron and Hodgson 1989, Veron 2000, Veron and Fenner 2000, Licuanan and Capili 2004, WY Licuanan and R van Woesik (pers. obs. – Lian, Batangas); MW Vergara (pers. obs. – Bolinao, Pangasinan)
Agariciidae	31	Zamboanga del Norte: Dapitan City; Palawan: KIG; Oriental Mindoro: Puerto Galera; Bohol: Talibon	Veron and Hodgson 1989, Veron and Fenner 2000, Licuanan and Alino 2009
Astrocoeniidae	5		Veron and Hodgson 1989, Veron and Fenner 2000
Dendrophylliidae	13	Cebu: Mactan Island	Nemenzo 1982, Veron and Hodgson 1989, Veron and Fenner 2000
Euphylliidae	13	Pangasinan: Bolinao; Palawan: Calamian Islands; Bohol: Caubian Island; Negros Oriental: Bais City	Veron and Hodgson 1989, Veron 2000, Veron and Fenner 2000
Faviidae	80	Surigao del Sur: Arangasa Islet; Palawan: Calamian Islands, Puerto Princesa Bay; Oriental Mindoro: Puerto Galera; Cebu: Pinamungajan	Nemenzo 1959, Hodgson v1985, Veron and Hodgson 1989, Veron 2000, Veron and Fenner 2000, Veron 2002, Licuanan and Capili 2003
Fungiidae	53	Iloilo: Guimaras Island; Cebu: Pinamungajan	Veron and Hodgson 1989, Veron and Fenner 2000, Licuanan and Capili 2004, Hoeksema unpublished
Helioporidae	1		Veron and Fenner 2000
Merulinidae	9		Veron and Hodgson 1989, Licuanan and Capili 2003
Milleporidae	4		Veron and Fenner 2000
Mussidae	23	Palawan: Calamian Islands; Pangasinan: Bolinao	Veron and Hodgson 1989, Veron 2000, Veron and Fenner 2000

continued on next page

Table A1 *continued*

Family	Number of species	Locality	Source
Oculinidae	5		Veron and Hodgson 1989, Veron and Fenner 2000
Pectiniidae	21	Palawan: Calamian Islands; Cebu: Mactan Island; Oriental Mindoro: Puerto Galera; Negros Occidental: San Carlos City	Veron and Hodgson 1989, Veron 2000, Veron and Fenner 2000
Pocilloporidae	14		Veron and Hodgson 1989, Veron and Fenner 2000, Licuanan and Capili 2004
Poritidae	48	Iloilo: Guimaras Island; Quezon Province: Padre Burgos; Cebu: Pinamungajan, Sumilon Island; Oriental Mindoro: Puerto Galera	Veron and Hodgson 1989, Veron and Fenner 2000, Licuanan and Capili 2003
Siderastreidae	14		Veron and Hodgson 1989, Veron and Fenner 2000
Stylasteridae	2		Veron and Fenner 2000
Trachyphylliidae	1		Veron and Hodgson 1989
Tubiporidae	1		Veron and Fenner 2000

Source: CoenoMap–Virtual Museum page, http://coenomap.philreefs.org/index.php?option=com_content&view=article&id=154& Itemid=68; Coral Laboratory, Marine Science Institute, University of the Philippines (UPMSI), Diliman, Quezon City, c/o Dr. Wilfredo Licuanan)

Appendix 2

Table A2 **Preliminary Estimates of Seagrass Beds in the Philippines**[14]

Region	Province	Location	Area (km^2)
I	Pangasinan	Cape Bolinao	25
II	Cagayan	Cape Engaño/Escarpada Point	9
II	Cagayan	Fuga	3
II	Isabela	Divilacan/Palanan Bay	5
IV	Marinduque	Calancan Bay	7
IV	Oriental Mindoro	Puerto Galera	9
IV	Palawan	Bacuit Bay	11
IV	Palawan	Bugsul Island	12
IV	Palawan	Malampaya Sound	21
IV	Palawan	Puerto Princesa/Honda Bay	43
IV	Palawan	Ulugan Bay	11
IV	Quezon	Calauag Bay	9
IV	Quezon	Polilio Island	13
IV	Quezon	Ragay Gulf	14
V	Sorsogon	Sorsogon Bay	17
VI	Negros Occidental	Bais Bay	9
VII	Bohol	Northern Bohol	19
VII	Negros Oriental	Apo Island	7
VIII	Samar	Catbalogan Area	11
X	Camiguin	Mantigue	9
X	Misamis Occidental	Baliangao	7
X	Misamis Occidental	Lopez Jaena	16
X	Misamis Oriental	Naawan	9
XI	Davao	Samal Island	17
XI	Davao Oriental	Mati	17
XIII	Surigao del Norte	Dinagat Sound	12

Source: PNSC 2004.

[14] Based on combined satellite images and ground truth surveys.

Appendix 3

Table A3 **Major Coastal Wetlands in the Philippines**

Name	Location	Features
Apo Reef	Sablayan, Occidental Mindoro Province	• Largest coral atoll in the Philippines • Deep channel, fine white sand bottom, numerous mounds and patches of corals
Balabac Group of Islands	Balabac, Palawan	• Threatened marine animals include *Eretmochelys imbricata* and *Crocodylus porosus* • Proclaimed as a marine reserve / tourist zone in 1978 but not officially protected under NIPAS
Balayan Bay	Batangas Province	• Diverse range of coastal ecosystems which include seagrass beds, fringing reef, and extensive mudflats
Buguey Wetlands	Buguey, Cagayan Province	• Brackish lagoon, freshwater marshes, mangroves, and intertidal mudflats • Important area for migratory waterfowl, especially ducks and shorebirds
Cabulao Bay	Tagbilaran, Bohol Province	• Less disturbed coastal areas in Bohol consisting of shallow waters with mangroves, rivers, estuaries and mudflats, and offshore islands • Endangered *Crocodylus porosus* is found in this bay
Caramoan Peninsula	Lagonoy, Presentacion, and Garchitorena (all in Camarines Sur)	• Mangrove forests, sand dunes, caves, limestone formations, white sandy beaches, an islet lake and subterranean river • Few records of restricted-range and threatened birds • *Dugong dugong* sightings in past years
El Nido Managed Resource Protected Area	El Nido, Palawan	• Popular nature spot with diverse coastal ecosystems composed of extensive intertidal sandflats and mudflats, mangrove forests, seagrass beds, and coral reefs • With marine mammals include *Tursiops truncates* and *Neophoecana phocaenoides*
Inabanga Coast	Inabanga, Bohol	• Large mangrove areas in Bohol • Wintering area for the rare Asiatic Dowitcher *(Limnodromus semipalmatus)*
Malampaya Sound	Taytay, Palawan	• Large areas of undisturbed mangrove forest in the Philippines • An important fishing ground
Mactan, Kalawisan, and Cansaga Bay	Mandaue City, Lapu-Lapu, Cebu City, Consolacion (all in Cebu)	• Shallow bays and channels, extensive intertidal flats, mangrove swamps, fish and seaweed ponds and salt pans, and coral reefs • Important staging areas for shorebirds in the Visayas • Important offshore fishery and seaweed culture
Manila Bay	Cavite City and Balanga, Bataan	• Vital to subsistence fishing for communities around Metro Manila • Most important wetland in socioeconomic terms • Threatened by massive pollution via domestic and industrial wastes, and overexploitation of its resources

continued on next page

Table A3 *continued*

Name	Location	Features
Olango Island	Lapu-lapu, Cebu City	• Important staging areas for migratory birds/shorebirds (Chinese Egrets, Eastern Curlews, Plovers, and Sandpipers) • Important site for the rare Asiatic Dowitcher *(Limnodromus semipalmatus)* • Has mangrove, offshore coral reefs, and extensive coralline sandflats and seagrass beds
Panguil Bay	Provinces of Misamis Occidental and Lanao del Norte	• Extensive mangrove areas, which serve as habitat for migratory shorebirds, Chinese Pond Heron *(Ardeola bacchus)* and Little Egret *(Egretta garzetta)*
Polillo Islands	Bordeos, Polillo, Panukulan, and Patnanungan (all in Quezon)	• With relatively good beach forest • Wetlands and marshes are feeding grounds for more than 25 species of migrant shorebirds
Puerto Galera	Abra de Ilog, Puerto Galera, San Teodoro, and Santa Cruz (all in Mindoro Oriental)	• Beach forests and mangroves • Ancestral domain claim issued to Iraya Manggang tribe • Marine animals sighted include *Globiocephala* • *macrorhynchus* and *Lepidochelys olivacea*
Ragay Gulf	San Narciso, Buenavista, Guinayangan, and Tagkawayan (Quezon); Del Gallego and Ragay (Camarines Sur)	• Protected gulf with estuary in the northern part, largely intact areas of mangroves with intertidal mudflats and some coral reefs offshore • Important for migratory herons and shorebirds, such as Chinese egret and Great egret
Siargao Island	Islands off eastern coast of Surigao City Surigao del Norte	• Extensive mangrove forests, which provide ecological service to large human populations
Talabong Island and Bais Bay	Dumaguete City, Negros Oriental	• Mangrove island with extensive mudflats that support many invertebrates and fishes • Feeding area of many ducks, herons, and egrets
Tayabas Bay (including Pagbilao Bay)	General Luna and Pagbilao, Quezon Province	• Vast mangrove areas and extensive intertidal mudflats • Staging and wintering area for migratory herons, egrets, and shorebirds
Tawi-Tawi, Simunul, Manuk Manka, Sibutu, Tumindao	Bongao, Languyan, Simunul, Sitangkai (all in Tawi-Tawi)	• With rich offshore reefs • Nesting area for Green Sea Turtle *(Chelonia mydas),* • Hawkesbill Turtle *(Eretmochelys imbricata),* and Leatherback Turtle *(Dermochelys coriacea)* • *Dugong dugon* are occasionally sighted
Tubbataha Reefs Marine Natural Park	Palawan Province	• 33,200-hectare reef complex • More than 300 coral species and 379 fish species are present • Sea turtles, sharks, tuna, dolphins, and jackfish are also found in the reefs • Declared as a world heritage site by UNESCO in 1993
Turtle Islands	Southwestern tip of the Philippines, between Philippines and Malaysia	• Protected since 1996 and is a major nesting site of the endangered green sea turtle (*Chelonia mydas*) • Various vegetative cover • Supports diverse species of fish and other marine invertebrates of very high commercial value
Ulugan Bay	Palawan Province	• Large old-growth-mangrove areas

Source: Davies et al. (1990), DENR-PAWB (1992).

Appendix 4

Table A4 **Number of Marine Protected Species under Each Order in the Philippines with Protection and Conservation Status**

Kingdom	Phylum	Class	Order	Number of species listed under IUCN			Number of species listed under CITES	
				VU	EN	CR	Appendix 1	Appendix 2
Animalia	Chordata	Actinopterygii	Atheriniformes	1				
			Clupeiformes	1				
			Ophidiiformes	1				
			Perciformes	10	1	1		
			Pleuronectiformes	1				
			Syngnathiformes	5				(All Hippocampus species)
		Aves	Anseriformes	1				
			Charadriiformes	2	1	2		
			Ciconiiformes	1				
			Pelecaniformes			1		
		Chondrichthyes	Carcharhiniformes	3	3			
			Pristi Formes			4	3	1
			Lamniformes	6				2
			Orectolobiformes	3				1
			Rajiformes	7		2		
			Squauformes	2				
		Mammalia	Carnivora	1				
			Cetartiodactyla	2	2		5	16
			Sirenia	1			1	
		Reptilia	Testudines	1	2	2	5	
	Cnidaria	Anthozoa	Heuoporacea	1				
		Anthozoa	Scleractinia	176	10			
		Hydrozoa	Milleporina	1				
Plantae	Mollusca	Bivalvia	Veneroida	2				7
	Tracheophyta	Magnouopsida	Malvales		1			
		Magnouopsida	Lamiales	1				
		Uliopsida	Hydrocharitales	1				
Total				231	20	12	14	>30

Source: CITES (2011), IUCN Red List (2011)

References

Alava, M.N. and J.A.B. Cantos. 2004. Marine Protected Species in the Philippines. In Department of Agriculture-Bureau of Fisheries and Aquatic Resources (DA-BFAR), *Turbulent Seas: The Status of Philippine Marine Fisheries.* Cebu City: Coastal Resource Management Project, Philippines.

Alcala, A.C. 1998. Community-Based Coastal Resource Management in the Philippines: A Case Study. *Ocean & Coastal Management*. 38. pp. 179–186.

Aliño P., C. Nañola, W. Campos, V. Hilomen, A. Uychiaoco, and S. Mamauag. 2004. Philippine Coral Reef Fisheries: Diversity in Adversity. In Department of Agriculture-Bureau of Fisheries and Aquatic Resources, In *Turbulent Seas: The Status of Philippine Marine Fisheries*. Cebu City: Coastal Resource Management Project.

Allen, G., R. Steene, P. Humann, and N. DeLoach. 2003. *Reef Fish Identification—Tropical Pacific.* Florida: New World Publications.

Allen G. and M. V. Erdmann. 2009. *Reef Fishes of El Nido, Palawan.* Palawan, Philippines: El Nido Foundation.

Allen, G. 2011. *Reef Fishes of Calamianes Islands, Philippines*.

Arceo, H.O., P.M. Aliño, and R.O.M. Gonzales. 2008. Where Are We Now with Marine Protected Areas? In *Reefs through Time 2008: Initiating the State of the Coasts Reports*. Quezon City: Coral Reef Information Network of the Philippines (PhilReefs), MPA Support Network, Marine Environment & Resources Foundation, Inc. and the Marine Science Institute, University of the Philippines.

Armada, N.B. 2004. State of the Demersal Fisheries. In Department of Agriculture-Bureau of Fisheries and Aquatic Resources (DA-BFAR). *Turbulent Seas: The Status of Philippine Marine Fisheries.* Cebu City: Coastal Resource Management Project, Philippines.

Armada, N., A.T. White, and P. Christie. 2009. Managing Fisheries Resources in Danajon Bank, Bohol, Philippines: An Ecosystem-Based Approach. *Coastal Management*. 37(3–4). pp. 308–330.

Asian Development Bank (ADB). 2011. *Comprehensive Action Plans of the Sulu-Sulawesi Marine Ecoregion: A Priority Seascape of the Coral Triangle Initiative.* Manila.

Atkinson S., N. Esters, G. Farmer, K. Lawrence, and F. McGilvray. 2011. *The Seascapes Guidebook: How to Select, Develop and Implement Seascapes*. Arlington, Virginia: Conservation International.

Ayling, B.F., J. Chappell, M.T. McCulloch, M.K. Gagan, and M. Elliot. 2006. High-Resolution Paleoclimate of the MIS 11 Interglacial (426-360 ka) Using Geochemical Proxies in Giant Tridacna Clams. *Geochimica et Cosmochimica Acta*. 70(18). p. A26.

Azanza, R.V., Y. Fukuyob, L.G. Yapa, and H. Takayama. 2005. *Prorocentrum minimum* Bloom and Its Possible Link to a Massive Fish Kill in Bolinao, Pangasinan, Northern Philippines. *Harmful Algae* 4(3). pp. 519–524.

Barut, N.C., M.D. Mijares, R. Subade, N.B. Armada, and L.R. Garces. 2003. Philippine Coastal Fisheries Situation. In G. Silvestre, L. Garces, I. Stobutzki, M. Ahmed, R.A. Valmonte Santos, C. Luna, L. Lachica-Alino, P. Munro, V. Christensen, and D. Pauly, eds. *Assessment, Management and Future Directions for Coastal Fisheries in Asian Countries.* Worldfish Center Conference Proceedings. Penang, Malaysia. 67. pp. 885–914.

Barut N.C., M.D. Santos, and L.R. Garces. 1997. Overview of Philippine Marine Fisheries. In G. Silvestre and D. Pauly, eds. *Status and Management of Tropical Coastal Fisheries in Asia: ICLARM Conference Proceedings*. 53: pp. 62–71.

Bell, J.D., P.C. Rothlisberg, J.L. Munro, N.R. Loneragan, W.J. Nash, R.D. Ward, and N.L. Andrew. 2005. Restocking and Stock Enhancement of Marine Invertebrate Fisheries. *Advances in Marine Biology*. 49: p. 16.

Bleakley, C. and S. Wells. 1995. East Asian Seas. In G. Kelleher, C. Bleakley, and S. Wells, eds. *A Global Representative System of Marine Protected Areas.* 3. Washington, DC: World Bank.

British Petroleum (BP). n.d. BP Statistical Energy Survey. http://www.bp.com/en/global/corporate/products-and-services.html

Brown, W.W. and A.F. Fischer. 1998. Philippine Mangrove Swamps. *Bull. Bur. For. Philipp. Is.* 22: 9–125.

Bryant, D., L. Burke, J. McManus, and M. Spalding. 1998. *Reefs at Risk. A Map-based Indicator of Threats to the World's Coral Reefs.* Washington, DC: World Resources Institute.

Bureau of Fisheries and Aquatic Resources (BFAR). 2009. *Philippine Fisheries Profile*. Quezon City: Fisheries Policy and Economics Division, BFAR, Department of Agriculture, Philippines.

______. 2010. *Philippines Fisheries Statistics.* Quezon City: Fisheries Policy and Economics Division, BFAR, Department of Agriculture, Philippines.

Bureau of Fisheries and Aquatic Resources–National Fisheries Research and Development Institute (BFAR-NFRDI) and Protected Areas and Wildlife Bureau (PAWB). 2005. *Biodiversity Indicators for National Use (BINU): Philippine Report on Coastal and Marine Ecosystems*. Quezon City: BFAR and Department of Environment and Natural Resources.

Bureau of Fisheries and Aquatic Resources (BFAR)–PHILMINAQ. 2007. *Managing Aquaculture and Its Impacts: A Guidebook for Local Governments.* Quezon City: BFAR-PHILMINAQ Project.

Bureau of Agricultural Statistics (BAS). 2010. Agricultural Statistics www.bas.gov.ph

______. 2011. Agricultural Statistics www.bas.gov.ph

Burke, L., E. Selig and M. Spalding. 2002. *Reefs at Risk in Southeast Asia*. Washington, DC: World Resources Institute.

Burke, L., K. Reytar, M. Spalding, and A. Perry A. 2011. *Reefs at Risk Revisited*. Washington, DC: World Resources Institute.

Carpenter, K.E. 1977. Philippine Coral Reef Fisheries Resources. *Philipp. J. Fish.* 15. pp. 95–126.

Castro, J.R., L.A. D'Agnes, and C.A. Aquino. 2004. Mainstreaming Reproductive Health and Integrated Coastal Management in Local Governance: The Philippine Experience. Paper prepared for the Coastal Zone Asia-Pacific (CZAP) Conference, Cebu, Philippines.

Center for Rural Empowerment and the Environment (CREE). 2009*. Babuyan Islands Humpback Whales Project.* http://www.conservationforpeople.org/projects.cfm?projectID=3

Centurioni, L.R., P.P. Niiler, and D.K. Lee. 2004. *Journal of Physical Oceanography.* 34. pp. 113–121.

Cesar, H. 2000*.* Collected Essays on the Economics of Coral Reefs. Kalmar, Sweden. CORDIO.

Chavanne, C., P. Flament, R. Lumpkin, B. Dousset, and A. Bentamy. 2002. "Scatterometer Observations of Wind Variations Induced by Oceanic Islands: Implications for Wind-Driven Ocean Circulation. *Atmospheric Research*. 28. 466–474.

Coastal Resource Management Project (CRMP). 2001. *Coastal Management Orientation and Review*. Philippine Coastal Management Guidebook, Series No, 1. Cebu City: CRMP.

Colchester, M. and M.F. Ferrari. 2007. Making FPIC–Free, Prior and Informed Consent—Work: Challenges and Prospects for Indigenous Peoples. Forest Peoples Programme, Moreton-in-Marsh, Gloucestershire, England.

Conservation International (CI)–Philippines. 2009. Priority Sites for Conservation, Key Biodiversity Areas of the Philippines. CI-MKBA Report. CI-Philippines, Quezon City, Philippines.

Coral Reef Information Network of the Philippines (PhilReefs). 2003. *Philippine Coral Reefs through Time: Workshop Proceedings Second of the Atlas of Philippine Coral Reefs Series.* Coral Reef Information Network (PhilReefs), University of the Philippines Marine Science Institute, Quezon City, Philippines and the Marine Parks Center, Tokyo, Japan.

______. 2005. *Reefs Through Time: 2004 Biennial Report on the Status of Philippine Coral Reefs.* Quezon City: Coral Reef Information Network of the Philippines (PhilReefs) and the Marine Science Institute, University of the Philippines, Diliman.

______. 2008. *Reefs Through Time 2008: Initiating the State of the Coasts Reports.* Quezon City: Coral Reef Information Network of the Philippines (PhilReefs); MPA Support Network; Marine Environment & Resources Foundation, Inc.; and the Marine Science Institute, University of the Philippines, Diliman.

______. 2010. *State of the Coasts: Promoting the State of the Coast Reporting.* Quezon City: Coral Reef Information Network of the Philippines (PhilReefs); MPA Support Network; Marine Environment & Resource Foundation, Inc.; and the Marine Science Institute, University of the Philippines, Diliman.

Crabtree, A. and P. Douglas. 2007. *Coastal/Marine Tourism Trends in the Coral Triangle and Strategies for Sustainable Development Interventions.* https://www.pdffiller.com/en/project/17560396.htm?form_id=213022

Dalzell, P., P. Corpuz, R. Ganaden, and D. Pauly. 1987. Estimation of Maximum Sustainable Yield and Maximum Economic Rent from the Philippine Small Pelagic Fisheries. *BFAR Technical Paper Series* Vol. X (3). Quezon City: Bureau of Fisheries and Aquatic Resources, and International Center for Living Aquatic Resources Management, Manila, Philippines.

Datar, Francisco A. 2008. *The Batanes Islands. National Commission for Culture and the Arts.* http:// www.ncca.gov.ph/ about_cultarts/comarticles. php?artcl_Id=226

David, L.T. 2011. Two-Way Coupled Atmosphere—Ocean Modelling of the PhilEx Intensive Observational Periods. *Oceanography*. 24(1). pp. 48–57.

______. 2012. n.d. Climate Topologies in the Philippines. Final Report. RESILIENT SEAS Program. UP-MSI and DOST-PCAARD. Unpublished.

Dela Paz, R. and N. Aragones. 1985. Mangrove Fishes of Pagbilao (Quezon Province, Luzon Island), with Notes on their Abundance and Seasonality. *Natural and Applied Science Bulletin.* 37(2). pp. 171–190.

Department of Agriculture–Bureau of Fisheries and Aquatic Resources (DA-BFAR). 2007. *Philippine Report on the Workshop on Assessing the Relative Importance of Sea Turtle Mortality Due to Fisheries in Southeast Asia*. 19–23 March 2007, Bangkok, Thailand. SEAFDEC and FAO.

Department of Environment and Natural Resources (DENR). 2004. ArcDev: *A Framework for Sustainable Philippine Archipelagic Development.* Revaluing our Maritime Heritage and Affirming the Unity of Land and Sea. Revised Draft. Quezon City: DENR. pp. 3-1–3-67.

Department of Environment and Natural Resources and Protected Areas and Wildlife Bureau (DENR-PAWB). 2009. *National Plan of Action for the Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security*. Quezon City.

______. 2011. *National Plan of Action for the Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security.* Quezon City.

______. 2009. *National State of the Brown Environment Report (2005–2007).* Quezon City: Environmental Management Bureau, Department of Environment and Natural Resources.

Dizon, E.R. Geronimo, E. Miclat. 2011. Benchmarking of Marine Protected Areas in the Philippines: Understanding the Level of Management Effectiveness of MPAs. Presented during the National Conference on Marine Sciences, Tagaytay City, 19–22 October 2011.

DOST–PCAMRD. 2010. Report No. 2229. PCMARD Book Series No. 33. Coastal Resources Center, University of Rhode Island, U.S. and Philippine Council for Aquatic and Marine Research and Development, Philippines. http://www.crc.uri.edu/download/VIS_004F.PDF

Ebue, A. 2011. MPA Networks through Fisher Federations within Municipal Waters: The Masinloc Experience. Presented at the National Marine Protected Area Network Forum at the Marine Science Institute, University of the Philippines, Diliman, Quezon City.

Faylona, M.G.P.G., C.E. Lazareth, A.M. Sémah, S. Caquineau, H. Boucher, and W.P. Ronquillo. 2011. Preliminary Study on the Preservation of Giant Clam (Tridacnidae) Shells from the Balobok Rockshelter Archaeological Site, South Philippines. *Geoarchaeology*. 26. pp. 888–901. doi: 10.1002/gea.20377.

Ferdouse, F. 2004. World Markets and Trade Flows of Sea Cucumber/Beche-de-Mer. In A. Lovatelli, C. Conand, S. Purcell, S. Uthicke, J-F. Hamel, and A. Mercier, eds. Advances in Sea Cucumber Aquaculture and Management. *FAO Fisheries Technical Paper* No. 463. pp. 101–118. Rome.

Ferrari, Maurizio Farhan and Dave de Vera. 2004. A Choice for Indigenous Communities in the Philippines. *Human Rights Dialogue*. 2.11 (Spring): Environmental Rights.

Flores, Efren. Community-Based Coastal Fishery Management in the Philippines: A Review of Small Islands Coral Reef Fishery Management. 1994. In Iwao Ushijima and Cynthia N. Zayas. *Fishers of the Visayas* (Visayas Maritime Anthropological Studies I). Quezon City: University of the Philippines College of Social Sciences and Philosophy.

Food and Agriculture Organization of the United Nations (FAO). 2008. http://www.fao.org/fishery/countrysector/FI-CP_PH/en

Fortes, M.D. 1995. Seagrasses of East Asia: Environmental and Management Perspectives. *RCU/EAS Technical Report Series* No. 6. United Nations Environment Programme. http://www.wwf.org

Fortes, M.D. and K.F. Santos. 2004. Seagrass Ecosystem of the Philippines: Status, Problems and Management Directions. In DA-BFAR. *Turbulent Seas: The Status of Philippine Marine Fisheries*. Cebu City: Coastal Resource Management Project, Philippines.

Gomez, E.D., P.M. Aliño, W.R.Y. Licuanan, and H.T. Yap. 1994. A Review of the Status of Philippine Reefs. *Marine Pollution Bulletin.* 29(1–3). pp. 62– 68.

Gomez, E.D. and S.S. Mingoa-Licuanan. 2006. Achievements and Lessons Learned in Restocking Giant Clams in the Philippines. *Fisheries Research.* 80. pp. 46–52.

Gordon, A.L., J. Sprintall, and A. Ffield. 2011. Regional Oceanography of the Philippine Archipelago. *Oceanography.* 24(1). pp. 14–27.

Guanco, M.R., S.V. Mesa, P.B. Belga, and D.R.M. Nunal. 2009. Assessment of the Commercial Fisheries of Western and Central Visayan Sea. *BFAR-NFRDI Technical Paper Series.* 12(1). pp. 1–44.

Guest, J.R., R.M. Dizon, A.J. Edwards, C. Franco, and E.D. Gomez. 2011. How Quickly Do Fragments of Coral "Self-Attach" after Transplantation? *Restoration Ecology*. 19. pp. 234–242. doi: 10.1111/j.1526-100X.2009.00562.x.

Han, W., B. Zhang, H.G. Arango, E. Curchitser, E. Di Lorenzo, A.L. Gordon, and J. Lin. 2009.

Seasonal Surface Ocean Circulation and Dynamics in the Philippine Archipelago Region during 2004–2008. *Dynamics of Atmospheres and Oceans.* 47. pp. 114–137.

Hazel, J.M., L. Lebata-Ramos, K. Okuzawa, R.J. Maliao, J.B.R. Abrogueña, M.D.N. Dimzon, and E.F.C. Doyola-Solis. 2009. Growth and Survival of Hatchery-Bred Giant Clams (Tridacna gigas) in An Ocean Nursery in Sagay Marine Reserve, Philippines. *Aquaculture International*. 18: 19–33.

Hermes, Rudolf. 2004. Marine Protected Areas: Urgent Call for an Offshore Marine Sanctuary under Republic Act 8550 in DA-BFAR (Department of Agriculture-Bureau of Fisheries and Aquatic Resources). In *Turbulent Seas: The Status of Philippine Marine Fisheries*. Cebu City: Coastal Resource Management Project of the Department of Environment and Natural Resources.

Herre, A.W.C.T. 1953. Check List of Philippine Fishes*. Res. Rep. U.S. Fish Wild. Serv.* (20). p. 977.

Hüttche, C.M., A.T. White, and M.M.M. Flores. 2002. *Sustainable Coastal Tourism Handbook for the Philippines*. Cebu City: Bureau of Fisheries and Aquatic Resources, Coastal Resource Management Project.

International Union for Conservation of Nature (IUCN). n. d. *IUCN Red List of Threatened Species* 2004. http://www.iucnredlist.org/ ______. 2011. http://www.iucnredlist.org/ *International Union for Conservation of Nature*-World Commission on Protected Areas (IUCN-WCPA). 2008. *Towards Networks of Marine Protected Areas. The MPA Plan of Action for IUCN's World Commission on Protected Areas*. Gland, Switzerland: IUCN-WCPA.

Jacinto, G.S., P.M. Aliño, L. Talaue-McManus, and E.D Gomez. 2000. The Philippines. In C.R.C. Sheppard, ed. *Seas at the Millennium: An Environmental Evaluation*. Vol. II Regional Chapters: The Indian Ocean to the Pacific. Pergamon Press of Elsevier Science.

Junio, M.A.R., L.A.B. Menez, C.L. Villanoy, and E.D. Gomez. 1989. Status of Giant Clam Resources in the Philippines. *Journal of Molluscan Studies*. 55. pp. 41–40.

Laffoley, D. d'A., ed. 2008. *Towards Networks of Marine Protected Areas. The MPA Plan of Action for IUCN's World Commission on Protected Areas.* Gland, Switzerland: IUCN WCPA.

Lane. 2004. Global Status of Coral Reefs, Coral Reef Monitoring and Management in Southeast Asia. In C. Wilkinson, ed. *Status of Coral Reefs of the World: 2004. Vol. 1*. Townsville: Australian Institute of Marine Science.

Licuanan, W. and E. Gomez. 2002. Philippine Coral Reefs: Status and the Role of the Academe to Improve their Management. *Proceedings of the 9th International Coral Reef Symposium*. 2. pp. 835–840.

Maboloc, E.A. and S.S. Mingoa-Licuanan. 2011. Feeding Aggregation of *Spratelloides delicatulus* on Giant Clams' Gametes. *Coral Reefs*. 30(1). p. 167. doi 10.1007/s00338-010-0703-5.

Magdaraog, G.L. 1998. *Environment and Natural Resources: Atlas of the Philippines*. Diliman, Quezon City: Environment Center of the Philippines Foundation.

Magos, Alicia P. 1994. The Concept of Mari-it in Panaynon Maritime World View. In Iwao Ushijima and Cynthia N. Zayas, *Fishers of the Visayas* (*Visayas Maritime Anthropological Studies I*). Quezon City: University of the Philippines College of Social Sciences and Philosophy.

Mamauag, S. 2004. The Live Reef Food Fish Trade in the Philippines. In Department of Agriculture–Bureau of Fisheries and Aquatic Resources (DA-BFAR). *Turbulent Seas: The Status of Philippine Marine Fisheries.* Cebu City: Coastal Resource Management Project of the Department of Environment and Natural Resources.

Mamauag, S., P. Aliňo, R. Gonzales, and M. Deocadez. 2009. Patterns of Demersal Fish Distribution Derived from Line Fishing Experiment in Calauag Bay, Philippines. *Philippine Agricultural Scientist*. 92(4). pp. 370–387. MARINA. http://www.marina.gov.ph

May, P.W., J.D. Doyle, J.D. Pullen, and L.T. David. 2011. Two-Way Coupled Atmosphere—Ocean Modelling of the PhilEx Intensive Observational Periods. *Oceanography.* 24(1). pp. 48–57.

Marine Environment and Resources Foundation, Inc. (MERF). 2009. Philippine Marine Protected Area (MPA) Gap Analysis. MERF, Marine Science Institute, University of the Philippines, Diliman, Quezon City. Unpublished.

Metzger, E.J. and H.E. Hurlburt. 1996. *Journal of Geophysical Research.* 101. pp. 12331–12352.

______. 2001. *Journal of Physical Oceanography*. 31. pp. 1712–1732.

McAllister, D.E. 1988. Environmental, Economic and Social Costs of Coral Reef Destruction in the Philippines. *Galaxea.* 7. pp. 161–178.

McGlone, M.L.S.D., G. Jacinto, I. Velasquez, and D. Padayao. 2004. Status of Water Quality in Philippine Coastal and Marine Waters. In *Turbulent Seas: The Status of Philippine Marine Fisheries.* Cebu City: Bureau of Fisheries and Aquatic Resources, Coastal Resource Management Project.

Mingoa-Licuanan, S.S. and E.D. Gomez. 2007. Giant Clam Hatchery, Ocean Nursery and Stock Enhancement. *SEAFDEC Aquaculture Extension Manual #37*. Quezon City: University of the Philippines–Marine Science Institute; Bureau of Agricultural Research; and Aquaculture Department, Southeast Asian Fisheries Development Center.

______. 2009a. Recruitment of the Giant Clam *Tridacna gigas* in the Philippines. Poster presented at the 10th National Symposium in Marine Science, 22–24 October 2009, Davao City.

______. 2009b. Bleaching in the Giant Clam *Tridacna gigas*. Poster presented at the 10th National Symposium in Marine Science, 22–24 October 2009. Davao City.

MPA Support Network (MSN). 2012. MPA Interoperability Workshop. 21–22 March 2012. Quezon City: Marine Science Institute, University of the Philippines. Unpublished.

Nañola, C.L., P.M. Aliño, A.L. Dantis, M.C.G. Rañola, V.V. Hilomen, and J.B.P. Cabansag. 2002. Understanding Philippine Reef Fishes: A Key to Fisheries Management and Marine Biodiversity Conservation. In P.M. Aliño, E.F.B. Miclat, C.L. Nañola, H.A.R. Quiaoit, and R.T. Campos, eds. *Atlas of Philippine Coral Reefs.* Manila: Goodwill Bookstore.

Nañola, C., A. Alcala, P. Alino, et al. 2004. Status of Coral Reefs in the Philippines. In *Status of Coral Reefs in the East Asian Seas Region*. Global Coral Reef Monitoring Network. Tokyo: Ministry of the Environment, Government of Japan.

Nañola, C., L. Aliño, M. Porfirio, and K.E. Carpenter. 2010. Exploitation-Related Reef Fish Species Richness Depletion in the Epicenter of Marine Biodiversity. *Environmental Biology of Fishes*. 90(4). pp. 405–420. doi:10.1007/s10641-010-9750-6.

National Statistical and Coordination Board (NSCB). 1999. *Philippine Statistical Yearbook*. Manila: NSCB, Philippines.

______. 2011. *Philippine Statistical Yearbook*. Manila: NSCB, Philippines.

Netherlands Organization for International Cooperation in Higher Education/Indigenous Knowledge (NUFFIC/IK-Unit) (1) and United Nations Educational, Scientific and Cultural Organization. Management of Social Transformations Programme (MOST). Database of Best Practices on Indigenous Knowledge. http://www.unesco.org/most/bpindi.htm

Nitani, H. 1972. Beginning of the Kuroshio. In H. Stommel and K. Yoshida, eds. *Kuroshio: Its Physical Aspects*. Tokyo: University of Tokyo Press.

Olano, V.L., M.B. Vergara, and F.L. Gonzales. 2009a. Assessment of the Fisheries of Sorsogon Bay (Region 5). *BFAR NFRDI Technical Paper Series.* 12(4). pp. 1–33.

______. 2009b. Assessment of the Fisheries of Lagonoy Gulf (Region 5). *BFAR NFRDI Technical Paper Series.* 12(5). pp. 1–31.

Ong, P.S., L.E. Afuang and R.G. Rosell-Ambal, eds. 2002. Philippine Biodiversity Conservation Priorities: A Second Iteration of the National Biodiversity Strategy and Action Plan. Department of Environment and Natural Resources–Protected Areas and Wildlife Bureau, Conservation International Philippines, Biodiversity Conservation Program-University of the Philippines Center for Integrative and Development Studies, and Foundation for the Philippine Environment, Quezon City, Philippines.

Padilla, J.E. 2009. Part II. Analysis of Coastal & Marine Resources. A Contribution to the Philippine Country Environmental Analysis. In N.C. Lasmarias, Z.M. Sumalde, and E.E. Tongson, eds. *Readings in the Economics of Climate Change & Natural Resources Management*. Quezon City: Resources, Environment & Economics Center for Studies, Inc. (REECS).

Padilla, J.E. and F. de Guzman. 1994. Fishery Resources Accounting in the Philippines: Application to the Small Pelagic Fisheries. Environmental and Natural Resources Accounting Project–Phase 2. Environmental and Natural Resources Accounting Project, Quezon City.

Palawan Council for Sustainable Development (PCSD) Report. 2008a. Live Reef Fish for Food: Live Reef Fish Food Industry. Puerto Princesa, Palawan, Philippines.

Palawan Council for Sustainable Development (PCSD) Report. 2008b. Coral Reef Health and Extent as Estimators of Maximum Sustainable Yield for the Live Reef Fish Food Industry, Palawan Province, Philippines. Puerto Princesa, Palawan, Philippines.

Panga, F. 2011. Working the Network: Gauging the Effectiveness of MPA Networks. Paper submitted to Marine Science 280: Management of Marine Resources. Marine Science Institute, University of the Philipippines, Diliman, Quezon City.

Population Reference Bureau. 2011. 2011 World Population Data Sheet. http://www.prb.org/Publications/Datasheets/2011/world-population-data-sheet/data-sheet.aspx

Protected Areas and Wildlife Bureau–Pawikan Conservation Project (PAWB-PCP). 2007. Number of Complete Nests and Egg Production per Year at BIMTS 1994–2007 as Part of the 4th National Report to the Convention on Biological Diversity: Assessing Progress Towards the 2010 Biodiversity Project 2009. PAWB-PCP, Philippines.

______. 2009. Complete Nests and Egg Production of Olive Ridley in Bataan and Zambales (August 2004–February 2009) as Part of the 4th National Report to the Convention on Biological Diversity: Assessing Progress Towards the 2010 Biodiversity Project 2009. PAWB-PCP, Philippines.

PHILMINAQ. 2007. *Managing Aquaculture and Its Impacts: A Guidebook for Local Governments*. Diliman, Quezon City: Bureau of Fisheries and Aquatic Resources (BFAR)–PHILMINAQ Project.

Philippine National Science Society (PNSC). 2004. *Seagrasses of the Philippines: Country Report.* UNEP/GEF SCS Project: Reversing Environmental Degradation Trends in the South China Sea and Gulf of Thailand. Manila.

Polidoro, B.A., K.E. Carpenter, L. Collins, N.C. Duke, A.M. Ellison, et al. 2010. The Loss of Species: Mangrove Extinction Risk and Geographic Areas of Global Concern. *PLoS ONE*. 5(4). pp. e10095. doi:10.1371/journal.pone.0010095.

Primavera, J.H. 2000. Integrated Mangroveaquaculture Systems in Asia. *Integrated Coastal Zone Management.* Autumn: pp. 121–130.

Primavera, J.H., R.N. Rollon, and M.S. Samson. 2011. The Pressing Challenges of Mangrove Rehabilitation: Pond Reversion and Coastal Protection. In E. Wolanski and D.S. McLusky, eds. *Treatise on Estuarine and Coastal Science*. Vol. 10. Waltham: Academic Press.

Pullen, J., J.D. Doyle, P. May, C. Chavanne, P. Flament, and R.A. Arnone. 2008. Monsoon Surges Trigger Oceanic Eddy Formation and Propagation in the Lee of the Philippine Islands. *Geophysical Research Letters*. 35: L07604. doi: 10.1029/2007GL033109.

Pullen, J.D., A.L. Gordon, J. Sprintall, C.M. Lee, M.H. Alford, J.D. Doyle, and P.W. May. 2011. Atmospheric and Oceanic Processes in the Vicinity of an Island Strait. *Oceanography*. 24(1). pp. 112–121.

Qiu B. and R. Lukas. 1996. Seasonal and Interannual Variability of the North Equatorial Current, the Mindanao Current and the Kuroshio along the Pacific Western Boundary. *Journal of Geophysical Research*. 101. pp. 12315–12330.

Qu, T. and R. Lukas. 2003. The Bifurcation of the North Equatorial Current in the Pacific. *Journal of Physical Oceanography.* 33(1). pp. 5–18.

Ramos, M.H., M.B. Candelario, E.M. Mendoza, and F. Lavapie-Gonzales. 2009. The Honda Bay Fisheries: An assessment. *BFAR-NFRDI Technical Paper Series.* 12(2). pp. 1–45.

Remote Sensing Information for Living Environments and Nationwide Tools for Sentinel Ecosystems in our Archipelagic Seas (RESILIENT SEAS). 2010. RESILIENT SEAS National Workshop held in November 2010 at the Waterfront Hotel, Cebu City, Philippines.

______. 2011. Project Report (final). Taguig City: Marine Science Institute, University of the Philippines; Philippine Council for Agriculture; Aquatic and Natural Resource Research and Development; and Department of Science and Technology.

Rowthorn, Chris. 2003. Philippines. Lonely Planet. http://books.google.com/ books?id=3XUy3b UTNQsC&pg=PA203&dq=Ivatan+in+Batanes&sig=nc_B11_ BqneELDUhNfK6y3StgUA.

Samson, M.S. and R.N. Rollon. 2008. Growth Performance of Planted Mangroves in the Philippines: Revisiting Forest Management Strategies. *Ambio.* 37: 234–240.

______. 2011. Mangrove Revegetation Potentials of Brackish-Water Pond Areas in the Philippines. In *Aquaculture and the Environment—A Shared Destiny.*

Sampang, Arlene G. 2005. Ethnoichthyology and Conservation Practices of the Calamian Tagbanwa in Coron Island, Palawan, Philippines. Graduate thesis, University of the Philippines Los Baños.

Scott, D.A., ed. 1993. Wetland Inventories and Assessment of Wetland Loss: A Global Overview. *IWRB Special Publication 26.* Proceedings of the IWRB Symposium in St. Petersburg, Florida, November 1992.

Short, F.T., R.G. Coles, E.K., Koch, and M. Fortes. 2004. Western Pacific Seagrass Monitoring Program: Year 3 Report. A Program Report of SeagrassNet.

Silvestre, G.T. and D. Pauly. 1987. Estimate of Yield and Economic Rent from Philippine Demersal Stocks (1946–1984) Using Vessel Horsepower as an Index of Fishing Effort. *University of the Philippines Visayas Fish. J.* 3 (1–2). pp. 11–24.

Spalding, M., M. Taylor, C. Ravilious, F. Short, and E. Green. 2003. The Distribution and Status of Seagrasses. In *World Atlas of Seagrasses*. UNEP-WCMC. http://www.unep.org/publications/search/pub_details_s.asp?ID=3694

Spalding, M., M. Kainuma, and L. Collins. 2010. *World Atlas of Mangroves*. United Kingdom: Earthscan Publication.

The Netherlands Organization for International Cooperation in Higher Education/Indigenous Knowledge (NUFFIC-IK Unit) and UNESCO–Management of Social Transformation Programme (MOST). 1999. *Best Practices on Indigenous Knowledge*. This database is part of the MOST database of Best Practices. http://www.nuffic.nl/ikpages/

The Netherlands Organization for International Cooperation in Higher Education/Indigenous Knowledge NUFFIC (IK Unit) and UNESCO–Management of Social Transformation Programme MOST.

______. 2002. *Best Practices Using Indigenous Knowledge*. This database is part of the MOST database of Best Practices. http://www.nuffic.nl/ik-pages/

Toole, J., R. Millard, Z. Wang, and S. Pu. 1990. Observations of the Pacific North Equatorial Current Bifurcation at the Philippine Coast. *Journal of Physical Oceanography.* 20. pp. 307–318.

Tri-National Committee for Sulu-Sulawesi Marine Ecoregion (SSME). 2009. Action Plan for the Sulu-Sulawesi Marine Ecoregion (Vol. 1: Threatened, Charismatic and Migratory Species; Vol. 2: Marine Protected Areas and Networks; and Vol. 3: Sustainable Fisheries). Manila, Philippines.

Tun, K., L.M. Chou, A. Cabanban, V.S. Tuan, Philreefs, T. Yeemin, Suharsono, K. Sour, and D. Lane. 2004. Global Status of Coral Reefs, Coral Reef Monitoring and Management in Southeast Asia. In Wilkinson, ed. *Status of Coral Reefs of the World: 2004*. Vol. 1. Townsville, Queensland, Australia: Australian Institute of Marine Science.

United Nations Environmental Programme (UNEP). 2004. Mangroves in the South China Sea. *UNEP/GEF/SCS Technical Publication No. 1*.

Villanoy, C.L., O.C. Cabrera, A. Yñiguez, M. Camoying, A. de Guzman, L.T. David, and P. Flament. 2011. Monsoon-Driven Coastal Upwelling Off Zamboanga Peninsula, Philippines. *Oceanography.* 24(1). pp. 156–165.

Wang, B., R. Wu, and K.M. Lau. 2001. Interannual Variability of the Asian Summer Monsoon: Contrasts between the Indian and the Western North Pacific–East Asian Monsoons. *Journal of Climate*. 14. pp. 4073–4090.

Wang, G., D. Chen, and J. Su. 2008. Winter Eddy Genesis in the Eastern South China Sea due to Orographic Wind Jets. *Journal of Physical Oceanography.* 38. pp. 726–732.

Weeks, R., G.R. Russ, A.C. Alcala, and A.T. White. 2010. Effectiveness of Marine Protected Areas in the Philippines for Biodiversity Conservation. *Conservation Biology: The Journal of the Society for Conservation Biology.* 24 (2). pp. 531–40. doi:10.1111/j.1523-1739.2009.01340.x.

White, A.T. and R.O. De Leon. 2004. Mangrove Resource Decline in the Philippines: Government and Community Look for New Solutions. In *Turbulent Seas: The Status of Philippine Marine Fisheries.* Cebu City: Bureau of Fisheries and Aquatic Resources, Coastal Resource Management Project.

White, A.T., C.M, Hüttche, and M.M. Flores. 2002. *Sustainable Coastal Tourism Handbook for the Philippines*. Cebu City: Coastal Resource Management Project of the Department of Environment and Natural Resources, and the Department of Tourism, Philippines.

World Bank Group. 2003. *Water Quality. Philippines Environment Monitor*. Washington, DC.

WWF-Philippines. 2008. Pulling the Plug on Poaching: WWF Ensures that Vietnamese Intruders Get their Due. *Biota Filipina*. July–September.

Zamora, P.M. 1990. Philippine Mangroves: Their Depletion, Conversion and Decreasing Productivity. *Wallaceana.*

State of the Coral Triangle: Philippines

Located at the apex of the Coral Triangle, the Philippines is an integral part of this global center of marine biodiversity. Unfortunately, climate change and human activities have taken a heavy toll on the country's coral reefs, mangrove forests, and endangered species, threatening the food security of its growing population. In response, the Philippines has embraced the goals of the Coral Triangle Initiative, adopting actions toward sustainable growth. This report describes the status of these actions and provides baseline data and information, which policy makers and project implementation agencies can use in monitoring the country's progress in achieving sustainable development of these vital resources.

About the Asian Development Bank

ADB's vision is an Asia and Pacific region free of poverty. Its mission is to help its developing member countries reduce poverty and improve the quality of life of their people. Despite the region's many successes, it remains home to approximately two-thirds of the world's poor: 1.6 billion people who live on less than $2 a day, with 733 million struggling on less than $1.25 a day. ADB is committed to reducing poverty through inclusive economic growth, environmentally sustainable growth, and regional integration.

Based in Manila, ADB is owned by 67 members, including 48 from the region. Its main instruments for helping its developing member countries are policy dialogue, loans, equity investments, guarantees, grants, and technical assistance.

Asian Development Bank
6 ADB Avenue, Mandaluyong City
1550 Metro Manila, Philippines
www.adb.org

Printed on recycled paper

Printed in the Philippines